DESIGN JUSTICE IN COMMUNITY-ORIENTED ENGINEERING PEDAGOGY AND PRACTICE

A Thesis

presented to

the Faculty of California Polytechnic State University,

San Luis Obispo

In Partial Fulfillment

of the Requirements for the Degree

Master of Science in Mechanical Engineering

by

Michael Solomon Reyna

June 2022

© 2022

Michael Solomon Reyna

ALL RIGHTS RESERVED

COMMITTEE MEMBERSHIP

TITLE:	Design Justice in Community-Oriented Engineering Pedagogy and Practice
AUTHOR:	Michael Solomon Reyna
DATE SUBMITTED:	June 2022
COMMITTEE CHAIR:	Jennifer Mott Peuker, Ph.D. Assistant Professor of Mechanical Engineering
COMMITTEE MEMBER:	Lizabeth Lea Thompson, Ph.D. Professor of Industrial and Manufacturing Engineering
COMMITTEE MEMBER:	Benjamin David Lutz, Ph.D. Assistant Professor of Mechanical Engineering

ABSTRACT

Design Justice in Community-Oriented Engineering Pedagogy and Practice

Michael Solomon Reyna

While engineering service-learning projects are seen as a favorable way for students to reinforce curricular learning while gaining cultural awareness, the outcomes of these projects center student benefits over partner community wellbeing. For these projects, and in other engineering contexts, various scholar-activists have conceptualized numerous principles and methods to center justice and equity in engineering outcomes. This research project and its associated intervention involved collecting scholarship and methods in engineering and social justice, and attempted to integrate these ideas into the practices of a local humanitarian service-learning engineering team. The collected scholarship centered around the topics of Design Justice, feminist qualitative science & technology studies, and Latin American decolonial theory. In partnership with the Engineers Without Borders Cal Poly Local projects team, following the frameworks of critical participatory action research and community autoethnography, the author spent time with the team to build relationships and facilitated presentations, dialogues, and activities around the collected scholarship. Two sets of semi-structured interviews were conducted before and after the intervention, and qualitative data was analyzed using iterative thematic inquiry. This project found that a local humanitarian engineering-service learning environment was a suitable space to advocate alternative design principles and methods, and that students expressed a desire to learn more about these topics, as well as utilize and share these resources with their friends and in other contexts such as their professional careers. Students experienced moderate amounts of success in using the collected scholarship to modify their project practices, specifically their plans for community assessment. These results imply that other spaces and organizations with an explicit focus on service or social justice may be ideal environments to attempt to implement alternative design principles, and that more efforts to enable students to learn about and share alternative principles could have lasting effects.

Keywords: Design Justice, Engineering Pedagogy, Service-Learning, Interdisciplinary

ACKNOWLEDGMENTS

The author would like to express their gratitude to Dr. Jane Lehr for their assistance in helping conceptualize this research project and for introducing the author to many of the fields of scholarship utilized in this research project, as well as offering assistance in qualitative methods. The author would also like to thank Dr. Lauren Cooper for assistance in the early stages of planning the research project and navigating the administrative process, even if they were not able to be present for the full duration of the project.

The author would additionally like to thank both Jane Lehr and Luka Uchiyama for their feedback and revision suggestions on the presentation and discussion materials prepared for the intervention into the EWB Local projects team. The author would also like to express appreciation towards his thesis committee members, who have provided invaluable feedback on the many drafts of writing and other materials that went into this thesis research project, as well as suggestions for literature to draw inspiration from as well as other guidance throughout the research process.

Lastly, the author wishes to express gratitude towards the other students they have worked and learned with throughout this project and in other spaces, in Engineers Without Borders and other spaces that are actively working towards a new vision of engineering practice and pedagogy.

TABLE OF CONTENTS

Page

CHAPTERS

1. INTRODUCTION 1
2. BACKGROUND 2
3. LITERATURE REVIEW 5
    3.1 Introduction to Relevant Literature 5
    3.2 Service-Learning & Critical Service-Learning 7
    3.3 Engineering Education, Engineering Cultures, and Engineering & Social Justice 8
    3.4 Autonomous Design, Peace Engineering, and Alternatives to Development 9
    3.5 Feminist and Anti-Racist Science & Technology Studies 11
    3.6 Qualitative Methods and Community Autoethnography 12
    3.7 Takeaways 14
4. METHODS 15
    4.1 Methods of Intervention 15
    4.2 Intervention Details and Timeline 15
    4.3 Research Questions and Hypotheses 20
    4.4 Data Collection 22
    4.5 Data Analysis 23
        4.5.1 Iterative Thematic Inquiry – Phase #1 25
        4.5.2 Iterative Thematic Inquiry – Phase #2 26
        4.5.3 Iterative Thematic Inquiry – Phase #3 26
        4.5.4 Iterative Thematic Inquiry – Phase #4 27
5. RESULTS 34
6. DISCUSSION & TAKEAWAYS 38
7. CONCLUSION 41

REFERENCES 43

APPENDICES

A. Intervention Materials 46
B. Interview Scripts 62
C. First Phase of Iterative Thematic Inquiry 64

Chapter 1
INTRODUCTION

While engineering service-learning projects are seen as valuable methods for practicing curricular skills while gaining cultural awareness, these projects are often criticized as being student-centered and prioritizing student outcomes to the detriment of partner community benefits. However, many scholar-activists have conceptualized and are advocating various principles and methods to move towards a more just and equitable practice of engineering practice and development. The goal of this project was to attempt to integrate said principles and scholarship into the activities of a student-led engineering service-learning team, aiming to evaluate if the discussion and attempted integration of this scholarship into the team's activities would contribute to the growth of students' capabilities and approach to humanitarian development, as well as enhance outcomes for the partner community. The results of this project can help evaluate potential approaches to incorporating alternative design methods and practices into both engineering service-learning, engineering curriculum, and other areas of engineering practice.

The *Background* section describes the context for this research, including information about the university, student chapter, and project team that this work is situated in. The *Literature Review* section describes the intersecting fields of scholarship that this project draws upon, including engineering education, humanitarian engineering, engineering service-learning, feminist anti-racist science & technology studies (STS), Design Justice, Latin American decolonial theory, and community autoethnography. The *Methods* section describes the methods of intervention, data collection, and data analysis, as well as research questions and hypotheses. The *Results* section describes the major themes and findings of the project. The *Discussion* section describes what this research may imply for future interventions into engineering education and critical service-learning projects. Finally, the *Conclusion* section summarizes the key points of this research. Additionally, the materials used for the intervention can be found in Appendix A.

Chapter 2
BACKGROUND

This research was conducted at California Polytechnic State University, San Luis Obispo – commonly abbreviated as Cal Poly. Cal Poly is a predominantly undergraduate, predominantly white public institution, classified as a comprehensive polytechnic university that is part of the California State University system. Cal Poly has roughly 21,000 students at this time and is committed to a hands-on “learn by doing” pedagogy. The university has six colleges with its college of engineering as the largest college – the college of engineering is recognized by the American Society for Engineering Education (ASEE) under the ASEE Diversity Recognition Program.

This research was conducted in collaboration with the student team members of the Local projects team at EWB Cal Poly. EWB Cal Poly is a student chapter of the broader Engineers Without Borders USA (EWB-USA) national nonprofit organization. EWB-USA, established in 2001, aims to “build a better world through engineering projects that empower communities to meet their basic human needs.” EWB Cal Poly was established in 2005, currently has three international project teams and a local projects team, with annual operating budget around $60,000 (from university Instructionally Related Activities funding & off-campus donations). Each project team is partnered with a community and non-governmental organization (NGO), aiming to help address a technical issue in the community, typically related to issues of water, energy, or sanitation. In student chapters such as EWB Cal Poly, projects are primarily run by student leaders, who consult with professional engineers, EWB-USA volunteers, and faculty members in order to perform their projects.

It is relevant to note that EWB Cal Poly chapter has in recent years attempted to grapple with the ethical implications of student-centered service-learning with vulnerable communities, as well as the broader criticisms of development articulated by Latin American activists and those in the Global South more broadly. However, despite these efforts, the learning and professional growth

of students is still centered over the well-being and needs of the partner communities that EWB Cal Poly aims to serve (Green 2021). Even so, because of these efforts, EWB Cal Poly was seen as a good potential fit for the goals of the research project.

The EWB Local projects team is currently partnered with a community in California – the Desert Shores community near the Salton Sea. The Salton Sea is facing a variety of environmental issues due to government decisions diverting water distribution away from the Salton Sea. The Local projects team is working with a nonprofit local to Desert Shores, EcoMedia Compass, to deliver a preliminary design of an earthen berm that will help to mitigate the impact of falling water levels on the community. This partnership has currently been ongoing for roughly two years, although the COVID-19 pandemic has led to significant delays in the team's ability to conduct a community assessment as well as conduct land surveying. The team's project work is typically divided into engineering design, community assessment, and team education, and the team typically meets for two hours every Monday during the academic year. Active membership over the 2021-2022 year has varied from roughly six to ten engaged members.

The Local project was determined to be the ideal team to partner with for two primary reasons. The first reason is that a team working on an international project would complicate the aspirations of this project dramatically – the difficulty of traveling, along with the language barriers, would be significant obstacles to the goals of the project. The second is that the Local project is one of two projects that was seeking to perform community assessment during the timeframe of this project. One major aspiration of this research project was to expand on the topics typically included in community assessment – by facilitating dialogue about the varying criticisms of the work conducted in EWB Cal Poly as well as scholarship on more just and equitable methods of design and community partnership, it is hoped that the research questions investigated by the team during the community assessment process will more deeply engage with questions on the community cultures, values, and power dynamics.

It is important to recognize the positionality of the author as well as one member of the thesis committee; having been members or a faculty advisor of EWB Cal Poly for several years, their experiences certainly affected the design and implementation of the research intervention. In addition, the author has served in multiple roles as a subteam lead in the projects as well as serving in multiple roles in the chapter officer board, including as a treasurer, fundraising coordinator, and vice president. Additionally, the author is a Latino man with a background in science & technology studies in addition to their mechanical engineering major.

Chapter 3

LITERATURE REVIEW

3.1 Introduction to Relevant Literature

Service-learning is a type of experiential learning with an emphasis on mutual benefit and capacity building (Sigmon, 1979). According to Sigmon, service-learning is distinguished by three principles:

- Those being served have agency over the “service” provided.
- Those being served become better able to serve by their own actions.
- Those who serve are learners, with agency over what is expected to be learned.

Typically in engineering education, engineering service-learning is seen a type of experiential learning in which engineering practitioners aim to serve a particular community, solving problems and learning and reinforcing engineering skills during this service (Birzer & Hamilton, 2019). Engineering service-learning is often described as a method by which students can practice applying their skills to relevant real-world projects, while also gaining an appreciation for social good and ethics in engineering practice. Students who engage in these programs are said to not only have reinforced their curricular training, but also to have gained greater cultural awareness, emotional intelligence, and empathy.

Furthermore, international service is said to have the added benefit of equipping engineering practitioners with a type of “global competency” (Downey et al. 2006), including a sense of intercultural sensitivity and ability to work with people with different practices and values. An emphasis on international service-learning for engineers would appear to nicely address calls for the need for engineers to center equity in their work in a more globalized context:

> *If they are to be able to carry out their work in a fair and responsible manner in a globalized world, engineers need to know a good deal more than merely how to make technical artifacts and technological systems function effectively. They need to be able to combine their technical and scientific knowledge with an understanding of how the wider*

> *world operates. In particular, as Downey, G. [2010] has recently argued, the globally-competent engineer needs to be educated about the very different cultures and cultural values that affect engineering work* (Jamison et al. 2011, p. 1).

Today, many different groups exist to facilitate international engineering service-learning, including Bridges to Prosperity and Engineers Without Borders - USA.

Despite the many proclaimed benefits of international engineering service-learning, these projects have been criticized as being volunteer-focused and of doing more harm than good in their partner communities (Nieusma & Riley, 2010). Typically, these projects do not live up to the principles they promote, and they often function as opportunities for experiential learning at the expense of the community (Birzer & Hamilton, 2019). With service-learning projects being used in educational environments, learning objectives are applied and student outcomes are measured, which pushes emphasis away from reciprocal learning and benefit. Research efforts on service-learning projects often focus on student outcomes, with community benefits being a footnote that are not commonly explored.

In addition to the criticisms of student-centered service-learning, there also exist many criticisms of the types of work done in international engineering service-learning projects as well. Many international engineering service-learning projects explicitly engage in engineering development projects. Despite being performed with express intents of aiding community members, typical development projects are performed with ingrained, unacknowledged mindsets that perpetuate exploitation, consumption, and the destruction of the environment and harm oppressed communities (Lucena et al. 2010). Key contentions of engineering development projects include the prioritization of “technical functionality” and sidelining of socioeconomic and cultural structures (Nieusma & Riley, 2010), the entwinement of engineering with histories of colonialism & imperialism, and the contention of development itself being an inherently colonial project (Kleba & Reina-Rozo, 2021).

Like many other scholars, Kleba & Reina-Rozo warn that engineering's long entwinement with colonialism and imperialism may imperil efforts to aid the disadvantaged. In order to confront and explicitly address this entwinement, we have situated this research project at the intersection of scholarship that engages with service learning, engineering education, peace engineering, and alternatives to development. To appropriately work with these concepts, this research intends to draw from the theories and methods of science & technology studies, qualitative methods (particularly community autoethnography), ethnic studies, and women's & gender studies.

It is the view of several scholar-activists, including the author, that in order to effectively conduct any design effort aimed at advancing equity and justice, we cannot only draw from engineering theory. The rest of this literature review will introduce the scholarship, principles, and methods that this research project draws from. The intent of this section is to introduce key topics and their relevance to this research project – to acknowledge sources of inspiration and provide resources for further exploration. It is not intended to portray these introductions as a full exploration of the topics – there is a rich history to these topics and the scholars involved with them that we cannot do justice to in a few short pages.

3.2 Service-Learning & Critical Service-Learning

In light of the criticisms of traditional service-learning, there are models of service-learning that seek to explicitly prioritize social justice. While traditional service-learning approaches center service without attention to systems of inequality, a more critical form of service-learning is envisioned that is explicit in challenging systemic inequality and power imbalances (Mitchell 2008). This critical service-learning approach involves a new attention to power, aiming to redistribute power amongst the different participants in the service-learning relationship, assuredly a challenging task when students nearly always enjoy greater social privileges than those who they work with. Additionally, this model prioritizes developing authentic relationships both within the student team and classroom but also with the various partner community members. A key task for community-oriented, justice-focused service-learning involves working

from a social change perspective - identifying and challenging systems and institutions responsible for the initial service need.

3.3 Engineering Education, Engineering Cultures, and Engineering & Social Justice

Currently, there is already a rich discussion surrounding engineering education & practice, service-learning, and social justice. A widespread belief of engineers is that engineering work is objective, and therefore free of bias and political ideology (Cech 2013). Additionally, engineers tend to possess a strong belief in meritocracy, believing that success or failure is a result of individual efforts, contributing to a lack of attention towards systemic inequalities as well as a justification for unequal distribution of resources and power. Belief in meritocracy and depoliticization affect how engineers perceive social justice, resulting in discussions of power, discrimination, and inequality being contested and/or cast as irrelevant (Cech 2013). Additionally, a longitudinal study of engineering programs and their respective students found that the students' interests in public welfare typically declined over the course of their engineering education (Cech 2013). These studies indicate that interventions into engineering curricular or cocurricular pedagogy must include examining what is included or excluded as proper "engineering" practice or culture. These studies indicate that interventions into engineering curricular or cocurricular pedagogy must include challenging engineering cultures - examining common beliefs and expanding what is considered or not considered as proper "engineering" practice.

Pulling from the works of feminist and decolonial scholars, there is a broad field of research in envisioning engineering with an explicit focus on advancing social justice. Employing gender & power as categories of analysis, the following three academic frameworks were identified as holding potential in shaping an explicitly justice-oriented engineering practice and education (Riley et al. 2009):

- Feminist science & technology studies (STS) - in particular, the qualitative methods developed and employed by feminists examining engineering identity

- An ethic of care - a critique on intellectually abstract models of ethics in favor of more relational models of sympathy
- Directly antiracist & liberatory approaches - drawing from Latin American models of grassroots engineering and critical pedagogies

Similarly, stemming from an emerging network of community organizers and designers, the social movement of design justice seeks to ensure an equitable distribution of benefits and harms from design activity, meaningful participation of community members in design decisions, and recognition of community-based practices and design traditions (Costanza-Chock, 2018). The Design Justice Network and their current ten principles challenge designers to consider that their good intentions alone are not enough, and seek to prevent designers from unwittingly reproducing existing inequalities in their attempted efforts for social good.

While the full implications of these frameworks may be difficult to put into practice, they remain powerful aspirations for a critical service-learning practice. The reminders to seek solutions based in indigenous and community knowledge, to share design tools with community members, as well as modeling change as an accountable, accessible, and collaborative process could provide inspiration for new approaches for student-led service groups. Examining the liberatory pedagogies of Latin America may also contribute to new approaches in an alternative model of humanitarian work. Of particular relevance are feminist qualitative STS methods - they may prove to be valuable tools in the relationships building and community assessment process employed at EWB Cal Poly.

3.4 Autonomous Design, Peace Engineering, and Alternatives to Development

There are a variety of insights and critiques stemming from Latin American on the notion of development (Kleba & Reina-Rozo, 2021). Development is generally understood as an international endeavor to raise the standards of living in impoverished areas as well as improving the fulfillment of human rights around the world. According to Latin American decolonial scholars, the efforts towards development have only served to impose a linear & western-based model of

living throughout the world. Frameworks intended for use in comparison of rich and poor countries, such as Gross Domestic Product (GDP) and Human Development Index (HDI), assume there are objective criteria to compare societies. This ignores historical & cultural contexts and largely undermines the agency of traditional communities. For example, Western ways of life are based on private property, intellectual property, and individualism, while many non-Western ways of life are grounded in common ownership and shared knowledge.

Kleba & Reina-Rozo define the concept of ‘engaged engineering’, an umbrella term that encompasses initiatives that seek social transformation with engineering education and service-learning, which is a definition that encompasses this research intervention. They proceed to define engaged engineering as a form of peace engineering, which applies engineering towards strengthening the conditions that build a positive peace while working against cultural, structural, and direct violence (Galtung 2007). Peace engineering is based on the notion that “...the more society provides a high degree of equality in wellbeing and respect for plural cultures and ways of life, the less fertile ground for violence that will thrive..." (Kleba & Reina-Rozo, 2021, Section 2). Thus, they advocate for a practice of peace engineering that prioritizes interdependence and collaboration.

Connecting peace engineering and the critiques of development, Kleba & Reina Rozo warn that engineering’s long entwinement with colonialism and imperialism may imperil efforts to aid the disadvantaged. It is due to this history that the insights of Latin American decolonial thinkers are so valuable – Latin American movements, and others from the global south, are much better positioned to propose insights and alternatives to development that adequately address the legacies of imperialism and neocolonialism that impact the world today. For example, the field of autonomous design advocates for design practices that explicitly center community autonomy and agency (Escobar, 2018). As Tim Brown puts it, “design is too important to be left to designers” (Escobar, 2018, p. 2). Thus, Escobar advocates for a model of ethnographic, participatory, and collaborative communal design. This entails taking the tools of design

(addressing human wants and needs within ecological and material constraints) and putting it in the hands of community members who never thought of themselves as designers.

One major takeaway from Latin American decolonial scholarship is that the history of engineering, development, and imperialism hinders any critical effort at aiming to aid others and dismantle systems of inequality. Perhaps the other essential point is that in order to effectively facilitate autonomous design, or any design effort aimed at advancing equity and justice, educational backgrounds cannot only draw from engineering theory. Escobar describes numerous fields that are essential educational background when engaging in critically engaged engineering: The history and philosophy of technology, theories of subjectivity, studies of culture and sociality, studies of change and politics, as well as studies and theories of power. Similarly, Kleba & Reina-Rozo describe key insights and alternatives to development in their work, from various intellectual & cultural movements. These include ideas such as autonomous design, grassroots engineering, dependence theory, political ecology, and solidarity economy. These concepts "...are of great value for rethinking development and putting peace engineering initiatives into a conceptual frame..."(Kleba & Reina-Rozo, 2021, Section 4.3). It is the opinion of the author that drawing from these insights could prove transformational to current service-learning pedagogies, especially as applied to engineering contexts.

3.5 Feminist and Anti-Racist Science & Technology Studies

This research draws from the field of Science & Technology Studies, also known as Science, Technology, and Society, or STS. STS is an interdisciplinary field that examines the interrelations between scientific research, technological development, engineering, society, politics, culture, and history. For example, a scholar in science and technology studies might examine the history and formations of various views on progress and technological advancement in the United States (Marx, 1987), or study how the history and lasting impacts of colonialism impact humanitarian engineering work today (Lucena et al. 2010).

In particular, this field has valuable insights in working to identify "...where human power structures and value choices get built into technical work..." with the goal of empowering individuals to intervene in technical contexts (CDSS at UC Berkeley). Methods of comparison of similar case studies, contextualization of a case study and the distant factors that impact it, and historicizing a case study by examining what factors led to the current situation all provide valuable ways of examining a complicated sociopolitical & humanitarian project.

Situated within STS, and especially feminist & anti-racist STS, are additional concepts that can be used to describe complicated factors influencing a sociopolitical situation. The notions of power, agency, identity, and institutions, amongst many other concepts, can be used to describe the complex relations operating within a particular under resourced community. Berkely's Human Contexts & Ethics toolkit provides a valuable collection of concepts and methods for introducing students to the skills used in STS, and how these concepts can be utilized in an engineering service-learning context.

3.6 Qualitative Methods and Community Autoethnography

Qualitative Autoethnography utilizes personal experiences to describe and interpret cultural experiences and practices (Adams et al. 2017). In other words, it describes the practice of cultural members giving an account of a culture from their own experiences. Autoethnography is a research method at the intersection of autobiography (using memory and hindsight to reflect on past experiences & events) and ethnography (observing, participating in, and eventually writing about a cultural experience).

Autoethnography is utilized to use personal experience and self-reflexivity to examine and articulate cultural experiences. In this research, the author's positioning as a long-time member within a research context implies that personal experience will inevitably affect how the research is conducted and research data is evaluated. Autoethnographic methods are appropriate in this context due in large part to the positionality of the researcher; autoethnography is an approach

that acknowledges and accommodates subjectivity, emotionality, and the researcher's influence on research, rather than downplaying these factors (Ellis et al. 2011).

Accordingly, for the purposes of critical service-learning, this research will draw inspiration from autoethnographers who hold critical, feminist, queer, and/or postcolonial positionings; these researchers utilize feminist principles by revealing the ways in which stories are produced, discussing the author's motivations and emotions in writing, and legitimizing experiential & narrative evidence as well as an interventionist political stance (Blair et al. 1994).

Since the work of critical service-learning projects within partner communities involves interpersonal ties within qualitative research, and this research in particular involves interpersonal ties within a student group, it is appropriate to discuss community autoethnography (Ellis et al. 2011). Community autoethnographies use the personal experience of researchers in collaboration with community members to describe cultural practices and experiences (Toyosaki et al. 2009). In critical service-learning contexts, community autoethnographic methods facilitate community-building research as well as interventions in cultural and social contexts. Since community autoethnographers work closely with community members, and indeed often develop interpersonal ties or friendships with their participants, adequate considerations of ethics & best practices in community autoethnographies are necessary. Transparency and strong communication with participants become even more important in the research process for community autoethnography (Tillmann-Healy, 2001).

Given the complexities of performing community assessment and defining problems & potential solutions in partnership with different and often highly multifaceted communities, qualitative research methods are a vital aspect of a critical service-learning project. Additionally, the positionality of the researchers warrants drawing from the methods and insights of autoethnographic methods, particularly community autoethnography.

3.7 Takeaways

There are two essential takeaways from this literature review. One is that the historical relationship between engineering & imperialism poses major concerns for critical efforts to dismantle systems of inequality in engineering service-learning. The other is that effectively implementing an intervention in engineering service-learning requires drawing from multiple fields outside of engineering theory. By grappling with the limitations of traditional service-learning, the current state of engineering education and design justice, and Latin American decolonial scholarship on engineering development, we can more thoroughly understand the histories and proposed strategies for our work towards more equitable practices of engineering. Drawing from anti-racist & feminist STS methods, as well as the methods of qualitative research and particularly community autoethnography, we can see potential tools and ways of thinking that can be incorporated into a critical service-learning project.

Chapter 4
METHODS

4.1 Methods of Intervention

This intervention follows the framework of critical participatory action research (McTaggart et al. 2016). Critical participatory action researchers commit to engaging in a broad social analysis of their practice, and a collective self-study of their practices to determine what to change to improve. It refers to self-reflective cycles of planning an intervention, facilitating said intervention, collecting data on the results of the intervention, and iterating as necessary. With the brief timeframe allotted to this thesis, it is appropriate to model this intervention as a first attempt that can be evaluated and iterated as helpful to similar contexts of service-learning and engineering pedagogy in the future.

While this project is an intervention structured as critical participatory action research, this particular application also draws from methods of community autoethnography, principally in how to address researcher positionality and ethics in a participatory research effort with interpersonal ties. Given the embeddedness of the author in the EWB Cal Poly community, consideration of research ethics was essential in this context – a strong emphasis on transparency with the other EWB team members was prioritized, as well as an attempt to maximize the input and agency of team members on the shape of this partnership.

4.2 Intervention Details and Timeline

The intervention implemented in this research aimed to help students better integrate critical scholarship, principles, and methods, into activities and practices of a cocurricular engineering service-learning team. This intervention involved conducting presentations and facilitating dialogues involving critical scholarship, as well as facilitating group activities and workshops. The timeline for this project was slightly less than an academic year - the author was able to spend slightly over two quarters (part of Fall 2021 alongside all of Winter 2022 & Spring 2022) of an academic year with the cocurricular service-learning team. This project took place over three

phases. The first phase involved identifying a team to partner with for the intervention, including meeting and establishing transparent in goals and expectations. The second phase involved spending time with the partner team to better understand their project context build a trusting relationship. The third phase involved planning and conducting the intervention and associated activities.

The first phase of this project was identifying a team to partner with to test the intervention, which ultimately was the EWB Local projects team, for the reasons discussed in the *Background*. As emphasized in community autoethnographic practice, a key part of this phase was transparency in the goals and activity of this research project. Additionally, emphasizing the idea of a participatory partnership that could shift with the input of the team to best fit the unique contexts and goals of the Local projects team was necessary.

The second phase of the project involved spending time within the Local projects group to better build a relationship with the team as well as better understand the current status of their project and partner community. Spending time with the partnered team, before holding more formal dialogues, allows for modification of the integrated content to best fit the context of the team, as well as building trust and relationship with the team. Taking this time is a key aspect of this research intervention. The author was able to join the team, and primarily assist in the areas of community assessment and team education. This entailed assisting with planning for community assessment in the Desert Shores community, as well as helping conduct team discussions around relevant history and scholarship that could prove useful in their work with another community. It was during this second phase that it was appropriate to plan for how to hold dialogues around the specific scholarship, principles, and histories that this intervention was intended to integrate.

At the end of this second phase, and before the third phase, an initial round of interviews was conducted to better explore the initial conceptions and approaches of the partner team before the presentations and dialogues of the intervention were held.

The third phase of the project involved conducting the intervention: facilitating presentations, dialogues, and activities with the partner team around the scholarship and methods described in the literature review. This involved collecting content and planning methods of dialogue and discussion, such as presentations and group activities, including creating research questions, or applying feminist STS methods to the research aspects of the team. Presentation samples of this third phase are included in Appendix A. These particular topics were curated by the researcher based on their prior experiences and beliefs for what would be most beneficial for engineering undergraduates working on this particular topic. Below are more details for the timeline of the intervention and details for what team activities were conducted.

The presentations focused on specific ideas or methods, such as the key ideas of Latin American Decolonial Theory, or STS concepts of identity and power, or how qualitative research questions can be utilized in helping structure an EWB community assessment. These presentations attempted to include activities for application of ideas, such as using action research to investigate making changes in the EWB Local team, or allowing time for the practicing of qualitative analytic reflections. The timeline of the intervention, along with other associated team activities, during the 2022 academic year, is as follows:

- February 21st & February 28th: Read selections from Chapter #2 (From Empires to Sustainable Community Development) of *Engineering and Sustainable Community Development* (Lucena et al. 2010).
- March 8th – March 18th: Conduct first round of interviews.
- April 4th: Discuss action research in weekly project meeting.
- April 11th: Discuss community assessment, research questions, introduction to STS, and positionality in weekly project meeting.

- April 18th: Discuss qualitative field notes, critical STS concepts, and the Design Justice Principles in weekly project meeting.
- April 22nd – April 24th: Team travels to partner community at the Desert Shores, to visit a community Earth Day pop-up.
- May 2nd: Discuss criticisms of service-learning, development, and other key topics on peace engineering and Latin American decolonial theory (Kleba & Reina-Rozo 2022) in weekly project meeting.
- May 6th – May 11th: Conduct second round of interviews.
- May 9th: Further brainstorm potential research questions for the community, using STS methods and Design Justice principles, during the weekly project meeting.

The discussion of action research was the first facilitated presentation of the intervention. This presentation described the use of action research as an iterative method of intervening in complex issues, and described the key steps of action research using this research project as an example. Following an explanation of action research, the team split into groups for an activity that involved identifying potential issues in EWB Cal Poly and attempting to map out potential interventions using action research.

The second facilitated presentation of the intervention centered on community assessment. This presentation involved discussing the purpose behind community assessment, the difficulty in meeting a new community in an unfamiliar site, and how qualitative research questions can be used to help plan an assessment as well as help determine what key issues to investigate. After this, the team split into groups and brainstormed potential research questions for the assessment process. The field of STS as well as its potential applications was introduced, and iterative thematic inquiry (Morgan & Nica 2020) was discussed to introduce how positionality, bias, and preconceived expectations can influence an individual's understanding of information and the conclusions they draw from it.

The third facilitated presentation was the final presentation before the team traveled to the partner community at the Salton Sea. This presentation described qualitative field notes, particularly scratch notes and headnotes, as well as analytic reflection. The team practiced writing and reflecting on any recent individual experiences, and volunteers shared how they approached reflection and how they felt using it. Afterwards, the presentation covered critical STS concepts as well as concepts common to ethnic studies and feminist & gender studies: power, agency, identity, institutions, classification, and expertise. The team discussed together how these concepts and dynamics might be active at the Salton Sea. Lastly, the team read the 10 principles of the Design Justice Network and discussed together takeaways as well as what they might imply for the project.

After the third presentation, the team traveled to the Salton Sea to attend an Earth Day pop-up held by several community groups in the area. It is notable to recognize how the team utilized or did not utilize tools from the intervention thus far. While not possessing full training on how to write or utilize field notes, the team members generally did try to write notes after interactions with community members as well as record their observations and reactions throughout the trip. Additionally, the team did leave the pop-up temporarily with the purpose of seeking to talk to community members not at the pop-up in order to talk with community members not heavily invested in the EWB project or other community activity regarding the Salton Sea and its environmental issues. However, outside of those two takeaways, the team didn't directly otherwise utilize tools and methods from the intervention at the pop-up.

The final facilitated presentation centered on the criticisms of service-learning and development, as well as takeaways from peace engineering and Latin American decolonial theory. This included discussion of colonialism and imperialism, the relationship of engineering to imperialism and colonialism, as well as descriptions of a "critically built development approach" that seeks to reduce structural violence, promote peace, and incorporate key takeaways from Latin American scholar-activists (Kleba & Reina-Rozo 2022).

In the following project team meeting to the final facilitated presentation, the team was able to spend time further investigating potential research questions for the community assessment process. This entailed the team examining the Human Contexts & Ethics toolkit (CDSS at UC Berkeley) and the Design Justice principles (Costanza-Chock, 2018) and attempting to use these resources to help brainstorm research questions that described what the team wanted to investigate with the community in order to determine future project focuses and situate their current project.

After the conclusion of the intervention, the final phase of the project involved conducting a second round of interviews in order to see how the intervention affected the partner team members and determine what aspects of the intervention they felt were successful or unsuccessful. Following data collection, data analysis was performed to determine the major findings of the project.

4.3 Research Questions and Hypotheses

With a collection of scholarship, methods, and principles created by many community activists, scholars, and other change-seekers, the principal research question that this intervention aspires to answer is examining if more explicit inclusion and integration of alternative design principles, feminist & STS qualitative methods, alongside discussion and consideration of the relationship of engineering to imperialism, into a student cocurricular service project will lead to more just and equitable outcomes for student participants, community partners, and all other stakeholders involved. With the timeframe allotted for this project, the current research questions seek to evaluate the changing attitudes of the students:

1. *To what extent can a local cocurricular service-learning engineering team environment be used as a space for promoting alternative engineering practices that promote equity, such as the Design Justice principles?*

2. *How can student-led engineering teams better incorporate feminist & STS qualitative methods into the community assessment & problem definition phases of a service-learning project, and what barriers might they face in incorporating these methods?*
    a. *Do these methods improve how the team intends to collect and integrate community input into their project?*

It was hypothesized that students would be interested in attempting to utilize the new scholarship and methods involved in the research intervention. Namely, the author predicted that some students may be entirely unaware of the relationship between engineering, colonialism, and imperialism, and that these dialogues may prove to significantly challenge their preconceptions of engineering. Additionally, learning about the Latin American decolonial critiques was expected to change how students think about engineering service-learning and the activities of engineering development more broadly. However, the author hypothesized that while dialogue on Latin American decolonial thought as well as the Design Justice principles may give the team some new ideas on how to approach their activities, the duration of this intervention might prove to be too short for them to be able to substantially alter their activities, although it might change their mindsets. Additionally, the constraints they faced on project structure due to their involvement with EWB-USA as well as a Cal Poly Instructionally Related Activity (IRA) might limit their ability to modify their practices as might be suggested by the newly introduced engineering principles. Organizing and recognizing new principles might require more time than the team is willing or able to spend. Some of the principles and scholarship collected in this intervention might play a major role in how the team approaches problem definition for their future projects, however, this was anticipated to be difficult to measure during the course of this project, since the primary data source is participant interviews and thus future project activities cannot be evaluated.

The author hypothesized that the largest impact of this intervention will be around how the team approaches community assessment. The author predicted that the team would gain a modest but substantial level of understanding of how to utilize feminist & qualitative STS methods in their assessment process. It was also hypothesized that the team's assessment approach would

change, including that they would aspire to more deeply examine the different values and goals of different community stakeholders. This may modify what questions the team intends to answer during the assessment process, potentially involving a more nuanced investigation into how power and identity operate in the team's partner community. It can also impact how the team designs and conducts qualitative data collection. This intervention may also affect how the team seeks community input, from whom they seek input from, as well as how they intend to use community input in their project process.

It should be noted that the above research questions are based on the specific context of this iteration of the project. In different research contexts, with more time for this approach, there would be several other impacts to potentially consider and evaluate. In a longer study, there could be a much more detailed examination of how critical scholarship affects the full results of a robust community assessment process. With more time to spend on dialogue and activities within an organization, there could potentially be an analysis of the changes to said organization's priorities and mission statement. With a completed community project, future researchers may evaluate how these methods and principles influenced the outcomes of a project, as well as if there are major differences in how community members, team members, and researchers perceive the success or failure of a project.

4.4 Data Collection

To gauge the impacts of this intervention and evaluate the research questions outlined above, a qualitative analysis was performed. Data collection consisted of semi-structured, hour-long interviews, approved by the Cal Poly institutional review board (IRB), conducted with individual members of the Local projects team and the author.

Data collection consisted of two sets of interviews, conducted in Winter 2022 & Spring 2022, intended to examine the student volunteers' goals with the project and the methods they utilized in their work. The interviews were timed to be at points before and after the majority of the

dialogue & activities within the team, with the intent of evaluating how this intervention impacted the student members. Five team members participated in the original round of interviews, with three of those five team members returning to participate in the second round of interviews.

The first round of interviews was intended to evaluate initial approaches to engineering service-learning before the intervention. The major themes of the interview centered on educational background, involvement in volunteer service, thoughts around engineering & social good, principles believed to be important in guiding community-oriented engineering, and the skills and knowledge that was perceived to be useful in community-oriented engineering.

The second round of interviews followed similar topics, aiming to evaluate if there were major changes in how the participants answered the original questions, as well as gauge if any aspects of the intervention were seen as especially impactful or unhelpful. One new question asked how participants felt about the dialogues and activities held in the team meetings, and another question directly asked if participants felt their approaches to community assessment and engineering-service learning changed in the past year. The remainder of the questions were modified versions of the original interview questions.

Both the first and second interview scripts are available in Appendix B.

4.5 Data Analysis

Data analysis was performed using the framework of Iterative Thematic Inquiry (Morgan & Nica 2020). This method of analysis was selected as appropriate in large part because of the expected influence of author's positionality on the themes and analysis of qualitative data. As a long-time member of EWB Cal Poly and as the sole individual involved in data analysis, the author's biases and perspectives could potentially heavily influence how themes are generated. Iterative thematic inquiry acknowledges that themes play a large role in generating research findings and presenting them to the outside audiences as research results, and so it proposes that initial

expectations and assumptions should be explicitly stated, and then confronted throughout the research process. Similar to reflexive thematic analysis, iterative thematic inquiry envisions analysis as a process that reflects not only qualitative data, but also the positionality of the researcher and the context of the researcher themselves (Braun & Clarke 2019).

Iterative thematic inquiry involves four phases. The first phase is an initial establishment of expected results as themes, which will be shaped by personal beliefs, prior theory, and research hypotheses – these factors will shape the initially stated expected results for this project. The key goal of this phase is explicitly stating initial expectations and personal biases as themes. These themes will then be either reinforced, challenged, or expanded throughout the other phases of Iterative thematic inquiry.

The second phase involves modifying the initial themes during data collection. This was primarily performed during the interview transcription process, when initial audio recordings and transcripts were corrected. After each interview transcription is corrected, they were re-read, and a memo was written about the interview, aiming to track any observations in the data that change the expected results established in phase one.

The third phase takes place at the end of data collection and beginning of the data coding analysis. After memoing on the results of both rounds of interviews, a set of tentative results-as-themes was created and were utilized to create an initial codebook for the coding process.

The final phase is concluded after the data coding analysis. Coding was performed using Dedoose software, with the corrected interview transcripts. A codebook was created using the themes from the third phase. The themes were be used to create root codes, with roughly five to six subcodes for different aspects of each theme. The goal of this final fourth phase was to perform a quality check and ensure that the tentative themes from the third phase are appropriate.

4.5.1 Iterative Thematic Inquiry - Phase #1

To develop the author's expected results of the intervention, memos were written to describe expectations for each of the research questions. These memos described the aspirations for the intervention as well as potential best- or worst-case results for each research question. These included reflecting on potential obstacles and barriers to successfully achieving the desired results of the intervention. It was hypothesized that the qualitative feminist STS concepts would have the greatest impact due to the potential for application to the community assessment process. Latin American decolonial theory as well as the design justice principles were expected to be reacted to with interest by the students but not easily applied to project processes. However, it was hypothesized that design justice principles and the feminist STS methods could modify how the team treated community feedback; namely, that the students might aspire to more carefully examine the lived experience and input of groups with less power in the community, as well as more thoroughly following community desires in their projects.

The author also memoed on their positionality and personal beliefs about the likely outcomes of the intervention, pulling from experiences such as prior research experiences and previous activities in the EWB Cal Poly chapter. Key ideas from personal experiences and positionality included the difficulties of time constraints for the project as well as potential difficulty in measuring results from qualitative interviews alone, although it also included hopes that this intervention could spark new interests for the individual team members.

Due to the ability to modify the results-as-themes in further phases of data analysis, it was decided to keep a larger list of themes in this first phase. The final list of initial results-as-themes were divided by formal research hypotheses as well as more personal expectations based on positionality, prior experiences, and researcher intuition, and the results of phase #1 of iterative thematic inquiry are available in Appendix C.

4.5.2 Iterative Thematic Inquiry - Phase #2

Initial expectations for the intervention were then evaluated using the data collected during the qualitative interviews. The second set of interviews directly asked for student feedback on the variety of discussions and activities conducted during the intervention. Additionally, the conversations in the second set of interviews were compared to the first set of interviews to examine how student mindsets changed after the intervention. For each interview utilized in the data analysis, memos were written to describe key takeaways and any unexpected ideas from participants. From this, takeaways were organized, and notes were written under each of the initial themes proposed in phase #1; with the notes focusing on how new information confirmed, modified, or rejected the results for the intervention, or even suggested new results entirely.

4.5.3 Iterative Thematic Inquiry - Phase #3

Using the qualitative data collected during the interview process, a tentative set of five results-as-themes were written. The initial results-as-themes were as follows:

- ***Student Attitudes*** *– The students who join a humanitarian service-learning project tend to have an intermediate understanding of social justice ideas in engineering and humanitarian work. This might indicate students self-select into these teams, and that these students are more interested in learning about these alternative principles and methodologies. Even before the intervention, they mentioned common criticisms of typical voluntourism and flaws of the EWB-USA model, which may have contributed to their enthusiasm to learn of new approaches.*
- ***Sparking Interest*** *– Students are originally unaware of the work of these scholar-activists, but upon being introduced to these ideas, they express an interest in not only learning about these topics for their work in service-learning, but also seeking them out in classes and for application in other contexts such as their future professional careers. Additionally, they express a desire to introduce these ideas to friends and co-workers about the importance of these topics.*

- ***Takeaways by Topic*** *– Students found the Design Justice Principles interesting and memorable, but didn't otherwise describe them as applicable. In contrast, feminist & qualitative STS methods were found to be useful in performing a community assessment and thinking about potential project solutions. Additionally, students all expressed interest in learning even more of Latin American decolonial theory and the relationship of engineering to imperialism – describing it as being useful context that wasn't otherwise taught in classes.*
- ***Assessment Methods*** *– The project team used the Berkeley HCE toolkit and Design Justice Principles to generate research questions for the community assessment. While the questions did often ask about ideas expressed in the Design Justice Principles, the HCE toolkit was substantially more useful in generating research questions. Additionally, in student interviews, every student described the importance of being led by community input, and in not privileging their own ideas over the communities.*
- ***Project Limitations*** *– Due to the current timeframe of the EWB Local project, the team has not been able to conclude community assessment nor engage in problem definition & proposal of solutions for new projects. Additionally, this project's primary data source was student interviews; this project could only examine student mindsets, and could not observe impacts on student actions in later parts of the project.*

4.5.4 Iterative Thematic Inquiry – Phase #4

These tentative results-as-themes were utilized to create a codebook, with each theme being used as a root code under which multiple subcodes being created. The subcodes were created by the researcher's perception of noteworthy trends for each theme that resulted from the memoing process and data collection process. A codebook with 26 total codes was created by the researcher for the coding process, with five root codes for each tentative theme and three to five subcodes under each root code:

- ***Student Attitudes***
    - *Initial Student Thoughts on Engineering & Social Justice*

    - *Initial Student Thoughts on Engineering & Humanitarian Development*
    - *Student Enthusiasm for Engaging with New Topics*
    - *Differences in Initial Student Attitudes by Progress in Degree*
- ***Sparking Interest***
    - *Students Affirm Positive Feedback to New Topics*
    - *Students Express Desire for Further Learning in New Topics*
    - *Students Describe Using New Topics in Other Contexts*
- ***Takeaways by Topic***
    - *Student Feedback on Design Justice*
    - *Student Feedback on Latin American Decolonial Theory*
    - *Student Feedback on Feminist Qualitative STS*
    - *Positive Feedback*
    - *Negative Feedback*
- ***Assessment Methods***
    - *Importance of Community Input Leading a Project*
    - *Application of Feminist Qualitative STS*
    - *Application of Latin American Decolonial Theory*
    - *Application of Design Justice*
- ***Project Limitations***
    - *Need for a Longer Timespan for the Intervention*
    - *Current Timeframe and Progress on EWB Local Project*
    - *Student Difficulty in Using New Topics for Project Applications*
    - *Inability to Separate Student Intentions from Future Impacts*
    - *Engineering Students, Expectations, & Scope*

The ***Student Attitudes*** root code and associated subcodes were utilized primarily for the first round of interviews, to examine initial student attitudes. The *Initial Student Thoughts on Engineering & Social Justice* subcode was applied to excerpts where participants described insightful initial views at the intersection of engineering and social justice. Similarly, the *Initial*

Student Thoughts on Engineering & Humanitarian Development subcode was applied to initial insights on humanitarian engineering and development work. The *Student Enthusiasm for Engaging with New Topics* subcode was utilized to describe where participants described valuing topics at the intersection of engineering, humanitarian work, and/or social justice as well or desiring to learn or otherwise further engage with these topics. *Differences in Initial Student Attitudes by Progress in Degree* was applied to excerpts where students expressed particular views or insights that were due to their prior experiences in their classes, EWB Cal Poly, or other experiences due to their prior experiences at Cal Poly.

The ***Sparking Interest*** root code was utilized to examine student attitudes towards the new topics and methods introduced throughout the intervention. *Students Affirm Positive Feedback to New Topics* was applied to excerpts where the participant described the topics as useful or relevant to themselves as engineers. *Students Express Desire for Further Learning in New Topics* was applied to excerpts where students described a desire to further learn and engage with the introduced scholarship. *Students Describe Using New Topics in Other Contexts* was applied to excerpts where students described utilizing the introduced scholarship outside of EWB Cal Poly and service-learning, such as in their professional careers, or in other classes, or simply in sharing it with their peers in engineering.

The ***Takeaways by Topic*** root code was utilized to describe feedback about any specific scholarship introduced in the intervention, split into three groups. *Student Feedback on Design Justice* was applied to excerpts where the participants gave feedback on the relevance and applicability of the Design Justice Network's principles. *Student Feedback on Latin American Decolonial Theory* was applied to excerpts where participants gave feedback on the relevance and applicability of Latin American decolonial theory, including the relationship of engineering to imperialism and the role that engineering played in oppression, as well as on current criticisms of international development today. *Student Feedback on Feminist Qualitative STS* was applied to excerpts where participants gave feedback on the relevance and applicability of feminist STS

concepts as well as qualitative STS methods. *Positive Feedback* was applied to excerpts where introduced scholarship were described as useful and/or relevant, while *Negative Feedback* was applied to excerpts where introduced scholarship were described as irrelevant and/or not applicable to the project. It can be noted that while feedback for all topics included that the topics were seen as relevant, not all introduced scholarship was viewed as immediately applicable to the project.

The ***Assessment Methods*** root code was utilized to describe how the students described utilizing the introduced scholarship to the community assessment process in the project. While this theme also pulls from the research questions developed during the project team meetings and associated activities, the codes are only concerned with feedback during the interviews. *Application of Feminist Qualitative STS* describes where feminist & qualitative STS concepts and methods were described or directly referenced in discussions around community assessment process. *Application of Latin American Decolonial Theory* describes where concepts from Latin American decolonial theory were described or directly referenced in discussions around community assessment. *Application of Design Justice* describes where the concepts of Design Justice were described or directly referenced in discussions around community assessment. The *Importance of Community Input Leading a Project* subcode was applied to excerpts where students emphasized the value of community agency as well as the importance of valuing and respecting their decisions.

The ***Project Limitations*** root code was applied to any excerpts where students described feelings of concern or worry about their ability to effectively incorporate the introduced scholarship into their projects. The *Need for a Longer Timespan for the Intervention* subcode was utilized to describe where students described wishing for more time to discuss the topics or participate in new activities. The *Current Timeframe and Progress on EWB Local Project* subcode was applied to excerpts where students described the difficulty in making progress in the project and communicating with the community. The *Student Difficulty in Using New Topics for Project*

Applications subcode described where students described new topics as being confusing or otherwise difficult to actually apply to the project. The *Inability to Separate Student Intentions from Future Impacts* subcode describes where students described their intentions for their future role in the projects, and how it was important to remember that the future actions and impacts of the project could not be evaluated. The *Engineering Students, Expectations, & Scope* subcode described where students expressed concerned the around what was realistic for university students to attempt to do, and what was realistic for the scope for the projects.

Coding was performed using Dedoose software, with the first and second round of interview transcripts. This phase of iterative thematic inquiry was performed to examine if the codebook could accurately describe all the relevant information in the qualitative data. This indicates checking for noteworthy trends in the data that the researcher did not include in the codebook, or for sections of the codebook proposed by the researcher that are not supported by the data (Morgan & Nica 2020). Dedoose analysis tools, particularly *Code Co-Occurrence* and *Code Application*, were utilized to further examine if there were any notable trends that should be noted in the results. From this coding analysis, several changes were made to the final results-as-themes.

The author noted that the subcodes describing different aspects of ***Project Limitations*** were applied somewhat infrequently, with the exception of a subcode describing expectations of engineering students as well as the scope of EWB projects and of this intervention more broadly. This subcode had a notable level of co-occurrence with a subcode corresponding to initial mindsets on engineering & humanitarian development. The data also showed that students felt concerned with the amount of knowledge they felt they needed to integrate in order for their projects to truly make an impact when they were already worried about simply keeping up with the engineering curriculum and career matters. Several students raised concerns about expectations on the student members and on whether a team of university students could

successfully complete a humanitarian development given their structural limitations, especially with minimal faculty support. This finding was integrated with the theme on project limitations.

Before the coding process, the author found that EWB students had varying levels of knowledge generally discussed in matters of engineering, social justice, and humanitarian development, and that EWB students tended to have substantial interest in topics relating to social justice. Due to the frequency of application of a subcode related to differences in student mindsets, the author proposed two substantial contributors to this effect. One contributor was how long the student had been in university, with longer durations giving the student more exposure to classes inside and outside of engineering related to topics of social justice and engineering development. The other was length of time in EWB Cal Poly, with some students expressing familiarity with ideas such as Latin American decolonial theory that had been discussed in other EWB contexts. This leads to an important modification to the ***Student Attitudes*** theme; differing students have different levels of experience in the topics introduced in the intervention, and similar interventions in the future should think carefully about their expected audience.

Similarly, based on the author's application of subcodes, there was significant code co-occurrence in application of Design Justice, application of feminist STS, and the importance of community input in project direction. This was largely because several EWB members previously described the importance of community input and not privileging one's own viewpoint, which is a key principle of Design Justice. These co-occurrences largely occurred in excerpts exploring the community assessment process. While the students did mention other aspects of the Design Justice principles, it is useful to note that they focused on what was most immediately obvious to the EWB project model, which is valuing community input in the project process.

Lastly, the researcher included in the codebook a subcode meant to examine limitations of the research project in gauging student intentions and the inability to evaluate future actions and impacts. Originally, this was listed under ***Project Limitations***, but since it was found to not be

included in the data, it was instead listed as a potential research limitation rather than a result from the data analysis and intervention.

Chapter 5
RESULTS

From the results of the analysis of qualitative data and processing via iterative thematic inquiry, it can be concluded that the student's initial attitudes and interests contribute to the suitability of a local service-learning environment for promoting alternative engineering principles and methods. Despite varying amounts of time and exposure to topics of social justice in curricular spaces, as well as varying amounts of experience in EWB Cal Poly, every participant displayed some familiarity with topics in engineering, social justice, and humanitarian development. Students described common criticisms of voluntourism and of the EWB-USA project model, as well as describing how engineers were not apolitical actors but instead actively involved in matters of equity and justice. One participant described their thoughts on joining EWB:

> "*I know that one of the criticisms of EWB is that, the help that you provide for the community doesn't last. And it's like not always exactly what they needed, and it wasn't exactly like the right solution. And that gets overlooked because the focus is more on educating students instead of helping the communities."*

It is important to note that students do generally have differing levels of knowledge and experience in matters of engineering and social justice, supporting the idea that is important to spend time with a team and tailoring content to their collective context. However, it does appear that the type of students who join a local service-learning team are typically open to and interested in learning more about the alternative topics and methods introduced in this intervention, making it a noteworthy space to introduce alternative principles.

Additionally, it was observed that students were originally mostly unaware of the principles and methods introduced during this intervention, but these students expressed an interest in further learning about these topics for not only their service-learning work but also their professional careers, and to share with their friends and co-workers in engineering:

> *"I also think that even if the assessment doesn't change much of what our plan is, I think it's very much been a good learning opportunity for me to just like, have these like serious*

conversations for like what I'm gonna be doing, like more engineering work later on. And realize an impact of what I'm doing, specifically like me going into aerospace, which is very much defense adjacent."

Students also described a desire to seek out classes and other curricular spaces to learn more of these topics. One student, who took an interest in exploring various classes that touched on content from the intervention, described:

"I think a new thing, a new principle I've learned since our discussions, is just education, like educating ourselves, and like because, I didn't even like know that all this information existed, on how to conduct research, like I didn't even know that was really a thing... like, the community deserves to have a well-educated person helping them, like you know you just, like want the best person on the job. So like, we need to make sure that we are, like good candidates, to be doing these projects."

It can be concluded that outside of project impacts, introducing these ideas and scholar-activists to students resulting in sparking new interests for them that the students may take into other contexts.

While the different topics introduced in this intervention all received positive feedback, it is noteworthy that the different topics had different feedback. Students found the Design Justice principles interesting and memorable, and the principles were often described but not named, but they weren't otherwise described as applicable. In contrast, feminist & qualitative STS methods were found to be useful in performing a more robust community assessment and thinking about potential project solutions:

"I really enjoyed all the of the content. Like every time we do something like that, it's such a good space, just like think about those topics, and like reflect on engineering, and like how it applies to design and social aspects of design. I think the most memorable aspect of all the things that we went over was the history of engineering, and how that affects how it's used today, like, how it was used for colonialism and imperialism and how it kinda started with those roots. And like I don't think that, like no one has really taught

that, and like, that's like an important thing to reevaluate so that we don't like continue having that kind of role in the future, when we do like design projects. And then another interesting thing that we talked about was how to come up with research questions, like contextualizing something, or like looking at similar cases, and coming up with questions related to that."

Additionally, students all expressed interest in learning even more of Latin American decolonial theory and the relationship of engineering to imperialism – describing it as being useful context that wasn't otherwise taught in classes. While this does indicate that the local service-learning environment was a good potential space for these ideas, it also indicates that the design of this intervention could be modified to better fit the specific local service-learning context to better apply and utilize the Design Justice principles.

Through this intervention, this student-led engineering team experienced moderate success in incorporating feminist & qualitative STS methods into their community assessment plan. The project team attempted to utilize the Berkeley Human Context & Ethics toolkit and Design Justice Principles to generate research questions for the community assessment. While the questions did often ask about ideas expressed in the Design Justice Principles, the HCE toolkit was substantially more useful in generating research questions. It was found that students expressed a strong emphasis on valuing community input, a key design justice principle:

"Like I think, very much, the discussions allowed me to like, think more critically on, the community, of how they've historically been impacted, and allow their voices to be heard, and just making sure to reach out to the community, and actually have a conversation rather than being like, "yes or no" on like a survey, or something, or being like, "what is your nationality" on a survey. And then us like, checking off the box of like, completed a survey - I think we're very much trying to have a conversation and relationship rather than just be like, just trying to get it done to say we got it done."

It should be noted that this was previously mentioned as an important value in interviews before the intervention, however, it does appear that the students are more equipped to communicate

with community members and seek more meaningful input. While students did mention other aspects of the Design Justice principles in the assessment process, valuing community input was the most commonly referenced idea, which may be due to the fact that it is easy to emphasis under the current EWB-USA project model.

Another noteworthy finding was a better understanding of the limitations of this particular intervention and the implications for further interventions. Students expressed concern with the amount of new knowledge they felt compelled to integrate in order to make better impacts, as well as concerns about the limited amount of time that could be spent in discussions and attempting to modify practices during an ongoing project:

> *"It's interesting that all the responsibility is placed on us to educate ourselves on these things, like it's all very self-guided, and like there's no one above us telling us to do these things really. And like, I think that would be beneficial. So like, I guess EWB should like raise awareness on like, this topic, so that more teams can be educated on the same topics. And then I think that that would help everyone. But just the lack of, like anyone above us, like any adults, or anything, being a part of any of this, is interesting, because I don't know, like I think that that should be a thing, like EWB should have that be a part of their model, to like educate us on that. And then like, I think I've said this before but just like the lack of adults helping us, like it's just all so like self-guided to a fault, sometimes, I think we need more help because we're still like students."*

Considering the amount of time necessary to keep up with engineering coursework and career development, students raised worries about expectations on the student members and on whether a team of university students could successfully complete a humanitarian development project given their structural limitations, especially with minimal faculty support.

Chapter 6
DISCUSSION & TAKEAWAYS

Critical participatory action research implies an iteration of a particular project or intervention in order to learn from prior outcomes and achieve better results for future endeavors. With that in mind, the results of this project can prove useful to others who want to incorporate alternative scholarship, methods, and principles into engineering education and practice.

It appears sensible that curricular and cocurricular environments, with explicit commitments to service or social justice, draw students who are actively interested in learning more about methods that can be used to enhance the outcomes of an engineering project from a social justice perspective. While this intervention was tailored to an environment involving humanitarian projects and service-learning, and it found that the team environment for a humanitarian service-learning project was a fitting space to introduce these alternative ideas, it is likely that other spaces with explicit engagements in service or social justice will also be well suited for an intervention of this type. For example, a cocurricular space that focuses on assistive or universal technology in order to assist individuals with disability may prove to be another space with engineering practitioners who are receptive to these alternative principles and scholarship. However, even with openness and interest to different methods envisioned by various scholar-activists, it is important to remember that individual participants may have differing levels of prior engagement with these topics; an intervention into these spaces must meet the participants where they are at. Additionally, the findings that different topics received differing levels of positive feedback indicates that future interventions should take care to ensure their content is tailored to the context of the participants and their projects.

The finding that participants expressed an interest in further learning and applications in other contexts was also noteworthy. This could suggest that once students are introduced to these topics during an intervention such as this one, they could potentially bring these ideas into other spaces, especially if the intervention seeks to further support them in sharing these ideas in new

spaces. Since students described a desire to share these ideas with their friends and co-workers, an intervention with a more explicit focus on long-term cultural change and enabling students to be able to confidently discuss and share these topics with others could have a potentially transformative effect on multiple cocurricular spaces.

It is also relevant to explore the limitations of an intervention that is conducted only by a single individual, as well as how an intervention's impact might be limited by the team it is conducted in partnership with. For this intervention, the students involved expressed concern with the amount of information they felt necessary to learn for their projects, and felt that it might be unrealistic to expect four-year undergraduate students to be able to successfully integrate multiple new methods and principles to their already complicated humanitarian projects. Students also expressed reservations with the limited amount of support they felt they received from faculty. While it remains valuable to explore these alternative design methods, it may be important to be considerate of the projects that students are asked to work on with these new methods; it may be appropriate to enlist more institutional support or reduce the scope of the students' projects in order to not place unhealthy burdens on the students (Reyna & Uchiyama 2021). For example, more explicitly incorporating these methods and principles into engineering curriculum could provide students with valuable practice in discussing and utilizing these topics.

With these takeaways from the results of this intervention, it is also important to consider the limitations of the findings from this project. Due to the current status and progress of the EWB Local project, the team was not able to conclude community assessment nor engage in problem definition and proposal of solutions for a new project, both of which would be useful for evaluation of the impacts of this intervention. Additionally, as the primary data source was student interviews, this project could only examine student mindsets and intentions, and it could not observe impacts on student actions in the future of their project. Lastly, it is important to keep in mind a relatively small sample size; while roughly 8-10 students participated in different parts of

the intervention, fewer students were present for the entirety of the intervention, and only three of those students were able to participate in the data collection process.

Chapter 7
CONCLUSION

While engineering-service learning projects are seen as a way for students to reinforce curricular learning while gaining cultural awareness, the outcomes of these projects center student benefits over the benefits to community partners, and these projects can be characterized as broadly harmful. For these projects and in other spaces in engineering, various scholar-activists have conceptualized numerous principles and methods to center justice and equity in engineering outcomes. From a review of associated scholarship and literature, it can be seen that the historical relationship between engineering & imperialism poses major concerns for attempts to advocate social justice in engineering practice. It was also determined that successfully addressing this issue requires utilization of scholarship outside of engineering theory; the scholarship collected and integrated centered around the topics of Design Justice, feminist qualitative science & technology studies, and Latin American decolonial theory.

This research project and its associated intervention involved collecting scholarship and methods in engineering and social justice, and attempted to integrate these ideas into the practices of a local humanitarian service-learning engineering team. Following the frameworks of critical participatory action research and community autoethnography, once a team was found to conduct this research in partnership with, the author spent time with the team to build relationships and determine how to best integrate the collected content. The intervention itself involved facilitating presentations, dialogues, and activities with the partner team around the collected scholarship. Qualitative data was collected via two sets of semi-structured interviews conducted before and after the intervention, with five students participating in the first round of interviews and three students participating in the second round. Data analysis was performed following the framework of iterative thematic inquiry and coding was performed using Dedoose.

This project found that a local humanitarian engineering-service learning environment was a suitable space to advocate alternative design principles and methods, and that students expressed a desire to learn more about these topics, as well as utilize and share these resources with their friends and in other contexts such as their professional careers. Students experienced moderate amounts of success in using the collected scholarship to modify their project practices, specifically their plans for community assessment. These results imply that other spaces and organizations with an explicit focus on service or social justice may be ideal environments to attempt to implement alternative design principles, and that more efforts to enable students to share new ideas could have lasting effects in multiple spaces. However, it is important to consider the expectations on the students involved with these interventions, and to consider enlisting institutional support for these efforts. The findings of this research project are limited by the timeframe of the project and a smaller sample size, and future projects should attempt to address these limitations as well as explore the implications of this project.

REFERENCES

Adams, T. E., Ellis, C., & Jones, S. H. (2017). Autoethnography. *The International Encyclopedia of Communication Research Methods*, 1–11. https://doi.org/10.1002/9781118901731.iecrm0011

Birzer, C., & Hamilton, J. (2019). Humanitarian engineering education fieldwork and the risk of doing more harm than good. *Australasian Journal Of Engineering Education*, *24*(2), 51-60. https://doi.org/10.1080/22054952.2019.1693123

Blair, C., Brown, J. R., & Baxter, L. A. (1994). Disciplining the feminine. *Quarterly Journal of Speech*, 80, 383–409. doi:10.1080/00335639409384084

Cech, E. A. (2013). Culture of Disengagement in Engineering Education? *Science, Technology, & Human Values*, *39*(1), 42–72. https://doi.org/10.1177/0162243913504305

Cech, E. A. (2013). The (Mis)Framing of Social Justice: Why Ideologies of Depoliticization and Meritocracy Hinder Engineers' Ability to Think About Social Injustices. *Philosophy of Engineering and Technology*, 67–84. https://doi.org/10.1007/978-94-007-6350-0_4

Costanza-Chock, S. (2018). Design Justice: Towards an Intersectional Feminist Framework for Design Theory and Practice. *Proceedings of the Design Research Society 2018*. https://ssrn.com/abstract=3189696

Downey, G., Lucena, J., Moskal, B., Parkhurst, R., Bigley, T., & Hays, C. et al. (2006). The Globally Competent Engineer: Working Effectively with People Who Define Problems Differently. *Journal Of Engineering Education*, *95*(2), 107-122. https://doi.org/10.1002/j.2168-9830.2006.tb00883.x

Ellis, C., Adams, T. E., & Bochner, A. P. (2011). Autoethnography: An Overview. *Historical Social Research / Historische Sozialforschung*, *36*(4 (138)), 273–290. http://www.jstor.org/stable/23032294

Escobar, A. (2018). *Designs for the Pluriverse: Radical Interdependence, Autonomy, and the Making of Worlds (New Ecologies for the Twenty-First Century)* (Illustrated ed.). Duke University Press Books. https://doi.org/10.1215/9780822371816

Galtung, J. (2007). Peace by Peaceful Conflict Transformation–the TRANSCEND Approach. Haz. Charles W. Johan G. *Handbook of Peace and Conflict Studies*.

Green, M. W. (2021, June 4). *Boundaries Within Engineers Without Borders: Impacts of Organizational Culture on Project Processes*. YouTube. https://www.youtube.com/watch?v=4ZKyLGiMM9U

HCE Toolkit. (n.d.). CDSS at UC Berkeley. https://data.berkeley.edu/hce-toolkit

Jamison, A., Botin, L., & Hyldgaard Christensen, S. (2011). *A Hybrid Imagination: Science & Technology in Cultural Perspective* (1st ed.). Morgan & Claypool.

Kleba, J. B., & Reina-Rozo, J. D. (2021). Fostering peace engineering and rethinking development: A Latin American view. *Technological Forecasting and Social Change*, *167*, 120711. https://doi.org/10.1016/j.techfore.2021.120711

Lucena, J., Schneider, J., & Leydens, J. (2010). Engineering and Sustainable Community Development. *Synthesis Lectures On Engineers, Technology And Society*, *5*(1), 1-230. https://doi.org/10.2200/s00247ed1v01y201001ets011

Marx, L. (1987). Does Improved Technology Mean Progress? *Technology Review*, 33–71.

McTaggart, Nixon, R., & Kemmis, S. (2016). Critical Participatory Action Research. In *The Palgrave International Handbook of Action Research* (pp. 21–35). Palgrave Macmillan US. https://doi.org/10.1057/978-1-137-40523-4_2

Mitchell, T. D. (2008). Traditional vs. Critical Service-Learning: Engaging the Literature to Differentiate Two Models. *Michigan Journal of Community Service Learning*, *14*(2), 50–65.

Morgan, D., & Nica, A. (2020). Iterative Thematic Inquiry: A New Method for Analyzing Qualitative Data. *International Journal of Qualitative Methods, 19*, 1-11. https://doi.org/10.1177/1609406920955118

Nieusma, D., & Riley, D. (2010). Designs on development: engineering, globalization, and social justice. *Engineering Studies*, 2(1), 29–59. https://doi.org/10.1080/19378621003604748

Reyna, M., Uchiyama, L., Cardenas, K., Lehr, J., & Medina-Kim, G. (2021). Good Intentions are Not Enough: Student-led Interventions to Reconfigure Relationships Between Engineering, “Caring” & Development. *2021 Annual Meeting for the Society for Social Studies of Science.* Toronto, Canada/Online.

Riley, D., Pawley, A.L., Tucker, J., & Catalano, G.D. (2009). Feminisms in Engineering Education: Transformative Possibilities. *NWSA Journal 21*(2), 21-40. https://www.muse.jhu.edu/article/316150

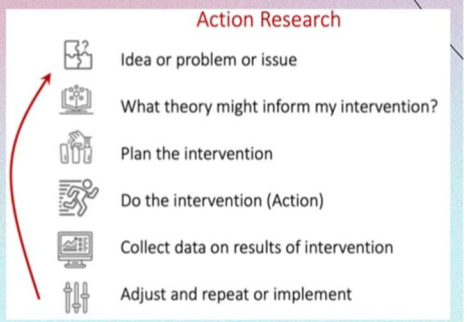
Sigmon, R. (1979). Service-Learning: Three Principles. Synergist, 8(1), 9–11.

Tillmann-Healy, L. M. (2001). *Between Gay and Straight: Understanding Friendship Across Sexual Orientation (Ethnographic Alternatives)*. AltaMira Press.

Toyosaki, S., Pensoneau-Conway, S. L., Wendt, N. A., & Leathers, K. (2009). Community Autoethnography: Compiling the Personal and Resituating Whiteness. *Cultural Studies ↔ Critical Methodologies*, 9(1), 56–83. https://doi.ofrg/10.1177/1532708608321498

Action Research
...an example

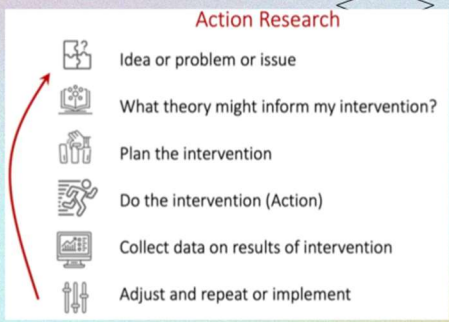
- Action Research is one (of many) potential ways we can approach problems in our teams or personal lives.
- We can potentially apply it to some of our own activities in EWB, but first maybe an example might be illuminating



My Thesis, as Action Research

- From my own desires to intervene in EWB Cal Poly, after 4 years as a member & officer, my Thesis and work within Local, *is an intervention*.

1) Idea/Problem/Issue - There is a lot of very valid criticisms of engineering service-learning, and the activities of EWB-USA. I want to address some of those criticisms.



My Thesis, as Action Research

2) Theory Informing Intervention - Many students in these groups aren't aware of these criticisms, or the research & tools that might help them achieve better outcomes

⇒ If an insider already familiar with EWB brings some of these resources into the projects, will it improve project outcomes and/or student capabilities?

Let's Try It!

- Split into 2-3 groups... and try to identify some problems you face in your own life or problems in EWB
- Then, consider how you might try to intervene to solve or mitigate the issue? How could you potentially evaluate if you succeeded or not?
- V rough and unrefined ideas encouraged!

Group Share-Out

*Group 1 - A******/E****/J*******

1. Problem - Communication between project teams
2. Theory - Being familiar with each other, and being in community, leads to more communication/collaboration.
3. Plan Intervention - Rotating team members between teams? Socials between teams? Advertise structure of club differently?
4. Perform -
5. Collect Data - Measure communication between each other? A form to collect feedback from people in the club? Want to examine impacts on project outcomes - talk to project managers
6. Analyze & Iterate - Presentations vs. Socials?

Group Share-Out

*Group 3 - L*****/J****/J****

1. Problem - Lack of communication from tribe, not sure if community/NGO has talked to them
2. Theory - Torres-Martinez tribe is really close and is an important stakeholder. Indigenous groups are historically poorly treated during these infrastructure projects (Lucena et al ⇒ that book we read!)
3. Plan - Get in contact with the tribe, or people who can contact them, during Earth Day)
4. Perform - If we perform interviews/focus groups with them, probably fill the Institutional Review Board Proposal
5. Collect Data -
6. Analyze & Iterate -

Community Assessment

We perform community assessment for a few reasons.

- Learn about our partner community
- Inform our ongoing project
- Potentially situate future projects
- Build relationships.

But what are we trying to learn through assessment?

Research Questions

We can approach assessment by first coming up with research questions.

Research questions are the core feature of beginning a qualitative research project. Qualitative researchers begin with basic questions such as, "What do I need to understand?" or "What is going on here?".

Research Questions

Some researchers hesitate to devise specific research questions before they enter the field because they fear it will limit what they naturally notice... but having questions can help us navigate an unfamiliar site.

- "Where are we going?"
- "What are we doing?"
- "Who gains, and who loses?"
- "What should be done?"

*See Tracy's Qualitative Methods for more info

Let's Make Research Questions!

Brainstorming!

Knowing that our questions may change after visiting Desert Shores, let's think about what we want to learn during the assessment process.

Goals for Assessment

- Learn about our partner community
- Inform our ongoing project
- Potentially situate future projects
- Build relationships

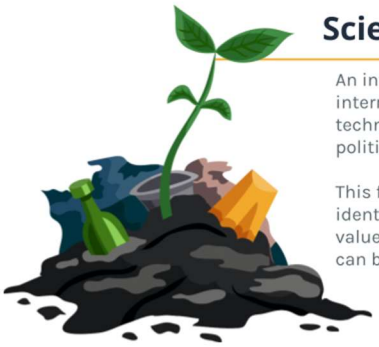
Assessment Questions:

1. How do they (Desert Shores residents) envision their community in the future?
2. What kind of project do people want... what kind of solutions are they open to or preferring?
3. What is their #1 priority, regarding their community and the salton sea?
    a. What do they value in their community?
4. Who are the people with power in this situation? What kinds of power?
5. How many people does this problem affect?
    a. How does it affect them?
    b. Is there anyone in the community who isn't impacted?
6. What do they think about the long term feasibility of the proposed berm project? Are there any concerns about climate change?

Assessment Questions:

1. What is their perspective on climate change?
2. How would you think the project impacts your life
    a. What do you think is the potential future impact on the area and people?
3. What do you think the future looks like if we don't do anything?
4. What has been done so far in the community to address the problem(s)?
5. What projects are people aware of addressing the problem(s)?
6. What is the Torres-Martinez tribe's involvement in the project?
    a. In the community more broadly?
7. What are the demographics and make up of the community?
    a. What is the general culture of the community?

Drawing from other fields



Science & Technology Studies

An interdisciplinary field that examines interrelations between scientific research, technological development, and society/ politics/culture/history.

This field has valuable insights in working to identify where "...where human power structures and value choices get built into technical work..." and can be used in humanitarian engineering contexts.

*Berkeley Human Contexts & Ethics Toolkit

STS Methods

Compare - Examine similar case studies across other contexts (industries, nations, cultures)

Contextualize - Examine other factors distant but directly connected to our area of interest (institutions, technologies, geography)

STS Methods

Interpret - Identify & explore significance of concepts, metaphors, and images used to describe the situation of interest.

Historicize - Examine what led to the current problems and situation. What forces led to this? Have we seen similar situations in the past?

Iterative Thematic Analysis

We've briefly talked about research questions and data collection (during Winter). Let's (briefly) talk about one (of many) methods of data analysis.

We want to use our data to answer our research questions. In Iterative Thematic Analysis, we find and refine *themes* that are the core of the results of our research and our communication to others.

Iterative Thematic Analysis

ITI describes qualitative research as *reflexive* - always in some way reflecting the researchers' perspectives and biases.
Qualitative analysis is situated and interactive, reflecting the data, identities of the researcher(s), and context of research itself.
Thus, it proposes to *explicitly state our biases and expectations* up front, and then modify throughout the research process.

Iterative Thematic Analysis

Phases of Iterative Thematic Analysis

1) Before data collection, assess initial beliefs as themes.
2) Build new beliefs during data collection.
3) Following data collection, list tentative final themes
4) Perform coding analysis, finalize themes.

Note - Qualitative coding is a process that requires training, but the idea here is that this can be a way to approach the assessment/research process.

Practicing Reflections

Field notes are used to make sense of information gathered on the "field", wherever you are collected data in some way.

- ***Scratch Notes***, or *raw records*, are initial, mostly unprocessed notes of your experiences.
- ***Headnotes*** are reconstructions of key experiences that marked the day.

We can use these to help us process and record our experiences at the Earth Day pop-up.

*see Chapter 6 of Tracy's Qualitative Methods for more

Analytic Reflection

While we don't need to go into detail about formal fieldnotes, we can explore ***analytic reflections***. We use this to reflect on the contents of our field notes, thinking about our reactions, doubts, frustrations, interpretations, etc.

We might ourselves "how did this relate to our research questions?" or "how did this make me feel? Why?"

Feminist Methods & Engineering

*Potential areas of transformative potential were identified for engineering, including:

- Feminist STS qualitative methods
- An Ethic of Care
- Antiracist & Liberatory engineering

*(Riley et al., 2009) Feminisms in Engineering Education: Transformative Possibilities

Key Concepts

- ***Power*** - The asymmetric capacity of an agent to structure or alter the behavior and decisions of other agents, populations, or systems.
- ***Agency*** - The ability or capacity to act or exert power. Technology informs the way in which people both perceive and exercise their agency.

**These definitions are adopted again from the Berkeley Human Context & Ethics Toolkit.*

Key Concepts

- ***Identity*** - Life-shaping and socially conditioned aspects of selfhood, such as gender, race, class, disability status, immigration, and income. Identity is not only about how you see yourself, but also ***how society sees (& treats) you***.
- ***Institutions -*** Informal customs, norms and practices **or** formal laws and organizations that ***support and generate forms of social order*** (e.g. institution of marriage, legal systems, schools).

Key Concepts

- ***Classification*** - Implicit and explicit social organization of beings and knowledge into discrete categories governed by identifiable principles. Societies produce knowledge and do work by classifying phenomena in the world. ***Classification systems inform social order and vice versa.***
- ***Expertise -*** Skill or knowledge in a domain. Technical expertise is usually institutionalized and is variously valorized in societies (e.g. associated with establishment of facts, trust, and authority). ***Technical experts often wield particular kinds of social power.***

Are these concepts in play at the Salton Sea?

- Power
- Agency
- Identity
- Institutions
- Classification
- Expertise

Design Justice Network

Who are they, and what can we learn from them?

DESIGN JUSTICE NETWORK
EST. 2016

"Design justice rethinks design processes, centers people who are normally marginalized by design, and uses collaborative, creative practices to address the deepest challenges our communities face."

- Design Justice Network

Design Justice Principles

Let's read their principles, and sit with them for a bit.

DESIGN JUSTICE NETWORK
EST. 2016

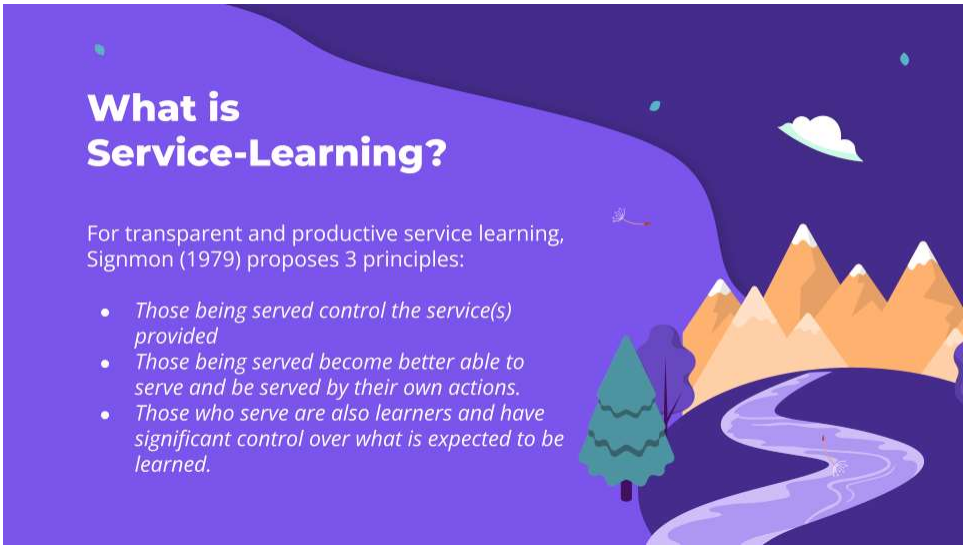
"these many development-oriented engineering programs and initiatives have as their primary goal that engineering should be used to help those who are disadvantaged or in need."

Lucena, Schneider, and Leydens

Engineering & Sustainable Community Development

"...unaware engineers may unknowingly entwine themselves in the long histories of colonialism, imperialism, and neoliberalism."
Kleba & Reina-Rozo, 2022
Fostering Peace Engineering & Rethinking Development: A Latin American View

What is Service-Learning?
Service-learning is often described in engineering as a method by which students can practice applying skills to relevant real-world projects & gain an appreciation for ethics and social good.
Students who participate in service-learning are said to:
Reinforce their curricular training
Gain greater cultural awareness.
Improve their emotional intelligence
Through EWB Cal Poly, we actively participate in engineering service-learning.


What is Service-Learning?
For transparent and productive service learning, Signmon (1979) proposes 3 principles:
Those being served control the service(s) provided
Those being served become better able to serve and be served by their own actions.
Those who serve are also learners and have significant control over what is expected to be learned.

Criticisms of Service-Learning

To be intentional about our work and its impacts, it is useful to examine scholarship about the shortcomings of the service-learning model:

- *Service-Learning projects can typically function as learning experiences for students at the expense of community partners.*
- *In international contexts, we may engage in voluntourism and resume-building at the expense of already-disadvantaged partner communities.*

Engineering, Development, & Neocolonialism

Earlier in Winter, we briefly read about the connections of engineering development to imperialism & colonialism.

Imperialism - A nation-state using economic or political power to spread ideology or extract wealth/resources from another peoples.

Colonialism - A nation-state exerting military power over another nation-state, with the aim of settling the area with settlers and dominating the peoples.

Engineering, Development, & Neocolonialism

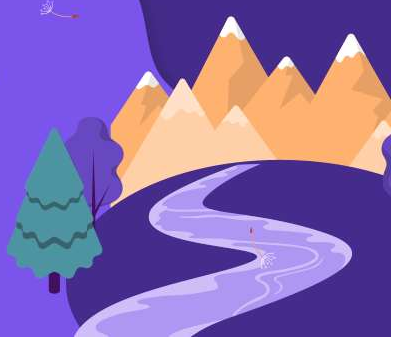
Earlier in Winter, we briefly read about the connections of engineering development to imperialism & colonialism.

Engineers often played a role in military occupation as well as building infrastructure to extract resources and wealth...

Engineering, Development, & Neocolonialism

To situate our engineering work in humanitarian development & service-learning...

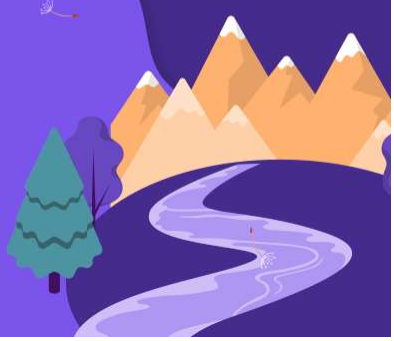
Fostering Peace Engineering & Rethinking Development: A Latin American View is a piece of literature that can help us!
Let's look through it.



Peace & Types of Violence

Consider three types of violence:

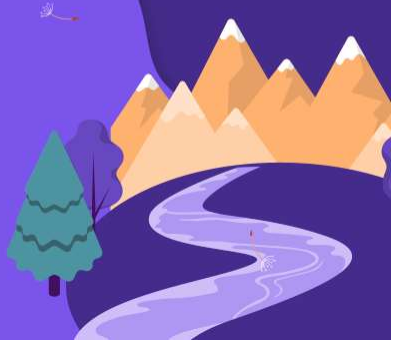
- *Cultural* - Narratives, symbols, and cultural dimensions, legitimizing structural and direct violence.
- *Structural* - Institutional exclusion of basic needs, rights, and dignity in any given economic/social order.
- *Direct* - Made possible by cultural/structural violence, harms others deliberately and directly.



Peace & Peace Engineering

Peace & Development are intertwined ⇒ the more society provides for equality in wellbeing and respect for plural ways of life, the less violence will fester.

Their key claim: Peace Engineering initiatives, based on a **critically built development** approach, can **reduce structural violence** and strengthen conditions of peace.

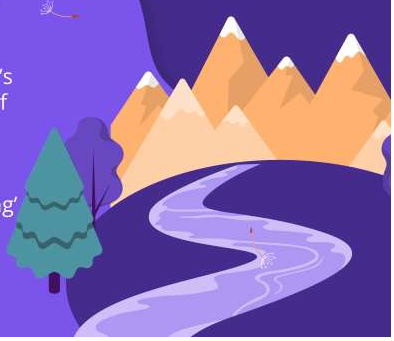


Engineering, Development, & Neocolonialism

What is a "critically built development approach?"

In general, *development* is a contested concept - concerned as raising living standards and society's well being. Primarily directed at those deprived of rights and opportunities.

Kleba & Reina-Rozo contend that we, along with many others, are involved in 'engaged engineering' and peace engineering, seeking to advocate for social justice.



Engineering, Development, & Neocolonialism

"...unaware engineers may unknowingly entwine themselves in the long histories of colonialism, imperialism, and neoliberalism."
So, a critical view of the idea of development is warranted.

Criticisms of Development

- Development implies a linear, Western-based model, centered on economic growth as the key indicator for 'progress'.
  - 'Linear' in the sense that there is an implied correct way to develop
  - That way is seen as the American/European models
  - Progress is seen as industrial growth

Criticisms of Development

- Metrics like Gross Domestic Product & Human Development Index rank all societies with universal criteria, ignoring historical and cultural contexts.
  - This comes back to the criticism of the idea that there is a correct way to develop, and that we can rank societies based on how they adhere to that.

Criticisms of Development

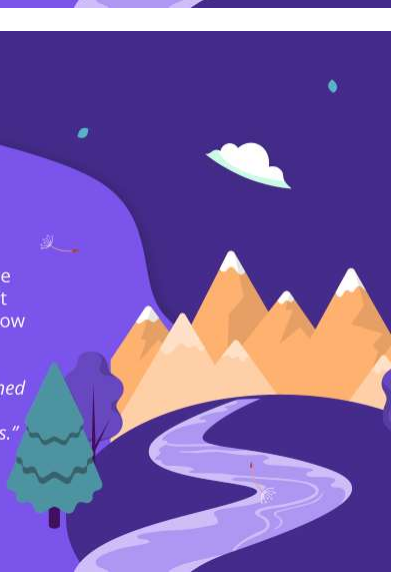
- Has a naive technological optimism and focuses on market innovation - spreading ideas of market expansion, private assets, and intellectual properties in all areas of life.
  - Essentially, this criticizes the Western models of intellectual property and market economies that are pretty contrary to lots of other ways of life.

Alternatives to Development?

Different alternatives to development have emerged - we can focus on those originating in Latin America. We don't have time to look at them in detail, but it is helpful to know there are alternatives to the current models.

Communal Innovation is an emerging concept - *"we defined as the process of iterative innovation carried out by marginalized communities in response to contextual factors."*

CI is mainly inspired by indigenous communities in the Andean-Amazonian region.

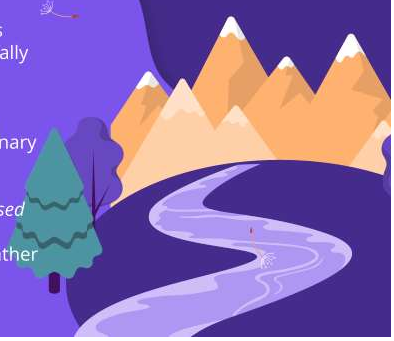


Latin American Insights

Theory of Dependence: Explains "underdevelopment" as due to peripheral countries' dependency on technologically developed ones.

Liberation Theology: Religious movements with policies favoring the disadvantaged - Catholic Indigenous Missionary Council advocating for Brazilian Indenous Peoples.

Critical Pedagogy - Paulo Freire's *Pedagogy of the Oppressed* advocates new methods of learning, focusing on independent, critical, creative, context-based thinking rather than more technocratic methods.



Takeaways for Peace Engineering

1. *Understand the richness of other knowledge systems.*
   a. Ex. Consider indigenous knowledge in environmental conservation.
2. *Consider diversity in worldviews.*
   a. Common ownership, shared knowledge vs. private property, individualism.
3. *Prioritize community autonomy*
   a. Communities aspire to make meaningful decisions about their ways of life.
4. *Ecological sustainability involves agency over territory.*
5. *Think about different forms of exclusion.*
   a. Some are less obvious (does development excludes certain ways of life?)

APPENDIX B – Interview Scripts

First Interview Script

1. To start off, can you tell me your major, any minors, and how long you have been at Cal Poly?
2. Why did you get involved with EWB Cal Poly? What motivated you to get involved in community-oriented work?
3. EWB sometimes utilizes the language of community development. What do you think it means to develop a community? To empower a community?
    a. What do you think it would mean to develop and empower your own community of students and volunteers in your EWB team?
    b. Do you think EWB partner communities could play a role in helping develop and empower your EWB community? What do you think this could look like?
4. Where do you think social good emerges from the activities of EWB? How would you describe justice and equity within the practices of EWB?
    a. Do you think that the approaches of EWB should be modified to better prioritize justice and equity? If so, how?
5. What role do you believe engineers play in matters of equity and justice? Feel free to be as broad or specific as you want.
    a. What role do you believe engineering could and/or should play in matters of equity and justice?
6. If you were to pursue a degree in community-oriented engineering, what skills and knowledge would you want to see in that degree?
    a. How many of your classes, inside or outside of engineering, have explicitly discussed matters of equity, justice, or human-centered design?
7. What principles do you envision guiding community-oriented engineering design and practice? For context, principles describe a rule or belief governing behavior, or a fundamental basis that serves as a foundation for a system of behavior.

8. Is there anything else that you would like to talk about before ending the interview? This could include your experiences within EWB, your educational experiences, a further insight to something we discussed earlier in the interview, or anything else you feel appropriate.

Second Interview Script

1. How did you feel about the dialogues we held in the team meetings? Were there any particular parts you found memorable or unimpactful?
2. Do you think your understandings and approaches to community assessment, problem definition, or engineering service-learning changed significantly this year?
3. How do you think that we can prioritize and advance social justice, as engineers?
    a. How do you think that EWB can prioritize and advance social justice?
4. What skills, knowledge, and methods do you believe are beneficial or essential to community-oriented engineering projects?
    a. Are there any skills or methods that you would like to learn more about in the future, to help you participate in these engineering service projects?
5. What do you think it means to develop or empower a community? What do you believe is our role in community development?
6. What do you think are the important principles that should guide community-oriented engineering projects?
    a. Is there anything that we discussed in the team meetings that really impacted your principles in your volunteer work?
7. Are there any other ways that you think you changed in your approach to community service-learning this year?
    a. Is there anything else you would like to discuss during this interview?

APPENDIX C – First Phase of Iterative Thematic Inquiry

1. ***To what extent can a local cocurricular service-learning engineering team environment be used as a space for promoting alternative engineering practices that promote equity, such as the Design Justice principles?***

Hypothesis - *Because qualitative STS concepts may have an immediately obvious use in the community assessment, the local service-learning environment could be a really great place to promote feminist qualitative STS methods.*

Hypothesis - *Regarding Latin American decolonial theory, I think they will be sympathetic to the arguments that humanitarian development and student-centered service-learning are not necessarily good things. But... while I think they will believe these arguments; I don't think they will be readily able to use these ideas to change their approaches.*

Hypothesis *– Design Justice is quite complicated in some principles, given the amount of time that this intervention is conducted in, I think it might inspire some research questions and approaches in community assessment, but I don't think the students will be able to use it for much else initially.*

Personal Expectation *- I would imagine that some students might have a basic understanding of social justice conversations related to engineering & humanitarian work.*

Personal Expectation *– This space & intervention might spark further interests - upon learning that these scholars and methods exist, they (team members) might seek them out in their classes, and in addition to bringing these principles into their spaces, they may seek them out for use in other contexts.*

Personal Expectation *– Potentially, there might just not have been enough time for discussion - I kind of imagine in the worst-case scenario that this will end up with the teams having this giant list of references and scholarship that they kind of understand the purpose of but aren't able to do much with.*

2. ***How can student-led engineering teams better incorporate feminist & STS qualitative methods into the community assessment & problem definition phases of a service-learning project, and what barriers might they face in incorporating these methods?***

Hypothesis *– I am hoping that this might be the single largest impact in this intervention – simply because I think introducing these topics as the team plans for community assessment, with a group of students likely to at least try to implement these ideas, has a lot of potential in integrating these methods in meaningful ways. The most obvious place to do this is in developing research questions for the community assessment process. In the dialogues led during the intervention, it is easy to introduce major building blocks of feminist STS, and research questions are an easy way to give the students an opportunity to put that learning to practice.*

Hypothesis *– I can imagine the most likely outcome is that the team is able to apply the feminist STS methods, especially those neatly summarized in Berkeley's HCE toolkit, into their list of research questions. They may think about issues of community assets, values, interest groups, and power dynamics within the different impacted groups.*

Personal Expectation *– Potentially, there might just not have been enough time for discussion - the team members may not have enough experience with the STS concepts to utilize them in a meaningful way. Perhaps they may include them in research questions but then struggle with actually evaluating them in the field.*

   a. ***Do these methods improve how the team intends to collect and integrate community input into their project?***

Hypothesis *– Considering both Design Justice Principles & feminist STS: More detailed community input may be most impactful in early problem definition – if the team moves on beyond the proposed berm design, and looks for other local projects in the area, centering community-led designs would be most impactful here. However, we probably will not see problem definition for a new project by the end of this year.*

Hypothesis *– Allowing others to use their lived experience and advocate using their own voice is a potentially achievable aspiration of these local engineering projects. If this intervention is successful in this category, it might manifest in the community assessment phase – detailed research questions about proposed solutions in the community and observing what groups with less power, potentially the Torres-Martinez tribe and the Spanish-speaking population, thinks about the situation and ways to address community problems.*

Personal Expectation *– I think this project would make an excellent research proposal for a 4-year PHD level project – plenty of time to conduct a longer, longitudinal qualitative analysis. I think measuring the impacts of works like this is a rather difficult topic for someone like me who is realistically maybe slightly more than a novice at qualitative work. I can't measure the full impacts on mindsets because it was such a short amount of time for a complex research question, and I can't measure the full impacts on the project because I am only seeing the community assessment phase of the project, not the problem definition or design phases.*