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[Work in Progress] Decolonizing humanitarian engineering education to achieve locally led development: Methods and strategies for Colombia and beyond.

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Abstract

Part of the movement represented by Engineering for Change (E4C) and Engineering to Help (ETH) [1], humanitarian engineering (HE) education programs have grown in the US for more than 20 years and exist in different forms such as majors, minors, certificates, courses, projects, field trips, study abroad opportunities, EWB-type volunteering activities, and graduate programs [2]. One of the most salient challenges that these programs face is avoiding colonizing and extractive practices by building relationships with communities and universities abroad that are long-lasting, trusting, effective, reciprocal for all parties, and attentive to local contexts. Critics have warned that HE programs could engage in new forms of colonization by creating initiatives with communities abroad without fully understanding contexts, diversity of stakeholders, complexities within and among communities, full dimensions of the opportunities available, and unintended consequences of assumptions, tools, and engagement practices involved [3], [4]. Inspired by recent policy changes for "locally led development" (LLD) in international development, this paper outlines methods, findings, and strategies for 1) relationship building that consider institutional and organizational differences and histories; 2) mapping communities and other stakeholders needs; and 3) building a decolonized ecosystem for HE in Colombia that could be used in other countries. This paper is part of a broader dialogue among HE educators, administrators, students, donors, and recipients, both in the US and abroad, about the practices, mindsets and methods necessary to establish decolonized HE education that will contribute to locally led development.

Introduction

Evidenced by the growth in E4C and ETH programs and the membership in ASEE community engagement division (CED), the growth and impact of HE-related programs in the US face at least two significant challenges: 1) assessing where and how to select locations and projects with reliable partners and stakeholders that will lead to long-lasting and responsible collaborations for community development; and 2) building these collaborations in ways that contribute to the capacity and autonomy of local institutions and communities. Most US HE-type programs and activities tend to be US-centric, focusing first on the contributions to US student learning [5], [6], [7], or the programmatic and curricular attractiveness in US universities [8], or the requirements for international experiences for US faculty and students in NSF-funded programs [9]. While responding to the priorities of US funding sources (private donors, universities, federal agencies) and having as the locus of attention to be "the experience" of US faculty and students, most of the initiatives rarely focus on capacity building of non-US institutions and communities or the experiences of non-US faculty and students. Perhaps this US-centric approach to community development in engineering education follows a problematic long-lasting trend in US international development that recently USAID administrator Samantha Power has been trying to correct by focusing on "localization" or "locally led development" (LLD) as "the process in which local actors – encompassing individuals, communities, networks, organizations, private entities, and governments – set their own agendas, develop solutions, and bring the capacity,

leadership, and resources to make those solutions a reality. USAID recognizes that local leadership and ownership are essential for fostering sustainable results across our development and humanitarian assistance work." [10]. Furthermore, USAID recognizes that each country is unique in its path to development hence LLD "is tied to each country's unique political, social, cultural, economic, and environmental conditions, including through local systems practice and local capacity strengthening." [10]. With the likely elimination of USAID, it is more imperative that US universities take the helm in materializing LLD in their international community development programs and initiatives.

This work-in-progress paper provides a model for the creation of HE education that can contribute to LLD by showing how to 1) build academic and professional networks in country and interest and capacity in HE education in local universities, 2) map and assess needs and capacities of local engineering schools and communities, and 3) map the ecosystem for HE Colombia. After showing the findings, the paper proposes specific interventions to 1) navigate the ideologies that get in the way of effective LLD and HE education and practice, 2) celebrate local institutional and actors' differences and enhance their readiness, 3) deal with different histories and levels of development among local communities, and 4) begin constructing an HE ecosystem.

Why Colombia?

To understand the creation of HE-Colombia we need to review how the idea of "underdevelopment" emerged and how it came to shape the view of the State and its technocrats as the problem solvers of people's problems, influencing engineering education and practices towards communities in countries like Colombia. In his second inaugural address in 1949, US President Truman divided the world between "developed" and "underdeveloped" and gave the US the mission to save the "underdeveloped" world from misery. In Truman's own words:

> we must embark on a bold new program for making the benefits of our scientific advances and industrial progress available for the improvement and growth of **underdeveloped** areas. More than half the people of the world are living in conditions approaching **misery**. Their food is **inadequate**. They are victims of **disease**. Their economic life is **primitive and stagnant**. Their poverty is a **handicap and a threat** both to them and to more prosperous areas. For the first time in history, humanity possesses the knowledge and skill to relieve suffering of these people. The United States is pre-eminent among nations in the development of industrial and scientific techniques. The material resources which we can afford to use for assistance of other peoples are limited. But our imponderable resources in technical knowledge are constantly growing and are inexhaustible.[11]

This statement clearly positions traditional communities from countries like Colombia as deficient and lacking and the US at the top of development and endorses a view of the world where powerful development institutions (World Bank, International Monetary Fund, US Agency for International Development, Peace Corps, etc.), and their technocrats (including engineers) would provide solutions to world poverty. This came to be known as "the project of

development." [12], [13] In Latin America, Colombia was at the center of this project, being the first country to receive a mission from the World Bank in 1949. Following Truman's view of underdevelopment, the World Bank's mission reported that in Colombia

> the great majority are inadequately fed, clothed, and housed. Their health is poor and life expectancy is short. A large proportion is illiterate, and few have more than two or three years of primary schooling…Colombia is presented with a unique opportunity in its long history. Its rich natural resources can be made tremendously productive through the application of modern techniques and efficient practices [14], p. 106-7.

The project of development had certainly reached Colombia and was embraced by the three presidents, all engineers, who followed the World Bank's mission – Mariano Ospina Perez (1946-50), Laureano Gomez (1950-53), Gustavo Rojas Pinilla (1953-57) – and who presided over the country's bloodiest political violence ("La Violencia" 1948-1958) and one of its most rapid periods of growth in infrastructure, industry, and technical education. This period saw the creation of Colombia's oil company (Ecopetrol), telecommunications company (Telecom), steel mills (Acerias Paz del Rio) and new engineering schools in Universidad Industrial de Santander (1947), Universidad de los Andes (1948), Universidad del Valle (1949), to name a few, which would supply the engineers needed for the project of development. [15]

Ironically, after more than seven decades of this project of development, Colombia is now a country with "one of the highest levels of income inequality in the world, the second highest among 18 countries in Latin America and the Caribbean (LAC), and the highest among all OECD countries." [16] According to development scholar Arturo Escobar,

> Colombia represents one of the most interesting cases of a capitalist and modernizing globalization. Colombia (along with Mexico) have ironically had the privilege of having maintained one of the most cruel and enduring regimes of control by the elites in Latin America, protected from and protecting the development policies imposed by the United States. Currently, these two countries continue to be strongholds of a neo-liberal model that goes against progressive policies for the good of the poorest. Therefore, it is no coincidence that these two countries have one of the highest levels of conflict, violence, inequality, and human rights abuses that exist in the Americas. It is also no coincidence that Colombia - endowed with immense natural resources and a highly trained professional class - continues to generate social movements. The peace processes are only one part of a larger attempt at social transformation generated by many actors such as peasants, Afro-descendants, indigenous people, students, unions, women, and environmentalists, among others. Therefore, Colombia presents a test case of the scope and limits of globalization and of the efforts of various groups to resist it to bring more livable and dignified social and ecological models.[17]

Hence, Colombia's problematic history with the project of development makes it an ideal location to reflect on the colonizing and perverse effects of this project, map possibilities for locally led development, and for develop HE education and practices that could enhance LLD.

Positionality

The author of this paper was born and raised in Colombia until the age of 13 where I learn to value, understand, and work with people from the poorest sector of society even at a young age. He then moved to the US to finish high-school, undergraduate degrees in engineering, and graduate degrees in Science and Technology Studies (STS). He then became a faculty member in a engineering schools where he developed transformative programs for engineers, including Humanitarian Engineering at Colorado School of Mines where he now teaches. Being fully bilingual in Spanish and English has allowed him to develop deeper personal and institutional relationships in Colombia. Yet he has found that most interested Colombian faculty and students are well versed in English and often prefer to read and speak in English. So while language barriers can be a hurdle in the development of partnerships it is not an unsurmountable barrier. Being a brown-skinned mestizo male also allowed me to operate safer in community contexts and to use this privilege to increase the safety of female faculty and students in community contexts where they often do not feel safe.

Methods

Building a preliminary academic and professional network. Prior to a semester-long sabbatical, I researched and contacted several universities with programs or initiatives that could potentially become places for HE education and practice. This process included identifying a faculty leader who had the ability to reach out to students and open spaces for dialogue with faculty and students once I would be in person in Colombia. These programs included the Institute for Engineering Education at Universidad Nacional de Colombia-Medellin (UNAL-Medellin), the technology for accessibility lab at Universidad de Antioquia (UdeA), Ingenieros sin Fronteras, a student organization similar to a chapter of EWB-USA, at Universidad de los Andes (Uniandes), and the Technology and Society course at Universidad del Valle (Univalle), to name a few. Also, I identified Colombian networks such as the Red Colombiana de Ingenieria para el Desarrollo Social (RECIDS), Amigos de Ingenieros sin Fronteras Colombia, and IEEE Colombia Chapter and US-based engineering organizations that have interests in HE topics and could potentially channel these to Colombia such as IEEE Humanitarian Technologies Board and Latin American and Caribbean Consortium of Engineering Institutions (LACCEI). In addition, I co-organized the creation of a network of scholars in Science and Technology Studies (STS) interested in researching and activism in HE-type of activities. Through this exercise I also identified many potential networks in other Latin American countries, such as Associação Brasileira de Ensino, Pesquisa e Extensão em Tecnologia Social and Red de Ingeniería Popular de Brasil, that could serve as key stakeholders for future national HE-led efforts. See [18] for a comprehensive mapping of these type of activities in Latin America.

Building interest and allies inside of universities. During my sabbatical, I continued building the academic and professional network in person by offering presentations in universities, existing and new to my network, on what humanitarian engineering is, how it exists in US universities, how it could exist in different Colombian institutional contexts, and what HE could do for these programs and their home institutions. Once I sparked interest, I offered more specific campus lectures or classes on, for example, how to integrate the social sciences and engineering to provide the sociotechnical approach required in HE [19], how to integrate social justice in a Dynamics and Mechanisms class [20], or Socially Responsible Engineering (SRE) framework [21] in an engineering project management class. I also interacted with groups of

students interested in connecting engineering to community service and, in some cases, supported the creation of incubators (semilleros) of students who wanted to do humanitarian engineering even when the curriculum at their home institution did not open space for these activities. Then I was able to secure one of the keynote lectures at the Colombian Society for Engineering Education (ACOFI) which created interest to be invited to present HE in other Colombian cities and universities. To address faculty and student interest on how to build HE initiatives in their schools, I organized a nationwide faculty development workshop and a HE-related student competition (see below).

Mapping communities and assessing their needs. With the assistance of university partners with extension offices and meaningful contacts in vulnerable communities in Medellin, I identified and visited communities and associations that could potentially use the services of HE. Given the complexity and security concerns in these communities, I always visited with university staff and/or community leaders who understood the place and its context (Where to go? What to avoid? What to say and not to say? How to act or not to act?) and provided me with the social capital necessary to engage key stakeholders [22]. Once on site, I engaged in contextual listening, in-depth conversations, and participant observation [23] to assess how Colombian HE students (and eventually US faculty and students) could serve these communities. After several visits to communities, organizations, and universities, I identified four problem areas – energy security and autonomy; accessibility for persons with disabilities in low-income setting; monitoring and management of geological risks; recycling of construction and textile waste – that eventually became the foci of a HE student design competition (see below) and my Spring 2025 courses and summer projects (see below).

Mapping the landscape for HE Colombia. In addition to assessing specific local needs in communities and universities, I engaged Universidad Minuto de Dios (Uniminuto), a Colombian university with the capacity and methodology to map ecosystems of science, technology, and innovation [24]. To increase representation and participation from different corners of Colombia, we held two virtual collaborative workshops with participation of more than 50 participants from Colombian universities, associations, and government agencies interested in HE.

The first workshop focused on establishing the main objectives of HE Colombia by engaging participants with the following questions:

1. What is the concrete impact that we are seeking to generate in communities in vulnerable conditions?
2. What characteristics does an Inclusive Humanitarian Engineering Ecosystem have?
3. What does it mean to collaborate between actors of a heterogeneous nature within the Humanitarian Engineering Ecosystem?
4. What should be the principles of the Humanitarian Engineering Ecosystem?
5. What strategies would you use to ensure collaboration in the ecosystem taking into account the proposed principles?

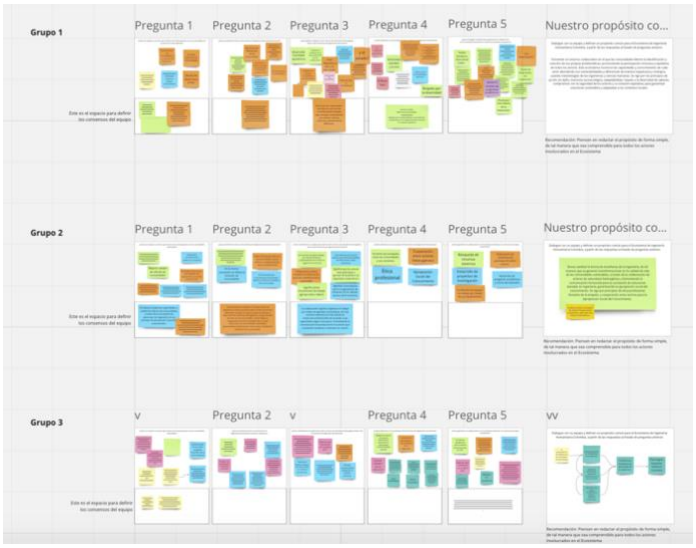

Fig 1. Virtual Canvas used in workshop 1.

The second participatory workshop focused on mapping the HE Colombia ecosystem through the sectors of the Quadruple Helix – academia, government, private sector, and civil society – the interactions among them, and the different roles that they can play in the ecosystem such as articulator, enabler, knowledge creator, promoter, and facilitator of social appropriation of knowledge. Participants addressed the following guiding questions:

1. Which actors in each sector perform which role(s)?
2. What capabilities must they have to contribute to the purpose of the HE Ecosystem?

Fig 2. Virtual canvas used in workshop 2.

Findings

The methods above yielded some context- and place-specific findings, yet many of them apply across contexts and places and can be useful to HE-type programs trying to figure out how to establish partnerships and programs in different parts of the world.

Presence of dominant ideologies of development, depoliticization, and State. As described above, Colombia presents a unique case of development, yet the project of international

development [12] has shaped, for better or worse, the economies, policies, infrastructures, and livelihoods of every country in the planet. Hence, faculty and students in HE-type programs will likely encounter this project still in place and in its current form and operating on actors and institutions through its dominant ideology: Modernization [25], [26]. Among its most pervasive effects, this ideology reinforces the beliefs that "traditional" communities are roadblocks to economic growth, hence they need to be transformed into "modern" actors (individuals) who can contribute to the country's GDP through training, methods, and technologies coming from more "advanced" economies in the Global North. Still very pervasive and influential in the way Colombian engineering faculty, students, and some community members think of themselves, this ideology conditioned, for example, the ways in which they expected answers from me (or from any of my US invitees. See below) as the professor coming from a US university and held the knowledge coming from a US actor to be of higher value. This, of course, presents significant challenges for those of us trying to promote locally led development which relies on local knowledge.

As described by Cech [27], one of the most dominant ideologies of engineering is depoliticization which encompass the beliefs and practices that the world is divided between two separate technical and social realms, that the knowledge created in the technical domain is always of more importance and value than the one in the social domain, and that the knowledge from the technical domain, when accompanied with good intensions, will necessarily yield positive social outcomes (impacts). While this ideology is highly pervasive and effective in US contexts, fields like Science and Technology Studies (STS) and Engineering Studies in the US with their subsequent scholarly and curricular contributions have provided much needed evidence and strategies to enhance our understanding of engineering as always a sociotechnical practice [28][29][30]. In Colombia, although present in some social science programs, these fields have yet to make inroads into engineering education and practice where the low levels of exposure by engineering students to humanities and social sciences (hu/ss)in their programs of study (sometimes relegated to one course in a 5-year program) make the ideology of depoliticization even stronger and more difficult to counteract. Similar to Catherine Roby's findings about French engineering education, I found that when hu/ss education is present they are "taught in an apolitical stance, based in corporate themes rather than questioning the social order or science and technology in society."[31]

A third pervasive ideology that I found is State Paternalism which includes the set of beliefs and practices where the State, as the paternal figure, knows, dictates, and provides funding for the solution of problems that communities (the child) have [32]. This ideology is strengthened by the other two as State functionaries (technocrats) often prescribe technological solutions to social problems within organizational practices and structures set in place by the project of development [33]. This ideology leads actors in the HE space (faculty, students, some community members) to believe that problem definition, solutions, financing, and rules and norms always come from the government in spite of histories of abuse and neglect by the State on vulnerable communities.

Institutional differences. Most Colombian engineering schools were created in the 1950s, a time of unprecedented contradictions between political violence and modernization of industry. Despite this common origin, engineering schools have evolved to be very different as they

inherit the regional and institutional character, governance, practices, and resources of the universities that house them. HE programs and initiatives that are beginning to emerge in Colombia reflect these institutional differences. For example, UNAL, as one of the premier research universities in Colombia, uses "semilleros" (incubators) of students to instill a culture of research among undergraduates. Hence, HE started at UNAL as a "semillero de ingenieria humanitaria" (HE incubator) and I had to work with them to advance HE in their school. In contrast, UdeA, as one of Colombia's universities with a very explicit commitment to serve communities and industries in the department of Antioquia, requires practicums (practicas) as a graduation requirement for engineering students. Hence, HE at UdeA must consider these practicums as spaces to grow. In Bogota, Uniandes, following a US-inspired example of allowing student organizations, created Colombia's first chapter of Ingenieros Sin Fronteras-Colombia (ISF-Colombia) so any HE initiative there must take this organization, and the community relations and institutional events that it has built over its 15 years of history, into consideration. Advocates of HE-type programs need to understand, value, respect, and work within these differences instead of trying to "export" what has worked in the US.

As external actors, US-based HE advocates, like myself, can also see possibilities for organizational and curricular innovations yet we need to acknowledge that we do not fully know the institutional history and context. For example, I proposed building bridges between UNAL's HE incubator and its STEAM makerspace/active learning classroom so HE can influence pedagogical innovations in engineering courses. Yet I had to be mindful of the very conservative culture of the institution, in large part shaped by dominant ideologies described above.

Institutional Readiness. Institutional differences are not the only factors to consider when assessing what is possible for HE-type of collaborations with universities abroad. There are different levels of institutional readiness in areas that are essential for successful collaborations, including access and support to secure external funding, research and publishing opportunities in HE areas, and evidence-based engineering education transformation. *Funding.* Government funding for S&E R&D is often scarce and its access highly bureaucratic in countries like Colombia that invests less than 0.2% of its GDP in S&E R&D. Different than US universities that have entire operations to secure funding from alumni, and private and public foundations, Colombian universities do not have a culture of alumni or foundation relations thus making it difficult to secure funding for HE-related projects, events (speakers, workshops, etc.), and scholarships. *Research and publishing*. Scarce funding makes it difficult to carry out S&E R&D and when it happens, researchers focus on publishing in indexed journals with high impact factors, which measures how often papers are cited but say nothing about how these are relevant to communities' wellbeing. [34] Thus S&E R&D in countries like Colombia is mostly disconnected from HE topics. *Engineering education transformation.* As I have shown elsewhere [35], effective HE education requires transformations in content and pedagogies from traditional engineering education. Yet teaching and learning in most Colombian engineering schools are still very traditional, following passive learning in lecture-format teaching. Economic pressures in universities make it difficult to provide funding for faculty development related to active learning pedagogies. Thus the curricular and pedagogical transformations needed for HE education are difficult to carry out.

Heterogeneity of faculty and student allies. Elsewhere, I have proposed a method to map the perspectives of actors along three dimensions: location, knowledges, desires (LKD) [35]. I used this method in Colombia to begin mapping the perspectives of potential HE allies, particularly faculty and students who come from different places, have and value different kinds of knowledge, and have different reasons to be interested in HE. While every individual occupies a unique perspective, I found some general patterns that might apply in different countries. *Socio-economic class.* Given the profound socio-economic disparities in Colombia, it is common to find privileged faculty and students in private schools and those with significant financial constraints in public schools [36]. This class difference between private and public schools dictates the availability of capitals, not only financial but also cultural as when one finds higher levels of English spoken in private schools. *Educational background.* Faculty with US-based graduate or post-graduate work have a deeper understanding of US engineering education, academic reward system, and publishing practices. Students who come from financially poor communities have a better understanding of the realities experienced in these communities. Faculty who come from universities seeking high-quality accreditation (acreditacion de alta calidad) are often pressured to publish in indexed journals with high impact factors and present in conferences in the Global North which often takes them away from working on community development projects. *Commitment to Social Justice*. Because of their social origins, faculty and students from public universities exhibit deeper commitments to social justice which often include critiquing systems of oppression that maintain the status quo (capitalism, patriarchy, racism). This is consistent with existing research among university students from high and low socio-economic classes in Medellin which shows that "The HIGH [class] social group individuals are on average significantly less conditionally cooperative, i.e., they contribute less [to social projects] than individuals in the LOW [class] group for a given level of the expected average contribution of other group members.In addition, the HIGH group consists of more free riders and fewer conditional cooperators than the LOW group, although the differences are not statistically significant."[37]

Different histories and levels of development among communities. Vulnerable communities of cities like Medellin have complex histories, diverse demographic compositions, different relationships with local and national governments, and complicated relationships with elected officials who often show up on site only to gather votes during elections [38]. In addition to these reasons, how communities embrace State Paternalism (see above) conditions to a large extent communities' levels of development, new opportunities for community development, and willingness or reluctance to enter into HE-type of partnerships with universities and other actors. For example, one of the most vulnerable communities around Medellin has experienced high levels of State Paternalism, for example, by receiving funds to build makerspaces for its youth as political reward for helping elect a city major. Now that the city has a new major who does not have a strong political following in this community, the makerspaces sit idle without any trainers and operational funds. In contrast, another vulnerable community with a different history with State Paternalism, where the State has repressed, incarcerated, and often killed its civilian population, there are slim expectations of State support. Hence, on their own, community leaders, in partnership with private foundations, built community gardens and makerspaces for single mothers and youth to grow crops and learn computer coding. How communities stand in relationship with State Paternalism not only conditions their current levels of development but

shapes possibilities for HE-type partnerships with universities who, for example, can provide capacity building to support community gardens and makerspaces.

Mapping the HE-Colombia landscape. The mapping of the HE-Colombia landscape helped determined that its main beneficiaries are "vulnerable communities that can be rural, urban or mixed, and face social, environmental and economic problems."[39] The main objective of the ecosystem is to "generate transformations in the quality of life of vulnerable communities through collaboration between diverse actors (academic, private, social, etc.) and the application of engineering following frameworks of social justice, equity and sustainability, and the social appropriation of knowledge as a bridge between technical solutions and community needs." [39]

The fundamental principles of the landscape are:
o Respect for the diversity of knowledge and dialogue of knowledge.
o Empathy, professional ethics and cooperation.
o Co-creation: collaborative solutions with communities.
o Environmental and social sustainability.
o Socio-ecological memory and commitment to the local context.

Strategies

How to counteract or navigate ideologies? During my sabbatical, I developed and delivered several activities to demonstrate to faculty and students 1) the existence and dominance of ideologies, 2) how they influence engineering thinking and practices, and, when appropriate, 3) how to counteract their negative effects in the relationship between engineers and communities. *Ideology of development.* In a project management class required for all engineering students in a Colombian university, they use a tool called Logical Framework Approach (LFA) to learn how to manage projects. I showed students how LFA was developed in the 1960's by international development agencies such as USAID and had inherited many of the problematic assumptions about traditional communities described above, including how it silences the less powerful, continues to protect the interests of the powerful, and, although it facilitates project management, it does not adapt to the confusing realities of development in practice.[40] Then, I invited students to apply the criteria of Socially Responsible Engineering (SRE) [21] to question LFA, its assumptions, and effects in power relations between engineers and communities. *Ideology of depoliticization.* I intervened in a similar manner with faculty and students in the Concrete and Cement Research Group at Universidad Nacional by challenging them to view concrete not as a purely technical material void of political agency but as a sociotechnical creation that made (and was made) possible by the policies, practices, and expenditures of Modernization within the project of international development [41]. Participants learned how the US the government has come to acknowledge the political dimensions of civil infrastructure made with concrete and funded projects to dismantle racist infrastructure [42] and learned about the Liberatory Infrastructure Lab at UC Berkeley whose mission is "to develop systems of critical infrastructure that support liberation and restorative justice for all, particularly of historically under-resourced and historically marginalized communities." [43] *Ideology of State Paternalism.* To begin counteracting this ideology, I helped organize field visits where engineering students co-defined problems with gray water usage with single-mothers heads-of-household in a community that lacks state presence in the delivery and regulation of public services. Initially wary of regulations

imposed and enforced by the State, students quickly learned from the mothers that the State is mostly absent from their lives, how they had to secure, treat, and reuse water, all on their own accord, and where and how engineering could make the processes easier. Counteracting this ideology will require more concerted efforts such as a multiple-stakeholder conference on Engineering Post-State that I am planning in the future.

Celebrate and leverage institutional differences. During my sabbatical, I celebrated and nurtured institutional differences and am planning to facilitate cross-fertilization across institutions. For example, I will be mentoring students from UNAL semillero to visit UdeA to incentivize the creation of a similar concept in the latter. Likewise, I am trying to facilitate the creation and expansion of "social practicum" (practica social) by encouraging UdeA's staff responsible for practicums to start projects at UNAL which could eventually become a credit-bearing practicum for UNAL's engineering students. For those Colombian universities with student organizations like IEEE student chapters involved in humanitarian activities like Tech4Good, I am facilitating exchanges with universities who do not have such organizations to motivate them to start one and become active in humanitarian projects.

At the national level, I developed opportunities to make differences visible and recognize HE-related efforts and initiatives that have been in place in Colombia for quite some time. For example, I co-organized a nation-wide symposium to showcase 1) Ingenieros sin Fronteras-Colombia, an organization similar to EWB that has been in existence and doing effective community development projects for over 15 years that allow make differences visible; 2) DIVERSA, a community engagement organization that specializes in connecting engineering students and vulnerable communities in co-creation of solutions to communities' needs; 3) "Ingenieria Para la Vida" (Engineering for Life), an initiative by the Institute for Engineering Education at UNAL-Medellin to transform and connect engineering education to the protection of life on the planet; and 4) the Humanitarian Engineering project option at Universidad Sergio Arboleda that allows any senior student in the university to choose a humanitarian engineering project as the final project for graduation.

Enhancing institutional readiness. To help Colombian universities understand the value of developing and growing HE-related initiatives, I invited US-based organizations with resources and expertise to Colombia to share "best practices" that would benefit both Colombian communities and students. For example, I brokered an IEEE Tech4Good Colombia competition by bringing together IEEE-USA Humanitarian Technologies and DIVERSA to co-organize and deliver a nation-wide student competition where students had to learn to co-create solutions with communities and then compete for best design ideas in three areas of significant community importance: technologies for accessibility, energy autonomy and security, and geological risks caused by climate change. 120 students organized in 30 teams entered the competition, 9 teams became finalists, and 3 teams won significant financial awards. During the process, students engaged faculty and university administrators in the creation of IEEE student chapters (a requirement to enter the competition), in the institutional readiness to engage nearby communities in problem definition and solution in any of the areas above (a requirement to move to the final round), and in the sponsoring of student travel to the final competition. For the 30 universities competing, this event demonstrated that it is possible to get funding for HE-related activities from non-State sources (thus contributing to demystify State Paternalism as well), that HE-related activities can result in significant student engagement and lead to good community

relations. Our intention is to make this a regular annual competition and to invite faculty to integrate these kinds of projects in engineering courses and programs.

To demonstrate to faculty how integrations of social innovation projects and engineering courses can happen, I invited Professor Khanjan Metha from Lehigh University to deliver a faculty-development workshop on Transformative Education for Sustainable Social Impact (TESSI) "designed to empower faculty with the expertise and tools needed to reshape their courses and curricula in response to global grand challenges. Rooted in the principles of creative inquiry and the praxis of Humanitarian Engineering and Social Entrepreneurship, the TESSI Institute offers educators an innovative framework for crafting curricula that engages students in authentic, real-world projects, where they co-create innovative, practical, and sustainable solutions that address the needs of vulnerable populations and communities facing social, economic, and environmental challenges."[44] Engineering faculty from more than 10 universities in Colombia and Spain participated and began developing curricular and programmatic integrations into their own programs.

Furthermore, we secured an NSF-funded International Research Experiences for Students (IRES) grant with Southern Methodist University (SMU), UNAL-Medellin, and Mines "to co-design and pilot solutions to reduce mining waste, prioritizing environmental assessment and clean up, and economic livelihood opportunities and integrate social-technical responsibilities, such as testing requirements for healthy-materials with innovations in recycling." [45]This project will engage US and Colombian faculty and students in virtual community encounters during the academic semester and in person summer community development projects.

Celebrate diversity of faculty and students while reducing gaps in opportunities and resources. In similar ways that we invite our graduate students in the [program deleted for review], recognizing and valuing differences among Colombian faculty and students allowed them to position themselves with respect to the histories of development and with specific struggles of vulnerable communities. For example, during participatory workshops with students, they mapped their perspectives, began to position themselves and their histories in relation to the histories of struggles in their territory, such as violent conflict around gold mining or State neglect in delivering basic services to their communities. Then they begin to become invested in working in HE-type projects in those communities. However, good intentions and historical connections are not enough to engage in effective and responsible community development. Proper training in community engagement is necessary such as the one delivered through the IEEE Tech4Good and TESSI workshops (see above).

To reduce gaps in opportunities and resources that emerge from differences in socio-economic class and educational background, presentations and workshops were delivered in Spanish (directly or through simultaneous translation) to audiences that did not have the opportunities to have learned English, fee waivers were secured for participants that did not have the resources to pay, and special attention was placed in recruiting and attending to the needs (meals, transportation, lodging) of student teams, in competitions like IEEE, coming from universities with scarce resources. In the future, I am planning events with university administrators to begin developing a culture of alumni and private foundation donations to secure resources for HE-related scholarships, events, and projects. Furthermore, I am mentoring future Fulbright scholars to come to Colombia to do HE-related sabbaticals and share their social and cultural capital with universities that need them most.

Dealing with different histories and levels of development among communities. To understand and assess collaboration possibilities with communities at different levels of development, we should apply the criteria for socially responsible engineering (SRE) [21] in the following way as I proposed in a vulnerable community (Garden Community) that wanted to build community gardens with gray waters from laundry use to reduce water consumption and cost while increasing availability of vegetables in a food desert area.

Criterion 1. Understanding structural conditions and power differentials among specific stakeholders of an engineering project. First, I built trust, empathy, and personal relationships with community leaders but understanding that each one faced different constraints and relationships with the State and the community. Then I learned from them about the different structures of power that affect communities, especially non-State power, which is mostly absent, such as militant groups, gangs, brokers in the informal economy, associations of single mothers, etc.

Criterion 2. Contextually listening to all stakeholders, especially those who are marginalized, to grasp their needs, desires and fears surrounding a specific project. During and after Criterion 1, I listened to natural and official leaders in Garden Community, actors with different histories and knowledges (formal, informal, ancestral) about the context of the grey water project like single-mothers heads of household who described how water usage increases when relatives displaced by violence from rural areas have to move into their homes or decreases when relatives are killed by urban violence.

Criterion 3. Collaboratively identifying opportunities and limitations of creating shared social, environmental, and economic value for all stakeholders, especially those who are marginalized. I helped organize and participated in a collaborative activity where single-mothers heads of household mapped water usage, collection, and reuse in their homes so engineering students could help evaluate the most cost-effective, environmentally sound, and fair use and reuse of grey waters.

Criterion 4. Adapting engineering decision-making to promote those shared values, acknowledging situations in which this is not possible and when engineering projects should not move forward. The Garden Community project is far from being completed yet students continue to frequently visit the community to continue assessment under Criterion 3 and jointly decide what kind of engineering project should move forward.

Criterion 5. Collaboratively assessing activities and outcomes with those stakeholders. This activity has not been completed as the project is still under development.

Mapping the HE-Colombia landscape. The actors involved in the mapping of HE-Colombia recommended the creation of a HUB for HE-Colombia to be "conceived as an integral driver of the ecosystem, functioning as an articulating, facilitating, and transforming platform that promotes applied research, the scaling of solutions and capacity building, in order to generate sustainable and contextualized impacts in vulnerable communities. Its purpose goes beyond the implementation of projects, as it acts as a key axis that links actors, resources and knowledge to energize the ecosystem and solve systemic problems." [39]

HUB as connector of stakeholders. “The HUB acts as a strategic intermediary, connecting national and international actors, leveraging resources and expertise from ecosystem actors, and aligning them with the needs of communities and the interests of funding agencies. This involves linking universities, companies, non-governmental organizations and communities to create synergies that promote the development of sustainable and scalable engineering-based solutions.”[39]

HUB as promoter of community-led innovation. “The HUB focuses on the specific needs and challenges of the most vulnerable communities, facilitating the identification of problems that can be solved through the application of engineering knowledge and in contexts that allow the application of innovative teaching approaches, through spaces for co-creation of solutions from a humanitarian perspective, ensuring that these are culturally appropriate and technically viable.”[39]

HUB as facilitator of resources and opportunities. “The HUB will channel and manage financial, technical, and human resources to ensure the effective design and implementation of engineering-based solutions and educational projects from a community learning and action without harm approach. This not only involves the active search, channeling and management of funds, through partnerships with public and private institutions and international organizations, the creation of shared funds that facilitate the execution of collaborative projects and the promotion of transparent mechanisms for the equitable management of resources, but also the training and education in humanitarian engineering for all actors in the ecosystem and the mapping of technologies with the potential to be adapted to local community contexts. On the other hand, one of its fundamental roles is to facilitate the scaling of innovative solutions. Through the documentation, systematization, and dissemination of successful projects, the HUB ensures that positive impacts are multiplied in different territories. This is achieved by creating replicable intervention models adapted to different contexts, in addition to bringing together actors to ensure the technical, social and financial sustainability of these solutions.” [39]

HUB as promoter of applied research. “The HUB promotes applied research, linking the real needs of communities with technical solutions based on engineering. This involves the identification of contextual problems through participatory diagnoses and the generation of applied knowledge that allows solving social, environmental, and economic challenges. In addition, it promotes the formation and mobilization of collaborative research networks that integrate local and academic knowledge, strengthening the ecosystem's capacity for innovation.”[39]

Dissemination and translation of knowledge. “As a driving force of the ecosystem, the HUB also develops instances of knowledge transfer, ensuring that the knowledge generated is disseminated and appropriated effectively. This includes the creation of knowledge banks with documented solutions and good practices, as well as the implementation of dissemination programs and spaces for exchanging lessons learned among the ecosystem's actors. With training in social innovation and community management as its central axis, through educational spaces that strengthen the capacities of the ecosystem's actors. Through training programs in community management, participatory methodologies, solution design and resource management, the HUB

trains local leaders and key academic actors who energize the innovation and sustainability processes in the territories."[39]

Conclusion

The growth of HE-type programs in the US has brought significant contributions to US engineering education, including recruitment and retention of students (especially white women) that otherwise would have gone to other programs with more social relevance. It has also brought new forms of international experiences to US faculty and students and, in some cases, a better public image to US universities. Yet, as recent transformations in the project of international development in the form of "locally lead development" show, there is an imperative need for US HE education to rethink how we engage communities abroad by building robust local networks of stakeholders, mapping institutional and community differences, needs, and assets, and then assessing what the contributions from US engineering schools could be, if any.

This paper contributes to this need by providing specific methods for mapping and assessment of local conditions, proposing interventions to those challenges that HE education champions will likely encounter in other countries (ideologies, actor and institutional differences and readiness, etc.), and finally proposing a specific method for mapping a national HE ecosystem. While the context of each country is very different, the methods and interventions proposed here can be adjusted to other country or regional contexts.

References

[1] J. Schneider, J. C. Lucena, and J. A. Leydens, "Engineering to Help: The Value of Critique in Engineering Service," *IEEE Technology and Society Magazine*, vol. Volume 28 Number 4, Winter 2009.

[2] Engineering for Change, "The State of Engineering for Global Development: United States and Canada," E4C, NY, New York, 2019.

[3] J. Lucena, "Can Community Development Projects in Engineering Education Be Both Responsible and Sustainable?: Theory, Education, and Praxis," in *2020 ASEE Virtual Annual Conference Content Access Proceedings*, Virtual: ASEE Conferences, Jun. 2020, p. 34254. doi: 10.18260/1-2--34254.

[4] J. Lucena, J. A. Leydens, J. Schneider, and S. Temple, *Engineering and Sustainable Community Development*. in Synthesis Lectures on Engineers, Technology, & Society. Cham: Springer Nature Switzerland, 2024. doi: 10.1007/978-3-031-48524-4.

[5] L. A. Nelson, "Making the Most of Site Visits," presented at the 2013 ASEE Annual Conference & Exposition, Jun. 2013, p. 23.884.1-23.884.14. Accessed: Dec. 29, 2024. [Online]. Available: https://peer.asee.org/making-the-most-of-site-visits

[6] C. B. Zoltowski, A. T. Cummings, and W. C. Oakes, "Immersive Community Engagement Experience," presented at the 2014 ASEE Annual Conference & Exposition, Jun. 2014, p. 24.689.1-24.689.11. Accessed: Dec. 29, 2024. [Online]. Available: https://peer.asee.org/immersive-community-engagement-experience

[7] M. C. Sanchez, D. A. Hazelwood, and D. K. Anand, "Engagement in Practice: Engineering for Social Change Course in Mechanical Engineering," presented at the 2018 ASEE Annual Conference & Exposition, Jun. 2018. Accessed: Dec. 29, 2024. [Online]. Available: https://peer.asee.org/engagement-in-practice-engineering-for-social-change-course-in-mechanical-engineering

[8] T. Zemach-Bersin, “Selling the World: Study Abroad Marketing and the Privatization of Global Citizenship,” in *The Handbook of Practice and Research in Study Abroad*, Routledge, 2009.
[9] A. Martinez, C. Epstein, and A. Parsad, “Evaluation of the National Science Foundation’s Partnerships for International Research and Education (PIRE) Program, Volume 2: Supplementary Materials. Final Report | Policy Commons”, Accessed: Jan. 03, 2025. [Online]. Available: https://policycommons.net/artifacts/14752717/evaluation-of-the-national-science-foundations-partnerships-for-international-research-and-education-pire-program-volume-2/15652693/
[10] “Localization | What We Do,” U.S. Agency for International Development. Accessed: Dec. 30, 2024. [Online]. Available: https://www.usaid.gov/localization
[11] G. Rist, *The History of Development from Western Origins to Global Faith*. London: Zed Books, 2004.
[12] D. Williams, *International Development and Global Politics: History, Theory and Practice*. London: Routledge, 2011. doi: 10.4324/9780203804414.
[13] A. Escobar, *Encountering Development: The Making and Unmaking of the Third World*. Princeton: Princeton University Press, 1995.
[14] W. Easterly, *The Tyranny of Experts: Economists, Dictators, and the Forgotten Rights of the Poor*. Basic Books, 2014.
[15] J. D. Henderson, *Modernization in Colombia: The Laureano Gomez Years, 1889-1965*. Gainsville, FL: University Press Of Florida, 2001.
[16] “Open Knowledge Repository.” Accessed: Dec. 30, 2024. [Online]. Available: https://openknowledge.worldbank.org/entities/publication/524a2f44-6e5c-5db7-b8a0-302375dd150a
[17] A. Escobar, *Sentipensar con la tierra: nuevas lecturas sobre desarrollo, territorio y diferencia*. Ediciones Unaula, 2014.
[18] A. G. Ochoa Duarte, “Las Ingenierías Comprometidas como factor transformador de la educación en Ingeniería para la transición hacia el Buen Vivir en Latinoamérica,” Trabajo de grado - Doctorado, Universidad Nacional de Colombia, 2024. Accessed: Jan. 03, 2025. [Online]. Available: https://repositorio.unal.edu.co/handle/unal/86138
[19] J. Smith, J. Lucena, A. Rivera, T. Phelan, K. Smits, and R. Bullock, “Developing Global Sociotechnical Competency Through Humanitarian Engineering: A Comparison of In-Person and Virtual International Project Experiences,” *Journal of International Engineering Education*, vol. 3, no. 1, Jan. 2021, doi: 10.23860/jiee.2021.03.01.05.
[20] J. A. Leydens and J. C. Lucena, *Engineering Justice: Transforming Engineering Education and Practice*. John Wiley & Sons, 2017.
[21] J. M. Smith and J. C. Lucena, “Socially Responsible Engineering,” in *The Routledge Handbook of the Philosophy of Engineering*, Routledge, 2020.
[22] J. C. Bridger and T. R. Alter, “Place, Community Development, and Social Capital,” *Community Development*, vol. 37, no. 1, pp. 5–18, Mar. 2006, doi: 10.1080/15575330609490151.
[23] J. Leydens and J. Lucena, “Listening as a missing dimension in humanitarian and sustainable community development efforts: The engineering curriculum as a potential learning inhibitor,” *IEEE Transactions on Professional Communication*, 2009.
[24] L. H. Silva, C. E. Velasquez, L. A. Becerra, and S. L. Hernández, “Social Innovation Route As A Methodology for the Construction of Socially Sustainable Innovations,” *Social*

Innovations Journal, vol. 9, Oct. 2021, Accessed: Jan. 03, 2025. [Online]. Available: https://socialinnovationsjournal.com/index.php/sij/article/view/870
[25] D. Ekbladh, *The Great American Mission: Modernization and the Construction of an American World Order*. Princeton University Press, 2009.
[26] D. Harrison, *The Sociology of Modernization and Development*. New York: Macmillan, 1988.
[27] E. A. Cech, "The (mis)framing of social justice: Why ideologies of depoliticization and meritocracy hinder engineers' ability to think about social injustices," in *Engineering education for social justice: Critical explorations and opportunities*, J. C. Lucena, Ed., Dordrecht; New York: Springer, 2013, pp. 67–84.
[28] G. L. Downey, "What is Engineering Studies For? Dominant Practices and Scalable Scholarship," *Engineering Studies*, vol. 1, no. 1, 2009.
[29] J. M. Smith, "Sociotechnical Integration and Critical Infrastructure Studies," *Engineering Studies*, vol. 16, no. 3, pp. 155–158, Sep. 2024, doi: 10.1080/19378629.2024.2405241.
[30] J. Pleasants, "Engineering for Whom? Investigating How Engineering Students Develop and Apply Technoskeptical Thinking," *Engineering Studies*, vol. 16, no. 3, pp. 159–183, Sep. 2024, doi: 10.1080/19378629.2024.2333242.
[31] C. Roby, "Humanities and Social Sciences in French Engineering Education: A Sociohistory of their Integration in an Apolitical Stance," *Engineering Studies*, vol. 16, no. 2, pp. 85–107, May 2024, doi: 10.1080/19378629.2024.2352351.
[32] C. Coons and M. Weber, *Paternalism: Theory and Practice*. Cambridge University Press, 2013.
[33] M. Barnett, "PATERNALISM AND GLOBAL GOVERNANCE," *Social Philosophy and Policy*, vol. 32, no. 1, pp. 216–243, Oct. 2015, doi: 10.1017/S026505251500014X.
[34] T. Wood, "Resisting and surviving the mainstream scientific model: Findings on social relevance and social impact in the tropics," *Management Learning*, vol. 48, no. 1, pp. 65–79, Feb. 2017, doi: 10.1177/1350507616659832.
[35] J. Lucena, S. Schlezak, E. Chapman, and M. Rojas, "Bringing it down from the ivory tower: Translating Engineering-for-Community-Development (ECD) graduate student research into community engagement and undergraduate student learning," presented at the 2022 ASEE Annual Conference & Exposition, Aug. 2022. Accessed: Jan. 31, 2023. [Online]. Available: https://peer.asee.org/bringing-it-down-from-the-ivory-tower-translating-engineering-for-community-development-ecd-graduate-student-research-into-community-engagement-and-undergraduate-student-learning
[36] A. Cuenca Hernández, *(Un)equal pathways to higher education. Social origins and destinations of Colombian graduates*. Münster ; New York: pedocs, 2021. Accessed: Jan. 04, 2025. [Online]. Available: http://nbn-resolving.de/urn:nbn:de:0111-pedocs-228073
[37] P. Martinsson, C. Villegas-Palacio, and C. Wollbrant, "Cooperation and social classes: evidence from Colombia," *Soc Choice Welf*, vol. 45, no. 4, pp. 829–848, Dec. 2015, doi: 10.1007/s00355-015-0886-3.
[38] A. A. Colak and J. Pearce, "Securing the global city?: an analysis of the 'Medellín Model' through participatory research," *Conflict, Security & Development*, vol. 15, no. 3, pp. 197–228, May 2015, doi: 10.1080/14678802.2015.1055136.
[39] Parque Científico de Innovación Social, Uniminuto and Humanitarian Engineering Program, Colorado School of Mines, "Ingeniería Humanitaria Colombia: Una mirada ecosistémica. Talleres de Mapeo," Bogota, Colombia, Dec. 2024.

[40] B. Hersoug, "'Logical Framework Analysis' in an Illogical World," *Forum for Development Studies*, vol. 23, no. 2, pp. 377–404, Jan. 1996, doi: 10.1080/08039410.1996.9666040.
[41] A. E. Slaton, *Reinforced Concrete and the Modernization of American Building, 1900-1930*. JHU Press, 2003.
[42] L. D. A. Williams, "The Race Audit: Mitigating Environmental Racism in Civil Infrastructure," in *Because Technology Discriminates: Anti-Racist Counter-Expertise*, L. D. A. Williams, Ed., Cham: Springer Nature Switzerland, 2023, pp. 99–125. doi: 10.1007/978-3-031-27868-6_5.
[43] "Home," Liberatory Infrastru. Accessed: Jan. 05, 2025. [Online]. Available: https://www.liberatoryinfrastructures.com
[44] "TESSI Institute (Colombia) | Creative Inquiry." Accessed: Jan. 05, 2025. [Online]. Available: https://creativeinquiry.lehigh.edu/outreach/tessi-institute-colombia
[45] "Ingenieria Responsable con el Entorno y la Sociedad (IRES)." Accessed: Jan. 05, 2025. [Online]. Available: https://people.smu.edu/nsfires/