



Righting Wrongs: (Re)Defining the Problem of Black Representation in U.S. Mechanical Engineering Study

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Abstract

The discourse concerning racial representation within U.S. engineering education has been long-standing; however, after George Floyd was murdered many engineering organizations shifted to pledges of anti-racism. Mechanical engineering (ME) departments within postsecondary education were among many to make anti-racist commitments to improve their educational climate for Black students, but none adequately acknowledged their role in perpetuating anti-Black norms within the professional formation of engineers. This omission of past wrongs and swift revision of discourse is not minor; in fact, it represents a tradition of misrepresentation and neglect regarding the racial history of the discipline. The goal of this chapter is to examine the historical foundations of engineering education and make connections to the insidious ideologies that established the culture of pedagogy, content knowledge, and professional practice within ME, which has resulted in the maltreatment of Black students and engineers. Black people have long been blamed for their own subjugation within ME using

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rationales of substandard academic preparation and poor work ethic. Such arguments lack sociopolitical context and have been invalidated, but still predominate discourses on racial representation within ME. In contrast, this chapter will deconstruct the epistemologies of Whiteness that undergird the ME ecosystem using the framework of hegemonic Whiteness. This analysis will demonstrate how the formation of ME study and practice in the USA ignored ancient mechanical innovations by peoples of the African diaspora and overlooked the correlation between technological innovation and Black subjugation throughout this nation's history, resulting in a construction of ME that innately excludes and dehumanizes.

Keywords

Anti-Black racism · Epistemology · Whiteness · Mechanical engineering · Underrepresentation

Introduction

The way to right wrongs is to turn the light of truth upon them.
– **Ida B. Wells-Barnett**

As more engineering organizations declare commitments to support the Black community through racial equity initiatives (ABET 2020; American Society for Engineering Education n.d.-a; Gallimore 2021; National Academy of Engineering n.d.), the time seems right to scrutinize this discourse by examining the contributing factors to the suppression of Blackness – Black people's ideas and humanity – in engineering. The current discourse around the minimal presence of Black people in engineering is framed in terms of underrepresentation – the disparity between Black people's demographic representation in the general populace and within the discipline; however, this narrative preserves Whiteness by passively neglecting the culture of racism in engineering. Given my professional background in Mechanical Engineering (ME), I will use ME as a case study to highlight cultural ideologies and mechanisms that dictate the norms of the broader discipline as ME's legacy has influenced much of what engineering has become. ME graduates a significantly higher number of undergraduate students compared with other engineering disciplines and is credited as the second formalized discipline of engineering. Many of our modern technologies would not be available without ME, so it is an important context for analysis given its influence on engineering education and society at large.

This chapter recontextualizes the role of racism in establishing the meaning of engineering and its function in society. Specifically, I will call attention to instances of anti-Black racism throughout history that have constructed its contemporary cultural landscape. Whereas other scholars have discussed the depoliticization of engineering (Cech and Sherick 2015; Foley and Barrella 2021; Niles et al. 2020), I assert that the deracialization of engineering has been most effective at sustaining a

White supremacist culture (Okun 2021), even when sociotechnical considerations are prioritized (e.g., human-centered engineering design). Even the scholarship that analyzes the experiences of Black engineering students seldom delineates the essential features of anti-Black racism as an oppressive social force. Instead, studies most often provide insight into the manifestation of that social force within the lives of Black students. Said differently, the literature on Black engineering students describes the outcomes of racism without explaining the ingredients that make racism so proficient and sustainable in minimizing the number of Black people within the engineering ecosystem.

There is no particular reason, or multiple reasons, that allow for a linear justification for why the representation of Black people in engineering is conspicuously low. In context, the problem – conveniently named “underrepresentation” – is about the resilience of Black people in White spaces. Historical analysis would show that the USA is a social engineering project that deemed Black people as a problem to be solved rather than problem solvers themselves. Engineering, ME in particular, has always been present in the orchestration of a Black underclass, from the technologies used to enslave and kidnap the bodies of West Africans brought through the middle passage to the epistemologies currently used to incarcerate the intelligence of Black Americans pursuing engineering degrees. Engineering has long been considered an absolute good for society, despite the legacy of engineering’s impact on humanity and the environment being extraordinarily toxic. The context that is used to study Black people in engineering needs to be broadened by taking these historic events into account when assessing their presence in engineering and investigating what needs to be done for engineering to be authentically beneficial for this disenfranchised demographic. My intention is to borrow concepts from ecological systems theory (Bronfenbrenner 1989) to elucidate connections between the United States cultural norms and sociohistorical events in the dilemma of Black people in engineering. I present a synopsis of critical events that disrupt the discourse of underrepresentation in favor of more accurately portraying this ongoing circumstance as the result of Whiteness thriving.

In addition to changing how the field talks about this problem, we must change how we act. Mechanical engineers have great potential to do good, but militarism, environmental exploitation, and capitalism govern the professional formation of engineers and their practice. Inspired by the words of Ida Bell Well-Barnett, I first turn the light of truth upon atrocities against Black people that are engineering feats though not usually regarded as such. Then, I examine cultural norms within education and sense-making that reinforce racial hierarchies even as social conditions change. I conclude with provocations regarding refining our discourse on the mechanisms and consequences of Whiteness to help us think critically about what is necessary to redress the legacy of harm in ME dominating our current reality and consider how we might favor the disfavored in mechanical engineering study and practice. The heritage of anti-Blackness in ME has harmed all of humanity, shifting the discourse regarding this issue is one small but necessary step to dignifying the disinherited of our society and humanizing those who receive social benefit from this deprived social structure.

Shining Light Upon the Darkness

Engineering the Social Order: Hegemonic Whiteness

America became White—the people who, as they claim, “settled” the country became White—because of the necessity of denying the Black presence, and justifying the Black subjugation. (Baldwin 1984, p. 91)

Recent tragedies and acts of violence within the United States have spurred many conversations about the origins and implications of this violence, including commentary on the racialized impacts of the novel coronavirus (Mein 2020), presidential politics (Naftali 2021), extrajudicial killings (Ray 2020), and a capitol insurrection (University of Oregon 2021). The public discourse suffers from misconceptions about racism. The most prominent discussions limit racism to individual actions motivated by an illogical animosity and presume racism is only a factor when explicitly stated. These fallacies are emblematic of an ahistorical approach to making sense of Whiteness, which prohibits any true understanding of what it is and, more importantly, its function in society. James Baldwin’s quote succinctly communicates the impetus of Whiteness to establish a set of cultural practices that legitimized the mythic inferiority of Black people and instituted a social hierarchy that cemented Blackness as the antithesis of Whiteness. Indeed, this process was socially constructed, but its repercussions have been long-lasting and devastating. Black subjugation was encoded into law and every aspect of the social fabric that underpinned the formation of the USA, though most damaging is the notion that this persecution was due to natural causes. Dorothy Roberts (2011) explains, “the diabolical genius of making this political system seem biological is that the very unequal conditions it produces become an excuse for racial injustice” (p. 24). This macro-level analysis of the U.S. social structure is the guiding scheme at the root of anti-Blackness in ME and the justifications for the maltreatment of Black people in the engineering ecosystem all point to intellectual and cultural deficiencies in Black people.

Acknowledgment of the political function of racism provides insight into *why* Black suffering in engineering is normalized. This chapter draws upon Hughey’s (2010) conceptual framework of hegemonic Whiteness to make sense of *how* Black suffering in engineering is normalized. Engineering has been in a decades-long campaign to broaden participation within the discipline, yet this nationwide and abundantly funded effort has been minimally effective in shifting the plight of Black engineering students and professionals (London et al. 2020). The phrasing of these campaigns appears to be aware of their inadequacy as they have been refreshed recently to include more specific notions of justice and anti-racism. Nonetheless, Hughey’s (2010) framework helps grasp how intra-racial diversity still results in a commitment to uphold the power of Whiteness, which is also an inherent indictment of the futility of diversity as a framing to address social inequity. Hegemonic Whiteness is an approach that:

conceptualizes Whiteness as a configuration of meanings and practices that simultaneously produce and maintain racial cohesion and difference in two main ways: (1) through positioning those marked as ‘White’ as essentially different from and superior to those marked as ‘non-White’, and (2) through marginalizing practices of ‘being White’ that fail to exemplify dominant ideals. (p. 1290)

Whether by ignorance, unwillingness, or inability to perceive due to hypervisible invisibility, predominant conceptions of Whiteness presumed heterogeneity among White people. Ironically, the same fallacious thinking that fostered a monolithic Black culture – making social deviance the norm for Black people – also constructed a monolithic White culture – making social adherence the norm for White people. Hegemonic Whiteness suggests that difference from Whiteness is synonymous with deficient, and the mainstream ideals will always serve to preserve White domination.

The delineation of the logics of Whiteness demystifies how those who ascribe to Whiteness form conclusions and inferences about social reality (Zuberi and Bonilla-Silva 2008). Table 1 provides brief descriptions and discipline-specific examples of the underlying principles of hegemonic Whiteness. These six tenets form the basis of the lens through which explanations of how numerous events in this nation’s history render Black suffering in engineering consistent with the social structure. The scenarios portrayed in Table 1 are often described as neutral behaviors, demonstrating the need for an approach for analyzing race relations in engineering that can

Table 1 Synthesizing Tenets of Hegemonic Whiteness

Premise	White people	Examples in engineering
White victimology	Ignore their social power to view themselves as marginalized because Whiteness is being increasingly critiqued	Describing equity-focused discussions and initiatives as non-engineering and biased
Black and Brown pathology	View Black and Brown people as inferior, either due to biology or culture	Claiming Black residents do not care about pollutive sites in their community
White debt and epidermal capital: perceptions of empty Whiteness	Use relationships with non-White people or knowledge of their culture to fill in self-identified shortcomings of Whiteness	Proclaiming support for the #BlackLivesMatter movement on anything regarding Black people
Affective Whiteness	Regulate appropriate expressions of emotion where expected based on the context of discussion and group identity	Displaying heightened outrage with White group members when racist remark is made in the absence of a Black classmate
Conscious Whiteness	Possess a political awareness that unequivocally esteems ideals of “individualism, equality, freedom, rationality, and objectivity”	Rejecting racially equitable admissions or hiring policies, denying subjectivity in grading practices
Simplistic Whiteness	Prefer shallow explanations of social reality, reject theoretical approaches to meaning-making	Viewing racial representation in engineering as a natural consequence of population demographics

demarcate the dynamism of Whiteness over time and across contexts. Hegemonic Whiteness rejects the bifurcation of so-called White racists and White anti-racists to highlight the consistency of Whiteness in diverse social conditions.

#EngineeringSoWhite: The Case of Mechanical Engineering

The rhetoric of racial underrepresentation has been so heavily repeated that it has forced its position as the quintessential rationale for more racial diversity in ME. The rhetoric of underrepresentation erroneously focuses on presence rather than power; Black people are not simply minorities, we have been minoritized and this is evident in the diminishing of Black contributions to mechanical innovation. Mechanical engineering is based on principles of mechanics and the science of machine systems. Burstall (1963) declares “the bow and arrow has a special importance in the history of mechanics as it was the first contrivance made to store energy” (p. 39). The earliest depictions of a bow were found in North Africa and the first arrowhead has been determined to be located in South Africa. However, standard narratives of ME’s history are whitewashed, eschewing the contributions of civilizations of the African diaspora for a sterilized narrative that begins with the development of the steam engine and the industrial revolution. Long before discourse on a disparity in population representation, there existed a disparity in epistemic representation. The ideal of objectivity is prevalent in ME, but world history suggests there was an intentional privileging of European inventors and inventions when establishing the foundations of what would become the formalized discipline of ME in the USA. In fact, the intellectual legacy of multiple engineering disciplines can be traced back to one man, “all the theories of kinematic and dynamic analysis of various machines are derived from the Newtonian mechanics” (Zhang and Yang 2020, p. 8). In accordance with hegemonic Whiteness, Eurocentric knowledge and culture – the foundations of what later became Whiteness in the United States – are superior to all else.

Exploitation of natural resources and technological innovation was deemed superior purposes for machinery, motivating campaigns for competition and domination. Zhang and Yang (2020) make known that “behind the development of science and technology are three important driving forces: the economic development, the national defense, and the scientific exploration of the unknown world” (p. 5). These motivations are not inherently problematic, but the social context of the USA is driven by maintaining a hierarchy of Whiteness. Therefore, the unstated but understood implication of those three driving forces is that they are specific to the economic development of White people, the national defense of a White colonial nation-state, and the scientific exploration of that which is unknown and can be conquered by White people (e.g., space colonization). The words of Rev. Dr. Martin Luther King, Jr. appear prophetic as he articulates how dangerous these driving forces are, “when machines and computers, profit motives and property rights, are considered more important than people, the giant triplets of racism, extreme materialism, and militarism are incapable of being conquered” (King 1967). A bleak

picture but true nonetheless; hence, this discussion asserts anti-Blackness is at the core of who is present in the ME ecosystem and the quality of their experience.

Scholars are expanding discourse on the depoliticization of engineering knowledge; these discussions could still benefit from unpacking how cultural knowledge and communal needs were separated from technical knowledge in engineering problem-solving. Depoliticization is commonly viewed as the fault of engineering professors who use decontextualized mathematical problems to teach so-called core engineering concepts; however, the derivation of this phenomenon occurred before engineering education was formalized. Instead of viewing resourcefulness in the absence of complex machinery as ingenious, mechanical creations conceived solely for communal continuity have long been considered primitive. For example, ancient Egyptian engineering is condensed to the world-renowned pyramids. Moreover, Egyptian engineers erected the pyramids to adhere to religious beliefs, and this commendable exhibition of engineering in service of culture is regrettably disregarded. Much less appreciated in the ME community is the simple machines (e.g., levers, ramps), mathematical knowledge (e.g., geometry and measurement), and social skills (e.g., collaboration and organization) these engineers used to produce such remarkable monuments. Another example is the lathe, which has been a critical tool in ME history and was particularly important during the industrial revolution. Its early presence and societal function in Egypt and even the tools used to create the first known depictions of a lathe, also located in Egypt, remain underrepresented today. These features of Egyptian engineering span the values, skills, and dispositions prescribed as essential for professional mechanical engineers, but rarely are Egyptian engineers hailed as exemplars for these engineering habits of mind and practice. Throughout history, dark-skinned people have engineered mechanical contraptions, but Whiteness has constructed a dominant narrative that renders these contributions insignificant, especially past 600 B.C.

Manufacturing Iniquity

The severity of the marginalization of Blackness can only be accurately described as evil, for its stronghold is so powerful that even its most disadvantaged victims would rather critique themselves than call it what it is. The exhibition of anti-Black racism in ME goes much deeper than the metanarratives that were curated and whose ingenuity shaped the discipline. The racialization of phenotype is engraved into the nation's social structure. From the literal use of mechanical systems for enslavement to the construction of educational institutions built on exclusivity, evildoing has been at the center of ME. Dreadfully, these atrocities have been reduced to issues of "equal opportunity," an oversimplification of history that is yet another example of Whiteness as work. Disrupting discourses of Whiteness requires truth-telling and a recalling of past events that reveal the lineage of racial oppression that preceded our current social reality. Accordingly, three concentrated accounts of the historical trajectory of ME that directly procured the subjugation of Black people in the USA are provided. The first account, entitled inhumane innovation, examines the ways

technologies were created and used to enact an invented political system based upon the social construction of race. Secondly, treacherous tendencies are described, the ways White people amplify barriers for Black people to demonstrate mechanical ingenuity but ignore or devalue our success when we overcome these hindrances. Laws, highways, and walls were purposefully designed to degrade Black people as some type of contagion to White people; nonetheless, as these practices became normalized Black people continued to generate major contributions to society. Thirdly, how the professional formation of mechanical engineers in institutions of higher education has been marred by an intellectual tyranny is explained, whereby violence is normalized and the inherently entwined nature of culture and cognition is separated. This is characterized as engineering (mis)education and presented as primarily responsible for the low presence of Black people in engineering despite issues of educational disenfranchisement.

Inhumane Innovation: Technologies of Whiteness

The earliest materializations of anti-Blackness in engineering are the contraptions built to enslave West Africans: chains restraining free movement of their body parts and tying them to one another, along with slave ships full of space yet vacant human dignity. Whiteness has somehow found a way to leave us largely ignorant of the details of this ME origin story, as many do not even associate this barbaric period of history with the discipline of ME. White people in the engineering community may agree with the nefariousness of this period of history, but they may not concede that Whiteness motivated the engineering ingenuity displayed by the complex designs of the chains, ships, and other technologies employed to kidnap West Africans. However, Walton (1999) illustrates that for Black folks it is obvious that this crisis was just the beginning of an ongoing struggle with technologies of Whiteness:

From the caravels, compasses, navigational techniques, and firearms of the first Portuguese explorers who reached the coast of West Africa in the 1440s. . .the Black community has had one negative encounter after another with the technological innovations of the mainstream. (paragraph 9)

Caravels, compasses, and firearms are all products of mechanical engineering. It is important to reinforce that the purpose of these technologies was to execute a uniquely distinct form of chattel slavery that resulted from an innovative racial ideology (Roberts 2011). Furthermore, the retelling of their historic uses is left to historians and museums (Brown University 2016), rather than to educate engineering students that the social implications of manufactured inventions are just as important as the technical knowledge used to create them.

The ships used to transport kidnapped Africans are deserving of particular attention because of their role as a machine that has transformed human history in so many ways. The use of ships has always been interconnected with an economic function, though the so-called slave trade made Black people into human cargo and established

unprecedented wealth economies. Indeed, it is important to understand that the innovative energy applied to improving ships for the transport of Black people was not simply for torture, rather the dehumanization of these people was justified to secure an exploited labor class. This context is often lost in a discipline entangled in notions of technology as objective and unbiased. In reality, technologies have not been used casually to subjugate Black people, but instead have been ingeniously fabricated for the specific purpose of Black subjugation. Many histories that delineate the craftsmanship of these vessels that would carry as many as 200–300 human captives reveal the perilous voyages that led to mass suicide and homicide; notwithstanding, much less are these inhumane innovations understood as technological feats. This significance is not lost on Rediker (2007) as he shares the words of Thomas Gordon, who in 1784 stated, “as a Ship is undoubtedly the noblest, and one of the most useful machines that was ever invented, every attempt to improve it becomes a matter of importance, and merits the consideration of mankind” (p. 41). Gordon was correct in viewing the improvement of ships as important, and in the case of the Transatlantic Slave Trade, it would be erroneous to consider ships as little more than an altered use of a long-existent technology. The ship became simultaneously a tool for White supremacy, in developing the economic power of White colonizers, and Black subjugation, in serving as a mass transportation mechanism for captured West Africans shipped all across the world, but Rediker does not stop there, and his insightful book proclaims to tell the story of:

the instrument that facilitated Europe’s ‘commercial revolution,’ its building of plantations and global empires, its development of capitalism, and eventually its industrialization. In short, the slave ship and its social relationship have shaped the modern world, but their history remains in many ways unknown. (p. 10)

Within ME, there is an absent diagnosis of this “social relationship” that has been so critical, and this relationship is founded upon the dehumanization of Black humanity in service of financial prosperity for White humanity.

This story of inhumane innovation continues after the landing of enslavement ships in what came to be known as the United States, where Black people were treated as chattel. Invention and innovation are hallmark ideals of U.S. nationalism, and these values sparked the ambition of Eli Whitney to forge the cotton gin. Though there are many other examples of inhumane innovations that occurred during the duration of chattel slavery, this one is particularly notable because of the circumstances surrounding its invention. The prominent narrative is that Whitney was simply trying to solve a problem and make a lot of money doing so. Many describe Whitney as thinking his invention would actually reduce the need for slave labor, despite there being no basis for such logic in a society that blatantly esteemed financial profits over Black human dignity. Many engineering students today are sold this same rhetoric of using mechanical engineering to solve problems and secure financial stability, even upward economic mobility for those coming from low-wealth backgrounds. What such rhetoric ignores is the distribution of wealth, power, and privilege in society, in particular, how each of those works to preserve a White supremacist hierarchy.

The cotton gin was a mechanical device that removed seeds from cotton fiber more efficiently; it could be done by hand or powered by a horse and later was powered by a steam engine. If Black people were viewed as human, this type of device *might* have been viewed similarly to how robots are being utilized today, as cheaper, more controllable, faster, and more reliable. However, Black people were seen not as human but as property, so the incentive was to expand one's enslaved workforce to maximize profits. Whitney's legacy is secure as a prominent inventor and financier regardless of the devastation his most well-known invention caused. One major takeaway from this account is the futility of intentions, much of the discourse concerning anti-Black racism in undergraduate ME programs and professional workplaces is whether those who cause racial harm intend to do so. In actuality, the intention of any actor, or a larger system, is less important than bringing accountability for the harmful outcomes one's actions have initiated. More importantly, the engineers' code of ethics is mum on redress. The cotton gin is a sobering reminder that Black lives do not matter, or maybe, money just matters more. . .perhaps both are true.

Treacherous Tendencies: Habits of Whiteness

The cultural practices of White people have functioned as a gatekeeping mechanism for what is regarded as excellent in ME and the terms of engagement percolate with hostility toward Black people. The propaganda proclaiming Black people are pathological and suffer from a deficient culture has been so effective that the ME community readily accepts allegations of low motivation, academic incapacity, and lack of role models. I am utterly confused by these assertions because even chattel slavery did not prevent Black people from generating mechanical innovations, nor did its residual de jure racial segregation. In his prolific essay, Coates (2014) delineates the presumed dysfunction attributed to Black people despite evidence to the contrary. He argues that this delusion is grounded in an unwillingness to concede the detriment of White supremacy culture and the dexterity of Blackness. The absence of a reckoning with Whiteness engenders the acceptance of defamatory beliefs about Black people which inhibits even those with a sincere desire to actualize racial equity in ME from being successful.

One unresolved habit of Whiteness is the tendency to overlook historic and contemporary contributions to ME made by Black Americans. The annual recap of Black engineers who were the first to achieve specific outcomes during Black history month is superficial, and it actually does more to demonstrate the long-standing stronghold of White supremacist culture that this nation is still undoing than to honor the fullness of these Black thinkers and creators. This tendency can be observed in the history of racial desegregation, whereby even as explicit and overtly violent racist laws declined the unwillingness to affirm Black humanity and intelligence persisted. Black people are not just differently raced people doing the things White people do. Black people are people doing things differently because they are forced to navigate this society with a different set of norms.

The whitewashed narratives of chattel slavery that undermine its heinous nature or characterize it as simply a peculiar institution (Phillips 1918) do little to advance our understanding of this systematically oppressive innovation. Enslavers did more than flaunt their status at social gatherings, and the enslaved did more than pick cotton and sing Negro spirituals. Take, for example, the life and legacy of Benjamin Montgomery, an enslaved Black man that created a new propeller design for riverboats on shallow rivers in the 1850s. Joseph Davis, the brother of Confederate President Jefferson Davis, enslaved Benjamin and regarded him as an excellent machinist. A notorious racist trope declares that Black people are largely illiterate and are disinterested in education; this claim is ludicrous when considering Benjamin's family made sure he could read when it was illegal for Black people to do so. This foundation of education is what Joseph Davis recognized and allowed Benjamin to pursue further education, which eventually led to construction plans for levees, maintaining steam engines for the plantation's cotton gin, and his shallow water boat propeller invention. The full intellectual legacy of Benjamin Montgomery remains unknown, in part because he was denied a patent for his invention due to his enslaved status and also because his influence on steamboat travel in the nineteenth century amid ruthless social conditions is deemed negligible.

By the time Black Americans were legally allowed to claim rights to ownership of their own bodies, they still were not permitted to fully engage in society as free citizens. Professions like engineering provided economic independence and stability, but the legalization of Black citizenship did not translate into access to the social networks needed to participate in engineering training. Since its inception, Whiteness has been immensely mutable and this tendency is revealed by how White people constantly modify the credentials for one to be officially identified as being trained to perform a particular job. The story of Elijah McCoy offers a lesson of how Blackness is an overriding disqualifier regardless of one's accreditation. Elijah's parents escaped slavery via the Underground Railroad, and he was born in Canada. Around the late 1850s, Elijah traveled to Scotland to advance his education. He engaged in a mechanical engineering apprenticeship, which was a common form of engineering education at the time. When we returned to the USA seeking job opportunities, he was unsuccessful due to racial discrimination, so he settled on working for the Central Michigan Railroad as a fireman. Sara Hoffman, a historian, created a learning module for my course on mechanical engineering and racial justice, in the lesson plan she describes:

Locomotives were steam powered. Firemen kept the boiler filled, kindled the boiler fire, manually oiled the engine parts when the train stopped, and operated the tender break. Firemen worked under the supervision of the enginemen who drove the trains, and even many enginemen were not literate. Many railroads would only hire very young men as firemen, and it was an opportunity for social mobility for young men from rural contexts.

These details clearly describe the role of railroad fireman as dangerous and incommensurate with Elijah's socioeconomic status and educational training, but through the lens of Whiteness it was perfect for his racial status. Undeterred, Elijah used his

knowledge of fluid mechanics to create an automatic lubricating device that “distributed calibrated amounts of oil through the engine at fixed intervals” (Hoffman 2022, p. 6), resulting in cheaper and more efficient railroad operation.

The relaying of Elijah’s story is not his superior intelligence over any other Black person nor to feature the resilience he and his family exhibited, though both are remarkable; rather, his story depicts the hypocrisy of Whiteness. The industrial revolution, which took place in Great Britain, of which Scotland is a part, is oft hailed by the White power structure as the start of mechanical engineering as we know it today. Thus, one can suppose Elijah’s apprenticeship equipped him to be more proficient than many engineers in the USA in understanding and applying the principles and practices that were formulating the discipline of ME at the time. Yet, Elijah’s training did not matter. His social status as a Black man was only recently upgraded from property to person, and so he was only deemed worthy of laboring with the lowest class of workers.

Indeed, other examples abound of White individuals and White society at large disparaging Black people’s talent in mechanical engineering, from Henry Ford’s arbitrating of Black workers (Foote et al. 2003) to underappreciated engineers like Sarah E. Goode, Garrett Morgan, and Patricia Bath who all created mechanical devices that dramatically improved the lives of others. These are not hidden figures; they are abandoned and dishonored. The stamp of Blackness literally necessitates Black people to embody rejection by Whiteness. From the standpoint of circumstance, Black people are not afforded the same opportunities, resources, and advantages as White people. From the standpoint of recognition, Black people do not get the same credit for doing the same things White people do, so those who manage to be successful must go above and beyond the standards of quality. From the standpoint of substance, many Black people do things to improve the living conditions for all of humanity, and especially for their racial community. For instance, Benjamin Montgomery set a legacy that led to the establishment of a Black city. Elijah McCoy enhanced railroad operations, transatlantic ship travel, and the functioning of factory machines during the industrial age. Garrett Morgan improved the safety of transportation norms (DeLuca 2021). Sarah E. Goode made space for intellectual activity and rest in places where physical space was limited (Boyd 2016). Patricia Bath made advancements to the process that restores people’s vision (Boyd 2016). We can only imagine the consequential inventions and human inspiration that could have been if their narratives were given the admiration afforded White mechanical engineers that enhanced violence, or even those who tolerated violence against Black Americans and were complicit in the social engineering of our subjugation.

Engineering (Mis)Education: Epistemologies of Whiteness

Engineering education can be understood in general as the knowledge, skills, and attitudes that shape the training students receive to become professional engineers. The recent emphasis on research in engineering education has exposed the dominant ideologies of Whiteness that govern the theories of knowledge applied across the

sub-disciplines of engineering. The framework of hegemonic Whiteness reaffirms that maintaining racial domination is the goal of both overt White supremacists and White people sympathetic to racial justice initiatives, and this can be seen in the ways engineering educators are miseducating people on the meaning and function of engineering in our society, specifically in ME (Douglas et al. 2020; Pawley 2017). The discourse on racial representation is deceptive because it focuses on people's identity rather than the racist constructions of knowledge generally accepted within ME. Epistemology is concerned with knowledge and what logics and beliefs influence perceptions of truth and rationality (Steup and Neta 2020). The epistemologies ubiquitous in ME require examination because there is a direct correlation between the power asserted through its sanctioned ways of knowing and the politics of who is affirmed within the ME ecosystem.

Mechanical engineering is about more than making and operating machines, and it is an applied science, but the separation of the biological, chemical, mathematical, and physical sciences from the arts, humanities, and social sciences was detrimental to the development of the discipline. The first engineering school in the world was the Paris Institute of Technology (École Polytechnique), which led to other similar schools across Europe, the USA, and Russia, all of these schools situated science and mathematics as the foundation of engineering (Zhang and Yang 2020). Some scholars suggest "it is the engineer who chooses the proper technology considering the economic, social, and environmental factors" (Dixit et al. 2016, p. 2). Taken together, these perspectives disclose the epistemological practices of mechanical engineers, and they have been trained to use sense-making processes within the natural sciences to understand sociological dynamics. Mechanical engineering is regulated by a positivist epistemology, which means legitimate knowledge claims can only be determined from empirical evidence. Consequently, other ways of knowing that tend to be more prominent in Black culture (e.g., intuition, spirituality, and self-examination) are disgraced. Moreover, the racial disparities in academic performance are viewed by positivist thinkers as factual evidence of White intellectual superiority and do not require any analysis of social conditions like educational disenfranchisement and racial violence. Associated ideals with positivist thinking are belief in a meritocratic educational system and cherishing objectivity as a value, which again make the persecution Black people experience in ME seem natural and therefore justified.

The first engineering education institution was established at West Point in 1802 as a military academy (Zhang and Yang 2020), just under a decade after the invention of the cotton gin. Dixit et al. (2016) define mechanical engineering as being "concerned with reducing or eliminating physical effort of humans or domestic animals with the help of tools and/or machines" (p. vii). The tacit implication of anti-Blackness was that this reduction in effort was for White people; everything, and everyone, else could be overburdened to maximize profits from the labor of resource production. This normalization of Black dehumanization was installed into the consciousness of mechanical engineers, and it was the first epistemology: One could be considered as legitimately improving machines to benefit humankind without regard for Black humanity (Benjamin 2019; McGee 2020; Wharton 1992). This duplicitous

epistemology remains a guiding philosophy in ME today, where engineering programs can both be recognized as exemplars of inclusive excellence while having an unresolved involvement with chattel slavery or a poor record of enrolling and supporting Black students (American Society for Engineering Education [n.d.-a](#)).

Howard University was the first HBCU to establish two-year ME bachelor's degree programs in 1907, which later grew into four-year ME bachelor's degree programs in 1911. There were 49 years between the time when the nation sponsored the training of White mechanical engineers and the time when the nation allowed an under-resourced infrastructure to be developed for the training of Black mechanical engineers (Grayson [1980](#); Slaton [2010](#)). The head-start White men received meant that they were able to embed their disdain for Black people into the educational and professional norms of the discipline: the knowledge that made one qualified, the teaching practices, the process for identity formation, the social networks that supported persistence in college and in industry, and so on. The Morrill Land-Grant Act of 1862 was a boon to engineering education at White colleges due to the expansion of college access for non-affluent White men in concert with expanded spending on engineering learning materials. Black people were largely excluded from this amplification of engineering education. The Morrill Land-Grant Act of 1890 required institutions of higher education to stop discriminating against Black people or designate separate institutions for educating Black people that ensured "the funds [were] divided in a "just," but not necessarily equal, manner" (National Research Council [1995](#), p. 1). The White institutions that did not permit Black people were expected to fairly manage funds for Black educational institutions. This led to the founding of many Historically Black Colleges and Universities (HBCUs). Black ME students were not afforded the misfortune of separating the social, political, and economic aspects of their learning and making like their White counterparts.

An epistemology of Whiteness proposes failure or academic misunderstandings are due to a students' inadequacy, so ME education became a process of weeding people out and cultivating infatuation with notions of hardiness. Epistemologies of Whiteness go deeper than who is represented, they constrain (a) what information is deemed necessary to be known, (b) what representations of knowledge are acceptable and what forms of articulating understanding are standardized (e.g., written word, timed exams), and (c) what problems are considered worthy of investments (i.e., money, time) and application of mechanical engineering knowledge (Holly and Masta [2021](#); McGee [2020](#)). The epistemology of Whiteness that provided the basis for ME was rooted in militarism and violence, and this was an exacerbation of the general education Black Americans received that fortified loathing of one's own culture and embracing mythologies of intellectual deficiency to fit in with the dominant White culture (Gordon [1990](#), p. 95). A discourse centered on who can be physically included without engaging the implications of power in knowledge production neglects the ways Black people are forced to give meaning to their experiences through the lens of Whiteness. Modern calls for broadening participation are just campaigns for cosmetic changes to ME if the underlying epistemic norms remain the same.

Conclusion

This chapter seeks to change the conversation on Black representation while also amplifying discourse on the imperative change ME must undergo. Much has been written and said about the state of Black people in ME study and practice, and yet there is little understanding of why so few Black people enter ME undergraduate programs and persist through to ME careers. Researchers have paid little to no attention to the extent of racism that produced the cultural norms of the discipline as we know it today, and educators and the public have adopted these impaired analyses and presented them as factual. The result has been exaggerating deficiencies of Black people, and minimizing the malpractice that White people have historically perpetuated. The mechanisms through which abuse has been produced within ME are technological innovations that are inhumane, tendencies of evolving treacherous practices to maintain dominance, and imposing narrow ways of knowing. Discussions on Black representation require a shift to holding White people, and the broader White power structure of hegemonic Whiteness, accountable for their depraved disposition. A practical step is rewriting the narrative of ME and historicizing its anti-Black racism more prominently. This accountability measure includes institutions of higher education and professional organizations within the ME ecosystem, along with government entities involved with workforce development, taking responsibility for their role in Black subjugation by enacting reparations – appropriate recompense for the specific harms inflicted. Detailing a plan of how to accomplish this is not the goal of the chapter; instead, I sought to portray why such redress is long overdue.

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