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GIFTS: Introducing a Human-Centered Design Challenge to First-Year Engineering Students

Dr. Matthew Thomas Garnett, Auburn University

Matthew T. Garnett received his B.S. in Chemical Engineering from Auburn University in Spring 2020 and continued his graduate work in Chemical Engineering starting in Fall 2020 pursuing his MS and Ph.D. in Chemical Engineering. Matthew's research focuses on bioinspired hydrogel materials but has a true passion to teach students the fundamental engineering concepts. Matthew began co-teaching Auburn University's Engineering Orientation (ENGR 1100) course to all first-year students in Fall 2023, teaching approximately 1300 students each year. Matthew recently defended his dissertation in February 2025 and plans to pursue a career in academia teaching first-year engineering students starting Fall 2025.

Jessica Bowers, Auburn University

Jessica Bowers serves as the Manager for Career Development Content and Strategy in the Samuel Ginn College of Engineering (SGCOE) at Auburn University. She holds a Master's degree in College Student Personnel from the University of Tennessee, Knoxville. With over a decade of experience providing student academic and career advising support, Jessica joined the SGCOE to support the launch of the college's first Office of Career Development and Corporate Relations (CDCR), charged with providing career development and graduation outcome support for 6,300 undergraduate and graduate engineering students. Today, she leads the CDCR's career education efforts to provide an infrastructure of embedded career development content and outcomes at strategic intervals within the engineering student academic experience. Jessica also serves as an active member of the SGCOE's Engineer Together committee which focuses efforts on the premise, "I belong. You belong. Together, we engineer for a diverse world."

Lucila Marcela Carias Duron, Auburn University

Lucila M. Carias earned her B.S. in Chemical Engineering from Universidad Centroamericana "Jose Simeon Cañas" in El Salvador in 2018. She continued her academic journey with a Master's in Process Engineering from the same university in 2021 and a Master's in Integrated Management Systems from Nebrija University, Spain, in 2020. Lucila has four years of professional experience in the flexible packaging and recycling industry. In Fall 2022, she began pursuing her M.S. and Ph.D. in Polymer and Fiber Engineering at Auburn University, focusing on bio-based polymers. In Fall 2024, she took on the role of teaching assistant for Auburn University's Engineering Orientation (ENGR 1100) course, guiding first-year engineering students. She plans to defend her dissertation in the Fall of 2026 and aims to pursue a career in academia.

Prof. Maria Lujan Auad, Auburn University

Maria Lujan Auad received her B.S. in Chemical Engineering in 1995 and Ph.D. in Materials Sciences in 2000 from the University of Mar del Plata in Argentina. After a postdoctoral position at the California Institute of Technology in the Chemical Engineering Department, she was a research assistant at the University of Southern California in the Department of Chemical Engineering and Materials Sciences. She joined Auburn University as an Assistant Professor in 2006 in the former Polymer and Fiber Engineering Department. She served as an Associate Professor and Interim Department Chair during her tenure in the Department. In 2015, she was appointed Professor in the Department of Chemical Engineering and Director of the Center of Polymer and Advanced Composites (CPAC). In 2017, she was awarded full professor and served as the Charles Gavin Distinguished Professor. In 2020, she was appointed to her current position as the Associate Dean for Graduate Studies and Faculty Development. In Fall 2023, she began co-teaching Auburn University's Engineering Orientation (ENGR 1100) course to all first-year students, teaching approximately 1300 students yearly.

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Motivation

Over the past few years, the Samuel Ginn College of Engineering at Auburn University has been working to restructure the first-year engineering sequence, starting with the Engineering Orientation (ENGR 1100) course. This course meets once a week for 50 minutes and is a required 0-credit Pass (S)/Fail (U) course taken by all incoming first-year engineering and computer science students. Two sections of the course are offered each semester, and there is a maximum enrollment of 410 students per section. Traditionally, this course served as an introduction to college life, campus resources, facilities, academic advising, and engineering departments/programs offered on campus. To better serve students at the beginning of their engineering academic curriculum and cover more fundamental engineering topics, the curriculum was modified to address issues in engineering design, technical communication, problem-solving, engineering ethics, safety, teamwork, sociotechnical engineering problems, and innovation in addition to the topics previously covered. These topics were introduced using lectures, in-class activities, and a semester-long design project. Our goal was to provide students with a memorable and fun course to boost enthusiasm around engineering at the beginning of their academic endeavors. Students were split into teams of six based on their declared engineering majors to build community and inclusion from the beginning of their undergraduate studies. For undeclared students, they were scattered throughout unfilled groups or placed in groups with other undeclared students. Our goal was not only to form a fun working environment in class for students with similar interests but also to help facilitate new friendships and study groups that could last throughout their time in engineering at Auburn University.

The Human-Centered Design Challenge is one in-class team-building activity we used to combine many of the topics above. This activity was designed in collaboration with the instructors of the ENGR 1100 course and members of the Career Development and Corporate Relations (CDCR) office within the Samuel Ginn College of Engineering. Using a scenario familiar to many in the Auburn community, students were tasked with redesigning and assisting a community recently devastated by an EF4 tornado. This activity provides students with a real-world scenario where they must use a people-first, human-centered engineering problem-solving approach to solve a scenario that affects people of all backgrounds [1]. This activity introduces the career readiness competencies required of successful engineers and crucial in engineering design. These competencies are identified by the National Association of Colleges and Employers (NACE) as well as by the ABET engineering program accreditation organization [2-3]. Through this activity, we stress the importance of being a well-rounded engineer and how lacking technical or social competencies can lead to unintentional engineering design failures that exclude critical groups and populations. Examples include products only designed for male specification, such as phones or airbags, soap dispensers that do not sense dark skin, or buildings inaccessible to people with disabilities or limited mobility [4]. The results from this activity will provide an assessment and inform the instructors whether students are learning the fundamental engineering topics offered in the course, as it addresses five-course outcomes.

Objectives

The objectives of this activity are as follows:

1) To enhance student's understanding of the engineering design process and its application.

2) To identify and discuss the importance and impact of engineering activities in terms of ethics and the impact on ethical, health, safety, and environmental issues affecting individuals and society.
3) To describe methods for evaluating team effectiveness and explain the concepts of team building, team dynamics, and functional and dysfunctional team behaviors.
4) To describe and expose students to the impact of engineers' work on society.
5) To describe the responsibilities and rewards of the engineering profession.

Practical Implementation Details

The Human-Centered Design Challenge was implemented in two sections of Engineering Orientation (ENGR 1100). A total of 527 students participated in the activity and worked in teams of six. Information regarding the student enrollment demographics of Auburn University and ENGR 1100 course, as well as information regarding team formation can be found in Appendix # 1-5. The following prompt was given for the challenge.

Prompt: On March 3rd, 2019, an EF4 tornado (166 to 200 mph winds) struck the community of Beauregard in eastern Alabama, approximately 8 miles away from Auburn University. This tornado ultimately claimed the lives of 23 people and injured 97 people. Trees were uprooted and snapped, power lines were downed, clean water access was disrupted, houses, cars, and property were destroyed, and debris was scattered miles away. The following information about Beauregard was reported in the 2020 census.

Table 1. Beauregard 2020 Census Data [5]

Population and People	12,605
Employment	57.9%
Median Household Income	$63,129
Poverty Percentage	12.8%
Education with a Bachelor's Degree or Higher	36.1%
People without Health Care Coverage	10.2%
People above 50 years old	4,339

After this tornado, many people did not have the necessities to survive, like a house to stay in, a car to drive, food and water to drink, power on their property, access to running water, and transportation to seek medical help. Imagine your engineering team is part of the effort to help the people of Beauregard the day after this tragedy by designing a solution to help this needy community. Your solution could involve facilities, transportation, technology, programs, or other considerations. Use your knowledge of the engineering design process to help design your solution. Your team has 20-25 minutes to answer the questions (see Appendix # 6) based on the above scenario. Upload your responses to Canvas under the Human-Centered Design Challenge Assignment. Be prepared to discuss your answers to the questions with the class.

Assessment Methods

Between the two class sections of ENGR 1100 in Fall 2024, 527 students participated in the Human-Centered Design Challenge. Student responses were collected both in teams and individually. Teams of six students answered the ten questions in Appendix # 6. They identified solutions such as implementing emergency housing, building food banks, establishing a temporary water supply, setting up temporary transportation systems to take community members to medical

appointments and work, installing new cell phone towers, materials needed for their design, etc. For the individual responses, the Canvas Learning Management System was used to collect the in-class responses to anonymous surveys about engineering competencies (pre-activity survey) and the effects of implementing a Human-Centered Design Challenge activity in the first-year course concerning critical thinking, engineering design, teamwork, and technical communication (post-activity survey). IRB approval was obtained to collect student's responses. Of the 527 students who participated in the activity, 415 agreed to participate in surveys surrounding the Human-Centered Design Challenge, while 94 declined participation. The pre-activity allowed students to select all competencies that applied to the question: "As a first-year engineering student, what skills or characteristics do you associate as most essential for an engineer?" The competencies are listed in Table 2, and the number of competencies a student can select is not limited. The post-activity anonymous survey used a 5-point Likert Scale and addressed the questions in Table 3.

Table 2. Anonymous Individual Responses to the Pre-Activity Survey about Engineering Competencies: As a first-year engineering student, what skills or characteristics do you associate as most essential for an engineer? [6]

Competency:	Percentage:	Competency:	Percentage:
Career & Self-Development	1.5%	Professionalism	0.7%
Communication	8.8%	Teamwork	6.3%
Critical Thinking & Problem Solving	78.1%	Technology	1.3%
Equity & Inclusion	1.3%	Understanding Sociotechnical Problems	1.8%
Leadership	0.2%		

Table 3. Anonymous Individual Responses to the Post-Activity Survey about Human-Centered Design Challenge

Question:	1: Strongly Disagree	2: Disagree	3: Neutral	4: Agree	5: Strongly Agree
Our team was able to apply the engineering design process into our solution.	2.5%	0.8%	5.2%	38.5%	53.0%
Our team worked great together on this activity.	3.9%	0.3%	9.3%	27.9%	58.6%
Our team made an effort to listen and evaluate all ideas and opinions of our team to determine a solution to the problem.	2.3%	0.4%	3.3%	30.5%	63.5%
All members of our team participated equally in our design solution to the given problem.	2.9%	2.2%	9.0%	33.7%	52.2%
The Human-Centered Design Challenge helped me understand how to implement a people-first, human-centered design approach in crafting a solution to a given problem.	3.9%	1.0%	10.2%	33.7%	51.2%
The Human-Centered Design Challenge required our group to think critically to solve a real-world problem.	3.3%	1.2%	15.5%	36.4%	43.6%
I believe this activity helped me improve my engineering technical communication skills.	3.5%	2.6%	15.6%	35.7%	42.6%

I enjoyed the Human-Centered Design Challenge and would love to participate in similar activities in the future.	4.1%	3.5%	19.3%	32.6%	40.5%

Based on the responses, the Human-Centered Design Challenge introduced first-year students to the essential skills needed in engineering design and to be successful engineers. As the pre-activity survey indicated, students associate critical thinking and problem solving as the vital skill to perform as a successful engineer at 78.1% (Table 2), even with the opportunity to select as many career readiness competencies as desired. This indicates students do not fully grasp the fundamental skills needed to excel as an engineer and which are required for engineering design. However, by participating in the Human-Centered Design Challenge, students enhanced their critical thinking and problem-solving skills by encountering a human-first scenario and enforcing the importance of non-technical competencies (Table 3). Working in teams allowed students to see the importance of collaborative work, design, and leadership in engineering. Specifically, this activity invited students to consider perspectives, including those of populations different from their own, when designing a solution to a problem. Furthermore, this activity prepared students for future careers by promoting ethical decision-making and communication skills.

For grading purposes, if students submitted individual responses to the survey questions on Canvas and their group submitted responses to the activity questions, they received full participation credit towards their grade. Submission of both individual and group assignments were verified by the instructors. The overall responses to the group activity questions were evaluated by the course instructors and members of the CDCR team. Feedback to their responses is uploaded to Canvas, and we discussed the results and solutions during the next class.

Based on feedback from the pilot activity, we are excited to offer this activity again in future iterations of the course. Specifically, we can facilitate the same activity or use other prompts developed by the instructors, CDCR team, or community to fit the Human-Centered Design Challenge theme and format. In the future, we would like to facilitate this activity across multiple class periods or a semester-long project to allow students time for further consideration of the topic as well as more meaningful responses to challenge questions All groups responded to all the scenario questions, but responses were consistent with the rapid challenge format with limited time allotted for team discussion and responses to challenge prompts. This will require slight restructuring in the course schedule and topics covered. Additionally, in the future, student responses to the activity will be examined to see how group responses vary based on engineering disciplines (i.e. Pre-Chemical Engineering students versus Pre-Mechanical Engineering etc). The impacts of the Human-Centered Design Challenge introduced in the Engineering Orientation (ENGR 1100) course will also be assessed using Auburn University's Introduction to Engineering (ENGR 1110) course. This course is usually taken after enrollment in ENGR 1100 and is taught by different instructors at the department level. We propose performing an IRB-approved study to determine the impacts of the activity on students who experienced the Human-Centered Design Challenge in ENGR 1100 compared to students who did not. Specifically, how did exposure to this activity affect how students approached their design activity in ENGR 1110 compared to those who did not engage in this activity? Similarly, we propose a four-year study that assesses how teams approach their senior design capstone projects. Specifically, we want to compare the designs of students who participated in the Human-Centered Design Challenge in ENGR 1100 and those who did not.

References

[1] Faste, R., The Human Challenge in Engineering Design, J. Engng Ed. Vo. 17, Nos. 4 and 5, pp. 327-331, 2001.

[2] "What is Career Readiness?", https://www.naceweb.org/career-readiness/competencies/career-readiness-defined/, accessed 10 December 2024.

[3] "Criteria for Accrediting Engineering Programs, 2024-2025", https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2024-2025/, accessed 10 December 2024.

[4] "Design for Humanity Challenge poses "people-centric" engineering design prompt", https://eng.auburn.edu/news/2023/03/design-for-humanity-challenge, accessed 28 June 2024.

[5] "United States Census Bureau: Beauregard-Marvyn CCS, Lee County, Alabama", https://data.census.gov/profile/Beauregard-Marvyn_CCD,_Lee_County,_Alabama?g=060XX00US0108190243#race-and-ethnicity, accessed 26 June 2024.

[6] Fergus, J. W., & Bowers, J. (2023, June), *GIFTS: Framing Understanding Implicit Bias as a Professional Skill to First-Year Students* Paper presented at 2023 ASEE Annual Conference & Exposition, Baltimore, Maryland. 10.18260/1-2--43796

[7] "Dean's Report: 2023-24 Rankings and Data", https://eng.auburn.edu/deans-report-2024/up-front/rankings-and-data.html, accessed 4 February 2025.

Appendices

Appendix # 1: Information about Auburn University

Auburn University is a land-grant R1 research university located in East-Central Alabama established in 1856, offering more than 150 majors for undergraduate students. Auburn awarded its first engineering degree in 1872 and currently awards approximately 1,450 engineering degrees every year. The Samuel Ginn College of Engineering is the second largest college on campus and has students from all fifty-states and over 60 countries.

Appendix # 2: Auburn University's Samuel Ginn College of Engineering Enrollment data from the 2024 Dean's Report [7]

	Engineering	**University**
Undergraduate Students	5,214	26,874
Graduate Students	1,090	6,141
Total Students	6,304	33,015
Male Students	4,854	16,442
Female Students	1,450	16,573
Underrepresented Students	788	8,254

Appendix # 3: Auburn University's Samuel Ginn College of Engineering Enrollment data by discipline from the 2024 Dean's Report [7]

Program	**Bachelors**	**Masters**	**PhD**
Aerospace Engineering	674	37	48
Biosystems Engineering	179	12	25
Chemical Engineering	444	12	83
Civil and Environmental Engineering	535	60	61
Computer Science and Software Engineering	1,125	92	112
Cybersecurity	0	16	0
Data	0	17	0
Electrical and Computer Engineering	510	35	72
Master of Engineering	0	19	0
Engineering Management	0	87	0
Industrial and Systems Engineering	446	48	71
Materials Engineering	33	6	26
Mechanical Engineering	1,196	53	93
Polymer and Fiber Engineering	0	1	4
Wireless Engineering	13	0	0
Pre-Engineering	59	0	0
Total	**5,214**	**495**	**595**

Appendix # 4: Enrollment data by major for ENGR 1100 in Fall 2024

Major	Number of Students:	Number of Male Students:	Number of Female Students:
Dual Enrollment (DUAL)	3	2	1
Explore your Major (EXPL)	4	2	2
Pre-Aerospace Engineering (PAE)	55	42	13
Pre-Bioprocess–Biosystems Engineering (PBPE)	4	3	1
Pre-Biosystems Engineering (PBSE)	7	5	2
Pre-Chemical Engineering (PCHE)	60	31	29
Pre-Civil Engineering (PCE)	62	34	28
Pre-Computer Engineering (PCMP)	34	20	14
Pre-Computer Science (PCPS)	5	3	2
Pre-Ecological-Biosystems Engineering (PECN)	5	2	3
Pre-Electrical Engineering (PEE)	50	32	18
Pre-Engineering (PN)	20	12	8
Pre-Forest-Biosystems Engineering (PFOE)	2	2	0
Pre-Industrial Engineering (PIE)	38	21	17
Pre-Materials Engineering (PMTL)	6	4	2
Pre-Mechanical Engineering (PME)	147	101	46
Pre-Software Engineering (PSEN)	23	12	11
Pre-Wireless Engineering (PWIR)	2	2	0
Total	**527**	**330**	**197**

Appendix # 5: Formulation of Engineering Design Teams

All students were placed in groups of six at the beginning of the semester for all team activities and projects. The students remained with the same group throughout the duration of the semester. Students were randomly placed in a group by major. If there were not enough students from a major to complete a group of six, those students were mixed with other groups and majors. In formulating the groups, the instructors of the course made sure there were at least two female students in each group. There were 87 groups of six students split between the two sections of ENGR 1100 in Fall 2024. Section 001 had 47 groups and section 002 had 40 groups.

Appendix # 6: Human-Centered Design Challenge Questions

1) What are some possible solutions?
2) How long do you estimate it will take to implement your design in the community?
3) What supplies and costs are needed to implement your design?
4) Do some of these approaches work well for some and not for others?
5) How competent do people need to be to use your design (i.e., do they need to be sufficient to work on specific technology)?
6) How sustainable is this approach for the long term? Consider using materials, costs, and social capital to maintain it.
7) How might you adapt these approaches to address user needs and design constraints?

8) How seamlessly does this approach integrate into the Beauregard community?
9) Is your design a short- or long-term solution for the people of Beauregard?
10) Are there any companies your group could contact to initiate collaboration to help implement your design?