Proselytizing Problem-Solving:
The Religious and Secular Values of Engineering for Good

Marie Mella Stettler Kleine

Dissertation submitted to the faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of

Doctor of Philosophy
In
Science and Technology Studies

Matthew H. Wisnioski
Brian M. Britt
Heather D. Curtis
Gary L. Downey
Donna M. Riley

December 16, 2020
Blacksburg, VA

Keywords: STS, engineering, values, humanitarianism, ethnography, secularity

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ABSTRACT

Over the last 20 years, "engineering for good" has grown into a widespread phenomenon premised on the belief that engineers can and should combine technical expertise with the desire to make positive change. In the United States and abroad, many organizations conduct projects that enroll over ten thousand engineering students, faculty, and professionals. These engineers pursue their "doing good" efforts in the context of the history of Christian missions and colonialism, failed development efforts, and often competing individual and institutional values. These individual and institutional values are entangled in religious analogies and engineers' desire to fit into an overwhelmingly "secularized" profession.

Given these nuanced dynamics, what do engineers mean when they say they want to "do good"? In this dissertation, I ask, what is *engineering for good?* Further, how do different individual and institutional values impact what *engineering for good* is and does? To answer these questions, I use three case studies of *engineers for good* being trained in institutions of higher education: Colorado School of Mines (CSM), Baylor University, and University of San Diego (USD)—a public (secular), Baptist, and Catholic university, respectively. I connect the training and practice of *engineers for good* to three larger social, cultural, and political movements—international development, humanitarian service, and social justice. I argue that *engineers for good* navigate complex dimensions of assessing and assigning need as they decide what it means to do their work

well. These new humanitarians do not simply engage in pro bono efforts done for new users that cannot afford their traditional services. They are creating a new type of engineering to address newly recognized forms of need. Those involved in *engineering for good* redefine what engineering can and should be used for by drawing on larger values to pursue their purpose and reconcile this purpose with their professional identity.

I conclude by showing what the formation of the *engineering for good* movement illuminates about good engineering. A close examination of the movement reveals engineers reformulating their relationship to notions of technological and moral progress. I show how differing values impact engineering pedagogy and practice. I argue that these engineers are remaking development, their identities, and the engineering profession itself. These findings are core not only to science and technology studies scholars, but historians, political scientists, religious studies scholars, and practitioners—in academia, the non-profit sector, and government aid work— just trying to "do good."

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GENERAL AUDIENCE ABSTRACT

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Given these nuanced dynamics, what do engineers mean when they say they want to "do good"? In this dissertation, I ask, what is *engineering for good?* Further, how do different individual and institutional values impact what *engineering for good* is and does? To answer these questions, I use three case studies of *engineers for good* being trained in institutions of higher education: Colorado School of Mines (CSM), Baylor University, and University of San Diego (USD)—a public (secular), Baptist, and Catholic university, respectively. I connect the training and practice of *engineers for good* to three larger social, cultural, and political movements—international development, humanitarian service, and social justice. I argue that *engineers for good* navigate complex dimensions of assessing and assigning need as they decide what it means to do their work well. These new humanitarians do not simply engage in pro bono efforts done for new

users that cannot afford their traditional services. They are creating a new type of engineering to address newly recognized forms of need. Those involved in *engineering for good* redefine what engineering can and should be used for by drawing on larger values to pursue their purpose and reconcile this purpose with their professional identity.

Dedication

In loving memory of Dad—who would have been so proud, most of all, because this means I probably won't have time to become a lawyer. Miss you always.

Acknowledgments

A hearty thanks to the engineers and their educators, donors, administrators, and community partners that agreed to participate in my research. I appreciate that it is no small thing to let someone observe you and talk with you, all while trusting them to help tell parts of your stories. Without you, this work doesn't exist.

I have an all-star crew of academic mentors to thank. First and foremost, Matt, your patience and persistence as a major part of my transition from eager engineer to measured critical scholar has changed my life. Gary, thanks for questioning me early on regarding how one might observe "motivation" and pushing me to enmesh myself in an environment all-the-while crafting a new language to describe it—something I will always struggle with, I'm certain. Brian, you understand the kinds of small changes I want to make in engineering better than I can articulate myself. I walk away from our conversations with a revitalized sense of why this work is worth doing. Donna, your courage and tenacity to make change in engineering practice and pedagogy is awe inspiring. And Heather, thanks for your guidance as I traverse unfamiliar disciplinary boundaries and your willingness to explore a new field yourself while providing crucial, probing feedback.

Beyond my committee, Virginia Tech has provided some unbelievable support in both personal and professional growth. Jim Collier, thanks for teaching me early on that engaging in STS *should* mean to constantly question what it means to take part in this beautiful mess. Ashley Shew, thanks for being such a kind and thoughtful early reader of this project's trajectory and helping me to question "doing good" as it relates to not only

my work but my personal life. Ashley Snider and Carol Sue Slusser, thanks for keeping us all afloat.

Special thanks to the Joseph F. Hunkler Memorial Scholarship and the Lake Institute on Faith & Giving at the Indiana University Lilly Family School of Philanthropy's Lake Doctoral Dissertation Fellowship for providing funds in support of this research.

I've also had lots of support from my fellow graduate students. Kristen Koopman, thanks for being such a wonderful neighbor and thoughtful reader. Your ability to weave together conceptual suggestions with practical writing advice made the final push much more endurable. And, to Kari Zacharias, thanks for being my grad student buddy and confidant, without you always being at least one step ahead I'd be lost.

Katie Johnson, my sister, and academic role-model, thank you for (if only a little) making pursuing a PhD make sense to our parents. Your friendship and mentorship mean so much to me.

And Kaleb, you have been so much more supportive than I could have ever expected or asked. I'm so glad that this wild idea made it to the top of our list of adventures, and I'm thrilled we will figure out the next ones together.

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Abbreviations

American Society for Engineering Education—ASEE

American Society of Mechanical Engineers—ASME

Baylor University—BU

Center for Community Service-Learning—CSL

Colorado School of Mines—CSM

Corporate Social Responsibility—CSR

Engineering for Change—E4C

Engineering for a Sustainable World—ESW

Engineering Ministries International—eMi

Engineering to Help—ETH

Engineering, Social Justice, and Peace—ESJP

Engineers With a Mission—EM

Engineers Without Borders-USA—EWB-USA

Faith based organization—FBO

Humanitarian engineering—HE

Institute of Electrical and Electronics Engineers—IEEE

Institutional Review Board—IRB

Justice and Mercy Energy Services—JAMES

Mines Without Borders—MWB

National Science Foundation—NSF

National Society of Professional Engineers—NSPE

Non-governmental organization—NGO

Planning, Monitoring, Evaluation, and Learning—PMEL

Revolutionizing Engineering Departments—RED

Science and Technology Studies—STS

Scientists and Engineers for Social and Political Action—SESPA

Shiley-Marcos School of Engineering—SMSE

Sustainable Development Goals—SDG

University of San Diego—USD

United Nations—UN

Urban Renewable Energy and Agriculture Project—Urban REAP

Volunteers for International Technical Assistance—VITA

Water, Sanitation, and Hygiene—WASH

Introduction

Progress, Religiosity, and the Education of Engineers for Good

We routinely expect far more from our artificial contrivances than mere convenience, comfort, or even survival. We demand deliverance.

—David Noble, *The Religion of Technology*

"Engineering for good" is a widespread and growing phenomenon premised on the belief that technical expertise should be combined with the value systems—and the training—needed to make positive change.[1] Within the United States and abroad, organizations such as Engineers Without Borders-USA (EWB-USA), Engineering for a Sustainable World (ESW), and Engineering Ministries International (eMi) conduct projects that enroll over ten thousand engineering students, faculty, and professionals.[2] Furthermore, since 2004, Engineering, Social Justice, and Peace (ESJP), a network of technical experts, convene annually to discuss how and why engineers should work towards alleviating social injustices.[3] For another example, large non-profits like World Vision International recruit engineers to compete in their Social

[1] I use "engineering for good" as an analyst's category to describe several engineering activities and includes engineering and social justice, peace engineering, engineering for development, and humanitarian engineering. Much like engineering to help (ETH) in Jen Schneider, Juan Lucena, and Jon A Leydens, "Engineering to Help," *IEEE Technology and Society Magazine* 28, no. 4 (2009): 42. A note—this language is not often adopted by practitioners, and, in fact, this project will tease out the complicated politics behind promoting or avoiding any particular identifiers.

[2] The largest numbers coming from EWB-USA, "Engineers without Borders USA," accessed November 2, 2020, https://www.ewb-usa.org/.

[3] "Engineering, Social Justice, and Peace," accessed November 2, 2020, http://esjp.org/.

Innovation Challenge.[4] These organizations have complex and differing mission statements and practices. All, however, prioritize societal benefit, usually at the community level, over more traditional engineering values such as cost, efficiency, technical rigor, or innovation.[5]

Engineers for good aim to make change through small-scale, sustainable solutions. Popular projects for these alternative engineers include water, sanitation, and hygiene (WASH) and bridge projects in international locations.[6] *Engineers for good* often travel to their international project sites for short periods of time, one to three weeks, every six to eighteen months, over the course of three to five years.[7] This work usually follows a linear set of steps like assessment, implementation, and evaluation, with project trips that roughly match onto these

[4] "World Vision Ignite Social Innovation Challenge 2020," accessed November 3, 2020, https://www.worldvision.org/ignite/2020/10/26/sic-2020/.

[5] For a historical look at how social responsibility is at odds with business interests see: Edwin T Layton Jr, *The Revolt of the Engineers. Social Responsibility and the American Engineering Profession* (ERIC, 1986).

[6] In EWB-USA's 2019 annual report, of the 452 projects "underway," 264 are water projects and 68 are structures projects. Other categories include sanitation projects (44), energy projects (32), agricultural (25), civil works projects (17), and information systems projects (2). Engineers Without Borders-USA, *The Essentials for Everyone* (2019), https://www.ewb-usa.org/wp-content/uploads/ewb-ar2019-final.pdf., 10.

[7] While this timing and frequency can vary, these ranges are most common among the international *engineering for good* student-led initiatives like EWB-USA projects. The travel and community engagement schedule for United States-based engineers participating in domestic *engineering for good* projects can look quite different. Also, while this work focuses on American engineers, and connects this to a longer history of U.S.-based international development, service, and social justice, there are *engineers for good* working all around the world. See, Jeremy Smith, Anh L. H. Tran, and Paul Compston, "Review of Humanitarian Action and Development Engineering Education Programmes," *European Journal of Engineering Education* 45, no. 2 (2020).

stages.[8] While the traditional model is for international projects, there is a growing focus on local, domestic projects.

Almost as soon as they commit, *engineers for good* confront the tensions that accompany an alternative engineering's "needs assessment" process. While engineers are trained to identify technical needs, prioritizing need when the goal is broadly to make positive change becomes difficult. These engineers also pursue "helping" others in the context of the history of Christian missions and colonialism, failed development efforts, and competing individual and institutional values.[9] However, these are concerns and histories that traditional engineers largely sidestep.[10] These alternative engineers question the limitations of traditional engineering disciplines, and the technical problem-solving practices that they have inherited. *Engineers for good* question the linearity and the long-term benefits of their projects, catalyzing them to create their own normative guidelines and construct a wide range of "build[ing] a better world" strategies.[11] In

[8] E.g. Volunteers with EWB-USA are encouraged to follow a Planning, Monitoring, Evaluation, and Learning (PMEL) program. Engineers Without Borders USA, *Planning, Monitoring, Evaluation and Learning Program* (2015), https://www.ewb-usa.org/wp-content/uploads/2015/05/PMEL-Program-Description.pdf.

[9] Schneider, Lucena, and Leydens, "Engineering to Help," 42-48; J. D. J. Vandersteen, C. A. Baillie, and K. R. Hall, "International Humanitarian Engineering," *IEEE Technology and Society Magazine* 28, no. 4 (2009), https://doi.org/10.1109/MTS.2009.934998.

[10] Erin A Cech and Heidi M Sherick, "Depoliticization and the Structure of Engineering Education," in *International Perspectives on Engineering Education* (Springer, 2015).

[11] The "better world" language is from EWB-USA, but for alternative procedures and examples of participating in these projects see chapter 2, 3, and 4. For a closer look at the discussion around "who benefits?" see David LaPorte, Erin Kim, and Jessica Smith, "Engineering to Help Communities or Students' Development? An Ethnographic Case Study of an Engineering-to-Help Student Organization," *International Journal for Service Learning in Engineering*,

addition, engineers' individual desires to "do good" are complicated by the differing values they bring to their work and instill in their designs.[12]

A striking feature of this form of engineering is that its participants are sometimes forced to express explicitly political or religious motivations for their work. This distinction creates tensions and uncertainties in a profession known for norms of disinterestedness and depoliticization.[13] *Engineers for good* deviate from traditional conceptions of engineering success and chose to volunteer their time, expertise, and energy. Engineers' process of prioritizing when, where, and how to volunteer these resources is filled with value-laden decisions.

Defining good is driven by values. Values help individuals choose what they will prioritize in their decision making. As applied to engineering, values can impact small decisions like whether a battery will be built out of more sustainably sourced material or will be cheaper for the end-user. Or values can drive decisions as big as what an engineer decides to do with their life and career, or what a large corporation does with their profits.[14] Values can originate in

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Humanitarian Engineering and Social Entrepreneurship 12, no. 2 (2017). And Vandersteen, Baillie, and Hall, "International Humanitarian Engineering."

[12] Batya Friedman and David G Hendry, *Value Sensitive Design: Shaping Technology with Moral Imagination* (Mit Press, 2019); Diana A Chen et al., "Vocation in the Engineering Curriculum: Challenging Students to Recognize Their Values" (paper presented at the 2019 ASEE Annual Conference & Exposition, 2019).

[13] Erin A Cech, "The (Mis) Framing of Social Justice: Why Ideologies of Depoliticization and Meritocracy Hinder Engineers' Ability to Think About Social Injustices," in *Engineering Education for Social Justice* (Springer, 2013); Donna Riley, "Engineering and Social Justice," *Synthesis Lectures on Engineers, Technology, and Society* 3, no. 1 (2008): 33-46.

[14] Peter-Paul Verbeek, *Moralizing Technology: Understanding and Designing the Morality of Things* (University of Chicago Press, 2011).

politics, religion, or indifference; they can be explicit, polarizing, or intimate. Shared values can help a group find common ground. But there are some value sets that engineers regularly avoid. Decision making that transcends the material is often seen as unimportant. If it does not affect technical specifications, then these values are ignored. Science and technology studies (STS) scholars reject the divide between values and technological production.[15]

Doing good through engineering is premised on assigning need and meeting those needs with material resources. Conceptions of humanitarianism, need, and poverty have long histories in American Christianity and religious allegory.[16] In response, engineers construct secular values, rhetoric, and conceptions of the good that do not have religious beliefs as prerequisites for participation. These engineers construct need in secular and material terms but aim to make change beyond just providing a technology. This dissertation focuses on that intersection—between assessing need, constructing the good, and providing technological interventions that transcend traditional conceptions of engineering. Not all *engineers for good* espouse explicit religious values, in fact, most do not, but all *engineers for good* are embroiled in a long history of defining technological and moral progress, which has been spurred by a belief in transcendental good.

Universities are the most important sites in the development of *engineers for good*, and they reveal the complicated tensions between traditional engineering formation and "doing

[15] This list could be dizzyingly long, but for a few foundational examples see: Langdon Winner, "Do Artifacts Have Politics?," *Daedalus* (1980); Bruno Latour, *Aramis, or, the Love of Technology* (Cambridge, Mass.: Harvard University Press, 1996); Sheila Jasanoff and Sang-Hyun Kim, *Dreamscapes of Modernity : Sociotechnical Imaginaries and the Fabrication of Power* (Chicago: The University of Chicago Press, 2016).

[16] Michael Barnett, *Empire of Humanity: A History of Humanitarianism* (Cornell University Press, 2011).

good" in practice.[17] Programs within institutions of higher education across the country have formed to train young engineers to bridge the gap between conviction and implementation. Increasingly, a wide array of public and private institutions, with secular or religious missions, have new minors, concentrations, and research agendas geared toward *engineering for good.*[18] These engineering programs, though differing in mission and scale, share distinct priorities and methods. While these programs represent great potential, they also represent the unmet promises of past engineering efforts.

Working at the nexus of science and technology studies (STS), development studies, and religious studies, I inquire as to how religious and secular values are entangled as they impact the training of the next generation of *engineers for good*. This project explores how values impact engineers' definition of the good, how they assess needs, and how their conception of need impacts the work that they do. Engineers are not unique in thinking through how religious conceptions of need and helping impacts their work; however, as a profession, they are among the most ill-equipped to manage the tensions that connect their collective purpose to their professional identities.[19]

I spent thirteen months embedded in *engineering for good* programs, observing their current practices but also studying the history of the institutions in which they reside. I employed historical and ethnographic methods to map the relationship between technological development,

[17] For a critical reflection on engineering studies scholars' role in unpacking the complexities of "engineering formation" see Gary Lee Downey, "Opening up Engineering Formation," *Engineering Studies* 7, no. 2-3 (2015): 217–20.

[18] For a list of "engineering for good" programs, see Appendix A.

[19] Cech, "The (Mis) Framing of Social Justice: Why Ideologies of Depoliticization and Meritocracy Hinder Engineers' Ability to Think About Social Injustices."

humanitarianism, religion, and the construction of secular values in these critical sites for the definition of *engineering for good*.[20] I aim to inform scholarship in development studies, religious studies, and STS. In development studies, I build on post-development critiques of needs assessment in international contexts. In religious studies, I analyze cases of both explicitly religious and secular constructions of the good. And for STS, I contribute to scholarship that connects individual and institutional values' influence on technological production. In addition, I hope my work not only engages the scholars in these disciplines but the practitioners working through purposes and practices.

This dissertation is also personal. An engineering student walked up to me after the first day of the humanitarian engineering (HE) class I would be observing and mentioned, "I'm really glad you're looking at how religion plays a part in 'all of this,' because my mom is uber religious, and I'm not, and she keeps insisting that you can't do good without religion."[21] This student, at a small public university, was facing questions about how their faith—or lack thereof—affected their individual and professional purpose. Furthermore, this student was curious about how their course *Engineering for Social and Environmental Responsibility* could address the tension they were feeling between a conception of "the good" they had grown up with and the ways their engineering training could retool and reframe "doing good" for them moving forward.[22] This student was working to reconcile their desire to explore their larger

[20] For more on these secular values and institutional framings, see chapter 2 and Talal Asad, *Formations of the Secular: Christianity, Islam, Modernity* (Stanford University Press, 2003).

[21] From field notes taken in January 2019.

[22] *Engineering for Social and Environmental Responsibility* is a core undergraduate course for the undergraduate humanitarian engineering programs at Colorado School of Mines, more in chapter 2.

purpose in a public university setting, alongside a common religious tenor about the ethics of having a positive impact.

When that student approached me, I saw a lot of myself in them. It was not long before that I was that curious engineering student, trying to "do good" as part of a communal latrine project in rural Ghana. When traveling with my engineering team, I was struck by the conversations we were not having. We would go back to our hotel at night, and I wanted to "unpack" the experiences of the day, question our reasons for being there, and figure out whether we were making any real change. But my colleagues largely avoided these conversations, for reasons I did not understand until later, when I had individual conversations with them. Despite all being engineers, we had radically different views about what it meant to be a guest in a new place, what kinds of expertise we had and could impart, and the kinds of deep personal convictions we had to motivate our participation. I also struggled with how my engineering education gave me few outlets for discovering my individual and our collective purpose.

This project focuses on *engineering for good*, among other reasons, because it is the most accessible site to see how engineers address their purpose, their "callings," and faith in technology. But I hope the conclusions for this project can be a catalyst for drawing connections between the construction of secular good, faith, and technology more frequently. While I understand the caution in connecting religiosity and technological pursuits, I argue that it is imperative that those that study the cultural and social dimensions of scientific and technological knowledge production entertain the similarities.[23] This project aims to be a small part of

[23] Latour promotes the attention to religion as an aspect of the construction of modernity in Bruno Latour, *An Inquiry into Modes of Existence* (Harvard University Press, 2013). See also David F Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention* (Knopf, 2013).

understanding how people's religiosity is co-constructed with their conception of technological progress.

Progress and Its Perils

Since the Industrial Revolution, the notion of "progress" has been built into the engineering profession's myths, fully articulated during the rise of corporate capitalism.[24] In addition, STS literature claims that engineering is inseparable from politics and that all technological production is value-laden.[25] When federal defense dollars pour into engineering research and development and large corporations hire engineers by the hundreds, it is no surprise that engineering, and engineering education as a result, is focused on efficiency, manufacturability, and innovation, three attributes that are understood to be beneficial to the "bottom line."[26]

Engineers' desire to "do good" is complicated by the fact that they may be taught to view *all* engineering as an effort for good. Engineering programs' college websites, recruitment efforts, and the National Society of Professional Engineers' (NSPE) creed all inundate students with messaging about how they are being trained to "solve complex global problems,"[27]

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[24] David F Noble, *America by Design: Science, Technology, and the Rise of Corporate Capitalism* (Oxford University Press, USA, 1979). For a critical and comparative view of how corporate capitalism with the United States effected workforce dynamics, particularly the lack of unions, see: Peter Meiksins and Chris Smith, "Why American Engineers Aren't Unionized: A Comparative Perspective," *Theory and Society* 22, no. 1 (1993): 57–97.

[25] Winner, "Do Artifacts Have Politics?," 121–36; Friedman and Hendry, *Value Sensitive Design: Shaping Technology with Moral Imagination*; Verbeek, *Moralizing Technology: Understanding and Designing the Morality of Things*.

[26] For a close look at "efficiency" in post-industrial life see Jennifer Karns Alexander, *The Mantra of Efficiency: From Waterwheel to Social Control* (JHU Press, 2008).

[27] "VT Engineering," accessed November 6, 2020, https://eng.vt.edu/

"improv[e] the planet,"[28] and "dedicate [their] professional knowledge and skill to the advancement and betterment of human welfare."[29] However, these are politically-laden charges that individual engineers often find difficult to integrate into traditional engineering practice. Moreover, traditional engineering education provides little space and time to discuss how they will apply these ethical demands to their professional trajectory.

This vision of progress is especially prominent when engineers extend their work to development. As I will show in the next chapter, international development of the mid-twentieth century shaped how the world sees the "haves" and the "have-nots," separating those that had technological artifacts and knowledge from those that "needed" them. Technological and scientific knowledge became the currency of international progress, spurred by post-WWII distinctions between the industrialized and "developing" countries. The gap between the "haves and the have-nots," between the "new world" and the "old world's" former colonies has only grown with increasing technological and "progress" disparity. In the Cold War, this division grew with large regions given labels of First, Second, and Third Worlds, the latter of which was cast as "struggling" to meet their basic human needs.[30] American humanitarianism and, in turn, engineers' conception of progress on an international scale still perpetuate this divide.

Visions of progress attached to international humanitarianism and development have long been challenged by both practitioner and critical scholar alike. Asset-based models of

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[28] "Three Ways Engineers Are Improving the Planet," accessed November 6, 2020, https://spectrum.ieee.org/the-institute/ieee-member-news/three-ways-engineering-are-improving-the-planet.

[29] "Engineers' Creed," accessed November 6, 2020, https://www.nspe.org/resources/ethics/code-ethics/engineers-creed.

[30] Brian Roger Tomlinson, "What Was the Third World?," *Journal of Contemporary History* 38, no. 2 (2003): 307–21.

engineering for good push back on the notion that development means success.[31] Critical scholars of humanitarianism and development interrogate the paternalism inherent in helping the world.[32] In addition, engineers do not see themselves helping others in their work and search for other venues to "do good" rather than their traditional engineering careers. As one of my interlocutors, who worked as a practicing engineer and described why they quit to participate in *engineering for good* efforts, stated, "I was more concerned about what the client was getting and making sure they knew what they were getting ... which isn't totally the mindset of engineers."[33] This predilection for providing what people need and describing what they were getting was not valued in this engineer's profession, forcing them to find a new community with a different vision for how engineers' contribute to society.

These critiques show there is widespread belief that progress and engineering are not inherently good.[34] This critique lives on in both traditional modes of engineering and the rebellious few who try to make a new field meant to address it. In part, the story of these *engineering for good* programs founded over the last 20 years is evidence of this tension, but

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[31] This revision from working to develop regions to building upon human capabilities is most directly attributed to Martha C. Nussbaum, *Creating Capabilities : The Human Development Approach* (Cambridge, Mass.: Belknap Press of Harvard University Press, 2011). For a survey of the asset-based model as applied to STEM education see Maya Denton, Maura Borrego, and Audrey Boklage, "Community Cultural Wealth in Science, Technology, Engineering, and Mathematics Education: A Systematic Review," *Journal of Engineering Education* (2020): 556–80.

[32] Barnett, *Empire of Humanity: A History of Humanitarianism*, 33-37.

[33] Interview O6.

[34] Kranzberg Melvin, "Technology and History: "Kranzberg's Laws"," *Bulletin of Science, Technology & Society* 15, no. 1 (1995).; Larry Laudan, *Progress and Its Problems : Toward a Theory of Scientific Growth*, (Berkeley: University of California Press, 1978).

these programs come after engineers have been a part of redefining global needs assessment over the last 60 years. *Engineers for good* recognize the challenges of assuming that engineers will just inherently "do good" and are involved in constructing a new vision of technological progress.

Remaking Progress

The *engineering for good* movement seeks to rekindle this sense of progress and do so with a more refined approach to those of the past. For example, *engineers for good* are trying to serve something other than corporations.[35] These new humanitarians critique and continually revise what it means to do engineering for the benefit of humankind. This movement is a revision of traditional engineering practice, rejecting the consumerism and destruction commonly brought on by technological development and calling into question the allegiance of engineers to their employer over their user.[36]

These new *engineers for good* claim to be better, setting normative guidelines for how they relate to progress. *Engineering for good* programs more directly address and acknowledge their values by focusing on social and environmental issues such as sustainability, social inequality, and the cultural appropriateness of solutions.[37] As I will show in the following chapters, participants insist that there are basic tenets of a good humanitarian engineer— having

[35] Layton Layton Jr, *The Revolt of the Engineers. Social Responsibility and the American Engineering Profession.*; Matthew H Wisnioski, *Engineers for Change: Competing Visions of Technology in 1960s America* (MIT Press, 2012).

[36] For the prevalence of this allegiance in "corporate capitalism," again see Meiksins and Smith, "Why American Engineers Aren't Unionized: A Comparative Perspective."

[37] For more on sustainability and social inequity see chapter 4; for more on "appropriate" solution see chapters 1 and 2.

basic technical skills, the willingness to learn, and the time, desire, and patience to serve where they are being "called."[38] Some of these engineers turn to *engineering for good* to combine their faith and vocation.[39] No matter the language used, this mode of engineering is an alternative to technical work done strictly in and for for-profit institutions.

This movement seeks to change both individual lives of those that reap the benefits and the profession's image. These engineers bring varying forms of new expertise to volunteerism, nonprofit involvement, and industry work. Some apply the tools they have learned to traditional engineering jobs in consumer goods or military defense spending.[40] For others, this training becomes preparation for the Peace Corps or working in international development efforts.[41] For others still, this new charitable training leads to networks of nonprofit workers that also have technical training, reshaping what engineers can donate beside monetary gifts.[42]

Engineering for good promises to ameliorate injustices and the mistakes from the past.[43] A popular textbook defines humanitarian engineering, a sub-field of *engineering for good*, as "design under constraints to directly improve the well-being of underserved populations."[44] But

[38] This is particularly clear at Baylor; see chapter 3.

[39] Again, see chapter 3.

[40] Fieldnotes from Fall of 2019.

[41] The Peace Corps Prep program at CSM is tied to the humanitarian engineering program, and active students in both refer to the Prep program as a part of their *engineering for good* identity formation. Fieldnotes and interviews from Spring 2019.

[42] For an example of non-profit network building based on shared values, see chapter 3.

[43] For an in depth look at just how engineering works through the profession's injustices of the past, see chapter 4 and Riley, "Engineering and Social Justice."

[44] Carl Mitcham and David Muñoz, "Humanitarian Engineering," *Synthesis Lectures on Engineers, Technology, and Society* 5, no. 1 (2010), xi.

freedom to define "improve" and "underserved" leads to varied practices. *Engineers for good* sometimes use the language of human rights and dignity—seemingly uncontroversial universals— to define what all humans "deserve" and "need." However, those categories of need are strikingly large, leading to assessing perceived need to be core to the *engineering for good* design process, in which engineers define which technical problems they believe are worthy of attention in order to address those needs. In addition, prioritizing need—whether one need over the other, one person's needs over another's, or one community's needs over another's—involves making decisions and confronting assumptions, a practice that often falls outside of traditional conceptions of engineering design pedagogy.

The existence of these alternative practices demands a reevaluation of engineering's purposes. This dissertation explores who these *engineers for good* are, how their values impact what this "good" looks like, and what evaluating "doing good" says about engineer's intended and sometimes elided purposes. I focus on a small, yet vocal, group of engineers and their educators who are creating a new type of engineering. Presented as an alternative to, and sometimes in combination with, traditional engineering disciplines like civil, environment, and electrical engineering, *engineers for good* have decided that the moral and ethical demands of engineering and the purpose of the engineering profession deserve their own venue for scholarly and practitioner debate. *Engineering for good* aims to make good the world, the profession, and ultimately the individual souls of the engineers who pursue it.

Wavering Faith in Engineering Alone

Engineering for good is in its language and purpose a moral project. Engineers decide what they mean by "good" by simply "doing good." *Engineers for good* are engaged in providing

normative visions for the future of engineering by claiming that there can be a "better world." [45] Simply by saying engineering *ought* to be in the business of building this "better world" distances the profession from its corporate stakeholders and rote expectations. Even simple technologies that engineers develop "mediate" morality. For example, nonhuman actors like speedbumps remind drivers to slow and energy-saving appliances are part of our "environmental conscience."[46]

Most expressions of good in engineering are cast in secular terms. Engineers often regard religious values as inconsequential features of design or generalize their effects by grouping religious values into broader contexts of cultural and social difference. However, these humanitarians often work in field sites where religious values are prominent features of the local community. Like the conceptions of progress it seeks to revise, the *engineering for good* enterprise is often implicitly and sometimes explicitly a religious endeavor.[47] Some of the largest global humanitarian organizations are faith-based, a trend mirrored among nonprofits and universities.[48] In addition, many engineers themselves are drawn to humanitarian work by their

[45] Wisnioski, *Engineers for Change: Competing Visions of Technology in 1960s America*., pg. 8.

[46] Speedbump example is from Latour discussed in Verbeek, *Moralizing Technology: Understanding and Designing the Morality of Things*, 2, 12.

[47] For cases that describe a long history of the religiosity and enhancement of technological pursuits see Noble, *The Religion of Technology: The Divinity of Man and the Spirit of Invention*.

[48] Jeremy Carrette and Hugh Miall, *Religion, NGOs and the United Nations: Visible and Invisible Actors in Power* (Bloomsbury Publishing, 2017); An important Christian NGO engaged in international humanitarians is World Vision, see David P King, *God's Internationalists: World Vision and the Age of Evangelical Humanitarianism* (University of Pennsylvania Press, 2019).

religious beliefs.[49] Even in secular institutions, many individuals participate in humanitarian efforts to fulfill faith-based desires to make a difference.[50]

The religious features of engineering are avoided because they do not fit into notions of secular progress, because they are controversial in public spaces, and because religious difference is polarizing. These tensions exist with good reason. Engineers, both secular and religious, wrestle with the legacy of the "savior mentality," a sentiment rife with Protestant Christian imagery.[51] Some engineers struggle with the radical nature of social movements such as social justice, a concept that comes with a religious history and politically leftist connotations.[52] Like other important identities, religious identities (or lack thereof) impact engineers' sense of "good," which can cause value differences between engineers, which can often go unexamined. I argue that defining the diversity of the ways that engineers see themselves "doing good" make some of these hidden ethical dilemmas visible.

Religion and humanitarianism are inherently linked. Critical scholar Michael Barnett argues that "it is impossible to study humanitarianism without being impressed by the importance of religion."[53] Not only are there major faith-based organizations (FBOs) that have directly impacted the conception of global need for large-scale humanitarianism, even after

[49] This is most clearly seen at Baylor University and chapter 3, but it is true, in some sense, at all my field sites.

[50] EWB-USA members mention religion and philosophy, among other interests, in contrast to nonmembers in Kaitlin Litchfield and Amy Javernick-Will, "'I Am an Engineer And': A Mixed Methods Study of Socially Engaged Engineers," *Journal of Engineering Education* 104, no. 4 (2015): 393–416.

[51] Jordan Flaherty, *No More Heroes: Grassroots Challenges to the Savior Mentality* (Ak Press, 2016).

[52] For more context on the complicated nature of combining engineering and social justice, see the end of chapter 1 and chapter 4.

[53] Barnett, *Empire of Humanity: A History of Humanitarianism*., 17.

humanitarians remove explicit religious messaging from their giving practices, Christianity is still central to Americans' perception of need and global poverty and, furthermore, underpins the metaphors and imagery embedded in American humanitarianism and disaster relief.[54] In contrast, humanitarians are criticized for being condescending to the people to whom they provide assistance, plagued by the legacy of the "civilizing mission;" but these critiques, while sometimes make engineers question their own intentions, rarely squelch their desire to help.[55] Today, based on a longer history of international development, these religious metaphors helped to shift "need" and "poverty" to a lack of technological advancement and large-scale industrialization.

One critical work at the intersection of engineering and religion is *Engineers of Jihad*, which makes a case that there is a strong connection between violent, Islamic radicalism and engineering education.[56] Authors Diego Gambetta and Steffen Hertog show, surprisingly, that well-educated engineers join jihad at a much higher than the average (non-engineers) population, a factor more influential than other social factors such as poverty, hardship, or lack of education. They reject the somewhat more obvious hypothesis that these men are recruited for particular technical skills, showing that there is diversity of educational background among those that participate in technically sophisticated tasks, such as bomb-making. Gambetta and Hertog draw further conclusions about the influence of relative deprivation, claiming that high achieving engineers who face harsh labor conditions after succeeding in school, then being denied the

[54] Heather D Curtis, *Holy Humanitarians: American Evangelicals and Global Aid* (Harvard University Press, 2018).

[55] Many engineering students I observed talked about their aversion to a "savior mentality/complex," a revision of the "civilizing mission."

[56] Diego Gambetta and Steffen Hertog, *Engineers of Jihad: The Curious Connection between Violent Extremism and Education* (Princeton University Press, 2017).

career and life that they may think they deserve, makes these men predisposed to this extremist behavior. This analysis connects engineers' training to their religious and civic engagement. My work does not suggest that all engineers are inclined to radical behavior, quite the contrary, but it similarly shows that engineers' education and positionality can impact their definition of moral progress.

Anthropological studies of American Christianity describe the flexibility of religious rhetoric. While observing explicitly religious engineers at a Baptist University, I build on the work of anthropologist Susan Friend Harding in encountering evangelical Christian language to understand how religious rhetoric is integral to how Christian engineers "act in their faith."[57] I describe how these evangelical Christian engineers articulate need, wealth, and the "sins" of not meeting one with the other. I draw on the example of explicitly religious *engineers for good* to think though how to critically analyze Christian language not only in religious spaces, but also how to identify it in seemingly secular ones.[58]

There are unique theoretical opportunities to study American humanitarianism in religious studies' post-secular framing.[59] Secularity is often referred to as the absence of religion. However, philosopher Charles Taylor and anthropologist Talal Asad have made popular the theoretical understanding that secularity is not a superior state of modernity and scientific

[57] Susan Friend Harding, *The Book of Jerry Falwell: Fundamentalist Language and Politics* (Princeton University Press, 2000).

[58] For this example, in more detail see chapter 3.

[59] For a thorough look at what's at stake for claiming a "post-secular" moment in critical thought see Jürgen Habermas et al., *An Awareness of What Is Missing : Faith and Reason in a Post-Secular Age*, English ed. ed. (Cambridge, U.K. ;: Polity, 2010); F. Dallmayr, "Post-Secularity and (Global) Politics: A Need for Radical Redefinition," Review of International Studies 38, no. 5 (2013).

rationality which replaces the necessity for god(s) to explain nature and truth. But rather, for Taylor and Asad, secularity is equally constructed as religious belief, only made possible when nonbelieving in religion is a viable option, a relatively new possibility for civic and moral engagement.[60] Understanding post-secular discourse relies on this nuanced distinction. Secularity is not just a person's choice to not believe in a formal religion, but rather, a social context that makes it possible.

Furthermore, religious studies scholars have recently questioned the reality of the right of "religious freedom," attributing this "impossibility" to the unique cultural and religious make-up of the United States, further questioning whether American's can chose "doing good" outside of a complicated Judeo-Christian narrative.[61] In addition, stiving to have excess to then have the ability to give to others is a part of American's mythology and identity formation, a notion built on *The Protestant Work Ethic* and perpetuated through the "bootstraps" mentality.[62] Private philanthropy, once reserved for religious settings and for strengthening and growing wealth in small communities, was secularized in the twentieth century.[63] Philanthropy and giving are connected to the kinds of *engineering for good* programs that can be developed and then thrive,

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[60] Charles Taylor, *A Secular Age*, Gifford Lectures ; 1999., (Cambridge, Mass.: Belknap Press of Harvard University Press, 2007); Asad, *Formations of the Secular: Christianity, Islam, Modernity*.

[61] Winnifred Fallers Sullivan, *The Impossibility of Religious Freedom: New Edition* (Princeton University Press, 2018). Talal Asad has urged for increased anthropology of the post-secular moment in *Asad, Formations of the Secular: Christianity, Islam, Modernity.*

[62] Max Weber and Talcott Parsons, *The Protestant Ethic and the Spirit of Capitalism* (Mineola, N.Y.: Dover Publications, 2013).

[63] One important example of the Pew and Rockefeller's influence see Andrew Jungclaus, "Secularizing Philanthropy in the Twentieth Century: The Pew Family as Trustees of Divine Endowment," *Religions* 9, no. 12 (2018).

and are also an interesting site for witnessing personal convictions as connected to "the good" in engineering. Studying *engineering for good* in institutions of higher education allows for new scholarship on secularizing "doing good" and philanthropy— often translated into academic-speak as "broader impacts."[64]

As described below, this project also contributes to the study of social justice as a part of American humanitarianism. Social justice has ties to religious conceptions of the "common good" from St. Thomas Aquinas, which Catholic institutions signal to as a part of talking about "Catholic Social Teaching."[65] In the last 20 years, *engineers for good* have shifted focus from development and international need to thinking about engineering need as the result of systemic injustice. This shift also created space for thinking about technical needs within the United States, because while the States are "developed," *engineers for good* can nevertheless identify systemic injustices at home. However, this shift comes with the threat of being too progressive for conservative Christian institutions; too political for public, "secular" universities; and too ambiguous in a discipline known for its calculated certainty.

Understanding the connection between secularity, religion, and engineering is crucial for understanding what *engineering for good* is and does. NSPE's Engineers' Creed concludes by acknowledging the "humility" and "need for Divine Guidance" required for Professional

[64]For a closer look at these standardized "academic" notions of "the good" see, Michael Davis and Kelly Laas, ""Broader Impacts" or "Responsible Research and Innovation"? A Comparison of Two Criteria for Funding Research in Science and Engineering," *Science and Engineering Ethics* 20, no. 4 (2014): 963–83. There is an interesting argument to be made that "broader" impacts means exactly just that, impacts outside of the classroom or research labs, but I would argue it is also so "broad" that it is often translated into the common or public good.

[65] For more on Aquinas and how Catholic affiliations impact an *engineering for good* program, see chapter 4.

Engineers to fulfill their commitment to their careers.[66] This indicates that all engineers must attend to transcendental features of their work, if not directly connected to their individual belief in (a) god(s). Traditional religious practice and teachings are one way to explore this commitment, but so is the faith in something secularly transcendent— technology as progress and "good" in and of itself.

Studying the Making of Engineers for Good

To explore how *engineering for good* is working to define itself, I focus on how these engineers are trained. These sites are where new students bring their desires, encounter the worldviews of those in the field, and develop and share expertise. Many universities that support *engineering for good* programs claim that their graduates will go out and be "changemakers" or go and make "big impacts," but what tools do they equip students with to figure out what exactly that means?[67] In what ways are different senses of social change embroiled in our national, international, and personal politics? How do different universities take up these large value-based charges and claim that it is part of their job to teach and train students to take part? This dissertation seeks to answer these questions by analyzing how modes of doing good are institutionalized, taught, critiqued, and revised. The project uses *engineering for good* as a case study to explore how moral, ethical, and religious values are a part of engineering design.

I look at the major ways in which groups of engineers define the good. I provide grounded evidence for how *engineering for good* blends and borrows traditions from

[66] It should be noted here that becoming a Professional Engineer (PE) is a professional licensure status and not required to be recognized as an engineer within the United States, although NSPE's code of ethics is often adopted as an overarching code for all engineers, regardless of discipline. NSPE, "Engineers' Creed."

[67] For an in depth look at "changemaking" as an institutional identity, see chapter 4.

international development, humanitarian service, and social justice. I also emphasize how these concepts are tied to secular and religious traditions and practices. At the core of each of the practices, and what makes them unique, are the kinds of problem definition involved in each of these movement. I explore how each—development, service, and social justice—stand out as organizing or dominant themes and how *engineers for good* learn from long histories of geo-political power dynamics, individual and collective convictions, and the ability to mobilize through grassroots community organizing.

To address these concepts and practices, I selected three institutions out of the range of programs, which each have a prominent organizing theme (among the three described above) and each have different secular and religious missions.[68] Specifically, I compare three university *engineering for good programs* with different religious and secular standpoints: Colorado School of Mines (CSM), Baylor University (BU), and University of San Diego (USD). Humanitarian Engineering at CSM, a public university, promotes itself as "engineering as it should be"—a type of engineering that trains engineers to learn and work towards a normative vision of engineering using the latest in post-development literature and the critical study of corporate social responsibility. Humanitarian engineering at BU, a Baptist University, focuses on combining evangelical Christian views of service with engineering design. Integrated Engineering at USD, a Roman Catholic University, seeks to make "changemaking engineers" that engage in social justice.

[68] The "prominent organizing themes" were identified and matched to sites while conducting field work; the religious or secular affiliation was a part of choosing the field sites.

To understand how values and *engineering for good* are co-constructed, I utilized ethnographic and historical data collection methods.[69] I employed participant observation methods and historical archival work at these three university programs, the humanitarian non-profit networks in their local communities, and accompanying international field sites in Uganda, Haiti, and Mexico.[70] I collected university and personal archival material. I spent a full semester at each university and collected ethnographic data through classroom, office, meeting, and event observations. As a part of this project, I observed over 150 hours of teaching time alone, collected over 810 pages of handwritten fieldnotes, and conducted 62 semi-structed interviews.[71] I conducted semi-structured interviews with students, faculty, administrators, alumni, international partners, and donors, which I later transcribed. My interviews centered on holistic questions about the interviewee's career trajectory, values within and purposes for their participation in *engineering for good* programs, and when appropriate, questions about institution building. I adapted interviews based on my participant observations.[72]

Participant observation is an all-consuming data collection method. Being an embedded observer was a full-body and full-psyche experience.[73] While my participants were welcoming

[69] Data access and collection methods were approved by Virginia Tech's Institutional Review Board (IRB) case #17-527. My application was later approved by CSM's IRB office.

[70] I draw from feminist ethnographer, Dorothy Smith's concept of "institutional ethnography" in *Dorothy E Smith, Institutional Ethnography: A Sociology for People (Rowman Altamira, 2005)* and a collection of critical reflection on the feminist dilemmas of institutional ethnographies in *Dorothy E Smith et al., Institutional Ethnography as Practice (Rowman & Littlefield Publishers, 2006).*

[71] These 62 interviews were with 61 participants: 31 students, 23 faculty, and 7 others.

[72] Example of Student Interview Guide Attached in Appendix B.

[73] And by full body, I mean it—I got bit by a pile of fire ants when I was too proud to not pick-up certain trash during Hurricane Harvey clean-up; I slept on a cold and wet concrete slab during a "Poverty Simulation;" I sweat as

and a handful are still actively interested in my findings, studying academics and their students can be overwhelming. My primary goal was, and remains, to be both fair and accurate in representing individuals and the programs in which they reside, presenting their language and actions as situated knowledge. I was not prepared for how much energy it takes to be attentive to this goal, alongside writing about, critically analyzing, and living it.[74] I was constantly aware of the kinds of data that I was collecting and the responsibility of relaying the "normal" features of my participant's life and work. Normal life for academics includes getting credit for the data and knowledge they produce, so when appropriate, I have cited their work or public claims.[75] I have tried my best at every turn to be accurate in representing individuals and the programs in which they reside. I also worked through various participant-researcher relationships that had unique power dynamics that affected access, trust, and reliable data collection.[76]

I used textual analysis and actor mapping to illuminate the connections between various data streams and the different cases. I also drew on archival and secondary material for the background section of the project. Preliminary analysis highlighted how development, service, and social justice discourse is both still present and actively critiqued as a part of *engineering for*

I hauled solar panels up a case of stairs in Haiti; and tried to hear a sermon over highway traffic at a church under a major overpass. And those were all from only one of the three universities I studied!

[74] Special thanks to Gary Downey whose ethnographic expertise was comforting in the moments juggling all these blurred identities got to be a bit too much.

[75] I have also been attentive to when citing their work would reveal they were an anonymous participant in other parts of my writing.

[76] I found solace in the stories of feminist ethnographers in Diane L Wolf, *Feminist Dilemmas in Fieldwork* (Routledge, 2018).

good. I compared how individual, institutional, and regional values impact how engineers assess need and how *engineers for good* consider their efforts a "success."

Structure of the Dissertation

Through *engineers' for good* desires to enhance the world, they blend secular and religious values in complex and sometimes implicit ways. These engineers' efforts build on compromised histories of colonialism and development, missionary proselytizing, the legacy of engineering "needs assessment," progressive secular goals, and visions of individual improvement versus systemic justice. Recognizing these motivations, tensions, and inextricable values creates a possibility for redefining the engineering profession's purposes and expertise.

My first chapter describes the rise of *engineering for good*—from the production of media and transportation technology delivering aid in the 19th century to a major non-profit enterprise, led by Engineering Without Borders-USA, that is growing in universities, non-profits, and federally funded development efforts around the world. Chapters 2, 3, and 4 map onto prominent, normative discourses and modes of practice of *engineering for good*—international development, service, and social justice, respectively. Focusing on the dominant discourses and practices allowed me to show how normative guidelines for creating alternative visions of progress are constructed at each program. Because there is significant overlap between these discourses and each institution's normative visions of needs assessment and progress, for clarity, each chapter also highlights one of three program's case studies. Through this extended case studies approach, I tell both brief institutional histories and accounts of ethnographic encounters at three undergraduate *engineering for good* programs at Colorado School of Mines, Baylor University, and University of San Diego— a public, Baptist, and Roman Catholic university,

respectively. In my analysis, I am attentive to how each university's religious affiliation (or lack thereof) shapes what doing good through engineering looks like at each institution.

Part of my argument is that all *engineers for good* wrestle with their relationship to these three modes of doing good—international development, service, and social justice. But, as previously mentioned, each institution has a movement that they most directly contribute to, making it an appropriate site to explore how the normative discourses have helped shape *engineering for good* efforts more broadly within each respective chapter. I start with how engineering for international development efforts are being remade at Colorado School of Mines because this institution most closely represents a mainstream model of *engineering for good.* Following the evolution of their projects and participants since its founding reveals major trends in the field of *engineering for good* across the country. This program has set the tone for *engineering for good* pedagogy for the last 20 years.[77] The next chapter depicts engineers engaged in eternal service at Baylor University. The BU case, a Baptist institution with evangelical participants, provides stark contrast in comparison to mainstream (secular) scholarship and research, but the engineers' individual and collective convictions are of note. These engineers serve as an example of pious dedication versus scholarly criticality. I turn to University of San Diego last to both depict a larger trend towards social justice and the complexities of engaging in social justice in a hybrid institution, one which borrows from both Roman Catholic tradition and secularized forms of academic research and pedagogy meant to be more universally shared and used by both religious and non-religious academic programs alike.

[77] Engineering students and their educators at all three universities referred to textbooks and critical scholarship written by faculty at CSM.

I describe how these cases are as similar as they are unique from one another. Their similarities make clear the kinds of religious images, allegories, and language that they all draw from on a national and international scale to help *engineering for good* define and ascribe need around the world. Their differences show the flexibility of "doing good" and its ability to both institutionalize and mobilize across a variety of engineering settings.

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Chapter Outline

Chapter 1: A Problem of Needs: The Origins and Dilemmas of Engineering for Good

This historical background chapter traces the notions of service, international development, and social justice from global imperialism to the rise of international development. The chapter describes how technology has been a part of the shift from the "common good" as a theologically grounded notion of community-building to part of a progressive liberatory movement. It shows how technology was more than just a tool for charitable giving, becoming central to Americans' conception of need, first abroad and now domestically. This chapter sets the scene for current *engineering for good* practices, one that acknowledges its religious past, institutionalizes its varied values, and reimagines what "doing good" with technology should mean.

Chapter 2: "Engineering as it Should Be": Addressing Tensions of Development and Compassion Through Humanitarian Engineering Expertise

Technology has always been central to what the "developed" world has in excess and can offer to those "in need" through international development efforts. Humanitarian engineers at the Colorado School of Mines work to rewrite the relationship between technology, development, and corporate social responsibility. Instead of focusing on technological dissemination and adoption, HE at CSM focuses on "enhancing human capabilities" and sustainable community

development. CSM's program claims that HE is "engineering as it should be." In other words, they are advocating a kind of revamped engineering, learning from engineering-for-development's missteps while revising and advertising it as something useful for all engineers.

Chapter 3: "Engineers with a Mission": Addressing "Energy Poverty" Through Eternal Service

Service is the central organizing principle of humanitarian engineering at Baylor University. But service to whom or what? Humanitarian engineers at Baylor explicitly tie their work to their Christian faith in God. They prioritize service that is selfless, relational, and part of a larger, eternal timeline. They see their work as an expression of "God's love," part of a larger plan and purpose to serve their creator. While this language is not common amongst most other *engineers for good*, many explain their desire to participate in "doing good" through similar religious analogies—including serving humanity, helping others, and "feeling called" to leave the world better than how they got to it. This chapter wrestles with the tension between two seemingly conflicting histories—evangelical Christianity and post-colonial critiques of international engineering.

Chapter 4: "Changemaking Engineers": Disciplinary Conservatism and Integrating Social Justice

More recently, social justice has become core to many *engineers' for good* identity and values. Engineers in the newly created Integrated Engineering program at the University of San Diego believe that engineering can address social injustices and inequality. Some faculty and students work on projects with and for communities experiencing these injustices, broadly construed, both domestically and abroad. The more than eight-hundred-year history between social justice movements and Catholicism provides institutional support for creating an engineering program that dedicates pedagogical resources to taking social justice, diversity, and inclusion seriously.

However, other engineering faculty question to what extent integrating social values into technical work dilutes the rigor of engineering education.

Conclusion: Engineering as it Can Be?

Engineers for good work in a complicated network of institutions and individuals that blend secular and religious values. This movement promotes engineering for "others." Defining who those others are and how their needs are assessed is core to the identities of *engineers for good* and helps them construct normative guidelines for their visions of how they will contribute to progress. A core contingent of *engineers for good* are working to fix development, fight against missteps of the past, and remake a community-based and sustainable *engineering for good.* Eternal service serves as another model, one that questions humanitarian action's inherent paternalistic qualities but expands on the "problem-definition" potential of all engineers. Integrating social justice within technological design can be a tricky balance between making *engineering for good* more accessible and proving that the practice is rigorous enough to maintain its engineering identity. All e*ngineers for good* assign need, construct normative guidelines of their work, and institutionalize good. The implications for these engineers extend beyond "doing good" to question the purposes of the engineering profession writ large.

Chapter 1

A Problem of Needs: The Origins and Dilemmas of Engineering for Good

During his TEDx talk in 2011, Bernard Amadei paced on his red-carpet dot and stated, "Engineering for the other 90 percent is giving people the fish first. I don't like charity, but it is hard to see someone who doesn't have food in his stomach, or her stomach, to take a shovel and start a project. We start with charity." The founder of Engineers Without Borders-USA continued, "Then we teach people how to fish. And that's not the end of the story. We teach them how to create fishing industries and fishing markets so that people can buy the fish."[78]

In the early 2000s, Amadei began a movement by founding EWB-USA for engineers to volunteer to produce "technology with a soul" through what he called "engineering for the other 90 percent."[79] While reflecting on the trip that inspired the founding EWB-USA, Amadei mentioned that he "had done engineering for the one billion rich people, that's completely useless." He went on and said, "I decided that for the rest of my life, I would do engineering for the other five billion people on this planet."[80]

Engineering for good means "engineering for others." Amadei assessed all but the "one billion rich people" as being in need of *engineering for good.* However, small, community-based

[78] Bernard Amadei, "Technology with Soul," in *TEDxMileHigh* (Youtube, 2011), 5:02. https://youtu.be/_vBYjx6ID4g.

[79] Amadei, "Technology with Soul." is the title of the talk, but he uses a good portion of the presentation defining "engineering for the other 90%," a concept borrowed from Paul Polak. For more on Polak and Amadei, see chapter 2.

[80] Amadei, "Technology with Soul," 2:35.

engineering projects require a more nuanced needs assessment process.[81] For example, in current EWB-USA projects, small engineering teams State-side work with "communities" that have communicated their need through a "Letter of Endorsement" or have partnered with an NGO that will "own" the project by this third party.[82] *Engineers for good* are also shifting towards more projects within the United States, addressing injustices within their borders. However, the sentiments borrowed from humanitarian aid and international development needs assessment, when the movement began to be institutionalized in higher education 20 years ago, are still present.

The *engineering for good* movement is thus filled with tools, methods, and judgements connected to broader social and political enterprises. This chapter describes the history of the normative tensions between traditional, secular engineering practice and a new, alternative form of needs assessment. It also highlights when and where religious sensibilities have influenced what "need" looks like around the world. This history informs the way engineers currently discuss need around the world and their ability to eradicate it. *Engineers for good* borrow language from three large geo-political movements—humanitarianism, development, and social justice—and then use these normative calls to action as motivations for retooling technological design for good. I argue that these larger movements ultimately shape who is in need of technological good, motivating engineers to work "for good."

[81] For examples of how this community needs assessment is being done in each university setting see chapters 2, 3, and 4.

[82] Engineers Without Borders USA, "New Community Program and Partnership Application," (Online, 2018). https://www.ewb-usa.org/wp-content/uploads/CommunityProgramApplication_Rev-March-2018.docx.

This background chapter explores the larger geopolitical and social movements that made it possible for *engineering for good* to institutionalize in American universities. I first survey the rise of American humanitarianism, describing historical scholarship that depicts how Protestant Americans assessed global need and how their messaging of need still impacts secular humanitarians' calls to action. Then, I describe the secularization of philanthropy, bringing large dollar contributions from Christian donors into the public sphere and creating a new American form of giving in the "third sector" of non-profits, NGOs, and volunteerism. Next, I explore how nation-states' involvement in international development primed Americans to provide expertise "lacking" in the other parts of the world—a parallel with colonial images and critiques of assumed cultural and religious supremacy.[83] I then describe how small, grassroots appropriate technology efforts eclipsed larger, nation-state level development and became the template for engineering for development pedagogy in the 1970s, and, later, for popular engineering non-profit networks like Engineers Without Borders. I finish with a brief overview of the rise of *engineering of good* over the last two decades. *Engineering for good* is also an outlet for technical professionals seeking to find their greater purpose, and furthermore it increasingly draws on social justice principles grounded in theological understandings of the "the good" for its participants' penchant for positive change.

Intersecting Histories of Humanitarianism and Development (1800s to 1960s)

[83] Both James Ferguson, *The Anti-Politics Machine:'Development', Depoliticization and Bureaucratic Power in Lesotho* (CUP Archive, 1990) and Arturo Escobar, *Encountering Development : The Making and Unmaking of the Third World* (Princeton, N.J.: Princeton University Press, 2012). strongly draw connections to colonialism in these post-development critiques. For application of this critique to Christian missions, see Marion Grau, *Rethinking Mission in the Postcolony : Salvation, Society and Subversion* (London: Continuum International Pub. Group, 2011).

It is important to understand humanitarianism and development as two different categories before seeing how their histories and current practices overlap. Humanitarianism is a much older enterprise. The United States involvement in international development did not start in earnest until after World War II. Prior to this era, "doing good" in the form of international and wartime relief had been categorically about humanitarian aid as opposed to providing resources, expertise, and knowledges to aid in "developing" communities or regions long-term.

However, humanitarianism and development have interconnected histories. They both help the "haves" articulate what they have and then assess what the "have nots" are lacking. They each articulate disparity of wealth, expertise, or time to dedicate to those "in need." Technology has always been integral to humanitarianism and development. Before the formalization of technological and scientific knowledge as aid in the 1950s and 60s, technology's role in humanitarian relief was primarily providing military, media, and transportation technologies for larger humanitarian efforts.[84] Technology has since shifted to "the good" itself, being the product of grassroots volunteer and development projects.

Michael Barnett, in his history of humanitarianism *Empire of Humanity*, argues that the major forces that perpetuate and maintain humanitarianism are destruction, production, and compassion.[85] Barnett continues by describing how technology could also equally be considered a primary force, saying "changes in material and human technologies have not only unleashed the destruction and disintegration that have motivated humanitarian action, they also have expanded the opportunities for it."[86] In turn, Barnett explains how religion is and has been

[84] Barnett, *Empire of Humanity: A History of Humanitarianism*, 29.

[85] Ibid., 9.

[86] Ibid., 29.

inextricably linked to humanitarianism throughout time, stating that religion is central to not only "the narrative but also in the allegories, concepts, and metaphors" that scholars use to describe humanitarianism.[87]

While "doing good" is as old as time, "humanitarianism" as a discrete practice rose in popularity in the early 19th century. Barnett claims that humanitarianism is defined by three attributes. First, while humanitarianism has origins both domestic and abroad, it slowly became associated with "compassion across boundaries"—humanitarianism is something beyond a citizen's duty or inherent responsibility to each other as a community member. Second, humanitarianism has "transcendental significance"—or the belief in something (either religious or not) bigger than the individual humanitarian. And third, Barnett describes that while it is other-worldly, it is very much grounded in the material and "the belief that it is possible to engineer progress."[88] It is in this tension between assigning need to others, conceptions of transcendental intervention, and the material that humanitarians are navigating their ability to do good.

Beginning in 1890s, thousands of Christian missionaries had some of the most sustained international cultural exchanges of the time. David Hollinger, in his history of early twentieth century missions, argues that missionaries are often characterized as stubborn and unidirectional in their "exchange," but, in fact, missionaries directly impacted American liberalism, rejecting stringent religious doctrine.[89] For a couple examples, Henry Luce, a son of a missionary, became an influential magazine publisher and Grace Hutchins, a missionary herself, came back to the

[87]Ibid., 17-18.

[88] Ibid., 17-21.

[89] David A Hollinger, *Protestants Abroad: How Missionaries Tried to Change the World but Changed America* (Princeton University Press, 2017).

United States from her missions work and wrote for the Communist Party, emphasizing the issues of racial and gender injustice in the United States.[90] It was these missionaries' exposure to difference that made them less likely to assign ideological need to others around the world.

Another example of evangelicals' influence on constructing the need of "others" is *The Christian Herald.* The late 19th and early 20th century newspaper *The Christian Herald,* as documented by historian Heather Curtis, served to translate need and poverty through the lens of American evangelicalism. Curtis argues that the newspaper has been an underemphasized medium for defining need both within the United States and for international aid efforts abroad. This periodical became a platform for American Protestant voices to define and depict how to participate in international and domestic humanitarianism. Furthermore, it situated Americans as those at the ready to provide goods and services to those that they deemed worthy. The imagery first depicted in *The Christian Herald* was later picked up by larger organizations like the American Red Cross, through similar messaging and illustration methods with regards to disparity.[91] The case of *The Christian Herald* shows how Protestant messaging about need and humanitarianism is part in parcel of how Americans access aid and relief needs.

In the 1910-30s, the United States developed its own "style of development."[92] As historian David Ekbladh argues, American development modeled itself after the Reconstruction era post-Civil War. The United States "reconstructed" other countries, like the Philippines, in its first attempts at international development.[93] The New Deal era established national supremacy

[90]Ibid., 25-26; 279-82.

[91] Curtis, *Holy Humanitarians: American Evangelicals and Global Aid*, 283-84.

[92] David Ekbladh, *The Great American Mission : Modernization and the Construction of an American World Order*, America in the World, (Princeton: Princeton University Press, 2010), 14-39.

[93] Ibid., 21-24.

in domestic public works and infrastructure projects which catalyzed the spread of liberal ideals around the world, further cementing the United States position at a global scale. In the mid-20th century, America began to exert its already "preexisting" desire to spread liberalism through modernization, by focusing on development and defining the "underdeveloped.[94]"

In 1949, in Harry Truman's inaugural speech, the newly reelected president proclaimed that the United States should help the "more than half" of its global counterparts "living in conditions approaching misery" due to the country's "inexhaustible" technological knowledge.[95] Truman rallied Americans around the national imperative for the U.S. to share its technological spoils with the rest of the world. He called for the people of the United States to work towards the diffusion of technology to unlock the world's "underdeveloped" potential. In this inaugural address, he stated that America must "embark on a bold new program for making the benefits of our scientific advances and industrial progress available for the improvement and growth of underdeveloped areas."[96]

This connection between the United States' industrial, advanced technology and how it could and should be used to aid in development "othered" non-industrialized nations, and even further, the people that reside within them. Truman described the people that require the United States' scientific and technological treasures as having an "economic life [that] is primitive and

[94] Ibid., 3.

[95] Harry S Truman, "Inaugural Speech," *Harry S Truman Presidential Library* (1949), https://www.trumanlibrary.org/whistlestop/50yr_archive/inagural20jan1949.htm.; see Gilbert Rist, *The History of Development: From Western Origins to Global Faith* (Zed Books Ltd., 2019).; Escobar, *Encountering Development : The Making and Unmaking of the Third World*.

[96] Truman, "Inaugural Speech."

stagnant." Truman warned that "their poverty is a handicap and a threat both to them and to more prosperous areas."[97]

The fear that this poverty would degrade America's way of life was veiled anticommunism.[98] This was a nationalistic, Post-WWII call to share the spoils the nation had to "other" previous colonies to promote peace and prioritize democratic ideals. Truman was calling for a response from the United States, for *American* engineers to both help underdeveloped regions for their own sake but also for protection against the communist Soviet Union and its allies. Through this patriotic call to action and others by John F. Kennedy in the 1960s, modernization and development became enmeshed in anticommunist ideologies.[99] This language of "underdevelopment," originally from Truman in the late-40s, still lives on in *engineering for good*, although *engineers for good* have replaced "underdeveloped countries" with "developing."[100]

The creation and promotion of American international development maintains Barnett's three tenets of humanitarianism described above. Development in the 1940s-50s called for

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[97] Truman, "Inaugural Speech."

[98] Stephen Macekura, "The Point Four Program and Us International Development Policy," *Political Science Quarterly* 128, no. 1 (2013): 127-60; Ekbladh, *The Great American Mission : Modernization and the Construction of an American World Order*, 77.

[99] Walt Whitman Rostow, *The Stages of Economic Growth: A Non-Communist Manifesto* (Cambridge university press, 1990); Michael E Latham, *Modernization as Ideology: American Social Science and" Nation Building" in the Kennedy Era* (Univ of North Carolina Press, 2000), 69-107.

[100] Also commonly used as "First" and "Third World" replacements, I often heard about "developing" communities vs. "developed" or "industrialized" countries, with some referring to what they saw as antiquated, Cold War connotations of these terms. Marcin Wojciech Solarz, "'Third World': The 60th Anniversary of a Concept That Changed History," *Third World Quarterly* 33, no. 9 (2012): 1561–73.

Americans to extend their resources outside of the United States, provide something material and promote a new vision of "progress" through technology, and rely on transcendent belief—working for something bigger than the individual. The transcendent piece of the original international development is two-fold: individual Americans' are called to put faith in their nation and God to fully participate in this "neo-humanitarianism."

Truman and John F. Kennedy both asked for divine guidance while establishing their vision for America's relationship to the rest of the world. Truman's Four-Point speech concluded by stating that the true key to the nation's success in international development was Americans' faith in God, saying "steadfast in our faith in the Almighty, we will advance toward a world where man's freedom is secure. To that end we will devote our strength, our resources, and our firmness of resolve. With God's help, the future of mankind will be assured in a world of justice, harmony, and peace."[101] Similarly, in 1961, in John F. Kennedy's inaugural speech Kennedy claimed, "Man holds in his mortal hands the power to abolish all forms of human poverty and all forms of human life. And yet the same revolutionary beliefs for which our forebears fought are still at issue around the globe—the belief that the rights of man come not from the generosity of the state but from the hand of God."[102] The men who established American international development called on God for guidance in distributing the embarrassment of riches they believed the country had.

American *engineers for good* now work largely within secular organizations, but these organizations were built on the shoulders of these transcendent images and calls to action. These

[101] Truman, "Inaugural Speech."

[102] John F. Kennedy, "Inaugural Address," *John F. Kennedy Presidential Library and Museum* (1961), https://www.jfklibrary.org/archives/other-resources/john-f-kennedy-speeches/inaugural-address-19610120.

images, once dependent upon faith in the nation and the divine, materialized in development and humanitarian action by both secular and faith-based organization (FBOs). *Engineers for good* participating in these organization still borrow from the religious imagery and rhetoric heavily influenced by twentieth century Protestants.[103] The Post-WWII era beckoned in a new form of "neo-humanitarianism."[104] Government-endorsed humanitarianism allowed for visions of the "good" and "progress" to be institutionalized in many forms. Humanitarianism and development, taken together, reinforce imagery of need and despair elsewhere, shifting the political focus from what was needed within the United States to the rest of the globe.

Making Technology Solutions Appropriate and Just (1960s to 1990s)

In the Cold War Era, attention to the United States' excess in terms of industrialized progress led a small but vocal minority of Americans to ask if the United States had taken it too far. Conflicts within the engineering profession arose around prioritizing nationalistic military spending over increasingly visible and domestic social problems.[105] The appropriate technology movement grew in large part out of these conflicts, as an alternative group of engineers focused on local, sustainable, technological solutions to relevant environmental issues.[106] The design and implementation of appropriate technology started as a countercultural movement in response to the emphasis on large, industrial, and militaristic engineering projects of the Post War era.

[103] This is especially clear in chapter 3, although can be seen at all three field sites.

[104] Barnett, *Empire of Humanity: A History of Humanitarianism*, 107.

[105] Wisnioski, *Engineers for Change: Competing Visions of Technology in 1960s America*.

[106] Carroll Pursell, "The Rise and Fall of the Appropriate Technology Movement in the United States, 1965-1985," *Technology and culture* 34, no. 3 (1993): 630.

Historian of technology Carol Pursell gave a retrospective of appropriate technology in his presidential address to the Society for the History of Technology in 1993. He claimed that the feminine nature of appropriate technology was in direct opposition to the re-masculinization of technology following the Vietnam War, which led to a dramatic decline of appropriate technology efforts for State-side use.[107] Domestic efforts were commonly dropped to make way for weaponry and "high tech" development—setting the scene for the design of appropriate technology as diffusion of western technological expertise *to* the rest of the world.

E.F. Schumacher's book *Small is Beautiful* (1973) describes intermediate technologies—the original name of appropriate technologies—as technologies somewhere between the southern hemisphere's "low tech" and the northern hemisphere's "high tech."[108] At this time, as summarized above, large, industrialized powers were dictating which regions were developed and which were not. They were also defining the potential development for each region, something that is still present in contemporary *engineering for good* work. Historian Daniel Immerwahr recently (2015) chronicaled this love for the "small" and its power over the American imagination in his book *Thinking Small.*[109]

[107] Pursell, "The Rise and Fall of the Appropriate Technology Movement in the United States, 1965-1985," 636. This gendering of technology is briefly covered in chapter 4, however, while interesting and important, is mostly beyond the scope of this dissertation.

[108] E. F. Schumacher, *Small Is Beautiful: A Study of Economics as If People Mattered* (London: Blond and Briggs, 1973). For an in depth look at the contentious relationship between large-scale, TVA-sized development within the United States and small participatory design see Daniel Immerwahr, *Thinking Small : The United States and the Lure of Community Development* (Cambridge, Massachusetts: Harvard University Press, 2015).

[109] Immerwahr, *Thinking Small : The United States and the Lure of Community Development*..

Small and intimate community development projects had an allure for Americans, Immerwahr described. Beginning by analyzing a 1958 popular culture touchpoint and bestseller by Eugene Burdick and William Lederer's *The Ugly American,* Immerwahr argues that Americans were looking for a community-based protagonist to redress the failings of the U.S. government diplomatic action in Southeast Asia. In the novel, Homer Atkins, a retired engineer working in a fake south Asian country, refuses to import the necessary water pump because the solution to the problem he faces "has to be something right here, something the natives understand."[110]

The book's protagonist exhibits localized and social knowledge while engaging in complex problem solving. The popularity of the 78-week best-seller crystalized that readers had, as Immerwahr notes, "a great appetite for the notion that the United States might engage with the rest of the world not as a broadcaster of some monolithic culture but as a sympathetic enabler of village-level democracy, plurality, and local knowledge."[111] This titular trope exemplifies everything wrong with large, nation-state development projects and the potential in small-scale development that grew in popularity in the 1950s and 60s.

Lessons learned from and reflected in *The Ugly American* contributed to the growing popularity of appropriate technologies in the 1960s and 70s. Engineers and technologists increasingly expressed that overdevelopment could be just as harmful as the threat that world

[110] William J. Lederer and Eugene Burdick, *The Ugly American*, [1st ed.]. ed. (New York: Norton, 1958), 2.

[111] Immerwahr, *Thinking Small : The United States and the Lure of Community Development*, 3.

leaders were claiming large swaths of world were falling victim to: underdevelopment. In Immerwahr's telling, this was part of a shift to do "development" without "modernization."[112]

In 1960, a group of engineers tied to GE and Union College in Schenectady, NY started a well-known appropriate technology organization that explicitly worked to diffuse technologies around the globe.[113] Volunteers for International Technical Assistance (VITA) later partnered with the United States Agency for International Development and diffused technological expertise through their publication *The Village Technology Handbook*.[114] This group believed that simple technologies could be packaged up, shipped, and implemented around the world. Among notable other groups like policymakers and Peace Corp Volunteers, this group teamed up with missionaries to diffuse their technological knowledge—after all, these were often people that were already connected to local communities to spread their theological perspectives, something that they could now do alongside sharing their 380 pages of simple schematics.[115]

Today, *engineers for good* largely borrow methods and language from small-scale development efforts, creating small technological solutions for people with "needs" around the world. These were, for the most part, technologies that were developed for other uses, but brought on new meaning when they were put in international aid contexts. These projects were cheap, simple, small-scale, creative solutions aimed at raising awareness about larger issues. Some engineers still use "appropriate technology" today, although many refrain for fear of its

[112] Separating these large geo-political motivations proved difficult. See Ekbladh, *The Great American Mission : Modernization and the Construction of an American World Order*. And Immerwahr, *Thinking Small : The United States and the Lure of Community Development*, 40-65.

[113] Wisnioski, *Engineers for Change: Competing Visions of Technology in 1960s America*, 130.

[114] Of which, over 20,000 copies were distributed. Ibid.

[115] Volunteers in Technical Assistance, "Village Technology Handbook," (VITA Publications, 1981).

technocentric and failed-gadgetry connotations.[116] Non-profit organizations like Engineers Without Borders-USA, discussed below, still use language of "appropriate solutions" in their literature and mission statement.[117]

Several small humanitarian engineering organizations have formed in response to the desire to help those that are underdeveloped and/or underserved. Notably, Christian organizations like Engineering Ministries International (eMi) started to blend both the desire to proselytize their faith and technical skills around the globe. Started in 1982, this small engineering non-profit works to "see people restored by God and the world restored through design."[118] Instead of seeing the world as under- and overdeveloped, this group sees the world as needing to be redeemed from sin rather than developed into an industrialized state.[119]

In 1975, learning from VITA and other engineers working in humanitarian contexts, the American Society of Engineering Education (ASEE) hosted an international conference to discuss how engineering students could be a larger part of international development. For this conference, 196 people representing 40 countries gathered in Estes Park, Colorado, at the start of multi-year initiative to "train and influence more engineers to be capable of an effective attack

[116] Interesting wiki catalogs appropriate technologies here: "Welcome to Appropedia," accessed November 12, 2020, https://www.appropedia.org/Welcome_to_Appropedia. Engineering for Change began to do something similar in 2012 through their Solutions Library "About Solutions Library," accessed November 12, 2020, https://www.engineeringforchange.org/solutions/about-solutions-library/.

[117] "We Build a Better World," accessed November 12, 2020, https://www.ewb-usa.org/.

[118] "Designing a World of Hope," https://emiworld.org/.

[119] For more on this form of faith-based restoration and a network of Christian engineers see chapter 3.

on world development problems."[120] Over the course of three days, participants discussed papers about "Resource Development" and "Human Settlements" among other large-scale development topics.

One of the major take-aways from this Congress was the consensus to educate engineers for working in international development using the "bank concept." This philosophical framing charged engineers to pay back the "withdrawal of non-renewable natural resources from any nation" with "a counterbalancing deposit which will enhance the quality of life of the human resources of the country."[121] For these engineers, "human development" in the form of "education, especially in the utilization of technology" became core to this reciprocal exchange in "favor of humanity."[122]

This World Congress painted a picture far removed from that of the "partnerships" of *engineering for good* of today. In fact, these engineers were trying to compensate for the natural resources that they had exploited, an apt form of penance in a region known for its rush to mine the American West's natural resources. This concept of "exchange," albeit in a different form, is still present in today's engineering for development work. *Engineering for good* is meant to be a partnership, a site to learn from two sets of expertise, that of the technical knowledge that the American engineers bring and the social and cultural knowledge that the partner communities possess. This is a stark contrast from the concept's origins in the 1970s, which framed

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[120] J. Morley English, William Leighton Collins, and Division American Society for Engineering Education. International, *Educating Engineers for World Development : Proceedings of a World Congress, June 10-12, 1975* (Washington: ASEE, 1975), 33.

[121]American Society for Engineering Education, October 1975, Engineering Education: World Congress Summary, 22.

[122] Ibid, 22.

engineering for development as recompense for what these educators saw as exploitative behaviors.

Where before Truman and Kennedy touted development as a gift that the developed world had to give, an embarrassment of riches that the westernized world must share, this new framing gave way to resource exchange. This ASEE World Congress created language that was the basis of a new field of study, borrowing from the appropriate technology movement and bringing the ideals of small-scale, localized problem-solving into the classroom and extracurriculars.[123] Since then, engineers have come to *engineering for good* trying to combine technical knowledge with helping the world's most needy, impoverished populations. Their attempts at creating space in engineering to be a part of a larger, global development plan did not come into full view until the early 2000s.

In the late 60s-70s, while VITA was active, there was a resurgence of radical engineering spurred by disapproval of the Vietnam War and broken promises of Cold War industrial service. In the 1970s, the Committee for Social Responsibility in Engineering (CSRE) represented the radical engineers of the left.[124] Through their publication SPARK (1971-75), CSRE criticized the "'oppressive' application of engineering skills and technology, with particular attention paid to the connections between engineering and military."[125] Less about social justice and more about

[123] See below for a look at the "appropriate solutions" of EWB-USA.

[124] Wisnioski, *Engineers for Change: Competing Visions of Technology in 1960s America*, 111-21.

[125] Dean Nieusma, "Engineering, Social Justice, and Peace: Strategies for Pedagogical, Curricular, and Institutional Reform" (paper presented at the American Society for Engineering Education, 2011), 3.

radicalism, this group "repudiated service to the corporation, to the state and to professional norms."[126]

The Origins and Resurgence of Social Justice

Today, an increasing number of engineers connect their vision of the good to "social justice." Social justice is often associated with the radicalism of the 1960s-70s, evoking a particular image of what the "good" is on a political spectrum. However, philosopher Martha Nussbaum has written that social justice is completely dependent on the political and social contexts in which it operates;[127] I add that the current social justice that *engineers for good* strive to enact is dependent on both social justice's religious history and current political leanings.

In 1923, Pope Pius XI first introduced the concept of *social justice* in Catholic writing in his encyclical *Studiorum Ducem,* an ode to Thomas Aquinas. Pius stated that it was the Church's responsibility to establish "sound principles of legal and social, commutative and distributive, justice and explaining the relationships between justice and charity."[128] Pius used this concept more frequently in later papal writings. In *Quadragesimo Anno* (1931), he established norms for distributive justice. Pius again focused on the social interaction between both employers and their employees and the property-owning class and the working class, stating that "one class is

[126] Wisnioski, *Engineers for Change: Competing Visions of Technology in 1960s America*, 122.

[127] Examples that exemplify this are found in Martha Craven Nussbaum and Jonathan Glover, *Women, Culture, and Development: A Study of Human Capabilities* (Oxford University Press, 1995).

[128] "Studiorum Ducem," accessed November 20, 2020, https://www.papalencyclicals.net/pius11/p11studi.htm.

forbidden to exclude the other from sharing in the benefits."[129] He charged public institutions to "conform to the needs of the common good; that is, to the norm of social justice."[130]

The rise of Social Gospel movement in the early 20th century led Protestants to become active in the Progressive Era's fight for labor reform. Walter Rauschenbusch published *Christianity and the Social Crisis* in 1907, a revolutionary synopsis of social gospel thought of the time.[131] The "social gospellers'" work had great impact on how Protestants engaged in civil life and the fight against the obsession of capitalist gains, prompted by the Industrial revolution.[132] Later, renowned American Reformed theologian Reinhold Niebuhr, who first preached the Social Gospel, revised his thinking, adding to mid-twentieth century liberal Christian theology. Niebuhr's "Christian realism" struck a balance between the optimism of the Social Gospel and the religiously conservatives' rigidly defined "true religion."[133]

The role of religion in defining and addressing the common good can be seen in its economic policies, as well as some of the secular, communist pushback that those policies received. Karl Marx and Friedrich Engels were particularly interested in thinking through progressive labor ideals—giving a voice to overworked and underpaid laborers.[134] The

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[129] "Quadragesimo Anno," accessed November 12, 2020, http://w2.vatican.va/content/pius-xi/en/encyclicals/documents/hf_p-xi_enc_19310515_quadragesimo-anno.html. 57, 58, 71.

[130] "Quadragesimo Anno," 110.

[131] Walter Rauschenbusch, *Christianity and the Social Crisis* (Macmillan, 1907).

[132] Charles R Strain, "Toward a Generic Analysis of a Classic of the Social Gospel: An Essay-Review of Walter Rauschenbusch, Christianity and the Social Crisis," *Journal of the American Academy of Religion* 46, no. 4 (1978): 525–43.

[133] Daniel F Rice, *Reinhold Niebuhr and John Dewey: An American Odyssey* (SUNY Press, 1993).

[134] Karl Marx and Friedrich Engels, *The Communist Manifesto* (Penguin, 2002).

Industrial Revolution was a pivotal era for questions of *justice*, motivating engineers to explicitly participate in questions of justice and equality.[135] All these theoretical camps Catholic, Protestant, and Communist, offered alternatives to just letting economic relationships "play-out" with a small government and little federal regulations, providing alternatives for fighting economic disparity.

However, Marx was vehemently anti-religious. Marx claimed that religion is the "sigh of the oppressed creature" and the "opium of the people."[136] Examination and comparison of his anti-religion and anti-capitalism critiques provide useful grounds for comparing how religious teachings related to economic structures during the time that Marx was writing.[137] However, Catholic leaders like Jesuit theologian Oswald von Nell-Breuning and Cardinal Reinhard Marx claimed that Karl Marx, even though a major critique of the church, was a foundational thinker in social Catholic teachings, specifically with regards to just wages.[138] These theologians argued that while they remain more capitalist and conservative in their teachings, the Church should learn from Marx, taking a more progressive, less materialistic view of labor relationships. Marxism was at odds with Catholic teachings for two reasons: first, Marx's outspoken anti-

[135] Caroline Baillie, "Engineers within a Local and Global Society," *Synthesis Lectures on Engineering, Technology and Society* 1, no. 1 (2006).

[136] Karl Marx, *Critique of Hegel's Philosophy of Right* (CUP Archive, 1977).

[137] John Raines, *Marx on Religion* (Temple University Press, 2002). Karl Marx, *Karl Marx: Selected Writings* (Oxford University Press, USA, 2000).

[138] "Cardinal Marx Pays Tribute to Karl Marx: The Archbishop of Munich and Top Papal Aide Says Catholic Social Teaching Is Indebted to Writings of the Controversial 19th Century Thinker," La Croix, 2018, 2020, https://international.la-croix.com/news/religion/cardinal-marx-pays-tribute-to-karl-marx/7573.

religious message, second, fears of aligning the church with communism and socialist ideals, which were antithetical to the Industrial Revolution and capitalist trends of the time.

This progressive movement of the mid-twentieth century was in stark contrast with the anti-communist sentiments of the post-WWII era. Marxism and social justice were anthems for rebels, cast as enemies to capitalism and American industrial supremacy. The Red Scare distanced the social justice movement from American identity. Social justice became the ideology that rallied the rebels of mainstream nationalism, activists in the civil rights and women's liberation movements of 1960s and 1970s.

Fighting for *social justice* is a popular rhetorical tool for contemporary political and social exchange. Religious conservatives and political liberals alike have a complicated history with the concept. Today, social justice is most commonly associated with liberal, progressive, and feminist movements which aim to protect and fight for marginalized populations broadly construed.[139] However, commentary by conservative theologians Michael Novak and Paul Adams reclaim social justice as a uniquely religious term, one that has Catholic origins, created for far different social and political configurations than how it is currently being used. Novak and Adams claim that social justice was first professed by Catholic leadership to keep state control to a minimum.[140] Regardless of its original origins, today social justice is used by religious and non-religious activists alike. The term carries rhetorical power for all who use it, despite having different meanings and interpretations for the "common good," making it inherently political.

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[139] E.g. Joyce M Bell, *The Black Power Movement and American Social Work* (Columbia University Press, 2014). Dorothy Sue Cobble, *The Other Women's Movement : Workplace Justice and Social Rights in Modern America* (Princeton: Princeton University Press, 2011). It is also worth mentioning here that politically liberal or progressives and religious people are not mutually exclusive.

[140] Michael Novak and Paul Adams, *Social Justice Isn't What You Think It Is* (Encounter Books, 2015).

Exploring the history of *social justice* exposes how it has been leveraged for political gains for different actors in dramatically different contexts.

Clearly, defining *social justice,* as Martha Nussbaum argues, is completely dependent upon the social and political context in which it is being legislated.[141] In the following chapters, this project describes how the languages of development, service, and social justice are navigated and leveraged in engineering. Engineering is often considered a conservative practice, one with "uncritical acceptance of authority."[142] But engineers also have "a desire to help . . . and the persistence to do it."[143]

The Rise of Engineering for Good (2000 to today)

Beginning in the early 2000s, a proliferation of new *engineering for good* efforts formed. Large non-profits began to enroll volunteers, while classrooms started developing appropriate curricula. Critical scholarship at the intersections of engineering and development and engineering and social justice rose. While service-learning as a practice and form of design teaching emerged, notably at Purdue University's Engineering Projects in Community Service (EPICS) program starting in the fall of 1995, extracurricular and scholarly communities began to form loosely around the concept of engineers learning from "real design for real people."[144]

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[141] Nussbaum and Glover, *Women, Culture, and Development: A Study of Human Capabilities*.

[142] While this is not a new critique to Riley, "Engineering and Social Justice," 42-43. it is a common sentiment that *engineers for good* in each of the institutions I visited studied and spoke directly to in their critical reflection of the engineering profession.

[143] Riley, "Engineering and Social Justice," 39.

[144] " EPICS Overview," https://engineering.purdue.edu/EPICS/about.; "Epics - Purdue University," https://engineering.purdue.edu/EPICS.; a popular text that humanitarian engineers at Baylor University referred me

EWB-USA's followed a much larger global trend in professional "Without Borders" nonprofits in the 1980s and 1990s.[145] Founded in 2002, EWB-USA now has both university and professional chapters working on projects in over 45 countries. EWB-USA, easily the most recognized *engineering for good* organization and one which at its peak boasted close to 17,000 members, states that their volunteers "build a better world through engineering projects that empower communities to meet their basic human needs."[146] Since EWB-USA's founding, hundreds of development engineering projects have been conducted by thousands of engineers in both student and professional chapters. While it is a popular mode of *engineering for good* and provides institutional backing in as diverse settings as its partner universities can be, it strives for a centralized approval process of the projects and assessment, design, and implementation processes.[147]

The appropriate technology movement of the 1960s and the move to make post-colonial technologies abroad have influenced mainstream *engineering for good* today. In fact, EWB-USA's claims that their top priority is to make "true partnerships" to "identify and implement

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to was co-authored by the director of EPICS, William Oakes, is Marybeth Lima, William C Oakes, and John L Gruender, *Service-Learning: Engineering in Your Community* (Great Lakes Press Wildwood, MO, 2006).

[145] Médecins Sans Frontier (MSF, translated to English as Doctors Without Borders) and many others, see an interesting list of these professions "without borders" here: "List of without Borders Organizations," accessed November 15, 2020, http://self.gutenberg.org/articles/list_of_without_borders_organizations.; EWB-USA is one of many in-country branches of EWB-International.

[146] "EWB-USA: Our Story," https://www.ewb-usa.org/our-story/about-us/.

[147] There was a trend of moving away from this centralized model at all three programs I observed through different institutional models, either creating equivalents or rejecting the model by focusing on local needs more cyclically than complying to linear process.

appropriate solutions that communities are equipped to maintain for years to come."[148] In other words, what was the extremely value-laden version of engineering in the 20th century has now become common practice and politically neutral rhetoric in engineering for development today.

Engineering a Sustainable World was also founded in 2002, reaching a peak of 4000 volunteers. As of this writing, it now has 1,750 volunteers "working to build a better work through hands-on projects" in over 50-chapter sites in the United States and Canada.[149] The organization focuses on domestic environmental or sustainability issues. While they are different from EWB-USA in that they focus on domestic issues opposed to international ones, especially in their earlier years they shared common principles with EWB-USA like "collaborative partnerships." They are also "committed to building a world where all people enjoy the basic resources to pursue healthy, productive lives, in harmony with each other, and with our earth."[150]

The need to concretize the goals of engineers working within development is not unique to specific organizations. The United Nation's (UN) Sustainable Development Goals sometimes serve as a vague set of "goals" for engineering for development.[151] In 2015, the United Nations' replaced its Millennium Development Goals with *The 2030 Agenda for Sustainable*

[148] "Approach & Solutions," accessed November 25, 2020, https://www.ewb-usa.org/our-work/approach-solutions/. Emphasis added.

[149] The organization was originally named Engineers without Frontiers, but changed their name in 2004 "Center for Transformative Action," https://web.archive.org/web/20110419050200/http://cta.sas.cornell.edu/esw.php. and "Home | Engineers for a Sustainable World," https://www.eswglobal.org/.

[150] "Center for Transformative Action."

[151] A couple examples include: internationally Royal Academy of Engineering, "Engineering a Better World." https://www.raeng.org.uk/publications/other/engineering-a-better-world-brochure.; IMPACT. Engineered 2020 conferences advertises an opportunity to learn about engineering and SDG here: "Impact.Engineered 2020," accessed November 25, 2020, https://www.impact-engineered.org/.

Development, naming 17 Sustainable Development Goals (SDG) included "no poverty (1)," "clean water and sanitation (6)", "industry, innovation and infrastructure (9)," and "peace, justice and strong institutions (16)."[152]

The 2017-2019 President of the World Federation of Engineering Organizations, Marlene Kanga, claimed "engineers are critical to advancing the SDGs." Specifically addressing the goal of "peace, justice, and strong institution," Kanga claimed that "SDG 16 on the governance of organi[z]ations is a foundation[al] SDG, because this then enables individuals to work within a framework of an organi[za]tion that is well run, has good systems and process, is not corrupt, is an ethical organization, and provides equal opportunities for all."[153] Here, Kanga blended large geo-political development goals with engineers' ability to participate in localized social justice efforts.

Engineering for Change (E4C), a nonprofit and network for *engineers for good* broadly defined, was founded first by ASME (originally American Society of Mechanical Engineers, 2009) and later partnered with Institute of Electrical and Electronics Engineers (IEEE), and EWB-USA in 2011. This organization, headquartered with ASME in a New York City office on Park Ave, organizes the Impact.Engineered event which "celebrate[s] cutting edge work solving humankind's biggest challenges and building a better future."[154] In 2019, E4C's Digital Community, an "open-access network and knowledge hub" boasts "one million active followers

[152] "The 17 Goals | Sustainable Development," https://sdgs.un.org/goals.

[153] Transcribed podcast here: "Engineering Leaders Podcasts Sdg 16 - Marlene Kanga," http://www.wfeo.org/podcast-engineering-leaders-sdg-16-marlene-kanga/.

[154] "Impact.Engineered 2020."

worldwide" with E4C membership at over 35,000.[155] E4C also hosted 61 Research Fellows, who worked part-time to maintain and add to E4C's "Solutions Library," which houses "products and services" that are "publicly promoted as solutions that are accessible and *appropriate* for those living in poverty or resource constraint."[156]

At the same time EWB-USA and ESW were founded ('02-03), *engineering for good* also became popular in the classroom and in small spin-off student extracurriculars. For a few examples, the first humanitarian engineering minor was developed at the Colorado School of Mines, Baylor University started their faith-based student group Engineers With a Mission, and Amadei started Engineering for Developing Communities (EDC, now Mortenson Center for Global Engineering) programming at CU-Boulder while founding EWB-USA.[157] These few years saw a rapid increase in the number of participants in *engineering for good* programs.[158]

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[155] "Engineering for Change (E4c) Digital Community," accessed November 26, 2020, https://www.asmefoundation.org/programs/ideas-that-innovate/engineering-for-change-e4c-digital-community/#:~:text=Engineering%20for%20Change%20Digital%20Community,of%20important%20global%20development%20issues. "ASME by the Numbers 2019," accessed November 26, 2020, https://www.asme.org/wwwasmeorg/media/resourcefiles/aboutasme/asme-by-the-numbers.pdf.

[156] Change, "About Solutions Library;" Emphasis added.

[157] "History - Humanitarian Engineering," https://humanitarian.mines.edu/history/. a faculty member at Baylor University commented to me how "they almost were the first" talking about how their Engineers With a Mission was founded at about the same time as CSM's program. More on CU-Boulder EDC, now Mortenson Center in Global Engineering in the next chapter "Our History | Mortenson Center in Global Engineering," https://www.colorado.edu/center/mortenson/about-us/our-history.

[158] For more information about the minor, see chapter 2; for more information about Engineers with A Mission, see chapter 3. For an inexhaustive list of these programs, see Appendix A.

Next came an influx of literature that served as both definitional and aspirational precedents for *engineers for good.*[159] Critical scholars and practitioners began publishing in a popular book series by Morgan and Claypool Synthesis Lectures on *Engineers, Technology, and Society* edited by Caroline Baillie.[160] The series currently has 24 volumes that broadly address themes at the intersection of engineering practice and society written for both practicing engineers and as a teaching resource for *engineering for good* coursework. *Engineers for good* across the country currently refer to the *Humanitarian Engineering* book by Carl Mitcham and David Muñoz (2010) and *Engineering and Sustainable Community Development* by Juan Lucena, Jen Schneider, and Jon Leydens (2010) as foundational texts.[161] More recently, and outside of the Morgan and Claypool series, *Engineering Justice* by Jon Leydens and Juan Lucena (2018) became a popular text used to apply philosopher Martha Nussbaum and Amartya Sen's "human capabilities model" to engineering practice.[162]

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[159] For one notable piece specifically looking at engineering and development, see Dean Nieusma and Donna Riley, "Designs on Development: Engineering, Globalization, and Social Justice," *Engineering Studies* 2, no. 1 (2010).

[160] "Synthesis Lectures on Engineers, Technology and Society," accessed November 12, 2020, https://www.morganclaypool.com/toc/ets/9/2.

[161] Mitcham and Muñoz, "Humanitarian Engineering." Juan Lucena, Jen Schneider, and Jon A Leydens, "Engineering and Sustainable Community Development," *Synthesis Lectures on Engineers, Technology, and Society* 5, no. 1 (2010).

[162] Jon A Leydens and Juan C Lucena, *Engineering Justice: Transforming Engineering Education and Practice* (John Wiley & Sons, 2017).; This book and its normative criteria were core to the *Engineering and Social Justice* course which I observed at USD. For more on these books, see chapter 2. For more on "human capabilities model" see Nussbaum, *Creating Capabilities : The Human Development Approach;* Amartya Sen, *Development as Freedom*, 1st ed. ed. (New York: Knopf, 1999); Amartya Sen, *The Idea of Justice* (Cambridge, Mass.: Belknap Press of Harvard University Press, 2009).

As described above, increasingly, "social justice" has replaced both "international development" and "humanitarianism" in *engineering for good* practice and pedagogy. Engineering, Social Justice, and Peace (ESJP) is a network of activists, engineers, and academics that come together each year to work through the complicated features of the intersection of its titular themes.[163] Their annual conference themes have included: "Grounded in Community, Engaged in Praxis (2008)," "Engineering for Development (2013)," and "Removing Borders among Disciplines (2019)."[164] This network also publishes *The International Journal of Engineering, Social Justice, and Peace.*[165] There is generous overlap between active members of the ESJP network and authors in the Morgan Claypool Synthesis Lectures series described above.

In 2008, engineering education scholar Donna Riley provided a practical tool for engineers to think through epistemological tensions and harmonies between engineering and social justice, describing the distinction between the profession and a set of common "engineering mindsets" in her book *Engineering and Social Justice.*[166] Along with the "engineering mindsets" tool, this book provided working definitions of social justice and case studies that can be used in engineering classrooms.[167] But a book like this is controversial in its existence. As Riley wrote in the book's preface, "this book offers a critique of the engineering profession and drives at the heart of its biases in worldview and thought as well as practice."

[163] "Engineering, Social Justice, and Peace."

[164] "Engineering, Social Justice and Peace," https://sophia.smith.edu/~driley/esjp.html; "ESJP 2013," http://esjp.org/esjp-conference/esjp-2013; "ESJP 2019," http://esjp.org/esjp-2019.

[165] "ESJP Journal," http://esjp.org/journal.

[166] Riley, "Engineering and Social Justice," 33-46.

[167] I witnessed talking through "engineering mindsets" at two of the three universities that I observed.

Riley added though, that "the critique of engineering may come across to some as an attack."[168] While Riley denies that intention, this declaration highlighted the risks of drawing attention to the potential for connecting social justice and engineering.[169]

Engineers for Good Today

In the following chapters, I will show how these large movements are being represented in classrooms, engineering design spaces, and *engineering for good* projects based around the country. I chose to study three university programs—Colorado School of Mines, Baylor University, and University of San Diego—and their networks of *engineers for good* to show the diversity of values and modes of practice enacted in a wide variety of settings. It is important to see both the similarities and differences among these programs and their engineers to both describe the movement's past and its potential futures.

The *engineering for good* movement is not one thing. It lives with the complex legacies that I have described in this chapter and seeks to draw on them while remaking these movements. *Engineers for good* particularly draw on these large political and social movements with respect to the range of tensions that stem from assigning need. Whether it is the unequal distribution of Americans' "inexhaustible" benefits from our scientific knowledge and "industrial progress" as Truman suggested, or the indescribable humanitarian drive in individuals just wanting to do good, *engineering for good* efforts come in all shapes in sizes.

[168] Riley, "Engineering and Social Justice," iv.

[169] For more on this vulnerability see chapter 4 and Alice L Pawley et al., "Panel Session: Targeted Harassment in Engineering Education: What It Looks Like, Why Now, and What Is at Stake" (paper presented at the ASEE Annual Conference and Exposition, Conference Proceedings, 2019).

I argue that *engineers for good* navigate complex dimensions of assessing and assigning need as they decide what it means to do their work well. These new humanitarians do not simply engage in pro bono efforts done for new users that cannot afford their traditional services. They are creating a new type of engineering to address newly recognized forms of need. Those involved in *engineering for good* redefine what engineering can and should be used for by drawing on larger values to pursue their purpose and reconcile this purpose with their professional identity. This inquiry contributes to scholarship that explores how engineering for positive change is in tension with core goals, institutions, and practices of the engineering profession.[170]

Engineers for good construct the needs of others around the world. Progress towards good is now justified by identifying large-scale social injustice, inequality, and human rights violations and change is enacted through development, humanitarian service, and social justice. All these justifications and calls to enact change have complicated histories. While religious values are a part of assessing need for international development and humanitarian aid, in many current instantiations of *engineering for good* these histories are now avoided, or at least carefully maneuvered, by student and pedagogue alike. This dissertation is about those that fully embrace those religious roots, those that actively critique them, and those that live somewhere in between.

[170] For e.g. about these tensions in the engineering profession from 1870s-1940s see Layton Jr, *The Revolt of the Engineers. Social Responsibility and the American Engineering Profession.* And in the "long 60s" see Wisnioski, *Engineers for Change: Competing Visions of Technology in 1960s America*.

Chapter 2

"Engineering as it Should Be": Addressing Tensions of Development and Compassion Through Humanitarian Engineering Expertise

A member from a team of engineering students timidly asked, "We were wondering if you have plans to pave the roads?" The group's translator relayed this question to the rural Ugandan town council's office filled with local business leaders, and the room erupted in cheers. The students exchanged glances, realizing there has been a mistake, but no one corrected the translator or the response by the room. The four-person team walked away from the meeting, confused about the promises that they had just made. They came to this rural community in Uganda to assess the viability of a requested solar lighting system for the main veins of the community, from market center to the most prominent school in the region. They went to see if there was need for their original project and whether the project was something that they could and should provide.[171]

Two of the students had land surveying and soil testing experience, so that is what we spent most of the 10-day solar lighting assessment trip doing.[172] I served as one of the team's chaperones and we all watched, as one student tasted the dirt to see how gritty it was using an old field guide for civil engineers given to them by their other chaperone, a bridge engineer. The taste test told them about the potential for dirt to hold the poles for solar lamp posts.

An Arlington, Virginia based non-profit sponsored the private academy that the American students came to work with, which is known as one of the best schools in the area and allows only one student from each family to attend due to demand. The student body of the school greeted the American students with an assembly, our hosts encouraged pictures, and the

[171] Fieldnotes taken on June of 2019 assessment trip to Uganda.

[172] Most remaining time was spent in the nonprofit sponsor's guest house, as we were escorted around the town for a majority of our work.

Ugandan children sang and danced to a choreographed song thanking God for bringing the engineers into the town to bring light to their community. There were obviously complicated politics at play.

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This chapter highlights the critical tensions in humanitarian engineering (HE) at Colorado School of Mines and how engineers both rely on and distance themselves from the history and redefinition of development.[173] As described in the previous chapter, *engineering for good* is, in part, in direct response to past international development efforts. This chapter provides grounded evidence and critical analysis for how engineers work within and through the tensions of needs assessment. Development serves as both a useful way to distinguish how HE is different than traditional engineering disciplines and makes it a vulnerable target for neocolonial critique.[174]

The HE program at CSM is one of the most well-known *engineering for good* programs in the United States.[175] This program has two decades' worth of practice defending how

[173] A note here about language. "Humanitarian engineering (HE)" is emic language commonly used by the students and faculty at CSM. This is so common that students often refer to it as "HE" or describe part of themselves and engineering problems of having an "HE-side" to me and each other. While this language is common at CSM, it is not adopted by all *engineers for good.*

[174] See Nieusma and Riley, "Designs on Development: Engineering, Globalization, and Social Justice." for applicable cases in Nicaragua and Sri Lanka

[175] In this chapter I will focus on its orientation to development, although there is a lot to say about how development (and this solar lighting project, in particular) is just a small piece of HE at CSM, which I will describe, albeit briefly, later in this chapter. In future work, I hope to cover, in more detail, how HE expertise prepares students for corporate engineering settings as well, through corporate social responsibility (CSR) research-informed pedagogy. For more on this see Jessica M Smith, Carrie J McClelland, and Nicole M Smith, "Engineering Students'

engineers can and do participate in development. The program had an original focus on humanitarian action, particularly within developing contexts, then shifted with CSM faculty developing a rigorous theoretical framing for "engineering for sustainable community development," and the program has recently reframed itself as "engineering justice," something that provides skills and experiences valuable to *all* engineers, or "engineering as it should be."[176]

In this chapter, I first describe the complicated tensions of needs assessment in development-based *engineering for good*. I then depict important *engineering for good* nonprofits in central Colorado in the 1980s, concluding with the founding of EWB-USA in 2002. These nonprofits placed CSM in Golden, CO in the center of a region of engineers concerned with "helping" people with technology, as an institution with critical scholars developing nuanced understandings of what that means. I also describe how this site serves as a secular space for good and introduce how students are reframing their experience in Christian missions as valuable, yet different, than HE at CSM. I conclude by describing what is at stake when forming a normative vision for what HE can be—coping with neocolonial critiques, establishing

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Views of Corporate Social Responsibility: A Case Study from Petroleum Engineering," *Science and Engineering Ethics* 23, no. 6 (2017). Jessica M. Smith, "From Corporate Social Responsibility to Creating Shared Value: Contesting Responsibilization and the Mining Industry," in *Competing Responsibilities: The Ethics and Politics of Contemporary Life*, ed. Susanna Trnka and Catherine Trundle (Duke University Press, 2017).

[176] See Mitcham and Muñoz, "Humanitarian Engineering."; Lucena, Schneider, and Leydens, "Engineering and Sustainable Community Development;" This tagline is on top of their program's banner on their newsletter and it also accompanies a normative charge to "join this wave of educators" committed to being "responsive to the needs and problems of the underserved," xxv, tying "underserved" as needs assessment denotation to a normative vision of engineering.

and sustaining academic recognition for this work, and questioning if and where humanitarian engineers' skills and professionalization apply outside of development contexts.

Development as Needs Assessment

The student team, described above, often mentioned how they were partnering with "the community," not simply providing a service or charity. In fact, as the team assessed whether they would continue with the project after this first assessment trip, all the students involved voiced some concern.[177] They spoke of how they had "fought for the project" before arriving and how they were hesitant because their organization knew that the community had already installed a solar light lamp post on their own. One of the students mentioned that their peers were worried that "there wouldn't be a technical thing, they just want you for money."[178] The engineers' concern over not wanting to provide *just* charity led to other tensions. While reflecting on the assessment trip, the students questioned whether there would be enough "technical" work for their extracurricular student group, Mines Without Borders (MWB). It was important that the extracurricular group received some practical learning experience in exchange for this technical product and knowledge.[179]

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[177] For a typology of "the community" in *engineering for good* contexts see Juan Lucena, Jen Schneider, and Jon. A. Leydens. "Making the Human Dimensions of Sustainable Community Development Visible to Engineers." *Proceedings of the Institution of Civil Engineers: Engineering Sustainability* 164, no. 1 (2011): 13-23.

[178] Interview S22.

[179] Mentioned in post-assessment interviews S22, S23, and S24. Others in service-learning educational research have thoroughly examined this phenomenon, asking who this type of service learning truly helps. For a detailed case study of this line of inquiry see LaPorte, Kim, and Smith, "Engineering to Help Communities or Students' Development? An Ethnographic Case Study of an Engineering-to-Help Student Organization." See also Nieusma and Riley, "Designs on Development: Engineering, Globalization, and Social Justice."

The student group traveled to Uganda because they—in partnership with a state-side member of this Ugandan community—perceived an overt need, but as one student claimed in the group's annual banquet speech, they did not view the communities they work with "in a state of need nor a state of dependence. They want to increase the opportunities available for themselves and their children and improve upon their current circumstances, much like you and me."[180] The students hesitated to assign need to anyone for fear of looking oppressive and paternalistic. In fact, they were sure to do the opposite and almost exclusively listened.

Figure 2.1: The Colorado School of Mines students participate in a town council and business leader's meeting in rural Uganda

The students saw their primary role as "contextual listeners."[181] The students were regularly silent because they were inexperienced in solar energy and they also were aware of, but

[180] Banquet speech from notes and script April 2019.

[181] "Contextual listening" is foundation to the criteria for engineering for sustainable community development outlined in Lucena, Schneider, and Leydens, "Engineering and Sustainable Community Development."

not well-versed in, the critical scholarship of the HE curriculum taught at Colorado School of Mines. In other words, they knew that they could harm others in their work but did not know how to move on from this warning, preventing them from moving forward quickly. The students were gathering as much information as possible to let their student club make big projects decisions when they got back to campus.

The group of engineers often mentioned that they were involved in an "exchange" or "partnership" recognizing the neocolonial critique that this "western" group is just in rural Uganda to provide aid. The students were learning a lot about the design process, civic governance, and regional customs. Though, even during the trip back to the United States, students voiced it was still unclear what exactly the engineers could or would provide to the community. The student representatives justified this uncertainty with the claim that they were there for an "assessment trip." But the local Ugandan nonprofit and government leaders knew that that meant that the group might not come back, and they often clued the American team in on just how important it was that they return.[182]

Early development scholars of the 1990s argued that international initiatives done in the name of "development" are a reframing of colonial power structures.[183] Postcolonial critics argue that post-World War II politics and economics created the division between the First World and Third World, the "haves" and the "have nots."[184] This distinction blurs with the adoption of terms like the "Global South," which draws attention to geographical positioning rather than

[182] These fieldnotes were all taken in a short "assessment trip" in June 2019 with the student group. All of the students voiced these concerns in post-trip interviews.

[183] Ferguson, *The Anti-Politics Machine:'Development', Depoliticization and Bureaucratic Power in Lesotho*.

[184] Escobar, *Encountering Development : The Making and Unmaking of the Third World*.

economic standing. “Global South” gives less power to hegemonic, colonial powers of the past, but much of the connotation—a non-industrialized region, striving to industrialize on a national scale—still lingers. As one student mentioned reflecting on the critical development scholarship and past engineering for development failures featured in their HE-course, “one thing that wasn’t settling at the end for me was I left with the question of like, should we even be like, in foreign countries, in low-income countries working on engineering projects at all?[185]

Gross Domestic Product (GDP) and Human Development Index (HDI) are still regularly used as standards of need, less frequently by small scale-*engineering for good* programs, but by large aid organizations. In fact, the United Nations Development Program uses HDI, a combination of three indices—life expectancy, education, and growth national—to determine those that need their aid.[186] A low HDI is reason for partnering with a country, and until these development standards improve and become more localized, development practitioners within industrialized countries see the standard as reason for intervention. However, regions assigned with low HDI’s are heterogenous; therefore, these standards rarely translate to individual’s needs, or at least the relationship between large nation-state geopolitical relationship and engineering needs can be difficult to parse. While *engineers for good* often justify participation in international projects by showing that a region is in need, it is not until they select a specific project that needs are translated to the local or individual levels.[187]

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[185] Interview S16.

[186] "Human Development Reports," accessed November 30, 2020, http://hdr.undp.org/.

[187] For example, these countries can sometimes be lumped into “developing countries.” Clearly there is disparity in wealth within “developed countries” like in the United States; but this complexity is often not discussed. These assumptions of homogeneity are usually fought with “listening contextually” (described below), but nevertheless, engineering students often operate with “developing countries/regions” as a conceptual framing.

In the case of the solar lighting system in rural Uganda, a US-based nonprofit had personal connections with one of the students. This personal contact conveyed to the student that there were a number of needs in the community, but that the solar lighting would be a good place to start and MWB's need for a new project spurred their engagement.[188]

The students on this trip and other committed HE-students have a robust "do no harm" attitude. Other active HE students are aware of critiques of development and have learned from failed case studies of the past in class and their HE-project involvement.[189] They relied on principles of "sustainability" and "contextual listening" to participate in "HE-like" projects such as the large NSF-funded Partnership in International Research and Education (PIRE) project and their individual senior design projects. [190] In addition, the constraints of the semester, and coursework, did not always allow for "good" to be fully achieved with one group of students. These projects are often used as a learning exercise for future application of lessons learned.[191] In other words, there are often "future implementation plans" that go unexplored.

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[188] All EWB projects in Nicaragua in '18-'19 were suspended to online/virtual implementation because of civil unrest; Mines Without Borders was currently looking for a new project when the student with the personal connection to the community was in the extracurricular's student leadership. They also wanted something beyond a "water project" because that is what they were doing in Nicaragua for several years prior. Interview S17.

[189] The most "active HE students" are Schultz scholars, a scholarship program designed for students to dedicate some of their studies and extracurricular time to HE community building and research.

[190] For more on PIRE see: "NSF Award Search: Award#1743749," accessed November 30, 2020, https://www.nsf.gov/awardsearch/showAward?AWD_ID=1743749.

[191] The interplay between engineering education and actual development practice is again explored in Nieusma and Riley, "Designs on Development: Engineering, Globalization, and Social Justice." and LaPorte, Kim, and Smith, "Engineering to Help Communities or Students' Development? An Ethnographic Case Study of an Engineering-to-Help Student Organization."

Assigning need in humanitarian engineering is what sparks neocolonial critique.[192] It is as soon as humanitarian engineers either 1) assume a region needs their "help" or 2) venture to ask whether their skills could be used in a particular setting do critical scholars and practitioners begin to question these engineers' motivations. In higher education contexts, these engineering students assigning need have relatively little experience assessing and/or addressing problem definitions on their own.[193] The suspicion of educators, critics, and savvy on-lookers is heightened when the project involves engineers from industrialized regions supplying engineering expertise to "developing" communities.

While needs assessment has long been a part of engineering design, humanitarian engineers' needs assessment is quite different. "Basic human needs" have been central to engineering for development needs assessment.[194] Playing on images of those around the world "in need" and how those with excess can begin to help has been a part of the major dominant humanitarian discourse for over 100 years. Depictions of "the poor" have impacted how need is

[192] Courses developed in *Human Centered Problem Definition* at CSM push students to think through just how much problem definition *should* be a part of engineering. For more on Problem-Definition and Solution see: Gary Lee Downey, "PDS: Engineering as Problem Definition and Solution," in *International Perspectives on Engineering Education* (Springer, 2015), 435-55.

[193] LaPorte, Kim, and Smith, "Engineering to Help Communities or Students' Development? An Ethnographic Case Study of an Engineering-to-Help Student Organization."; Again, courses like *Human Centered Problem Definition* provide space for practicing this practice.

[194] James C. Scott, *Seeing Like a State : How Certain Schemes to Improve the Human Condition Have Failed* (New Haven: Yale University Press, 1998). This was present in Truman's speech discussed in chapter 1; "basic human needs" is also core to EWB-USA's mission "Mission & History," accessed November 30, 2020, https://www.ewb-usa.org/mission-and-history/.

assessed both within the U.S. and abroad.[195] Conceptions of "helping" through development play into images of "depravity" and extreme poverty, mixed with geopolitical politics, allow *engineers for good* to evade local issues. But, in response and most recently, there has been a refocus on local needs in the form of social justice to combat these critiques.[196]

How did these students end up working in Uganda and what did they feel that they could provide the community? This student organization mimics a common model of engineering for development— small groups of technical professionals working in regions that the U.S.-based engineers perceive as having need, but they are hesitant to assign or confirm the need outright. Even in an institution of higher education that focuses on theorizing what humanitarian engineering (HE) is like, Colorado School of Mines, these students traveled to an engineering for development site with a complicated and contentious relationship to needs assessment. This is in part because they are tapping into a movement that is bigger than just the institution, one that was founded by a network of *engineers for good* setting precedence for how you "partner" with the "underdeveloped."[197]

Colorado's Place in the Origins of Engineering for Development

There is something unique about the landlocked area of central Colorado. As I described in my first chapter, the ASEE World Congress in Colorado spurred interest in an engineering education for "world development" in the mid-1970s.[198] Currently, there are non-profits and universities

[195] See chapter 1 for more details on this history.

[196] There was increasing focus on local *engineering for good* efforts at all three university locations.

[197] This "underdeveloped" language harkens back to Truman-Era development rhetoric, see chapter 1.

[198] English, Collins, and American Society for Engineering Education. International, *Educating Engineers for World Development : Proceedings of a World Congress, June 10-12, 1975*.

that focus on *engineering for good* in developing contexts, speckled throughout the state. Both individuals and institutions helped shape engineering for development, creating norms for what technical work for good is and what it should become. From engaging in international conversations about how engineers are involved in development to creating small and intimate settings to bring "appropriate solutions" to those in need, Central Colorado has set the standard for engineering for development. In addition, CSM, since its curricular development began in 2003, called this work "humanitarian engineering," a scholarly and practitioner apparatus that easily travels across the country (and, in turn, the world) as practical normative criteria for technical work, textbooks, and widely accepted academic literature.

But how did this region become so central to engineering for development? In 1982, engineer Paul Polak traveled to Somalia and found the need for a redesign of an animal-drawn cart. Focused on building a customer base of the world's other 90%, he famously asked design professionals to treat people in developing nations like those stateside, as consumers ready to buy engineers' products. With a former career in psychiatry, Polak retooled his skills for analyzing human behavior to design and sales in the developing world.[199] With an eye towards customer feedback and strongly favoring affordability, Polak designed for the 5 billion living in poverty.[200] He started several international development ventures that aimed to create markets in developing regions. His strategies are still mimicked today, with many engineers borrowing language from his two books, particularly *The Business Solution to Poverty*, emphasizing that

[199] "A Tribute to Paul Polak," 2019, https://www.ideglobal.org/story/tribute-to-paul-polak.

[200] Paul Polak and Mal Warwick, *The Business Solution to Poverty : Designing Products and Services for Three Billion New Customers*, First edition. ed. (San Francisco: Berrett-Koehler Publishers, Inc., 2013).

engineers should speak to one hundred "consumers" before they make any design decisions; Polak believed that consumers justify the design process.

Consumerism was less of a focus for the beginnings of an evangelical engineering nonprofit based out of Colorado Springs, Engineering Missions International (eMi). For Michael Orsillo, he was inspired by a mission's trip to Saipan. He returned, less ready to make more consumers than to help build an army of believers. In 1982, the structural engineer came back to the States with the desire to "mobilize design professions to minister to the less fortunate in developing nations."[201] The mission of the organization has since shifted from the short-term model to one with in-country offices providing sustained contact and communication, but Orsillo's original vision, of an evangelical Christian *engineering for good* organization, remains.[202]

Engineers Without Borders-USA was born out of engineer Bernard Amadei's vision for helping those still trying to "meet their basic human needs."[203] Now headquartered in Denver, and founded in 2002, EWB-USA helped make central Colorado the epicenter of providing engineering solutions by American engineers for developing regions around the world. In 2000, Amadei's life-altering inspiration took place in Belize. He noticed that there was a group of Indigenous Mayan children that could not attend school because of how much time and energy it took to collect water.[204] He established EWB-USA to solve what he saw as the problem in this

[201] Anna Seeley, "History of eMi," (2019). https://prezi.com/p/wvj5riuhlg2v/history-of-emi/.

[202] "Designing a World of Hope," accessed November 25, 2020, https://emiworld.org/.

[203] EWB-USA, "Mission & History."

[204] Mortenson Center, "History." https://www.colorado.edu/center/mortenson/sites/default/files/attached-files/edc-history_v3_final.pdf.

community, and now hundreds more communities around the world.[205] He saw a gap between technical knowledge and physical need. Amadei frequently quotes Polak, justifying that these people have needs just like the "richest one billion," which Amadei believes is the consumer base engineers usually have in mind when designing new products.[206]

Amadei blends engineering's ability to provide a new market with its potential to be a source of empowerment. He espouses both the necessary "outer work" that he interprets Polak prioritized through the production of new markets for appropriate technology, and the "inner work" that is core to Orsillo's vision for humanitarian engineering.[207] Amadei claims that the work that he does is "engineering with soul."[208] While he sees the need for charity, he thinks that just scratches the surface. At a panel about engineering leadership, Amadei denounced pure technology transfer, claiming that "dump[ing] another technology on the poor people of the world" is a "crime against humanity." [209] Amadei claims that it is about "teaching them to fish and ensuring a market for their fish."[210]

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[205] See chapter 1 for more information on Amadei, CU-Boulder's Mortensen Center, and EWB-USA.

[206] Amadei, "Technology with Soul."

[207] Amadei's "inner work" is not explicitly religious, but rather promotes "compassionate" politicians and leaders in Amadei, "Technology with Soul."

[208] Along with the TedX talk, Amadei advertised that he was writing a book *Engineering with Soul* in 2008, no book with that title has been published by Amadei. In "Bottom-up Approaches to Global Poverty," 2008, accessed November 30, 2020, https://www.baylor.edu/ifl/index.php?id=948375.

[209] Alan S. Brown, "Are Engineers Ready to Lead: ASME Decision Point Dialogue," *ME Magazine*, July 1, 2013, 37, https://asmedigitalcollection.asme.org/memagazineselect/article-pdf/135/07/32/6358458/me-2013-jul1.pdf.

[210] Brown, "Are Engineers Ready to Lead: ASME Decision Point Dialogue," 38.

While Amadei and EWB-USA are most widely known for engineering in developing contexts, Colorado School of Mines is known for theorizing and articulating what "humanitarian engineering" is and can mean. In 2003, faculty started the first humanitarian engineering minor at CSM, just a twenty-five-minute drive south of EWB-USA's founding university, CU-Boulder. Humanitarian engineering at CSM has evolved from an engineering for development effort to a site that standardizes an integral set of skills that all engineers can use. The transition is more than 15 years in the making. The William and Flora Hewlett Foundation supported faculty working within engineering and liberal arts and international studies to help develop the practice and study of humanitarian engineering at CSM.[211] Spurred by the Hewlett Foundation funds, these faculty members, with the help of championing administrators, developed the first HE-specific courses including *Humanitarian Engineering Ethics*.[212] In tandem, David Muñoz, originally trained as a mechanical engineer, served as the faculty advisor for many of the first international, experiential learning projects. Then, the field, and this program, went through a series of disciplining stages to respond to both academic debate and practical experience.

Disciplining Humanitarian Engineering

Since the HE minor's founding in 2003, the field has gone through a series of transitions. At CSM, the practice, critique, and reframing of development and the building of happens simultaneously. Having to prove that it is a "rigorous" part of engineering education, in contrast to traditional systems and "problem-solving" and quantitative courses, humanitarian engineering faculty at Colorado School Mines created a set of standardized criteria which both faculty and

[211] "History - Humanitarian Engineering."

[212] Interviews F7 and F13. I've heard HE profs around the country say that they were "right behind" CSM in making it official; the race to be first is real!

students implement in their own program. This criterion also helps CSM's scholarship travel to other *engineering for good* programs.[213] Humanitarian engineering scholars and educators train students to define their own problems.[214] Critical STS scholars, engineering education scholars, and anthropologists now work with practicing engineers and design experts to both theorize HE and participate in development work in the HE program. At CSM, along with the more common extracurricular activities in engineering and development, a series of texts helped shape both academic and practitioner discourse in engineering for development.

In 2009, three CSM professors—engineering educators and critical scholars (Lucena, Schneider, and Leydens)—published *Engineering and Sustainable Community Development*, a book accessibly written for practicing engineers.[215] This book laid the groundwork for normative criteria for participating in humanitarian engineering and engineering service. It guides engineers to do this work well.[216] At this same time, sustainability and "sustainable solutions" become popular rhetoric tools for *engineers for good*, borrowed from environmental movements and used in response to critical reflections that engineering for development's products rarely work

[213] Leydens and Lucena, *Engineering Justice: Transforming Engineering Education and Practice*. These criteria travel quickly, I have observed other faculty at other universities use these criteria in their own coursework and projects. E.g. These criteria are core to *Engineering and Social Justice* curriculum at USD.

[214] The development of the course, *Human Centered Problem Definition* and *Projects for People,* for example, provides student's space to practice this. Downey, "PDS: Engineering as Problem Definition and Solution."

[215] Lucena, Schneider, and Leydens, "Engineering and Sustainable Community Development."

[216] For a look at the criteria for sustainable community development, based on "Bridger and Luloff criteria" Jeffrey C Bridger and Albert Elliot Luloff, "Toward an Interactional Approach to Sustainable Community Development," *Journal of rural studies* 15, no. 4 (1999): 126. see Lucena, Schneider, and Leydens, "Engineering and Sustainable Community Development," 192.

for long after the engineers leave their international work site.[217] Along with the connection to sustainability as core to environmental and civil engineering, failed examples of humanitarian engineering—from merry-go-round water pumps to questionable clean burning stoves, engineering for developments "failings" were advertised and mocked among engineers and humanitarians alike.[218] In addition, students began to read literature about "voluntourism," or an unsustainable travel practice that is more about the tourists' enjoyment and fulfillment than it is about making change, and tried to avoid it when possible.[219]

The focus on "sustainable" development reframed the tension between engineers and how they used already existing technological solutions.[220] Relying on wikis like the Appropedia

[217] This connection to "sustainability" is also prevalent in Bridger and Lullof's work, arguing that the practice of sustainable community development should emphasis "the importance of striking a balance between environmental concerns and development objectives while simultaneously enhancing local social relationship" Bridger and Luloff, "Toward an Interactional Approach to Sustainable Community Development," 381. quoted in Lucena, Schneider, and Leydens, "Engineering and Sustainable Community Development," 85.

[218] For e.g., the failing play pump in popular literature: Marie Vandendriessche, "The Story of Playpumps: Merry-Go-Rounds, Water, and Failures in Development Aid," (2012). http://unitedexplanations.org/english/2012/03/22/the-story-of-playpumps-merry-go-rounds-water-and-failures-in-development-aid/.; Marc Gunther, "Opinions: These Cheap, Clean Stoves Were Supposed to Save Millions of Lives. What Happened?," *The Washington Post* 2015, https://www.washingtonpost.com/opinions/these-cheap-clean-stoves-were-supposed-to-save-millions-of-lives-what-happened/2015/10/29/c0b98f38-77fa-11e5-a958-d889faf561dc_story.html.

[219] This was particularly apparent when the student group in Uganda took a cruise on the Nile River and the cruise company was based out of a major tourism hub for international visitors; the students were very clear with me that they were not fans of being amongst the tourists when they were there to do engineering work.

[220] On a critical reflection on the potential for "sustainability" to be thoroughly explored in engineering education settings, see: Dean Nieusma, "Sustainability" as an Integrative Lens for Engineering Education: Initial Reflections

and the Engineers for Change (E4C) solutions library, some *engineers for good* (external to CSM) encouraged engineers to apply the right technology appropriately so that it can be adapted to individual contexts.[221] This debate between applying technologies to developing contexts and focusing on community development is alive and very well in current humanitarian engineering practice. But critical scholars in the field starkly contrast this "gadgetry" development to the work they are doing in finding appropriate "solutions."[222] However, even if technological development is not the key focus in these humanitarian engineering efforts, traditionally trained engineers cannot be blamed if their response to a development problem is a technological artifact.

Engineering and Sustainable Community Development, as defined by CSM professors Lucena, Schneider, and Leydens in 2010, is engineering for something different than industrialized, consumer-markets.[223] Rejecting the idea of prioritizing markets, in contrast to Polak and parts of Amadei's work, this alternative mode of engineering prioritizes impact by emphasizing human well-being. Later, in a 2017 publication, authors Lucena and Leydens reframe "engineering and sustainable community development" as "engineering justice," both expanding the reach of and honing normative criteria for humanitarian engineering activities, discussed below. These authors expressed the need to reject traditional markets for engineering

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on Four Approaches Taken at Rensselaer" (paper presented at the American Society for Engineering Education, 2009).

[221] E.g. "Welcome to Appropedia."

[222] For current examples of "solutions" see Change, "About Solutions Library;"; For questioning gadgetry and technology transfer see Lucena, Schneider, and Leydens, "Engineering and Sustainable Community Development," 5.

[223] Lucena, Schneider, and Leydens, "Engineering and Sustainable Community Development," 55.

problem solving by defining a new problem space, one that lets engineers expand the kinds of problems they are solving by becoming aware of the power, politics, and contexts in which they work.[224] This new, contextualized engineering makes for tricky competition with other traditional engineering disciplines. If the criticism is that traditional engineering is not usually attuned to the political dimensions of engineering that already exist, humanitarian engineering becomes a revision of engineering as much as an outlet for good. This revisionary mode of operation enrolls engineers with kindred spirits, but it also has traditional engineers questioning what exactly it is that humanitarian engineers are and what it is that they are claiming to do differently.

In 2010, the titular book within the field of *Humanitarian Engineering* by Carl Mitcham and David Muñoz guides students through "design under constraints to directly improve the well-being of underserved populations."[225] Programs across the country quote and adapt this definition for their individual contexts.[226] This short book, written by a philosopher of technology and a mechanical engineer, both professors at CSM at the time, explains how the professionalism of engineering and the rise of humanitarianism in Europe and North America combine to make the States an apt place for the emerging field that blends these two practices into humanitarian engineering. They critically examine this "controversial activity" in which they both participate.[227] This text published in 2010 both depicts past humanitarian engineering debates and sets the scene for vibrant discussion of what humanitarian engineering can be today.

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[224] For a look on the need for "problems" to solve see: Downey, "PDS: Engineering as Problem Definition and Solution."

[225] Mitcham and Muñoz, "Humanitarian Engineering," xi.

[226] Several public lectures on *engineering for good* I have attended use this as a jumping off point.

[227] Mitcham and Muñoz, "Humanitarian Engineering," ix.

Landing somewhere between a new technological skill-set to produce appropriate technologies of the past and a reinvigorated appreciation of social science and the humanities' influence on the new forms of engineering, humanitarian engineering for Mitcham and Muñoz is more about the engineers' intent and motivation than it is about rigid ways to conduct *engineering for good.*

Further, Mitcham and Muñoz contextualize the conflict between American engineering and war and violence, but do not offer normative solutions like their book series' counterparts.[228] Humanitarian engineering, in other words, is the application of an existing discipline, engineering design, for particular "under-served" contexts, not a new discipline in and of itself. Analyzing a history of humanitarianism rooted in European practices and "active compassion for those on the margins of social wealth and power," the authors promote humanitarian engineers' intent, making space to question how these motivations are put into practice.[229] Since this textbook's writing, humanitarian engineering practitioners have wrestled with the source of the field's compassion and how compassion can be translated (or not) into social justice efforts. However, social justice efforts (re)localize and (re)politicize engineering in ways that traditional engineers rarely frame problems, leading to a rift between the compassionate and the critics.[230]

In *Engineering Justice* (2017), Lucena and Leydens return with a revised definition of humanitarian engineering.[231] The bulk of the text's actionable content provides seven distinct

[228] For general guidelines for "what counts as a humanitarian engineering project" see Mitcham and Muñoz, "Humanitarian Engineering," 42.

[229] Mitcham and Muñoz, "Humanitarian Engineering," 34.

[230] Cech, "The (Mis) Framing of Social Justice: Why Ideologies of Depoliticization and Meritocracy Hinder Engineers' Ability to Think About Social Injustices."

normative criteria for doing this work well. These criteria are listening contextually, as I already mentioned above, along with identifying structural conditions, acknowledging political agency and mobilizing power, increasing opportunities and resources, reducing imposed risks and harms, and enhancing human capabilities.[232] This last criterion is the main take away, an interpretation of development scholar Amartya Sen and philosopher Martha Nussbaum's "human capabilities approach."[233] These criteria give "engineering justice" legs to both travel around the country (and the world), providing a normative vision for *engineers for good* and academic legitimacy.

Through the appointment of Jessica Smith as Director of Humanitarian Engineering Graduate Programs and Research, corporate social responsibility (CSR) research and research-engaged pedagogy compliments engineering for development, the two major parts of the core of humanitarian engineering at CSM. Students, faculty, and donors often emphasize one of these applications of HE (CSR or development) over the other, reflecting what the individual thinks HE does and how it should move through the world. While the HE program has historically been about international development work as cited above, scholarly and practical concerns pushed

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[231] I hesitate to use "humanitarian engineering" here because it is not used frequently in the text, however they are addressing similar audiences and reworking the definition of HE in earlier scholarship and how it is practiced at CSM. Leydens and Lucena, *Engineering Justice: Transforming Engineering Education and Practice*.

[232] A nice chart is on Leydens and Lucena, *Engineering Justice: Transforming Engineering Education and Practice*, 32.

[233]Sen, *Development as Freedom*; Nussbaum, *Creating Capabilities : The Human Development Approach*.

engineers to work on more domestic project sites.[234] CSR was cited by both students and donors alike as means to make HE more applicable and relevant for more engineers.[235]

Having a "Big Heart" is not Enough

Humanitarian engineering and those that amass expertise in this arena wrestle with several common challenges. Most notably, humanitarian engineers cannot shake the neocolonial critiques of international development efforts as mentioned above. There is also a naivety associated with wanting to "do good." In addition, creating secular, moral forms of doing good through technology calls into question "traditional" forms of engineering. Lastly, humanitarian engineering both tries to blur the technical/social divide but emphasizes the social in ways that create an "HE-side" of things, an engineer that does "technology-plus," ironically reinscribing the very divide it aims to dismantle.[236] Humanitarian engineers must first legitimize their role in engineering and technological production, but then question its limits, by becoming a new-and-improved engineer.

HE faculty recognize the tenets of engineering by prioritizing expertise and knowledge and deprioritizing compassion and individual values. I was struck when students would discuss "the HE-side of things" as the social side as opposed to technical.[237] This was not about doing good with engineering, but rather a common understanding that social-scientific expertise led to an enhanced engineering. Students could take this enhanced version of engineering and use it

[234] This trend is also reflected in non-profit work with EWB-USA creating its Engineering Service Corps, to operate completely within the United States.

[235] Interview O7.

[236] Interview S16.

[237] Interview S16.

where they wish--traditional HE projects in international contexts or organizing events that combat housing insecurity in the greater Denver area.

Humanitarian engineering faculty also have the pressure of the academic community around them, which points out the colonial and oppressive connotations of defining what "doing good" through engineering can mean and urges them to slow before they act. One faculty member mentioned how they prioritized fighting "paternalism" inherent in pairing development with engineering, saying,

> a lot of the problems with development [are] rooted in this paternalistic view that people in poor countries do not know how to solve their own problems. They are deficient. They are inferior. And it is our responsibility as white saviors from the global north to go save them. If you asked me. I mean, I know that development is a very complicated thing, but the number one problem with development as a practice is that it's rooted in that idea of paternalism that way.[238]

There is also a practiced rationality that makes for good humanitarian engineering. One of the program's donors described humanitarian engineering to me as "capitalism with a heart," emphasizing that the free exchange of goods and services as key to the success of *engineering for good*.[239] Other contributors wrestled with whether humanitarian engineering is or should be a "heart" or a "head" issue, reconciling parts of their identities to do good with their engineering identities. For example, one faculty member criticized another academic for being too "well

[238]Interview F7.

[239] Interview O7.

intentioned" and "saying yes to everything," accusing too loose a definition of HE, which "dilute(s)" the concept and the practice.[240]

HE faculty at CSM see HE as a practice of social scientific inquiry applied to engineering education. Further, particular morals or value sets are not emphasized, but rather the contextualizing of HE scenarios is stressed. One HE student joked with me that "humanitarian engineers are either engineers that want to be anthropologists or anthropologists that want to be engineers."[241] This hybrid expertise is very much valued in CSM's humanitarian engineering training. This is not a practice of morals or ethics training, but rather an engineer's first dive into social scientific methods and analysis.

Social science training has increasingly become part of *engineering for good* curricula and projects. EWB-USA reached out to STS scholars to help them equip their students to account for "the social."[242] While there has been a pull away from the purely technical "fix" in recent years, its legacy remains. Engineers think about their humanitarian work in terms of "projects" and "solutions."[243] But this revised type of engineering rejects some of the mainstays of engineering. As one HE-faculty member mentioned, "I won't say 'solution' in class, because I don't believe that they're doing that. I don't believe that exists. I think that it's much more precise to say that students are designing an intervention."[244] This HE-faculty member questions traditional notions of what engineering is for, namely, "fixing problems by finding solutions."

[240] Interview F7.

[241] Student interview S23.

[242] E.g., EWB-USA Virtual Conference Series "Putting Humans & Justice at the Center of EWB Projects: The Role of the Social Sciences" June 30, 2020 Panel discussants were Lucena, Lehr, and Kleine.

[243] Downey, "PDS: Engineering as Problem Definition and Solution."

[244] Interview F5.

While the faculty member uses "intervention" here as a description of an important mode for how they hope their students move and act in the world, engineering students might be surprised to hear that their instructors are actively avoiding this "solutionist" language. Another faculty member echoed the same sentiment about not promoting problem-solving, saying, "it's not, 'we're here from America and we're here to fix your problem.' It's, 'if you will agree to it, we would like to learn how you see the world. And we're likely to learn as much from you as you are from us, if not more, if that's okay for you.'"[245]

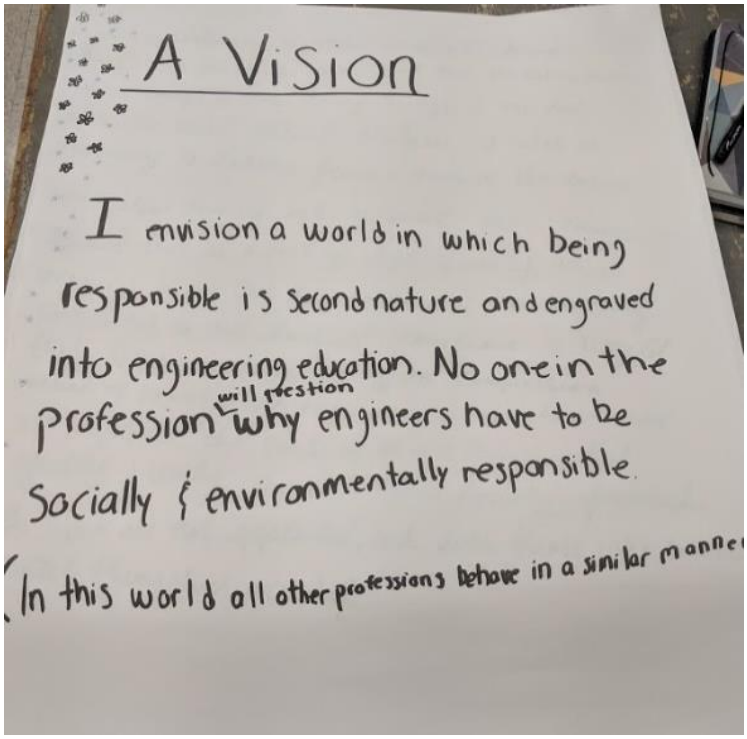

Figure 2.2: A student's vision for an engineering profession that is socially and environmentally responsible

While having a shared compassion is not something that HE-faculty teach, they acknowledge the concept's potential. They often talk about how their students self-select to be in their classes and often rely on their own motivation to do good, rather than defining what exactly

[245] Interview F13.

that means for everyone. However, students draw from each other and the kinds of forms of "responsibility" that they are asked to engage with through their coursework to create their revised visions of the engineering profession. For example, in the core course for both HE-minors, *Engineering for Social and Environmental Responsibility*, students are asked to depict their vision for a world where all engineers are socially and environmentally responsible.[246] Students envisioned worlds where "everyone's opinions are valued equally," "being responsible is second nature," and operate because of "decisions that are based on compassion instead of power."[247] Students note that equality between people is important, but one student emphasized that their ideal vision would be a possible future where "All living creatures/things have value and not just those who have the ability to fight for their value. A world where the health of the world is as important as the health of society."[248] These students learned about inanimate actors, namely government, policy, nature, and technology, and want to work in a world that acknowledges and respects their agency. In other words, they want the world to be engineered by STSers.[249]

[246] Field Notes March 2019.

[247] It should be noted that while the above are closer to the typical responses, but others included a "'mafia-style' syndicate/association/group that's very honor based and places heavy emphasis on social & environmental responsibility with threat of ostracization/punishment (death?)." Students were creative with how these ideal professions restructured their "responsibilities."

[248] Posters and presentations of visions, March 2019.

[249] Donna Haraway, "A Cyborg Manifesto: Science, Technology, and Socialist-Feminism in the Late 20th Century," in *The International Handbook of Virtual Learning Environments* (Springer, 2006); Bruno Latour, *Reassembling the Social : An Introduction to Actor-Network-Theory* (Oxford ;: Oxford University Press, 2005).

HE at CSM is much more about head than it is heart. This prioritization of academic expertise over compassion allows for study of a constructed, secular good. Where before American humanitarianism and development was rooted in Christianity and religious images of disparity and helping, it is now seen as a secular practice.[250] Decades after Truman and Kennedy gave heartfelt justification for the States' large-scale involvement in international development, engineering has shifted how it participates in "the good" by making it an academic practice more than an appeal to individual and nation-state value claims.[251] In contrast to engineers who feel comfortable being explicitly religious, like we will see in the chapters to come, these engineers base what good humanitarian engineering is by a peer-reviewed process vetted by other critical scholars of engineering education and engineering and social justice.

As religious studies scholar Talal Asad calls for, the anthropological study of modern forms of secularism deserves more academic attention. Held up against the other programs in this project, these *engineers for good* serve as an example of a constructed, secular form of "doing good." As Asad argues, and others have emphasized, these forms of secularized settings are as unique and rare as the religious lived experiences that get so much more anthropological attention.[252] *Engineering for good* practice has the potential to be an important site for the interrogation of the secular morals and values of our nation's engineers.

One faculty member at CSM mentioned the ability to operate as a completely secular discipline while recognizing the potential for HE to be a "calling" for others. This faculty member, contrasting their academic pursuits to those with explicitly religious motivations said,

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[250] Jeffrey Haynes, *Religion and Development: Conflict or Cooperation?* (Springer, 2007), 1-15.

[251] See chapter 1 for more on the "nationalistic" call to be an *engineer for good*

[252] Asad, *Formations of the Secular: Christianity, Islam, Modernity.*

“we don't really approach it as a religious calling, we approach it as an intellectual discipline, but one that has an emotional, and a cultural, and a human-centered component to it.”[253]

A few humanitarian engineers at CSM recognized Christian missions' influence on the practice of engineering for development. One student, who participated in missions trips prior to their time participating in HE projects at Mines, noted the similarities between missions and HE, saying, “A lot of the core of what we're doing and what I was doing was similar in that it was building relationships between people across different cultures and trying to like, benefit people's lives through those relationships, except that in the missions work their relationship was between the people and then also an attempt to get people to have a relationship with God.[254]”

Furthermore, the students with mission trip experience made it clear that they were not proselytizing any “good news” as a part of their work in humanitarian engineering. A couple humanitarian engineering students with evangelical backgrounds described how in the past they felt uncomfortable participating in any forms of religious proselytizing through their churches and mission trips. In fact, they were comfortable describing their missions experience as relevant to HE only after they explained to me that the groups that they were working with were “already all Christian” and they were not doing anything to change anything anyone already believed.[255]

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For some, humanitarian engineering is a place to “help marginalized communities;” for others, it’s an academic playground to experiment with STS in engineering education; for others still, humanitarian engineering is the site where engineers can engage with “capitalism with a heart;”

[253] Interview F13.

[254] Interview S21.

[255] Interview S18.

and others use it as a site to both secularize and depoliticize their moral and ethical values. HE provides an infrastructure and institutional setting to participate in "doing good" without having to make individual value statements about why engineers might want to participate.

The practical benefits of HE-training can be intuited, as one administrator said, "the skills that come out of it are things that you can't necessarily quantify. It's not a test score. It's not a GPA. It's in their ability to communicate and evaluate and come up with solutions that I think gives them a great marketable tool." This administrator adds, "I definitely think that these students will have an advantage because they can look at things from different perspectives. Because they're being exposed to things that require empathy. And I think in traditional engineering, you're not approached with, you know, people that have specific issues."[256] Similarly, students came to me saying how surprised they were that their HE training was so versatile, saying it's "not necessarily for just marginalized communities," but rather, could be applied to all forms of engineering work.[257]

"Engineering as it should be" must constantly redefine itself to keep up with critical scholarship and guard against development's misgivings. If the fight against the historical failings of past engineering for development efforts and the "dilution" of its academic expertise were not enough, it also comes across institutional limitations. HE must navigate its relationship to other engineering disciplines. It must be rigorous but also recognize the complexities of dealing with sociotechnical problems.

"Engineering as it should be" provides an example of normative visioning for the professions' future. These visions could be as diverse as the students' in *Engineering for Social*

[256] Interview O6.

[257] Interview S15.

and Environmental Responsibility or a shared vision among a group of *engineers for good.* At CSM, faculty and students' personal convictions are rarely prioritized, and instead, "engineering as it should be" is engaged in professional, scholarly debate. However, the chapter that follows offer a very different alternative.

Chapter 3

"Engineers with a Mission": Addressing "Energy Poverty" Through Eternal Service

"How could a just God permit great misery? The Haitian peasants answered with a proverb: "Bondye konn bay, men li pa konn separe," in literal translation, "God gives but doesn't share." –-Tracey Kidder, *Mountains Beyond Mountains* [258]

"Americans have forgotten how to be resourceful," one of the Waco-based engineers noted, adding that the resulting wastefulness has become a "socially acceptable sin."[259] Another chimed in and said, "Yeah, I have a 4-year, $200k degree and I don't know what these guys know," describing the thriftiness of the Haitian technicians and day laborers that they were working alongside the last few days. Meanwhile, on the other side of a patio, another group of humanitarian volunteers staying at the same resort outside of Cap-Haïtien, Haiti, were loudly singing a Christian praise song, *Our God is an Awesome God*.[260] One of the engineers at the table hummed along. Two Justice and Mercy Energy Services (JAMES, hereby after called JustEnergy)[261] board members sat on outdoor patio furniture with their former instructor and the founder of nonprofit, Brian Thomas. The three engineers had gathered to debrief the day and

[258] In an interpretation of Paul Farmer's "charge" to help "divvy up the loot" in Tracy Kidder, *Mountains Beyond Mountains* (New York: Random House Trade Paperbacks, 2004), 79.

[259] Field Notes; JAMES Board Meeting on May 29, 2019.

[260] The engineers I was observing were unhappy that they had to stay in a resort. They would have rather stayed at the Joshua House, where we stayed later in the week which is on the grounds of their first solar panel array system and IDADEE, their Haitian nonprofit partner.

[261] The nonprofit went through a name change in summer 2020.

have a frank conversation about whether their nonprofit was "going about this the right way."[262] During the meeting, the sun set, and the group did not move to turn on any lights until resort staff walked by and insisted that they flip the switch.

Thomas first founded JustEnergy as a subsidiary of Mission Waco.[263] Mission Waco serves as an umbrella nonprofit for several efforts in central Texas and around the world. The evangelical nonprofit boasts that "mobiliz[ing] middle-class Americans to become more compassionately involved among the poor" is core to its mission.[264] Around the same time, in 2004, Thomas co-founded a student organization on Baylor University's campus, Engineers With a Mission.

Engineers With a Mission (EM) was started by a student and faculty team, Leah Richter and Thomas. Richter could not find a student organization on campus that allowed her to pursue her technical interests and her faith simultaneously, leading to her desire to start EM.[265] This extracurricular organization was first started for Baylor engineering students to have a place to "share the gospel of Christ" through "word, deed, and design."[266] That said, in practice,

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[262] Field Notes; JustEnergy Team Meeting on May 29, 2019; The other team members were resting from what proved to be an exhausting day.

[263] JAMES originally stood for Justice and Mercy Engineering Society; the organization changed its name to "energy services" in early 2019 and then to JustEnergy in the summer of 2020 in effort to streamline their messaging and mission.

[264] "Mission Waco | Mission Waco, Mission World," accessed September 5, 2019, http://missionwaco.org/mission-waco/.

[265] "Baylor Engineers Focus Talent, Interest on Needs in Developing Countries," Baylor University, 2004, https://www.baylor.edu/mediacommunications/news.php?action=story&story=20443.

[266] "Engineers With a Mission," Baylor University, Internet Archive accessed October 3, 2019, https://www.baylorem.org/.

spreading the gospel is in the abstract, instead of explicitly proselytizing the "good news" these engineers emphasize showing God's love through their actions.[267] They often work with Christian partners, both domestically and abroad.[268] Spreading the gospel, for these students, means witnessing Christ through "good" and "loving" deeds, particularly deeds that leverage their technical interests and abilities.

Because Thomas was focused on the growth of Baylor's HE curriculum and service projects on Baylor's campus through Engineers With a Mission, the JustEnergy nonprofit took a backseat. In the fall of 2018, when I first began observing this group of engineers in Waco, TX, JustEnergy was not much more than a "handful of YouTube videos" describing simple photovoltaic principles.[269] Only six months later, when I met these engineers in Haiti in the early summer of 2019, the nonprofit was working to alleviate "energy poverty" in the suburbs of Haiti's second largest city. This quick transition, into a fully functional non-profit, came with more than a decade's preparation.[270]

This chapter explores humanitarian engineering practices that have explicitly religious motivations.[271] I focus on the broader network of which JustEnergy is a part. This includes the

[267] I did not witness any kind of traditional proselytizing methods, in fact, the community partners these engineers worked with closely were all practicing Christians.

[268] I observed two active humanitarian engineering sites with Baylor, first a project with Engineers With a Mission when they partnered with Habitat for Humanity (an ecumenical Christian organization) down in Rockport, TX. And the JustEnergy partnership with IDADEE, a Christian children's home in Haiti.

[269] Interview F3-A.

[270] This transition was also catalyzed by Baylor University canceling a trip for the student group "Engineers With a Mission" (that Thomas also advises) earlier in the year to do the same project.

[271] Although this chapter is about evangelical Christians, it is important to mention that "service" is not only a Christian endeavor, service has been tied to "Americanness" for marginalized religious minorities in the United

Humanitarian Engineering program at Baylor University, the student group Engineers With a Mission, and JustEnergy. This network includes academic, nonprofit, and church partners that help define need and address poverty in their local community and domestic sites like hurricane relief areas in southern Texas and in international sites like the JustEnergy project in northern Haiti. This case allows for an analysis of how engineers assign need as poverty and what makes someone "called" to address that need. It also places this practice in relationship to a larger postcolonial and post-development critique of service.[272]

A speaker at Thomas's church first inspired him to combine his technical interests and his "servant's heart." He spent some time in industry and on the brink of a major company layoff he found a home as an Electrical and Computer Engineering Lecturer at Baylor University. Since coming to Baylor in 2001, Thomas has traveled to Afghanistan, Uganda, Kenya, and Haiti, among other countries, figuring out what humanitarian engineering is by trial and error. A natural tinkerer, Thomas was often working on small side projects like building e-bikes. Thomas then began teaching two courses: *Technology for Developing Countries*, which focuses on basic solar panel principles and small-scale water distribution systems, and *Ethics of International Service*—the two core courses for the humanitarian engineering concentration at Baylor.[273]

States since the late-nineteenth century see R. R. Corbett, "For God and Country: Religious Minorities Striving for National Belonging through Community Service," *Religion and American Culture* 26, no. 2 (2016).

[272] For more on the history of evangelical values and messaging "need" and providing service see: Curtis, *Holy Humanitarians: American Evangelicals and Global Aid*. For more work on service and engineering see: "From Systems Builders to Servants of the System" in Wisnioski, *Engineers for Change: Competing Visions of Technology in 1960s America*, 15-40; Ken Alder, *Engineering the Revolution: Arms and Enlightenment in France, 1763-1815* (University of Chicago Press, 2010).

[273] I observed the *Technology for Developing Countries* course during my semester at Baylor.

Thomas's interest in the technologies emphasized in *Technology for Developing Countries* also led to a few design projects State-side.

For example, in 2017 a junior design group, under the guidance of Thomas, designed and installed a solar panel array for Mission Waco's Urban REAP (Renewable Energy and Agriculture Project). Urban REAP, along with exhibiting the solar panels to the general public, hopes to educate visitors about hydroponic farming, 24-hour compost production, and energy sell-back options. Focusing on designs to reduce the footprint of food production for urban settings, Urban REAP aspires to teach urban dwellers that food production is possible in their neighborhood. In fact, Urban REAP provides produce to the adjacent grocery store, Jubilee Market. Jubilee Market is a nonprofit grocery store which provide groceries in an urban food desert is Waco, Texas.

Like this Urban REAP and Jubilee Market project, the Humanitarian Engineering program at Baylor is primarily interested in converting solar energy for community needs. In fact, Brian Thomas defines engineering, in general, as "converting energy to do usable things."[274] Guided by this definition and the desire to do engineering for those in financial need, Thomas readily equated energy as allegorical to money. In fact, in Thomas's first two lecture periods of *Technologies for Developing Countries* he explains units of energy and converts them "like you would any currency."[275] To participate in engineering for good at Baylor clearly means to most efficiently and most cheaply harness, store, and use energy.

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[274] Field Notes; August 23, 2018.

[275] Field Notes; August 21, 2018.

This chapter develops and analyzes the concept of "eternal service" and seeks to reconcile academic notions of poverty and development with evangelical theology. I argue that these engineers work within a mode of *engineering for good* which blends technical and spiritual understandings of what it means to "do good" as a part of a life-long, eternal endeavor. This vision, for humanitarian engineers based at Baylor University, is steeped in a notion of faith-based empowerment that is constructed in a Baptist university. I followed the implementation of a solar panel array project in Haiti to demonstrate how what Baylor engineers frame as "energy poverty" is integral to their needs assessment process.[276] This empirical and analytical framing brings attention to the ways in which humanitarian engineering can be a site to explore how technologies serve as an intermediary between religious values and questions of modernity and progress.

Energy poverty's victims are people, not the environment. While describing the "broken relationships" of "God's kingdom," humanitarian engineers at Baylor very rarely describe it in terms of environmental injustices. As described in class, energy is like money—everyone wants and needs it. This view is fundamental to how industrialized nations think about "need," but what these engineers often avoid questioning are the underlying systems of these needs—people need energy to run their machines and they need money to be economically independent.[277]

Radically, politically progressive engineers at other institutions question the very underpinnings of these assumptions, discussing the role of consumerism and capitalism in

[276] Just for clarity: "Eternal service" is not language that these engineers use, however, "energy poverty" is and it is central in JustEnergy's messaging. See "Justice and Mercy Energy Services," accessed November 30, 2020, https://justiceandmercy.energy/.

[277] The notion of "excess energy," however, was present, as I will discuss below.

engineering and society more generally.[278] That is what makes alternative energy use in a politically conservative place such an outlier. These engineers focused on efficiency as a justification for their expertise but avoided engagement in how alternative energy works to alleviate the effects of climate change, for example.

This rhetorical strategy emphasizes their group's technological expertise over any particular politically value-laden motivations about energy use, making alternative energy expertise more palatable to all potential State-side partners and donors. This was salient when I asked Thomas about the use of calling the work that they do "social justice." He replied, "my thought is, you may hear of social justice [engineering] programs in other parts of the country that are traditionally bluer states, but in the red states, you may not hear that term, even though it's essentially the same thing, because it's a buzzword or a catch word. People can choke on it."[279]

Studying these engineering identities also allows for analysis of the blending of two, otherwise separate, epistemologies—knowledge of what it means to participate in a successful engineering project and what it means to be an honorable member of "God's kingdom;" challenging both helps reevaluate what it means to serve humanity. Often the public sees religious tradition and technological progress at odds, one impeding the other. This case also faces head-on what many humanitarians fear, that they are perpetuating a "civilizing mission" made famous by global Catholics, Protestants, and secular agencies alike. These engineers are

[278] For more discussion on how this "needs assessment" is done, see the end of chapter 1 and chapter 4. To see how this was done in the "long 60s" see Matt Wisnioski, "Inside "the System": Engineers, Scientists, and the Boundaries of Social Protest in the Long 1960s," *History and technology* 19, no. 4 (2003): 313-33.

[279] Interview F3-A. As it turns out, this language is tricky in "bluer states," too, for more on the tension of social justice, see chapter 2 and chapter 4.

aware of the pitfalls of missions' histories and paternalism but still have a desire to "do good." Therefore, in response, they constructed a theologically compatible reframing of poverty, in the end, addressing "energy poverty." Similarly, these engineers reconcile their work with a highly politicized technology (solar) by highlighting the universal need for energy and not drawing attention to the environmental or political advantages to their expertise.[280] Through this chapter, I hope to depict a group of faith-based engineers while also placing their efforts in a long history of critiques and analysis of "doing good."

Techno-faith Empowerment and Eternal Service

Engineers for good at Baylor University use a combination of engineering expertise and religious rhetoric to explain how and why they do the work that they do. They use this hybrid identity to justify their work, their metrics for its success, and their motivations for "doing good." This section first describes a form of techno-faith empowerment which helps them define the desired outcomes of their work. Then, it describes how this form of empowerment leads to a new engineering professional identity, the eternal servant.

That night in Haiti, described at the beginning of this chapter, the JustEnergy board members' conversation centered around a few key themes, not the least of which was how JustEnergy payment structure of the Haitian workers they employed reflected their model of empowerment. These volunteers discussed the workers' skills and experience as justification for certain workers' pay being more than the others. They described how they were working to transition power over to their local foreman. They all agreed that his most recent work and initiative were evidence of his being empowered by his involvement in the project. And they

[280] In fact, I rarely heard the engineers connect their work in solar energy to the recent gas shortages that were one of the main reasons behind the violent civil unrest in Haiti around the time we traveled to Cap-Haïtien.

believed his more formalized payment structure was partially a factor in these perceived improvements. They then described their mild discomfort with the Haitian crew doing most of the physical labor, while the American crew did most of the wiring and technical work. This trend was evident, but, in practice, it seemed that JustEnergy was most limited by language barriers while assigning tasks because communicating physical tasks in broken English and creole was much easier than communicating technical ones.

That evening, JustEnergy board members also established a clear distinction between economic and social empowerment. Playing devil's advocate, one of the engineers asked with regards to the crew, "why are we paying ditch diggers less than people with technical skills?" They then all came to an agreement that there is a divide between economic and social treatment, that yes, "people *should* be paid based on contribution but *socially* we should not look down or up on them." By this they meant they would pay based on normalized payment structures (with physical labor valued less than welding or technical expertise), but they should not treat any of these workers any differently than one another.[281]

Their conversation was not just about labor and compensation; it was about talent, or "God's gifts" to both them and the Haitian crew. One of the engineers summed up a part of their mission as "use[ing] our gifts that we've been given by our Creator to love" while also "celebrat[ing] their gifts with them."[282] Some of "our gifts" were technical skills but others included social skills and financial privilege.

[281] Ironically, this discussion resulted in a crew member receiving a pay increase because he had performed a day of labor-intensive ditch digging earlier in the week.

[282] Field Notes; JAMES Board Meeting on May 29, 2019.

Thomas, the Executive Director of JustEnergy, selected his team based on their unique individual skills. For example, during this meeting, Thomas mentioned that he feels "seen by [one of the board members]," and jokingly Thomas added that "[they are] so good at people that sometimes it sometimes scares him."[283] For the limited time this board member had spent in Haiti (about a month total), they had an impressive grasp on conversational creole, and all the JustEnergy leadership clearly valued enhancing their language skills to build relationships with their Haitian counterparts.

For JustEnergy, it was not a "gift" to live with an American sense of resource depletion. The board members, with Thomas in the lead, agreed that the vision that they had for Haitian energy use was something different than bringing industrialized technology to non-industrialized nations. These engineers worked to "alleviate energy poverty" with a vision rooted in efficient use of energy and opting out of energy usage when given the option. Thomas repeatedly spoke of the "excess" that he saw every time he flew back into the States, how ridiculous he thought it was that lights line the highways at night or illuminate most gridded cities when most of the blocks go unoccupied. He insisted that their work is not an effort to bring Haiti's energy resources "up" to match America's standard in energy, but rather they work with their partner communities to instill an anti-energy-waste mentality in their Haitian partners. They promote energy consciousness through things like posting the light switch tags depicted below and voicing their frustration when storage closets filled with nothing but cleaning supplies were left for hours illuminated by the hybrid solar/generator system that they helped implement.

[283] Field Notes; JAMES Board Meeting on May 29, 2019.

Figure 3.1: The light switch tags that a JustEnergy board member posted in the Haitian hospital that the group was installing a solar panel array

For engineers at Baylor University, the oldest Baptist institution of higher education in Texas, I expected to witness a training grounds for young professionals to explore what they considered to be an overlap between technical service and faith. But I did not expect to find so many students who wanted to mimic what their instructor Thomas had done in his career. To them, he was the best model for how engineers' can be in service to "the kingdom." I met students that could very quickly dip into a register that described their college situation as a "God thing," or a set of circumstances that only makes sense in the context of their faith. I met a group of students that didn't want to "just get a job," but to "make communities better" by "spreading the love of Christ."[284] These students had strong convictions about their faith but were timid when determining the best ways to express and act on their ideals. They looked to Thomas to be their guide to sustainable and "God honoring" acts of service.

[284] Interviews O4 and Interview S8. Field Notes; October 17, 2018.

Baylor University is not just a Christian institution by name. It is a faith-based place for all students to explore how to combine their vocation and Christian convictions. While the school is technically Baptist, the students use a variety of Protestant, evangelical Christian language to describe their religious identity.[285] I had students I hardly knew come up and ask me, "So, how long have you been a believer?" As a part of a hurricane relief project to southern Texas, students led worship sessions and group prayer before they played the usual late-night board games. During breaks at the worksite, students accused certain faculty of being heretical because of their non-literal interpretation of the Old Testament. As a part of my application to participate in the BU Missions trip to Haiti, I was asked to provide written answers to the questions, "How do you hope this trip will shape your spiritual journey?" and "What are your top three prayer requests concerning your involvement with this trip?"[286] One student said that the Engineers With a Mission's student chaplain role is to make sure that the organization does their work with a "mindset of truly helping people in the sense of like, like, God is the reason we're doing this, we're doing it to serve Him and worship Him through our service."[287]

At an Engineers With a Mission board meeting, one of the student leaders mentioned that the Engineers Without Borders-USA (EWB-USA) headquarters recently contacted the organization to see if they were interested in starting a chapter at Baylor. The student leadership quickly dismissed the idea. They defended EWB-USA's mission and the work that they do, but in chorus they responded with, "at this point, that would hurt more than it would help;" another

[285] On evangelical language I rely on Harding, *The Book of Jerry Falwell: Fundamentalist Language and Politics*. For a discussion on how Baylor was (written in 2005) working through a potentially "religious identity crisis" see: "Identity Crisis," https://www.baylor.edu/alumni/magazine/0304/news.php?action=story&story=22168.

[286] "Baylor Bearsabroad," accessed November, 2018, https://bearsabroad.baylor.edu/. password and login protected.

[287] Interview S8.

student added, “well, they’re not a Christian organization, are they?” and “that’s what makes EM and Baylor so unique,” continues a student at the beginning of a long soliloquy about Christianity’s role in the work that they do adding that, “it’s not a Christian organization, and our God is a just God, and this is about reconciliation, reconciliation of relationships as we discussed in our chapter meeting.” Thomas chimes in to say, “there is a lot of overlap of what we do and what they do, and a lot of the tech is helpful to know about.” While Thomas insisted there was valuable content to be learned at secular *engineering for good* forums, and this discussion reaffirmed the students’ reason for going to the annual EWB-USA conference, they were quick to dismiss the suggestion that they should become a part of EWB-USA.[288]

Baylor administrators noted how Baylor’s career counseling could be different because of its Christian affiliation. One engineering academic counselor told me, “I think that is the unique thing about Baylor, where we, we’re allowed to have those conversations and call it a ‘calling’; and for me, your calling is where your strengths and your passions align.”[289] In addition, humanitarian engineering students at Baylor looked to Thomas as a model for their own careers. Numerous students said that “the dream” was to be Thomas someday, having an outlet to conduct *engineering for good* projects on a regular basis. Several students that I interviewed had taken his *Ethics of International Service* course, maybe gone on a trip or two, and that had been enough to show them that their passions were best fulfilled by pursuing service abroad.

Both the student group Engineers With a Mission and nonprofit JustEnergy are committed to a distinct engineering identity—one that pairs their engineering expertise with service not just for the duration of a single project but for their lifetimes. They are engaged in a

[288] Field Notes; September 20, 2018.

[289] Interview O4.

practice, which for them, has eternal consequences. Both organizations' logos use the infinity symbol (below), EM's suggests that they will be conducting their mission for the sum of 1 until infinity. Volunteers of JustEnergy also see their jobs as part of an eternal timeline which for them starts with the "fall of man" and continues far past their lives on earth (as I will discuss in more detail later).[290]

This notion of the eternal or being a small piece of a much longer narrative, is evident in how these engineers speak about their work. Thomas is committed to solar panel projects in northern Haiti indefinitely, not just for the duration of a grant or the principled 3-5 years that it takes for "sustainable development." His conception of sustainability is influenced by secular asset-based community development literature that suggests projects should eventually be able to be managed by local, in-country contacts, and so he works to set up and sustain these connections. But for him, the commitment to stick with this project for the very long term is as much a part of the service as the initial steps of bringing any solar panels to a job site.

[290] "Brokenness" because of "the fall of man" is emphasized in Steve Corbett and Brian Fikkert, *When Helping Hurts: How to Alleviate Poverty without Hurting the Poor... And Yourself* (Moody Publishers, 2014) and emphasized by both Thomas and students (most of which had taken *Ethics of International Service)* during interviews.

Figure 3.2: On the left, the logo for the Baylor student organization, Engineers With a Mission. On the Right, the logo for JustEnergy.

One student described the role of Engineers With a Mission's student chaplain as making sure the group is in the right mindset so that the group could focus on the "eternal." The student portrayed how the organization should help families with day-to-day activities so that they can "focus on the eternal" and "join alongside them and be the body of Christ. . . and the whole world becomes better. And like, the whole world is knowing God a little bit more."[291] For this student, entering service work became about alleviating physical deficits so that others can focus on the eternal.

Eternity is a long time to be working through a problem. For engineers, the unit of analysis is usually a problem set or a project. In contrast, Thomas provides a model for *eternal* service. These engineers' dedication to engineering service for the long term does not prevent them from discussing their short term aims and goals. They are not "doing good" for just anyone; like any engineering project, these engineers still assess need. They have constructed a form of needs assessment linked to conceptions of poverty.

[291] Interview S8.

Not Afraid of Calling those in Need "Poor"

Needs assessment is a core piece of the engineering design process. However, led by Thomas and his core courses in humanitarian engineering, the Baylor humanitarian engineers are aware of the critiques that their needs assessment could dip into the traps of paternalism. In fact, Thomas commented to me how annoyed he was with the printing service of his course reader for *Ethics of International Service.* On the cover of the reader, they had printed a large tree with a country's flag included in each of the tree's leaves, with the United States flag being on the very top. Thomas shared with me how bothered he was by that, that it was the opposite message he wanted to send to his students— that it conveyed that Americans knew how to most ethically participate in international service, while he wanted to emphasize that the best international service is done through collaboration and humility.[292] But engineers must assign need before they begin a project, so how can they determine who to work with if they are working in complete collaboration? Most *engineers for good* answer this question by saying that volunteers should wait for a community to ask for a project. But, how do communities "in need" find eager and willing engineers? And furthermore, how do engineers deem a project worthy? Who gets to ask for technological solutions for their problems?

Mission Waco, a prominent nonprofit in Waco, Texas, organizes and promotes events like the annual "The Walk for the Homeless" and monthly "Poverty Simulations" to teach financially stable attendees to "see the world through different eyes."[293] Through these events and others, Mission Waco is active in combatting poverty and homelessness in the surrounding

[292] Field Notes; December 16, 2018.

[293]It cost me $69 to simulate poverty for 43 hours. Quote from: "Poverty Simulation," accessed October 2, 2019, http://missionwaco.org/poverty-simulation/.

region and they have international partnership and missions, most notably, in India and Haiti. Baylor's Humanitarian Engineering Program has strong ties to Mission Waco and shares many of its theological underpinnings, leading to their work in Haiti.[294]

The humanitarian engineers at Baylor University quickly assign "need" to those that "live in poverty." A tension exists between assigning need versus knowing what those needs are in all humanitarian engineering work. But, for Baylor engineers, it is common to assign *economic* poverty to those who live under what they consider an acceptable threshold. They acknowledge their privilege in this way, assessing that they have the financial means to participate, plan, and contribute to their engineering projects to help those "in need." Instead of racial, gender, or regional difference, the difference between these engineers and their users is economic. They work to alleviate this poverty with technological solutions.

I saw the implementation of one of these technological solutions firsthand during a trip to northern Haiti with JustEnergy in the summer of 2019. The goal of this trip was to install their second solar panel array for a locally-run nonprofit IDADEE (a children's home and their partner hospital) near Cap-Haïtien. When we were in northern Haiti, Thomas turned to me and said, "You know, Paul Farmer is always given a hard time because he talks about working with 'poor people', but I admire him, among other reasons, because he calls it how he sees it." I sat there, listening to Thomas in a passenger van, surrounded by what these engineers see as undeniable poverty. At least by most Americans' standards, the trash-covered streets and waterways signaled that these Haitians were very poor. But Thomas was addressing a discomfort about speaking about those around them as if they are "in need." However, he saw Haitians' need as a

[294] Many of the students participate in Mission Waco events, for example, the Poverty Simulation is a requirement for the *Ethics of International Service* course.

rationale for JustEnergy being there. Assigning need proves tricky, both in teaching engineering students how to pick projects but also in describing where they should conduct their work.

Humanitarian engineers can get in a "chicken and the egg" problem of "needs assessment and project definition." One strategy that I saw implemented at Baylor is to form intimate friendships with you potential partners. In other words, engineers turn to building relationships with whom they feel they should be working with before they begin but attempt to intuit whether this relationship building could lead to a potential partnership ahead of time. But the ability to be able to recognize and name "poverty" allows for these engineers to engage in needs assessment more generally before confirming whether their partners are in need of services that they can provide.

The engineers that I observed in Haiti read Farmer's biography, *Mountains Beyond Mountains,* in book club fashion, sharing with each other how accurate they thought the descriptions of Haiti were, but they also shared with me how encouraged they were by the famed global doctor and medical anthropologist's dedication and no-nonsense attitude. Thomas regularly referred to excerpts from the book and described how they guided his thinking about sustainability and the justification for working with the poor. He one time referred to an excerpt of the book where Farmer is ridiculed for handing out nail clippers and bibles to his patients, others calling it an "nonsustainable" practice.[295] But then he reflected on Farmer questioning the pricing of tuberculosis treatment in Haiti compared to the tens of thousands of dollars back in the United States, highlighting his critic's hypocrisy by probing just how sustainable a system that consistently bankrupts its patients could be.[296]

[295] Kidder, *Mountains Beyond Mountains*, 42.

[296] Kidder, *Mountains Beyond Mountains*, 165-77.

Farmer, who started his work as a lapsed Catholic but has since returned to the religion's teachings, credited theologians on helping him "understand[] structural violence, the notion of accompaniment, and a preferential option for the poor."[297] He argued that those who are in need are those who don't have certain resources. For him, health care issues most greatly affect the poor, so health care professionals must focus their efforts on the poor. Farmer's understanding of the "preferential option for the poor" flirts with rigorous and progressive academic frameworks of equity and inclusion, but it also keeps politically conservative humanitarians onboard.[298]

The JustEnergy engineers are not prioritizing any message more than the importance of alleviating energy poverty, but they are aware of the critiques of past missionary work. They know that when white missionaries travel around the globe, often proselytizing "the good news" becomes more important to them than attending to the physical and bodily needs of those they wish to work with. I did not witness any proselytizing of the Christian gospel, in fact, Thomas has publicly condemned this kind of missionary work as a type of "heresy" or "evangelical Gnosticism" that promotes the idea that the material and spiritual worlds are separate, prioritizing spreading "the good news" and spiritual health over physical health.[299] And, in addition, most of their long-term partners are already practicing Christians.

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[297] M. Sophia Newman, "The Liberation Theology of Dr. Paul Farmer," (2016). https://religionandpolitics.org/2016/03/01/the-liberation-theology-of-dr-paul-farmer/. "Dr. Paul Farmer: How Liberation Theology Can Inform Public Health," Partners in Health, 2013, accessed September 19, 2019, https://www.pih.org/article/dr.-paul-farmer-how-liberation-theology-can-inform-public-health.

[298] Paul Farmer and Haun Saussy, *Partner to the Poor : A Paul Farmer Reader* (Berkeley: University of California Press, 2010).

[299] Brian Thomas, "Humanitarian Engineering: When Justice Fist Bumps Calculus," (Youtube, December 23, 2019 2016). https://www.youtube.com/watch?v=6e19zocYPdA.

The humanitarian engineers in Waco understand needs assessment and assignment as a requirement for their work. They selected their Haitian partners because Mission Waco was already working with them. The community found the engineers ready and able to design a solar panel system on their children's home and, in turn, their hospital. These humanitarian engineers see assigning poverty as part of assessing their potential partners. However, they also understand the problematic aspects of acting like they know who needs help, fearful of paternalism. They make sense of this tension by defining 'poverty' through a common theological grounding.

Believing All Are Poor

Thomas mentioned to me that other faculty members are slow to use the term "justice." He says, "when they hear the word justice they think about socialism and redistribution of wealth; they are afraid of it."[300] So if it's hard to agree upon who is poor and who is rightfully in need, how do engineers choose which needs they want to alleviate? What does this look like in practice?

Baylor's humanitarian engineers see poverty as everyone's problem. A common text that all humanitarian engineering students at Baylor study entitled *When Helping Hurts* describes how humankind has the potential of being subjected to several different poverties. "Poverty of spiritual intimacy," for example is between God and man, with symptoms like materialism and worshiping false gods. In addition, poverty of being, poverty of community, and poverty of stewardship are all between individuals and self, others, and the rest of creation, respectively.[301] These engineers describe the root cause of all poverty as the "fall of man"—or the irreversible first sins in the garden of Eden when Adam and Eve first disobeyed God. This decision,

[300] Interview F3-A.

[301] Corbett and Fikkert, *When Helping Hurts: How to Alleviate Poverty without Hurting the Poor... And Yourself*., 59.

according to those that believe in its significance, has made sin an inevitable reality for all human beings, shaping the brokenness of the religious, political, social and economic systems of "God's kingdom."[302] Acknowledging the brokenness of all of these systems allows for these Christians to "embrace [their] mutual brokenness."[303] For them, it's this commonality—or the belief that all people live in poverty— that enables the necessary humility required to do their work.

This understanding of universal poverty allowed these engineers to explain how God could allow for economic poverty while also drawing attention to the kinds of "broken" relationships that all humankind faces. In other words, all are poor, but it is the duty of those that are struggling with poverties such as materialism, resulting from a broken relationship "with the rest of creation," to help others with their economic poverties. The text *When Helping Hurts* insists that "every human being is poor in the sense of not experiencing these four relationships in the way that God intended."[304] It's through helping others with their poverties that these Christians can become aware of their own poverties. In turn, these engineers work to alleviate economic poverty, particularly converted to energy poverty, so that others can focus on these spiritual and relational poverties that they believe all humankind must attend to.

This framework allows these *engineers for good* to participate in and critique a series of poverty trade-offs. A particularly salient example from *When Helping Hurts* is that of a church member asking the church to help pay their personal electric bill. The text goes onto describe that the potential underlying problem is the "self-discipline" of the person to be able to keep a

[302]Interview S6.

[303] Corbett and Fikkert, *When Helping Hurts: How to Alleviate Poverty without Hurting the Poor... And Yourself*, 61.

[304] Ibid., 59.

job to pay for the bill.[305] And what follows is the charge to the church to help this individual with their self-discipline instead of (or maybe in addition to) the material resources asked for. Now, there are some that would read this diagnosis of need in horror. Post-development literature has critiqued this "teach a man to fish" mentality and it intuitively does not make sense to humanitarians that are focused on systemic injustice.[306]

The "teach a man to fish" mentality is in tension with very common "community partnership" language. Humanitarian engineers from Baylor often say that a project is worth pursuing if "it is something the community actually wants."[307] These engineers listen to how communities define their own needs and desire to be in partnership with them to create the solution. Baylor engineers for good often mentioned to me that "you don't want to barge in and say this is what you need," a cautionary lesson that they learned from the technological adoption missteps showcased in their coursework.[308] They also struggled with listening to the community while trying to avoid unsustainable charity. However, they ask, if those in need want you to "give them a fish," isn't it disrespectful to the poor not to oblige?[309]

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[305] Corbett and Fikkert, *When Helping Hurts: How to Alleviate Poverty without Hurting the Poor... And Yourself*, 53.

[306] Flaherty, *No More Heroes: Grassroots Challenges to the Savior Mentality*. There is much more about this post development critique in chapter 2 and systemic injustice in chapter 4.

[307] Interview S8.

[308] Interview S8.

[309] Because of this tension, these engineers are often okay with charitable donations. I witnessed individuals giving money for prescription medications to people that they had been working with because that is what these individuals were claiming that they needed, not unlike Paul Farmer's nail clippers. These engineers were okay with participating in charity because they were more concerned with building and sustaining relationships than sustainable engineering

Focusing on service also ignores underlying systemic failings that engineers often ignore. While the *When Helping Hurts* model for poverty explains that needs may not be as simple someone's electric bill, it does not question the political and social underpinnings that put this person behind. This model lets the church (and its congregants, in this example) dictate what those in need, need. In this case the suggestion is to promote "self-discipline" as opposed to more radical solutions such as labor reform or political protest, a strategy on par with a politically conservative interpretation of this charitable dilemma.

Reflecting on *When Helping Hurts,* Thomas alludes to the tension between conservative and progressive "doing good" in humanitarian contexts saying,

> the political left tends to view the people's problems as systemic problems. And the political right tends to view people's problems as individual problems. And [Corbett and Fikkert] argue[] for a Christian understanding of a whole broken world. The individuals are broken, and then they make systems and because those broken people make broken systems, there are broken systems, and they do really hurt people and oppress people, but also, individual choices and systemic decisions are part of the problem and part of what needs redemption. I find it, it's very neutral and yeah and it doesn't embrace hundred percent either side.[310]

Thomas describes his Christian understanding of poverty as something that transcends political understanding. But if acknowledging both the individual and systemic brokenness is in play, when do you make trade-offs between them? Conservative onlookers may say that to travel

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projects. This is in stark contrast with other *engineering for good* models that see this as unsustainable and in tension with their project goals.

[310] Interview F3-A; Corbett and Fikkert, *When Helping Hurts: How to Alleviate Poverty without Hurting the Poor... And Yourself*.

to Haiti is an act too far—like the example above, providing funds for the electrical bill instead figuring out how to help those asking for money with "self-discipline." Politically progressive observers could charge these engineers with not being radical enough because they are addressing symptoms versus root causes. But these engineers have found a position somewhere in the middle in an attempt to depoliticize the act of "doing good.'" They do not blame either individuals or systems for poverty, but rather the human condition that creates and perpetuates flaws in each. In a "Last Lecture" during Parent's Weekend 2016, Thomas positioned himself squarely within this debate, he stated that in addition to broken people,

> systems can be broken too. Economic systems, political systems, educational systems, all of these are made by broken people, and they therefore are broken too… they work imperfectly. . .they tend to favor some folks more than others. . .they tend to favor mMmm… white, Baptist, republican males a whole lot, in fact. So, sometimes, people like me with good intentions, for whom the systems have worked well think that complaints about fairness and discrimination are largely imagined, after all, the systems have worked well from my perspective [pause, squinting at his lecture script] what I have written here is ' the systems have worked well from their perspectives' but the word *my* came from my mouth, I'm not sure what that means.[311]

He paused and joked about his supposed slipup because he knew exactly what it means. For Thomas, these decisions are personal. He sees the tension between political progressives and conservatives in the arena of defining the causes of injustice, but he also sees himself as defined by the regional and personal identities that complicate how he thinks about justice. Thomas also recognizes other ways in which he identifies that make him want to think more critically about

[311] Thomas, "Humanitarian Engineering: When Justice Fist Bumps Calculus." starting at 13:36

how humanitarians ought to combat injustices. He recognizes that the large systems work for him and others like him in ways that they don't for others, and he points to those advantages as one of the reasons for not being able to identify systemic inequalities.[312]

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Baylor's humanitarian engineers' sense of "good" is not primarily based in a code of professional ethics or academic critique, but, instead, a collective sense of faith-based empowerment.[313] It is about the connection between technical expertise and the willingness required to serve, eternally. It is an effort to eradicate energy poverty, an engineering identity which asks interesting questions of both narratives of progress and religious tradition.

Analyzing this small group of engineers that tie their religious values to their work is useful to both religious studies and STS. In contrast to the thousands of other *engineers for good* working in public institutions, this small group of engineers explicitly tie their work to their personal, religious values. While they can openly express how they tie their faith to their work, they are institutionally and regionally constrained. They are careful when speaking about social justice because of its political connotations, but they are constantly wrestling with the practicalities of balancing how to assign individual needs in place of what some see as systemic issues.

How does "eternal service" expand on engineers' purpose beyond solutionist problem-solving? Assigning "poverty," no matter how well-intentioned the humanitarian, is still problematic. Even if both parties, communities from industrialized regions and not, want a

[312] For more of a discussion on systemic inequalities, see chapter 4.

[313] Unlike other engineering ethics classes, in *Ethics of International Service* Thomas highlights the ethics of theologically-based service. For example, his selected readings packet for the course begins with a chapter of a text entitled "Why did Jesus Come to Earth?"

certain kind of poverty alleviated, focusing on technologically mediated service elides systemic and individual conflict. A growing body of literature depicts the failings of "doing good" that decentralizes the assets or the existing "human capabilities" of those being served.[314] Eternal service allows for a Haitian hospital to ask for a solar power system that they would never be able to afford or maintain by themselves because lending in Haiti is haphazard, and engineers don't just want to "gift" it. "Energy poverty" allows engineers to perform their expertise, even though the local technicians help with most of the solar panel array installation.

Acknowledging that these engineers work with an eternal service mindset has implication for engineering studies—it provides an alternative example to what anthropologist and engineering studies scholar Gary Downey describes as a transition from problem solving to problem definition and solution.[315] Eternal service goes further, admitting that engineers can recognize what they see to be the very root of all problems, continuously work to alleviate what they see as the effects of systemic injustices, and integrate their individual values along the way. Eternal service provides an alternative to the image of the American engineering profession, rational in all decision making, career trajectory included. In other words, the eternal service mindset allows for quirky engineers to follow their calling.

Of course, the concept also has limits. Simply put, not all engineers see their work as having eternal impact, and few commit to an evangelical worldview that injustice has its roots in original sin. Obviously and practically speaking, most public and secular organizations do not speak in these terms nor will they choose to adopt them. That said, other secular humanitarian engineers often borrow the language of "calling" or "greater purpose." And, increasingly, with

[314] Nussbaum, *Creating Capabilities : The Human Development Approach*.

[315] Downey, "PDS: Engineering as Problem Definition and Solution."

the imminent threats of climate change, engineers have begun to think in much longer time frames, thinking about their efforts and impact if not eternally then at the very least multi-generationally. Eternal service allows for an expansion of our understanding of the engineering project and how long engineers conceive of their responsibility to care for their creations.

If engineers strive to become eternal servants, to whom or what are they committed? It is true that not everyone can make the case that their work is a theologically justified form of "doing good." But, furthermore, doing good is not inherent to engineering service. Emphasizing service can quickly get coopted by government or corporate interests; someone's "servant's heart" can quickly serve other masters. This is a cautionary tale for all engineers, not just Christian engineers. Service is quaint in theory, but the engineers that are serious about it must be intentional regarding whom they serve.

Chapter 4

"Changemaking Engineers": Disciplinary Conservatism and Integrating Social Justice

A four-student team drove themselves from San Diego to the last exit off the highway before the U.S.-Mexico border to visit the Tijuana River Estuary. What at first felt like a peaceful respite from the San Diego's urban density brought a new form claustrophobia, as military helicopters flew overhead. One of the visitors from University of San Diego (USD) asked our guide whether they were conducting Border Patrol. We were informed that the air space was filled with military training, and it was not connected to the nearby border security. But, as our tour drew closer to the fences, I realized that that question was not farfetched. We were frequently passed by Border Patrol while we were in the Tijuana River Estuary and once asked why we were there. While we were down in the river's dried path looking at plastic waste for the student's project, we watched as the agents pulled tires behind their vehicles. Our guide explained that the Border Patrol did that to erase footsteps in the dry earth so that they can better spot new ones. As we passed through one of the area's many fences by vehicle, our host pointed to a small, tattered fragment of a cloth appended to the chain links and mentioned that the fabric was for border crossers to

Figure 4.1: On the left, part of the Tijuana River Estuary; Right: Waste just inland from the mouth of the river that is drudged out of the water before it can make its way out to the Pacific Ocean

put on their feet to try to avoid leaving footprints. The car fell silent.[316]

Back on campus, the social justice issues were less evident. The students spent a majority of their semester waiting for their hot press machine to come in so that they could begin pressing different plastic composite materials. They mimic past projects of the non-profit that is sponsoring their senior capstone project, Waste for Life. Previous Waste for Life projects took place in Buenos Aires, Argentina, and Sri Lanka—all pressing plastics into small-scale manufactured goods to sell, mostly in industrialized markets. [317] These students were hoping to replicate the successes of those projects in Tijuana, Mexico.

This capstone senior design team, in effort to get a sense of their "problem space" for both their capstone project and analyzing their project for their *Engineering and Social Justice* course, visited the spot where waste was drawn annually from the Tijuana River. Tires, like the ones used to clean footprints, were one common waste item that the students noticed on their onsite visit.[318] the students researched how to "upcycle" tires to provide an alternative design option for their required coursework, but that strategy was ultimately abandoned for the original hot press and plastics idea.

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[316] Field notes from October 8, 2019.

[317] For details about their work in Lesotho and Argentina see Caroline Baillie et al., "Needs and Feasibility: A Guide for Engineers in Community Projects---the Case of Waste for Life," *Synthesis Lectures on Engineers, Technology, and Society* 5, no. 1 (2010).; "About Waste for Life," accessed September 3, 2020, https://www.wasteforlife.org/.

[318]A current report confirms that tire waste is still an issue, see HDR, *Tijuana River Valley Needs and Opportunities Assessment – Trash Technical Memorandum* (2020), https://www.sdparks.org/content/dam/sdparks/en/pdf/Resource-Management/Appendix%20F%20-%20Trash%20Technical%20Memorandum.pdf.

University of San Diego is regularly described as a "changemaker" campus on public-facing material.[319] On a billboard close to campus, USD honored Dr. Martin Luther King, Jr., for the national holiday in King's honor as an exemplar of a "A True Changemaker" atop the display.[320] One of the "pathways" of the university's strategic, long-term plan for *Envisioning 2024* is "Practice Changemaking." Underneath the *Envisioning 2024* title on their university website which details their revised mission and visions statement reads, "Because the World Needs Changemakers…"[321]

More specific to the engineering program at USD, conceptions of "doing good" blend this changemaker title with social justice efforts. *Engineering and Social Justice* is a core course for the newly formed major, Integrated Engineering. And both students and faculty are recognized for their involvement in social justice related engineering through the new organization, Engineering Exchange for Social Justice. At the end of the beautiful campus promenade on which USD sits lies the Joan B. Kroc Institute for Peace and Justice. Social justice is also tied to USD's Roman Catholic affiliation, providing justification for its broader community involvement, and lending flexibility to "doing good" in religious and secular spaces.

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This chapter explores the notion of "social justice" as integral to understanding current *engineering for good.* This form of social-justice-informed-*engineering for good* engages in both

[319] University of San Diego, "Changemaker Hub," https://www.sandiego.edu/changemaker/about/. This "changemaking" language is also tied to the university's Ashoka affiliation. For more see, "University of San Diego: Changemaker Campus," https://ashokau.org/programs/changemakercampus/university-of-san-diego/.

[320] Seen during a return trip in January 2020.

[321] For more information on revised mission and vision statement see, "Envisioning 2024," accessed November 30, 2020, https://www.sandiego.edu/envisioning-2024/.

critical scholarship and notions of compassion and care. This hybridity allows for these *engineers for good* to borrow from political movements and contribute to critical engineering education scholarship. I will first describe the idea of "changemaking" in higher education and how it made "social justice" language more accessible to engineers at USD. I will illuminate some of the challenges in operationalizing social justice in engineering curriculum and extracurriculars. It is important to note that this engineering looks different than the *engineering for good* previously described. The students who traveled to Tijuana above were one of the few engineering teams who left San Diego, let alone the country, for their project work. This form of e*ngineering for good,* closely tied to "social justice" and "change," displaced engineering for development projects and deprioritizes service as a main mode of practice.[322]

I show how "social justice" is leveraged by engineering faculty, students, and administrations to justify training "changemaking engineers" in a "contemporary Catholic university."[323] This idea of a "contemporary Catholic university" affords, for the engineers, further flexibility, loosely tying their institution's motivations to Catholic Social Teaching, while also being competitive for large, public funding. I argue that *engineering for good* at USD is malleable— infused with critical theory and engineering education scholarship, has an emphasis

[322] I will explore how USD has a robust history of volunteerism (more closely aligned to service) below, but within engineering, "doing good" is much more closely associated with "social justice."

[323] Language comes from University's revised mission drafted 9/25/19 published by USD titled "Because the world needs changemakers…" Diego, "Envisioning 2024."; While I won't elaborate on boundary objects here, I did find it to be a useful theoretical apparatus as I thought about how social justice was being used by different actors on campus, see: Susan Leigh Star and James R Griesemer, "Institutional Ecology,Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39," *Social studies of science* 19, no. 3 (1989).

on diversity and inclusion, and the advantage of having multiple orientations with respect to traditional engineering disciplines. But including social justice in engineering curriculum comes with its challenges, as it defends itself against the gatekeeping of engineering's disciplinary conservatism.

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As discussed in chapter 1, engineering education and social justice have had explicit organizational ties since the formation of the Engineering, Social Justice, and Peace network in 2004. The network provided not only a practitioner-oriented space, but a forum for those interested in a new form of engineering education expertise. Since the network's forming, the publication of Donna Riley's book entitled *Engineering and Social Justice* (2008), the increased publication of accessible literature at the intersection of engineering and social justice, and Riley's tenure as NSF's Program Director for Engineering Education radically shifted the conversation about *engineering for good* towards social justice.[324] Through the case of engineering at USD and its engagement with the larger engineering and social justice movement, I will explore the affordances and limitations of working towards an engineering for social justice.

A History of "Changemaking"

In 1972, the San Diego College for Men and the San Diego College for Women, that both overlooked the Linda Vista neighborhood in San Diego's Mission Bay, merged to become the University of San Diego. In its recent "Civic Action Plan" for Campus Compact, a national coalition of institutions of higher ed committed to "civic education" and "community

[324] There was also a shift towards diversity and inclusion, but I will explore how these are tied together below.

development," the University representatives boasted that have been "focused on public service and development of civically engaged individual to help improve the human condition" ever since.[325] This section will connect the history of USD's conception of "the good" to current *engineering for good* practices.

The Center for Community Service-Learning (CSL) at USD was founded in 1986 by the Provost, Sr. Sally Furay, which earned USD national notoriety for providing venues for discussing complex issues of social justice and peace. The CSL hosted world-renowned speakers. Maya Angelou served as a "Social Issues Speaker" in 1988 which sparked an annual Social Issues Conference series starting in 1989. The Social Issues Conference drew speakers like George Takei (1992), Arun Gandhi (2000), Nadine Strossen, the first woman President of the ACLU (2004) as keynote speakers for conferences with themes such as *The Bridges and Barriers of Immigration* and *Challenging Injustice with Solutions for Peace*. While the CSL hosted many prominent speakers engaged in both national and international peacemaking, the students, for the most part, have remained engaged in local, San Diego-area community volunteer, service, and social justice opportunities.

With CSL's founding, school-sponsored volunteer service work became more organized. Most student volunteer work was done near the school itself, including literacy and outreach programs in San Diego and a diverse set of volunteer opportunities in Tijuana.[326] This local focus remains apparent in engineering and social justice efforts at USD. During my time at USD, the

[325] "Campus Compact Overview," accessed November 30, 2020, https://compact.org/who-we-are/.; "Campus Compact Vision and Charge." https://docs.google.com/viewerng/viewer?url=http://compact.org/wp-content/uploads/large/2017/04/USDCAPPDF.pdf&hl=e.

[326] University of San Diego, "CSL History." https://www.sandiego.edu/mccasa/documents/history.pdf.; The CSL is now called The Mulvaney Center for Community, Awareness and Social Action.

Global Engineering Brigades student chapter, a more internationally focused engineering for development and water access nonprofit, had been temporarily disband because the most active members questioned the ways in which this group could perpetuate colonial views of development.[327]

Thinking about local issues is emphasized by both the curriculum and the community partners that are brought in for longer-term engagement.[328] There are a small handful of international capstone design projects presented to engineering students—a Japanese drone docking station project, for example. But each of these either are engaged in global, large-scale international business (as opposed to development contexts) or have local contacts. They do not look like the "traditional" development projects like those in previous chapters. The two closest things to these international development projects are the Waste For Life project and the Sunshine Box-sponsored capstone design project. Sunshine Box is a solar charged phone charging box, meant to be mobile in "first emerging nations." While this business has clientele outside of the United States, namely in Haiti, the business was started by a USD alumna based in the United States, and she provides the stakeholder feedback to the capstone design team.

Founded in 1987, the engineering program at USD was made to "meld engineering into a liberal arts tradition."[329] Engineering on campus started with an electrical engineering program,

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[327] "Home - Engineering Brigades," https://engineering.globalbrigades.org/.; Field notes November 2019. Interview S25. See Chapter 2 for more of this discussion.

[328] Again, this is in contrast to the other two field sites that were discussed in chapter 2 and 3.

[329] Thomas F. Schubert, "Melding Engineering into a Liberal Arts Tradition: A Unique Nine-Semester BS/BA Electrical Engineering Program," *FIE* (1997).For a preview of some of the potential challenges and how well this could go, see Matthew H Wisnioski, ""Liberal Education Has Failed": Reading Like an Engineer in 1960s America," *Technology and Culture* 50, no. 4 (2009).

adding industrial and systems engineering in 1996 and mechanical engineering in 2002. In a ten-year reflective history of the program, written in 1997, one of the original engineering faculty members noted the difficulty of fitting in the Accreditation Board for Engineering and Technology, Inc. (ABET) required credits with the general electives and core of the liberal arts education. They noted that there were a number "tradeoffs" when trying to satisfy both the extensive general education courses and develop an engineering curriculum.[330]

The engineering programs were originally housed in the College of Arts and Science, and then in the School of Business Administration for over fifteen years before becoming the foundation of the Shiley-Marcos School of Engineering (SMSE) in 2012, adding General (now, Integrated) Engineering program a few years after.[331] The liberal arts tradition of USD is seen as a selling point for all SMSE degrees, however the tension in balancing a liberal arts education with "rigorous" engineering education still remains. Some faculty argue that pulling the curriculum too far from traditional engineering will detract from the rigor of what defines engineering education, but others argue that pulling too far from the core liberal arts tradition of USD will detract from the holistic critical thinking that it is preparing all of its students to engage in.

Being a "changemaking engineer" can also mean to integrate "the social" and "the technical." But how engineers ought to engage in the division (between social and technical) means different things for different people. Preserving an engineering identity remains important to those that believe that social justice, or the "social side of things," is included in a liberal arts education. They ask, if social justice is in embedded in USD's liberal arts education, why would

[330] Schubert, "Melding Engineering into a Liberal Arts Tradition: A Unique Nine-Semester BS/BA Electrical Engineering Program."

[331] The SMSE also has a Department of Computer Science.

there have to be special emphasis within engineering? USD's engineering degrees are all joint BS/BA degree, the result of a university wide effort to "enhance the science portion of its liberal arts tradition."[332] But this origin story and the BS/BA distinction still remain core to how all the Shiley-Marcos School of Engineering differentiates itself from other San Diego area engineering programs.

The Shiley-Marcos School of Engineering (SMSE) was formed in 2012 through a $20M donation from Darlene Marcos Shiley.[333] This donation sparked a search for the School's founding Dean. Chell Roberts, an executive dean for the College of Technology and Innovation at Arizona State University (ASU) was hired following his experience in developing a General Engineering program at ASU. Roberts innovative curriculum-building experience mixed with USD's community service-learning history made the SMSE a perfect site for thinking through the integration of the social and the technical, and in turn, social justice through engineering practice. As mentioned above, changemaking is core to what USD is and does. Historically, the university has been focused on local efforts and that remains true in their engineering and social justice initiatives. In many ways, efforts to make "changemaking engineers" embraced USD's history and is flexible enough to create something new.

"Something new" became a possibility in 2015 with an influx of $2M National Science Foundation Revolutionizing Engineering and Computer Science Departments (NSF-RED) grant. The primary goal of USD's RED grant was to develop "changemaking engineers." As described in the RED grant abstract, "changemaking engineers" are being exposed to "an engineering

[332] Schubert, "Melding Engineering into a Liberal Arts Tradition: A Unique Nine-Semester BS/BA Electrical Engineering Program."

[333] Diana Crofts-Pelayo, "USD Department of Engineering Gifted $20 Million," (2012). https://www.kpbs.org/news/2012/sep/25/usd-department-engineering-gifted-20-million/.

education that integrates traditional technical skills, enhanced social awareness, and an integrated profession spine" which will "empower[] graduates to improve society – by practicing engineering with the contexts of social justice, peace, humanitarian advancement, and sustainable practices."[334]

However, with the possibility of making a new kind of engineer, a sense of rigor and disciplinary oversight became important.[335] In addition, the role of teaching versus research in University of San Diego engineering went up for debate. With this large NSF grant coming in, a few faculty members pointed to their teaching responsibilities as their primary role, justifying why they could or would not participate in the research. One faculty commented that they were confused by the shift to research saying, "you know, our focus wasn't on being great researchers, our focus was not, not bringing in tons of money. Our focus was on getting three programs up and running and functioning. And, and well, they changed the rules on us."[336] Substantial NSF dollars coming in through the RED grant changed the SMSE inter-departmental dynamics and made way for a new department.

Part of the RED grant provided funds for the General Engineering program, started in the fall of 2016. An initial cluster higher of two tenure track lines and a Professor of Practice for this

[334] "NSF Award Search: Award#1519453," https://www.nsf.gov/awardsearch/showAward?AWD_ID=1519453.

[335] For more on this tension and how engineering was failed by and failed liberal arts education see Wisnioski, ""Liberal Education Has Failed": Reading Like an Engineer in 1960s America."; For why I want to scare quote "rigor" every time I write it see: Donna Riley, "Rigor/Us: Building Boundaries and Disciplining Diversity with Standards of Merit," *Engineering Studies* 9, no. 3 (2017), https://doi.org/10.1080/19378629.2017.1408631.

[336] Interview F15.

new program emphasized the RED grant's promise to focus on making "changemakers."[337] The program, now titled Integrated Engineering, offers four concentrations along with an individualized plan of study: Biomedical Engineering, Embedded Software, Sustainability, and Engineering and the Law. The integrated engineering concentrations have varied relationships with the traditional engineering disciplines. The Biomedical Engineering concentration has the closest connection to a traditional discipline, while Embedded Software uses a more multidisciplinary approach, and Sustainability Engineering borrows from environmental and civil engineering but focuses on sustainable design as applied to many different contexts. Last, Engineering and the Law is in collaboration with the Law School on campus, which primarily prepares students for patent law.

Integrated Engineering Concentration	**Enrollment** (according to Fall 2019 numbers, projected for 19-20 graduates)
Embedded Software	11 graduates; 13 declared
Biomedical Engineering	7 declared
Sustainability	12 declared
Engineering and the Law	2 declared
Individual Plan of Study	2 graduates; 5 declared[338]

Figure 4.2: Students graduated (by '19-'20 academic year) and declared for each Integrated Engineering concentration

It is important to note here the "integrated" engineers and "changemaking" engineers are not completely synonymous. The training of "changemaking" engineers is meant to happen throughout the SMSE; however, integrated engineering faculty lines were advertised as "associated" with the RED grant, defining "changemaking engineers" just as I have above, and

[337] Eventually, 7 hires were included in the cluster "devoted to social justice and humanitarian practices [to] help revolutionize" the new program. See "New Faculty Hires to Revolutionize Engineering Program," accessed August 30, 2016, https://www.sandiego.edu/news/engineering/detail.php?_focus=56190.

[338] Data from Integrated Engineering Advisory Board Meeting Agenda December 6, 2019.

job advertisements specified that the new hires would interface with this project. As a result, the cluster hires, while having different specialties, all respond to issues of social justice through their research or teaching, and these faculty members are many of the usual suspects involved in curriculum and program building when "changemaking" is talked about in terms of "social justice."[339]

Social Justice as Changemaking In Practice

Back in a classroom on campus, engineering students sifted through their waste for the week, questioned its contents, and learned about their heap's recyclability.[340] One student commented rather loudly, "You can wash red Solo cups in the dishwasher!?" A few classmates snickered; a classmate shook their head in agreement.[341]

These students were participating in an NSF-RED grant-sponsored classroom module for their *Engineering Materials Science* course. Throughout the week, the students were tasked with collecting their personal waste and, in class, reflected on its contents. They were not, however, asked to adjust their waste production. These modules were one way that faculty of the RED grant were trying to train "changemaking" engineers.[342]

[339] Job Posting, iRecruitment IRC 18414

[340] The heaps were smaller than expected heaps because the exercise coincided with the university's "No Waste Week." So, the normative charge came from other campus-wide initiative, but not the class itself.

[341] Field notes in the Fall of 2019.

[342] "Social Justice" is mentioned in the programs large NSF grant and can be found in a handful of engineering course descriptions. Much more on this below.

Figure 4.3: Students sort through their weekly waste during a RED grant classroom module

While "changemaking" is used to describe the engineers in the NSF-RED grant materials and to those outside the department and the university, the language of "changemaking" was rarely used in the classroom. In fact, how "changemaking" relates to other institutional entities is sometimes unclear, even to the actors within them. Those that work on the NSF-RED grant *know* they are engaged in making "changemaking engineers." But that is only a select few across multiple engineering disciplines. The Changemaker Faculty Fellows, a university-wide program devoted to raising awareness of USD's "Changemaker Campus" affiliation, are equipped with the university-wide message that it is important piece of their community identity, but don't regularly engage with what it looks like in practice.[343] And, all the recently hired Integrated Engineering are Fellows in this program, so the department is vaguely tied to the identity.[344]

The connection between "sociotechnical" thinking, "holistic" thinking, and "social justice" played out in varied ways at USD. By some, these principles are treated as synonyms: if

[343] This conclusion drawn from a series of Changemaker Faculty Fellow interviews.

[344] "Changemaker Faculty Fellows," https://www.sandiego.edu/changemaker/faculty/champions.

engineering students know more about how their work is situated in the world, they will be more ready to "tackle the world's most complicated problems with an interdisciplinary mindset."[345] The complicated nature of these problems involves understanding, diagnosing, and addressing humanitarian need, injustices, and sustainability issues of their (and others' past) engineering efforts, but engineers must first understand that they work and live in complex sociotechnical systems.[346]

Besides a few curricular requirements, students or faculty were not required to participate in social justice efforts, but the university celebrated engineers that were already integrating social justice into pedagogy and practice. For example, every student is required to take two courses which have Diversity, Inclusion, and Society Justice "flags," or designations for curricular requirements. *Engineering and Social Justice*, the course that I observed, fulfills one of these two courses for any student.

The newly formed Engineering Exchange for Social Justice (EXSJ) celebrates those that are already integrating social justice and inclusion into their engineering work. EXSJ, a new organization at USD, recognized work including a mobile trailer for local, K-12 children STEM education and outreach, implementing social justice into engineering curriculum, and the Waste for Life plastics project. This group emphasizes exchange "from, with & for the community" and "work[ing] collaboratively with diverse marginalized community groups to co-create alternative

[345] "Integrated Engineering," https://www.sandiego.edu/engineering/programs/integrated-engineering/.

[346] This idea was most readily seen in the few days in an introductory design course I observed that covered "social constructions" in design spaces. Field Notes November 2019. Understanding the complexity of engineering design spaces was further complicated in higher level courses like *Engineering and Social Justice.*

solutions to problems which are technical in nature."[347] The purpose of the creation of EXSJ was to "bring together a lot of the service-learning activities together, under one hub, to ensure that 'we are truly in partnership.'"[348] But who they partner with and what kind of technical expertise an engineer might bring to the partnership remains flexible.

Social justice efforts in USD's Integrated Engineering Department emphasize diversity and inclusion.[349] While this emphasis is unique to this university, of the three that I describe in this dissertation, it follows a larger shift within *engineering for good* programs around the country. Social justice is a natural shift from conceptions of "service" or working through conceptions of "development," like the previous sites discussed, reflected in *engineering for good* literature and program-building in engineering education. But pausing on diversity and inclusion issues here may call attention to what is missing at other sites for *engineering for good*.

Diversity and inclusion efforts are core to USD's identity. The university has general "foundations" curricular requirements which include: Theological and Religious Inquiry, Philosophical Inquiry, Ethical Inquiry, and Diversity, Inclusion and Social Justice Flag.[350] All USD students are exposed to "foundations" requirements through required general electives courses. These foundations courses are important because they are designed to help students "become individuals who, through the search for truth and goodness, uphold the dignity and

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[347] "Engineering Exchange for Social Justice," accessed November 28, 2020, https://www.sandiego.edu/engineering/community-and-partners/engineering-exchange.

[348] University of San Diego, "Engineering Exchange for Social Justice."

[349] I observed a secondary emphasis of sustainability as applied to any disciplines, but I will focus on the primary theme I observed in the *Engineering and Social Justice* course and beyond.

[350] "Foundations," https://www.sandiego.edu/core/four-areas-of-the-core/foundations.php.; note that all other foundations are inquiry, but DISJ is a "flag."

aspirations of all people; and who critically and creatively explore the 'big questions' about God, personal identity and social identity."[351] These "big" and difficult questions are rarely explored in engineering practice.[352] The Integrated Engineering department is working against particular "engineering mindsets" that limit the scope of engineering practice to rigidly defined technical problems, while also trying to gain and maintain respect from the other engineering faculty within the institution.[353] One integrated faculty member wishes to change this narrative, hoping that their students,

> in wherever they're working, to feel like . . . [their work] kind of resonates with their own values and that they are helping to maybe make the world a better place. And that they are the leaders in sort of asking maybe sometimes the hard questions but getting people to think beyond just the numbers and the calculation, those are still very important, but they don't exist in a vacuum.[354]

One of the major features of the diversity and inclusion efforts at USD was the idea of expanding what engineering can be and what kinds of knowledges are considered engineering knowledges. In a public announcement of the RED grant, Dean Chell Roberts said that

[351] University of San Diego, "Foundations."

[352] Chen et al., "Vocation in the Engineering Curriculum: Challenging Students to Recognize Their Values."; Cech and Sherick, "Depoliticization and the Structure of Engineering Education."

[353] Riley, "Engineering and Social Justice," chapter 2.; Diana A Chen, Joel Alejandro Mejia, and Samantha Breslin, "Navigating Equity Work in Engineering: Contradicting Messages Encountered by Minority Faculty," *Digital Creativity* 30, no. 4 (2019).

[354] Interview F23.

"solutions and innovations for the world require a diverse group of engineers."[355] Integrated Engineering faculty are committed to increasing diversity in engineering by supporting women, military veterans, and other underrepresented minorities through both research and pedagogy.[356] Hiring critical scholar Dr. Joel Alejandro Mejia as Assistant Professor expanded these efforts, with Mejia's research focuses on Latinx and Chicano/a success in engineering.[357]

Doing social justice *through* engineering and *as a part* of engineering education research can be conflated in institution-building efforts, leading those that are interested in social justice and engineering broadly to do both. For example, Mejia does both. Mejia's critical scholarship draws attention to underrepresented "funds of knowledge" of Latinx and indigenous engineers, drawing a more inclusive boundary around who gets to count as an engineer.[358] In addition,

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[355] "USD's Shiley-Marcos School of Engineering Awarded $2 Million Grant to Revolutionize Engineering Education," 2015, https://www.sandiego.edu/news/engineering/detail.php?_focus=52071.

[356] Michelle Madsen Camacho and Susan M Lord, *The Borderlands of Education: Latinas in Engineering* (Lexington Books, 2013); Field notes from Fall 2019.

[357] Mejia was recently awarded the NSF CAREER award for research in this domain; "USD Professor Awarded $579,000 NSF Career Award to Promote Latino Success in Engineering," 2020, https://www.sandiego.edu/news/detail.php?_focus=75106.

[358] Leroy L Long and Joel Alejandro Mejia, "Conversations About Diversity: Institutional Barriers for Underrepresented Engineering Students," *Journal of Engineering Education* 105, no. 2 (2016); Amy Wilson-Lopez et al., "Latina/O Adolescents' Funds of Knowledge Related to Engineering," *Journal of Engineering Education* 105, no. 2 (2016) ; Joel Alejandro Mejia and Amy Wilson-Lopez, "Sociocultural Analysis of Engineering Design: Latino High-School Students' Funds of Knowledge and Implications for Culturally Responsive Engineering Education," in *Qualitative Research in Stem* (Routledge, 2016). Mejia has also been supported by the NSF for this work, see "Research: Asset-Based Practices in Engineering Design (Aprende): Formation of Engineers through a Funds of Knowledge Approach Award #1826354," accessed January 7, 2021, https://www.nsf.gov/awardsearch/showAward?AWD_ID=1826354&HistoricalAwards=false.

Mejia, in his class *Engineering and Social Justice*, works with undergraduate engineers to learn about social justice *through* engineering practice, by stepping the students through Leydens and Lucena's criteria in *Engineering Justice* as applied to current capstone design projects at USD, like the Waste for Life project described above.[359]

A few students told me how they felt welcomed in Integrated Engineering at USD because of the department's commitment to diversity and inclusion. In particular, when I asked one student what led to their choice to pursue an Integrated Engineering degree, they mentioned to me the impact that a diverse faculty makeup had on their education, saying, "I was like, wow, I love [this professor], I just thought she was so cool. She was my first female engineering professor. I think that had a big impact. And also, she's a woman of color. So I was like, oh my gosh, like, that's me. I'm a woman of color, and I'm doing engineering."[360]

In addition, in the *Engineering and Social Justice* course, students wrestled with the notions of privilege, inclusion, and diversity within engineering, and how their senior capstone projects were enacting social justice or not. Embedded in this class was an inherent critique of traditional engineering education, but its instructor treaded lightly. These students, after all, were active participants in forming the young Shiley-Marcos School of Engineering (SMSE) and had to be committed to their engineering identity, first, before they could be committed to any rigorous critiques of the profession.

Social Justice as Religiously Pliable

[359] For more on these criteria, see chapter 2. Leydens and Lucena, *Engineering Justice: Transforming Engineering Education and Practice*.

[360] Interview S29.

USD's Roman Catholic affiliation has always been a justification for its students to participate in service and volunteerism.[361] In contrast to a public land grant mission, for example, this private institution is inherently tied to the "common good" through their religious affiliation. But there is flexibility in the religious teaching at the University. As one engineering faculty member mentioned to me, "since we're not Jesuit. . . I think we have sort of a conflicted Catholic identity, like sometimes we acknowledge it, and other times, we kind of want to hide it. Whereas I feel like the Jesuits are more like, 'this is who we are.'"[362]

The university's Catholic affiliation was rarely acknowledged in the engineering classrooms that I observed, although each classroom has a stenciled cross above each doorway. This avoidance may be in an attempt to not exclude people with other beliefs or an attempt to hide from the connotations of traditional, religious inquiry. One faculty addressed some of the connotations of being a Catholic intellectual, saying,

> I believe that God gave us all an intellect and we're supposed to use it and we can't ask questions that are gonna like unmask God or like suddenly leave God short. If that's true, then God is a very limited concept, right? So, I've never had a fundamentalist approach. And I do think Catholic education with the idea of, you know, you are supposed to study all sorts of things because you learn in all sorts of different ways. And that's how you are able to make contributions and stuff.[363]

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[361] This was evident when I saw *engineers for good* present their work on social justice to other universities, but more frequently in public facing documents about the university's involvement in service or community engagement.

[362] Interview F23.

[363] Interview F23.

Here, the faculty member both pushes against the idea that Catholicism is intellectually limiting and makes room for interdisciplinary inquiry at a Catholic institution. This flexibility leads to social justice being used as a term that can shift meaning depending on the topic at hand. But at its core, the institution supports social justice when it means treating all people with equal dignity. The faculty member continued with respect to the kinds of social justice that is applicable in a reinterpreted, modern Catholicism, saying,

> you know the ideas around Catholic Social Thought, you know the preference for the poor, that fits very well with the social justice stuff and, you know, treating all people with dignity and not like on a fundamental level and trying really hard to work for justice and always like, those really do resonate with me… some of the doctrinal things ... I don't think that's so important. I mean, when Jesus was on the earth, he hung out with these people that no one thought were worth anything. Right? So who would he be hanging out with now? If he were here? I mean, I don't, I don't think it's the clergy, I think he would be hanging out with the people with HIV. So, I think a lot of that message, like once the religion becomes a religion of the State, right, good in some ways, because then many more people have access and can practice safely, but it also means that you lose the like radicalness of what it was, which is really, truly was the power.[364]

The "radicalness" of this revised, contemporary Catholic way of thinking about Jesus's life as described by this faculty member is very similar to politically progressive, secular conceptions of social justice.[365] At the core of both is the respect and prioritization of human dignity. However, the two movements' historical underpinnings make social justice mean

[364] Interview F23.

[365] For more critical reflection on this, see chapter 1.

different things in these contexts, one showing care to an individual, the other thinking about systemic or structural change. There is still a political conservativism imbued in most Catholic universities, but only 40% of the students in the 2019-20 USD class were Catholic, and while some of the faculty members working through issues of social justice and engineering identify as Catholic, it is not clearly a part of their teaching. One faculty member mentioned, "I just have great difficulty in sort of labeling [social justice] as a 'Catholic thing'… but, but to me, it's not my faith. . . I would say it's more my spirituality, [it's not] like the doctrine of the Church type of thing that guides me, and I don't that is the thing that guides many people I work with."[366] What's left, then, is a social justice that is translatable to secular organizations and research agendas.

The founding of the Kroc School of Peace and Justice in 2000 solidified USD as a theoretical and scholarly leader in social justice and peace studies. Collaborations between the Kroc School of Peace and the Shiley Marcos School of Engineering like the resulting course, book, and Good Drone Lab developed by Austin Choi-Fitzpatrick and Gordon Hoople are exemplars of how the university provides unique engagement between peace and technology.[367] The project's popularity in public spheres also shows how peace and social justice scholarship at a Catholic University is not inherently religious and can be translated to public, secular forums. University of San Diego was also the site for *Build Peace*, a technology-based conference that

[366] Interview F22.

[367] Gordon D Hoople and Austin Choi-Fitzpatrick, "Drones for Good: How to Bring Sociotechnical Thinking into the Classroom," *Synthesis Lectures on Engineers, Technology, and Society* 9, no. 1 (2020); Elizabeth Reddy, Gordon Hoople, and Austin Choi-Fitzpatrick, "Interdisciplinarity in Practice: Reflections on Drones as a Classroom Boundary Object," *Engineering Studies* 11, no. 1 (2019).

explored the borders of peacebuilding.[368] The Peace and Justice Theatre housed the *Build Peace* conference along with world renown visiting speakers, which often addressed the theatre's titular themes.

Liberal arts education at USD promotes a holistic student, informed by personal values as much as professional or scholarly ones. This holistic emphasis is connected to religious beliefs. In a paper about the history of the engineering program, one engineering faculty member stated that "USD has remained committed to the ideals of liberal education, which emphasizes the potentialities of men and women as human beings and creatures of God."[369]

Similarly, more than twenty years after the writing of that paper, faculty in the Integrated Engineering department partnered with the USD Office of Mission and Ministry to conduct pedagogical research on how to best integrate student's personal values to the idea of a purposeful vocation.[370] This project asked students to categorize values such as "self-acceptance" and "wealth" in levels of importance, then reflect on how and if those values affect students' choices and whether they are confronted with these value-laden choices in their engineering curriculum.[371]

But because social justice and engineering at USD is not closely tied to a specific religious or scholarly study of social justice movements, applying "social justice" is flexible. It can mean fighting off oppressive behavior and increasing opportunities within STEM in local

[368] One notable border was the geographic one between the U.S./Mexico that all of the conference participants crossed as part of the event. "Build Peace," accessed December 17, 2020, https://howtobuildpeace.org/.

[369] Schubert, "Melding Engineering into a Liberal Arts Tradition: A Unique Nine-Semester Bs/Ba Electrical Engineering Program."

[370] Chen et al., "Vocation in the Engineering Curriculum: Challenging Students to Recognize Their Values."

[371] Ibid.

communities, but it can also mean broadly working in sustainability and diversity and inclusion. The Integrated Engineering major is also influenced by social justice as a guiding principle, if not only because many faculty members in the department were hired in response to calls that asked for just that. What follows is that there is an inherent connection between integrating the social and technical aspects of problems and social justice; the space between these two concepts widens when having to explain what integrated engineering is as expertise, but it closes when its participants are pressed on how engineers should engage in social justice.

Resistance to Change

Not everyone agrees that engineers need special training to ensure that they are "changemakers." This tension, between what is happening in industry and what new, changemaking engineers might contribute was apparent. Establishing a new Integrated Engineering major came with resistance because some engineering faculty already saw themselves as doing integrative engineering strategies, or at the very least think that engineers "already know this stuff" and were offended by others implying that they don't by teaching engineers to do so.[372]

Integrated Engineering, during its founding, was first described to some engineering faculty as a "skunkworks" lab, "an incubator" that would serve as a testing site for new majors before they became their own departments. The influx of the RED grant and the hires that followed established other expertise beyond incubator-friendly engineering disciplines. The SMSE hired for a new mode of engineering, in and of itself, rather than other, more traditional forms of engineering. This strategy was not widely accepted. When I asked about what alternative direction one faculty member would like the school to go in instead of integrated engineering, the faculty member quickly responded, "civil engineering, the country is in great

[372] Interview F15.

need of civil engineers."[373] There was also extreme disrespect for particular expertise within the SMSE, one faculty member mentioned how they didn't understand engineering education expertise within a small, teaching institution, and they did not know what that expertise would prepare faculty members to teach. Not everyone shared those opinions, but the tension that this perspective brought forward was apparent and felt by others.

That said, studying and promoting social justice had much more university-wide institutional buy-in then at CSM and Baylor. All students are required to take courses with social justice requirements, so it is less about social justice's place in USD's curriculum than about social justice in engineering curriculum. However, as one faculty member mentioned, implementing social justice strategies is sometimes about "sneaking" it in amongst more traditional engineering education so students see it as a reputable source of engineering knowledge.[374]

The *Engineering and Social Justice* course's final project was premised on the same normative criteria used at Colorado School of Mines's from the book *Engineering Justice*.[375] Students were asked to examine their projects based on Leyden's and Lucena's criteria but have difficulty when they realize that users are either never consulted or their users are part of the military defense contractors that cannot disclose their intended user or design context. Some capstone design projects, that are sponsored by defense contractors, *could* be used for emergency or firefighting applications, but that is clearly not this company's primary clientele, making actual "stakeholder identification" difficult. Students talk about how citizenship is a barrier for

[373] Interview F15.

[374] Field notes, December 2019.

[375] Leydens and Lucena, *Engineering Justice: Transforming Engineering Education and Practice*.

entry for government defense and contracting projects as they talk about diversity and inclusion, and they discuss power dynamics between employer and employee as they are not allowed to know many details with regards to how their capstone design project will be used.[376]

Many students saw doing both capstone design and analyzing their capstone design project for engineering and social justice as a "two-for-one." Students were not penalized for not scoring well on their engineering and social justice criteria, but they were tasked with brainstorming ways that they could improve upon their score. Some groups did not have any overlap in participation, with no direct effect on what the capstone project team would do, but it did give a sense of connectivity between the theoretical and the practical. The course fulfilled both the Diversity, Inclusion, and Social Justice Flag and the Advanced Writing Flag—another form of "double counting" that some students admitted to me is why they took the course.

USD's core "changemaking" messaging gives engineers the permission to engage in social justice as a student in that university, but that does not mean that their engineering identity completely matches with these institutional values. Not all students easily adapt to the "changemaker" label. One student denounced this label, stating,

> We're normally fairly well-off students, who don't struggle, and we got into a private university that we can afford, and we don't need change. Like why, why would 90% of students here, why would they want change in the world?
>
> Like, it benefits us. So there's no real reason to want to change a lot of it. Yeah, there's certain things that everyone would agree we should probably change. But I just I just don't feel like it's a good representation of [our] community.[377]

[376] From class observation field notes, fall 2019.

[377] Interview S26.

This student felt as if USD was not primed for making change because of the students' privilege. On one hand, you can applaud the student's honesty; but on the other, this attitude is reflective of just how hard it is to get engineers onboard with social justice efforts. Because of these critiques, and others, the integration of social justice within engineering education remains a rather small effort. In turn, this vulnerability catalyzes faculty to dedicate time and energy to defend their research and pedagogy.

Training "changemakers" falls disproportionately on already underrepresented faculty and administrators.[378] In fact, a few members of the Integrated Engineering faculty wrote an auto-ethnographic account of how and why this work falls on minority faculty. They found that "the heavy-lifting of justice work has been put upon the shoulders of those who have learned through their lived realities the importance of diversity in engineering space." They also witnessed stereotyping, microaggressions, and the reproduction of hegemonic knowledge dynamics.[379] This translates to questions about tenure and promotion and what it means to be successful in a university setting.

Social justice is sometimes used as a stand-in for diversity and inclusion in effort to subtly revise traditional engineering practices. The concept affords actors a pliability of the term to justify their work to the university as a religious institution and their scholarship, research, and teaching as a major grant recipient. In addition, critical scholars and practicing engineers question whether this kind of integrated engineering has already been done, hoping not to repeat

[378] Chen, Mejia, and Breslin, "Navigating Equity Work in Engineering: Contradicting Messages Encountered by Minority Faculty."

[379] Ibid, 7-12.

it's failing.[380] Social justice's hybridity, and recognizing its engagement with both scholarship and personal convictions, makes it unique.

It is also important to note the limitations of pairing social justice and engineering. As I have mentioned in previous chapters, social justice can be difficult to rally support around because of its leftists' political connotations. There are only particular institutional contexts in which social justice thrives. In addition, social justice can sometimes be too big a "problem space." While the students in the Waste for Life capstone design project were traveling to go see trash for their hot press project, they weren't able to truly engage in the issue of immigration and border crossers that their field site visit made so apparent.

[380] Wisnioski, ""Liberal Education Has Failed": Reading Like an Engineer in 1960s America."

Conclusion

Engineering as it Can Be?

Engineers for good have deeply rooted and complex values, drawing on both secular and religious themes. This dissertation depicts engineers' strong individual convictions and the learned normative dimensions of their work. These humanitarians design and implement engineering "solutions" with unique visions of the roles the technologies that they design will have in society. *Engineers for good* have constructed and institutionalized something new that goes beyond traditional engineering's usual purposes, in some ways expanding engineering's usefulness, and in others simplifying its technological output. In both religious and secular settings, this work was sparked by technological "excess" and the desire to share these resources with others. Working with and for "others" is what makes this work so complex.

Engineering for good is to engineer for others. These engineers work to acknowledge the colonial legacy of development, the inherent paternalism of humanitarian service, and the contentious politics of social justice work. Through the rejection of more traditional engineering goals like capital gains and career advancement, these new engineers have redesigned engineering "success" to be more in line with their individual convictions of serving the common good. Many of these engineers are "called" to this work, citing if not religious a spiritual connection to their profession and this alternative mode of technological production. But assigning need is a balance between acknowledging the power and privileges of engineering expertise and the humility to know that engineers do not have all the answers.

These values are strongly shaped and disciplined in the process of educating engineers for good. In universities across the country, engineers enroll in international development projects, take ethics classes that examine the capitalistic and destructive nature of engineering, and work to critique engineering while working within it. Each engineer wrestles with their

individual values, but they grow in their ethics and moral commitments together at the institutional level. Each program that I studied is directly addressing the pitfalls and lessons learned of failed development efforts, fruitless service projects, and contentious engagement with social justice efforts. They are aware of the damage they could cause because they recognize that their predecessors often did more harm than good. They battle within their institutions to be taken seriously as a new form of expertise but are careful not to wield it too confidently. Because what they do is relatively new, as compared to other engineering disciplines, they are constantly being asked to justify their existence to other technical professionals and academics. But they persist.

Fixing Development

The *engineering for good* movement came, in large part, out of a nationalistic call for international development efforts. Responding to the United States' efforts to extend their technological resources out to the rest of the world, engineers began grassroots efforts to attend to making "appropriate solutions" for people living in "developing" countries. While the efforts became small and localized, many of the assumptions about the need that these engineers were addressing remained the same. These engineers were working to provide "basic human needs" and work to "eradicate poverty," echoing larger trends in international policy and aid.[381] Engineers must assume need to engage with development, but then they quickly confront the difficulties of assigning needs to others. Today, much of mainstream *engineering for good* remains in direct response to and serves as a revision of large-scale international development, but it cannot easily shed the baggage of its past.

[381] Rist, *The History of Development: From Western Origins to Global Faith*, 160-64.

Enthusiastic engineers are often drawn to development efforts to participate in cultural exchange and to "help" others.[382] These well-intentioned students and faculty are excited to have impact while using their technical expertise but are soon disciplined into seeing all the pitfalls of this perspective and the potential for undesired impacts. Drawing on post-development and post-colonial lessons learned, they quickly question their intentions for pursuing work in "developing" contexts, wondering whether they should even be doing this work at all.

Engineers for good are warned of both the wrongs of past development efforts and the power differentials within present engineering practice. Engineers working within development reflect on "the savior mentality" of international aid and development and focus on community engagement over nation-state policy.[383] In addition, faculty in this new field depict past engineering efforts by promoting the integration of "the social" and "the technical" of engineering efforts.[384] Faculty at the fore of engineering for development aim to put people at the center of their work while also pointing out the complexity of acknowledging just how much of a social endeavor all engineering is in practice.

Students, readied with normative sets of criteria for sustainable community development and social justice prioritize "listening contextually" and "enhancing human capabilities" as they

[382] Schneider, Lucena, and Leydens, "Engineering to Help," 42.

[383] Flaherty, *No More Heroes: Grassroots Challenges to the Savior Mentality*.

[384] I want to be careful here as I describe this integrative method. For example, there are STS-trained faculty at CSM that do not perpetuate this divide as they describe the integrated nature of engineering; however, the divide between "social" and "technical" and the inherent power dynamics between the two are apparent in practice. For more of what I mean by this see, Wendy Faulkner, "Dualisms, Hierarchies and Gender in Engineering," *Social studies of science* 30, no. 5 (2000): 759–92.

head out into international project sites.[385] Young engineers are faced with difficult decisions as they participate in small-scale development projects with now more "appropriate" goals, but arguably more challenging ones. The time and expertise limitations in educational settings prevent students from taking deep dives in development work, and, for most, learning and critically reflecting on the criteria is a majority of their learning.

While *engineering for good* originates from international development, there is a pull for this practice to become more generalizable. Faculty in prominent programs tout that they are training students to engage in "engineering as it should be: responsive to the needs and problems of the underserved."[386] The enthusiasm that students bring to participate in more traditional development projects can be shifted towards a wider range of engineering projects, in effort to widen who engineers think of as potential users of their products.

Doing good in this way comes with its challenges. Simply put, people do not often like to be fixed. In attempt to revise what development is in engineering by relying on "human capabilities" approach, problems become more complicated. What at first looked like a simple water well or sanitation problem becomes an issue of basic human rights and thinking about these projects just in terms of development becomes limiting. Students become confused about the kinds of impact that they can have, and faculty find themselves balancing between encouraging their students' enthusiasm and sharpening their criticality.

Eternal Service

[385] Leydens and Lucena, *Engineering Justice: Transforming Engineering Education and Practice*.; Lucena, Schneider, and Leydens, "Engineering and Sustainable Community Development." For human capabilities, see Nussbaum, *Creating Capabilities : The Human Development Approach*.

[386] Leydens and Lucena, *Engineering Justice: Transforming Engineering Education and Practice*, xxv.

Before the international development efforts of the 1950s and 60s, Protestant missionaries served as America's first international philanthropists.[387] Similarly, humanitarianism from the United States is greatly influenced by religious allegory and metaphor.[388] The Christian *engineers for good* that I observed espouse different convictions and motivations for the work that they do. For example, Baylor can more easily partner with other Christian nonprofits, but it is more difficult for their faculty member's conceptions of humanitarianism to be heard in academic spaces. These engineers are forced to focus on the technologies that they design rather than the Christian mission that they have when they bring their work into other, secular spaces.

These Christian engineers can be equally, if not more, enthusiastic about their desire to do good. Like-minded engineers rally around the idea of "spreading God's Love" alongside their technical expertise. While the engineers I observed did not explicitly proselytize the gospel, they tie their religious conviction to their intentions, their persistence, and their devotion. It is their shared belief that all people are living in need and are suffering from a number of poverties beyond "material poverty," such as social or spiritual, that frames the humility required to work for "God's Kingdom."[389]

These evangelical engineers teach each other how to merge their religious values with a specific set of technical training for good. Their faith is a moral compass for doing specific technical work within "underserved" communities. They, too, are revising development in their own way, but the Christian engineering groups I observed are much more focused the act of service with "their gifts from God" than any end goal. They see their service as endless and the

[387] Amanda Porterfield, "Protestant Missionaries: Pioneers of American Philanthropy," *Charity, philanthropy, and civility in American history* (2003).

[388] Barnett, *Empire of Humanity: A History of Humanitarianism*, 17-18.

[389] Corbett and Fikkert, *When Helping Hurts: How to Alleviate Poverty without Hurting the Poor... And Yourself*.

communities that they work with as long-term partners, collectively enacting the kingdom of God. These engineers see their profession as one piece of their Christian identity.

These engineers' commitment was striking. The evangelical engineers I observed are committed to providing solar energy power to Northern Haiti amid an energy crisis and civil unrest. They prayed for guidance and insight as they all met to talk about the ethics of their student group's work, and the students gave up their fall break to provide hurricane cleanup in Southern Texas.[390] These engineers are committed to their servant identity, primarily, over their engineering identity.

Thinking about service, in this way and as a primary outcome of engineering professionalization brings something new to critical engineering studies. This example gives new meaning to engineering problem definition and solution as defined by Gary Downey. Using Downey's language applied to this explicitly religious case, the eternal servant's identity brings service to God (the social) to the "center" and engineering expertise (the technical) to the "periphery" in ways not seen in other engineering education settings.[391] Eternal service pushes past the call for engineers to be involved in problem definition before they begin working on solutions. The "problems of poverty" are deeply a part of their religious identity and values, making them less prone to short-term technocentric solutionism.

But explicit religious values are in tension with the engineering profession's inherent secularity. Christian logics about devotion that are predicated on a commitment to serve God are not applicable to all. Eternal goals are incommensurate with traditional engineering goals such as

[390] I traveled with the Engineers With a Mission student group to Rockport, TX to do Hurricane Harvey clean-up, over two years after the hurricane hit the Texan coast in 2017.

[391] Downey, "PDS: Engineering as Problem Definition and Solution."

efficiency and short-term measurable impact. Similarly, neocolonial critiques of Christians traveling internationally to provide aid still haunt evangelicals. While all the engineers I studied were worried about being paternalistic, the line between paternalism and an ethics of care can be slim. Meaning, when you have everything to give and think others could potentially use it, engineers dedicated to service might ask: why not share it? But over-caring can be "oppressive and suffocating."[392]

Integrating Social Justice

Engineers integrating social justice into their work as their primary means of providing "good" offer a hybrid perspective. Engineers emphasizing social justice are heavily influenced by both critical scholarship and personal conviction. Further, some engineers in Catholic settings have religious motivations for participating in social justice movements and there are also complimentary social, secular values aligned with social justice efforts. Social justice acts as a go-between for both religious and secular settings, a "common good" that many *engineers for good* can agree on.

Social justice efforts can have wide institutional backing. Universities with religious affiliations, especially Catholic affiliations, have long connected social justice values to their mission. While public schools can have long-standing and robust connections to service, connections to development and social justice are either too niche or too progressive. I observed varying support for social justice at each institution I studied. At Baylor, while their engineers are engaged in providing "just energy," they are hesitant to use "social justice" because of its progressive connotation. Faculty at CSM identify "social justice" as one of their three core pillars for humanitarian engineering but are sometimes asked to take this core principle off their

[392] Barnett, *Empire of Humanity: A History of Humanitarianism*, 12.

letterhead on donor letters. However, at USD, the school's Roman Catholic affiliation justifies these engineers' affinity towards social justice and inclusion efforts.

At USD, titles like "changemaker" were frequently used interchangeably with students engaged in social justice.[393] While "changemaker" had many different meanings around campus, the ability for these terms to be conflated shows the flexibility of "social justice" in engineering contexts. While this flexibility is helpful to enroll participants, it can be hard to motivate students around a unifying cause.[394] However, sustainability and diversity/inclusion within engineering were two unifying themes. Sustainability engineering allowed students to pursue their passion for environmental issues while having a degree they found they could market. Diversity and inclusion efforts were mostly a passion that students pursued outside of class and were core to how the students and faculty felt that they could pursue social justice *within* engineering as opposed to *with* engineering.

Students in Catholic institutions can be exposed to a variety of religious, ethical, and moral teachings through their coursework. USD also required students to participate in courses flagged with "Diversity, Inclusion, and Social Justice" content, making sure that all students are exposed to social justice principles. The Roman Catholic affiliation served as justification for students to engage in the politics of social justice initiatives, but it remained flexible and fluid for student and faculty members' own interpretations. For example, e*ngineering for good* can mean engineering done by a more diverse group of people who may be able to assign need differently based on their positionality.

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[393] "Strengthening Diversity, Inclusion, & Social Justice" was Goal 2 in the September 25, 2019 Visioning statement. See chapter 4 for more detail and analysis on this point.

[394] For a look at "enrolling participants" see Bruno Latour, *Science in Action : How to Follow Scientists and Engineers through Society* (Cambridge, Mass.: Harvard University Press, 1987).

There is currently a shift, at all the *engineering for good* programs that I observed, toward *social justice*. It is helpful language and an apparatus for assessing the need of these engineers' work while also quickly makes their priorities distinct amongst other, more traditional, engineering disciplines. Prominent scholars at the intersection of engineering and social justice cite development scholar Martha Nussbaum as their major contributor in defining the major tenets of the field.[395] Nussbaum's "enhancing human capabilities" theoretical framing, in some form or another, has been influential in almost all *engineering for good* efforts I witnessed.

But *social justice* also has practical limitations. *Social justice* has politically progressive connotations, making engineering, typically a conservative discipline, slow to adopt this language. *Social justice* efforts can also fall on the already marginalized students and faculty members.[396] I witnessed a "usual suspects" effect. By that, I mean that because social justice and engineering is so large a category, while all of the faculty generally associated with social justice were part of the institution building and promotion of social justice work, there was difficulty in breaking out from the usual group and getting support from other engineering faculty.

Needs Assessment, Normative Guidelines, and Institutionalizing Good

Needs assessment is core to all these *engineers' for goods* work. In each of my three field sites, engineers draw from complicated narratives and histories to decide the kinds of "good" they might engage in. These engineers draw from development efforts, service, and social justice, each leading to a wide array of projects and pursuits, but one thing that remained common across these sites—engineers must assign needs.

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[395] Leydens and Lucena, *Engineering Justice: Transforming Engineering Education and Practice*, 14-15; 28-30.

[396] For example, see Chen, Mejia, and Breslin, "Navigating Equity Work in Engineering: Contradicting Messages Encountered by Minority Faculty."

The underlying assumption in the case of development engineers is to assign need to the economically impoverished, and it greatly shapes the communities they partner with. For those devoted to service, the need is a bit more unclear, because these engineers are often willing to serve anyone that asks for or exhibits obvious need of their assistance. However, these engineers often refer to economic poverty or "underserved communities" in similar terms as engineers for development. Social justice efforts not only assess need on others as they decide whose "human capabilities" ought to be "enhanced," these engineers assign need to the engineering profession itself.

Engineering for good co-constructs normative guidelines with all its participants. As part of institutionalizing good, those involved must decide what qualifies. While at CSM these normative guidelines are codified through a set of criteria, each of the institutions have implicit metrics for successful *engineering for good.* At Baylor, successful *engineering for good* includes spreading God's love, and they see their work as endless. At USD, successful *engineering for good* is a more diverse engineering.

Engineering for good faculty must balance critiquing older, more traditional forms of engineering with the prestige that comes along with being counted as engineering practice. The faculty I observed are acutely aware of how some other engineering faculty see the work they do and are aware of the hierarchy and subordination of their expertise as compared to other traditional disciplines. While most of the faculty that I observed excel in their respective fields, they found it difficult to gain the respect of their engineering colleagues.[397] In addition, some of

[397] Chen, Mejia, and Breslin, "Navigating Equity Work in Engineering: Contradicting Messages Encountered by Minority Faculty."

the faculty are trained exclusively in the social sciences, worsening perceived power dynamics among engineering colleagues.[398]

Another commonality is that there seems to be no one, clear path for expanding beyond academia. While the field seems to be growing with more curricular promotion and support, the career paths of *engineering for good* are unclear. Some institutions promote public works as an outlet for their alumni's desire to do good, while others promote the Peace Corps. Others still encourage their students to seek employment non-profits, although paid positions there often require full-time industry experience or dramatic pay cuts.

Across the programs I studied, there are obvious differences. Some emphasize critical scholarship, while others focused on individual convictions. *Engineers for good* both aim to rewrite the errors of their predecessors in both missionary and development work and create something aspirational and new. *Engineering for good* provides multiple visions of the future: futures where humans live more harmoniously and less destructively with technology and their environment. Individual institutions also make normative guidelines more or less explicit. These differences can lead to either more unifying practices or more flexibility amongst different groups.

Different *engineers for good* also relate to secularity and depoliticization in different ways. In public settings, there are often efforts to stay away from institutional values that could be construed as either explicitly religious or political. That said, when creating normative visions for the future while also admitting the political nature of technology, efforts to depoliticize become tricky. At religious institutions like Baylor, while depoliticizing remains a priority, secularizing good is not required. And at a Catholic institution like USD, engineers explicitly

[398] Faulkner, "Dualisms, Hierarchies and Gender in Engineering."

take on the politics of doing good, but let their religious values remain malleable depending on the setting and audience. Engineers engaging in social justice can secularize their "good" as much as their NSF grant requires or as little their personal convictions deny.

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What does it say about engineering, writ large, if engineers have made an alternative engineering to do good with? *Engineers for good* are creating new visions for what engineering could be if it were to address traditional engineering's destructive nature. *Engineering for good* deemphasizes destruction and production and prioritizes the common good and compassion. The existing tensions show just how difficult it is to fuse alternative values on engineering identity, practices, and formation. In fact, all *engineers for good* are rebels.

But they must tread lightly. They still benefit greatly from not tearing down the institutions that allow them to do their work, but just by existing they are a threat to other engineering disciplines. In effort to blend "the social" and "the technical" they critique their engineering colleagues of not already doing so adequately. In emphasizing care, they claim (implicitly or explicitly) that other engineers do not care naturally or enough.

All *engineers for good* wrestle with the tensions of assigning need, creating normative guidelines, and institutionalizing good. *Engineers for good* sit with and work through arguably some of the most challenging aspects of providing solutions to problems—defining the needs of the people their solutions aim to aid. All engineering perpetuates an uneven power dynamic between those that decide something is worth fixing and those they are fixing it for. In an ideal *engineering for good*, this relationship would be lateral; however, technical expertise rarely operates as an equal exchange.

And finally, this dissertation shows how seeing both religion and secularity at play in *engineering for good* allows for analyzing both critical scholarship and personal convictions

together. Allowing a deep examination of how doing good has been a religious endeavor, how its participants reject or embrace those histories and connotations and move to pursue their "calling" nonetheless is telling. These engineers are persistent and stubborn and continually evolve into new ways of doing good in response to fervent critiques. It is only through an examination of the critical, secular scholarship and the personal, sometimes religious, convictions of the engineers themselves that a true picture of *engineering for good* emerges. These engineers question dominant understandings of moral and technological progress and, in turn, their collective sense of good engineering.

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Appendix A: List of Engineering for Good programs[399]

Arizona State University – Global Resolve

Arizona State University – EPICS

Arizona State University – Global Technology and Development

Baylor University—Humanitarian Engineering

Colorado School of Mines – Humanitarian Engineering

Dartmouth—Humanitarian Engineering

Drexel University- Peace Engineering

George Fox University – Servant Engineering Program

Johns Hopkins University – Engineering for Sustainable Development Minor

Mercer University – Engineering for Development

Metropolitan State University of Denver-Sustainable Systems Engineering

Michigan Tech—Humanitarian Engineering Minor

Michigan Tech – D80: Prosperity by Design

Missouri S & T- Humanitarian Engineering and Science Minor

MIT – D-Lab

MIT- Humanitarian Supply Chain Lab

The Ohio State University- Humanitarian Engineering Center

Oregon State University-Humanitarian Engineering

Penn State University: – Humanitarian Engineering and Social Entrepreneurship

Portland State – Institute for Sustainable Solutions

[399] Note that this list is inexhaustive, includes only programs within the United States, and includes a wide array of institutional arrangements from degree-granting programs to research centers.

Princeton – Sustainability and Engineering Development Scholars (SEADS) Program

Purdue University – EPICS

Purdue University – Humanitarian Engineering Concentration

Purdue University – Global Engineering Studies and Global Engineering Programs and Partnerships

Santa Clara University – Miller Center for Social Entrepreneurship

SMU Lyle School of Engineering – Hunter and Stephanie Hunt Institute for Engineering and Humanity

Stanford Institute of Design – d.school

Stanford Peace Innovation Lab

UC Berkley – CITRUS

UC Berkley – Development Impact Lab

UC Davis – Certificate in Development Practice

UC San Diego – Teams in Engineering Service

University of Colorado at Boulder – Mortenson Center in Global Engineering

University of Dayton—ETHOS Center

University of Michigan – Global Design Lab

University of Michigan– Socially Engaged Design MS track

University of Oklahoma – Water Technologies for Emerging Regions

University of San Diego-Integrated Engineering

University of St. Thomas – Peace Engineering

University of South Florida – Engineering for International Development

University of Texas- Austin – Humanitarian Engineering Certificate

University of Washington – ICTD Lab

Villanova University – Engineering Service Learning for International Development

Villanova University – Sustainable Engineering

York University – Engineering and International Development Studies

Appendix B: Sample Interview Guide

Student Interview Guide

Background.

- Describe how you got here.
  - Where are you from?
  - How/why [insert institution]?
  - How/why did you pick your major?
- Describe your involvement in the [academic program] and [extracurricular]?
  - What projects have you participated in and what was your role(s)?
  - Why do you participate in these courses, programs, clubs?

If they have gone on trips/worked on projects:

- During [project x]:
  - Describe the goal(s) of the project.
  - When were you involved?
  - Describe your and others' involvement.
  - Who assessed need and why did the organization participate in this project?
  - Who financed the project?
  - Describe current status of the project. When will it be completed?

Defining H.E.

- What is different about [humanitarian engineering/engineering for development/general engineering] than other forms of engineering?
  - What materials or people have inspired how you answer this question?
  - What is different about the users of the technology produced?
- What skills do you have to have to be a good humanitarian engineer?

Self-identifying motivations.

- Why do you participate in [humanitarian engineering/engineering for development/general engineering] activities?
- What makes a good humanitarian engineering project?
  - How do you access need in these situations?
- When is a humanitarian engineering project complete?
- Do you think people from different regions, beliefs, and backgrounds do this work for different reasons?
- Will there be a time in the future when/where H.E. will be unnecessary?
- What do you hope to do after your time at [institution]?

If H.E. student (asked to bring list of courses that they have taken):

- Step me through the courses you have taken, and what are your brief impressions of each and how they have informed what it means to be a humanitarian engineer.
  - -What skills have you gained moving through this curriculum?
  - -What skills do you think you have yet to develop?

Other follow-ups from observations.

Appendix C: Image Annotations and Permissions Information

Figure 2.1: Author captured image; picture was taken in a public venue; no written permission necessary

Figure 2.2: Author captured image; no permission necessary

Figure 3.1: Author captured image; no permission necessary

Figure 3.2: Logos courtesy of Engineers With a Mission and JustEnergy via email from Brian Thomas on December 22, 2020, included in supplementary materials

Figure 4.1: Author captured image; no permission necessary

Figure 4.2: Author created figure; no permission necessary

Figure 4.3: Author captured image; consent obtained by all photograph subjects, written confirmation obtained via email, included in supplementary materials

Appendix D: IRB Approval Letter

VIRGINIA TECH

Division of Scholarly Integrity and Research Compliance
Institutional Review Board
North End Center, Suite 4120 (MC 0497)
300 Turner Street NW
Blacksburg, Virginia 24061
540/231-3732
irb@vt.edu
http://www.research.vt.edu/sirc/hrpp

MEMORANDUM

DATE: May 21, 2020

TO: Matthew Wisnioski, Marie Mella Stettler Kleine

FROM: Virginia Tech Institutional Review Board (FWA00000572, expires October 29, 2024)

PROTOCOL TITLE: An Analysis of Moral and Ethical Decision-Making and Design in Humanitarian Engineering

IRB NUMBER: **17-527**

Effective May 21, 2020, the Virginia Tech Institution Review Board (IRB) approved the Continuing Review request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

https://secure.research.vt.edu/external/irb/responsibilities.htm

(Please review responsibilities before beginning your research.)

PROTOCOL INFORMATION:

Approved As:	**Expedited, under 45 CFR 46.110 category(ies) 5,6,7**
Protocol Approval Date:	**June 7, 2020**
Protocol Expiration Date:	**June 6, 2021**
Continuing Review Due Date*:	**May 16, 2021**

*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

ASSOCIATED FUNDING:

The table on the following page indicates whether grant proposals are related to this protocol, and which of the listed proposals, if any, have been compared to this protocol, if required.