**Looking to the future: PhD scholar perspectives on Humanitarian Engineering research, practice, and paradigm**

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***Abstract****: This paper presents an autoethnographic exploration of seven PhD scholars in dialogue with how we conduct research in a humanitarian engineering context. Our experiences and reflections contribute to the evolving definition of humanitarian engineering and to developing systems that better support such humanitarian engineering research. For us, to do humanitarian engineering research is to traverse boundaries: between humanitarian engineering and mainstream engineering practice, across disciplines, and beyond hegemonic conceptions of engineering and development. Drawing from our experiences conducting such research, we explore how both our individual positionalities and institutions impact our research. With a range of backgrounds and experiences, we are well placed to speak to what is happening at the nexus of humanitarian engineering research and practice at a critical juncture where the future direction of humanitarian engineering education and best practices will be established. We recommend options for how PhD scholars and other actors within our institutions (and beyond) might better support the humanitarian engineering research impact. This paper will be informative for both current and prospective humanitarian engineering PhD scholars, university administrators and leadership, and anyone else looking to make impact through humanitarian engineering research.*

**Keywords:** Humanitarian engineering, collaborative design, socio-technical engineering, research methodology, community development, research impact, participatory research, Ecological Systems Theory, decolonial, autoethnography, multi/transdisciplinary, pluriverse

1. **INTRODUCTION**

Humanitarian engineering has a growing presence in global north universities. Australia has seen a rapid proliferation of diplomas, minors and majors in humanitarian engineering over the past decade (Smith et al. 2020). An increasing number of humanitarian engineering academic positions are emerging to service delivery of these offerings. These academics also support a growing number of PhD scholars positioned within humanitarian engineering. We – the authors of this paper – are a group of PhD scholars from a number of such institutions. We informally came together in 2020 to develop a space for collaborative learning and knowledge exchange in humanitarian engineering research.

Humanitarian engineering research is an emerging field in Australia, lacking theoretical and material/programmatic framing. Despite growing recognition as a field (e.g., receiving an Australia and New Zealand Standard Research Classification (ANZSRC) field of research (FOR) code in 2020) we have found these emerging programs lack institutional and other supports to guide ethical and impactful research. Engaging with (relatively) nascent humanitarian engineering literature, we have encountered problematic articulations of humanitarian engineering that inhibit ethical and impactful research and risk perpetuating colonial paradigms. In this paper we articulate an alternative vision:

*Humanitarian engineering must care for the humanity of today and of tomorrow by protecting and regenerating resources to create sustainable places and cultures for future generations. We envision a diversity of place-based practices underpinned by mindsets of humility and courage. These are needed if humanitarian engineers are to contribute to the creation of sustainable pluriversal communities.*

* 1. **This paper**

In Section 3 we expand this articulation of humanitarian engineering, first demonstrating how it differs from existing articulations, highlighting a pluralist and cross-disciplinary orientation that we believe should be adopted beyond ‘humanitarian’ contexts. After synthesising our perspectives, in Section 4 we explore the diverse ways we are working. Finally in Section 5, we describe how these ways of working might be better supported within our institutions, providing insights and recommendations for current and prospective PhD scholars, institution administrators and leadership. Before proceeding, Section 2 describes the methodology of this paper and briefly outlines our positionalities.

1. **METHODOLOGY**

We apply an autoethnographic methodology, utilising methods of collective reflection and writing as inquiry (Cord and Clements 2010; Mitchell and Clark 2021). Rather than simply recording individual perspectives, this methodology generates a negotiated consensus through extended dialogue rooted in collective accountability. Taking a critical lens to our own situations and work, we operate from an interpretivist epistemology (Sovacool and Hess 2017). Influenced by approaches in social research, our methodological choice is inextricably linked with our epistemology (nature of knowledge and ways of knowing) and ontology (ways of being and reality) (Crotty 2020). To apply this methodology, both the context of our collaborative work and our individual positionalities need to be unpacked (see Section 2.1).

The conceptualisation and development of this paper were preceded by approximately one year of fortnightly group sessions. In these sessions, we came together to discuss texts relating to our research in humanitarian engineering and provide peer support. We sought to collaborate and learn, developing a safe space to exchange new ideas, seek feedback and engage in dialogue. This group consisted of the authors, along with several other PhD scholars from humanitarian engineering and adjacent fields. The idea for this paper emerged within this group in 2021, responding to a call for papers on what is happening at the nexus of humanitarian engineering research and practice by the Journal of Humanitarian Engineering.

We began the development of this paper by undertaking individual written positionality statements and written reflections on our research projects and visions for humanitarian engineering in 2030 (Holmes 2020; Secules et al. 2021). We then gathered to share and discuss our individual findings as a group. Through rounds of individual and group reflection, we refined our perspectives about ourselves - our positionalities, work, visions and challenges that we face.

We split into smaller groups to write individual paper sections which were then shared for review and discussed during further group meetings. Initial drafts were composed of text from individual reflections by gathering the reflections into themes. In turn, this reflective and collaborative writing process further developed our articulations of our perspectives (Jasper 2005). After several iterations, the lead author then took responsibility for weaving a cohesive narrative from the draft, generating a coherent authorial voice.

This methodology is well suited to the task of untangling how both individual perspectives and system-level factors support and challenge our experience of humanitarian engineering research. As our experiences and insights are grounded in our positionalities, it is first necessary to introduce our standpoints (Martin and Mirraboopa 2003; Wilson 2020).

* 1. **Positionality**

We are a group of seven PhD scholars across three Australian universities. We bring a range of disciplinary experience, including engineering, anthropology, and sociology, with professional backgrounds in infrastructure, design, public service, universities, NGOs, and community development in Australian and international contexts. We are mainly situated in engineering faculties, considering engineering and technology within social and development settings. As both Settlers and Indigenous people on unceded Indigenous lands, we are all “entangled in resettlement, reoccupation and reinhabitation that … furthers settler colonialism” despite our identities or wishes (Tuck and Yang 2012, p. 1). As such, there is a risk of perpetuating harm and reinforcing colonisation and its impacts (Smith 2021). Our positionalities are also characterised by an openness to evolve our practice, engaging in learning, discourse and action that address these contradictions.

We have included individual statements at the conclusion of the paper to highlight what lived experiences we each bring – our positionalities in this research. A summary of our research sector and professional and academic backgrounds can also be found below in Table 1. In line with an interpretivist lens, the aim is to ground both the material and interpretive contexts of our autoethnographic analysis.

* 1. **Notes on interpretation and scope**

Humanitarian engineering is a contested term with various interpretations, meaning some scholars may not define their work the way we do. Being an interpretive, autoethnographic work, this paper is representative of the authors’ experiences rather than all Australian PhD scholars working in humanitarian engineering or related fields. Despite this, our perspectives do represent an emerging critical mass of researchers in named humanitarian engineering research groups. We hope this stimulates a critical and reflexive dialogue about what it means to do PhD research in humanitarian engineering, and how we might better engage in this research. Throughout this paper we may indicate that some or all scholars hold a particular perspective or experience. Sometimes we name particular authors, and when we wish to remain anonymous, we do not indicate names.

Table 1: The table below expands on our individual research perspectives through the lens of sector, collaborations, theoretical perspectives and impact.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Author | Sector/Field of Research | Extra-Institutional Collaboration | Theoretical Perspective | Mechanism for Impact |
| Anna Cain | Energy justice | Research partnership with Indigenous NGO, including positioning of researcher within project delivery teams. Collaboration and engagement with other Indigenous-led service delivery and advocacy organisations. | Research at the settler-Indigenous interface, drawing on critical energy studies, STS, Indigenous, feminist and decolonial theory.  Exploring communities, implementers, policymakers and funders bring policy to life through project ethnographies of energy projects.  Research is instrumental in supporting and validating practice. | Engaged, policy-relevant research, responding to research priorities identified by Indigenous communities and researchers.  Knowledge translation and mobilisation developed with collaborators. |
| Elia Hauge | Participatory climate adaptation in regional water systems | Iterative research; community and practitioners influence research direction in initial phases. Ensures cases are grounded in “real world” practice. | Applying a socio-eco-technical systems framework to understand water systems adaptation.  Drawing from resilience and adaptation sciences, social sciences, alongside water engineering and water management science. | Participatory workshop research; creating opportunities for knowledge sharing and collaboration through the research activities. |
| Ruby Heard | Energy justice for Indigenous communities | Investigating the barriers to responsible and sustainable power solutions for remote Indigenous communities. | Evaluating the energy system through the lens of Indigenous values, design principles and ideas of equity/justice.  Acknowledging the interconnectedness of all things and the influences of seemingly non-sentient and unrelated aspects (according to Western perspective). | Evaluation of the barriers to implementing real change.  Giving communities a voice to share their assessment of outcomes.  Establishing accountability for service providers and designers. |
| Ellen Lynch | Engineering education and practice | Work with tertiary and accreditation bodies to implement recommendations of study  Personal impact for practising engineers | Drawing together thinking from psychology, philosophy science and technology studies.  Engaging with engineering practitioners to understand their experiences and the role of relationship building in their work. | Two-way development of recommendations and implementation plans.  Open-access and publication of outcomes to educators and practitioners, including educational and personal development material. |
| Angus Mitchell | Collaborative, engineering design of agricultural technologies for Indigenous land-based enterprises | Partnership with Indigenous-led NfPs, businesses, communities, and farmers. Links with Engineers Without Borders Australia. | Collective, action-oriented, and emergent research practice. Research is influenced by Indigenous decolonising methodologies, participatory and autonomous design while being grounded in the pragmatic needs and lived experiences of Indigenous and Settler co-researchers. | Co-producing technology designs and artefacts with Indigenous communities and organisations who own and control these outputs. Research insights shared through Engineers Without Borders Australia to improve engineering on Country. |
| Leandra Rhodes-Dicker | Water, sanitation, and hygiene | Partnerships and collaborations with communities and local organisations.  Participatory research with local practitioners. | Incorporation of multiple approaches including decolonising methodologies, intersectional approaches, and strengths-based approaches. | Participatory research; collaborative creation of heuristics and other practical tools or guidance. |
| Hugo Temby | Anthropology of technology | Participatory action research partnerships primarily with two climate and energy organisations working in the Pacific. | Multidisciplinary approach incorporating STS, anthropology, and Pacific studies. Exploring the social worlds surrounding a renewable energy project in the Pacific, with a focus on (understudied) technology practitioners. | Engaged approaches seeking to empower partners to solve challenges they identify. Working in partnership to ensure research outputs are relevant and useful. Open access publication where possible. |

1. **OUR VISION FOR HUMANITARIAN ENGINEERING**

In responding to the call from the Journal of Humanitarian Engineering to explore what is happening at the nexus of our humanitarian engineering research and practice, we considered the question *what might humanitarian engineering research and practice be in 2030?* To answer this, it is necessary to consider the outcomes we hope to achieve through our research (Bakewell and Garbutt 2005; Mitchell et al. 2015). We foreground this vision to emphasise that we see our research as instrumental towards desired outcomes, drawing from pragmatic and materialist foundations of an *engineering axiology* (value system). We start by grounding ourselves in the current context of humanitarian engineering practice and research. We then move through different aspects of our vision, demonstrating how this interweaves with both emerging discourses and with our own experiences and identities.

* 1. **Our Humanitarian Engineering Context**

Peoples throughout the world have developed and innovated Indigenous engineering and other practices of sustainment for millennia (Hess and Strobel 2013; Kutay et al. 2022). More recently within this time-scale, western engineering has emerged along with the colonisation of Indigenous lands (Abdilla 2018; Lucena et al. 2010). Humanitarian engineering as we know it is historically situated within this development of western engineering (Amadei and Wallace 2009; Lucena et al. 2010). In turn, our perspectives and practices emerge from humanitarian engineering and a host of other disciplines implicated in the ongoing processes of colonisation. This uncomfortable reality has been a key point of reflection for this paper, stimulating a critical sensibility when we draw from existing literature; to value existing knowledge while recognising new knowledges are needed. This approach is similar Nataka’s concept of working at the cultural interface of western and Indigenous knowledges in education research (Nakata 2007). Engaging in this way, we have found that our visions for humanitarian engineering in 2030 grow from existing approaches but are in some ways unique to existing articulations of humanitarian engineering.

* 1. **Beyond hegemonic technologies and systems**

Much existing humanitarian engineering literature flattens ontological and epistemological diversity, contributing to an a-historic narrative with western development at the conclusion. In contemporary iterations of this persistent story, western engineering is both the historic *villain* and contemporary *hero* of interventions abroad (Amadei and Wallace 2009). In this narrative, historic *villains* include colonisation and subsequent failed development interventions, while the *heroes* are reformed contemporary human-centered humanitarian engineering. While this is an improvement on the more blatantly racist development narrative of the past, western technology and governance structures unquestioningly relying on market delivery mechanisms are still taken for granted as the logical conclusion for development (Adelman 2018).

Some humanitarian engineering literature emphasises the need for “globally competent” engineers to work with the epistemic divergence of diverse communities (Downey et al. 2006; Nieusma and Riley 2010; Owiny et al. 2014). Such literature includes laudable critiques of modernisation theory, neoliberal politics and technocratic fixes (Lucena et al. 2010; Nieusma and Riley 2010). This literature problematises humanitarian engineering by drawing on development and sustainability discourses.

However, we have found that mainstream humanitarian engineering literature and practice utilises a *harm minimisation* approach in addressing the tangible inequalities of underserved peoples across the globe. Many of us have been moved by witnessing these extreme inequities at home and abroad. We come to humanitarian engineering with a drive to reduce these harms, but tempered with an unease that the means of addressing them could reify the technocratic and political determinism that have created and continue to propel this system. In our research and discussions, we draw on these critiques to explore how humanitarian engineering might shift away from this harmful pattern.

* 1. **From inclusion and assimilation to sovereignty and autonomy**

While the current literature explores *how we might include diverse knowledges*, if deployed uncritically, this could mean the assimilation of local and Indigenous knowledges within western *worlds* including frameworks of engineering and economic development. We instead seek to reframe this to *how might we support the creation of diverse worlds* in supporting the autonomy/sovereignty of diverse ontologies or “life-worlds” (Escobar 2018). As such, our focus on diverse values and protocols not only encompasses the ability to work with others of epistemic diversity, but also aims to support the revitalisation of these epistemologies and ontologies with communities, aiming to embrace these perspectives ourselves.

Towards ontological diversity, we believe that humanitarian engineering needs to embrace diverse practices towards sustainable development. This means working with the epistemologies and ontologies of often-marginalised communities towards situated interventions that produce pluriversal systems and technologies (Escobar 2018; Velasco-Herrejón et al. 2022). Put simply, local communities need to be supported in imagining and creating their futures according to their diverse cultures, knowledges, perspectives, and traditions.

Engaging in this way requires both courage and humility. Working in collaborative, innovative ways with *othered* knowledges and peoples, humanitarian engineers will meet resistance from the hegemonic system. Practising with courage and persistence will be required. Respecting diverse people and their knowledges also requires humility in understanding our own limits, and to navigate the dangers of essentialism or fetishisation (Foley 2018). Actively applying a reflexive, strengths-based lens, humanitarian engineers must also work from the wealth of our own epistemological and ontological standpoints (Cain et al. 2023).

* 1. **Humanitarian engineering applies to all engineering**

All engineering could learn from this vision for humanitarian engineering. By limiting the scope of humanitarian engineering to only ‘humanitarian’ contexts, we miss an opportunity to critically reflect on and reimagine our own communities. This is both a missed opportunity for ‘developed’communitiesas well as the most ‘undeveloped’communities.

Western engineering is an essential part of a system that harms peoples of the ‘developing’ world. Despite the transition into a ‘post-colonial era’, colonisation, imperialism and capitalism continue to unfold. Imperial nations (such as the USA and France, and Australia as a sub-imperial power) continue to benefit from the extraction of cheap labour and natural resources from developing nations in a dynamic of inequality and dependency (Fernandes 2022; Lennerfors et al. 2015; Martínez-Vela 2001). Within this system, the ‘developing’ nations present new frontiers for the consumption of people and landscapes into capital - a process that results in interconnected social, environmental and economic devastation – exacerbating the challenges that humanitarian engineers are attempting to address (De Angelis 2000; Tsing 2012).

Western ‘developed’ nations face significant internal social justice, and sustainability challenges- a topic often overlooked in conventional humanitarian engineering discourse. What value might critical humanitarian engineering bring, and what does it mean that these contexts are often overlooked in favour of the “glamour” of remote or international work? This is often a topic of discussion amongst our group, as many of us graduated with conventional disciplinary engineering degrees. For us, turning to humanitarian engineering is a way to pursue engineering in a way that aligns with our values in an otherwise depoliticised engineering profession (Cech 2013). Our own communities would benefit greatly from an engineering practice that is holistic, collaborative and values driven (Muñoz and Mitcham 2012). Such an engineering practice would be the tool for our own local communities to create diverse, sustainable futures.

* 1. **Our Vision**

This ambitious vision is further reaching than just 2030. It requires a far-reaching transformation of today’s material and cultural structures. While taking action in this space is daunting and fraught, inaction is worse. Acting with humility, bravery and accountability are essential in developing a new practice that opens the possibility for change. For us, humanitarian engineering research is a space to adopt new ways of doing engineering and research that can challenge these systems of co-option to create a world where many worlds can co-exist. This contrasts with humanitarian engineering practice, which (understandably) is focused on more quantifiable ‘impact’ and donor metrics that constitute a harm minimisation approach. We now turn to how we engage in research, spotlighting the methodologies that enable us to research and practice humanitarian engineering in alignment with this vision.

1. **DOING HUMANITARIAN ENGINEERING RESEARCH**

We remain inspired by Audre Lord’s call for new tools: “What does it mean when the tools of a racist patriarchy are used to examine the fruits of that same patriarchy? It means that only the most narrow parameters of change are possible and allowable” (Lorde 2003, p. 25). In this section, we explore how we draw from our vision, deploying different tools that may support humanitarian engineers and engineering researchers to both examine and radically reconstruct our world, allowing for broader parameters of change. Aligning our methodologies with our values in this way also aligns with our positionalities as humanitarian engineering researchers, supporting us to “bring our whole selves to the work” (Leydens and Lucena 2017, p. xix).

* 1. **Humanitarian engineering methodologies in the literature**

Existing humanitarian engineering literature engages with other disciplines such as science and technology studies, social sciences, international development, design thinking and often encourages the inclusion of social scientists, economists and other experts as part of multidisciplinary teams (Amadei and Wallace 2009; Leydens 2012; Leydens and Lucena 2017; Lucena 2013). In particular, literature from the USA has a strong focus on social justice in engineering, asserting that “Justice can be engineered, but it can also be sung, danced, written, painted, sculpted, historicized, politicked, philosophized, calculated, experimented, and simply felt” (Leydens and Lucena 2017, p. xix). Humanitarian engineering and humanitarian engineering research source methodologies from these disciplines to conceptualise, ideate and design solutions with communities. Our research builds on the foundations established by these authors to engage in community-relevant, transdisciplinary, holistic methodologies for humanitarian engineering research.

* 1. **Community-relevant methodologies**

Central to our vision of humanitarian engineering is the validity of Indigenous and *othered* life-worlds and their knowledge systems. Beyond validity, these epistemologies are rich in solutions that are relevant to community and place. Having grown up with western cultural influences, and being trained by western institutions, many of us are researching as outsiders in unfamiliar or non-default contexts. As such, we have often not been trained in the methodologies of the communities in which we work. Instead, we work from within the western academic knowledge system, purposively selecting methodologies that allow the flexibility required for reflexive research at the cultural interface. Where possible, we embrace opportunities to appropriately engage in methodologies that challenge or critique existing power structures by being relevant to communities.

Some of us are working to decolonise our research by centring the concerns and world views of non-western individuals/peoples, while understanding and respectfully acknowledging theory and research from “Other(ed)” perspectives (Battiste 2000; Smith 2021). Increasingly, Indigenous researchers are developing and documenting methodologies that incorporate their ontologies and epistemologies, such as Kakala (Tongan), Vanua (Fijian) and Talanoa (across the Pacific) recognising valid knowledge making that exists within Indigenous communities (Naepi 2020). We see it as our responsibility to support these efforts to improve the cultural safety and cultural relevance of our research, drawing where possible on Indigenous and community knowledges. Angus, for example, is adopting participatory action research, enabling Indigenous and settler research participants to shape research aims and methods. He is engaging with some participants in yarning - an Indigenous methodology that has built relationships, generated knowledge and served as data collection for reflexive qualitative work (Bessarab and Ng'Andu 2010; Kennedy et al. 2022). This choice foregrounds the importance of establishing relationships prior to and through the research process, and the centrality of trust-based relations to ethical Indigenous research (AIATSIS 2020; Atkinson et al. 2021). Community relevance is also relevant in our default contexts. Elia, for example, hopes to model participatory approaches that can be used to incorporate citizen perspectives into water planning processes that are historically excluded through conventional power structures.

Disappointingly, university processes do not always support culturally responsible approaches/methodologies. Ruby had planned similar Indigenist research practices to resist colonising structures and to privilege Indigenous voices. Although she deeply understood the importance of establishing strong relationships and trust with community research partners, she found the university demands and processes inhibited community-building processes and required her to predefine her research plan to fit with the engineering research curriculum. The ideas she reluctantly presented at her confirmation fell through when the community that was centred in the research had changes in leadership and decided that the project was not community-led. Ruby’s research plan failed to be accepted by the community because university requirements and processes prevented the research from being compatible with the community’s priorities/agenda/ways of working. Angus experienced a similar situation with a potential collaboration that fell through.

These approaches are attempts to ensure that our research doesn’t just address a literature gap within western knowledge systems, but also addresses engagement and impact beyond our academic spheres. By adopting culturally appropriate methods, we improve the validity of our findings and resist dominant western models of knowledge-making that have swept aside Indigenous ontologies and epistemologies (Naepi 2020; Vallance 2012). We believe that this is an important element of responsible research and is key to supporting the aspirations of the communities we are working with.

* 1. **Methodologies across disciplines**

Western epistemologies have emerged in relation to western ontologies of extraction and domination. As such, western knowledge traditions contain both problematic and fruitful discourses. Many of us have come to PhD research with a disciplinary background in engineering, and have come to recognise that engineering has been used by ideologies of depoliticisation to decontextualise development interventions (Broto et al. 2018; Hillerbrand 2018; Sims 2015).

Despite this, we see an opportunity in social science discourses to balance the techno-solutionist tendencies of conventional engineering practice. Hugo’s research is inspired by anthropologies of science and of policy, and traces the intersections of different cultures, worldviews, assumptions and biases among technology practitioners working in the Pacific, and how these shape technology and project design choices to meet (or not meet) the aspirations of end users (Gusterson 2021; Nader 1972; Wedel et al. 2005). By applying anthropology ‘upwards’ to those in positions of (relative) power, this research seeks to reveal the assumptions and choices embedded in a seemingly technical or apolitical domain. In Ellen’s examination of humility in engineering, she draws from theories within positive psychology, virtue philosophy and power (Callahan 2021; Davis et al. 2010; Davis et al. 2011; Weber 2004). Embracing diverse literature enriches our research approach, providing us with critical tools that are complementary to conventional engineering mindsets, practices, and settings.

* 1. **Research methodologies towards holism**

Another theme in our methodologies is a shift towards the holistic integration of other (often critical) methodologies alongside technical domains of engineering. Traditional engineering research spans technical areas such as energy, water, climate change, environmental engineering, and technology development. Drawing methodologies from a range of disciplines combats reductionist approaches present in traditional western engineering. It may be possible that purely technical research is needed to contribute to positive impact, for example, research that reduces the cost of solar power may make electricity more affordable for people currently without access. However, without a holistic approach to systemic and social factors, humanitarian engineering work risks becoming co-opted. Ultimately, humanitarian engineering must be driven by community-defined outcomes.

Many of us are engaging in research that underscores this need for holism and are developing approaches that support humanitarian engineering to engage holistically. Leandra’s research exemplifies this in exploring the mentalities of organisations and programs delivering water, sanitation, and hygiene interventions. In highlighting organisational responses to complexity, she has engaged deeply with intersectionality literature (e.g., Crenshaw 1989). An intersectionality perspective demonstrates the entanglement of *social* and *technical* aspects of humanitarian engineering, informing a more holistic approach (Rhodes-Dicker et al. 2022). Anna’s research is positioned within energy, investigating tools and approaches that support community-identified development priorities to be incorporated into the technical design and operation of energy systems. With a significant technical experience in renewable energy projects, Anna is utilising her PhD to explore and drive a more holistic engineering practice. In addition to these examples, many of us are applying ethnographic approaches to help us more deeply understand the impact of technology by considering the role of people and culture in ascribing value to outcomes.

1. **SUPPORTING HUMANITARIAN ENGINEERING RESEARCH**

Having established our vision for humanitarian engineering and articulated how we are working to realise impactful research, we now turn to our findings from practising this within our own contexts. This section outlines the insights, challenges, and recommended interventions for practising this type of humanitarian engineering research in our institutions. To present a more holistic account of why this research faces barriers, we use a systems framework to present how individuals, research teams, institutions and our broader society might better cultivate the conditions for this research to thrive.

Inspired by Ecological Systems Theory (EST), we use McLinden’s framework to delineate different layers of the systems that we work in (Bronfenbrenner 1979, 2005; McLinden 2017). In McLinden’s framework, the student sits in the centre of a series of nested circles, each representing a different layer of the university system (Figure 1). While we have advocated for the use of Indigenist and decolonising approaches, this framework emerges from western intellectual traditions bringing with it the “logic of coloniality” (Schultz and Barnett 2015, p. 1). Given our ontological contexts and our methodology, we have selected a framework that is accessible to us all, but also begins to erode atomising and alienating colonial logics. Despite presenting a separation of system layers, this systems framework is designed to highlight the ‘progressive, mutual accommodation’ between individuals and different layers of their environment. This helps us unpack the co-construction of our individual experiences through others, space and time.

We have renamed these layers to provide a more succinct articulation. The *research environment* represents our immediate environments, including supervisors, mentors, research collaborators, and colleagues as well as the broader social and professional networks that we interact with. The *organisational environment* represents the “behind the scenes” processes and people within the colleges, schools or research groups where we are situated - such as engineering school/department staff, processes and infrastructure (McLinden 2017). The *institutional environment* represents our host organisations at a broader strategic and leadership level - such as central university policy, leadership, and culture. The *societal context* reflects the broader social, cultural, and political context - such as cultural expectations of institutions and government programs or legislation concerning PhD programs.

While this section presents recommended interventions for practising humanitarian engineering research, it is not intended to contribute the most efficient nor exhaustive list of interventions. Instead, it reflects our evolving perspectives, often with practical steps that we have taken in response to gaps within our contexts. Current and future humanitarian engineering PhD scholars may find these useful in scoping research and navigating their contexts. This section also proposes further interventions that might be actioned to support future humanitarian engineering scholars. These will be useful for *research, organisation and institution* level actors (e.g., academic staff, operational and leadership staff.) Ultimately, all people should have supportive environments that enable them to thrive; we do not want to suggest that making positive impact through humanitarian engineering research is only an individual endeavour.

Three thematic areas emerged from our autoethnographic analysis which cut across the four research ecosystem layers. These are: enabling community relations, embedding cross-disciplinary research, and supporting holistic research impact.

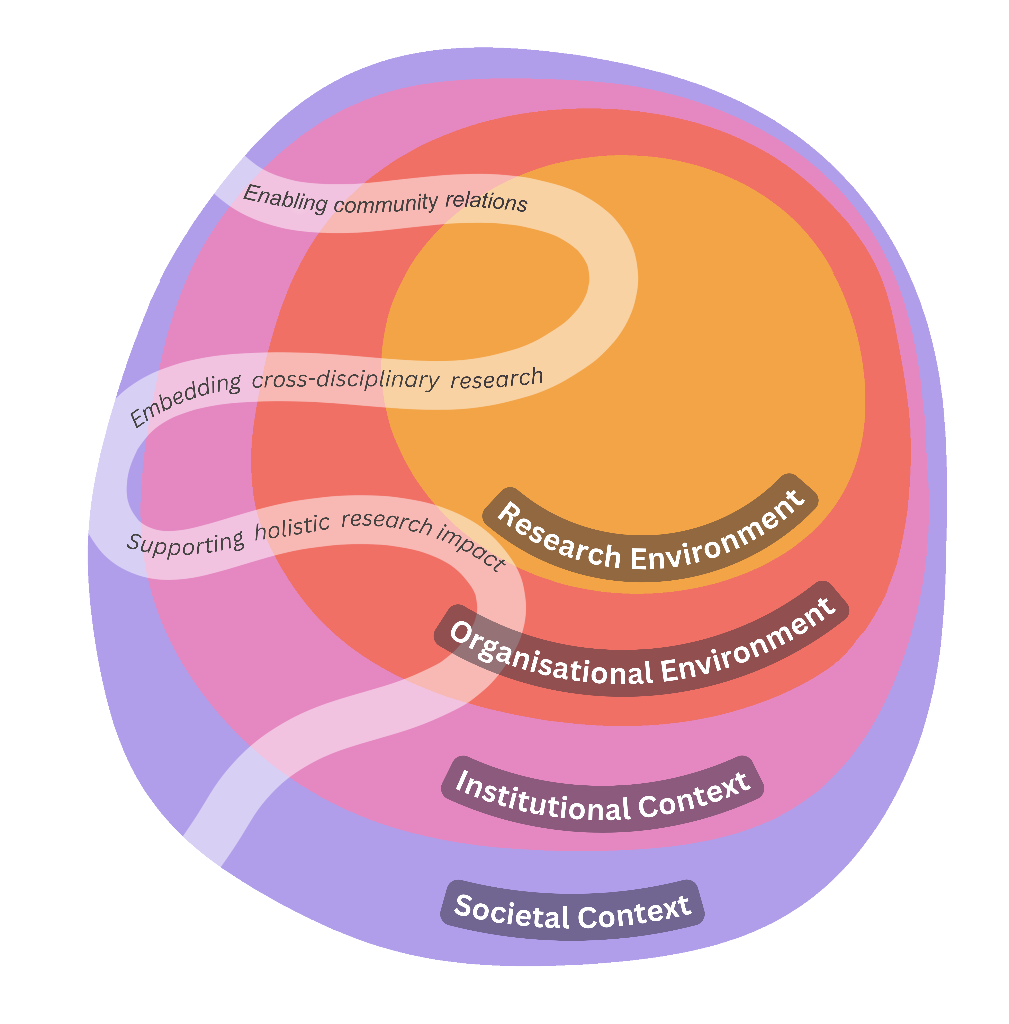
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Figure 1: Our adapted EST Framework for student experience in higher education. The figure includes the themes that require support throughout a humanitarian engineering PhD *journey*. These apply across all system layers.

* 1. **Enabling community relations**

Good community relations are critical for impactful and ethical humanitarian engineering research (AIATSIS 2020; Maurrasse 2002). Towards holistic research impact, many of us have developed community partnerships in our PhDs. Nurturing community partnerships can be a difficult task requiring situated and flexible engagement. In their review of university-community partnerships in Australia, Cuthill et al. (2014) found institutional and academic capacity to be lacking . The review also noted that doctoral candidature is a particularly valuable opportunity to develop partnerships alongside collaborative skills. Our experiences align with this assessment. Many of us have been able to utilise our PhDs to develop partnerships. We have experienced a range of challenges and tensions in establishing, developing, and maintaining good community relations. In this section, the terms “community partners” and “communities” are used to refer to communities themselves through individual participants, community representatives, or organisations that represent communities.

**Exclusive institutions**

Relations between universities and communities are challenging in the first place because many communities are excluded from and harmed by powerful institutions of knowledge production (Bond et al. 2021; Millora et al. 2020). The *societal context* of our universities is one of global inequality, resulting in communities that have different levels of access. This is reflected in the *institutional context*, *organisational* and *research environments*, where western university structure, governance and incentive mechanisms are designed for those who have historically (and presently) accessed these spaces: wealthy, white, male people from western or westernised communities. This situation could be addressed in several ways – most obviously through achieving global equality (changes within the *societal context*). Merely calling for this change is clearly an insufficient response, and as such, in this section we explore how we are responding to the challenge of community engagement in these spaces - towards both benefit for communities, and their increased influence in institutions.

**Establishing community relationship: processes**

Some of us have found that our *research* and *organisational environments* do not have appropriate processes for establishing community partnerships. In trying to establish a research partnership with an NGO, one of us found that nobody in their *research* *environment* could provide clear guidance on the university’s protocols or support mechanisms. Similarly, there were no policies or guidelines available in the *organisational environment* to shed light on this process. The scholar was able to follow leads provided through their direct network to wider networks and draw on prior experience in collaborative partnerships. Eventually, appropriate institutional processes were identified, however this took time and affected the confidence of the NGO collaborator in the PhD scholar and the institution. This is further complicated by a lack of clarity in the *organisational environment* around roles in partnership engagement. Some of us found that university industry-engagement teams, contracting departments or marketing departments (*organisational environment*) sought to engage directly with partners. This was concerning to some scholars who observed behaviours within these teams reflecting insufficient context or critical awareness to engage appropriately.

**Establishing community relationship: ethics contracting processes**

For many of us, university ethics processes have also been prohibitive or challenging to developing these relationships. Many of our research ethics committees require research collaboration contracts or similar legal agreements to be in place before research can commence. Angus, Anna, and Hugo found that the legal language and contracting model provided to them by their university took an overly antagonistic stance, particularly with respect to Intellectual Property. Angus found that he had to seek out definitions of Indigenous Cultural Intellectual Property (ICIP) and Indigenous Ecological Knowledge (IEK), and actively advocate assigning IP to participants to develop sufficient protection for them. This process did not seem to be systematised and while legal support was receptive to additions and amendments to support community requirements, this process started anew for each community partner rather than building from lessons from earlier collaborations. Both Angus and Hugo found that potential partner organisations struggled to interpret long, jargon-laden research collaboration agreements. For both, this contributed significantly to impeding a relationship with a potential partner. Anna relied on her earlier contract negotiation experience to negotiate internally with her legal department to ensure the agreement reflected discussions with her community partner. She also “translated” the contract to provide a “plain English” explanation of legalistic contract text and provided the community partner with the option to access financial support to seek their own legal review of the agreement.

**Establishing community relationship: ethics protocols**

Elia and Angus found that intensive ethics committee requirements around engagement with potential Indigenous collaborators prevented the inclusion of their voices in their research. These unwieldy ethics processes were adaptable for working with our participants and communities. Ultimately, this discouraged the inclusion of marginalised participants in research. While we welcome ethical research codes and guides, we encountered difficulties in navigating the interpretation of these current codes within our *institutional* and *organisational environments.* Our institutions’ implementation of these codes is overly focused on minimising risk to the institution through a ‘tick box’ approach of training and compliance processes rather than creating cultures of ethicality and safety, or allowing for situated and community-responsive approaches to managing risk. For our research, these codes are The Australian Code for the Responsible Conduct of Research and AIATSIS Code of Ethics for Aboriginal and Torres Strait Islander Research. Ironically, current processes appear to exacerbate the burden of research on historically over-researched communities and inhibit their participation in research designed to support community impact.

The responses to these challenges described here are largely individual, however a broader set-up of supports/responses is needed. Establishing our reading and peer support group for humanitarian engineering PhD researchers has developed a supportive *research environment* to assist us in these challenges. If universities are to develop partnerships with communities in the current *societal* and *institutional contexts*, they need to create *organisational* and *research environments* that support relationship establishment. This means implementing clear, ethical, and community-relevant processes and adequately resourcing research students, academics, and other staff to engage in these processes.

**Maintaining community relationships**

Once relationships are established, many of us have also experienced challenges in carrying out research in a way that maintains reciprocity. Relationships need to be nurtured through consistency that establishes trust rooted in reciprocity (Maiter et al. 2008). This means engaging in day-to-day research activities in a way that aligns with community protocols and capacities. These such activities include undertaking fieldwork, accessing consistent funding, and in undertaking design and fabrication work.

Extensive fieldwork may be required to effectively and ethically work with community, often requiring funding and time, both limited in a PhD. Many of us have faced challenges in a lack of clarity from our *research* and *organisational environments* about funding for the travel often required to establish and maintain community relationships. As an example, Hugo currently lives in Samoa, where his partner is working, so he has been able to overcome the challenges of distance in working with Pacific organisations. However, for much of his program, this has not technically counted as field work, and he has had difficulty finding research travel funding for the regular trips back to Australia required under his university’s policies for remote students.

Despite the presence of supportive *institutional,* *organisational* and *research contexts,* Angus has also encountered challenges around fieldwork and with design and fabrication work. His collaborators work closely with Australian ecosystems, responding to changes that can occur within a single day. This short lead time is at odds with his institution’s fieldwork, WHS, COVID-19 travel and other procedures which require specific dates provided with at least a week’s notice. While Angus, his supervisor and school staff have strived to complete these requirements at short notice, this has still been a barrier to engaging in some trips. This has resulted in lost opportunities for relationship building through fieldwork and in collaborators viewing the institution as inflexibly bureaucratic, and therefore ill-suited to collaboration. These barriers also extend to ‘hands on’ design and fabrication work, where procedural and compliance-focussed safety mechanisms prevented research from succeeding within the university.

One promising response to building community relationships within the ANU’s *organisational environment* is the Bandalang Studio. Collaborative projects with external Indigenous co-researchers have strong support from leadership in the *institutional* and *organisational contexts*, and *research environment* at the ANU, partially due to a growing awareness of Indigenous culture and issues within the *societal context* in Australia and globally. This has resulted in the establishment of the Bandalang Studio – an Indigenous engineering platform within the School of Engineering that supports Indigenous engineering “residents” to undertake funded placements within the university. This reduces the burden of participation for Indigenous residents. Importantly, these residencies are flexible and funds are transferred to participants to administer themselves, demonstrating trust. The Bandalang Studio staff assist residents to overcome remaining bureaucratic/administrative barriers within the *organisational environment*. Angus has benefited from this as a number of co-researchers have been awarded residencies. This has enabled them to better shape and participate in the collaborative research. The studio aims to create a culturally safer niche within the university with untied, flexible funding to reflect the (often unrecognised) time and expertise of Indigenous collaborators exploring self-identified research priorities.

* 1. **Embedding other-disciplinary research**

We have highlighted the importance of cross-disciplinary capabilities for our humanitarian engineering PhD research. At the individual level, we have benefited from an awareness of the broad spectrum of research approaches that fall outside of the western engineering research paradigm. We have also found that we’ve needed perseverance and courage in advocating for the use of these methodologies within *organisational environments* geared towards traditional engineering research.

An appropriate *research environment* is essential in enabling us to engage in other-disciplinary methodologies. This includes PhD supervisors, colleagues (peer researchers, PhD candidates and otherwise), and mentors. We have greatly benefited from supervisors who have direct experience in cross-disciplinary research, and supervision panels containing multiple disciplinary perspectives. We have found it important that supervisors have strong emotional/interpersonal intelligence, humility, and criticality to effectively supervise in this context. This orientation is required to navigate the inevitable ambiguity encountered when engaging across/between/outside of familiar methodological spaces – for example negotiating different perspectives between supervisors, or encountering PhD scholars with interest in alternative methodologies. The need for appropriate supervision is evident when we consider one author’s negative experience of pursuing a humanitarian engineering topic with theoretically-rigid supervisors:

“As an electrical engineer focusing on social and cultural implications of energy systems, I was not supported within the Electrical Engineering (EE) department. Although I could point to a previous EE PhD which followed a similar non-technical approach, my supervisors would not recognise it as a valid precedent due to their own personal beliefs and biases about what subject matter is appropriate for an engineer. … They could not understand the necessity of community engagement and could not see value in observing real-world applications outside of the lab. Their mindsets were completely counter to everything we believe that humanitarian engineering represents and aspires to achieve. Humanitarian engineering students cannot thrive and succeed in such an environment.”

Some of us have had more positive experiences with supervisory teams. Hugo, for example, has associate supervisors whose current research and background sit outside of engineering disciplines. Leandra’s supervisors sit firmly within engineering disciplines, but they acknowledge and strongly encourage cross-disciplinary research. In this way, PhD scholars and their supervisors can learn and grow together as a humanitarian engineering research team.

Examination panels are another area of concern for non-traditional methodologies. While none of us have completed the examination process, some are concerned about being subject to examination by thesis reviewers without appropriate disciplinary expertise. Several universities – through *institutional context* policy – enable the PhD scholar and primary supervisor to short-list potential examiners. This enables the scholar and supervisory team to identify reviewers with relevant disciplinary expertise. In short-listing examiners, care should still be taken to ensure that examiners do not hold dramatically conflicting epistemological or research perspectives, resulting in revisions or feedback that cannot be reconciled. This mechanism is also dependent (to varying degrees, depending on the institution’s policy) on a constructive relationship between the primary supervisor and the candidate. In contrast, some institutions enforce the recruitment of international examiners. This may cause issues for humanitarian engineering PhDs applying Indigenist research paradigms that require local knowledge and therefore local examination.

Challenges in pursuing innovative other-disciplinary research within an engineering *organisational environment* and/or *research team* can also be addressed through participation in cross/trans/multi-disciplinary research groups. Existing initiatives to embed into cross-disciplinary (engineering and adjacent) research have resulted in the development of trans and multidisciplinary co-operative research labs grouped by thematic focus rather than disciplinary background. Angus, Anna and Hugo have benefited from such an initiative at the ANU: the Battery Storage and Grid Integration Program (BSGIP). Anna, Angus and Hugo have supervisors with social science expertise within BSGIP. Angus has similarly benefited from supervision and engagement with residents and staff at the Bandalang Studio at the ANU.

* 1. **Supporting holistic research impact**

Despite working towards holistic positive impact through a range of mechanisms, we are challenged by a lack of incentives in the *research, organisational,* and *institutional contexts* for pursuing these impacts. While many university strategies emphasise “impact” as a core objective, embedded norms and structures continue to prioritise publication, citation metrics and commercial opportunities (Cuthill et al. 2014; Doyle et al. 2015; Murphy and McGrath 2018). While academic knowledge creation and commercial opportunities may engender some change, knowledge needs to be mobilised by communities, and innovation taken beyond a quantification of commercial activities for positive impact to occur. Despite this, a PhD still necessitates the compilation of a large monographic text or selected published works, demonstrating the *institutions* value system – that value is measured in the quality of a written text, as evaluated by relevant academic peers. Non-academic forms of learning, information exchange, or direct and indirect positive outcomes are not accounted for. An example can be seen in Angus’s work developing and delivering humanitarian engineering intensive learning experiences with local First Nations People in 2022 and 2023. This both generated and disseminated situated knowledge and learning with Indigenous and settler participants. Despite this, the work will need to be ‘written up’ as an academic article or dissertation to have any value within the current paradigm. Ultimately, this makes Angus accountable to metaphorical “peers” in a “research community”, rather than literal peers in a relationally received (local) community. This contributes towards a value and knowledge system that prioritises the extraction of knowledge.

This is operationalised through research governance in the *institutional context* and is tied to collective historical norms within our *societal context.* All levels of our institutions and society need to engage in a dialogue about what we value, what role research plays in generating value, and how it might better be holistically accounted for. In the meantime, assessors within the *organisational* and *research environment* can take direct action by exercising the discretion available to them through Higher Degree by Research award rules. These vary somewhat between institutions, but generally allow for some flexibility in thesis outputs such as thesis by alternative format.

1. **CONCLUSION**

We represent a significant portion of the humanitarian engineering PhD cohort in Australia and have gathered to co-create and articulate our perspectives. In this paper we call for an expansive vision: that humanitarian engineering principles and approaches should apply to all engineering practice and centre the diverse priorities, practices, epistemologies and ontologies of communities. We explore how this vision has influenced methodologies that draw from numerous academic disciplines and from communities themselves to balance technical engineering skillsets with critical and holistic orientations. Finally, using an EST framework, we explore how our work is challenged by our contexts at multiple levels. We suggest a range of interventions that could assist humanitarian engineering PhD scholars like us to enact impactful, values-aligned research. Some of these are immediately actionable; however many challenges are linked to larger systemic changes that require much further exploration and need to be negotiated through processes of activism and reform. Apart from these suggestions, this paper can provide valuable insights for current or prospective humanitarian engineering PhD scholars in framing and undertaking humanitarian engineering research. University administrators and humanitarian engineering educators can gain insights to inform the design of research initiatives and collaborations with communities and researchers. This paper presents a productive first step in exploring how Australian humanitarian engineering PhD scholars are conceptualising our role and actioning this towards positive impact in humanitarian engineering.

1. **FUTURE WORK AND LIMITATIONS**

This research is an exploratory, early step into the relatively new, broadly conceived field of humanitarian engineering research. As noted in the methodology section, this paper is based on the authors’ positionalities and experiences. This itself is a choice rather than a limitation, however there are an increasing number of PhD scholars working from other standpoints whose perspectives may further enrich this work. As our research is ongoing, our vision for humanitarian engineering, ways of working and challenges are always evolving. This work reflects a snapshot in time, presenting an analysis of our current context. Part of this snapshot has been the COVID-19 pandemic, with all the associated upheaval within our universities including tightening budgets, restructuring and rapidly changing WHS and fieldwork procedures.

As future work, the paper could be updated when our research is further developed to provide a comparison of our current and future perspectives. Future work might also include a broader landscape study surveying the broader perspectives of additional humanitarian engineering PhD scholars. This work touches on work with communities and institutional actors, but is not scoped to include those voices. Important future work would be to expand this research to include these entities in data collection or as co-authors. Such entities might include organisations and communities working with humanitarian engineering PhD scholars, postgraduate academics, university staff or humanitarian engineering practitioners.

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1. **APPENDICIES**
   1. **Appendix 1: Author positionalities**

**Angus Mitchell**

My positionality statement was developed using Positionality Map by Jacobson and Mustafa, the 8-ways Identity Map developed by Baakindji, Ngiyampaa, Yuwaalaraay, Gamilaraay, Wiradjuri, Wangkumarra traditional owners, and takes inspiration from works in settler colonial theory and Whiteness studies (Baakindji 2021; Jacobson and Mustafa 2019; Kowal 2015; Tuck and Yang, 2012). My positionality is primarily that of a settler on Indigenous lands. My ancestors are Welsh and Irish convicts and Scottish, Malay and Mandailing migrants. My family history is entwined in colonial projects in Australia, Malaysia and Sumatra. I live and work on the traditional lands of many Indigenous peoples in South-Eastern Australia including Ngambri, Ngarigo, Ngunnawal, Walgalu, and Yuin peoples. I’ve experienced a privileged pathway through high school completion to undergraduate engineering education. I’ve also benefited from some exposure to subaltern knowledges and methodology- for example, growing up with my father practicing acupuncture and other traditional Chinese medicine traditions.

**Anna Cain**

I grew up on Dhunghatti Country in the town of Kempsey on the mid north coast of NSW in Australia. Growing up in this place complicated my understanding of the world. On one hand, there were many visible and genuine efforts to recognise the destructive impact of colonisation and to celebrate Dhunghatti culture. I am grateful to both the Aboriginal people who shared their stories of dispossession, returning home and cultural connection and the people and organisations that made sure there was a space for these stories to be heard. However, as a young person from a respected middle class family, unencumbered by day-to-day experiences of racism, the opportunities to fully benefit from Australian society were seemingly endless. Yet, I could directly observe health, education and employment outcomes diverge between Aboriginal and non-Aboriginal people who lived side-by-side. This motivated a personal and professional commitment to continually inform and challenge my understanding of the world, and to find ways to contribute to a more just, inclusive and to the extent possible, decolonised society.

This motivation influenced my decision to pursue an engineering career and led me to humanitarian engineering community via volunteer and later staff roles with Engineers Without Borders Australia (EWBA). It seemed obvious to me that the community development approaches I learned with EWBA apply just as much in negotiating a solar farm grid connection in Australia as in what might be typically considered HumEng work. HumEng allows me to internalise social justice in the way I practice engineering; In fact, this make me a better engineer. HumEng has led me to Ngunnawal and Ngambri Country (Canberra) where I now live and work and to my PhD research project. I believe we all have a stake in the future. This paper is a way to take part in the conversation about opportunities for HumEng research to contribute to what this future could look like.

**Elia Hauge**

I am a woman, able-bodied and white, educated and educator, humanitarian engineer and PhD researcher. I was raised by European migrant parents on the unceded lands of Bundjalung Country, a regional area of NSW characterised by environmentalism, community-centredness, and alternative ways of living and knowing. I still live here today. Borne from my upbringing in this progressive environment, I have always been motivated to address the injustices of our inequitable and unsustainable global systems. I believe we have collective and individual responsibility to act in pursuit of social and environmental harmony, in both personal and professional capacities. This principle brought me through engineering (where I found it difficult live my values) to HumEng and a PhD in participatory climate adaptation for water systems. In this work, I am both an insider and outsider: an engineer with “industry experience”, a passionate environmentalist, a participant in my local area. I came to this paper to explore what it means to do a humanitarian engineering PhD, to understand the tension I experience between engineering (my discipline) and transformation (my motivation). I write today knowing I am not alone in this tension, and with a new collective understanding of how to navigate it. My sincere hope for the paper is that it helps other HumEng researchers to do the same.

**Ruby Heard**

Since graduating with a degree in electrical engineering in 2010, I have spent 10 years working in consulting in the building services and renewable energy spaces in Australia and in the US. I am a woman of Jaru descent (an Indigenous mob from the Eastern Kimberley in WA) but as my father was taken from his mother at age 5 my cultural heritage is fractured. My PhD brings my personal life into alignment with my professional career. I aim to walk in two worlds. I believe it is part of my life's purpose to use my western education to empower disadvantaged communities while influencing the mainstream engineering paradigm to embrace Indigenous principles and knowledge.

**Ellen Lynch**

Raised on Yuggera, Turrbal and Kabi Kabi land of South-East Queensland, I am a white, cis-gendered, (usually) able-bodied woman. Greatly influenced by my mothers’ immigrant family and working-class upbringing, education, faith and financial stability was emphasised. The cultural diversity in my early years sat starkly against my teenage years on the Sunshine Coast and into my adulthood. At 17, I moved to Ngunnawal and Ngambri country, Canberra to study engineering. This has greatly influenced my ideas of class, knowledge and the wide variety of experiences across Australia. In my second year, I became involved with Engineers Without Borders, shifting my ideas of how engineering could be applied. This shifted further while on an Engineers Without Borders Summit in Cambodia and short-course in South Africa into an interest in anthropology and sociology.

These experiences throughout my life, and particularly in my PhD has worked to help unpick assumptions, ideas and values I have reproduced. In particular, my work has challenged me to be open to and value other ways of knowing, thinking and being. To acknowledge my limits, and the fallibility of my standpoints and thinking. Through this, I hope to engage in and encourage bettering the world, using engineering, my own and the many talents of others.

**Leandra Rhodes-Dicker**

My positionality is that of a white woman, “neurotypical”, and generally healthy and able-bodied. I recently came to understand and embrace my queerness, having been unable to do so until my late 20’s. My upbringing was deeply linked to intergenerational trauma and cycles of abuse; this resulted in strong tendencies towards empathy and societal responsibility, but also a notion that I could not simply be my authentic self. I recently moved to Australia from Canada, and I am descended from British and Dutch imperialists. As such, I have lived the majority of my life on unceded lands and with colonialist, one-sided narratives of my heritage. I currently live on the lands of the Woi Wurrung and Boon Wurrung language groups of the Eastern Kulin nations.

My work explores the notion of complexity in lived experience which is frequently simplified and de-valued for capitalist purposes. I am motivated to explore approaches in my research and practice that allow people to voice their realities and be their authentic selves (e.g., intersectionality, decolonising approaches). This is often at odds with my “traditional” engineering background which tends to default technical and “solution”-oriented mentalities. I acknowledge that my positionality is constantly evolving as I learn, grow, and experience.

**Hugo Temby**I am a white, cis-gender, able-bodied man and, aside from (largely internalised) biphobia, have not been marginalised or oppressed due to my ethnicity, gender identity, health status or sexuality. I was raised on stolen Ngunnawal land, and later in Papua New Guinea before going on to work in several decolonising large ocean states, with many inspirational Pasifika and other collaborators. My positionality has continued to evolve through these experiences, and I am unlearning much of what (I thought) I knew about development, knowledge, and myself. At the same time, I’m learning (for me) new things about living well: in myself, in relation to others, and within planetary boundaries. In this paper, as in my other work in the anthropology of technology, I seek to continue this unlearning/learning, in support of efforts (already underway in the Pacific) to develop more equitable, inclusive approaches to climate technology projects.