Engineering for the People: Putting Peace, Social Justice, and Environmental Protection at the Heart of All Engineering

By Darshan Mukesh Arvinda Karwat
School for the Future of Innovation in Society and The Polytechnic School
Arizona State University
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Abstract: It is both a cognitive dissonance and a mundane fact that inequality and injustice are hardwired into current models of technological design and technical work in the US, one of the most technologically advanced and resource-rich nations on Earth. However, the onus for change is not only on those who officially *make* social policy—politicians, lawyers, and business people—but also those who *build* social policy and *create* possibilities—engineers. For example, if engineers didn't design and build bombs, there would be no bombs (or way fewer of them); engineers can *not* create the possibilities of mass destruction. At the same time, engineers can create possibilities for deep good by aligning their work with those traditionally marginalized and exploited in and by technical work. Fortunately, there is a rich historical legacy of activism in engineering and science that we—practicing engineers today—can build on to put peace, social justice, and environmental protection at the heart of engineering. My talk will describe different ways in which engineers across the US are centering these ideals, and pose questions I think are important for engineers to consider to build a movement of engineering for the people.

Talk: I don't have to go back home to Mumbai, India to find technological inequality and its interplay with poverty and environmental injustice and marginalization. I simply have to walk the streets of Phoenix, where many have inadequate access to cooling services, or San Francisco, the US's tech capital, where the poverty now has shocked even the UN's poverty expert Philip Alston, or Detroit, a posterchild for the effects of American industrial capitalism, or Hale County in the Black Belt of Alabama, where homes aren't built to code.

What I want to discuss today relates to this contradiction: we live and work in the richest country in the world, a country that has driven the scientific and engineering agenda for the world for many decades now, and looking across this country, there is vast technological inequality, access to scientific information and resources. The history and legacy of science and engineering is not only replete with incredible and awe-inspiring advances and achievements like refrigeration, flight, and getting to the moon, but is also full of oppression, marginalization, racism, and the development—and continued development—of the capacity to destroy humans, life, and the Earth. While these are certainly issues of social policy, they are also issues of science, engineering, and technological policy, and they are also issues with how we as engineers justify to ourselves the work we do.

One current issue in the limelight in which engineering work is deeply implicated is the fortification of the US-Mexico border. Here's a quote by George Ishee, national sales manager for Cast Lighting, based in Hawthorne, New Jersey—one of many such quotes I found—that I find deeply problematic:

> There could be a political backlash, but we are in business to make money and put people to work and provide a good service, whether it's a wall or substation or airport or prison. We don't want to approach it from a political standpoint, only from a business standpoint (Adely & Alvarado, 2017)

Maybe not every company bidding for the new wall shares this point of view, but quotes like these highlight a particular problem with how many engineers and companies see their role in the world and how their work is valued. By saying building a wall is "just work," engineers and companies shift the moral burden from themselves—those who actually design and build these projects—to those who order and pay for them. But people, politicians, and governments can talk all they want about doing something; they do not have the skills to actually do it. We do. This is where engineers and engineering holds power. And this power is exactly what

Google employees exerted, when they challenged management about Google's involvement in providing artificial intelligence expertise to a military pilot program called Project Maven, or Algorithmic Warfare Cross-Functional Team (Work, 2017), which aimed "to speed up analysis of drone footage by automatically classifying images of objects and people" (Conger, 2018), vehemently protested internally, then wrote a petition to Google Inc. CEO Sundar Pichai, which started off with

> We believe that Google should not be in the business of war. Therefore we ask that Project Maven be cancelled, and that Google draft, publicize and enforce a clear policy stating that neither Google nor its contractors will ever build warfare technology (Google Employees, 2018).

On June 1, 2018, a New York *Times* headline read, "Google Will Not Renew Pentagon Contract That Upset Employees" (Wakabayashi & Shane, 2018).

I can state my motivations simply: I want *all* engineers to instill the values of peace, social justice, and environmental protection in *all* engineering work, aerospace to naval architecture. No more bombs, or work that advances the ability to kill. We have a lot of that already. But more of engineering and design that centers the poor and marginalized, including here in the US, or, for example, to reimagine migration corridors for animals whose abilities to migrate are being chopped up by land development. I'm fine with being called idealistic because as I'll discuss a little later, it is in fact possible and practical to create new visions of what engineering should by and large be.

I like to think of engineering as social experimentation: we see issues and challenges in the world, and we develop material interventions without fully knowing the social implications of what we do. That's designs are dictated by the variables we choose to design for and modulate and who we consider important in our designs. The world is always more complicated than the variables we choose. Using only white males as the faces that face-detection algorithms are trained on can leave black faces detected as gorillas (Breland, 2017; Vincent, 2018), and this continues to happen. We might justify the continued investment in the development of weapons in the US by saying that we need to maintain military superiority, but in doing so, we implicitly devalue the lives of others those weapons are used on and against, especially civilians, who will inevitably lose their lives to satisfy the egos of power brokers.

We also legislate the future (Zimmerman, 1995)without really knowing it, creating path dependencies for future generations. What we do now, each day, really matters. As engineers, we create possibilities; we open and close technological, social, political, economic, and environmental futures. For example, people can fight all they want to mitigate climate change, but if in ten, fifteen, twenty years we are left with these same roads, these same cars, this same infrastructure—all of which is the outcome of our engineering and planning work—we will completely fail to meaningfully bend the arc of greenhouse gas emissions. The built world of the future needs to look completely different than the world we live in, and engineers and engineering are crucial to that. How do we—engineers—push social, science, and technology policy to make the possibilities for these futures possible?

And so, given all of this, I think about questions that I think all engineers should be grappling with: Why are we engineers? For whose benefit do we work? What is the full measure of our moral and social responsibility? (Karwat, 2018)

These questions aren't new. They were posed a few decades ago in the fervent of the anti-Vietnam War movement, which found a home right where we are, at MIT. *Science for the People* is an organization, being revived today, that was founded in the late 1960s by scientists and engineers who raised critical questions about how and why their intellectual labour was being used to develop weaponry and perpetuate war. As chronicled by Professor Matthew Wisnioski, a historian of science and engineering at Virginia Tech, many of those scientists

and engineers were in fact professors at MIT. On March 4, 1969, faculty and students at MIT shut down the entire Institute for a day to have a teach-in that featured panels on DOD and ONR sponsored research being done right here at Lincoln Laboratory, military technology, and the Vietnam War. This shutdown wasn't only about research; it was about a battle over the values of our technological society. In fact, the MIT Fluid Mechanics Laboratory—which at the time included three full and three assistant professors, a support staff, and approximately 20 graduate students—underwent a complete transformation. It changed the entire focus of its research from fluids research for military purposes to four other research fields: air pollution, water pollution, biomedicine, and desalination (Wisnioski, 2012). All of this comes from the recognition of the deeply political nature of science and engineering. Who decides what to research, what is considered a good design, and even the simple act of posing a question reflects values and motivations, and circumscribes a set of tools and methods that can be used to accomplish goals. Whether we admit it or not, each engineer in this room is a political actor. Engineering is a political endeavor.

What are the values we bring to the table when we *do* engineering? What are the goals, and visions we instill in what we design? What future are we creating? Here are some examples of engineers, scientists, technical workers, and other leaders thinking about engineering and technology differently:

Linking experts with real need: On-Call Scientists: Our engineering and technical skills, many of which seem underutilized by the entities we work for, can add incredible value to groups that can't afford to have staff technical workers. The AAAS's Scientific Responsibility, Human Rights and Law Program runs On-Call Scientists, which connects scientists, engineers, and health professionals interested in volunteering their skills and knowledge with human rights organizations that are in need of technical expertise (American Association for the Advancement of Science, n.d.). Through On-Call Scientists, a hydrologist enabled a Kenyan human rights group to incorporate social impacts into the requirements of a government-mandated EIA for exploratory oil drilling in that country. When the Syrian government denied its use of chemical weapons on its civilians, Amnesty International and Human Rights Watch were connected with a forensic anthropologist, a pharmaceutical scientist with expertise in toxics, and a biochemist with expertise is detection of chemical weapons, to provide the NGOs with evidence to dispute these denials and build international will to address the war crimes (Harris, 2017).

Connectivity for the overlooked: The Equitable Internet Initiative: A quarter of the US, people not only in rural America but also in the inner cities, don't have broadband internet access or can't afford it (Smith, 2018), and this is creating a digital and information divide in the US. But to counter this, the Detroit Community Technology Project's Equitable Internet Initiative is taking matters into their own hands by increasing internet access through the distribution of shared Gigabit Internet connections in three underserved neighborhoods; increasing internet adoption through a training program that prepares residents of those same neighborhoods with the skills necessary to bring their communities online; and increasing pathways for youth into the opportunities of Detroit's burgeoning Innovation District through intermediate and advanced digital literacy trainings (Detroit Community Technology Project, n.d.)

If you can see it, you can change it: SkyTruth: Throughout the 1990s, John Amos worked in the private sector as a geologist who used remote sensing as an exploration tool for the fossil fuel industry. But when he looked at a time series of remotely-sensed images of his hometown in Wyoming, he saw the landscape that he grew up in and loved transformed from one of raw beauty to one marred by fossil fuel rigs. That spurred him to lay the groundwork for SkyTruth, a non-profit that uses the view from space to motivate people to protect the environment. In 2010, when the Deepwater Horizon disaster happened, SkyTruth questioned BP's and the government's estimates of how much oil was being pumped into the ocean. SkyTruth found that the flowrate of the spill was being significantly underreported—by a factor of twenty. That analysis thrust SkyTruth into the spotlight, and since then, they've used satellite technology and remote sensing to monitor threats to the planet's natural resources such as urban sprawl, fracking, mountaintop removal mining, and overfishing of the

oceans. Their goal is to not just to report on disasters, but to inspire a global movement where everyone can easily access the resources we use, and be motivated to protect the planet from future catastrophes (SkyTruth, n.d.).

Engineering for a singular purpose: Peace: Drexel University's Peace Engineering is "the nation's first program dedicated to preventing and reducing violent conflict through education and research that integrates innovative technologies, approaches, and policies with the studies and practices of peacebuilders" (Drexel University, 2018). There are incredibly important action-oriented engineering projects and research programs that can be developed with a goal in mind: creating the conditions of peace, and reducing the possibilities of violent conflict. For example, given the incredible flux in social justice, economic inequity, political fracturing, and ecological degradation, developing system models that predict how disparities in health, education, and access to resources affect the dynamics of interacting economic and social systems and that lead to conflict, or understanding how sudden population changes, like those that occur in disasters like hurricanes or armed conflict, on economic and social systems in communities that absorb the population (Drexel University, 2018), can be vital to being prepared for a politically turbulent and climate-changed world.

Give the people what they need: Understanding the science, engineering, and technical needs of environmental, energy, and climate justice groups: Even within the environmental movement, communities across the country are continuing to be overlooked by government, academia, and non-profits. Communities across the country are asking questions they don't have the resources to answer. These are communities surrounding industrial facilities that have concerns about how these facilities are polluting their air, water, and land; communities concerned about what climate change means for them; communities that don't have either the technical knowledge or resources to take adequate steps to reduce their energy burdens. But what exactly might help these communities? And how can mobilize more engineers and scientists to engage directly to address the needs of these communities? And so, in my lab group, re-Engineered, we are starting by asking the question: What are the scientific, engineering, and technical needs of environmental, energy, and climate justice groups across the US? What we will learn will then help shape the engineering research and development work we do in re-Engineered. But not only that. So that others may get involved, we are building an online portal that will give the rest of the science and engineering community opportunities to be involved and get linked to communities in need.

So engineering for the people *is* happening. And we need to be in the business of normalizing this kind of work as day-to-day engineering practice, of scaling it up, of creating ways to value it differently. But there are, as you can imagine, many barriers and open questions in how to do this, and to ensure the proper training of engineers, scientists, and other technical workers to do this work. First are the connected issues of values, financial security, and debt. Aside from of course educating engineers-in-training differently, we must bear in mind that the vast majority of the engineers in the world aren't in school—their out in the working world, and we need to figure out more ways to engage and mobilize them. These are engineers who have stable jobs, families, and maybe a mortgage, and they probably went to college at a time where thinking about issues of social justice and environmental protection and sustainability *in engineering* weren't a part of their educational experiences. What we can leverage is, what I observe to be the case, that a lot of engineering jobs take creative, talented people, and turn them into cogs in a vast bureaucratic machine, order takers, with little sense of purpose. Those who engaged with On-Call Scientists, for example, have remarked how their experiences completely changed their sense of purpose (Harris, 2017). What we need to do is change this work from being *pro bono* to work that allows technical workers to earn a decent paycheck. What are ways to reach engineers in the working world to highlight opportunities for engagement that exist? How can they create these opportunities for themselves?

Related to what I just said, the shackles of student debt can lead to unfortunate compromises in values. I recall overhearing a conversation among graduating engineers at the University of Michigan, where I went, in which

one student said, “I really don’t want to take this job building missile systems, but I have a ton of student debt, and this would be a good paycheck. So, I am going to try to make the best missiles possible that only kill their intended targets.” This problem shifts the moral burden of graduating students from challenging the dominant system of engineering to one in which they are morally conflicted internally. So we’re creating the most socially- and environmentally-conscious generation of engineers, but by and large, the only options available to a vast majority of them are traditional ones. How can we create more opportunities for graduating engineers to find employment with align with their values?

We need to be clear about what problems we want to address and solve. That clarity will guide the kind of research and development done. Some might say that there are trickle-down civilian benefits doing military research: new materials, new sensing technologies, quieter commercial aircraft, and so on. Sure. But what could we do in the US *directly* for schools and colleges, poverty alleviation, hunger reduction, environmental remediation, climate change resilience, with the additional $200 billion that has been added to the military budget over the past two years (Korb, 2018)? Of course I recognize that this challenges fundamental values and principles that guide science and technology investment in the US.

The world we live in has in no small part been created by engineers, and engineers will continue to dictate the design and development of technologies that shape human relationship to the Earth. Thus, to infuse the engineer with ideals of justice, with practical tools to understand the impact of their work on people and the Earth, and with the ability to work intimately with those who have different kinds of knowledge, is to change the world. I care deeply about this vision of engineering.

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