Decolonizing Engineering Curriculum to Design an Equitable Society

(Technical Topic)

Framework for Ethics in UVA's SEAS' Engineering Curriculum Using Actor-Network Theory

(STS Topic)

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

After the protests in response to George Floyd and Breonna Taylor's murders, universities, corporations, and leaders were called to be accountable for their role in perpetuating violent racism and the history of white supremacy in the United States. Engineers also responded to these events in the Journal on Engineering Education's October 2020 issue. Here, engineering professors — almost all from marginalized backgrounds— highlight how engineering curriculum and the discipline contribute to upholding white supremacy. The journal focuses on how the influence of the industrial revolution, colonization, and capitalism have centered engineering education curriculum and pedagogy around the white and male perspective (Kelly C., 2020). Western colonizers dehumanized BIPOC communities into areas that were considered 'wastelands' ready for their resources and culture to be stripped away. As prescribed by Traci Voyles in Wastelanding: Legacies of Uranium Mining in Navajo Country, "wastelanding" is "a racial and a spatial signifier that renders an environment and the bodies that inhabit it pollutable." Western colonization of the Americas led to the genocide of nearly 50 million Indigenous people. Here, colonists' "primary motive for [this genocide] was not race (or religion, ethnicity, grade of civilization, etc.) but access to the territory" considered "empty except for Indians" (Voyles, 2015). This ideology formed the framework of the nation, was supported through economic development during the industrial revolution, and is relevant to the engineering curriculum because it formed the motivation and lenses for technological innovation.

Locally, the Black Charlottesville community called the University of Virginia (UVA) to be accountable for the foundational roots connected to racism (Black Community, 2020). These roots come from Tomas Jefferson's design of the university to uphold the segregated southern

society. Further, Jefferson's support of slavery, colonization, and eugenics shaped the social framework at UVA(Kasey J., 2020).

While the School of Engineering and Applied Sciences (SEAS) does advertise a focus on justice and diversity through engineering, the school fails to center equity (UVA Engineering). Centering equity requires social and curricular changes which deemphasize the authority of the dominant male and western perspective. Further, it also fosters an environment where students and professors learn from their unique experiences and expertise. This co-learning breaks generational social differences while creating an environment of accountability and respect for all parties. Theoretically, SEAS tries to address UVA's history of racism in the engineering school's required course STS 1500; however, the curriculum and discussions fail to address the relevance and necessity of understanding how engineers and racism are interconnected. It is also frequently reported by students that the professors are not trained to handle conversations on race and racism, which creates a harmful classroom environment. SEAS must prioritize equity as a core value throughout the engineering school to become an anti-racist program that fosters social and educational inclusive excellence (UVA Division of Diversity, Equity, and Inclusion, 2021).

As a technical solution, STRIVE (Students and Teachers Revolutionizing Inclusivity Values in Engineering), developed a six-year framework to tangibly provide a framework for interventions, programs, and further research on equity in the SEAS curriculum. This plan contains short, mid, and long-term interventions that specifically address the culture of white supremacy at UVA, which furthers the prioritization of western male perspectives in SEAS. After diagraming the components of this socio-technical problem, the Actor Network Theory (ANT) highlighted that western cultural influences and people had the largest influence over the SEAS curriculum. The actor-network theory is the "framework and systematic way to consider

the infrastructure surrounding technological achievements. Assigns agency to both human and non-human actors (e.g. artifacts)" (David L., 2020). The interventions were developed by analyzing the actors of the engineering curriculum that are specific to UVA's historical context and targeted human opinions, reflections, and biases. These interventions are supported on the social side, with the analysis between SEAS and engineering programs explicitly prioritizing equity ANT frameworks.

Technical Topic

Jefferson designed UVA to save white Southern men from having to attend Northern universities that would be "poisoned by the federalist doctrines of the North" (Louis N. and Maurie M., 2019). Here, he wanted to create a school where he could pass on his values of a segregated society as the "Father of the University" to future students (Monticello, 2015). This legacy is also deeply connected to Charlottesville's foundation in Confederate history and legacies of the "Lost Cause". This "Lost Cause" movement "argued for a distinctive Southern culture and for the preservation of the heroism of their cause", which Southern towns quickly accepted because it allowed them to view the Civil War as a "battle lost in the long war to White dominance" (American Battlefield Trust, 2020). This battle has violently continued in Charlottesville as recently as August 11th and 12th in 2017 (Louis N. and Claudrena H., 2018). All of these components create a foundation of inherent support of white supremacy by UVA and SEAS which will continue unless explicitly addressed.

As a technical solution, STRIVE (Students and Teachers Revolutionizing Inclusivity Values in Engineering) is building social momentum to demand accountable structural changes in SEAS through educational and behavioral interventions. STRIVE is an undergraduate initiative working with professors and graduate students to decolonize and deconstruct the

foundation of white supremacy in SEAS. This initiative addresses needs laid out by both the Racial Equity Task Force and Black Charlottesville community while fitting into the inclusive excellence framework. The overarching goal is to fully restructure the core engineering curriculum and student educational experience to ensure engineers' average deficit in historical and social justice topics is accounted for, students are welcomed into classrooms using culturally sustaining pedagogy, and professors are prepared to moderate conversations on race and privilege (Eswaran S., Toluwalogo O., Jeffery T., 2018).

The planning for STRIVE took an extensive literature review, numerous meetings with professors and administrators, and securing funding for the interventions through grants. When creating a mind map, STRIVE identified that the largest components that influenced the core engineering curriculum at UVA were pressures from cultural norms and people. After these connections were found from the socio-technical model, our technical focus turned to design interventions that targeted these components and functioned in the trading zones between engineers and humanities discussions, UVA and the Black Charlottesville community, and SEAS professors and students. Currently, STRIVE has helped design, organize, and run the newly mandatory first-year historical tour and discussion program and is analyzing the impact on first-year engineering students. This successful program has given STRIVE the foundation and support to implement our future intervention.

STRIVE currently has a framework of short (present-1 year), mid (2-4 years), and long (5-6 years) for interventions targeting UVA students' lack of knowledge of the school's history and its relation to trends of racism and white supremacy throughout the country and engineering's culture of perpetuating traditional wastelanding concepts (Voyles, 2015). The short-term programs have been capitalizing on the current momentum of accountability at UVA

(Voices for Equity, 2019). These programs are already under development and given support, so, the focus for analysis will be on the quantitative and qualitative survey and observational data. The mid-term goals currently have grants written for the programs and are waiting for responses. Finally, the long-term goal is hypothesized to come to fruition if these programs and connecting research from professors Juan Garibay, Rosalynn Berne, and Garrick Louis can also have success in their grants. The goals are outlined in Appendix A.

STS Topic

Engineering is still a predominantly white and male profession in the United States (Data USA, 2020)(Shi, 2018). These demographics are influenced by the social and cultural perspectives prioritized in society, some of which were developed and instilled in the foundation of the country and UVA by Thomas Jefferson. Western colonization, as carried out by Thomas Jefferson and settlers during Manifest Destiny, valued the masculine domination of conquest and the economic power gained from extracting resources (Cronon, 1995). Manifest Destiny is the "self-serving belief of white Americans to rationalize the removal of American Indians from their native homelands because the expansion of the United States was divinely ordained, justifiable, and inevitable" (Smithsonian American Art Museum, 2019). This ideology formed false ideas of separation of wilderness and society in engineering, where the wilderness originated in wastelands and was available to extractive practices. Dehumanization was a necessity in this process and has simply transformed during the twentieth and twenty-first centuries into manipulative engineering and technical practices that frequently ignore marginalized communities in the planning and approval processes (Federal Energy Regulatory Committee, 2017).

At UVA, Jefferson's vision on race, gender, and the value of each, impacted and continues to impact the process of diversifying the student body. In 1898, the university expanded on Jefferson's "lack of contemplation for female education" and declared that higher education would "unsex women " (McInnis, M. D., & Nelson, L. P, 2019). This decision coincides with the manifest destiny ideology of masculine domination and was influenced by the university's eugenics research. Here, the university believed that educating white women, the only women at this time considered for coeducation, would lower birth rates and thus allow Black populations to increase in comparison (Preston R., 2017). It is this mentality on both race and gender that continues to impact marginalized students' experiences at UVA because this school was explicitly built in opposition to their identities.

Engineered systems have tremendous impacts on society and individual human lives and the impacts and effects are felt across a broad range of diverse populations. However, as Garrick Louis stated in their National Science Foundation proposal, "engineers are not trained to consider the diverse dimensions and impacts of their work. This has and continues to result in systems that benefit some while harming other members of society." Engineering programs have a responsibility to ensure their graduates are not continuing to perpetuate harm against marginalized communities. In analyzing other movements — most specifically the environmental justice movement— the modern-day unintentional harm that continues is from a lack of emphasis on values-based and ethics-directed missions (Ernst, 2010). This is similar to the engineering curriculum. The lack of this curriculum or focus is from a lack of valuing equality for this extended period. Since the culture and individuals in power did not want equal conditions for men and women and non-white individuals, they did not include this in their frameworks of engineering.

While SEAS's core values do include societal impact and excellence through diversity, these are approached on a superficial level. In reality, the mission statement and values are misaligned. The mission is focusing on disseminating knowledge and solving global challenges but does not specifically state the ethics to which this mission will be followed. This is a misalignment in the vision framework and perpetuates solutions that do not target the root problem. The misalignment here is part of a principal-agent problem that I intend on researching further.

Using the Actor Network Theory, I identified key components — social pressures, implicit biases, cultural influences, historical contexts, communities, stakeholders, and individuals— which impact core engineering requirements. While described as a theory, ANT is actually "a method of problemesation that highlights unseen and tangential connecting points" (Burns, 2017). ANT develops a framework of connections of all actors and influences that highlight how biases and social constructs are connected, formed, and used in engineering while providing areas for solutions with distributive justice and equity in mind (Danielyan & Romanenko, 2021). Designing an equitable engineering curriculum takes a community or localized approach, tailored to each university; however, SEAS can still model restructuring the core engineering requirements off of the general themes of programs that emphasize equity.

ANT's of other universities highlight themes that compare to the findings from UVA's model. These themes serve as the core analysis for interventions and changes at UVA. It must be stated, this work is innovating engineering curriculum and, like any changes or growth, is uncomfortable. Accountability and uncomfortable feelings when addressing these foundational and social injustices at SEAS is a success. This program and research call engineers to reflect on their personal biases, positionality, and privileges, which has not been done on an institutional

level. However, it is these changes and findings from research that support my argument that UVA needs to specifically include ethics-based values in its mission statements to emphasize human impact as a priority and responsibility.

Research question and methods

Throughout the technical and STS research, STRIVE is investigating how the lack of emphasis on values-based and ethics-directed engineering curriculum at UVA has led to the perpetuation of violent colonial wastelanding. Further, in the STS portion, STRIVE is identifying specific opportunities for intervention to prioritize a learning environment based on diversity, respect, inclusion, value, and equity (DRIVE). Quantitative and observational data from each intervention are being collected through surveys and interviews to measure the impacts of each program. Further, in collaboration with Juan Garibay, this data will be processed in the algorithm he designed for his paper on 'STEM Students' Social Agency and Views on Working for Social Change: Are STEM Disciplines Developing Socially and Civically Responsible Students?' Here, Garibay finds engineering students have a deficit in social and civic responsibility, in comparison to other STEM and humanities students. Garibay then analyzes how professors' value of diversity in engineering curriculum impacts this deficit (Garibay, 2015). After meetings with Garibay, the survey and observational data collected by STRIVE fits into this model and can contribute and benefit from this previous analysis to further highlight areas to intensify or reduce specific interventions. These preliminary surveys and analyses on the value of diversity from engineers are the leading data analysis for these interventions. We are using similar survey questions and the same program developed by Garibay.

Conclusion

Since a misalignment of vision and stated values has influenced the lackings in the engineering curriculum, STRIVE has designed multiple interventions and a framework to incrementally change the culture, human knowledge, and curriculum in the engineering school. Through analyzing the successes of engineering programs that explicitly prioritize and include social justice in the core requirements, ANT comparisons will provide targets for the interventions. This analysis through the actor-network theory, as a principal-agent problem, and through trading zones will shape the argument for including specific ethics and values-based language in the mission statement. Combining the long-term framework from STRIVE and analysis of how our mission statement has misdirected the goals of the program will hopefully target cultural and interpersonal changes enough and build enough momentum of support to lead to complete analysis and restructuring of core engineering requirements.

Appendix

Appendix A:

Short (present- 1 year):

I. Inclusion of educational slides throughout the engineering school
    A. This program will provide a database of PowerPoint slides. This database contains three categories: 'Contextualizing UVA's History', 'Designed Racism', and 'Alumni Successes.' Every week each class in the engineering school must discuss one of these slides, connecting the slide to their particular class, technical solution, or potential career path. Looking for implementation within the ESE department during the spring semester to pilot the program.
II. Oral History Exhibit of SEAS Integration and Coeducation
    A. In collaboration with Reflections: Oral History at UVA to be presented in Spring 2022.
    B. Focusing on rebuilding relationships with BIPOC and female alumni and collecting their narratives of their time at SEAS.
III. Collaborating with Professors Keith Williams and Ben Laugelli on developing the new STS1500/ENGR curriculum
IV. Creating introduction slides for all the maintenance and facilities workers throughout SEAS.
    A. Including pictures and bios submitted by each individual who chooses to participate. Slides then included on TVs throughout SEAS. Students will be encouraged to get to know the facilities and maintenance workers. Addressing the history of UVA's segregation, the treatment of the Black Charlottesville community, and a general disregard for the workers providing necessary services for the functioning of the university.
V. Expanding STRIVE numbers to ensure longevity within the engineering program and commitment to these goals.
VI. Designing a website based on trading zones to educate engineers on environmental justice and the Rights of Nature to limit the support of hazardous projects.
    A. Designed in collaboration with SunTribe Solar and the Social Justice in Engineering Workshop and under the guidance of Kimberley Fields and Leidy Klotz (draft published by December)

Mid (2-4 years):

I. Creation of a grant program partnering undergraduates with professors to redesign a course's curriculum with a focus on including diversity, equity, and inclusion throughout the class.
    A. Creating between 6-10 pairs that can take their research and findings into their smaller learning communities (i.e. major departments and classroom discussions), creating an ever-expanding network of impact. Currently collaborating on this program with the Center for Teaching Excellence.
    B. Has the potential to expand with Professor Louis' NSF proposal by having cross UVA and local minority-serving institution partnerships.
II. Create direct pathways for classes to work with the Charlottesville community in outreach projects targeting the requests and needs of the local community.
III. Mandating all professors attend moderator training for discussions concerning race and privilege.

Long: (5-6 years):

I. Complete overhaul of core engineering curriculum ensuring that social justice, human impact, and one's privilege are adequately addressed.
    A. Including culturally sustaining pedagogy throughout every class.
    B. Examining how traditional teaching examples may or may not be connected to White supremacy.
    C. Including classes relating courses technical material and social justice in core major requirements.

Resources

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