Metaphors of Change

Navigating a Revolution in Engineering Education

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Metaphors of Change: Navigating a Revolution in Engineering Education

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Abstract
Engineering education is often decontextualized, even as it is suffused with metaphoric language and sociocultural norms and beliefs. Efforts to embed social context and sociotechnical content in engineering education are often met with resistance. We contribute to conversations about how to change dominant knowledge regimes by detailing the process by which a team grapples with efforts to change technically-focused curricula and practices in engineering education – and faculty members' values and beliefs about them – by invoking metaphors. Metaphors of war and revolution, conversion/evangelism, and care permeate faculty discourse as they interpret and attempt to enact change. We show how these metaphors are significant in the ways that they both enable and constrain possibilities for change.

*Keywords***:** Education; Metaphor; Change; War; Conversion; Evangelism; Care

Introduction

> *There is nothing wrong with metaphors … provided that one is aware of the perils lurking behind their misuse. If one regards them, however, as a species of liminal monster … whose combination of familiar and unfamiliar features or unfamiliar combination of familiar features provokes us into thought, provides us with new perspectives, one can be excited by them; the implications, suggestions, and supporting values entwined with their literal use enable us to see a new subject matter in a new way.*[2]

Engineering education often fails to address the broader societal context in which engineering takes place; yet some of that context flows through engineering educators' continual

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[2] Turner, *Drama, Fields, and Metaphors*, pp. 30–31.

use of metaphoric language that references sociocultural norms and beliefs. This article explores the role of metaphors in shaping efforts to change engineering education. In higher education, the dominant paradigm of engineering education cultivates 'engineering mindsets' that prioritize technical knowledge and preclude consideration of the social.[3] Previous studies have shown that these mindsets fuel environments in higher education and industry that reproduce racism, sexism, and other discriminatory practices that lead to inequities, injustices, and structural violence.[4] Without question, engineering has produced numerous technological achievements that enhance the standard of living for many.[5] Undeniably, it has also contributed to ecological damage, harmful impacts on local communities, ethical problems, and the elaboration of products and instruments of war.[6]

Researchers attempting to change the discourse and practices within engineering education, including those identifying and challenging dominant white heteromasculine ideologies, have long occupied the margins of the discipline.[7] Resistance to change in engineering education is not only limited to 'organizational silence;'[8] it is a result of longitudinal complicity with a legacy of exclusionary norms and practices that reproduce inequalities. Some scholars who have tried to expose and undermine exclusionary norms in engineering education have faced accusations of diluting the curriculum or engaging in 'soft' engineering practices.[9] In this context, this paper examines the efforts for change at the University of San Diego (USD), a Roman Catholic-based private university in the southwestern United States, which received a 'Revolutionizing Engineering Departments' (RED) grant from the US National Science Foundation (NSF). Our findings analyze the variety of metaphors used by faculty members as they interpret and attempt to enact change. We discuss how the use of metaphors both operates as a means for navigating change towards an undefined transdisciplinary and sociotechnical future, but also produces tensions in enacting that change across different scales. We operationalize a 'sociotechnical future' in engineering education as one that includes diverse stakeholders' perspectives so that technical solutions are embedded within critical analyses of power relations and framed within pressing societal challenges.

In exploring metaphors of war, religious conversion/evangelism, and care, we describe how some metaphors offer promise in discussions of changing engineering curricula. However, we also consider how, in the broad context of engineering and higher education in the United States, all three interrelated categories of metaphors present perils. Engineering education and

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[3] Riley, *Engineering and Social Justice*; see also Godfrey and Parker, "Mapping the Cultural Landscape in Engineering Education."

[4] Banks and Lachney, "Engineered Violence"; Cech and Waidzunas, "Navigating the Heteronormativity of Engineering"; Faulkner, "The Power and the Pleasure?; Pawley, Mejia, and Revelo, "Translating Theory on Color-Blind Racism to an Engineering Education Context."

[5] Olson, *The Past Half Century of Engineering--And a Look Forward*.

[6] Andersen, "Purification"; Lucena and Schneider, "Engineers, Development, and Engineering Education"; Lynch and Kline, "Engineering Practice and Engineering Ethics"; Nieusma and Blue, "Engineering and War."

[7] Breslin, "The Making of Computer Scientists"; Camacho and Lord, *Borderlands of Education*; Cech, "Culture of Disengagement in Engineering Education?"; Chen, Mejia, and Breslin, "Navigating Equity Work in Engineering;" Lucena, *Engineering Education for Social Justice*; Pawley, Mejia, and Revelo, "Translating Theory on Color-Blind Racism to an Engineering Education Context"; Riley, "Rigor/Us"; Slaton, *Race, Rigor, and Selectivity in U.S. Engineering*; Slaton, "Metrics of Marginality."

[8] Morrison and Milliken, "Organizational Silence." Organizational silence refers to employees' tendencies within an organization to acquiesce or fail to respond to organizational inequities and injustices.

[9] Pawley et al., "Panel Session : Targeted Harassment in Engineering Education."

practice in the US are closely intertwined with the military, not only in terms of funding sources throughout history, but also through normalized applications of engineering knowledge taught in undergraduate education.[10] Similarly, religious proselytism and modernization through engineering development have often gone hand in hand as part of colonialist projects of expansion.[11] Although metaphors of care may offer an alternative approach within the hegemonic space of engineering, care-work has also been wielded in support of colonial expansion, and as a philanthropic mode of power.[12]

More broadly, these metaphors are implicated in material-discursive frames that construct boundaries and hierarchies in relation to knowledges and people. Feminist and Science and Technology Studies (STS) scholars have brought to light and critiqued dichotomies such as technical/social, masculine/feminine, public/private, and subject/object.[13] These divisions are based in 'modernist' conceptions of the world and concomitantly a (white heteromasculine) liberal humanist subjectivity based in ideals of autonomy and transcendence.[14] As N. Katherine Hayles suggests, 'humanity' defined in such a way 'may have applied, at best, to that fraction of humanity who had the wealth, power, and leisure to conceptualize themselves as autonomous beings exercising their will through individual agency and choice.'[15] Nonetheless, these dichotomies form the basis of exclusionary practices in engineering, with engineering idealized as 'technical,' 'hard,' and 'masculine' against what is constructed as 'social,' 'soft,' and 'feminine.' Globally, these material-discursive frames have been used to justify colonial and modernist projects of expansion as they construct 'other' people and places as objects of improvement, control, and domination.[16]

The use of metaphors of war, religious conversion/evangelism, and care constrain and enable possibilities to produce specific change. These categories of metaphors overlap with, and operate as responses to, one another. We first discuss the specific context of the RED project, our methodology and position as researchers, and the significance of metaphors in relation to change. We then discuss each category of metaphor in turn, considering both the shifts in uses of metaphors and how they are used in producing (and preventing) change. We conclude with a discussion of how these metaphors are significant in their enactment by faculty members, and how these shape the possibilities for change.

Revolutionizing Engineering Education

In an effort to promote sustainable changes in undergraduate engineering curricula and departments, the US National Science Foundation (NSF) created and awarded a series of grants centering on 'Revolutionizing Engineering Departments' (RED). These grants, valued at up to $2 million for a duration of five years, have been awarded to several colleges and universities each

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[10] Slaton, *Race, Rigor, and Selectivity in U.S. Engineering*; Lucena, *Defending the Nation*.

[11] c.f. Bornstein, *The Spirit of Development*.

[12] Camacho, "Power and Privilege"; Martin, Myers, and Viseu, "The Politics of Care in Technoscience"; Murphy, "Unsettling Care."

[13] e.g. Latour, *We Have Never Been Modern*; Wajcman, *Feminism Confronts Technology*.

[14] Latour, *We Have Never Been Modern*.; Hayles, *How We Became Posthuman*; Franklin, "Science as Culture, Cultures of Science"; Keller, *Reflections on Gender and Science*; Haraway, *Modest_Witness@Second_Millenium.FemaleMan(C)_Meets_OncoMouse(TM)*.

[15] Hayles, *How We Became Posthuman*, p. 286.

[16] Keller, *Reflections on Gender and Science*; Scott, *Seeing Like a State*; Li, *The Will to Improve*; Mitchell, *Rule of Experts: Egypt, Techno-Politics, Modernity*.

year since 2015. The RED grants were meant to spur revolutionary change in engineering education. According to the program solicitation, revolutionary was defined as 'not incrementally reformist… Revolutionary means radically, suddenly, or completely new; producing fundamental, structural change; or going outside of or beyond existing norms and principles.'[17] The need for and the promise to make significant personal, institutional, and curricular changes are thus premises of this grant program's funding, framed by the metaphor of revolution. For example, describing a 'Vision for Revolutionizing the Engineering Department' was a requirement of the grant application.[18] The project at USD**,** which received a RED grant in 2015**,** focused on 'how an engineering education that integrates traditional technical skills, enhanced social awareness and an integrated professional spine produces connected learning that empowers graduates to improve society - by practicing engineering within the contexts of social justice, peace, humanitarian advancement, and sustainable practices.'[19] The grant's goals include broadening the 'engineering canon' to promote the formation of values and practices around the four pillars of the grant, mentioned in the preceding sentence. Over the course of the grant, the RED team came to formulate these goals as taking and promoting a sociotechnical approach in engineering.[20]

   The NSF required that the principal investigator for the grant be a department chair or dean, with the rationale that systemic change requires buy-in from university leaders. At USD, the leadership team was composed of the Dean, the Associate Dean, each of the department chairs in the School of Engineering at the time of the grant application, a social scientist (the second author), and two postdoctoral positions that began partway through the grant (one was held by the first author). The leadership team, while composed primarily of engineers from different sub-disciplines, is also composed largely of those holding institutional and administrative power, although this has also changed over the course of the grant as department chairs have changed. Additionally, the permanent engineering members of the team consist of three white men, one white woman, and one Asian man. The researchers and authors of this article are two anthropologists who, at the time of research, were integrated as part of the RED team, one as a co-PI on the project and one as a postdoctoral fellow for the grant. Both authors are women, one of whom is white and the other Latinx, and are viewed by the team as contributors towards a vision for a sociotechnical approach in engineering, broadly and multiply construed. While this structure ensured institutional support, it also created a leadership team of people from multiple disciplines and different levels of commitment to, and knowledge of, sociotechnical approaches in engineering.

   A 'sociotechnical approach' to engineering is broadly conceptualized by the team as treating social and technical concerns as fundamentally intertwined. In practice, this includes efforts for change such as developing modules for courses, full courses, and workshops for faculty that address social context and social impact, drawing on literature and expertise from social science disciplines and connecting to themes of peace, humanitarianism, social justice and sustainability.[21] For example, modules have been developed to discuss the social and

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[17] NSF, "IUSE / Professional Formation of Engineers: Revolutionizing Engineering Departments (RED)."

[18] NSF, "IUSE / Professional Formation of Engineers: Revolutionizing Engineering Departments (RED)."

[19] NSF, "Award Abstract #1519453."

[20] See, for example, Roberts and Lord, "Making Engineering Sociotechnical"; Lord et al., "Developing Changemaking Engineers – Year Five."

[21] Lord et al. "Developing Changemaking Engineers, Year Five".

environmental context and implications of mining for tantalum and lithium in electronic technologies; the course 'Engineering and Social Justice' was structured to explicitly challenge students to grapple with the exclusionary history of engineering and how technical solutions are often fraught with power relations (thereby questioning the idea of 'engineering to help'); and workshops have been offered by invited speakers with expertise in engineering and social justice and science and technology studies.[22] A smaller proportion of efforts for change focuses on professional development and mentorship for students and thus include foci that might not clearly count as a 'sociotechnical approach,' but that nevertheless show how team members are exploring and navigating what 'sociotechnical' means for themselves and for the grant by, for example, producing change in engineering by integrating different stakeholders and perspectives.[23]

Most discussions of change that mobilized metaphors, as discussed throughout this article, relate to efforts to implement the former approaches to sociotechnical engineering, i.e., those focused on social context and social impact, or to the grant's efforts as a whole, rather than those centering on mentorship and professional development. The composition of the team and some of these distinctions between different ways of enacting the 'sociotechnical', however, also embody and represent many of the structural problematics of engineering discussed above. Women, early-career, or marginalized faculty often carried the responsibility for exposing and sometimes contesting the layers of power in engineering, in general; and that asymmetric division of labor also played a role in how the work of the grant unfolded, in specific.

The tenure of the RED grant also coincided with, and in some cases catalyzed, broader changes in the size and administrative structures of the School. The RED grant thus became a focal point for (and exacerbated) tensions within the School of Engineering. Those tensions were seen as centering on differing visions for the role of 'changemaking' values in engineering and the University. 'Changemaking' is a part of the University's strategic plan, which also boasts its status as one of Ashoka U's Changemaker campuses.[24] In these contexts, the meaning of 'changemaking' is broadly construed, but centers on making positive social change. Despite much shared agreement about its Changemaker identity, tensions nonetheless pervade the implementations and governance processes for bringing about change. From the RED team's perspective, members describe divisions between those faculty members within the School of Engineering whom they perceive as valuing, promoting, and implementing changemaking ideals (including a vision of engineering as a discipline that integrates social and technical approaches), and those whom they perceive as resistant to change. In this context, we discuss the effects of particular metaphors as they are used by faculty in the School of Engineering, and particularly RED team members, in implementing change.

Methodology

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[22] Breslin et al., "Design for the Future"; Lord et al., "Teaching Social Responsibility."; Lord et al., "Creative Curricula for Changemaking Engineers"; Mejia et al., "Revealing the Invisible"; Schneider, Lucena, and Leydens, "Engineering to Help."

[23] See the multiple different grant initiatives in Lord et al., "Developing Changemaking Engineers – Year Five."

[24] Ashoka U is an international network of universities that promotes social entrepreneurship and 'changemaker' values, broadly defined.

This article is based on ethnographic observations of the RED grant process, as well as a total of 37 semi-structured interviews conducted with engineering faculty.[25] We draw particularly on the thirteen interviews conducted in 2017 and 2019 with RED team members. All quotes cited with pseudonyms are based on interviews. Through our participant observation, we inductively found that in addition to the framing metaphor of 'revolution' that the grant was premised upon, team members drew upon militaristic language to describe their experiences as actors involved in the grant's outcomes and in describing other faculty members' resistance. As discussed below, talk of 'bullets,' 'heavy fire,' and 'being shot' among other graphic and evocative militaristic metaphors frequently accompanied RED meetings that repeatedly centered on tense and anguished discussions about some faculty members' experiences with working to enact change. Additionally, in discussions about the work of the grant that took place outside of formal meetings, RED team members described and grappled with a myriad of emotions and personal implications of the work involved in producing change in engineering; here, too, team members often drew on metaphors. As the social scientists for the project, we were attentive to both the social dynamics of the team and of change itself. Team members' experiences of 'revolution' and their expressions of those experiences thus emerged as a key focus for investigation.

We shared our preliminary observations and insights from our fieldnotes with the RED team about the metaphors used in meetings and our plans for examining these metaphors as they related to the project's aim of producing change in the engineering curriculum. We also introduced our plans to conduct follow-up or additional interviews with the RED team and other faculty members. This additionally prompted RED team members to occasionally reflect on their use of metaphors during meetings – metaphors that previously they had used without remark. The first author conducted these follow-up and additional interviews in 2019 with faculty members in the School of Engineering and the RED team, centering on their experiences and perceptions of institutional change, changemaking, and the RED grant. Interviews with RED team members also had an additional focus to ask explicitly about their use of language and metaphors. In particular, in the follow-up interviews with RED team members, we probed for additional details and reflections about metaphors that we had heard in meetings and in other contexts and in the RED team's original interviews (conducted in 2017), which we also revisited in preparation.

The first author coded interview transcripts using Atlas.ti, following a process of thematic open coding, but centering on metaphors, processes of change, and structural conditions that shape the possibilities for change.[26] Focusing on these broad categories, we derived a variety of codes that described the types of metaphors, types or forms of change, and structures shaping change. For metaphors, for example, the most frequent codes form the basis of our sections below and include 'revolution,' 'war & peace,' 'evangelism,' 'caring,' and 'soft engineering.' Other metaphors and codes that were found, though much less frequently, include, for example, 'sports,' 'body/medicine,' and 'materials and substance.' Codes relating to structure include, most commonly, 'SMSE politics' relating to politics within the Shiley-Marcos School of Engineering, 'meaning of expertise,' and 'social vs. technical.' Some of these codes are to be expected as we observed these issues prior to interviews or they were tied to the framing of the grant, such as 'war & peace' and 'social vs. technical.' Other codes, however, while

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[25] Research for this article was approved by the University of San Diego's Institutional Review Board, approval # 2014-11-105.

[26] Maxwell and Chmiel, "Notes Toward a Theory of Qualitative Data Analysis."

unsurprising in relation to the questions about equity in engineering outlined above, were also not purposefully sought out *a priori* but were derived from the interviews.

Our positionality as social scientists on the team shaped our interactions with both the RED team and the rest of the engineering faculty, enabling this research and shaping its focus. We participated in RED meetings and could easily ask team members for interviews. Yet our position as social scientists, at least partially outside the organizational hierarchies and politics of the engineering School, contributed to the willingness of other members of the engineering faculty to speak with us. At the same time, being part of the RED team meant balancing and representing conflicting perspectives, while also honoring the goals of the RED grant. RED team members also reviewed this manuscript prior to submission. In presenting a critical perspective on the use of metaphors and their implications, we struggled with how to present this research in ways that would not exacerbate tensions within the team and School while at the same time disseminating this research in a way that is useful to social scientists, engineers, and other researchers engaged in related transdisciplinary projects. In light of the above, we have taken significant efforts to preserve anonymity.

Given the relatively few women and nonbinary faculty in engineering, throughout this article we employ gender-neutral pseudonyms and pronouns when referring to participants, in order to obscure those participants' identities. In some cases, we do not associate quotes with particular pseudonyms; we did this when linked quotes might have made a participant identifiable or where quotes were taken from participant observation rather than interviews. The choice to obscure identities potentially dilutes the narratives of those whose experiences are marked by painful histories in engineering. For example, in reviewing a draft of this paper, the woman engineer on the RED team suggested that the pseudonyms minimized her experiences. The authors recognize gender is a central organizing principle in the domain of engineering, yet kept the gender-neutral pronouns throughout because of a commitment made to the team at the outset of the writing process and because these pronouns protect other marginalized voices. While there is much to unpack in relation to processes of change from the perspectives of both the RED team and other faculty members, our scope here focuses on the metaphors used primarily by the RED team because of the central role they play in working to institute change and implement the goals of the grant.

Metaphors and Change

The role of metaphors in poetics and practice has been a key area of interest for social scientists.[27] As a language construct, metaphors combine two disparate terms to illuminate the meaning or experience of one in terms of the other, where the terms include a 'bundle of shared features,' as well as a topic and general knowledge about that topic.[28] Anthropologist J. Christopher Crocker outlines how metaphors operate in and speak to different strategic levels: interpersonal interaction, narrative context, and rhetorical/proverbial worldviews.[29] While Crocker suggests anthropologists historically have focused on the final dimension of rhetorical/proverbial worldviews, he argues that metaphors necessarily operate across all three.[30] The interaction of these three dimensions is precisely our focus here: how the use of metaphor by

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[27] Lakoff and Johnson, *Metaphors We Live By*; Sapir and Crocker, *The Social Use of Metaphor*; Sontag, *Illness as Metaphor*; Turner, *Drama, Fields, and Metaphors*.

[28] Sapir, "The Anatomy of a Metaphor," pp. 6–12; see also Lakoff and Johnson, *Metaphors We Live By*.

[29] Crocker, "The Social Functions of Rhetorical Forms," pp. 38-39.

[30] Crocker, pp. 38–39.

the RED team members shapes interactions, contexts, and worldviews relating to the project, School, and processes of change.

The specific metaphors that we use matter because of their relationship with how we see, experience, and construct the world. As Lakoff and Johnson surmise, 'if we are right in suggesting that our conceptual system is largely metaphorical, then the way we think, what we experience, and what we do every day is very much a matter of metaphor.'[31] They point out, for example, how the operation of a metaphor such as 'argument is war' shapes what is recognized as argument and how it is enacted and constituted.[32] They emphasize this point by asking readers to consider how conceptualizing argument as dance would fundamentally change the nature of argument in a culture.[33] Lakoff and Johnson's point is useful for illustrating how perception and action are intertwined with metaphor. That is, metaphors are embedded within frames of thought and interpretation.[34] Anthropologists have also shown how metaphors are entangled with the worldviews and ontologies of a culture through societal structures, ritual practices, and sociocultural beliefs.[35]

Science and Technology Studies (STS) scholars have shown how metaphors are fundamental to the conceptualization and construction of technologies such as the Internet, the computer, computer viruses, cloud computing, device control (e.g., the 'master-slave' metaphor), and algorithmic problems (e.g., the 'stable marriage problem').[36] In scientific practice, metaphors are central to conceptualizing biological processes such as reproduction, the immune system, and illness.[37] Susan Sontag, for example, raged against cancer metaphors that blame patients for their own suffering, and called for restraint in the use of metaphors relating to illness.[38] Susan DiGiacomo, who also experienced cancer and theorized metaphors, by contrast, argued that metaphors are valuable precisely because they produce shared, socially constructed meanings.[39] Metaphors can accentuate or hide cultural stereotypes and inequalities. Leo Chavez describes how popular media describe unwanted Mexican migrants in the US as vermin, echoing terminology leading up to the Holocaust.[40] Metaphors can serve to perpetuate sexism, homophobia, racism, and ageism, as seen, for example, in the metaphors for technologies mentioned above, as well as metaphoric derogatory terms for older women, homosexual men, genitalia, sex, and menstruation.[41]

Sociocultural change is also constructed and embodied through metaphors. While particular metaphors may seem nonsensical or may confer vastly different meanings when taken out of context, metaphors can also produce new understandings. Sally Wyatt explores the use of

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[31] Lakoff and Johnson, *Metaphors We Live By*, p. 3.
[32] Lakoff and Johnson, pp. 3–4.
[33] Lakoff and Johnson, p. 4.
[34] Foucault, *The Order of Things*.
[35] Douglas, *Purity and Danger*; Turner, *The Forest of Symbols*; Turner, *Drama, Fields, and Metaphors*.
[36] Wyatt, "Danger! Metaphors at Work in Economics, Geophysiology, and the Internet"; Brahnam, Karanikas, and Weaver, "(Un)Dressing the Interface"; Helmreich, "Flexible Infections"; Boellstorff, "Culture of the Cloud"; Eglash, "Broken Metaphor"; Wagner, "Mathematical Marriages."
[37] Martin, "The Egg and The Sperm"; Martin, *Flexible Bodies*; Martin, "Medical Metaphors of Women's Bodies"; Sontag, *Illness as Metaphor*.
[38] Sontag, *Illness as Metaphor*.
[39] DiGiacomo, "Metaphor as Illness."
[40] Chavez, *The Latino Threat*.
[41] Asma, "Metaphors of Race"; Martin, "Medical Metaphors of Women's Bodies."

metaphors by scientists in relation to economics and 'geophysiology' and finds metaphors either help or inhibit how scientists conceptualize new ideas, but 'a successful metaphor can alter our understanding of the world.'[42] Cognitive scientists adapted 'machine' as a metaphor of the mind, for example, and consequently began creating new metaphors and interpretations for cognition such as 'information processing,' 'symbol manipulation,' and 'serial processing stages.'[43] Metaphors produce meaning in the absence of both pre-existing frames of reference and access to the visible/tangible. For example, metaphors of the Internet as a 'highway' or 'bridge' versus a 'revolution' or 'evolution' provide means of interpretation, but also have tangible effects by influencing public opinion and policy and generally shaping the future.[44] In the context of differing cultures and epistemologies, metaphors also provide a base for producing understanding and constructing novel concepts and interactions. For example, Wiebe Bijker discusses metaphors such as the 'the STS kiss' and 'the STS mirror' that were used by scientists in interpreting the role of STS scholars and researchers in transdisciplinary projects.[45] The use of metaphors can capture an understanding of one or more topics in an attempt to bridge epistemological differences.

Metaphors are thus performative, shaping our realities as the words we use iteratively (re)produce norms, values and beliefs through their use. The metaphors we use *matter*. Following Karen Barad's approach to posthumanist performativity, metaphors are part of producing the material-discursive 'becoming' of the world.[46] More specifically, metaphors are a part of dynamic materiosemiotic 'intra-actions' that contribute to creating certain specific realities and excluding others.[47] Barad's approach calls us to consider how, through the use of different metaphors, reality could be otherwise. In the next section, we consider the realities intra-actively constructed as engineering faculty members use metaphors of war to grapple with processes of change and the concomitant social and political inter/intra-actions within their School.

Revolution and War

The RED grant is formulated around the concept of revolution, explicitly outlined to solicit and promote *more than* incremental change or reform. For the RED team, this formulation has fostered the sense that they can and should contribute to large-scale, drastic change in engineering education. In practice, however, there is significant variation among team members. Some hold ideals of how engineering needs to change in order to be a more welcoming environment for future and, ideally, increasingly diverse students. For others, the focus of change is primarily on professionalization and developing engineering education that is relevant to industry practice.

In terms of the former group, some team members are deeply invested in efforts to produce revolutionary change because of their own negative experiences in engineering education. These team members explicitly work to address the kinds of inequities in engineering that were outlined in the introduction to this article. Some of these faculty members indicated they do not like thinking of themselves as revolutionary because the metaphor does not resonate

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[42] Wyatt, "Danger! Metaphors at Work in Economics, Geophysiology, and the Internet," p. 249.
[43] Bowdle and Gentner, "The Career of Metaphor," p. 193.
[44] Wyatt, "Danger! Metaphors at Work in Economics, Geophysiology, and the Internet."
[45] Bijker, "The Need for Public Intellectuals," p. 446.
[46] Barad, "Posthumanist Performativity," p. 822.
[47] Barad, "Posthumanist Performativity"; Barad, *Meeting the Universe Halfway*.

with their sense of selves; even so, the NSF grant has enabled them to 'think big' and advocate for broad-scale changes, such as working to shift cultural norms within the School. As one team member discussed in relation to the need and desire for revolutionary change:

> I think that what makes it revolutionary is when you're trying to make it more systemic, and I don't know that we have gotten all that . . . as long as it's individual champions, which is what it's been, right? That doesn't translate into the revolution because the champion gets shot and there's nobody left to take over, right? (Aubrey)

This team member relies on the concept of revolution to point to the differences between incremental reform and systemic revolution. Changes (not all directly the result of the RED grant, but often seen as tied to it) that are intended to have a systemic impact include the development of a new department and degree program and cluster hiring of new faculty for this program and across the School with a focus on gender, area of expertise, and other diverse perspectives grounded in positionalities. The metaphor of revolution works primarily on the interpersonal and narrative/context levels here, providing team members with a semiotic frame for their work relating to the grant as they interpret the context of their efforts to enact a 'revolution.'

Yet, Aubrey also uses metaphors relating to violence and war to point to the individual challenges of change, namely that the 'champion' of change may be 'shot.' For example, efforts to introduce new courses that cross disciplinary boundaries and incorporate sociotechnical content and that ask students to consider the social contexts and implications of engineering technologies and designs based on considerations relating to social justice and sustainability have been a focal point of much debate in faculty meetings. The risks and feelings of being 'shot' discussed by Aubrey are embedded in a field of tensions, while also relating to the vulnerabilities entailed in efforts to enact change.

Another team member similarly uses metaphors of violence to reflect on the struggles of producing change:

> I think the word 'revolution' is an appropriate word because it is the changing of values and hearts to something… (long pause) But I think that … it's bloody. It's hard. It's messy. I don't think that I saw it to be that hard… I thought what we're doing is really cool… [It has been] much more of a war than I thought. (Remi)

Following the discursive construction of metaphor, Remi invokes details of this 'revolution' finding it to be 'hard' and 'bloody' in its challenges, suggesting that they had not anticipated the 'messy' elements of the process. While revolution is used to conceptualize and describe the scale of change that the project has sought to produce, Remi's and Aubrey's reflections also cross into operating at the strategic level of a rhetorical/proverbial worldview. They show how the team has taken on the metaphoric connotations relating to violence and war seen in the word's political usage, with effects on the types of change that are being made possible.

Faculty members, who took different positions in discussions of how and what kinds of change to effect, frequently used metaphors of 'fighting' to describe their interactions and efforts; in interviews and informal conversations they talked about 'fighting the fight,' 'fighting these issues,' or that it can be a 'battle' when discussing curricular change centering on changemaking values. Following a contentious debate around the integration of changemaking themes in the curriculum, for example, one faculty member suggested in a meeting (un-prompted in that particular moment, but seemingly reflecting on our discussions in meetings about

language and metaphors of war) that 'for the first time I feel that we're in the revolution… [it] was a battle scene … We need to find common ground, but, yes, there will be heavy fire… that's the reality of our current situation.' Another respondent reflected on the source of these divisions in an interview, though without explicitly remarking on or noticing the metaphoric connotations at the time: 'The longer that they have been in academia in engineering, the more *entrenched* they are with those values...' (emphasis added). While one definition of 'entrenched' is resistance to change, where resistance itself has connotations relating to violent opposition and war, the word's origins also stem from the creation of literal trenches as defensive fortifications. Interestingly, in interviews and casual discussions not explicitly about metaphors, other faculty members in the School also talk about what is going on in the 'trenches' to refer to the mundane struggles of those who teach regularly (as opposed to the upper administration, who are part of the RED team).

Metaphors of war and violence were used to explain the divisions within the School, but also to discuss the effects that these divisions and struggles had on individuals. As one team member explained in an interview while discussing the team's use of militaristic metaphors, 'there's no question that people feel beat up and ostracized and attacked' (Max). Another team member explained in an interview while discussing efforts to initiate change, 'I can only become so big of a shield' and also highlighted how other faculty members have pointed out that they 'shouldn't have to be a bigger shield, we need [others] to stop firing the bullets.' The elicitation of visceral and graphic sensibilities varied across the team; some members felt the burden with great intensity. Metaphors of 'shields' and 'bullets' and being 'beat up' provide a means of expressing and understanding how efforts for revolutionary change, seen as necessary for an inclusive and diverse engineering, are also personally painful.

Yet, as these metaphors increasingly shape the worldview of the team, efforts for change themselves come to center on how to manage the internal debates, with all their painful political implications. This focus takes the place of attention to systemic elements and structures that would enable change. Team meetings repeatedly centered on the pain of experiencing 'bullets' and 'heavy fire,' as well as how to strategically implement changes to minimize such fire while shielding more vulnerable members of the faculty. In doing so, the discussion was continually re-focused on interpersonal conflict or strategic confrontation between opposing sides, rather than on the broad structures of inequality that pervade engineering or the inequalities within the institution, including institutional inequalities between the RED team members and other faculty members. For example, faculty members in engineering who were not part of the RED team often pointed to governance processes as key sources of contention. Yet, these processes are precluded from discussion because of the predominant focus on interpersonal and oppositional confrontation.

In the context of the US defense industry, Carol Cohn has explored how the use of technostrategic language among defense intellectuals 'does not allow certain questions to be asked or certain values to be expressed.'[48] While the use of metaphors of war in our case are not nearly so elaborated as the technostrategic language explored by Cohn, they function in similar ways. Using such metaphors creates an accentuated dichotomy between (what were perceived as) opposing sides, to the exclusion of questions about infrastructure, governance, and structural inequalities. One RED team member describes how the use of war metaphors connects with the team's difficulties in producing change:

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[48] Cohn, "Sex and Death in the Rational World of Defense Intellectuals," p. 708.

> We're trying to stay safe… I really did resonate with that word [revolution] ... [but] it has come to my attention that a lot of the words and the metaphors that we use are very battle focused… It's like, 'We're at war. We have a war room,' and with that frame, you are not going to build a cohesive culture. You're going to build something that is an us-versus-them, it's the North versus the South… And that is a huge reason why we can't have conversations with the opposition, 'cause you feel it's wasting your time… And it will be a waste of time. If you see it that way, it will be. (Arin)

Efforts to stay 'safe' are responses to feelings of being attacked, as well as the challenges to producing change in 'revolutionary' terms. This respondent also points out how the use of war-like metaphors, and the opposition they assume and produce, is counter to efforts to produce change because neither 'side' can listen to or learn from the other. Such positioning limits and shapes the types of interactions – and thus the types of change – that are possible through the (re)production of opposing 'sides' (or 'forces of good' versus implied 'forces of evil,' as one faculty member referred to in an interview).

In the case of technostrategic language used in the defense industry, according to Cohn, metaphors were imbued with performances of hegemonic masculinity, but the language was also 'fun' to speak even as (or because) it enabled the speaker to 'feel in control' while also eliminating 'victims' of war and creating them as 'users.'[49] In the case of war metaphors, other faculty members are framed as the 'opposing side,' positioning them as distinct from one's own 'side'. The use of the metaphoric theme of war meshes comfortably, in many ways, with historical and existing discourses and practices in engineering, including long-standing connections to the military-industrial complex.[50] On the other hand, some explained that the battle metaphors connected to their own deep personal painful experiences of feeling verbally attacked in the context of engineering. Although in our analyses of the data here we have limited the discussion of gender to protect the identities of our informants, the different uses of battle metaphors follow gender power relations.

Thus, without losing sight of the broader structural inequalities that have produced the need for a revolution and, indeed, the ways 'revolution' and war as metaphors have enabled some team members to point to systemic inequalities and discrimination in engineering and in their own experiences, the (re)production of opposing sides that are 'fighting,' 'firing bullets' and at war demonstrate the 'perils' of using a revolutionary metaphor.[51] The war metaphors also suggest that one 'side' wins and another loses, which could seemingly imply either a victory or defeat for integrating social context and justice – among other values of the RED grant outlined above – in engineering. Our contention is that a metaphoric war undermines efforts to produce a sociotechnical future in engineering that is reflective about and accountable to current and historical power relations and inequities and that works to address key societal problems; it indicates the perpetuation of an organizational silence, grounded in hegemonic engineering norms which are thoroughly implicated in the reproduction of 'modernist' dichotomous exclusionary approaches outlined in the introduction. What is more, such 'perils' in this case are counter to goals of the grant, including those relating to social justice, sustainability, and peace.

Conversion and Evangelism

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[49] Cohn, p. 704.
[50] Slaton, *Race, Rigor, and Selectivity in U.S. Engineering.*
[51] Turner, *Drama, Fields, and Metaphors*, pp. 30–31.

Recognizing these perils, some team members sought instead to describe the 'conversion' and 'evangelizing' process through which they themselves have changed and through which they spread information to others in the hopes that they would adopt a new mindset about engineering. One team member explained:

> I think I started using the word 'converted' because of the values proposition. Whenever you change values, that's a conversion, whether it's a religious conversion or a conversion to a cause, somehow you're adopting values and if you have to go through a process of changing values. I think that's what I mean by the word conversion. (Remi)

Some of these team members themselves felt they had been converted through the process of the grant. One faculty member talked about the significance of attending a workshop on entrepreneurial-minded learning that inspired them in thinking about how to creatively integrate active learning and address the social contexts and ethical implications of course topics, which had previously focused exclusively on technical concepts and systems. The faculty member also discusses the significance of meetings with the grant's external advisory board, explaining:

> I came back armed with the knowledge and understanding of... how to [take] a technical class and in bringing some sociotechnical aspect and still overall it's… something that fit, it's not something that just, oh, you're just doing something just to… check the mark… but now it's integrated and it's meaningful in that sense… and then having participated in the advisory board, and fully engaged in it, and then the question they asked… I keep on asking the question, 'Why? Why do you do what you do, right?' (Kai)

These events led Kai to 'evangelize' a sociotechnical approach to engineering by actively discussing the topic with other faculty members, following their own 'conversion,' as discussed further below. In this way, these metaphors operate on interpersonal and narrative strategic levels to both describe how the team is trying to approach change differently and explain how they themselves have changed.

Anthropologist Susan Harding has explored the process of conversion among fundamental Baptists:

> The membrane between disbelief and belief is much thinner than we think. All I had to do was to listen to my witness and to struggle to understand him. Just doing so did not make me a fundamental Baptist born-again believer, but it drew me across that membrane in tiny ways so that I began to acquire the knowledge and vision and sensibilities, to share the experience, of a believer.[52]

Listening is the first step in conversion. The composition of the RED leadership team produced a structure where members such as Kai and Remi could listen to the values of the grant and 'acquire the knowledge and vision and sensibilities' of revolutionary change through dialogue with other team members – including with the social scientists. Conversion became a metaphor for RED team members to understand their own relative roles in the grant and to reflect on how these roles changed over time; several team members explained they did not view themselves as 'converted' when the grant initially started. This overlap shows the interrelationship of language usage and practice and how these inform one another.

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[52] Harding, "Convicted by the Holy Spirit," pp. 178.

Building on their own 'conversion,' metaphors of evangelism provided team members with a framework for conceptualizing how to promote the grant's goals beyond the team. Chris, for example, explained the significance of evangelism in the context of enacting curricular change, which requires voting by all faculty members: 'Yeah, everything is voted on, so you can only evangelize and socialize your ideas and hope that [others] find value in them' (Chris). Another faculty member expressed the challenges in this process, indicating that it cannot be a top-down change by force. Mixing metaphors of math and religion, they asserted that engineering is sociotechnical in the sense that social and technical concerns are intertwined, which should be seen as a 'truth statement' – taken as an objective statement of fact, a 'truth' about reality.

> I'm pretty confident saying engineering [is] sociotechnical. That's a true statement. It's even axiomatic. I mean just look at what it is, right? You don't need a proof because the proof is … apparent. And I think very few people would disagree with that, okay? But then [the question is] how do we lead and convince?... I call this a truth statement because … you're causing people to change values, change what they believe… It doesn't work by going there and then putting a knife to someone's throat and saying, 'You've got to convert.' (Kai)

This faculty member uses a metaphor of evangelism to describe the steps through which others find meaning, while using the metaphor of violence (knife to throat) to illustrate the challenge and failure of producing change by using force or power. This faculty member further explains why evangelism is a useful way of approaching cultural change in engineering:

> Evangelism, if you will, is through dialogue, through conversations, and then being able to talk about what is the reality of things, right? It's not, 'okay, everybody can believe whatever they believe and then you do whatever you do, it's all good, da-da-da…' There is some reality check, and so that's why I think reaching a truth statement is so important… The hows of things could be very different and they can argue on that... You may disagree with the hows, but if you agree with [the truth statement], [the question becomes] do you have any suggestions? Right? (Kai)

Here, Kai explains how the metaphor of evangelism is put into practice, using skills and knowledge from religious evangelism to start a dialogue with other faculty members. The idea of having a fundamental 'truth statement' provides a bedrock to build further discussion. Kai also rehearsed different kinds of arguments and discussions that they might have with faculty members and kept notes of different things to point to in discussion. Kai's 'truth statement' is an important foundation for laying claim to, and spreading, the grant's goals, with the idea that such a truth is not subjectively defined but rather taken as objective and therefore unobjectionable. Yet Kai's comment that they were 'armed with the knowledge' to pursue change points to the ways that metaphors and practices of evangelism can cross with those of war. The metaphor of evangelism provides both a frame of interpretation and a method for enacting change; the metaphor is operationalized as team members work towards promoting the goals of the grant among others in the School. The metaphor of evangelism thus demonstrates the way such metaphors operate performatively to intra-actively shape interpretation and action through their use.

That USD is a Catholic university focused on 'mission' in both the religious and business senses sustains the discursive field for this metaphor's use and its shared relevance among the

leadership team. 'Mission' is, of course, also associated with military actions and objectives, which also aligns with our analysis. From the large cathedral in the middle of campus to the crosses painted on classroom walls, and hallways lined with church pew seating in the engineering building, the university's Catholic identity is omnipresent. Even if evangelism is not necessarily a part of Catholicism specifically, the Christian faith-based context sustains the relevance and acceptance of the metaphor. Members of the RED faculty, like all members of this institution, respond in their annual performance evaluations not only to prompts on Teaching, Research, and Service; they also address a fourth criterion, 'Commitment to the Mission of the University.' In doing so, some faculty members draw upon the social justice tenets of the Catholic Intellectual Tradition and Catholic Social Teaching to frame and justify their advocacy and equity work.[53] Some faculty members also suggested that this context allowed more permeability in the engineering curriculum in support of the grant's goals. Yet, while team members' own conversions to integrating social and technical concerns in engineering can be seen as one success of the grant, and while the religious context of the University may make their use comfortable in support of the goals of the grant, metaphors of conversion/evangelism are also not without their perils.

The acceptance and integration of metaphors and practices tied to religion often preclude questions about their implications. Humanitarian practice – one of the pillars of the grant, along with peace, sustainability, and social justice – seemed to be among the most widely accepted and practiced approaches across the School. Regardless of the intention, practices of humanitarianism and evangelism entail taking on a position of trusteeship; 'a position defined by the claim to know how others should live, to know what is best for them, to know what they need.'[54] While the goals of many engineering educators are to teach students how to innovate technical solutions to societal problems, 'the claim to expertise in optimizing the lives of others is a claim to power' or an exercise of power. [55] Design scholars have pointed to similar power dynamics where designers are often positioned as experts who know and solve 'others' problems.[56] In other contexts, historically, trustees have included colonial officials and missionaries (including Christian evangelists), technological and biomedical interventionists, and nongovernmental organizations.[57] Among the team members and others in the School actively pursuing the grant's goals, there were varying levels of susceptibility to these power dynamics and variations in how these metaphors were enacted.

Some team members internalized and enacted an evangelizing approach to sharing the revolutionary grant goals; others applied the metaphors of conversion, but truly struggled with understanding how to dismantle – or recognize – their own position in and loyalty to the status quo that rendered them in privileged positions. Raising complex issues of subjectivity and naming unequal team dynamics has been highly painful for some, and produced tension among those unprepared to engage in the emotional labor required for difficult dialogues. Marginalized and early career faculty who have often taken the lead in integrating social justice within engineering and questioning broader power dynamics have also shared their experiences of how their perspectives and expertise are both devalued and rendered marginal.[58] These dynamics

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[53] Cernera and Morgan, eds, *Examining the Catholic Intellectual Tradition;* Pulido, "A Vocation of Space."
[54] Li, *The Will to Improve*, p. 4.
[55] Li, p. 5.
[56] Costanza-Chock, *Design Justice;* Irani, "'Design Thinking'."
[57] Li, p. 5; see also Comaroff, "Christianity and Colonialism in South Africa."
[58] Chen, Mejia, and Breslin, "Navigating Equity Work in Engineering."

suggest that, although some RED team members claim to have been converted to the aims of socio-technical approaches, their actions do not always align with the intention of evangelizing the grant goals.

The intra-actions of metaphors of evangelism and conversion are multiple and complex. For some the metaphor of conversion operates on an interpersonal and narrative level to interpret and share what they have learned and how they have changed as part of the grant. The use of religious metaphors aligns with the University's faith-based mission and the thread of 'change-making,' which is used to justify and support the goals of the grant and, indeed, to grapple with and challenge the power dynamics embedded in both the religious context of the School and of engineering. Yet, these metaphors also produce a paradox. While conversion suggests a change, if devoid of ethical-political obligations, recognition of one's own position, and commitment to grappling with power dynamics, the results can be hollow and potentially dangerous. The metaphors operate at the strategic level of rhetorical worldview in promoting change, even as metaphor and context may mutually support one another to reproduce existing hierarchies and structures of power. These complex dynamics are seen further in metaphors of care.

Care

As the tenure of the grant progressed, some team members began to shift their approach to change, conceptualizing it in terms of 'care' in response to the tensions discussed above, particularly in relation to metaphors of war. Care is conceptualized herein as an encompassing category for a variety of metaphors that also include 'fluff,' 'soft,' and 'peace.' One team member reflects on this process, pointing out the shifts in how the team conceptualized their efforts towards producing change, with a renewed perspective:

> I think we're finding a more peaceful way to move about in this where it doesn't have to be complete opposition, I think that there's been some surrender of trying to get other people converted, that word, trying to get other people to suddenly see the light as opposed to celebrating what's already being done… [to celebrate] the people that are already doing this, and finding others in the external community [with shared goals], and not worrying so much about getting people to do it. I think that's a subtle change. (Remi)

This team member later suggested that the RED team is now focusing on finding 'kindred spirits' in following 'a more peaceful approach to the revolution.' In this regard, care as an approach and metaphor is intertwined with some interrelated initiatives by the grant team for all faculty in the School, namely social gatherings to recognize and celebrate the efforts of those who have contributed to the goals of the grant and providing collaborative support for those outside the RED team who want to do work that is relevant to the grant.

The use of concepts of 'care' and 'peace' by team members in part reflects the values promoted by the University more broadly. The University has a School of Peace Studies, and the campus' strategic plan includes 'care for our common home' as one of its six pathways for the future direction of the institution. This deliberate focus on care can entail a reconceptualization of engineering practice that overturns the primacy and dominance of technical knowledge, as well as a new process of conceptualizing change. Caring as a metaphor diverges both from the metaphors of war and violence discussed above, and from routinized ways in which engineering is habitually framed. The possibilities of care as a metaphor for change are clear when thinking about how these initiatives would be impossible based on metaphors of war across all three strategic levels – interpersonal interaction, narrative context, and rhetorical/proverbial

worldview. The opposition entailed in metaphors of war precludes such offering of broad recognition or support. Similarly, metaphors of conversion/evangelism can suggest that once a person is 'converted' there is no longer any work to be done.

At the same time, metaphors of care can have overlapping connotations with metaphors of conversion/evangelism. One team member used the idea of a shepherd to refer to some of the ways that other leadership team members are guiding early-career faculty members: 'The shepherd ... [guides] all untenured faculty, kind of under [their] wing, protecting them, guiding them to the ... not the promised land, but guiding them to tenure, and guiding the program' (Chris). This respondent emphasizes how leaders guide early-career faculty towards tenure in the context of the values of the grant. This team member elaborated on care as a value when asked what other metaphors they thought of in relation to the project:

> 'Caring,' I mean that's sort of the one that I think of. I mean, a lot of things that we - whether it's social justice, or professional skills maybe not as much, but a lot of things that stem around the humanitarian engineering - is caring; sustainability, caring for our earth; social justice, caring for common people… Revolution is 'I'm doing it no matter what because I have a goal that I want to do'. (Chris)

Chris points to the ways that the values of the RED project are associated with care, including for people and for the earth. Contrasting care with their interpretation of revolution suggests that caring is meant to operate as a more inclusive metaphor for the project more broadly.

This team member further reflected on their own role in the RED grant, thinking through the overlap with the metaphor of shepherds, as compared with others as evangelists:

> I'm not the shepherd, I'm more of a disciple. (Chuckling) I agree [with the goals of the RED grant]... I just don't have a flock, or anything that I'm shepherding… (pauses) ... [B]eing an advocate for this and talking, and encouraging, [it's] mildly shepherding but I wouldn't use the word 'shepherd' for me, more of evangelizing. (Chris)

Chris is conceptualizing department chairs as having a pastoral guiding role for their 'flock,' as opposed to the evangelism of faculty peers. This division reflects changes in the position of grant team members as some have stepped down from their role as department chairs since the beginning of the grant, but continue to be team members. Chris' division also reflects the ways that team members themselves continue to learn and change as 'disciples' as part of the grant. Chris also explained that their sense of evangelism centers on ways of including more people in the project while 'preaching' within the team about the need for openness. At the same time, these uses of metaphors relating to care evidently continue to be closely implicated in existing discursive frames discussed in relation to religious evangelism. Moreover, care can also entail a position of trusteeship if the care-giver makes claims to 'to know what is best for them, to know what they need.'[59] The pastoral role suggested in the metaphor of the shepherd also suggests a paternalistic form of guidance, even as the metaphor is applied to members of the team of differing genders and as some uses of metaphors of care reproduce gendered associations and divisions between private/public, social/technical, and even soft/hard.

Despite this association between care and paternalist guidance, care is often linked with femininity and, in this regard, metaphors of care are deeply imbricated with gendered disciplinary divisions. Terms such as care, femininity, social, and soft entail a cluster of

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[59] Li, *The Will to Improve*, p. 4.

discursive associations that often frame the grant and its efforts for change. Indeed, divisions between engineering faculty members who are seen to support or contest the grant and its goals, discussed above, are often mapped onto *a priori* social divisions between 'soft' versus 'hard' academics, or 'social' versus 'technical' content. One faculty member explained how others have reacted to some of the workshops for faculty members by experts in Science and Technology Studies and to curricular changes for new and existing courses to address social context and social impact: 'some have said to me, "This is fluff, doing this is fluff." Others because they think they already do it and they don't understand the difference in what they do and what we're trying to achieve… Those that think it's fluff, I think they're really hard to change' (Remi). Terms such as 'fluff' are used similarly to 'soft' engineering, but more pejoratively.

USD offers a combined BS/BA for engineering, which is a unique combination in the United States, and can offer students more exposure to arts and social science courses than is common in engineering programs. Thus, from the perspective of some faculty members, these students are already learning about societal contexts. The reactions, however, also reflect the ways that the technical is most highly prized in engineering, while courses in other departments, such as the social sciences, are deemed 'soft.' In this context, engineering as care would be associated with 'soft' and 'social' sciences and engineering, i.e., with work and forms of knowledge that are often devalued. Feminist scholars have also pointed to the ways women's work is often associated with care work (as forms of reproductive and emotional labor) and concomitantly devalued or made invisible.[60] These divisions (and hierarchies) are reproduced through metaphors such as 'soft' and 'fluff' engineering when contrasted with the normalized conception of engineering as a 'hard,' 'rigorous,' and technical practice.

In response to these pejorative divisions, some team members reclaim the term and idea of 'fluff,' including whimsically suggesting that the team mascot should be a fluffy chinchilla. Not all team members are enthusiastic about such uses of the metaphors and mascots. One team member, for example, explains that the reclaiming of the word needs to be publicized for it to be useful and subversive. Such equivocations point to the tensions and multiple perspectives produced as the team navigates how to integrate concepts of care, softness, and even fluff in engineering. In particular, following the gendered associations with care, such tensions are seen in how offering support outside of the RED team has often been the purview of the postdocs and women members of the team. Similarly, many of those beyond the RED team who have taken on the goals of the grant are women and marginalized faculty members.[61] That is to say, the ways metaphors of care are used and enacted can reproduce structural associations and inequalities, even as some team members seek to valorize them. In particular, where 'care' is restricted to knowledges already treated as 'soft' and 'fluffy' – and to persons who are experts in those forms of knowledge – these divisions (re)produce existing inequalities in engineering.

Despite and, in this case, because of, these 'perils,' embracing metaphors of care could constitute a counter-narrative to dominant discourses defending masculine technical rigor.[62] That is, integrating care and metaphors of care in engineering in ways that challenge the divisions between technical/social, hard/soft, and so on, points to possibilities for reconfiguring hegemonic norms in engineering. Moreover, scholars point to the value of care in centering the ethico-

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[60] e.g. Hochschild, *Commercialization of Human Feeling*; Luxton, *More than a Labour of Love*.
[61] Chen, Mejia, and Breslin, "Navigating Equity Work in Engineering."
[62] Riley, "Rigor/Us."

political obligations involved in studying and doing technoscience.[63] As argued by Martin, Myers, and Viseu, 'the turn to "matters of care" invites attention not only to how care operates in sociotechnical contexts, but also to the roles that we play in our studies of technoscience and our accountabilities to the worlds that we co-construct.'[64] Such accountabilities include continually attending to the perilous history and potentialities of care to disempower and reinscribe gendered, racial, and other divisions and inequalities, while metaphors of care may work to bridge hegemonic cultures of engineering with an aspirational engineering focused on values such as ethics, social justice, and peace.

Discussion

Metaphors socially construct reality, not to reflect or mirror what is obvious, but rather, to deepen our understanding of what is abstract and enrich what is most meaningful. In the context of engineering education, we can better understand how reality is constructed by considering the metaphors that constitute these meanings. Returning to the opening quote by Victor Turner, metaphors 'enable us to see a new subject matter in a new way,' providing 'new perspectives' such that 'one can be excited by them.' In the context of the transdisciplinary project to 'revolutionize' engineering education that we discuss here and have been a part of, metaphors following themes of war, conversion/evangelism, and care have been used to conceptualize and navigate processes of change. These metaphors work across the strategic levels (interpersonal, narrative context, and worldview) with distinct implications for how change is made (im)possible.[65]

What realities and changes, then, do these metaphors produce – or fail to produce? All three categories of metaphors are implicated in histories of colonialism and 'modernist' ideologies that reproduce inequalities relating not least to gender and race. As the narrative/context level of these metaphoric categories operate also on interpersonal and rhetorical/worldview levels, however, they have distinct implications. Metaphors of war produce interpersonal interactions based on difference and opposition between two 'sides.' They also reproduce worldviews based on conflict, but also a quest for dominance. As such, even as metaphors of war suggest the seriousness of the pain some have felt and of the need for a revolution in engineering, metaphors of war have contributed to reproducing conflicts among faculty members in the School. These metaphors have simultaneously blocked from view the structural conditions within the School fostering such conflicts, as this use of language (re)produces a focus on opposing 'sides' and establishes a sense of an unbridgeable difference between politics and perspectives and thus people in the School.[66] Taken together, metaphors of war reproduce hegemonic norms in engineering even as the purported 'battle' against those norms is meant to overturn them.

Metaphors of conversion/evangelism emerge, in part, from the context of a Catholic university and suggest, for some, a more contextually relevant and interpersonally engaging way of promoting change in the School. Metaphors of conversion have also provided the RED team a way of interpreting changes in themselves brought about through the grant. The religious context and an unreflexive claim to the idea that some have successfully 'converted,' however, also

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[63] Puig de la Bellacasa, "Matters of Care in Technoscience"; Martin, Myers, and Viseu, "The Politics of Care in Technoscience"; Murphy, "Unsettling Care."

[64] Martin, Myers, and Viseu, "The Politics of Care in Technoscience," 629.

[65] Crocker, "The Social Functions of Rhetorical Forms."

[66] See also Cohn, "Sex and Death in the Rational World of Defense Intellectuals."

limits the extent to which the use of these metaphors – and the power relations they are embedded in – are questioned and examined. Similar to metaphors of war, metaphors of evangelism also reproduce norms and histories associated with paternalistic guidance and colonialism. Moreover, the normalization of these metaphors in the context of a Catholic university obscures questions of who is excluded from this context and what other realities are possible, and claims to conversion may hide the ways change is being promoted even as much remains the same.

Metaphors of care are no less perilous than metaphors of war or conversion/evangelism and, indeed, the categories of metaphors can blend with one another – for instance in the conflation of 'shepherding' with caring. However, metaphors of care do provide 'new perspectives.'[67] As Feinrup-Riordan suggests, 'Just as metaphors in general are expressions that establish relationships of similarity among conventionally unrelated categories, these cross-cultural metaphors establish relationships between originally unrelated ways of life.'[68] Metaphors of care in engineering suggest the possibility for breaking the binaries and hierarchies of soft/hard, public/private, and masculine/feminine, while also entailing accountability for our metaphors – and engineering practices. Metaphors of care thus point towards possibilities for reconceptualizing engineering and processes of change. The use of these metaphors among the team members is only nascent and preliminary; it remains to be seen whether the perils of enacting care (e.g., reinscribing power relations) can be avoided or, rather, cared for.

Conclusion

We have shown how the choice and use of particular metaphors are intertwined with constructing the possibilities for change as part of a transdisciplinary project that seeks to integrate changemaking themes - peace, sustainability, humanitarian practice, and social justice - as part of engineering education. With the growing significance of such transdisciplinary projects, considering the fundamental metaphors that shape the interactions, narratives, and worldviews of these projects is a key part of their direction and potential success. As suggested with regard to metaphors about the Internet, 'it is actors who choose to repeat old metaphors and introduce new ones. Thus, it is important to continue to monitor the metaphors at work to understand exactly what work it is that they are doing.'[69] That is, following insights from the politics of design, in pursuing and designing educational and cultural change through such transdisciplinary projects, we need to make ourselves accountable for the metaphors we use and the effects they produce.[70]

In particular, as we have shown, metaphors of war and conversion/evangelism are not productive in enacting change as they cement interpersonal and organizational divisions and inequalities, while also reproducing white heteromasculine ideologies and practices associated with the reproduction of sexism, racism, and colonialism. While such metaphors may be useful on a narrative level for exploring personal change, on the strategic level of interpersonal and rhetorical/worldviews these metaphors are problematic in enacting interdisciplinary change. We suggest that metaphors of care point to a possible way forward. Even though metaphors of care are no less perilous, they are also full of potential for reconfiguring existing 'modernist' divisions. Caring interactions also suggest the need for accountability in our relationships with

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[67] Turner, *Drama, Fields, and Metaphors*, pp. 30–31.
[68] Fienup-Riordan, "Metaphors of Conversion, Metaphors of Change," p. 112.
[69] Wyatt, "Danger! Metaphors at Work in Economics, Geophysiology, and the Internet," p. 258.
[70] Suchman, "Located Accountabilities in Technology Production."

others, including in the language and metaphors that we use. In this regard, metaphors of care also point to the value and need for continually examining the use of metaphors and how they shape project dynamics and processes of change. Transdisciplinary teams and projects can regularly re-examine the language and metaphors they use as a reflexive exercise in accountability. Metaphors of care also point to the structures of support that need to be created to enable care.[71]

Acknowledgements

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[71] Liboiron, "Care and Solidarity Are Conditions for Interventionist Research."

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