UNVEILING THE POLITICS OF ENGINEERING

How Depoliticization Shapes Technological Impact with a focus on TSA scanners

Nikki Zainer and 5 Peers

Engineering is often perceived as a neutral, objective field focused solely on technical problem-solving. However, this perception overlooks the inherent politics embedded in every technological artifact. Engineers must acknowledge that as long as their designs intertwine with human relationships, they cannot be separated from politics. This paper discusses how engineered artifacts, such as the advanced imaging technologies and computed tomography X-ray scanners utilized by the Transportation Security Administration (TSA), are deeply political. These scanners, introduced following the heightened security measures post-9/11, exemplify how engineering design can reinforce power imbalances and serve political purposes, whether intentionally or not. By exploring the context of depoliticization within engineering practice, this paper illustrates the pervasive mindset that treats technological artifacts as neutral, ignoring their significant social and political implications.

The engineered artifacts that can be seen as products of our political system can also feed into it, reinforcing imbalance, with or without intention. It is important for engineers to recognize that as long as engineering design intertwines with people's relationships, it cannot be separated from politics. Technology should serve to increase freedom of choice, which is an inherently political act. An apt example of a deeply political and engineered artifact are the advanced imaging technologies and computed tomography X-ray scanners utilized by the Transportation Security Administration in airports the world over. Airports experienced a surge of security measures succeeding legislation passed by President George W. Bush following the September 11th attacks on the world trade center. Passengers are required to comply with these security screenings or forced to undergo a full-body pat-down. These machines are examples of artifacts that were created with political intent, have been normalized, and continue to serve a political purpose, though engineers and others with a depoliticization mindset would say otherwise. In this paper we discuss the context of depoliticization within the engineering practice and follow the example of TSA scanners to illustrate this dominant engineering mindset.

Engineering is not the purely technical, neutral, and objective field that it seems like from the outside. As long as things are engineered for people, by people, they can never be free from subconscious issues inherent in people. Artifacts are prone to carry the ideologies of their creators, for better or for worse. Even when designers are aware of them, things like biases and interpersonal issues can seep into the intended purposes of products. The mindset of depoliticization in engineering is the pervasive idea that technological artifacts are neutral, asocial, and apolitical rather than deeply intertwined within people's relationships. These relationships can in turn affect the arrangements of power and authority between classes of people and create a feedback loop in the system of politics. As engineered systems and artifacts impact society, society impacts engineered systems and artifacts as well. Artifacts the exemplify appropriations can further suppress marginalized groups, making it even harder for these cultures to break free from harmful biases and environments. Depoliticization in engineering is not only the idea that engineering is simply incidentally separate from social justice, but also that it *should* be separate from subjective fields such as social justice (Cech, Misframing of social justice, p.71)

The issue inherent with the discussion of politics in engineering is, as Cech puts it, "At the most basic level, engineering students and practitioners will only be motivated to consider social justice issues to the extent that they recognize such issues as relevant to engineering practice." (Cech, Misframing of social justice, p.68). Engineers will only give thought to social

justice as it affects engineering, not reciprocally, in the way that engineering affects social justice. This can be a product of project budgeting, leadership, time constraints and deadlines, company culture, personal lack of experience, or even discrepancies within engineering education itself. Engineering higher education is structured in tradition, often neglecting social justice concerns within projects, class examples, or discussions. This directly validates the incorrect mindset that engineering and all that it addresses is separate from community concerns

The danger of this separation of socio-political issues and engineering appears whenever these topics are dismissed as irrelevant to the field. This upfront dismissal does not mean that these issues simply disappear, it only means that they will not be thought about throughout the design process. If you were an engineer, and your boss told you to design a product "as if money were no object", that product would still have some sort of cost at the end of the day. You would simply be designing as if cost was negligible and not important. This is analogous to political acts in engineering. Simply because you decide to treat social factors as invisible, does not mean your product does not have any.

In engineering education spaces, an unconscious belief in depoliticization creates environments that exclude social contexts from problem definitions. It is critical to acknowledge this because "what we emphasize or de-emphasize, whose perspectives are allowed to enter and whose are left out, all shape the overall effectiveness of the final design." (Friedman, page 6) When classrooms set the precedent that only certain information matters when solving problems, that precedent is carried on to engineering design spaces. Often in engineering classrooms, professors teach students to cross out parts of problems that don't include numbers. The issue with this is that students learn that ignoring the context of a design problem is a common and acceptable design practice, when it is not. Frequently, the contextual elements of a design problem are the most important elements to consider. "Thoughtfully engaging such perspectives can help prevent abuse of or ill-service to already marginalized communities." (Friedman, Page 5)

The inherent politics in design stem from the idea that every technological artifact is embedded with the values, intentions, and power dynamics of its creators. As Friedman notes, "There is a tightly coupled interaction between our experience of ourselves as human beings and our tools and technologies so much so, that it makes little sense to speak of one without the other" (Friedman, VSD, p.3). This quote underscores the profound impact that technology has on shaping human experiences and societal structures. It suggests that technology is not neutral; rather, it is a reflection of human priorities and power relations.

Building on this understanding, it becomes evident that designers and engineers have a significant responsibility to actively engage with the social and political dimensions of their work. Rather than striving for an unattainable objectivity, they should embrace a more conscientious and reflective approach to design that acknowledges and addresses the complex interplay between technology and society. This entails not only identifying and mitigating biases but also actively seeking to understand the broader implications of technological innovations. By doing so, designers can create technologies that are more inclusive, equitable, and responsive to the diverse needs of society. Furthermore, incorporating interdisciplinary perspectives, such as those from sociology, ethics, and cultural studies, into the design process can provide valuable insights into the societal impacts of technology

Technology stems from the human imagination and, as such, inherently reflects human values. This connection suggests that the biases and perspectives of the designers can shape the technology, consciously or unconsciously. Design should not only consider functionality but also

Commented [CC1]: Good sentence!

human flourishing. Overlooking the values of a design can lead to biased or less than beneficial outcomes. Algorithmic decision-making systems are an example of how biases can be embedded within human-made technologies, potentially magnifying existing structural inequalities. This reflects the unconscious biases of the creators who develop these systems, impacting areas like education, employment, and criminal justice.

There is a clear overlap between the common engineering mindsets of depoliticization and social-technical dualism. Depoliticization has already been defined above, but social-technical dualism focuses more on the larger social contexts of a designed product, emphasizing the division between technical and social realms. It upholds the notion that technical systems and social systems operate independently of each other, with engineers responsible for the technical aspects and other stakeholders addressing the social implications. This dualistic approach often overlooks the interconnectedness of technical and social factors, potentially leading to designs that fail to address important social needs or exacerbate existing inequalities.

The overlap between these two mindsets lies in their shared belief in the separation of the technical from the social and political. Both perspectives can lead to an undervaluation of the social dimensions of engineering practice and a neglect of the ways in which technical decisions are inherently political. For instance, the choice of materials, the prioritization of certain functionalities, or the decision to exclude certain user groups are all technical decisions with social and political ramifications. Ignoring these connections can result in technology that reinforces existing power structures and fails to serve the broader public interest.

It is not enough to simply be aware of these ideologies that are present all throughout engineering; one must also actively combat them through the design process. One of the ways this is being done is through changing the design process itself to incorporate political and social thought and to continually reflect on the impact of design decisions. An example of one of these modified design processes is the idea of value sensitive design, a method intended to "provide guidance on how to engage in a particular kind of research or design inquiry" (Friedman, VSD ch.3, p.1) and to be used in conjunction with other design processes. Value-sensitive design is used to continually ensure the values of any designed product align with those of any stakeholders and those affected by said product.

Another important approach is human-centered design (HCD), which emphasizes designing solutions with a deep understanding of the needs, behaviors, and experiences of the people who will use them. Human-centered design involves empathy and active engagement with end-users throughout the design process. This approach typically includes stages such as empathizing with users, defining their needs and challenges, ideating potential solutions, prototyping designs, and testing them with real users to gather feedback and refine the product. This method promotes a holistic view of design, acknowledging that technological solutions must be rooted in the social and cultural contexts of their users to be truly effective and equitable.

The biases and political contexts inherent in the engineering design process have significant effects on the development and deployment of technologies. These influences manifest in various ways, shaping the functionality, accessibility, and societal impact of the resulting artifacts. Specific examples include facial recognition systems and TSA scanners, which illustrate how biases and political considerations permeate technological design and implementation.

- Facial recognition technology has come under scrutiny for its significant biases, particularly affecting people of color and women. Research led by Joy Buolamwini at the MIT

Formatted: Normal, Indent: First line: 0.25", No bullets or numbering

Media Lab and Timnit Gebru at Stanford University revealed that commercial facial recognition systems exhibit higher error rates for darker-skinned individuals, especially women. Their studies found that these systems misidentified darker-skinned women up to 34.7% of the time, compared to less than 1% for lighter-skinned men. This discrepancy stems largely from the unbalanced data sets used to train these systems, which predominantly feature lighter-skinned individuals and males. The resulting biases in facial recognition technology can lead to severe consequences, such as wrongful accusations and arrests, undermining the reliability and fairness of these systems in real-world applications. These findings underscore the critical need for diverse and representative data sets to train AI systems, ensuring more equitable outcomes. (MIT Media Lab Article 1) (MIT Media Lab Article 2)

Case Study

The biases and political influences in engineering design are also evident in the TSA scanners used for airport security. These scanners were introduced as a political response to the heightened security concerns following the September 11th attacks. The first whole body scanners used by the TSA would create the controversial 'nude' images of passengers that then had to be screened by an operator. Engineers identified two issues with these scanners, and neither was the violation of passengers' privacy. Instead, the scanners were found to be too labor intensive, and that the officer reviewing the images was subject to observer fatigue. The current generation of millimeter wave scanners solved this issue by implementing automatic target recognition (ATR), which replaced the operator reviewing images. ATR is an algorithm used by the scanner to identify anomalies, which are then displayed on a basic human figure. The introduction of millimeter wave scanners using ATR algorithms has introduced an additional burden on marginalized people screened at TSA checkpoints. Millimeter wave scanners are unable to differentiate between materials and completely rely on the shape of a scanned subject to identify them as safe or threatening. The usage of an algorithm to make this decision required engineers to define what they believed a 'normal' body is (Valkenberg). By focusing solely on improving technical performance of scanners, the engineers depoliticized the design of the new scanners and have harmed communities who do not fit their ATR model. The biases of designers are a major contributing factor to the discriminatory nature of ATR scanners. However, even with all the biases of designers removed, reliance on an algorithm that equates threats to any deviation from 'normal' will always reproduce these discriminatory outcomes [Amir]. This renders the technology of millimeter wave scanners insufficient for equitable screening of passengers.

Following the September 11th terrorist attacks in 2001, the Transportation Security Administration (TSA) was founded for the purpose of "protecting our Nation's transportation systems from terrorist threats." The establishment of the TSA was a direct response to a national security issue and was driven by a political need to enhance public safety and restore confidence in air travel. This political pressure inevitably shaped the design of the technologies used by the TSA. The motive behind the creation of the TSA as an organization is an incredibly political one, and consequently the devices used by the TSA are inherently politically influenced as well, regardless of whether or not it was intentional. Decisions regarding the development, funding, and implementation of these technologies are influenced by political agendas, public perceptions of safety, and legislative requirements. This political influence can determine which technologies are prioritized, how they are integrated into the security infrastructure, and the extent to which

privacy and civil liberties are balanced against security concerns. Therefore, the tools that equip the TSA, including the scanners used at airport checkpoints, must be inherently political as well, embodying the complex interplay between technological innovation and the political landscape in which they operate. This serves as an excellent example of how simply not acknowledging the political context of an engineering design does not mean that that design is free of social contexts or consequences.

The usage of ATR in whole body scanners integrates biases into the scanners, resulting in harm to marginalized communities who are subjected to additional screening which can escalate into invasive searches. A report by the United State Government Accountability Office identifies multiple groups who are disproportionately flagged by scanners. Groups of TSA officers from four airports were interviewed, and all the groups observed that ATR scanners frequently alarmed on "Transgender passengers, passengers who wear religious headwear, or passengers with certain hair types and styles" (GAO). Another report by the Government Accountability Office identifies passengers with high BMI as a group that is frequently flagged. This report also reveals that data during testing of the ATR system showed biases towards certain groups, but this issue was never fixed before the machines were installed in airports (GAO). The targeting of marginalized groups by the ATR algorithm is especially concerning because many marginalized categories have historically been policed and even criminalized. Designation of marginalized groups as 'abnormal' then reproduces this policing of these groups and even exposes them to potential violence at the hands of TSA officers.

One of the greatest concerns that passengers have had with whole body scanners is the creation of nude images of passengers. Although the TSA claims that no images are stored, the machines have the capability of storing images for "testing, training, and evaluation purposes." This capability is not intended to be active during normal operation of the scanners, however, there have been cases of this occurring. In one such case, the US Marshals Service was found to have saved 35,314 images from a courthouse in Florida [McCullagh]. The potential for images to be saved from scanners violates the privacy of passengers and creates a strong argument for the elimination of these images altogether. In interviews with designers of the ATR scanners, two different types were identified. One manufacturer's scanner does not create any images of passengers and instead applies the ATR algorithm to data directly from the sensors. The other manufacturer still creates an image of the passenger and applies the algorithm to this image [Valkenberg]. This difference between manufacturers reveals that the creation of an image is completely unnecessary and may be eliminated to ensure passenger privacy.

To combat these issues, the TSA must conduct research into how ATR scanners impact various communities, including engaging with representatives from marginalized groups to better understand their experiences and concerns. By incorporating this feedback, engineers can develop more inclusive technologies that minimize false alarms and reduce the likelihood of harassment. Updating the technology to better recognize a diverse range of body types, clothing, and medical devices is critical. This could involve incorporating artificial intelligence algorithms that integrate findings from this research and adjust scanner detection as they learn over time. These advancements would not only lead to fewer false alarms but also enhance the comfort and dignity of individuals from marginalized communities. Beyond updating the current scanners, when new scanners are designed, they should implement technology to detect different materials. The ability to detect what a material is would eliminate the need of current scanners to analyze the shape of passengers. Additionally, continuous training for TSA personnel on cultural sensitivity and the specific needs of these communities is essential. By taking these steps and

others, the TSA can create a more equitable and positive security process, ensuring that airline safety does not come at the expense of social justice and human well-being.

The examples of facial recognition systems and TSA scanners illustrate how biases and political contexts influence engineering design. These technologies, while intended to enhance security and efficiency, often perpetuate existing inequalities and raise significant ethical concerns. Acknowledging and addressing these biases through inclusive design processes, diverse data sets, and training can lead to more equitable and effective technological solutions. This approach underscores the importance of integrating social and political considerations into engineering practice, ensuring that technological advancements contribute positively to society.

References

[1] Cech, Erin A. "The (Mis)Framing of Social Justice: Why Ideologies of Depoliticization and Meritocracy Hinder Engineers' Ability to Think About Social Injustices." Engineering Studies, vol. 5, no. 3, 2013, pp. 217-242, doi:10.1080/19378629.2013.858063.

[2] Friedman, Batya. "Value Sensitive Design: A Guide to Ethical Technology Innovation." Value Sensitive Design, Chapter 1, Cambridge University Press, 2019

[3] Buolamwini, J., & Gebru, T. (2018). Gender Shades: Intersectional Accuracy Disparities in Commercial Gender Classification. Proceedings of Machine Learning Research, 81, 77-91.

[4] Riley, Donna; Hess, Justin; Jeseik Brent. "Decentering an Engineering Ethics Center." Issue 2, Teaching Ethics (2021.) https://openurl.ebsco.com/EPDB%3Agcd%3A8%3A15211928/detailv2sid=ebsco%3Aplink%3Ascholar&id=ebsco%3Agcd%3A156483671&crl=c

[3] Katz, Andrew; Main, Joyce. "Applying Concepts from Political Science and Economics to Advance the Study of Engineering Education." (2022.) Studies in Engineering Education. https://scholar.archive.org/work/r6udpfa7lvhn7ltlgliltn3ydu/access/wayback/https://www.seejournal.org/articles/10.21061/see.75/galley/76/download/

[4] Vale, Julie; Dar, Qurat-ul-ain; Bradford, Andrea. "Capitalism and Engineering Student Attitudes Toward Design." (2024.) Proceedings of the Canadian Engineering Education Association. https://ojs.library.queensu.ca/index.php/PCEEA/article/view/17015

[5] Riley, D. (2017). Rigor/Us: Building Boundaries and Disciplining Diversity with Standards of Merit. *Engineering Studies*, *9*(3), 249–265. https://doi.org/10.1080/19378629.2017.1408631

[6] Buchanan, Richard. "Human Dignity and Human Rights: Thoughts on the Principles of Human-Centered Design." *Design Issues*, vol. 17, no. 3, 2001, pp. 35–39. *JSTOR*, http://www.jstor.org/stable/1511799. Accessed 12 June 2024.

[7] Aranda-Jan, C. B., Jagtap, S., & Moultrie, J. (2016). Towards a framework for holistic contextual design for low-resource settings. International Journal of Design, 10(3), 43-63.

[8] Faulkner, Wendy. "Nuts and Bolts and People: Gender-Troubled Engineering Identities." Social Studies of Science, vol. 37, no. 3, June 2007, pp. 331-356. SAGE Publications, doi:10.1177/0306312706072175.

[9] Atman, Cynthia J., et al. "Engineering Design Processes: A Comparison of Students and Expert Practitioners." Journal of Engineering Education, vol. 96, no. 4, 2007, pp. 359-379.

[11] Reynante, Brandon. “Learning to Design for Social Justice in Community-engaged Engineering.” *Journal of Engineering Education (Washington, D.C.)*, vol. 111, no. 2, 2022, pp. 338–56, https://doi.org/10.1002/jee.20444.

[12] Nieusma, Dean, and Donna Riley. “Designs on Development: Engineering, Globalization, and Social Justice.” *Engineering Studies*, vol. 2, no. 1, 2010, pp. 29–59, https://doi.org/10.1080/19378621003604748.

[13] Phillips, Lisa, and Raquel Deleon. “Living Testimonios: How Latinx Graduate Students Persist and Enact Social Justice Within Higher Education.” *IEEE Transactions on Professional Communication*, vol. 65, no. 1, 2022, pp. 197–212, https://doi.org/10.1109/TPC.2022.3140569.

[15] Carroll, Tomeka, et al. “Cultivating Solidarity for Action on Social Justice in Engineering: A Collaborative Autoethnography.” *International Journal of Engineering, Social Justice, and Peace*, vol. 9, no. 1, 2022, pp. 62–91, https://doi.org/10.24908/ijesjp.v9i1.15216.

[16] Niles, Skye, et al. “Integrating Social Justice and Political Engagement into Engineering.” *International Journal of Engineering, Social Justice, and Peace*, vol. 7, no. 1, 2020, pp. 57–69, https://doi.org/10.24908/ijesjp.v7i1.13568.

[17] MIT Media Lab. (2020). "Uncovering Bias in Facial Recognition Systems."

[18] MIT Media Lab. (2018). Facial recognition software is biased towards white men, researcher finds. Retrieved from https://www.media.mit.edu/articles/facial-recognition-software-is-biased-towards-white-men-researcher-finds/

[19] MIT Media Lab. (2018). Study finds gender and skin-type bias in commercial artificial intelligence systems. Retrieved from https://www.media.mit.edu/articles/study-finds-gender-and-skin-type-bias-in-commercial-artificial-intelligence-systems/

[20] Transportation Security Administration. (2021). "20 Years After 9/11: The State of the Transportation Security Administration." https://www.tsa.gov/news/press/testimony/2021/09/29/20-years-after-911-state-transportation-security-administration

[21] U.S. Government Accountability Office. (2014). "Advanced Imaging Technology: TSA Needs Additional Information Before Procuring Next-Generation Systems," GAO Report No. GAO-14-357.

[22] U.S. Government Accountability Office. (2023). "Aviation Security: TSA Could Better Ensure Detection and Assess the Potential for Discrimination in Its Screening Technologies," GAO Report No. GAO-24-107094.

[23] McCullagh, D. (2010). "Feds Admit Storing Checkpoint Body Scan Images," CNET. http://news.cnet.com/8301-31921_3-20012583-281.html

[24] Valkenburg, G., & van der Ploeg, I. (2015). "Materialities Between Security and Privacy: A Constructivist Account of Airport Security Scanners," Security Dialogue, 46(4), 326-344. DOI: https://doi.org/10.1177/0967010615577855.

[25] Amir, M., & Kotef, H. (2017). "In-secure Identities: On the Securitization of Abnormality," Environment and Planning D: Society and Space, 36(2), 236-254. DOI: https://doi.org/10.1177/0263775817744780.

[26] Mehta, Pratik & Smith-Bindman, Rebecca (2011). "Airport Full Body Screening: What is the risk?", National Library of Medicine. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3936792/

[27] "Whole Body Imaging FAQ." National Center for Transgender Equality (2009.) https://transequality.org/sites/default/files/docs/releases/NCTE_Body_Scan.pdf