Ulaanbaatar, the capital of Mongolia, is the coldest and most polluted capital city in the world.[1] Heating is essential in Ulaanbaatar, where winter nighttime temperatures frequently drop below -40C. The city's three central power plants, which provide district heating to the city center, all burn coal to produce heat and electricity. Most residents of the ger district, an area on the edges of the city where people live on small plots in gers, also called yurts, or houses, burn charcoal briquettes for heat during winter. The coal burned by both the city's power plants and ger district residents, combined with Ulaanbaatar's geographic location in a valley, leads to awful air pollution in the winter. Concentrations of PM 2.5, ultra-fine particles that can become lodged deep in our lungs, frequently exceed 10 times the WHO guidelines during the winter, reaching as high 133 times the recommended limit.[2,3,4] This air pollution has significant, negative health impacts on Ulaanbaatar's residents. Pneumonia is common among children, many of whom will get sick once and remain sick for the entire winter.[5] Stillbirth and child mortality rates are higher in the winter than in the summer.[6]

I first learned about this problem through a class I took my sophomore fall, titled "Anthro-Engineering Decarbonization at the Million Person Scale." The class centered around a proposed heating technology for ger district residents, a molten-salt heat bank, which was originally conceived of by Professor Munkhbat Byambajav at the National University of Mongolia. The molten-salt heat bank is essentially a thermal battery, or a device that stores energy in the form of heat. Physically, it's a steel box that contains a mixture of salts. The

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[1] Joseph Hincks 2018
[2] Ganbat et al. 2020
[3] What Are the WHO Air Quality Guidelines? n.d.
[4] Joseph Hincks 2018
[5] Chisato Fukuda 2020
[6] Joseph Hincks 2018

molten-salt heat bank takes advantage of the fact that when a material turns from liquid to solid, it releases heat at a constant temperature. The molten-salt heat bank can provide enough heat to keep the ger warm for up to 8 hours as the hot liquid salt inside becomes a solid.

The initial idea was the heat bank could be heated during the day using waste heat from Ulaanbaatar's power plants, which belch out massive clouds of hot steam. Using power plant waste heat would ensure that no pollution was produced while heating the heat bank. Once heated, the heat bank would be transported from the city's central power plants to households in the ger districts. The heat bank would sit in each household overnight, releasing its heat to keep the ger warm. From an engineering perspective, this seemed like a perfect solution: 8 hours of pollution-free heat contained in a roughly 40 pound brick. Of course, there were still kinks to be ironed out, which had been the subject of previous design classes, but largely, no one was questioning that the molten salt heat bank could be a viable heating source in Ulaanbaatar.

From an anthropological perspective, the molten salt heat bank looks a bit less perfect. When Professor Mike Short, an MIT engineering professor who was collaborating with Professor Byambajav, brought the idea to Professor Manduhai Buyandelger, an anthropology professor at MIT, she immediately identified new challenges and issues. She pointed out the poor road conditions in the ger districts and awful traffic in the Ulaanbaatar city center that would make any kind of a distribution system difficult at best. She pointed out the possibility of political resistance from politicians, many of whom have ties to charcoal briquette manufacturers. She pointed out these and many other issues that had not previously been a part of the engineering discussions around the molten salt heat bank.

The class I took – Anthro-Engineering Decarbonization at the Million Person Scale – was born out of this project, and explored the relatively new field of anthro-engineering. Anthro-engineering is an interdisciplinary field meant to bring together anthropologists and engineers to better understand and solve problems. Anthropology and engineering are vastly different fields, and anthropologists and engineers usually don't work together much. The class explored how these two fields could work together to improve engineering design.

Throughout the course, we dived deep into understanding Mongolia, and Ulaanbaatar in particular. We read ethnographic articles and books, where authors detailed their observations and conclusions about Mongolia resulting from long-term anthropological research. We talked about the history of Ulaanbaatar and the ger districts, the mining boom and bust in the early and 2010s and how it affected everyday people, the high levels of debt that many in Ulaanbaatar are saddled with, and the effects of neoliberal "shock therapy" in the 1990s when socialism ended. We talked about past interventions targeting Ulaanbaatar's air pollution, why they had not been successful, and the harms they had caused. The instructors brought in guest speakers who were from Mongolia and had worked on air pollution issues. During a week in January, following the end of the class, we traveled to Ulaanbaatar, where we spoke to a wide variety of stakeholders including ger district residents, international development workers, government officials, and others. We wanted to better understand the complex history and layers of issues surrounding the air pollution problem in Ulaanbaatar, and to fully grasp the human side of the problem.

We delved into issues surrounding engineering and development. Week after week, we discussed ideas that blew my mind. We talked about how technological development can be political. We talked about the ways that designers and engineers abdicate responsibility for the social or ethical effects of their work by conflating "unanticipated consequences" and “unintended consequences.[7]” We talked about how anthropologists critique the very idea of development and the way that development projects are carried out.

The anthro-engineering class was quite different from the way that development is typically taught to engineers. There is an extensive literature in anthropology and other social sciences critiquing the way engineering schools teach and do “engineering for development.” In “Designs on Development: engineering, globalization, and social justice,” Nieusma and Riley describe a case study of a two-week product entrepreneurship class that was a collaboration between two universities in the US and two in Nicaragua, where students worked in teams to design a product for sale in the city of Estelí.[8] Despite the desire of the faculty, particularly on the US side, to avoid the issues of past development projects, the class still ran into multiple problems. Nieusma and Riley argue that the class showed a clear “product over process” orientation, where the final technology the students developed was prioritized over the process by which they developed it. The involvement of Estelí community members in the design process was limited to two market research surveys, calling into question how much the course instructors considered the involvement of community members essential. Despite being an entrepreneurship course, the course faculty never fully discussed entrepreneurship in the political and economic context of the way Nicaragua’s economy has been affected by larger forces like neoliberal policies. These issues faced by this two-week course, Nieusma and Riley argue, are illustrative of larger problems with engineering for development: its over-attendance to technology at the expense of process, failure to prioritize community engagement, and lack of consideration for the larger historical, political and economic contexts.

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[7] Parvin and Pollock 2020
[8] Nieusma and Riley 2010

In “Engineering to Help,” the authors argue that engineering programs aimed at designing technology for people in developing countries are often based around a problematic “need/help” model, where communities in developing countries are seen as “in need” and engineers are the problem-solvers with solutions.[9] This need/help framing is problematic because it encourages engineers to see the communities they are “helping” as other and deficient.

The anthro-engineering class was unlike any other class I have taken before or since (I’m a chemical engineering major), and it had a huge impact on me. It forced me to question assumptions I hadn’t even realized were assumptions about the nature of engineering as a discipline and international development, and made me much more attuned to the complexities and human dimensions of problems. I recently interviewed other students who took the anthro-engineering class with me about their experiences, and heard that the class also had significant impacts on them. One student said that what she took out of the class was “really thinking about problems from a people perspective...it’s not just designing the solution that’s important, but really the rigor and the thought that you put into the process of even getting all the data and making sure the rollout goes well.” She said that the anthro-engineering class allowed her to hone in one problem in a way that her other courses didn’t, and that she thinks “more holistically and human-centered as an engineer than most people would” as a result of having taken the class. Another student said that it made him more prepared to work with the “social impacts” of decarbonization. Another said it made her feel like she could bring issues like the human side of problems or inequalities in resource allocation “into conversations in spaces that it wouldn’t have been mentioned before.” Every student I spoke to said they found actually going to Ulaanbaatar and talking to people on the ground immensely valuable.

[9] Schneider, Lucena, and Leydens 2009

Anthro-engineering as an approach to addressing large-scale challenges and as a way to teach development engineering is still new, and not without its challenges. Talking across the disciplinary boundaries between anthropology and engineering is hard, and doing meaningful collaboration across them is even harder. Despite this, anthro-engineering presents a promising alternative framework for doing and teaching engineering for development. By centering the social, political and historical context of a problem and leading with anthropology, it has the potential to address many of the issues with current development engineering programs. Anthro-engineering as a framework for teaching development also has a positive impact on students who are exposed to it, helping them to learn about problems in a more human-centered way. It is a nascent field, and there is still uncertainty over exactly how to do or teach anthro-engineering, which is challenging and perhaps daunting, but also exciting. My hope is that more people – both engineers and anthropologists – can begin exploring the challenging but productive space of meaningfully working together.

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