Towards social, popular and local practices for technology development: an example of an engineering course developed in dialogue with residents of a rural encampment in Southeast Brazil

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Introduction

Engineering education in the American continent was founded in the late 18th century for military and/or colonial specific purposes and embedded in monarch and Christian values[1], based on the doctrine of discovery[2], and these relationships continue [1]. Engineering has a clear historical and political role, as engineers' work is intrinsically related to the power of the technologies they produce, and the structures that re-build the environment around us [2]. Still today, engineering is used as a vehicle for development and research and plays a key role in ensuring the growth and development of a country's economy [3]. Despite this reality, engineering education in North America largely fails to acknowledge the inherent politics of its development and ongoing practices.

Engineers are hired to do things such as develop automated systems that reduce the number of jobs, design and operate toxic waste facilities that are built in low-income neighbourhoods, and work to advance settler futures by relying in resources from Indigenous Lands [2]. Engineering has a clear capitalistic agenda focused on technology development and economic growth embedded in progress narratives, and engineering education still operates as if science is universal and by training students for the corporate workforce by teaching and motivating them to come up with new standardized global solutions that are ever cheaper or easier to manufacture.

The purpose of this WIP research paper is to promote Social Technology for liberatory engineering education as an alternative to the technological development practices in North American engineering education. Here, we highlight an example of engineering practice from South America that focuses on the social development of an oppressed group. Our goal is to contribute to the discussions in North America about these liberatory ways of doing engineering

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[1] The Engineering Polytechnic School of the Federal University of Rio de Janeiro (UFRJ) in Brazil was the first engineering school of the Americas. It was founded in 1792, when Brazil was Portugal's colony, as Royal Academy of Artillery, Fortification and Design. The main objective was to build fortifications to defend the colony. [14]
The United States Military Academy (USMA) was established in 1802 in West Point, New York, USA by President Thomas Jefferson. The objective was to train officers for the rapidly expanding army. [15]
King's college, now University of New Brunswick in Canada started offering engineering courses in 1854 [16]. The institution was founded in the context of the end of the American Revolutionary War in the 1780s when thousands of loyalists gathered in New York City to be transported to their new homes in Canada [17]. It was modeled on Tory and Anglican ideals of King's college, New York [18] so youth could have "virtuous education" in such things as "Religion, Literature, Loyalty, & good Morals..." [17].

[2] The doctrine of discovery is a belief of the idealized conquer model brought by the Christian Europeans to the American continent that generated a consciousness that presumes racial superiority of European Christian peoples and was and still is used to dehumanize, exploit and subjugate Indigenous Peoples and dispossess them of their lands [21].

– ones that center local, instead of global, issues to transform realities and worlds of marginalized populations.

In Canada, "Tech steward" terminology has recently gained prominence in engineering education, mainly through the Tech Stewardship Practice Program (TSPP), an online course in which more than 2000 engineering students have enrolled since 2021. The program references the terminology from the book *Digital Habitats: Stewarding Technology for Communities* [4] that defines "tech stewards" as community members who pay attention to and seek to influence the adaptation of a technology within their community, which implies that the tech stewardship role is for someone within a community working for community development. The TSPP should be a movement "to help evolve limited societal systems as opposed to accepting them as they are". However, despite the intentions of having a role that is more community centered, the program promotes technological stewardship as a set of principles and behaviors that enable technological design and development that is "beneficial for all" stakeholders and rightsholders as if there would be a global solution for all the interested parties, which is aligned with engineering education operating as if science can be universal. The reality is that if aligned with corporate dominant values, the same cannot be aligned with the values of grassroots local groups that are oppressed by them.

The tentative to create new terminology that would imply principles and behaviours but still supports and operates for the corporations that are fed from the extractive capitalist system is not enough. The engineering community must come into consciousness about the role they play perpetuating the power dynamics of capitalism so students can have the freedom to choose, consciously, if they want to remain on this path or choose a different one forward [2]. This is inspired by the first author's experience in South American engineering education and her participation as a student and researcher in the *Núcleo Interdisciplinar para o Desenvolvimento Social* – NIDES (Interdisciplinary Nucleus for Social Development) of the Federal University of Rio de Janeiro (UFRJ). The work of the professors, staff, students and partners from NIDES shows that engineering education can be liberatory and students could have the option to be educated to develop critical consciousness and to engage in reflections and actions that allow them to choose to work for oppressed groups, such as social movements, co-operative organizations, activist's groups, slums, Indigenous Nations and other socially-economically groups that are oppressed by the capitalist system.

We will share the example of technological development of a cassava flour mill in the Osvaldo de Oliveira Sustainable Development Project agrarian reform settlement to show another way of educating engineers focused on oppressed groups' needs. This settlement is part of the Social Movement of Landless Rural Workers (MST[3]), located in Córrego do Ouro, Macaé district/RJ in partnership with the *Laboratório Interdisciplinar de Tecnologia Social* – LITS (Interdisciplinary Lab of Social Technology), that is one of NIDES' partners, of UFRJ campus Macaé (UFRJ –

[3] The Landless Rural Workers' Social Movement is organized in 24 of the 26 Brazilian states, present in all five regions of the country. In total, there are around 450 thousand families who have acquired land through the struggle and organization of the rural workers. [22]

Macaé). We want to invite new imaginaries into a liberatory engineering education that promotes local and social technology development for oppressed groups of people.

“Beneficial for all”

Science is often seen as universal, as if it is the same all around the world. However, this thinking comes from the affirmation that human and nature are the same across planet Earth and science can only be developed towards progress as if time is the only variable that explains scientific development. [5] This reinforces the idea of a perfect Nature to be explored and that any barrier to dominate would be overcome with time and progress. This is aligned with a western way of knowing, thinking, doing and relating, that is different than other ways; for example, in Indigenous cultures and in the Global South.

The idea of technology that is “beneficial for all” is western-centric and aligned with mainstream design methodologies such as one-size-fits-all design, in which the ‘best’ design must be widely usable and account for different physical abilities, cultures, identities, etc. This ideology is reflected in engineering education when students, through approaches focused on industrial principles, are motivated to design solutions that will meet the needs of all interested parties. However, despite these good intentions, efficiency and profitability are typically the main conditions of what is “beneficial” in engineering education. The second part of the phrase, ‘for all,’ adds further complications. First, the implication is that ‘all’ is equated to humans. Since humans are different across the planet, interpretations of the world change from place to place, which is reflected in how people develop their own technological tools. Second, the implicit conception of ‘for all’ discounts all living beings, including the land, waters, plants, trees, animals, birds, insects…etc. This too, is a western-centric notion of who ‘all’ encompasses, perpetuating the hierarchical relationship of humans to Nature.

The concept of technology

According to the definition *logos of tékne* [6], technology is the way humans interpret the world around them into the form of technique, art or craft. Interpretation is explaining, reframing, or showing your own understanding of something. First, the person must understand the thing and then have an explanation of it, which is a communication process. Thus, technology is an outcome of human communication with the world around them. Technology is one expression of human’s many layers of intimate and interconnected relationships with each other and the environment around them.

So, it is important that engineering students understand the local social realities of the groups that will be using that technology but also consider the existing relationships of these groups with their environment: the Land[4] they are part of.

Social Technology

[4] The word Land is capitalized because it carries the philosophy that earth and humanity are just one, humans are Land. [19] The Land, capitalized, also includes all elements of the environment as well, for example, lands, waters, air, plants, animals, birds, insects... “all” living beings.

The widespread concept of efficiency is linked to conventional (a.k.a. capitalist) technology (CT), which is characterized by the fact that it is segmented. That is, workers are not involved in the entire process; it reduces human labor as much as possible; it is based on synthetic (waste) production factors and is therefore ecologically unsustainable; and it has ever-increasing production volumes [7].

Social Technology (ST) methodology opposes the notion that technology is neutral and can enable different paths than the hegemonic conventional one for technological development. ST is adapted to small scale, non-hierarchical, self-managed organizations [7]. The technology development process is participatory from conceptualization to practice focused on local autonomy, since the tools will belong to the users, and the users will be responsible for operating and repairing them in the future.

Social technology experience in South American Engineering Education

Osvaldo de Oliveira Sustainable Development Project (PDS Osvaldo de Oliveira) is an agrarian reform settlement in Rio de Janeiro state in southeast Brazil. The area is 1.650 hectares and is occupied by approximately 60 families [8]. This settlement is in the sustainable development modality[5] (PDS) so, by the law, its habitants must follow principles such as: forest protection, agroecological production, and collective land appropriation. Since its formation in 2014, the community has collectively produced foods as sources of sufficiency and income such as: cassava, beans, banana, corn, pumpkin, watermelon, okra, passion fruit, sweet potato, yam, pepper, chives, sugar cane, lemon, papaya, among others.

The partnership with the Federal University of Rio de Janeiro campus in Macaé city in the state of Rio de Janeiro (UFRJ – Macaé) began with two main motivators. First, in 2018, residents from the PDF Osvaldo de Oliveira settlement attended a sharing circle about social technology in UFRJ – Macaé. This event enabled relationship-building with community members and students and professors from engineering departments. Second, some researchers and professors had existing relationships with some of the residents through previous projects. From these relationships, the course *Aprendizagem por Projetos*, Learning through Projects, was created.

This new course was developed to go deep into community members' real life praxis and generate social transformation. It relied on collective participation of professors, students and community members in the process of building solutions that combined popular knowing from the local context with technological scientific knowing from the university [9]. For that, the syllabus was built throughout the course process in dialogue with community members and grounded in their real local issues. It was offered for the first time in 2018. Rolim Larichia et al [8] describe the experiences from the first three sessions in this book chapter (2018.1, 2019.1 and 2019.2).

The students were prepped for this course before visiting the community. This preparation grounded the students, since, in the group, there were some students who had never been

[5] Alternative settlement modality created for environmental protected areas by the National Institute of Colonization and Agrarian Reform (INCRA).

exposed to concepts such as social movement or agrarian reform. The first (2018.1) and third (2019.2) sessions started students off by reading texts designated by the professors about social technology [10] [7] and popular education[6] [11], which was followed by a discussion circle class. Social technology was used as a starting point in this experience, allowing for the discussion of the differences between conventional and social technologies, and the myths of universal solutions and science and technology neutrality to evolve [8]. Students learned that a purely technical solution to a problem does not exist, since technical problems are not separated from social problems. Through the semester, students were exposed to lived experiences demonstrating that technological decisions are connected to social and political consequences. This set a theoretical grounding point so the students could understand the methodologies that the professors used to guide the subsequent classes.

The second session of the course (2019.1) started by doing a group dynamic called *Mate com prosa* (yerba mate tea with prose) from *the Notebook of Methodologies: Inspirations and experimentations in the construction of the agroecological knowing*, published by the Brazilian Agroecological Association [12]. This dynamic consisted in making four stations. Each one had a host student, a food preparation from cassava (flour with molasses, flour with coffee, tapioca biscuit and cassava cake), and a question so the students could engage in debates to answer questions posed by the professors and build a collective knowing. The questions were: Do you think that technology is sexist, racist and classist? How was land distributed in Brazil? Does the food you eat respect life? Do you think that universities allow the exchange of knowledge with society? [8] From these interactions, the students were able to place themselves in the discussion by bringing in their past perspectives, experiences, and knowing. The students' ideas, questions, uncertainties and wishes contributed to the syllabus creation and made them participants in and protagonists of their own education.

After the preparation, the course followed a problem-based learning methodology that allowed students to be protagonists of their own knowing inspired by their curiosity. The students visited PDS Osvaldo de Oliveira, which, as many other agrarian reform settlements, has a precarious infrastructure[7]. [8] At the first visit in 2018.1, the group of students and professors heard the residents' local demands so they could collectively develop a learning proposal from a real social problem [8]. From the conversations, they understood that the settlement production was difficult to move and sell in the city due to poor access infrastructure. The residents' needed to expand their cassava's durability by turning it into flour. This way, they could sell more of their production and have more income so they would purchase more diverse food to consume. [13].

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[6] Popular education is methodology developed by the Brazilian philosopher Paulo Freire. Its main purpose is equality of opportunity and freedom for everyone through social transformation [8]. Its epistemology is based on dialogue, love, conscientization and transformation of the reality and the world of concrete reality to create a collective construction of knowing [20].

[7] Residents lived in camps made from wood and tarp, with no electricity or running water. The kitchen had a woodstove, and the bathroom was a septic tank toilet. The settlement used to have a road access, but the bridge collapsed and has been replaced with a pedestrian bridge, which increased their transportation barriers. [8] [13]

The group collectively decided to build a *casa de farinha*[8] (flour mill) according to all the parties' capacity [8].

From there, the students did research on the necessary machinery keeping in dialogue with the residents. Class locations varied from happening at the university and at the settlement. The first design was developed from a flour mill offered by Macaé City to be powered by the pedals on an attached bike [13]. From there, the residents understood that they needed to make this process more automated so they would increase their production capacity. The next step for the students was to dimension a photovoltaic energy system attached to an electric machine. Later, this needed more improvements which came to be identified through the residents' use of their own technology. This way, the students were able to integrate their learning from school into real social problems to assist an oppressed group of people according to the community's own needs and capacity.

Conclusion

This paper is part of a bigger dream to invite new imaginaries into engineering education, so we can build practices that center local issues that will transform realities and worlds of marginalized groups of people through engineering practice. It is possible to educate engineers that can understand local and social issues and act in partnership and in dialogue with oppressed groups. We invite North American engineering education to overcome the idea that one solution will be "beneficial for all" and to learn about South American practices of educating engineers to work for marginalized communities for communities' own social transformation.

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[8] "A flour mill is a structure where cassava is processed into flour. The production process is organized in the following order: crushing the cassava, pressing the crushed mass, toasting the pressed mass and packaging the flour ready for consumption. The main machinery includes the cassava grater, a press to extract the liquid and a pan oven to dry the mass." Translated from [13].

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