While EGR 101 students produce basic prototypes, EGR 102 students iterate on those prototypes to produce functional prototypes that combine machining skills, electronics, and programming."

- Shankar Ramakrishnan, Former Lecturer and Spring 2017 KEEN Professor

**Case at a glance**

**Integration goals:** Instilling an entrepreneurial mindset by vertically integrating a single design project in two consecutive freshmen engineering design classes

**Materials affected:** Course outline and schedule, lecture content, project handouts and evaluation criteria, and ordering of prototyping materials

**Lessons learned:** Setting up teams and matching teams across two classes requires flexibility in course scheduling.

**Context**

EGR 102 follows EGR 101, the introductory course of the engineering degree project spine. Integration of entrepreneurial mindset (EM) included vertically integrating the courses, in that EGR 102 students now work on the same project that EGR 101 students worked on. Appropriately, because EGR 102 students are introduced to knowledge and skillsets EGR 101 students are not, specifically electrical circuits,
soldering, and programming using a microcontroller board, EGR 102 students are expected to deliver functional prototypes that advance the EGR 101 students’ projects.

The vertical integration of EGR 101 and EGR 102 was the focus of Shankar Ramakrishnan’s Spring 2017 KEEN Professorship (Shankar Ramakrishnan, Micah Lande, and Deana Delp, “Vertical Integration of the Freshman Experience to Instill Entrepreneurial Mindset”). Dr. Ramakrishnan was the coordinator for both courses. In spring of 2017, there were five sections of EGR 102, with most class sections structured so that lectures are followed by design activities. The course teams have not delivered a lecture on EM using the specific term “entrepreneurial mindset,” but they teach its principles of the 3Cs throughout the course and have integrated EM via the KEEN framework into the design tools students use to complete the projects.

EGR 102 has two projects, the first the redesign of the EGR 101 project, then a second instrument project that culminates with a concert of the whole class playing a song on programmed instruments.

Integration details

This integration effort began with the EM workshops for faculty and lecturers that marked the beginning of phase one of FSE’s EM integration initiative, which focused on integrating EM into both core and elective courses up and down ASU’s engineering curriculum. That training began with the School of Biological and Health Systems Engineering (SBHSE) and the Polytechnic School, the latter being home to the EGR 101 and 102 sequence. As the EGR 101 lecturers who were trained on EML did, the EGR 102 lecturers revised course design projects to explicitly address creating value for the customer and to encourage students to discover customer needs through customer or other stakeholder interviews and research.

In EGR 101 and 102, the affected project is titled “Redesign the Future.” Students in both courses engage with the same problem and the same user, but EGR 101 students design using wood or 3D printing (their prototypes have no movement), while EGR 102 students take the solution and automate it. During the ideation stage of the project in EGR 102, students meet with 101 students to discuss their designs and the basic prototypes they created, what they liked and did not like about them, as well as initial design ideas that they explored. Based on these interviews, EGR 102 students create and eventually present improved functional prototypes to the EGR 101 students.

Key to this integration effort was revising the class schedule for the vertical Integration of a single project between two classes, as well as revising and developing new course materials, including project handouts and lectures. Also key was figuring out the logistics of setting up teams and matching teams across two classes.
The milestones below marked this integration effort’s progress:

2016

- **October:** KEEN Professorship mini-grant proposal submitted
- **November:** KEEN Professorship mini-grant awarded
- **December:** Written materials and schedules prepared

2017

- **January:** User-Centered Design Project launched in EGR 101
- **February:** User-Centered Design Project completed by EGR 101
- **March:** User-Centered Design Project launched in EGR 102
- **April:** User-Centered Design Project completed by EGR 101
- **May:** Student Survey implemented
- **June:** Assignments revised for 2017-2018

NOTE: Supporting resources for this case study can be found within its companion KEEN card (link below), which is also where the community can discuss the case and its broader topic.

**Integration outcomes**

The first version of the vertical integration project was implemented in spring 2017 and was considered a success based on both student and instructor feedback. Further implementations are needed to finetune the project based on student feedback. The EM team administered its student mindset survey with these students and further progress in that workstream will help to determine the specific mindset outcomes of this integration effort.

**Future plans**

In addition to continually improving and updating the projects, materials, and processes as needed, and implementing the projects, our primary plan for the future is expanding the vertical integration to include EGR 101 students working with high school students, which will result in three-point vertical integration: High school to EGR 101 and EGR 101 to EGR 102. In this expansion, high school students will come to ASU’s campus to be interviewed by EGR 101 students for a hovercraft that the 101 students will then design and deliver. The high school students will come back to see presentations of the resulting designs and ride the hovercrafts to evaluate whether the designs meet their needs.
We will also continue implementing the survey/reflection assignment. We are not yet sure when we will begin using the term “entrepreneurial mindset.”

**Considerations**

Throughout this integration effort, we had the benefit of receiving feedback from senior faculty and often were collaborating with like-minded faculty. There are, predictably, administrative challenges associated with setting up teams and matching teams across two classes. We found that flexibility in course scheduling is key. We also found it helpful to have help ordering prototyping materials and making other purchases.

Although students’ presentation of their work is treated as an event, with photos taken of and videos created for each team, we have not been able to include these great projects in the *Innovation Showcase* held each semester on the Polytechnic campus, where lack of space and the number of upper-level teams prevents including the exceptionally large number of freshman teams from also presenting.

**KEEN Card**

This case study has a companion card on the KEEN Engineering Unleashed [website](#).

**Related Cases**

**Curriculum**
Foundations 1: EGR 101 and FSE 100

**Engagement**
Starting Strong: E2 Camp
Change Makers: KEEN Professorships
Extraordinary Customer Service: Entrepreneurial Catalysts

**Workshops**
Onboarding 1: EM Workshop for Faculty
Onboarding 2: EM Workshop for Staff
Onboarding 3: EM Workshop for Undergraduate Teaching Assistants

**Life Cycle**
The Impact Meter: Assessing Student Mindset
Institutional Learning: Evaluating the Initiative