



Forming Engineers for the Common Good

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The American Society for Engineering Education (ASEE) showcases the many effective ways experiential learning (EL) is incorporated into engineering education, including cooperative education (co-ops), project-based and problem-based learning, service learning, capstone design

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courses, internships, and undergraduate research. EL is embraced by engineering schools as a high-impact pedagogy that deepens and generates academic knowledge, develops professional skills, and enhances students' ability to achieve Accreditation Board of Engineering and Technology's (ABET) learning outcomes (Kuh, 2008; Swan, Paterson, & Bielefeldt, 2014). In this chapter, we reflect on a pedagogy of community-based EL, which is becoming popular to develop global citizens who are critical thinkers and can communicate and partner effectively across difference. Community-based EL is commonly used in international community development work and project-based courses, and is frequently incorporated into engineering centers, programs, and student organizations (Ermilio, Clayton, & Kabalan, 2014; Payne & Jesiek, 2018).

Engaging with community is a long-standing institutional tradition strongly influenced by the five characteristics of a Catholic, Marianist education: education for formation in faith; an integral, quality education; education in the family spirit; education for service, justice, and peace; and education for adaptation and change. Our university's Marianist identity also contextualizes how we practice community-based EL through reciprocal forms of engagement and transformational educational experiences. These experiences provide students with a better understanding of human dignity and the desire to pursue human rights (Acosta-Matos, Bohrer, & Sakuda, 2017). The School of Engineering is no exception to the integration of community engagement and EL as part of a University of Dayton (UD) educational experience to advance the common good. One of the most notable examples is the School's Engineers in Technical Humanitarian Opportunities of Service-learning (ETHOS) Center, which has integrated and embraced community-based EL pedagogy for over 18 years (Pinnell, Daniels, Hallinan, & Berkemeier, 2014). Here, we share how we integrate, critique, and advance ETHOS Center work with partners, community-based EL opportunities, and engineering in a global world.

Historically, community-based EL has been termed "service learning" (SL); however, in following suit with critical analyses to de-emphasize transactional activities and the savior mentality that can result from SL, we refer to our programming as community-engaged learning (CEL) and refer to our community-based, semester-long experiences also as immersions. In our context, CEL is distinguished from other forms of EL by its (i) intentional contribution to the common good, (ii) a meaningful "experience" that is driven and co-defined by the community, and (iii) an ongoing collaboration with community partners and members. CEL

includes full participation of students, faculty, and community partners in solving public challenges and leveraging community assets, providing students with authentic experiences that align with both course learning and community objectives. CEL has the added benefit of deepening learning around civic, social justice, and global learning outcomes (Jacoby, 2014).

A REFLECTIVE ACCOUNT OF ETHOS

I am Kelly and I joined the ETHOS Center in 2018 as the School of Engineering's Director of Community Relations. My lens for the work we do has been shaped by many key experiences in my EL vocational journey. I came to EL work through a deep appreciation of the value it brought me as an environmental biology student. EL animated my academic studies and provided the opportunity to discern where my strengths and skills met my passions and the world's greatest needs. Thus, I began my higher education career designing and teaching high-impact EL in the Biology Department. Appreciating a good challenge to grow professionally and personally, I soon joined national scholars advocating for deeper EL opportunities in science education, including inquiry-based learning and CEL (then called service learning).

Upon incorporating CEL into my academic courses and leading an international immersive breakout, I noticed my students' growing depth of critical thinking, ability to apply systems thinking, and heightened sense of social responsibility. About the same time, I participated in a year-long program to study social justice and Catholic Social Teachings (the JustFaith program), which inspired me to further integrate community engagement work into my vocational journey, and interrogate such work in light of social justice theories.

Over the next 10 years, I worked with two key community engagement centers at UD, primarily engaging with local partners using a lens of reciprocity and collective action. My intense desire to continue learning, connect deeper with UD's Marianist tradition in CEL work, and address ways I was potentially perpetuating injustices through university practices led me to facilitating many conversations with scholars, practitioners, and community. We gathered to co-create a set of principles and ethics for community engagement work and to examine what it means to be a primarily middle- to upper-class white institution engaging with communities much different from these privileged identities. I also leveraged the

university's application process for the Carnegie Foundation's Community Engagement Classification to adjust our language around "service" and strive for reciprocity and transparency in community partnerships.

The critical lenses and prophetic voices that Mitchell (2008), Stoecker (2016), and Butin (2006) bring to CEL work continue to inform my practice and inspire me to embrace the tension, rather than running from the work. I continue CEL work because I believe in its potential to promote right relationships (attentive and responsive to the needs of all, without exploitation, oppression or manipulation, doing "with") and shape students' sense of social responsibility and commitment to human rights. I am also inspired by the community members I have worked with, greatly appreciating how they share their passion, dedication to social change, and Dayton community stories with our university community.

Despite my passion for CEL, I was hesitant to engage with *international* service learning (ISL) work. I had experience with forming local CEL practices to avoid paternalism and examine power and privilege, but I was critical of ISL's ability to navigate these. I heard about instances of ISL looking more like neocolonialism, reinforcing the white savior mentality, and objectifying people. Also, I worried about well-intentioned projects going awry (soccer ball nightlight, broken and unused water filtration systems, etc.) and the expense of international trips for students.

Eventually, through attending global-focused conferences and leading a faculty learning community on global-local connections, I was inspired to follow the intense scholarly dialogue regarding challenges and benefits of ISL and global citizenship education (Adler, 2019; Hartman, Kiely, Boettcher, & Friedrichs, 2018, and the *Michigan Journal of Community Service Learning*). I agreed we must provide opportunities for students to understand the context of other places, transnational or local, and the historical, political, and social factors that drive inequality in the world. I was eventually introduced to the Fair Trade Learning framework (Hartman, 2015), which resonated with me for many reasons. The framework addresses the struggle universities have with designing ethical and effective partnerships and practices, an important piece of the work to me. It brings awareness to the lure of host communities being used as learning labs and host cultures being seen as static and exotic, while also decentering the student as the only agent of change. Lastly, the framework addresses the struggle that communities (and local organizations working with those communities) have in CEL work, including keeping

community voice central, having ownership of the project, and preventing mission drift.

When the opportunity presented itself, I was excited to join the ETHOS Center to assist its expansion with Dayton and domestic partnerships for CEL. Also, the ETHOS Center was addressing the challenges of CEL work and deepening its work with a focus on the Fair Trade Learning framework. The ETHOS Center's values, foundational framework, and vision aligned well with my values as an educator and community engagement professional. I appreciate the way the ETHOS Center focuses on "projects" as a part of (not more important than) long-term partnerships and ongoing initiatives, which are initiated and driven by the community. I also appreciate that the center's staff own up to and rectify missteps, are weary of having students work on projects beyond their competence and without community input, and seek honest feedback and ongoing dialogue.

To write this chapter, I am joined by three co-authors, Margie, Malcolm, and Christine, who have been instrumental in the legacy of the center. We have also incorporated the stories, thoughts, and reflections of our diverse stakeholders (partners, students, alumni). Due to the methods we use for surveying and gathering feedback, we have limited documentation of first account narratives from our community partners that we can directly quote in this chapter. However, as we continue to improve our documentation procedures, we look forward to future opportunities to include more of the community voice.

ESTABLISHING ETHOS

The ETHOS Center's humble beginnings start with Christine Vehar Jutte when she was an undergraduate engineering student. Christine was no exception to UD students craving an intimate connection between their academic studies, their future career, and working to advance the common good. Christine describes how ETHOS was created:

Being inspired by Mother Teresa, I felt called to help the poor in India through engineering solutions. To explore this calling, I participated in a campus ministry cultural immersion trip to India in the summer of 2000. I received a fellowship based on the following proposal: to learn how to apply appropriate technology (AT) in India, to work with a rural community to implement an AT project using local resources, and to further

develop the technology in my upcoming senior capstone design course back in the States.

My plan for implementing AT in India did not materialize for many reasons, including my naive assumptions of the required time and communication necessary for effective community engagement. However, the observations I made during that visit were eye opening, making me much more aware of what it takes to develop AT solutions in a culture other than my own. I was also astonished to realize that unfortunate challenges, such as lack of running water within a community, were not purely of a technical nature (meaning lack of resources, design, and labor) but instead, more heavily integrated in political, cultural and economic issues. I quickly realized that engineers need to step back and understand the big picture before helping to address a ‘technical problem.’

India humbled me, but that was good. My newfound humility gave me new understanding and passion – to create opportunities for other engineering students to have similar transformational learning experiences. I shared these reflections with the Chair of the Mechanical and Aerospace Engineering Department, who encouraged me to form a multi-disciplinary team of students and use my upcoming senior capstone design course to create opportunities for other engineering students. To design what is now called “ETHOS immersions,” we used aspects of the engineering design process, including gaining a better understanding of appropriate technology, researching other organizations engaged in international engineering service, and considering best approaches for community engagement. After this process and many consultations with campus and community experts, we identified our main objective as developing an experience built on partnerships grounded in reciprocity in which engineering students would work side-by-side with communities to co-create technical solutions.

FOUNDATIONS AND ELEMENTS FOR SUCCESS

Thanks to the efforts of these engineering students, along with the support they found at UD, the ETHOS student programs reflect the philosophy, theory, and best practices of community/university partnerships and CEL pedagogy (Clayton, Bringle, Senor, Huq, & Morrison, 2010; Jacoby, 2014). Furthermore, students’ desire to align with Marianist values of solidarity and building inclusive communities led the ETHOS Center to be one of the first UD examples of grounding CEL within sustainable and reciprocal community partnerships to address grand challenges. To this day, such attention to sustainable and place-based partnerships is one of our priorities and informs what community challenges we work

on, which students are matched where, and how we prepare and reflect with students.

Very early on the ETHOS Center (then called the ETHOS program) identified a set of core values to guide the center's activities. These core values are deeply rooted in the Marianist character for which our university was founded: (1) appropriate technology—do more with less: make use of local resources without exploitation and co-create sustainable design solutions with the community; (2) cultural sensitivity—respect and appreciate the inherent values of the culture: integrate cultural knowledge into design specifications and develop culturally appropriate design solutions; (3) partnership—develop relationships: live and work within the community, spread hope, and seek to create employment and empowerment; (4) cultural immersion—act in solidarity through community engagement: learn with and from the community; and (5) personal transformation—let the world change you.

A recent reflection from an alumnus demonstrates the integration of these values in ETHOS immersions. We highlight aspects of the reflection that demonstrate the core values listed above:

I chose to do ETHOS immersions because I wanted to work on meaningful projects in collaboration with local partners abroad [partnerships]...ETHOS showed me that I could combine my love for engineering and human rights to solve challenges with others who are different from me [cultural immersion]. If I didn't participate in ETHOS, I guarantee I would not be where I am today (conducting doctoral research in Humanitarian Engineering) [personal transformation]...Professionally, I feel that I am a much better engineer because of my immersions. I learned about designing for end-users in low income communities and to carefully evaluate the context in which a technology will be used [appropriate technology and cultural sensitivity].

As ETHOS evolved from a program to a center, several key undertakings aided the success of our EL programs. During the first several years, the university did not award academic credit for the immersions, and only a graduate assistant coordinated program logistics with volunteer guidance of a faculty member and financial support from a department chair. As the program grew to include close to 30 students immersing internationally per year, and as it began receiving national attention, the administration recognized the ETHOS international immersion program as a mission-aligned, distinguishing program providing transformational

learning experiences for UD engineering students. As a result, the School of Engineering provided ETHOS with financial and personnel resources, enabling the creation of a credit-bearing engineering elective course EGR 330: Engineering Design and Appropriate Technology, development of 10-day ETHOS Breakouts to further support community partners and expand student opportunities, and strengthened collaborations with a variety of campus partners (Student Health Center and Center for International Programs). Lastly, domestic immersions and partnerships were added to the opportunities for students.

More recently, as a result of the School of Engineering's strategic planning process, the ETHOS program was created into a center with a dedicated program facility and expanded staff to include a faculty center director (Malcolm), a program manager, 2 graduate assistants, and a Director of Community Relations (Kelly). With this increased capacity, we have expanded our partnerships to include local community organizations for "Dayton immersions" and are even better equipped to collaborate with our partners in reciprocal ways, including incorporating partner needs and desires into other engineering courses, involving graduate students who can dive deeper into technical challenges, and supporting faculty and student research projects for our partners.

FAIR TRADE LEARNING AND ETHOS CENTER'S PROGRAMS

To assess how we engage locally, domestically, and internationally, we reference recent work by Hartman, Paris, and Blanche-Cohen (2014) on the Fair Trade Learning framework. Their work contextualizes community-based global learning within the critiques of SL and volunteer tourism movements, developing an ethical framework for evaluation and assessment. We offer some reflections on how our EL programs measure up to the aspirational principles and standards within the framework. Each core principle and standard below follows Hartman et al. (2014) terminology.

Dual Purposes

This core principle stresses the importance of developing programs with well-balanced community and student outcomes. Alumna Lori Hanna-McIlvaine's story demonstrates how we balance community outcomes with student learning outcomes.

During the spring semester that Lori was enrolled in the pre-immersion ETHOS course, she also had a co-op experience with a medical device company. Following that semester, Lori's international ETHOS immersion included working on a variety of solar projects with Grupo Fenix, an NGO located in Sabana Grande, Nicaragua. While living in, working with, and learning from the local community, Lori identified many community assets and desires as well as challenges. One noted challenge was the inability to sterilize medical equipment on-site at any time, which was greatly impacting the local community's ability to provide health care for all. Thus, Lori leveraged her work experience at the medical device company to explore an opportunity for device sterilization through the community's asset of solar-powered technology.

Back on campus Lori researched solar sterilizers and found that they exist, but could benefit from design improvements; thus, Lori pursued the design and development of the solar sterilizer for her undergraduate thesis. She integrated various aspects of this research into class projects for two required undergraduate mechanical engineering courses and participated in a second ETHOS immersion with the same community. During her senior year, her senior capstone project team designed and tested the solar sterilizer. Additionally, through partnering with business students and receiving first place in a business plan competition, Lori's team established a small not-for-profit business, which they transferred to the community.

Community Voice and Direction

Another project with Grupo Fenix highlights the role of community voices directing our engagement with the Sabana Grande community in Totogalpa, Nicaragua. Residents of Sabana Grande rely on several hand-pumped water stations throughout the community. Without ready access to clean water, many homes rely on simple latrines for human waste management. The resulting challenges, particularly during the rainy season when many latrines flood, require little description and are broadly recognized throughout the community as a challenge to community and environmental health and well-being.

Using a process modeled after the WASHTech technology assessment and implementation framework, we collaborated with the community on (i) a comprehensive community survey, (ii) multiple community meetings, and (iii) consultations with local government representatives and

funding agencies to explore sustainable solutions. Subsequently, Grupo Fenix developed model latrine designs and established a community-based social enterprise to maintain and fund new latrines across the community. The ETHOS Center continues to advise and support a sustainability assessment plan for this initiative with environmental assessment processes directed by local Grupo Fenix staff. The partnership continues with support for capacity development, for assessment of their developing social enterprise structure, and for the development of a long-term, comprehensive public relations strategy.

Commitment and Sustainability

These last two examples from the Grupo Fenix partnership also speak to the importance we place on commitment and sustainability in our partnerships (Reynolds, 2014) and in encouraging students to continue connecting. From the community partners' perspective, Susan Kinne (2019) writes:

These partnerships [between a village, NGO, and international partners] have created a path out of poverty and dependency for many of the villagers. Just as importantly, not only have many people in the community become more materially secure as a result of these collaborations, but they have become teachers themselves—teachers both to others in the community and to visitors. Indeed, the increased confidence and self-esteem of the community members as a result of these genuinely reciprocal collaborations... is perhaps the best evidence that the changes in the community are enduring and sustainable.

Similarly, our partnership with a Dayton nonprofit, Mission of Mary Cooperative, has evolved from sending students as volunteers or observers to having immersion students working on projects which advance the organization's net-zero energy use goals. Mission of Mary Cooperative often provides feedback to improve our practices and shares their hopes for our sustained partnership work in the future. We now have many engineering students involved with this partner through various projects in engineering courses, all of which are driven by the community partner's desire for net-zero energy use and their work to ensure food security for their neighborhood.

The student-centered aspect of “Commitment and Sustainability” and the standards of “Student Preparation, Connect Context to Coursework and Learning, and Preparation for Healthy Return to Home Communities” advanced by Hartman et al. (2014) advocate for having students participate in facilitated critical reflective practices before, during, and after immersions. This aligns well with EL best practices at UD and helps students engage ethically and effectively, and with our world. We believe critical reflection is key to success. For international immersions, students who participate in EGR 330 reflect on cultural, ethical, and practical considerations for their upcoming immersion. During the immersion, students write a critically reflective photo journal and, upon return, submit both a personally reflective paper and a technical project report. They also engage in a one-day retreat, which facilitates positive reintegration into their home communities and reflective analysis of the structural forces that shape community challenges and engineering solutions in other countries. A recent alumnus reflects, “ETHOS showed me how as engineers we have so many tools and so much knowledge that when combined with human relationships and creativity create a unique and powerful perspective to solve difficult problems.”

Dayton and domestic immersion students participate in a week-long orientation before their immersion, a course *during* their immersion, and attend a post-retreat. The course incorporates similar content to the EGR 330 course and further explores human-centered design, becoming a self-aware engineer, and principles of democracy and community engagement. The Dayton immersion students meet together once a week for this course and incorporate dialogue and transdisciplinary activities, while the domestic students complete modules online, and share project “products” that exemplify course concepts and ETHOS’ values. Both sets of students create an online portfolio for reflection, analysis, and sharing and meet with career services professionals to support continued personal and professional growth. During the post-retreat, students reflect on their vocational journey, as this domestic immersion student reflection demonstrates.

Because of the work I have been doing at my community organization, I have learned skills to help me make a positive change in the future. I have been inspired to pursue either graduate school or a doctorate program in order to learn more about water resources and waste water management. I

have learned so much about a community based, sustainable, waste diversion program and I have also learned a lot about myself and what my future plans are.

While we have found successful ways to deeply engage students in their experience, we recognize the need to more intentionally connect students with resources upon return to continue developing their passion, skills, and intercultural learning.

[Funding] Transparency

We strive to be as transparent as possible about our budget model and expenditures, which includes being upfront about the cost of immersion experiences and connecting regularly with university units responsible for internal fund tracking. The center pays for all Dayton and domestic immersion experiences (room and board), and most of the international students' expenses, so many students may not be fully aware of the budget limitations and immersion expenses. Students receive cash advances for room and board and must track their expenses. The domestic and international partners arrange students' homestays, shopping, and meals; therefore, we are assured that most of the funds (minus flights) are spent locally and sustainably. These practices also reflect aspects of the "Economic Sustainability Principle" and embrace the standard of "Local Sourcing." Because we partner only with organizations who have a long-time presence in and commitment to the local community, project work makes use of locally available resources. This also ensures more program funds are locally and sustainably spent.

Environmental Sustainability and Footprint Reduction

Despite the numerous ways ETHOS international immersions are aligned with Fair Trade Learning core principles, there are aspects of the program that are challenged by some of these principles. For example, we send over 40 students and many faculty and staff annually to international sites for immersions and partnership visits. If we estimate the average carbon cost of an international flight to be about 8500 pounds of carbon dioxide, the total amount of carbon dioxide that the ETHOS international programs are putting into the atmosphere annually is about a half a million pounds. Even though ETHOS partnerships and projects are often

related to environmental sustainability, this makes it clear that our program's environmental costs are significant and prevent us from achieving full sustainability.

Deliberate Diversity, Intercultural Contact, and Reflection

We believe strongly in reflective practice that shapes our own work as well as student learning. While diversity in our programming is typically only realized by engaging our students (most identifying as white and middle to upper class) in global communities and cultures different from their own, we mentor students to make meaning of that intercultural contact throughout our programming. While ETHOS international immersions certainly include deliberate intercultural contact and structured reflective practices about diversity, we fail at having diverse student participants for any of our immersions. Of the over 500 participants since 2001, only a few students have been underrepresented minorities or international students. The exact reasons for the low participation of underrepresented minorities and international students are unclear. Potential contributing factors may include low institutional diversity, competing paid opportunities, cultural differences of the perceived value and inclusiveness of the program, and (for international students) travel restrictions and visa issues.

Global Community Building

Global community building expresses the necessity of striving for reciprocity in partnerships for outcomes of solidarity, equity, and right relationships. Hartman et al. (2014) summarize three orientations of reciprocity based on different meanings of the word reciprocal: exchange, influence, and generativity reciprocity. While most of our partnerships begin with mutually beneficial transactions (exchange reciprocity), many have matured into generativity reciprocity, producing project outcomes that neither partner could achieve without the other.

Further, we strive to build a campus community increasingly informed and engaged in achieving the goals of our community partners. This is modeled in our commitment to leverage our resources, and the talents of our students, faculty, and staff in technical research and technology development to meet direct community needs: whether this is water supply design in Malawi or the development of educational engineering modules

to increase interest in STEM fields. This principle also becomes apparent when we host our global partners on campus to meet their development goals, or when we sustain domestic and Dayton community-driven projects through connecting partners with academic courses, student clubs, and part-time student interns.

*Direct Service, Advocacy, Education, Project Management,
and Organization Building: A Community-Centered Standard*

This standard expresses the importance of students being in capacity-building roles with an on-the-ground organization to learn from and contribute to community-driven projects. Many students and alumni share their appreciation for this program design element, as this student shares,

Being with a small non-profit allowed me to see how community engagement can be achieved on a local and personal level with appropriate feedback from the collaborators working with us. Nearly everybody living locally appreciates and reveres the surrounding ecosystem, so it was encouraging to see people come together to work towards a common goal with passion and perseverance.

Similarly, an international immersion alumnus reflects, “Working with the locals to make it (a water pipeline project) happen taught me the value of respect, empathy, and diverse perspectives in teamwork.”

All of our partners have community expertise and many have field expertise with appropriate technology, sustainable development, or human-centered design. Students feel that the opportunity to engage with such partners has contributed to their professional development. By having students incorporate community voice into designs and co-build non-traditional technologies based on engineering principles, students deepen their understanding of engineering work. A recent alumnus shares, “The program offered an opportunity to gain insights into communities and technologies different than my limited background could.” Such exposure to alternative technologies allows students to recognize the far-reaching effects, positive and negative, of engineering and technology and thus the responsibilities of being an engineer in a global society.

Challenge and Support: A Student-Centered Standard

Although the structure has changed through the years, ETHOS international immersion students are intentionally sent in pairs rather than large groups and stay with host families to better ensure full engagement with, and cultural immersion in, the community. Students immersing with domestic partners are either alone or with one other student and stay with host families or in housing provided by the organization. ETHOS Dayton immersion students are fully immersed in a community-living situation during the summer.

The ETHOS Center holds fast to the structure of homestays internationally for three reasons: (1) to prevent the experience from becoming a UD-insular experience, (2) to increase foreign language skills and international/cultural awareness, and (3) to share financial resources as locally and ethically as possible (Hartman et al., 2018). Here is an example of how a homestay impacted an alumnus:

To be in a place so different than the US for an extended period of time, living and working with people who live and grew up there and have come from a very different culture and upbringing was an eye-opening experience. You begin to realize how interesting, and diverse the world is, yet how similar we all really are, and how easy it was to become close friends with people who were completely different than me.

CONCLUSION

CEL, whether through immersions, breakouts, or course connections, presents a distinctive model of EL that, despite the ever-present challenges which impact successful ethical engagement, has the potential for students' transformative learning and empathy building (Adler, 2019). Additionally, the work encourages sustainable global partnerships to advance human rights and well-being. Being aware of the confounding complexities involved in our work and wanting to better understand the implications of our global engagement on all stakeholders, we have found the aspirational goals of the Fair Trade Learning framework helpful for examining the confluence of community partnerships, EL, and appropriate technology. The framework guides us through the struggle to design and offer critically reflective, affordable, and accessible experiences and

move beyond our tendencies to be transactional-oriented in our partnerships.

As our university mission inspires us to educate students with critical minds and compassionate hearts by providing them community engagement and cross-cultural experiences, we take seriously our commitment to build ethical community-based global learning experiences for engineering students. By offering these opportunities in the ETHOS Center, graduates are arguably more effective and influential engineers by having enhanced cultural appreciation, resilience, and self-confidence; a greater understanding of and commitment to civic responsibility; and an increased awareness of the impact of professional decisions on society and the environment. While the intentional, value-based program design and the support of our university community have influenced CEL success in the ETHOS Center, another critical piece is prioritizing and honoring the desires and assets of our community partners around the world. We aspire to base our community partnerships on right relationships, solidarity, and human dignity, and we will continue a priori focus on these partnerships to ensure ethical CEL. This is our responsibility and a necessity as we continue to form engineers for the common good.

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