From Empowerment to Emancipation – A Framework for Empowering Sociotechnical Interventions

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Engaged engineers intend to transform society by working with people at a structural disadvantage or with vulnerability. However, how to overcome vulnerability or achieve a radical transformation has commonly passed unthematized. In this paper, we provide an eight-dimension framework to enhance the potentially transformative effects of sociotechnical projects based on the concept of empowerment. In the first section, we screen five journals in the engaged engineering and service-learning field to conclude that most authors use the idea of empowerment without defining its meaning. We then shed light on the concept, debating some of its essential features and misinterpretations. In the third section, we argue why a framework of empowering dimensions may be helpful to people engaged in transformative sociotechnical projects. The framework is presented in the fourth section. The eight dimensions, ranging from sociotechnical inclusion to political emancipation, are illustrated and explained with actual engineering projects. In section five, we state that empowerment is a necessary but not sufficient condition for emancipation. Empowerment for emancipation must not only include a proper articulation of all the framework's mentioned aspects (density) but is also a result of carrying out the intervention with care and critical sense (quality). Section six compares the interventions practiced by Brazilian Enactus and popular engineering initiatives in the light of density, quality, and their empowering impacts. The

conclusion summarizes the article's central arguments and sketches two issues in this field that call for further research.

Key Words:

Empowerment; Emancipation; Engaged engineering; Community engagement; Sociotechnical intervention frameworks.

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INTRODUCTION

We call engaged sociotechnical intervention (EI) every project aimed to transform society through the practice of a technical intervention or assistance, distancing itself from mainstream ideologies that naturalize vulnerabilities and structures of injustices. How this transformation looks like is open, and there is a wide variation in the approaches hereto (Smith, Tran, Compston, 2019; Kleba, 2017). Those engaged approaches oppose (profoundly or slightly) the dominant concept of development that follows a Western ideal type, is environmentally harmful, politically disempowering, and based on a biased or restricted form of science and technology at the service of capitalism, neocolonialism, authoritarianism, and the military-industrial complex.

There are uncountable examples of such engaged interventions, from Brazilian Popular Engineering (Cruz, 2021) and originally Scandinavian Participatory Design (Robertson and Simonsen, 2013) to Enactus (Ungari, 2021), Techo (Melo et al., 2021), Value Sensitive Design (Davis and Nathan, 2015), and Terceira Margem (Guizzo, 2021). All of them usually acknowledge some degree of technology non-neutrality, technology's role in shaping society, and, conversely, society's role in shaping technology and technical intervention (Alver, Cruz, and Kleba, 2021a; 2021b). That is why, strictly speaking, most of these interventions understand themselves in disaccord to the naïve or deceiving mainstream view of community interventions detached from the social, political, and cultural dimensions, constructing a solution that is given top-down, from experts or technocrats to society, and designed based on purely technical aspects.

So, when we speak about EI, the “engaged” here refers to the way these initiatives see and define themselves as seeking social change. In other words, we depart from their self-comprehension, however different this social change might be. So, the authors refrain from judging whether those approaches deserve to be called engaged or transformative, encouraging the richness of having multiple perspectives on this field. This is a critical remark to prevent the misunderstanding that this paper stands for a one-size-fits-all or one best form of EI or that every EI practice, when honestly reflecting on itself, must agree on how community empowerment should be achieved. Plus, as ideologically distant as they may be, EI approaches can learn from each other.

The EI transformative potential increases as much as it can integrate all (eight) proposed dimensions of empowering communities (density) and as much care and critical sense (quality) the interventions manage to achieve in each of these dimensions. The less sociotechnical interventions are able to advance in those two fields, the closer it is to scratching only the surface of effective social change. However, as we will see, there are many ways to advance in such dimensions, and still various questions about further dimensions to be considered and how best to evaluate density.

Although this paper's primary focus is on EI from the engineering realm, that is, engaged engineering (EE) (Kleba 2017), EI encompasses every technical discipline (such as architecture and design). Plus, since our analysis here refers to broad aspects of the technical design process, which does not vary significantly across the technical disciplines (Van de Poel, 2009), the discussion developed in this paper applies to EI as a whole, not just to engaged engineering.

Particularly in engineering interventions engaged in social transformation, there has been great concern about the right way of addressing community projects to avoid a top-down, technocratic approach. However, a broader framework to help evaluate and enhance the reach of sociotechnical

community interventions is lacking. This paper proposes such a framework providing a list of critical dimensions of empowering community interventions and reflecting on how empowerment relates to emancipation.

The paper's first section provides evidence for our hypothesis that, despite many publications in journals related to EE refer to empowerment, they generally do it intuitively, without the necessary conceptual foundation. Defining empowerment and some of the concept's features and misunderstandings is undertaken in the second section. The third section follows to discuss why the proposed framework may be helpful to rethink engineering and sociotechnical practices in general.

The fourth section presents our framework with the key empowering dimensions in sociotechnical projects, going from sociotechnical inclusion and cultured-centered design to socio-economic and political emancipation. We then discuss how we understand this framework and illustrate the dimensions with real cases of sociotechnical projects. In the fifth section, we draw on the relationship between empowerment and emancipation, making explicit the risk of disempowering processes. Although empowerment is not synonymous with emancipation, it is then argued that it constitutes a necessary condition to achieve the latter.

The sixth section tests the robustness of our framework in providing analytical insights by applying it to two EE approaches: Enactus and popular engineering. Finally, in the conclusion we summarize the work's fundamental assumptions and findings and address research themes related to the investigation field.

THE UNREFLECTED IDEA OF EMPOWERMENT IN ENGAGED ENGINEERING

We took a closer look into some journals specialized in EE, asking how often the concept of empowerment comes up and in which contexts.¹ There is a lack of reflection or explicit foundation on what empowerment is, or could be, in most articles, with few remarkable exceptions. At the same time, many articles depict issues closely related to the concept of empowerment, showing that there is at least an intuitive stance of what it might mean in practice.

For instance, let us take the case of the IJSLE (*International Journal for Service Learning in Engineering, Humanitarian Engineering and Social Entrepreneurship*), which is published semi-annually since the spring of 2006.² Searching on the journal's website, we found 27 articles, but none of them provided a specific definition of the concept. Most of them intuitively refer to it, and

¹ The five elected journals are a non-exhaustive sample of representative journals in the fields of engaged & service learning engineering, publishing in English, Spanish, and/or Portuguese. In this survey, undertaken in September 2020, we sought for the word "empowerment" or its translations "empoderamento" (Portuguese) and "empoderamiento" (Spanish) in the journals' websites. When the word was found (in the articles' titles, keywords, or abstract), we analyzed the respective manuscript, searching for how the concept (empowerment) was (or was not) defined or presented. Unfortunately, in some journals, the available search engine allowed us to search titles or keywords, but not abstracts. In these cases, we tried to overcome that by supplementing such limited investigation with a Google Scholar search.

² <https://ojs.library.queensu.ca/index.php/ijsle>

some only marginally (only four mentions were found in the abstracts). The concept is often associated with women's or gender empowerment, economic empowerment, or student empowerment.

However, a clear distinction is provided by some articles that work out very relevant aspects to empowering communities or specific local stakeholders (artisans, leaders, vendors, etc.). Notably, Walla Walla University chapter of the Engineers Without Borders (EWB)-USA (EWB-WWU), working in off-grid solar electrification in rural Peru, has developed an approach to system and labor sourcing aiming at “*empowering communities with the necessary logistical framework, connections, knowledge and confidence to maintain, expand and replicate any projects we work on together*” (Jensen, Hopps and Roth 2019, pp. 77-78). That is also the case for Riley and Bloomgarden (2006). They, rejecting “*the “expert” model of learning relationships that operate both in the classroom and in the community,*” invite to consider the connections between development engineering, appropriate technology, and ‘liberative pedagogy,’ last inspired in the Brazilian educator Paulo Freire. Further, many articles raise issues closely related to empowering investigative tools, such as using effective community listening (Aslam and Pearson-Beck, 2013).

In the *Journal of Humanitarian Engineering* (JHE), established in 2012, we have a similar pattern.³ Many articles give a central role to concepts related to empowerment, such as ‘community engagement,’ ‘community participation’ (Mazzurco and Jesiek, 2017), or ‘community-driven engineering innovation’ (Eseonu and Cortes, 2018). However, all articles only look at particular dimensions of empowerment, leaving out the broader map.

Nothing different is found in two other journals, in which, when “empowerment” (or its Brazilian or Spanish translations) appears and is used in some paper, it is never defined: the Argentinian based *Revista CTS*,⁴ an Ibero-American journal established in 2003 that focuses on STS (Science and Technology Studies) discussions from a theoretical or theoretical-practical standpoint; and the *International Journal of Engineering, Social Justice, and Peace* (IJESJP)⁵ established in 2012.

On the other hand, in the sixth analyzed journal, the Brazilian *Revista Tecnologia e Sociedade* (RTS),⁶ established in 2005 with a focus on STS theoretical and theoretical-practical discussions, from the 37 papers that mention “empowerment,” “empoderamento” or “empoderamiento,” just two refer to single elements of the concept, as building a “critical view of social reality”⁷ or as

³ In this journal website, a systematic search is available just for the titles or key words. So, we do not have the total number of articles referring to empowerment, but we were able to find a representative sample with other search tools. <https://jhe.ewb.org.au/index.php/jhe>

⁴ <http://www.revistacts.net/>

⁵ <https://ojs.library.queensu.ca/index.php/IJESJP>

⁶ <https://periodicos.utfpr.edu.br/rts>

⁷ Fernandes, c. de s.; Carniello, M. F. (2017) Análise estrutural do município de Mineiros/GO para implantação da Cidade Digital. R. Tecnol. Soc., Curitiba, v. 13, n. 28, p. 132-151, mai./jun., p. 142.

related to changes in awareness, autonomy, and identities. Moreover, only one defines the term properly.⁸

WHAT IS EMPOWERMENT?

The concept of empowerment has been used in many fields of knowledge, such as community psychology, health sciences, women studies, management, and political sciences, with different connotations (Hur, 2006). However, a classical definition of it is the “*multi-dimensional social process that helps people gain control over their own lives*” by fostering power in people to operate the changes they may want “*in their own lives, their communities, and in their society*” (Page and Czuba, 1999).

Thus, empowerment is multi-dimensional as, in order to be advanced, it must encompass different layers or aspects like the technological, sociological, psychological, and political ones (Hur, 2006; Page and Czuba, 1999).

Further, empowerment involves both a process and its outcome(s) and is a social, relational process. This way, it must be achieved at two different levels simultaneously: individually, empowerment includes issues such as meaning (cognition, critical consciousness, values, and behavior), self-determination, the capacity of making a difference in society, and other competencies (skills and abilities) and knowledge; collectively, empowerment is related to belonging, social involvement, active participation in the community decisions and initiatives, and community building (adapted from Hur, 2006).

As a result, it is a mistake to see empowerment as just “gaining control over one’s own life” in an individualistic way. Paulo Freire was very concerned about this interpretation in the USA due to the spread of ideas emphasizing only individual students’ agency, motivation, and liberties towards (individual) self-realization (Freire and Shor, 1987). Indeed, empowerment empty of its relational substance leads to maintaining the status quo, for structurally changing or improving reality can only be achieved collectively. This way, such individualistic empowerment turns out to be disempowering given that it limits what can be done or sought.

At the same time, Freire argues that “if individual empowerment ... is not enough ..., [it is] absolutely necessary for the social transformation process” (Freire and Shor, 1987, p.71). Empowering students and citizens enable the development of critical, creative, and autonomous thinking, setting the foundation for empowering communities.

Either way, empowerment is never given but developed or fought for from within and along with others. Freire says that “we do not educate people, people educate themselves” (2005a). In the same line, it is essential to grasp that “*while we cannot give people power [or] make them “empowered,” we can provide the opportunities, resources and support that they need to become involved themselves*” (Page and Czuba, 1999, p.4) and, as a result, potentially advance their empowerment.

⁸ Vilarinho, L., Lopes, W., and Monteiro, M. (2018) Desenvolvimento e capital social no agronegócio do Cerrado do Piauí, Brasil. *R. Tecnol. Soc.*, 14, 30, p. 30-46.

That is why engaged engineering interventions can be empowering if they manage to provide such opportunities, resources, and imagination.

So, empowerment is a robust criterion for conceiving sociotechnical approaches aiming at changes that enable people to overcome deprivation, oppression, structural violence, and negative aspects of life in general. Moreover, the concept is closely related to fostering citizenship and social justice and creating spaces for participatory democracy, autonomy, cooperation, care, and influencing policy through civil society organizations (Kleba and Wendhausen, 2009, p.736).

As such, this definition does not stand for any particular worldview, identity, or arrangement of power to be enforced universally. On the contrary, in dialogue with the decolonial literature (Estermann, 2014; Maldonado-Torres, 2009; Quijano, 1999), empowerment relates to: 1) individual and collective cognitive, psychological, political, and technical skills in addition to knowledge; and 2) material and immaterial instruments and means that can amplify or render possible individual or collective action (say, crack a nut, make live group chat, organize a social movement or positively change one's living space and working conditions). Thus, an empowered individual or group is the one who can navigate their social and natural environment, recognize its potentials and limits, and transform it in dialogue with the needs and desires of everyone (human and non-human) deemed worth participating in this process.

EMPOWERMENT IN SOCIOTECHNICAL INTERVENTIONS

Engaged engineers have put a lot of effort into thinking of ways to empower students academically, raising their awareness, sociopolitical commitments, capacities, and skills. This effort also encompasses changing how faculty do research, teaching, and extension/service-learning and build a favorable institutional setting, including recognizing and valuing engaged activities, creating curricular and extra-curricular opportunities, access to funds, and fostering interdisciplinary collaborative teams (Kleba and Cruz, 2020).

However, when we think about integrating the aim of effecting structural or lasting changes in society with our projects, we must think of empowerment in a broader sense.

After working with sociotechnical interventions in theory and practice for many years, we have grown disquiet about the gap between what we would like to achieve and what is possible to realize in real-life contexts. Recognizing that many community needs and desires relate to broader issues such as the political and economic order, how could our engaged projects contribute to these communities to move forward? At the same time, we observed that engaged engineering approaches are usually unaware of the richness and complexities around the concept of empowerment. Many EE approaches are good at tackling some dimensions of empowerment, leaving others unaccounted for.

We think that the issues we discuss in this paper are useful to engaged engineers in at least two ways. First, if engaged engineers want to transform social realities of injustices and vulnerabilities, debating the conditions and aspects of that transformation is essential. So, the eight dimensions of empowerment proposed below help acknowledge different elements that must be addressed in order to properly put our ideas of effecting structural change into practice. Second, the proposed

dimensions allow us to seek and identify better practices concerning investigation, design, and the ethical-political aspects in interventions. This way, they facilitate identifying the essentials of good practices, what might be lacking, what is unacceptable, and which dimensions we need to learn more about.

Before presenting the dimensions, though, it is necessary to remark on the two strains of empowerment of our particular concern here. One is about people at a structural disadvantage. The other focuses on engaged citizens and social movements.

People in structural disadvantage are those with unfavorable conditions due to, among other possibilities, class, race, color, gender, political or ethnic affiliation, disability, and/or poverty. They are structurally disadvantaged due to asymmetries of power, privilege, and injustices. They are our primary concern when we think about social justice and inequalities in society. They lack resources and opportunities compared to those who do not face the same oppressing conditions, i.e., privileged people. For the former, empowerment means being able to engage in social transformation with an active agency.

Engaged citizens and social movements also need to expand their capabilities of collective and individual action. They (such as the Brazilian Landless Rural Workers Movement) usually include some of those people in structural disadvantage (e.g., landless rural workers) alongside privileged people (e.g., university professors and liberal workers) committed to political demands for social transformation (for instance, popular/grassroots agrarian reform, agroecology, and solidarity economy). Empowering these citizens and social movements means that more social actors can mobilize against what they conceive as flaws and injustices of markets, governments, and other institutions towards fostering their ideal of social justice through policies, laws, and/or rights. Regulatory frameworks and political environments may play a central role in enhancing or hindering the aimed social change of any community project and working partnership.

For some types of EE like popular engineering, dealing with structural disadvantage necessarily means working side by side with social movements as a political ally⁹ and structurally transforming the political-economic and legal reality. For others, such as Enactus, the focus relies on groups with vulnerabilities (concerning, say, the capitalist ideal of wellbeing and happiness), as capitalism itself is not to blame or be overcome but rather to be improved or corrected. Thus, although popular engineering and Enactus can be distinguished according to their intervention's density, both are examples of what we defined as engaged engineering.

In this paper, we decided to focus on empowering the local actors that EE initiatives have as their central focus. We call them “communities,” even when such actors do not necessarily live in the same space but share a structural disadvantage (e.g., women offering and needing a service of

⁹ Being a political ally seems to represent here both the commitment to fight for the structural change(s) sought and to co-construct the present reality's diagnosis and the possible political and sociotechnical alternatives to it. That understanding tries to acknowledge each participating actor's place (with their knowledge, possibilities, and experience) and importance for the transformation aimed, and, at the same time, prevent hierarchies of any type and origin (patriarchal, colonialist, racist, classist, etc.) from happening (say, by unwittingly assuring engineers the place of technical sage).

domestic repair) or are members of the same social movement (e.g., feminists and black power movement activists).

DIMENSIONS OF EMPOWERMENT IN COMMUNITY INTERVENTIONS

At least eight dimensions of empowerment can be identified in sociotechnical community interventions. They can be sketched as:

- a) Fostering sociotechnical inclusion, i.e., assuring fundamental conditions that depend on technological development and dissemination for a (more) dignified human existence. For example, the community has no drinkable water or energy, and the intervention addresses those needs.
- b) Valuing cultural difference, i.e., acknowledging and supporting plural ways of life (from the Yanomami indigenous people in the Amazon to the Chinese Mosuo communities ruled by women) and actively transforming the design process to incorporate them and thus promote them also through appropriate sociotechnical solutions. Awareness of cultural richness is a pre-condition for the construction of other possible worlds. The intervention process shall endeavor to deeply understand, respect, and integrate the local culture (worldviews, traditions, knowledge, etc.). What is unique in the local culture must be considered in all eight dimensions here exposed. Culture also encompasses how particular communities relate to their natural and social environment and their territories.
- c) Nurturing qualitative relationships, i.e., strengthening the relational basis for structural change, building trust and mutual respect, caring for each other, establishing affective bounds. Interventions shall avoid the adverse effects of power asymmetries by seeking equity throughout the design process with appropriate language and methods to assure horizontal relationships. This embraces all the persons and partnerships involved in the project.
- d) Sharing technical competencies, i.e., sharing and training technical knowledge that can make the group autonomous or at least less dependent on technical support from others. Technical appropriation and project sustainability must be assured by training local competencies and capabilities (Jensen, Hopps and Roth 2019).
- e) Practicing investigative competences, i.e., sharing and training knowledge, skills, and competences related to the construction of knowledge and self-organization. The project's ends and the design process shall be co-proposed and co-constructed by the communities or social groups from the very beginning, fostering sociotechnical self-determination. This encompasses shared investigation, co-construction, action-research, critical thought, 'listening' (Aslam and Pearson-Beck, 2013), among other participatory tools and methodologies of collective work.
- f) Promoting social and economic emancipation. That begins with allowing/encouraging the community to identify its social and economic issues, addressing them according to its talents, needs, and desires. Broader community aims shall be integrated into the sociotechnical project, creating opportunities for income generation, education, and health, among others.

- g) Cultivating political emancipation by allowing/encouraging the community to advance its political potentialities and build alliances with other actors that enlarge its potential to make the changes it wants for society and itself to happen. Communities and individuals can only be empowered by integrating into the project links to socio-political dimensions. Political empowerment encompasses identifying strengths, fostering leadership and self-organization capabilities, and relating identified needs and desires with the dynamics of public policies, rights, and political participation. This dimension also includes, among other issues, critical thinking, identities and gender, structural injustices, inequalities, peacebuilding, political ecology, and rights to territories.
- h) Growing environmental awareness, i.e., supporting the group's commitment or promoting a responsibility concerning at least one of these three issues: i) maintaining human (and non-human) life on Earth in this Anthropocenic era we live in; ii) overcoming human blindness concerning our relational nature and the mutual dependence we have with the other human and non-human beings; iii) acknowledging non-human beings as entities capable of desires, intentions, communication, and agency (as in the Yanomami worldview (Kopenawa and Bruce, 2015)), admitting their "human-like dignity or status" and assuring them "seat and say" throughout the entire design process. At any rate, environmental awareness points towards environmentally sound technologies capable of protecting the environment, reducing pollution and waste, and using resources more sustainably.¹⁰

This eight-dimensional framework does not intend to be exhaustive. Readers are welcome to expand it and make it clearer. Either way, it is supposed to be seen as a kick-off checklist to evaluate how robust are the interventions we and others put into practice.

All dimensions are somehow intertwined. Our fundamental assumption is that the more profound they are integrated into sociotechnical projects, and the more appropriately worked out, the higher is the project density and quality as well as its potential empowering effects.

Most engaged interventions usually focus on **sociotechnical inclusion** (a), which is the main interest of the journals specialized in EE in general. However, many of these projects have been increasingly recognizing the relevance of other empowering dimensions in practice.

A blueprint for **sociotechnical inclusion**, with particular concern with empowering the partner communities by training **technical competencies** (d), is given by the Village Empowerment project of the University of Massachusetts Lowell (UML) in rural Peru. The project emphasizes that:

There is a danger in the apparent popularity in students participating in service projects in developing countries involving "one-shot" designs and installations in which there is no sustained involvement for training, maintenance, and replacement. Such systems typically

¹⁰ Ecological concerns challenge capitalism. They demand zero waste, the reduction of material consumption (whereas capitalism must expand it continually),; require tackling climate change and cost externalizing,; and oppose the extensive industrial and technological systems, such as agribusiness, large dams (and the catastrophes they produce), the non-renewable oil industry. In the view of indigenous peoples, the Western capitalist model is building a dystopian world, increasing systemic vulnerabilities in multiple ways, from burning forests to global water scarcity. Environmentally sound technologies must have all this in mind (and more) when designing processes and products.

fail sooner or later and can result in local people concluding that “solar does not work.” (Duffy, 2008, p.13)

In 2008, Village Empowerment was returning twice a year for more than ten years to continue working in a series of partner villages. Most villages had no grid electricity, no communication system (or just one phone per village), no water purification, and some relied on water from rivers that had to be hand-carried to houses and clinics. In the program, students and faculty worked together with local people to design and install over 80 systems in 44 villages and towns, involving renewable energy systems, health care, education, and communication.

As the example of UML’s Village Empowerment shows, advancing sociotechnical inclusion and training technical competencies are *necessary conditions* to promote local development opportunities towards **social and economic emancipation** (f). The lights, radios, vaccine refrigerators, laptop computers, irrigation, and purified water supply systems have helped increase productivity, deliver better health care and education, and even helped save lives. Besides these community-driven projects, Village Empowerment also helped individuals implement small business development, e.g., aquaculture systems (Duffy, 2008).

A mainstream way of thinking **sociotechnical inclusion** is stating that disconnected people now have access to the digital world, and that is all. By contrast, an empowering and in-depth sociotechnical inclusion is provided by initiatives such as Alter Mundi (Prato; Weckesser; Segura, 2021) and Portal sem Porteiras¹¹ (PSP - Portal without Gates) working with community communication networks. They show ways to undertake counter-mainstream technical inclusion by building community self-determination, making independent hardware, and critically using internet tools.

The **cultural difference** (b) is related to the general issues of decolonialism and the dialogue of knowledge systems (Kleba; Reina-Rozo, 2021). It must be considered across all eight dimensions of empowerment. Among the interventions especially concerned with this dimension is the Colombian technical assistance to a group of traditional embroiderers called *caladoras*. This initiative supported a dialogue of knowledge powerful enough to: 1) widen the engineers’ and *caladoras*’ labor practice alike; and 2) show that the idea the technical team had for the intervention at the outset (automating the embroiderers’ labor) was not what the group wanted. Among other things, for the women involved, embroidering is more than just work (Rivera et al. 2016; Pérez-Bustos 2017; Pérez-Bustos and Márquez 2016). Integrating dialogue of knowledge into the sociotechnical project leads to asking how mutually beneficial knowledge-sharing can be built up, enlarging both the technical team’s and the community’s capacity to know from different perspectives and sociotechnically transform reality.

Thus, **cultural difference** aims are the opposite of what Santos (2016) calls epistemicide, demanding some realization of dimensions ‘c,’ ‘d,’ and ‘e’ of empowerment: **qualitative relationship, technical competencies, and investigative competencies**. The more different from ‘ours’ the community’s culture is, the more challenging it is to attempt a sound cultural difference. In this regard, engineers working on peace projects in Colombia have integrated the local and traditional knowledge and considerations about how locals see reality differently than

¹¹ <https://portalsemporteiras.github.io/#psp>

academicians do in their projects (so-called epistemological and ontological inclusion) (Kleba, Reina-Rozo, 2021).

A milestone in **investigative competences** (e) is provided by the Scandinavian participatory design in engineering, which arises in the 1970s (Robertson and Simonsen, 2013). Originally associated with the process of informatization of workplaces in the by then heavily unionized Scandinavia, the participatory design approach expanded into different social realms, technical disciplines, and continents, being currently practiced in both a market strand and in the original emancipatory one (Robertson and Simonsen, 2013). Its participatory methodologies articulate activities of telling, making and enacting, through which the assessment of the local reality (locals' demands, pieces of knowledge, values, worldviews, and the like), the investigation of possible solutions, and the anticipation of such solutions' (unexpected) side-effects are carried out collaboratively by the technical team (designers) and the local actors (individuals and groups) (co-designers) (Brandt et al., 2013).

Investigative competences are closely related to concerns of **qualitative relationship** (c). Great effort is made to avoid an academic or technicist language that is strange to the assisted group, as well as to cultivate care, affection, and trust. So, adverse effects of intellectual or technical hierarchies can be avoided (Wallerstein, Muhammad, Sanchez-Youngman, et al., 2019), and the relational basis (as the efficient cause) for both co-designing and bringing about the change sought with the co-designed sociotechnical solution is strengthened. Therefore, qualitative relationship is essential to reach not only the best possible intervention results but also, and as a condition for that, to properly practice and share investigative competences.

An excellent example of bringing together **sociotechnical inclusion** (a), **qualitative relationships** (c), **investigative competencies** (e), and **political emancipation** (g) is delivered by the non-profit organization Techo. Techo has been working in 18 Latin American countries with vulnerable settlements (lacking infrastructure and unsafe houses), applying various creative tools to strengthening community capacities for self-organization (Melo et al., 2021). Techo's working table is a brilliant tool to learn to share ideas and knowledge and to plan together.

Concerning **environmental awareness** (h), some examples of engaged interventions (EI) are: working alongside cooperatives of waste pickers (Pereira; Goes 2016) and developing ecological sanitation (Chaves et al. 2020) – which illustrates the sought to maintain human and non-human life on Earth; supporting grassroots' agroecological initiatives (Wezel et al. 2009) – based on the acknowledgment of our relationality and on supporting harmonization among human and non-human beings; and developing architecture design acknowledging the other beings present to the territory and seeking to incorporate their needs and points of view into the design process (Guizzo 2021).

EMPOWERMENT AND EMANCIPATION

Any improvement an EE project may produce in the quality of life through **sociotechnical inclusion** of people in need (dimension' a') has great relevance in social justice and equity. Technical inclusion allows enhancing the agency of individuals and communities. For example, having access to energy or digital inclusion for the first time opens possibilities to income

generation and educational opportunities. Moreover, with social inclusion, people may get the time and motivation to engage in other dimensions of social life, such as community building and political organization. So, **sociotechnical inclusion** provides some of the *necessary conditions* for moving forward towards emancipation.

However, meeting only some improvement in the quality of life ('a'), without integrating the other dimensions of empowerment, leads to disempowering people, reinforcing top-down technocratic approaches, power asymmetries, and colonialism. So, engaged engineering projects with the best intentions may fail to address the key factors which help oppressed individuals or groups to empower themselves. Disempowering may work on many levels. For example, "*political discourses that present 'social entrepreneurship' as a replacement for publicly funded services and as a 'solution' for budget cuts*" represent a disempowering process (Avelino et al., 2019, p. 200). So, "while [social entrepreneurship] might be empowering in terms of increased independence/autonomy, it also obscures fragile and precarious lives that many self-employed entrepreneurs are forced to live (e.g., limited access to social security benefits)" (idem).

Without empowerment, there is no emancipation. But empowering processes do not necessarily lead to emancipation. Let us define emancipation as an ideal state of collective and individual realization of needs, values (including the respect for diversity), and desires (including justice), from which the idea that another world is possible is not precluded (but not imposed either). This horizon of emancipation is probably never fully reached but is something to which we can move closer and closer. Empowerment represents the essential steps, or stages, to move forward in a process that may (or may not) end up in emancipation. Structural bottlenecks, trial and error, (unexpected) contingencies, and disempowering risks will be on the way. So, a concept of *empowerment for emancipation* not only includes accounting for all the dimensions described above (and indeed many more issues) in an integrated, organic way (which we called density) but is also concerned with the quality of how this process is carried out, which can be identified with developing it with care and critical sense.

Freire has already pointed out early on the inexorable unfinished character of emancipation processes (2005a; 2005b). Possible outcomes of sociotechnical interventions must then be taken not as ends in themselves but, more often, as small steps in a long road. Further, the road map may go in different directions, depending on the values cherished by the involved actors and the ethical-political choices the communities or social groups and the intervention teams have at hand. In other words, there are different shades and degrees of depth concerning emancipation that can be achieved through empowering sociotechnical projects.

EMPOWERING ENGINEERING DESIGNS

This section presents two different approaches to sociotechnical intervention: Enactus and popular engineering. Apart from exemplifying different dimensions and scales of density concerning empowerment and emancipation, this presentation also offers some details of such approaches' theoretical and methodological basis. That allows us to glimpse the impacts of these elements on the type and depth of empowerment sought and achieved in each case.

Enactus,¹² an acronym for *Entrepreneurial Action Us*, is an organization established in 1975 in the US seeking to make university students leaders and entrepreneurs. It is now found in 37 countries and 1,700 university campuses, being practiced by 72,000 students and stating that they have impacted the lives of more than 1.3 million people (Ungari, 2021). Students are organized into teams (minimum of 10 members) mentored by a teacher from the hosting campus. It is also highly recommended that each team has a business advisory board composed of managers of (local) companies or other organizations (Ungari, 2021).

What connects all teams from a country is the annual national championship, where the best ones are chosen. This way, the team's intervention is doubly motivated: by its transformative impacts on the assisted realities/groups; and by going as far as possible on the intended outcomes to win the contest.

The competition is Enactus' central, constitutive element. So, the type of empowerment sought by the teams is the one that is valued most in the contest. Interventions must address some of the seventeen United Nations sustainable development goals. However, in Brazil, the economic impacts on the assisted group or the intervention team (which may become a social business, a highly encouraged unfolding) play a central role (Alvear et al., forthcoming).

Considering the two teams that won the last four Brazilian competitions – IFCE-Iguatu (2017 and 2018) and UFPA (2019 and 2020) –, the types of projects they develop have some elements in common: 1) they last for at least a couple of years; 2) their main results are sociotechnical inclusion (income generation or overcoming some vulnerability), women empowerment, and ecological sustainability; 3) they frequently work some technical competence (usually aimed at capacitating the assisted groups/individuals to be entrepreneurs and keep improving their enterprises); 4) they lack a more systematic reflection and practice concerning methodology, which is meant to be participatory, to listen to the assisted individuals/groups and, in some cases, to encourage co-construction, but, in practice, usually falls significantly shorter than intended (Alvear et al., forthcoming).

This way, Brazilian Enactus leading teams succeed in addressing the dimension of sociotechnical inclusion (a), technical competences (d), and environmental awareness (h), fail in addressing cultural difference (b), investigative competences (e), and political emancipation (g), meeting only tangentially qualitative relationship (c) and social and economic emancipation (f). As such, these are interventions with low (or low-medium) density. But density is not something these teams are pursuing. On the contrary, the competition's feedback shows that they achieve what they are looking for. Indeed, the background understanding that sustains the whole Enactus approach considers entrepreneurship the best possible way to solve any problem (either economic, environmental, or social). Plus, by lacking any critical account of the state's role in producing welfare and of the unregulated market in generating problems, it ends up considering market capitalism (in its "social-environmental responsible" improved version) as an unquestionable order and as the solution for any social problem. This way, Enactus does not question some key elements that sustain the hegemonic (oppressing) order like individualism, consumerism, and the centrality of money and profit as values to be sought. Further, it does not consider that local, uneducated (or

¹² <https://enactus.org/>

less educated) people's knowledge can play a significant role in the interventions they do. Otherwise, they think that part of these people's vulnerable condition could be overcome if only they got rid of their knowledge and learned some of the academic, entrepreneurial, hegemonic knowledge the team has acquired at the university and with Enactus (Alvear et al., forthcoming).

As a result, Enactus does not aim at emancipation (or dense interventions). Nonetheless, 1) some of its interventions, like the irrigation system the IFCE-Iguatu team created to support family agriculture in the Brazilian semi-arid as a low-cost strategy of living with drought (Silva, 2018), are remarkably empowering (mainly, sociotechnical inclusion, technical competence, and environmental awareness). This achievement might have something to teach to other interventions' approaches, even denser and emancipatory ones. 2) Such technological and economic improvements allow opening space for advancing in other dimensions of community empowerment. For instance, once familiar farmers manage to increase their production and improve their profit, they can also find it helpful to create an association or cooperative of small producers to fight for better prices or some public policy that grants them better conditions to compete with larger producers.

Turning now to the second approach to the sociotechnical intervention, popular engineering¹³ (PE) is a Brazilian creation arising in the mid-2000s, which embodies self-management, social technology, solidarity economy, and popular education to propose a new paradigm to sociotechnical solutions. Social technology is a Latin-American offspring of the appropriate technology movement practiced in the continent until the late-1980s. Like appropriate technology, social technology addresses poor people's urgencies and problems (sociotechnical inclusion). But unlike appropriate-technology initiatives, social technology is firmly committed to the emancipation of the assisted group and the valorization and incorporation of the group's knowledge into co-designing technical solutions (Fraga et al., 2020).

PE is practiced by extension (or service-learning) university centers. It is committed to Paulo Freire's popular education, taking the intervention process as a way of helping the involved actors to grow emancipated. In methodological terms, action research is a central reference, which gives to PE's interventions a three-fold aspect: a) the technical team (usually composed of undergraduate students and graduate students and teachers) takes the assisted group's situation as a research problem; b) doing PE means joining the assisted group in the political struggles they have; c) research, sociotechnical design, and the political fight are supposed to be an endeavor addressed in a collaborative and dialogic way by the technical team and the assisted group (Fraga et al. 2020).

One team that practices PE is GPERT (an acronym for "Research Team on Companies Recovered by Workers" in Portuguese). It comprises a group of teachers and students from different Brazilian universities working with self-organized workers who run autonomously companies that went bankrupt. Their intervention conjugates popular education, action research, and ergonomic analysis

¹³ In some publications, as Cruz (2021), the Brazilian "engenharia popular" is translated as "grassroots engineering," which seems to better convey to an anglophone audience the practice's commitment to grassroots people, communities, and movements. Nonetheless, given Paulo Freire's "popular education" central role in this practice, its consecrated translation as "popular education" (instead of "grassroots education"), and the very same meaning of "popular" aimed at in "popular education" and "popular engineering," it was recently decided by "engenharia popular" practitioners to use "popular engineering" as the proper translation of "engenharia popular."

of activity, aiming to help workers understand better and improve the work process they perform (Nepomuceno et al. 2019; Cruz, 2021).

Throughout the whole intervention process, the technical team works side by side with the workers, learning from and with them the details of the activities they perform, the company's general functioning, and the values they praise and make use of, consciously or not, in the activities they perform. Additionally, the technical team also shares with the workers engineering practical knowledge, ensuring moments for the workers to critically take their work, values, desires, and worldviews (Nepomuceno et al. 2019; Cruz, 2021).

Other PE teams have adapted and developed (somewhat) different approaches, resulting, among other factors, of the engineering realm and the specific type of grassroots groups they work with and the kind of technical assistance they intend to provide. Given such diversity, it is hard to assess PE interventions as a whole. For denser interventions like GPERT's, all eight dimensions of empowerment are aimed at. For some less dense ones, like Pegadas' (Rufino, 2018), investigative competences, social and economic empowerment, and political empowerment seem not to be addressable, at least, not directly. Either way, it is not easy to know to what extent PE succeeds in its purposes. Part of the problem here is that whereas assessing sociotechnical inclusion can be straightforward, that does not apply to the other seven dimensions. Furthermore, in some cases, only time can show if an apparent success, such as building a cooperative, leads to the group's empowerment or represents an unnoticed imposition from the technical team that ends up producing disempowerment instead (Addor et al., 2015).

It does not mean that dimensions other than sociotechnical inclusion are unassessable or that no PE project has produced measurable impacts on them. In fact, in interventions like the GPERT's (Araujo et al., 2019; Cruz, 2021) and those from other teams (e.g., the Soltec (Addor, 2015; Addor and Henriques, 2015; Addor and Lianza, 2015), ITCP-Unicamp (ITCP 2011; 2013), Alter-Nativas (Lima et al., 2019), and Pegadas (Rufino, 2018)) such impacts are evident. Nonetheless, we think a more precise assessment of these impacts applying evaluative tools and conceptual frameworks (like the one presented in this paper) can clarify what is indeed achieved and what could be improved.

As a strategy to deal with some of the challenges associated with empowerment and emancipation, some PE teams have chosen to assist organized social movements instead of isolated initiatives. That may, indeed, help improve the performance in the dimensions of cultural difference, social and economic emancipation, and political emancipation. Further, it may reduce the probability of the technical team unwittingly imposing its ideals, dreams, values, and the like on the assisted group.

Table 1 - Comparative summary

	<i>Enactus</i>	<i>Popular Engineering</i>
<i>Sought horizon</i>	Socio-economic inclusion; improving capitalism	Emancipation; post-capitalism built from the bottom-up
<i>Guiding principles</i>	Social entrepreneurship	Solidarity economy; social technology

<i>Average intervention period</i>	Smaller (up to a couple of years)	Longer (at least a couple of years)
<i>Dimensions addressed</i>	Sociotechnical inclusion (a), technical competences (d), and environmental awareness (h)	All eight (ideally)
<i>Dimensions partially addressed</i>	Qualitative relationship (c) and social and economic emancipation (f)	---
<i>Dimensions not addressed</i>	Cultural difference (b), investigative competences (e), and political emancipation (g)	---
<i>Density</i>	Low-medium	High
<i>Strengths</i>	Assertiveness regarding economic impacts	Emancipatory potentiality; partnership with social movements
<i>Challenges</i>	Transform reality (addressing UN's 17 SDGs) without structurally criticizing the status quo and growing denser	Being more assertive regarding economic empowerment; Assessing its interventions and improving them accordingly

CLOSING REMARKS

When we decided to write this paper, we had three purposes in mind:

1. Understand whether the concept of empowerment could be helpful to conceptualize, undertake, and evaluate sociotechnical interventions;
2. Explore how empowerment might relate to emancipation; and
3. Make it possible for approaches as ideologically distant as, for instance, Enactus and PE, to be seen through a bird's-eye view, finding ways of learning from one another. If cultivating truly bias awareness and multiple perspectives, they certainly can learn from one another and even construct mutually beneficial partnerships.

We think our framework does address these three aspects. Moreover, it can be helpful to provide a checklist for best practices and ethical-political standards in community interventions.

As said, though, the proposed framework does not intend to be exhaustive. That means that readers are welcome to expand the dimensions and clarify them more thoroughly. The framework may be seen as a kick-off checklist to evaluate how robust are the interventions we and others put into practice. Are we missing an angle? Is there any domain to learn more about? We may always learn more and do better in any dimension, reading more, working with people with experience in such areas, and experimenting by putting in practice and reflecting upon our experiences.

Moreover, there are many possibilities and paths to go deeper in any dimension of empowering projects. These many pathways might include different concepts, theories, methodologies, and,

most importantly, the very particular context in which every intervention and participating actor is situated. So, the provided list is no cake recipe. It is rather a way to provoke sensibilities and invite sharing experiences to reach depth in our practices. There are many levels of depth in any dimension, going from the unacceptable to the exceptionally good. In other words, the framework is simply an analytical tool intended to help checks and balances. In the real world, the dimensions are fluid and interconnected. There is no rigid border between the categories. By the same token, concepts such as creativity (rethinking technologies, institutions, and ways of working and educating) or engineering against structural and cultural violence (Kleba; Reina-Rozo, 2021) may be single out to learn more about them or transversally integrate them into the framework.

At any rate, it is essential to highlight that our understanding of empowerment resembles a set of individual and collective skills, instruments, means, and knowledge, making it possible for people and collectives to liberate or decolonize themselves and pursue their life projects in the environments they live. In other words, liberation/decolonization is content-free as it does not impose any specific worldview, identity, or power arrangement into particular groups or individuals.

Taken isolated, each of the eight dimensions of empowering sociotechnical interventions is a necessary but not sufficient condition for emancipation. On the one hand, that comprehension argues in favor of denser interventions as they are more likely to satisfy more of emancipation's conditions. But even dense approaches, like PE's, can fail emancipation, due to some lack of care or critical sense (quality), unwittingly fostering disempowerment. On the other hand, less dense projects like Enactus', although not even (intentionally) aiming at emancipation, can powerfully lay some basis for that eventually to occur, if carried out with care.

Furthermore, albeit being possibly incomplete, the list itself is a powerful tool for EE initiatives to set up research questions and practice reflections about the types of empowerment they are trying to address and/or achieve in practice and better assess (and improve) their intervention.

Nevertheless, much work remains to be done in the reflection concerning empowering/emancipating sociotechnical interventions. This manuscript names three lines of such investigation: improving the list of community empowerment's dimensions (adding lacking ones and refining those presented); investigating the conditions and processes of how empowerment/emancipation may be achieved and enhanced in and by other EI actors like academia (with faculty, students, and institutionalized processes); and inviting to reimagine the relationship between empowering communities and the broader realms of the economy, the civil society, and the state.

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