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Logics of Collaboration: An Ethnography of Engineering Co-design in the Brazilian Amazon

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Abstract – **Participatory design approaches such as co-design are promoted as ways to increase the likelihood that engineered products are economically, environmentally, and socially sustainable by incorporating stakeholders into decision-making processes. However, executing collaborative design practices that incorporate the variety of stakeholders represents an enormous challenge. In this paper we examine these realities as experienced by a co-design team comprised of design engineers from a foreign country who are engaged with local stakeholders to develop a product for a community in the Brazilian Amazon. Based on more than a year of ethnographic research, we identify three types of perspectives or institutional logics operating in this setting—engineering, modernization, and traditional—which interact to constrain and enable the co-design process. We find that these logics can undermine co-design because the design team is better equipped to respond to stakeholders who express modernization logics rather than traditional ones. We conclude that while co-design can be truly collaborative in development projects, other times it may lead to the appearance that the design process is collaborative when it may in fact mask the marginalization of certain stakeholders voices.**

Index Terms - co-design, institutional logics, international development, sustainability

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Introduction

Although the desire for products that positively affect society is not new,[1] scholars and practitioners of sustainable development have renewed the call for products that deliver positive impacts for local stakeholders.[2,3] Accordingly, designers and other practitioners seek to develop products for low-income communities that meet "the needs of the present generations without compromising the ability of the future generations to meet their own needs."[4] Achieving this objective, however, is far from straightforward as ineffectual international development projects have been well-documented.[5] Perhaps more concerning, sometimes development projects generate negative consequences, as was the case when an irrigation improvement project in Tanzania created water shortages for downstream users and thus exacerbated inequalities between farmers.[6] Adverse effects are more likely to occur when designers follow a conventional market model, where products are "generated by a manufacturer and directed to a consumer."[7] This traditional design approach relies too heavily on the designers' expertise without addressing or integrating the perspectives and experiences of local stakeholders. In these cases, it is not uncommon for development products to fail to meet expectations due to, among other things, product designers' lack of knowledge of local context or failure to develop relationships with local partners in the community.[8]

Participatory design approaches are advanced to address the disconnect between designers who come from high-income countries and users' experiences in low-income countries and to create products that are culturally appropriate for these settings.[9] Among these approaches, co-design is the most prominent. Saunders and Stappers define co-design as "collective creativity as it is applied across the whole span of a design process."[10] Co-design involves the practice of joint discovery across the activities that constitute the design process wherein designers and users collaborate not only to generate ideas and product concepts, but to develop prototypes and gather feedback on and improve the product. Directly engaging potential users and other stakeholders in design decisions can bring to light the variety of issues users face on a day-to-day basis that traditional design approaches are unlikely to uncover.

We believe that co-design does well to address many of the pitfalls commonly associated with design for communities in low-income countries.[8] Still, the implementation of co-design, especially in collaborative settings that include partners that span cultural and geographic boundaries, is far from straightforward.[11] Orchestrating co-design collaborations is likely to bring its own set of challenges that are endemic to group decision-making processes. The collective generation of novel solutions is often is hindered by Groupthink,[12] power and status differentials between group members that lead to suppressing the expression of new ideas and alternative perspectives,[13] the desire for consensus,[14] and the need to orchestrate the numerous activities associated with successful innovation such as idea generation, product development and manufacturing, and product distribution.[15,16] In a co-design setting, collaborators' diverse backgrounds and varied expertise shape the way team members approach, define, design, and project their views about the design, future production, and eventual success of a product. When these communication and coordination challenges emerge, collaborative efforts can become merely symbolic. Or, they may end up masking colonial tendencies found in traditional development approaches that impose hierarchical and dependent relationships,[17] where consideration of local interests may be limited or altogether non-existent.

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Given the challenges associated with collaboration among a diverse set of team members across geo-cultural borders, the purpose of this study is to examine co-design's collaborative aspirations in real time. Specifically, we ask, what practical collaborative hurdles do designers face when enacting co-design across boundaries and why are these challenges likely to arise? In this paper we explore what happens when a group of engineers from a university located in one country engages in a product development project with local stakeholders to create a mechanized mandioca (cassava root) peeler, intended to benefit the local community and rural farmers in the Brazilian Amazon. Through the lens of institutional logics,[18,19] we examine how this co-design team embodied distinct logics, how these logics came into conflict, and how the engineers on the team navigated the conflicts. Based on interviews with team members including engineers and local stakeholders, we find that, at times, the engineers' dual commitments to engineering and local stakeholders' logics were incompatible. When this occurred, these competing logics challenged the collaborative aspirations of co-design. The implication is that intentionally collaborative efforts can still unintentionally prioritize certain groups' interests over others, which can undermine the goals of the co-design process.

THE COMPETING LOGICS OF CO-DESIGN

Scholarship on new institutional theory[20] and one of its derivatives, institutional logics,[21,22] provides a framework for examining how the views represented by different members of a co-design team might impact their efforts to employ democratic decision-making processes. New institutionalists are concerned with the institutional environment—professional, normative or cultural-cognitive, and regulatory pressures that influence action[23]—in which actors (i.e., individuals and organizations) are embedded, as well as the cultural meaning of the practices that actors enact. In their seminal article, Meyer and Rowan argue that certain policies, practices, and structures are legitimated by "myths" promulgated by the institutional environment.[24] These myths come in the form of culturally agreed-upon, formal or informal policies or practices and are often diffused through, for example, professional associations, consultants, regulatory agencies, or scientific communities. These myths may also be adopted ceremoniously and become decoupled from functional imperatives that individuals face. In other words, once adopted, the policies and practices that are animated by the myths propagated by the institutional environment may be ignored in reality. They may also become problematic if they contradict the day-to-day interests or needs of individuals. For example, firms may adopt any number of management fads (or design practices) regardless of their observed benefits or the day-to-day work demands of employees.[25]

Myths that are promulgated by professional, normative, and regulatory pressures that are pervasive in the social environment are many times constituted by a central logic or organizing principle, an institutional logic, that shapes the lens through which actors see the world. Thornton, Ocasio, and Lounsbury define institutional logics as "the socially constructed, historical patterns of cultural symbols and material practices, including assumptions, values and beliefs, by which individuals and organizations provide meaning to their daily activity, organize time and space, and reproduce their lives and experiences."[26] Actors who enact certain institutional logics are more likely to be endowed with legitimacy, "a generalized perception or assumption that the actions of an [actor] are desirable, proper or appropriate."[27] For design engineers, then, to be viewed as legitimate (especially those in academe that we study), in addition to having the proper credentials, they must comply with an engineering mythos. This mythos includes, among other things, not only employing engineering methods, but also focusing on particular outcomes, obtaining funding from governmental and industrial sources, presenting research at conferences, publishing papers in peer-reviewed outlets, and developing patentable technologies.

The new institutional and institutional logics scholarships direct our attention to two potential pitfalls that may beset a co-design team's best intentions. First, the team's efforts to remain democratic may be undermined by the conflicting institutional logics in which its various members are embedded. A typical co-design teams brings together designers with potential users or other stakeholders, each with different cultural values and assumptions, to share in decision-making responsibilities. Although co-design is premised on the idea that product design will be more successful if it involves people who bring together multiple perspectives, incorporating these perspectives can be extremely difficult in practice. Co-design teams may be faced with the extraordinary task of responding to and incorporating vastly different user or stakeholder logics.

Second, the new institutional literature suggests that aspects of the practice of co-design may take place only ceremonially if it does not comply with a certain institutional logic on-the-ground. Just as organizations might decouple the adoption of a particular policy from their day-to-day activities, when tensions arise between logics, aspects of the collaborative process may become largely symbolic, with those involved in co-design ceremonially asking for feedback while effectually dismissing it. Or a local stakeholder may go through the motions of providing feedback while deferring to the expertise of the designers or engineers or other team members who exhibit certain gendered or racial characteristics or possess certain credentials and who, subsequently, may be endowed with higher status or greater legitimacy. Appearing to engage in collective decision-making during the design process may in reality privilege certain views over others.

Because it is difficult to understand the experience of every type of person who may use a product, co-design-in-practice might not fully recognize that what is best for certain prominent users may be disadvantageous or even detrimental to others. By virtue of some users being included in the co-design process, their interests may take priority over others. For example, pre-existing relationships with like-minded, perhaps more cosmopolitan, users may come at the expense of collaboration with users from indigenous or other minority groups based on race, social class, or gender. While no product can be all things to all people, co-design's intention to provide a space where democratic collaboration takes place has the potential to disguise the varied interests of stakeholders who may not be included or heard in the design process.

METHOD

Research Setting

For this paper, we conducted ethnographic research of a university engineering team whose goal was to develop an industrial mandioca peeler (see Figure 1) with the assistance of rural farmers in the Brazilian Amazon. The team consisted of several faculty and graduate students at a university in the United States. The engineering faculty had extensive expertise in design methods and designing products for communities in low-income countries. The co-design project was one of several projects conducted by this research group. The project was led by a small portion of the team, but additional engineering graduate students from the same lab were

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involved in various stages of the project's design and development. All of the graduate students worked on the project as part of their paid research assistantships.

For more than a year, we conducted interviews with these engineers and local stakeholders who were part of the co-design team, observed regular Skype meetings and phone calls between the engineers and local stakeholders, and took two trips to Brazil to participate in meetings and observe interactions between the engineers and local stakeholders (the engineers spent an extensive amount time in discussions on Skype and phone calls with local partners prior to their site visits). The machine was designed to peel the mandioca root, commonly known as cassava outside of Brazil, which is a type of starchy tuber that has long been a staple of the Amazonian diet. After it is peeled, it is typically ground and roasted to produce farinha: a hard, granular substance that is sprinkled over food in Amazonas. In addition to farinha, mandioca is used to produce other foods—for example tapioca can be made from strained-off liquid starch, and a sweet cassava cake is often made by mixing wet farinha with coconut and other ingredients and roasting it in a banana leaf. Farinha is ubiquitous in Amazonas. Nearly everyone eats the condiment daily, sprinkling it on fish, rice, beans, and other side dishes. While many consider themselves consumers of the product, a great majority of the local stakeholders we met said to have helped their parents or grandparents make it from scratch as youth.

FIGURE 1
INDUSTRIAL MANDIOCA PEELER

While the Brazilian state of Amazonas is lush with vegetation and the potential for farinha production is great because of its residents' expertise with cultivating, harvesting, and producing the plant, regional production is insufficient to meet local needs. Many locals buy one-kilo bags of farinha at the supermarket where it is shipped from more developed regions of Brazil, which is an affront to many who take pride in local agriculture. This situation led a small group of producers from a local farming cooperative to organize their efforts toward modernizing and reinvigorating the local industry. On a jointly purchased piece of land, they planned to build a state-of-the-art farinha production center. Their operation would apply advanced technologies as taught by regional and national agricultural agencies. Local producers in the region could bring their crops to the center to make farinha efficiently (instead of making it at home), or they could sell their crops to the group to produce.

Through a mutual contact in Itacoatiara, the farming group connected with one of this study's co-authors, who leads a team of graduate student design engineers, and who has worked previously in the region. The engineering team's portfolio of products address a wide range of basic human needs and social initiatives. The engineering team, whose mission is to create sustainable products, decided to use this opportunity to employ co-design as a method for creating an industrial mandioca peeler alongside members of the local cooperative.

Data Collection and Analysis

Participant observation in weekly design meetings and interviews with team members comprised a significant portion of our field research. For a little more than one year, we gathered interview and observational data from the co-design project team. We met with them at least once a week to discuss the project and review the ongoing design process. With consent from team members and Institutional Review Board approval, we took detailed fieldnotes in each meeting, noting topics of discussion, communications with local stakeholders, design issues, cultural and social issues, and numerous other matters relating to the project. We also held regular interviews with both the team's director and the project lead and attended Skype calls between the engineers and local stakeholders.

The lead author of this paper accompanied a small team of engineers on two site visits to Itacoatiara and Manaus, Brazil. The first included approximately two weeks of observation, fourteen interviews with eight females and six males, and design activities such as ideation and prototyping. Approximately half of the informants were considered by the group of engineers to be producers and the other half considered consumers of farinha. We identified people to be included in our sample by working with our collaborative network in Itacoatiara, purposively sampling according to gender and relationship to farinha production. The second trip, which took place about six months later, was focused on prototype testing and included eleven days of observation and additional interviews with the design team and 30 local stakeholders, 14 of whom were females and 16 were males. The sample of local stakeholders included nine co-design team members, 10 informants from urban areas, and 11 informants from rural areas. Sampling for the interviews during the second trip was purposeful with the intent of interviewing roughly the same number of females and males from urban and rural areas. We found informants through personal and local contacts.

We recognize our involvement in ethnographic research alongside the design team likely biased the teams' conversations and behaviors. Sources of bias may include team members' hesitancy to reveal potentially undesirable information or outcomes. To help address this issue, we obtained informed consent and assured informants we would maintain anonymity when reporting results. Another potential source of bias includes the tendency for embedded ethnographers to 'go native' or become fully immersed in and sympathetic with the community under study. Becoming so immersed produces trade-offs[28] such as unfettered access to otherwise unobservable behaviors or activities, on the one hand, or empathy that prevents reporting negative results or seeing other points of view, on the other hand. While the results of our study are no doubt biased by virtue of our involvement in and interactions with team members, we also

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believe that the results usefully shed light on collaborative challenges inherent in the practice of co-design.

Data analysis proceeded as follows. First, we recorded fieldnotes and took audio and video recordings of meetings and interviews. After each meeting and interview, we transcribed the notes and interview transcripts. The first author translated the interviews with local stakeholders, which were conducted in Portuguese. Next, we coded the notes and interview transcripts for key themes and examples related to the potential impacts of an industrialized mandioca peeler and the collaborative challenges associated with the co-design process. We used a combination of inductive and deductive coding to analyze the data.[29] Some codes came from the literature (e.g., design requirements), and others were based on our reading of the data (e.g., time constraints). The coding process was iterative.[30] We read the data, applied codes, engaged with the literature, wrote, refined the codes (adding, merging, etc.), engaged more with the literature, and so on. This kind of pragmatic approach, which allowed us to be both systematic and flexible, is common among qualitative researchers.[29,30]

In a process that Strauss and Corbin[31] refer to as axial coding, we assessed the codes in relation to each other. For instance, we did not code explicitly for the different institutional logics, but the logics nevertheless became apparent to us as more fine-grained codes clustered together and became obvious as elements of a broader category. The findings that appear in the manuscript are therefore a result of reading the data closely, working through them by systematically coding, stepping back to understand the codes in relation to each other, and then communicating what we learned through writing.

RESULTS

Three Institutional Logics

Across the team's work, we observed what we call an engineering logic that was expressed in formal and informal discussions among the engineers on the co-design team. The hallmark the engineering logic was an emphasis on clearly defined outcomes. Accordingly, to ensure that everyone on the team was working effectively toward a same goal, early in the collaboration process the engineers wrote a statement of purpose that they shared with local partners. The statement explained the engineers' rationale and intentions. The statement explained that to avoid past failures of global development engineers, the engineers hoped to collaborate with and gather information from local partners, farmers, and other stakeholders "to create better products."

Another component of the engineering logic was measurability. The engineers on the team were constantly discussing ways to identify and then measure inputs and outputs to include in their models. Once the inputs and outputs could be measured and the relationships between them could be modelled, the engineers felt more comfortable deriving actionable solutions. Based on our observations, the engineering logic generally supposes that many outcomes can be modelled if the correct variables are identified and included in the models. As an example, two of the engineers were elated as they listened to a recorded interview with a local informant about how an industrial mandioca peeler might be beneficial to the community. The engineers noted that this information produced "requirements," a crucial but sometimes difficult to obtain set of measurable objectives for the product's design. These requirements could be placed in a "requirements matrix," a key tool of design engineering that establishes a link between market needs and product performance metrics.

Among the local stakeholders on the co-design team, we observed two additional, relevant logics. The first we identified as a modernization logic. Those who held this view were generally favorable to Western ideals and valued and promoted the modernization of society. Specifically, those who expressed this logic favored systematic approaches to farming and standardization as a way to modernize farinha production. Farmers who expressed a modernization logic, for instance, planted their crops in straight rows and cared for them methodically, seeking to maximize the efficiency of the land and farming processes. These individuals tended to be less concerned with tradition than they were with pursuing newer, better ways of doing things. Most of the individuals who adhered to the modernization logic had experience operating in the formal economy. One of these individuals was the head of a rural farming cooperative. In conversations, he prioritized things like business growth, entrepreneurial opportunity, wealth generation, and market advantage. Those like him, those who held views that were consistent with the modernization logic, often expressed views that overlapped with the ideals held by engineers (and the engineering logic), which made collaboration between the two groups easier.

Another logic, the traditional logic, was often at odds with the engineering and modernization logics. Informants who articulated sentiments consistent with this logic emphasized the importance of farinha production for preserving cultural practices. Many of the rural farmers we spoke with opted to follow long-held, traditional methods for growing mandioca and producing farinha. For instance, most rural farmers with which we spoke tended to plant two stem segments together in each hole, even though experts insist that the two plants compete for nutrients, and neither is maximally developed. Another insisted on planting the crops randomly, not in rows to ensure optimal density of plants in an area. Additionally, sometimes a thin, inner peel was left partially intact by rural farmers even though government agencies and agriculture organizations insist that this must be removed entirely because it reduces the quality of the product. Rural farmers who espoused this logic often saw farming as a way to subsist, support their community, and connect with their heritage thereby confirming their cultural identity. Advocates of this view were not necessarily averse to modernization, commerce, or technology, but nor were they motivated by them.

The differences between the traditional and modernization logics were clearly illustrated in a video produced by EMBRAPA, a state-owned agricultural research agency (translated roughly as the Brazilian Agriculture Research Corporation) that described the cultural significance of mandioca.[32] The video tacitly introduced these two views of mandioca production by, on the one hand, depicting the traditional logic by celebrating the cultural significance of mandioca and the human labor that goes into its production. This view was presented as an affection that traditional producers have for their culturally reproducing work. For example, the video described the mandioca plant as "motherly"—mandioca agriculture and production is generally viewed as the purview of the matriarch of a household, though the entire family is needed for the time-intensive tasks associated with harvesting the root and then preparing it for production. To emphasize the point, a small, elderly woman was shown moving through her field, pulling up large mandioca roots from the ground as she explained that she learned the farinha-making process from her parents and will pass it along to her children and grandchildren.

On the other hand, the video portrayed the modernization logic by lamenting the underperformance of regions like Amazonas where production processes are outdated and inefficient. It shows a man in an EMBRAPA cap and shirt who explained, “People talk about this as a rustic culture, but it also has its problems.” He said that local farmers are only producing around three to six tons of mandioca per hectare, and that studies conducted by EMBRAPA have shown that farmers can achieve more than twenty tons. These advancements are juxtaposed with the woman mentioned above who was working in her small casa de farinha—an outdoor kitchen, of sorts, roofed with corrugated tin and populated by a makeshift grinder (to pulp the roots), a pulley and lever press (to squeeze liquid from the pulp), and a large iron pan with an open fire underneath (to cook out deadly toxins). A variety of farm animals roamed in and out of the farinha house. The indigenous culture that had been celebrated just a few moments earlier in the video now seemed quaint and cumbersome. A hand grinder that had been precariously mechanized using an old washing machine motor looked out of place against the backdrop of the sterile laboratory machines shown in the video.

Institutional Logics in Practice

Co-design requires negotiating the expression of these varied logics among team members. This negotiation could be manifest in group decision-making processes when one logic was privileged over another. The views that appeared the most resonant with an engineering logic were those consistent with the modernization logic: North American engineers and some of the Brazilian team members who held views consistent with the modernization logic similarly valued efficiency and productivity. The congruence between these logics was reinforced by the fact that the leader of the local cooperative who was on the co-design team espoused the modernization logic. He was the key contact for the engineers and the local team member with whom they most frequently communicated. In the early stages of the collaboration, the engineers engaged in conversations with him about the possibility of developing several different products before their conversations with him resulted in the decision to create an industrialized mandioca peeler. He was also their key local contact in subsequent video calls to lay the groundwork for their collaboration. In the latter stages of the collaboration, he was also the principal person who helped organize the site visits and meetings with other local stakeholders. Our discussions with the engineers revealed that they were fully cognizant of a common pitfall by design teams to prioritize stakeholder needs with the one sponsoring the project. Nevertheless, when multiple stakeholders were advocating for different things, it was practical for the engineers to defer to and prioritize his views, which commonly represented the modernization logic. Of course, this was not out of malintent but because the engineers’ basic outlook was fundamentally similar to those of this key team member. While successful co-design offers one way to empower disadvantaged groups, such collaborations still provide the opportunity for outsiders to bring perspectives that are more likely to resonate with some local views rather than others.

Time constraints were also critical for understanding how the engineers navigated conflicting logics. Time constraints provided an opening to privilege the engineering logic over collaborative decision-making processes or difficult-to-implement decisions from local partners. For example, shortly after the first site visit, a sense of urgency began to weigh heavily on the engineers. They expressed a strong desire to produce rapidly a prototype that they could unveil to Brazilian collaborators on subsequent Skype calls. The team recognized the substantial time requirements of analyzing transcripts and interpreting interview data from the first trip that could be used to inform the product’s design, yet they also felt compelled to move the design forward at the pace that is more consistent with traditional engineering work. As the engineers progressed on the machine's design, one recognized the ease with which the "collaboration" could become just another "over-the-wall" project—a term they used to refer to a type of ineffective project in which engineers would design a product without input from local stakeholders and then deliver it without further feedback.

Another time, on the second trip, the team hoped to have the machine fully operational within a day or two of arriving in Itacoatiara. But by day five the group was still discovering new problems that would make meaningful field tests impossible. As a result, several activities involving local stakeholders were cancelled or postponed. Although the team had hoped to involve local collaborators at this stage, it became clear that "too many cooks," as one engineer put it, would be counterproductive. The engineers felt that to involve non-engineers would at times hinder rather than help the work proceed in the required amount of time.

As the prototype moved forward, the engineering members of the team made a concerted effort to involve local stakeholders in design decisions, but sometimes they found it difficult to fit this aspiration into their engineering framework and time frame. At times it was difficult to know how to make decisions with local stakeholders and incorporate these decisions into the product's design. As one engineering team member commented, it was important to him, but difficult to do. The engineer both valued co-creation and acknowledged having difficulty knowing how to do it.

Further illustrating the challenges associated with linking the results of stakeholder decision-making processes to product features that benefit potential users, was the subjective or multiple meaning of some concepts. One example comes from a meeting among the engineering side of the co-design team that was trying to understand the product's impact on a user's education. In the meeting, the team debated the possible meanings of the concept of education. They soon realized that it likely carried different meanings for different stakeholders, and even for a single stakeholder at different times. In one setting, the engineers speculated, education could refer to formal education, as in "maybe this machine will liberate me to finish my education." In another setting they decided it might refer to on-the-job training, as in "maybe this machine will provide me opportunities for [informal] technical education [about how to use the machine]." It was difficult for them to know whether the machine might influence someone's ability to obtain formal schooling or on-the-job training, which inhibited their ability to know how to create a model of how the product might positively benefit potential users.

We also found that the specialized expertise embodied by the engineering logic (and the engineers) became a priority at some points in the design process. One day during the second trip to Brazil, the engineers showed the local co-design partners the most recent prototype of the product. The local partners made several suggestions such as turning the grip arm a different way, shaping the blade differently, and simplifying the gripping mechanism. The engineers accepted each suggestion courteously. Later, however, one of the engineers explained that a lot of the suggestions the local collaborators made had already been considered by the engineering side of the team or were not mechanically viable. But rather than explain the technical details behind why an idea had not been incorporated into the prototype, he replied that they would "give it a try." The frustrating reality, this engineer explained, was that the local partners did not have the technical expertise to understand the rationale behind what had already been considered or done. To him, it was not always clear which tasks should be co-designed and which ones fell distinctly within the domain of engineering. Further, it was not obvious whether this was a failure to communicate on the part of this engineer or just a co-design reality. When the

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engineers and local stakeholders made joint design decisions (or tried to make joint design decisions), knowing how to move forward was not always straightforward.

DISCUSSION AND CONCLUSION

For design teams that work across global and cultural borders, the ideals of co-design can be difficult to achieve in real time. Based on our ethnography of a co-design team whose objective was to make a product intended for use by a community in the Amazon, there were times when the endeavor was as much a cultural as a mechanical challenge. Stakeholder preferences in this co-design project were not always easily translated into clear mechanical directives. In other words, although practitioners of co-design are expected to elevate the user or other stakeholders to the role of decision-maker, when it came to the engineering aspects of a technical product like the industrialized mandioca peeler, the ability of a non-technical collaborator to fill such a role was at times diminished. In some respects, it seemed necessary that the engineers, as technical experts, focus their efforts and privilege their expertise on technical concerns over other issues.

Other times, it was difficult to know which stakeholders the product design should benefit. Despite the best of intentions, when multiple logics entered the group's field of vision, some logics were easier to incorporate than others. For instance, EMBRAPA and the farming cooperative promoted principles consistent with the modernization logic—cost-effectiveness, quantifiable productivity, and wealth creation, to name a few—that proved more compatible with the engineering logic. The preferences of many rural farmers, who were more likely to advocate traditional logics, were more difficult to quantify and incorporate into engineering models and, therefore, the final product design.

It was their explicit commitment, nevertheless, that caused the engineers to actively seek opportunities to co-design, even if these instances were sometimes impractical or symbolic. This pattern reflects the process of decoupling when difficult-to-realize demands lead to the dissociation of day-to-day activities from formally implemented policies or practices. Due to the technical demands of the product design efforts that we studied, there were a few instances in which the engineers decoupled their work from compliance with the ideals of co-design and design input from local users. In these selective moments, we believe that decoupling—seeking feedback and symbolically treating the idea as useful even if it was not in a practical sense—provided a way for the engineers to move forward with the development of the product without getting bogged down by the demands placed on them by the collaborative imperative of co-design.

All of this highlights the practical challenges to achieving the idealized version of co-design. These challenges can end up privileging some stakeholder voices. Some stakeholders' involvement in the decision-making processes become less visible, if not invisible, when the cultural predispositions of group members are inconsistent. The omission of these voices may be wholly unintentional. But they result from the technical and cultural tensions that are manifest in this type of collaborative arrangement. The irony is that when left unchecked democratic collaborative arrangements (whether in design, nonprofit, for-profit, or political settings) may be likely to reproduce the existing social and power relationships that they purport to address.

Although there are no easy solutions to the challenges facing this co-design team, we believe steps can be taken to detect biases among team members to minimize their effects on decision-making and increase the efficacy of collaboration. First, based on our findings, we suggest that feedback from local stakeholders about the decision-making process, in addition to the product design, is necessary to minimizes biases that may be manifest in the co-design process. We propose that a critical element of co-design is the opportunity for reflection by and feedback from all of the team members regarding the decision-making processes employed by the group. For those who take seriously the aims of co-design, this type of reflection is essential for assessing its efficacy and addressing its shortcomings. Second, Kahneman, Lovallo, and Sibony provide one tool that consists of a series of steps to help decision-makers identify common sources of bias. These include things like avoiding overoptimism, applying certain quality controls, and soliciting dissenting views. Another tool is the nominal group technique.[33] Third, the nominal group technique can be applied in group decision-making settings. The nominal group technique is designed to involve everyone in the group in generating alternatives and narrowing and selecting the best options. The nominal group technique is overseen by a facilitator and the steps include group members silently writing down ideas individually, taking turns sharing the ideas, a preliminary vote to narrow the ideas, a group discussion, and a final vote to settle on the idea that the group thinks is best.[34]

The attempt to translate local needs and preferences into engineered products designed by outsiders is a challenging enterprise. In the case presented here, the service-learning team members faced uncertainties about how to account for these needs and preferences when they were not easily quantified or translatable into product features and requirements. During the mandioca peeler's development, the engineers grappled with questions of whose values matter, how to address them mechanically, and which potentially negative impacts are worth fretting over. Still, the effort is worthwhile. Illuminating the distinct institutional logics operating simultaneously will help practitioners navigate these points of tension, identify perspectives that have been excluded altogether, question the assumptions that often accompany product development projects, and overcome the pitfalls that prevent us from realizing a more socially sustainable future.

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