

## Intro to Engineering Course Restructured to Promote Retention

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### **Abstract**

To improve student engagement in the major (Mechanical and Aerospace Engineering), participation in complementary extracurricular activities, and overall retention to the discipline, we redesigned our departmental seminar for underclassmen, “Departmental and Professional Orientation”. The course includes an ethics component to satisfy ABET requirements and was being used previously as a “siloeed” catchall for assorted guest lectures. Our new integrated approach organizes the 200-250 students into teams of ten, providing students a new support group for the remaining semesters of their degree, and walks them through projects related to four grand challenges: Food and Water, Security, Healthcare, and Energy and the Environment. In addition to group projects that engage students with the campus community, we encouraged professional development through peer review of resumes, attendance at professional society meetings, and guest speakers from industry and academia. Here, we share example syllabi, projects, and lessons learned from redesigning and implementing our large introductory course.

**Keywords:** Intro to Engineering, Professional Development, Grand Challenges, Retention

### **Introduction and Motivation**

In addition to the college-wide “Introduction to Engineering” course that introduces students to the different majors, our Department of Mechanical and Aerospace Engineering runs a “Departmental and Professional Orientation” course that is required of all students in the major. The course includes a required ethics component to satisfy ABET requirements, and prior to 2016, the course was being used as a siloeed catchall for an amalgam of guest lectures on professional development topics. We felt this course – a graduation requirement for every student in the department – was the perfect opportunity to engage underclassmen in our department in wide ranging, real world applications of Mechanical and Aerospace Engineering while covering the required material. In keeping with the “three dimensions” of becoming an engineer,<sup>1</sup> we strove to support students by (1) defining and modeling accountable disciplinary knowledge (ADK), or the actions that constitute engineering knowledge, (2) helping them to form an identity as an engineer through participation in simple projects, and (3) providing them tools to navigate through engineering education. In particular, we emphasized the broad content areas of Mechanical and Aerospace Engineering; the varied technical, communication, and interpersonal skills that compose ADK; and critical extracurricular activities that could complement their coursework and increase their competitiveness on the job market.

### **Organization of Course**

Our new integrated approach organizes the class into teams of 10 students, which provides a convenient management tool for organizing and assessing the large enrollment. More importantly, the groups provide students an introduction to peers in the major for comradery

2018 ASEE Southeastern Section Conference

throughout the remaining semesters of their degree. With complementary lectures, reading assignments, and quizzes, we guide the group through projects related to four grand challenges in engineering: Food and Water, Security, Healthcare, and Energy and the Environment. Each themed block of the course also covers professional development topics like resume preparation, canons of ethics, and graduate school preparation. Just-in-time pre-reading with short, online credit/no-credit surveys<sup>2</sup> are due before each class meeting, and various individual and group assignments due every few weeks were used to reinforce the breadth of material being covered (Table 1).

Table 1. Example assignments and lecture topics for introductory Mechanical and Aerospace Engineering course

Week	Theme	Just-in-time Assignment	Class Time (50 mins)	Deliverables
1			<ul style="list-style-type: none"> <li>• Intro to course and learning objectives</li> <li>• Introduce grand challenges</li> <li>• Assign CATME survey [3]</li> </ul>	
2		Complete CATME survey, readings on resumes [4] and LinkedIn [5]	Guest speaker: Writing resume, building LinkedIn profile, and creating professional e-Presence	Resume, LinkedIn for peer review
3	Food and Water	Water re-processing article [6]	<ul style="list-style-type: none"> <li>• Intro to teammates, seating chart</li> <li>• Introduce water usage project, include discussion of professional engineering certification and environmental regulations</li> </ul>	
4		Select “My Engineer’s Notebook” entries by American Society of Mechanical Engineers (ASME)	<ul style="list-style-type: none"> <li>• Panel with seniors about their involvement and internships</li> <li>• Introduce professional societies and motivate membership and participation</li> </ul>	Report on Ben Hill Griffin Reservoir due
5	Safety and Security	Students prompted to research to determine a value for Statistical Value of Life	<ul style="list-style-type: none"> <li>• Intro to Security and next Team Project</li> <li>• Canons of ethics based on ASME curriculum</li> </ul>	
6		Article on guest speaker	Guest speaker from local company to motivate next project, e.g. Phalanx in Spring 2017	
7		Electronic ethics quiz used to satisfy ABET requirements	Discussion of diverse career paths in engineering	Safety/Security project due
8	Healthcare	Introduction to MedTech [7] & Informational Interviews [8]	<ul style="list-style-type: none"> <li>• Intro to MAE in healthcare</li> <li>• Graduate school and informational interviews</li> </ul>	
9		CATME peer evaluation due	<ul style="list-style-type: none"> <li>• Intellectual property</li> <li>• Introduce implant project, distribute implants</li> </ul>	
10		<i>none</i>	<ul style="list-style-type: none"> <li>• Regulatory affairs</li> <li>• Class time to work on project</li> </ul>	Implant/patent project due
11	Energy	Article on Waste-to-Energy plant [9]	Intro to Energy in MAE, project assigned	
12		Summary of Informational interview posted for review	Case study on local power plant in the news	Energy project due
13		Debrief on Professional Society meeting attended	<ul style="list-style-type: none"> <li>• Discussion of creativity in engineering</li> <li>• Art+Engineering project assigned</li> </ul>	Art+Engineering due
14		PPT slides for Art+Engineering	Groups present and vote on winner of Art+Engineering assignment	

The “Food and Water” unit introduced students to concepts of fresh water scarcity and energy requirements for water treatment by asking them to consider the university’s football stadium as a reservoir serving the entire city of Gainesville in a group project. Another year, we asked students to consider using a popular lake on campus as a reservoir. To explore “Safety and Security”, students meet with their teams to discuss costs related to implementing design changes relative to the statistical value of life. In “Healthcare”, students receive an orthopedic implant donated by local company Exactech and are asked to identify related patents and follow media reports of a similar device recall. Students assess the carbon footprint of various buildings on campus for “Energy and the Environment”. For the final “Art+Engineering” assignment, we ask students to propose a group project for next semester’s class that brings together art and engineering that must center around one of our four grand challenges. The last class is used for groups to pitch their ideas and collectively vote on a winner.

These simple assignments help reinforce modeling, estimation, data collection, background research, and written communication as important ADK. In addition, students begin to envision themselves as practicing engineers while encountering many human factors of engineering that are often hard to incorporate into early technical courses.

### **Leveraging Campus Resources**

Since the number of students in the course vastly outnumbers our capacity for individualized attention, we leverage a variety of existing campus resources for support. For example, we invite representatives from the Career Resource Center to visit class while we are introducing resume writing, and they summarize their offerings for the students which include free resume editing. We leverage leadership of our student professional societies for this course, inviting them to come to class to serve on panels. In addition to exposure during lecture, students are required to attend at least one professional society meeting or other event during the semester, further reinforcing those resources.

We also engage our recent alumni to support our students for their informational interview assignment. We email all recent alumni (within last five years) explaining the informational interview assignment, and they are asked fill out a survey with their current position and contact info if they are willing to be contacted by underclassman for a 15 minute phone call. We then randomly assign students to “interview” two participating alumni and report on their conversation as a homework assignment.

### **Recommendations and Future Work**

We have been carefully tracking persistence and retention statistics for the department, and after teaching the redesigned course for a few semesters, we will use completion of the redesigned course as a correlation variable to see how we have impacted retention. In the interim, anecdotal evidence suggests students value incorporation of real-world themes and problems into the curriculum, while faculty throughout the department value the inclusion of professional development content that students otherwise do not get through the technical curriculum.

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David W. Hahn, Ph.D., received his BS and PhD in Mechanical Engineering from Louisiana State University in Baton Rouge. Following graduation, he was a National Research Council Research Associate at the FDA where he worked on laser-tissue interactions, and then a member of the technical staff at Sandia National Laboratories. David joined the University of Florida in 1998 and has served as Department Chair of the Department of Mechanical and Aerospace Engineering since June 2011. His research and teaching interests are in the general area of thermal sciences, and he has published over 100 journal papers and book chapters, has 9 US patents, and recently completed the text book *Heat Conduction*, 3rd edition, with M.N. Özışık.