Journal of Women and Minorities in Science and Engineering 28(2):95–110 (2022)

RECKONING WITH THE HARM OF ANTI-BLACKNESS IN ENGINEERING EDUCATION: A REPARATORY JUSTICE RESEARCH APPROACH

James Holly, Jr.[1,*] & Lauren Thomas Quigley[2,*]

[1]*Assistant Professor, Mechanical Engineering, University of Michigan, Ann Arbor, Michigan, USA*

[2]*Affiliate Assistant Professor, University of Washington, Seattle, Washington, USA*

*Address all correspondence to: James Holly, Jr., Assistant Professor, Mechanical Engineering, University of Michigan, Ann Arbor, MI 48109; Tel.: +(313)643-5071, E-mail: jhollyjr@umich.edu; or Lauren Thomas Quigley, University of Washington, Seattle, WA 98195; Tel.: +(201) 406-9679, E-mail: laurendt@uw.edu

Anti-Blackness has a consistent and insidious influence in engineering study and practice, hindering Black engineers' access and experiences in the classroom and beyond. Within engineering education research, some scholars have sought to understand, describe, and increase the presence of Black people in the discipline. However, their research approaches have sustained many of the same anti-Black practices and perspectives endemic to engineering in the United States. We present this position paper to initiate a discussion regarding harms caused in engineering education research that are specifically anti-Black in nature, and to prompt exploration of reparatory justice as a framework to reimagine research about Black people in engineering. We draw on the work of Joyce E. King's reparatory justice curriculum as a conceptual framework calling for undoing mis-education regarding chattel slavery and centering African epistemology and wisdom through what she calls heritage knowledge (intergenerational cultural memory) to rectify our research praxis.

KEY WORDS: *engineering, anti-Blackness, reparation, higher education, epistemology*

1. POSITIONALITIES

1.1 Lauren's Positionality

I come to this work as an engineering education researcher whose career has for the most recent years been embedded in the tech industry. I am a womanist whose purpose is to change science, technology, engineering, and mathematics (STEM) education such that anyone can choose to be an engineer and to ensure that people have the technical literacy to participate fully in society. My own lived experiences as a Black woman—with a strong Black identity, commitment to liberative pedagogy, and a clear-eyed approach to dismantling systemic oppression—motivates my research work. I view engineering as a field with the potential to achieve meaningful social justice ends; however, this requires a broader set of worldviews and theories to become a reality. In this piece, my aim is to challenge my field and colleagues to consider a

different worldview and the ways it would move the discipline toward a more socially just position.

1.2 James' Positionality

I come to this work as a Black male assistant professor of Mechanical Engineering. My racial identity, academic background, and career experiences have motivated my scholarly focus on inequities that reproduce harmful learning experiences for Black engineering students. I examine these instances through the lens of Black critical theory with the intention of mitigating anti-Blackness within teaching and research practices, and promoting pro-Blackness instead. Additionally, my religious identity, informed by Black Liberation Theology, provokes my pursuit of reparatory justice for Black people in engineering as genuinely remedial. In this position paper, my aim is to generate a discourse within our scholarly community that pushes us to pursue a material transformation in all things related to research on the intellectual development and professional practice of Black people in engineering.

2. INTRODUCTION

> *And I know, which is much worse, and this is the crime of which I accuse my country and my countrymen, and for which neither I nor time nor history will ever forgive them, that they have destroyed and are destroying hundreds of thousands of lives and do not know it and do not want to know it* (Baldwin, 1963, p. 17).

There is an abundance of research focused on the methods by which Black people are excluded in engineering, along with clarity on the Whiteness, maleness, and imperialistic ways of engineering culture (Barus, 1987; Blosser, 2020; Eastman et al., 2019; Fletcher et al., 2021; Hacker, 1993; Mejia et al., 2020). However, there has not been substantive discussion of how to create a context where Black people are seen as human, essential, and inherently magnificent (i.e., contrary to anti-Blackness). The racial trauma resulting from anti-Black racism in engineering remains an unresolved affliction; therefore, promoting diversity and inclusion in campus climate and scholarship without a lens of reparation will sustain the exclusion of Black engineers. Moreover, misunderstanding the contributing factors to how and why Black people are mistreated preserves unjust cultural norms. In this position paper, we aim to engage the discipline of engineering education in a difficult but needed conversation about repairing the harm experienced by Black Americans as they study and practice engineering. We draw on the work of colleagues that explore both the systemic anti-Black oppression within the discipline (McGee, 2020; Slaton, 2010; Wharton, 1992) and colleagues of other disciplines—such as sociologists, economists, and historians—to illustrate the need for structural repair of both historical and current practices in engineering education (ENE) at the collegiate level.

We locate our critical examination of the STEM education system within the research practices of ENE, beginning with the contempt laid upon Black people as deficit narratives pervade the literature (Harper, 2010; Mahoney, 2017; Mejia et al., 2018). While we affirm calls for a cultural shift in ENE away from tokenism, mythic assumptions of low interest, and allegations of low talent as rationales for Black people's representation in engineering, we assert such changes as insufficient and delinquent. We encourage our colleagues to work toward repair of this legacy by de-marginalizing Black perspectives in literature and correcting dominant paradigms (Gordon, 1990). Our position is that ENE as an ecological system has a responsibility to institute restorative procedures that recognize the suffering Black people in engineering as an act of healing; and simultaneously create a climate where Blackness is recognized as an intellectual asset in its own right. We reference James Baldwin's words in the aforementioned quote to characterize an unfortunate reality in ENE—the destruction of Black lives and ongoing loss of human potential has become a comfortable catastrophe. When and how will the weathering (Geronimus et al., 2006) Black people demonstrate be taken seriously, as we endure violence against our mind, body, and soul? We hope our proposition for employing a reparative justice approach to research spurs racially equitable research practices to counteract this onerous plight of being Black in engineering.

3. REIMAGINING OUR RESEARCH DISPOSITION

Racialized harm is not exclusive to Black Americans. Black people with family histories that do not include American slavery, Native Americans, Latinx, and some Asian communities have also endured decades and centuries of racialized harm. Nonetheless, we aim to make a historically situated argument that aligns with the proposal of reparations first made in the waning days of the Civil War intended to provide economic and social footing to formerly enslaved Black people. In other words, our proposed reparative justice approach for research is rooted in a broader proposal for recompense that would have altered the developmental trajectory of this nation. Our aim is not separation but specification to illuminate the overall failings of diversity efforts that do not take a reparative approach; accordingly, we will discuss the ways racism is uniquely manifested in the lives of Black people.

Anti-Black racism, or anti-Blackness, can be summarized as "behaviors, attitudes, and practices of people and institutions that work to dehumanize Black people in order to maintain White supremacy" (Amherst College, n.d.). One prominent example of anti-Blackness is former President Abraham Lincoln's signing of the Emancipation Proclamation. While many regard him as the great emancipator, his own words reveal more interests in saving the Union than abolishing slavery and much less considering Black people as equal beings to White people (Kendi, 2016). On one hand, such political actions have been made to mitigate anti-Black discrimination; on the other hand, these same policies have failed to affirm the humanity of Black people (Bell, 2004). In higher education, particularly at White institutions, the degradation of Black people

takes on a different form but is no less potent. Dancy et al. (2018) offered a poignant explication of consistencies between contemporary higher education and the savagery of settler colonialism. They suggested a system-wide analysis is necessary to fully capture the duplicity of these organizations, which support a "robustness that can practice epistemic murder of Black humanity, while supporting celebrations of multiculturalism" (Dancy et al., 2018, p. 178). Most of the failure to successfully address issues of equity and inclusion are due to the unwillingness of scholars to acknowledge the depths of this violence.

We situate the struggle for Black freedom in engineering education within the broader struggle for freedom in this nation. We draw upon the King (2018) reparatory justice curriculum approach to redefine the problem of Black people's low presence in engineering, and to rethink the extent to which the entire engineering education ecosystem (e.g., policy, structure, and pedagogy) needs to be changed. The core of anti-Blackness in education—prominent across STEM from pre-college to professional practice—is that Black people are treated as inferior to White people. This practice is proliferated through the scholarship that guides the field; thus, a reparatory justice approach "requires accurate scholarship informed by African epistemology and wisdom to undo the mystifying, well-worn, ideological narratives of our dispossession that are justified by our so-called inferiority" (King, 2018, p. 158). The tenets of this reparatory justice approach, presented in Table 1, move us toward reimagining ENE by first remembering—recovering diverse experiences and knowledges about the past to establish a broadened and more accurate record (King and Swartz, 2014)—our nation's history.

African history and culture are often framed as deficient in the United States; thus, descendants of enslaved Africans are often framed as deficient. The historical context embedded in this approach helps reframe Black people's cultural and intellectual traditions as rooted in a broader contribution to humanity. Too often research that seeks to normalize the history of enslavement in the United States, or suggests that the effects of those 246 years are settled, diminishes the barbarity of chattel slavery. Mainstream research practices misconstrue the realities of Black people because they lack the appropriate tools to decipher what they observe; devaluation of our humanity has allowed disbelief in what we share with our narratives. Consequently, we need to tell our own stories in our own ways as an educative practice in how to understand our experiences (Holly, 2021). Characterizations of Black individuals, families, and communities need to be contextualized by delineating the United States' history of state-sanctioned violence (often with impunity) against Black people. This frame of reference is critical for people to be able to understand how learning settings operate as sites of Black suffering (Dumas, 2014). Accordingly, we now provide a brief review of the historical experiences of Black Americans and show how this historical context has shaped our experiences in ENE. We then discuss why prioritizing reparative action (i.e., reparation) is so essential; for the sake of contextualization, we explain what we mean by reparation; and we conclude with thoughts on how this can be achieved in engineering education research.

TABLE 1: Reparatory justice curriculum approach (Based on King, 2018)

Premise	Relevance for research
Our story does not begin with enslavement but with humanity's origins in Africa.	Questions that imply something is wrong with Black people should shift to studying the ways Whiteness, which is rooted in Eurocentrism, has sought to annihilate our intergenerational cultural knowledge.
The narrative that Africans selling Africans made European slaving possible is incomplete, and therefore distorts history in several ways.	Scholars should employ a robust understanding of the concept of race, and thereby racism, as constructed and maintained in the United States. This would enhance the ability to identify the nuances of racism across raced groups, across time, and across context.
Rewriting the debt owed requires a method of knowledge construction using accurate scholarship that affirms our own voices as well as our family/community consciousness as sources of validation.	First, supposed gaps (e.g., opportunity, achievement, etc.) would be re-identified as debts. The exploited labor and unspeakable abuse of Black people remains unatoned. Second, Black people's ways of learning and doing would be determined by us, not measured by our ability to be understood by White people.
After European enslavement and importation of Africans directly from the continent were outlawed, chattel slavery devolved into the lucrative business of domestic slave trading.	The consequences of state-sanctioned violence against Black people do not simply dissolve; scholarship would need to balance celebrating the ingenuity of Black people to survive this reality while attending to our legitimate suffering.
The ongoing global dehumanization of people of African ancestry is also rooted in the legacies of four centuries of Arab enslavement before Europeans kidnapped and enslaved Africans for 300 years.	Reparations are long overdue: scholars ought to examine the extent of responsibility for higher education institutions and engineering programs in particular (see Douglas-Gabriel and Wiggins, 2021). Shift from constantly studying Black people's negative experiences to exploring what happens when the actions Black people suggest as restorative are enacted.

4. AN ABBREVIATED VIEW OF THE HISTORY OF BLACK AMERICANS

The history concerning the experiences of Black people in the United States has been a tense relationship between struggle and triumph as descendants of enslaved Africans kidnapped from their homeland continue to endure deplorable circumstances to persist toward recognition of their humanity and dreams of material prosperity. A detailed analysis of the event known as the Middle Passage, where Africans were shipped across the Atlantic to be enslaved as chattel, is necessary to adequately grasp how a system of racialized power was initiated through this heinous period of history. Such an account is beyond the scope of this paper, yet some discussion of this tragic event is essential to consider the undiminished benefits of enslavement that drove the evolution and modernization of the United States (Baptist, 2016). The actual number of Africans killed during

this time of history can only be estimated—but exceeds millions—the loss of dignity and even identity for many is again immeasurable, the number of families fractured is multitudinous, and the list of other atrocities is extensive. Even when legalized enslavement ended, the institutionalized oppression of those categorized as Negro continued.

> In the foreword of the DeGruy (2005) book, Randall Robinson exclaims American slavery was the economic cornerstone on which American wealth and power were built—wealth and power which lasts to this day, as do psychosocial consequences of American slavery, both for the descendants of the enslaved as well as the descendants of the enslavers (p. ix).

This claim was supported by the ability of Whites to enact Black codes, sharecropping practices, the convict lease system, and other exclusionary actions that further cemented the social standing of Black people as antithetical to White people (DeGruy, 2005). Being aware of these unjust occurrences does not fully capture the traumatic effects on Black people that suffered through these lawful crimes or the generational trauma and economic setbacks they originated. These circumstances alone were excessive, but history tells they were only precursors to legalized segregation.

The Jim Crow era revealed a trend that continues to stifle the uplifting of the Black community. The extraordinary adaptability of racism has perpetuated a "process through which White privilege is maintained, though the rules and rhetoric change" (Alexander, 2010, p. 21). When analyzing the structures of racialized power enacted through policy and culture in the United States, one can identify a trend that when traditional methods of racism are disputed and eventually overturned, new methods of racism emerge that are stronger in rhetoric and support than their predecessors (Alexander, 2010; Tatum, 2003). The cost of such a cycle has been tremendously damaging to the Black community, particularly those residing in urban settings. Racialized messaging and corrupt housing practices essentially created urban ghettos (Rothstein, 2017), which in turn became hotbeds for massive unemployment, violent activity, and a host of other affairs that work together to delimit the number of opportunities and quality of life for Black people in the inner city.

Racial disparities in housing are perhaps the most significant (Desmond, 2017; Moskowitz, 2017), since many sectors where inequalities exist not only work together but are interrelated. For example, segregated communities have direct correlations with communal wealth, rates of crime, standards of public schooling, and many other factors that shape one's quality of life and lifespan. The absence of restoration for these abuses is one rationale why a recent report found that Black people are at or near the bottom in comparison to other races/ethnicities across 10 key measures of social well-being (i.e., employment, poverty, safety net use, housing, education, incarceration, health, earnings, wealth, and mobility) (Stanford Center, 2017). The report states Black men have had the lowest rate of employment among all men for every month dating back to 1940, and the reasons for this epidemic presented in other literature include "racial discrimination, arrest records, and, for older men, weaker educational credentials" (Hout, 2017, p. 5). The

educational system is an important structure for the preparation of youth to be engaged and active citizens. According to Reardon and Fahle (2017), "nonschooling factors—persistent racial and ethnic disparities in family resources and segregation patterns—are fundamental determinants of unequal educational opportunity for minority students" (p. 20). This is systemic racism—where a combination of factors across institutions work together to disenfranchise one or more persons belonging to a racial group. It is evident from these reports that systemic racism is ensuring destituteness for non-White citizens, especially Black Americans. The authors profess that this national affliction can be significantly condensed if our country is committed to eliminating discriminatory practices across various sectors and enforcing fair initiatives for Black people.

5. HISTORICAL AND CURRENT PERSPECTIVES OF BLACK PEOPLE IN ENGINEERING

This national history directly shaped the entry of Black Americans into the field of engineering. First, only men could study and practice this profession, and Black men had to go to educational institutions in other nations to receive engineering training, only to return to the United States and be denied work within the industry (Latham, 2018). The Second Morrill Act allowed for the creation of racially segregated colleges and universities; however, engineering was not available at these institutions until 1910, and the limited availability for Black people to study engineering in the United States remained for many decades (Allen, 2017). This history is important to contextualize the minimal presence of Black people in engineering often lamented today; moreover, this knowledge prompts deeper qualitative analysis of the injurious effect of these conditions on those who were able to pursue engineering study with deficient resources *and* those who were not due to severely limited opportunity. Additionally, we must examine the negative impact on White people who could erroneously believe their few Black colleagues that were permitted to take up work as engineers were inferior:

> *It is reasonable to assume that there would have been no change in attitude had our position of leadership not been threatened or if our ability to prosper had continued. Black Americans see this clearly as their White fellow citizens and though they are beginning to respond to the opportunities, they approach these opportunities with full knowledge that theirs is something less than a wholehearted welcome. The years of segregation and educational denial have left a national market that must employ them skeptical of their ability to produce the same quality of work as their White co-workers* (Wharton, 1992, p. 121).

The irony of this historical context is that Wharton (1992) declares it was the fear of Americans being technologically inferior that prompted the inclusion of Black Americans into engineering education and practice, citing the successful launch of Sputnik as generating expanded opportunities (Malcolm, 1996). However, being in the same place of work did not guarantee that one's work would be appreciated in the same way.

These social inequities shaped the foundational culture and policies of engineering in collegiate study and professional practice. Until these inequities are remedied, we will remain unable to actualize the racially equitable environment many aspire to experience.

In STEM education broadly, diversity has been a topic of emphasis, discussion, research, and funding for well over 30 years, as evidenced by a host of reports from the National Academies of Engineering and Science (National Academy of Engineering, 2004, 2008; National Academy of Sciences, National Academy of Engineering, and Institute of Medicine 2007, 2010). These reports to Congress and the public are designed to inform policy action and funding direction. If the indicators of these reports regarding racial minority participation in engineering are a priority, these efforts' funding and success would logically follow, yet the reality does not align. According to the National Science Foundation (NSF), "in FY 2017, federal agencies obligated $32.4 billion to institutions of higher education in support of science and engineering (S&E), up 2%" (Pece, 2019, p. 1); however, "total S&E support to historically Black colleges and universities (HBCUs) declined for the third year in a row, to $308 million, down 17% from FY 2017" (Pece, 2019, p. 1). Effectively, a shrinking 1% of federal funds for science and engineering are allocated to the universities successfully graduating Black engineers. An additional consideration is the broader impacts requirement for NSF grants. Scholars such as Intemann (2009), Mathieu et al. (2009), London (2014), and London and Borrego (2017) have called into question the framing, understanding, and possibilities of the broader impacts section because this requirement of the proposal is often where good intentions for diversity are tacked onto the existing research idea. In part, these broader impacts are part of the funding decision, and a large portion of funded works have made commitments toward diversity of all groups, some more specific to Black people. London et al. (2020) stated in their review of the scholarship that the lack of emphasis on Black and African Americans in engineering and computer science education research also points to the ineffectual outcomes of these funding efforts for Black engineers.

With these commitments and significant amounts of funding available, representation outcomes should naturally follow, but the data show poor outcomes for these efforts. From 1997 to 2016, the number of bachelor's degrees in engineering awarded to Black graduates ranged from 2,892 to a peak of 4,206 in 2016. The total number of engineering bachelor's degrees (in the same years) ranged from 59,214 to 108,976 in 2016. This averages to a maximum share of 3.8% of engineering graduates identifying as Black. In 2016, HBCUs awarded 17% of engineering bachelor's degrees to Black graduates (n = 722). Engineering transfer programs, or 3-2 engineering programs, bolster the number of Black engineering graduates for many large universities that are not HBCUs (Newman and Jackson, 2013); however, the data reported in the engineering graduate reports do not delineate the first institution of enrollment of Black engineering graduates. These students have nearly completed a liberal arts STEM degree before transferring to an engineering school to earn a second bachelor's level degree, which is typically awarded after completion of both. This lack of specificity within the data requires attention because of the already low number of Black engineering graduates. In addition to these completion data, the cost of completion is also a topic of consideration.

According to Beal et al. (2019), engineering students accrue higher rates of student debt and Black students have disproportionately high rates of student loan debt. The Upton and Tanenbaum (2014) analysis of NSF data pointed to the overreliance on HBCUs at both the undergraduate and graduate levels for the graduation of Black STEM PhDs and the high debt load of those graduates.

These data, together, point to a few conclusions. The 107 HBCUs, as designated by the Department of Education, provide the majority of lift for the total number of Black engineering graduates. These institutions do so with significantly less funding in S&E research—even diversity-related educational research. Black engineering students and graduates bear the financial burden of an engineering degree through student loan debt accumulation. Despite institutional funds availability, the research on Black engineering students seems to have no material or experiential benefit. Given the historical exploitation of Black people without appropriate compensation, representation, or inclusion, we can surmise from these points that engineering education is complicit in the same.

The filtered progression of Black participation in engineering is also clear in the research produced in the field of engineering education. In the American Society for Engineering Education (ASEE) conference proceedings from their annual conferences and exhibitions, section meetings, and other published conference proceedings, the term African American appeared in 3,298 papers, and the terms Black and race together* yielded 1,700 papers. In the *Journal of Engineering Education*, the same search results yielded 266 papers with the term African American and 150 papers with either Black or race. The mere mention of Black people in research publications only represents 8% of the leading engineering education society's publications. The highest mention of Black engineers published in ASEE annual conference proceedings occurred in 2019, when 161 papers used the terms Black or race and 214 used African American. The number of mentions increased in 2021, following the constraints of a global pandemic and uprising in the fight for Black lives in the United States (Table 2). We offer these statistics to convey the need for a research agenda that is proactive in addressing anti-Blackness in ENE, as opposed to reactive.

Words and phrases such as restorative justice, reparation, and White supremacy are even scarcer in the published text, while the word diversity can be found in over 15,000 publications in the proceedings. Reimagining engineering education research requires an updated lexicon that adequately and accurately covers the issues Black people

TABLE 2: Use of African American, Black, and race in ASEE conference proceedings

Year	African American	Black and race
2019	214	161
2020	171	171
2021	359	308

*The terms Black and race were searched together to avoid non-human references (e.g., black box design).

navigate in engineering. Correspondingly, we can fulfill this task by first better understanding the use of Black theory and methodologies within research. We encourage this academic community to read and contemplate the works of Black scholars such as W.E.B. DuBois, Bell Hooks, Kimberlé Crenshaw, and Haki Madhubuti, as guides to properly studying the Black experience.

6. NECESSITY OF REPARATION IN ENGINEERING EDUCATION

> *If you stick a knife in my back 9 inches and pull it out 6 inches, that's not progress. If you pull it all the way out, that's not progress. Progress is healing the wound that the blow made. They haven't pulled the knife out; they won't even admit that it's there* (Malcolm, 1964).

We utilize the description of reparations from Darity and Mullen (2020) as they suggest, "[r]eparations are a program of acknowledgment, redress, and closure for a grievous injustice" (p. 2). Acknowledgment is a critical first step toward conciliation because it involves recognizing the injustices levied upon Black Americans in engineering. This includes the complicity of engineering educators (e.g., faculty, administrator, etc.) that denied access and success based on dehumanizing stigmas claiming Black Americans were unfit intellectually, psychologically, and even morally for science careers (Slaton, 2010). The deeply harmful and debilitating beliefs about Black inferiority remain prevalent in engineering education programs today (McGee and Martin, 2011, McGee, 2020). Other heinous inequities include disparate funding allocation for engineering programs at White and Black institutions (Slaton, 2010); maintenance of standards that reinforce racially prejudiced measures of intellect (Anderson, 2004; McGee, 2009; Wharton, 1992); and epistemic injustice, which denies the legitimacy of Black Americans' experiences of everyday racism while navigating engineering education and practice (Anderson, 2017; Atkins, 2019; Fricker, 2007; Moore et al., 2003).

Additionally, while acknowledgment requires concession of responsibility, more than a formal apology is required. The words of Malcolm X are keen. Black people within the engineering ecosystem extol so much time and energy trying to get violent individuals and systems to admit their wrongdoing. This exhausting operation occasionally results in performative acknowledgement, but our desire for healing remains unfulfilled. Subsequently, we are told progress was achieved even as the core elements of inequity and violence remain, and healing is neglected. Perpetrators and beneficiaries of the injustices must identify their gained advantages and diligently work to remedy the wrongs committed (Darity and Mullen, 2020). Acknowledgment lays the groundwork for redress: as the injustices and resulting benefits are identified, a process can be pursued to rectify the remaining detriments.

Applying the Darity and Mullen (2020) framework to engineering suggests that Black Americans who have been wronged should (a) be supported to attain a circumstance they would have achieved if not for the maltreatment they endured, and/or (b)

establish conditions of acceptable forgiveness for which offenders and beneficiaries are prescribed to meet. Admittedly, meeting these conditions would be complex; nevertheless, it is not impossible and would ensure a truly holistic paradigm to amplify and enrich Black participation in engineering. Finally, closure requires tremendous imagination and will since it involves collective action to recreate engineering education and practice. These steps for reparations are sequential, and each step taken increases the possibility for "advancing and sustaining the deep and wide change that will be necessary for this nation to begin to achieve the aspirational words that are the preamble to the US Constitution" (American Society for Engineering Education, 2020).

7. A REPARATORY JUSTICE APPROACH IN ENGINEERING EDUCATION

The concept of reparation has been and continues to be explored in public discourse and the higher education context (Harris, 2021; Wilder, 2013). Engineering education as a field of endeavor and discipline of research has an opportunity to chart a new way forward. Our discipline has stated an emphasis on epistemological consistency in research, declarations for inclusive praxis, and awareness that the outcomes of engineering education are felt by society at large. As researchers and engineering education researchers, we are calling *in* and *on* our colleagues to reexamine our theoretical framings, methodological assumptions, and tools of analysis when it comes to Black people in engineering education. We propose a reimagining of engineering education that advocates for Black prosperity more than Black persistence amid anti-Black racism.

A reparatory justice approach can liberate research practices in many ways—the following examples are not exhaustive and are provided to prompt further dialogue and critical praxis. Prioritizing reparation can transform the theoretical constructs that individuals utilize when engaging in engineering education research by demanding interdisciplinarity and historiography. Since ENE is a relatively new field, scholars would benefit from literacy in the disciplines United States and world history, sociology, and education to not only dispel myths of inferiority but also gain understanding as to how such ideologies underlie the structure of our societal institutions. We see this re-education as necessary to be able to ask better research questions such that the ways power and privilege shape our social interactions are taken into account. Research questions would be asset-based and refocus examination toward institutions' epistemic exclusion and protection of White supremacy. In current research, it is often the case that even as some scholars acknowledge racism as a barrier for Black students, they do not actually study racist policies and practices (Harper, 2012; Lewis et al., 2019), opting instead to study the effectiveness of Black assimilation.

A reparatory justice approach would de-center White cultural norms as the standard of success, and reposition Black people as not only capable of success but as models of how to humanize our teaching and professional practice. Black intellectualism in engineering study and practice is underappreciated and simply characterized as resilience, when that alone is insufficient to overcome the ever-changing racecraft of the United States (Fields and Fields, 2014). Perhaps, most importantly as it relates to research, cen-

tering reparation would disrupt and counteract traditional practices of investigation and dissemination. Specifically, we mean (a) affirming the dignity of research participants by changing how we make space for their agency in our studies; (b) admitting our subjectivity by articulating the ways who we are and how we think influence the research process and takeaways; and (c) connecting research and practice by broadening access to publications, valuing diverse publication venues, and presenting findings in diverse ways. Finally, the impetus of such work would go beyond the benefits of diverse teams, national global competitiveness, and any other aim that falls short of human freedom. Reparation seeks the well-being of the harm and the perpetuators of harm; thus, professional recognition, economic mobility, and prestige would not suffice until justice is realized.

In conclusion, we welcome the recent attention given to the plight of Black Americans within this country, and within engineering specifically. Many statements released by higher education institutions and engineering organizations express solidarity with the Black community, and others included a restatement of their values regarding diversity, equity, and inclusion (American Society for Engineering Education, 2020; Gunalan et al., n.d.; Jackson, 2020; Martini, 2020; Society of Hispanic Professional Engineers, 2020; Society of Women Engineers, 2020; Warren, 2020). Notwithstanding, we recommend studying past attempts at retrofitting and reform (London et al., 2020) to better understand what actions have been unsuccessful and why. To be clear, we are not simply encouraging more opportunities in engineering for Black people; we are urging broader deconstruction of the ways Whiteness has produced the cultural norms of what we currently recognize as engineering education and practice. Simultaneously, we urge a reconstruction of engineering education research that is formed by the diverse cultural paradigms of Black people in pursuit of educational equity and reparatory justice.

ACKNOWLEDGMENTS

We want to express gratitude to the guest editors of this themed issue for making space for us to share our vision of what is necessary to actualize authentic justice in engineering education research. We thank the reviewers who read our manuscript and provided the constructive feedback that significantly improved our articulation of this concept. We thank Dr. Joyce E. King for her visionary scholarship in centering Afrocentric epistemologies in pursuit of a more just curriculum.

REFERENCES

Allen, A. (2017). *Do we know who is really doing the planting? A case study of traditionally White institutions identified as top degree producers of Black engineering undergraduates* [Unpublished doctoral dissertation]. University of Pittsburgh.

Alexander, M. (2010). *The new Jim Crow: Mass incarceration in the age of colorblindness*. New York: New Press.

American Society for Engineering Education. (2020). *Policy statement by the American Society for Engineering Education on the implications of the death of Mr. George Floyd*. Accessed 21 Feb 2021.

Retrieved from https://www.asee.org/documents/about-us/news/Policy-Statement-on-the-Deathof-George-Floyd-June-2.pdf.

Amherst College. (n.d.). Race and ethnicity terms & definitions. Accessed 28 Feb 2021. Retrieved from https://www.amherst.edu/campuslife/our-community/multicultural-resource-center/terms-and-definitions.

Anderson, J. D. (2004). The historical context for understanding the test score gap. *National Journal of Urban Education and Practice*, 1(1), 1–21.

Anderson, L. (2017). Epistemic injustice and the philosophy of race. In I. J. Kidd, J. Medina, & G. Pohlhaus (Eds.), *The Routledge handbook of epistemic injustice* (pp. 139–148). Routledge.

Atkins, A. (2019). Black lives matter or all lives matter? Color-blindness and epistemic injustice. *Social Epistemology*, 33(1), 1–22.

Baldwin, J. (1963). *The fire next time*. New York: Dial Press.

Baptist, E. E. (2016). *The half has never been told: Slavery and the making of American capitalism*. Basic Books.

Barus, C. (1987). Military influence on the electrical engineering curriculum since World War II. *IEEE Technology and Society Magazine*, 6(2), 3–9.

Beal, M., Borg, M. O., & Stranahan, H. A. (2019). The onus of student debt: Who is most impacted by the rising cost of higher education? *International Research Journal of Applied Finance*, 10(8), 219–231.

Bell, D. (2004). *Silent covenants: Brown v. Board of Education and the unfulfilled hopes for racial reform*. Oxford University Press.

Blosser, E. (2020). An examination of Black women's experiences in undergraduate engineering on a primarily white campus: Considering institutional strategies for change. *Journal of Engineering Education*, 109(1), 52–71.

Dancy, T. E., Edwards, K. T., & Earl Davis, J. (2018). Historically white universities and plantation politics: Anti-Blackness and higher education in the Black Lives Matter era. *Urban Education*, 53(2), 176–195.

Darity Jr, W. A., & Mullen, A. K. (2020). *From here to equality: Reparations for Black Americans in the twenty-first century*. Chapel Hill, NC: UNC Press Books.

Degruy, J. (2005). *Post traumatic slave syndrome: America's legacy of enduring injury and healing*. Milwaukie, OR: Uptone Press.

Desmond, M. (2017). Housing. In "State of the Union: The Poverty and Inequality Report." Stanford Center on Poverty and Inequality. *Pathways Magazine*, special issue, 16–19

Douglas-Gabriel, D., & Wiggins, O. (2021). Hogan signs off on $577 million for Maryland's historically Black colleges and universities. *The Washington Post*. Retrieved from https://www.washingtonpost.com/education/2021/03/24/maryland-hbcus-lawsuit-settlement/.

Dumas, M. J. (2014). 'Losing an arm': Schooling as a site of black suffering. *Race Ethnicity and Education*, 17(1), 1–29. DOI: 10.1080/13613324.2013.850412

Eastman, M. G., Miles, M. L., & Yerrick, R. (2019). Exploring the White and male culture: Investigating individual perspectives of equity and privilege in engineering education. *Journal of Engineering Education*, 108(4), 459–480.

Fields, K. E., & Fields, B. J. (2014). *Racecraft: The soul of inequality in American life*. London: Verso.

Fletcher, T. L., Jefferson, J. P., Boyd, B. N., & Cross, K. J. (2021). Missed opportunity for diversity in engineering: Black women and undergraduate engineering degree attainment. *Journal of College Student Retention: Research, Theory & Practice*. DOI: 10.1177/1521025120986918

Fricker, M. (2007). *Epistemic injustice: Power and the ethics of knowing*. Oxford University Press.

Geronimus, A. T., Hicken, M., Keene, D., & Bound, J. (2006). "Weathering" and age patterns of allostatic load scores among Blacks and Whites in the United States. *American Journal of Public Health*, 96(5), 826–833.

Gordon, B. M. (1990). The necessity of African-American epistemology for educational theory and practice. *Journal of Education*, 172(3), 88–106. DOI: 10.1177/002205749017200307

Gunalan, K. N., Smith, T. W., III, & Pearson, Y. E. (n.d.). American Society of Civil Engineers. Retrieved from https://info.asce.org/unity.

Hacker, B. C. (1993). Engineering a new order: Military institutions, technical education, and the rise of the industrial state. *Technology and Culture*, 34(1), 1–27.

Harper, S. R. (2010). An anti-deficit achievement framework for research on students of color in STEM. *New Directions for Institutional Research*, 2010(148), 63–74. DOI: 10.1002/ir.362

Harper, S. R. (2012). Race without racism: How higher education researchers minimize racist institutional norms. *The Review of Higher Education*, 36(1), 9–29.

Harris, A. (2021). *The state must provide: Why America's colleges have always been unequal—and how to set them right*. New York: HarperCollins Publishers.

Holly, J., Jr. (2021). Criticality is crucial: Fidelity in what we say and what we do. *Studies in Engineering Education*, 2(2), 46–53. DOI: 10.21061/see.78

Hout, M. (2017). Employment. In "State of the Union: The Poverty and Inequality Report." Stanford Center on Poverty and Inequality. *Pathways Magazine*, special issue, 5–8.

Intemann, K. (2009). Why diversity matters: Understanding and applying the diversity component of the national science foundation's broader impacts criterion. *Social Epistemology*, 23(3–4), 249–266.

Jackson, J. (2020). *A call for justice. A call for solidarity*. National Society of Black Engineers. Accessed 21 Feb 2021. Retrieved from https://theeastbay100.com/national-society-of-black-engineers/

Kendi, I. X. (2016). *Stamped from the beginning: The definitive history of racist ideas in America*. New York: Bold Type Books.

King, J. E. (2018). A call for a reparatory justice curriculum for human freedom: Rewriting the story of our dispossession and the debt owed. In J. E. King (Ed.), *Heritage knowledge in the curriculum: Retrieving an African episteme* (pp. 155–174). Routledge.

King, J. E., & Swartz, E. E. (2014). *Re-membering history in student and teacher learning: An Afrocentric culturally informed praxis*. Routledge.

Latham, S. (2018). *A history of innovation: Pioneering achievements of Black engineers*. Link Engineering. Retrieved from https://www.linkengineering.org/Explore/LE_Blog/52515.aspx.

Lewis, A. E., Hagerman, M. A., & Forman, T. A. (2019). The sociology of race & racism: Key concepts, contributions & debates. *Equity & Excellence in Education*, 52(1), 29–46. DOI: 10.1080/10665684.2019.1627958

London, J. S. (2014). The impact of national science foundation investments in undergraduate engineering education research: A comparative, mixed methods study (Publication No. 3687797) [Doctoral dissertation, Purdue University]. Open Access Dissertations.

London, J. S., & Borrego, M. J. (2017). *Board # 90: Toward a shared meaning of the "impact" of engineering education research: Initial findings of a mixed methods study* [Conference paper]. 2017 ASEE Annual Conference & Exposition, Columbus, OH, United States.

London, J. S., Lee, W. C., Phillips, C., Van Epps, A. S., & Watford, B. A. (2020). A systematic mapping of scholarship on broadening participation of African Americans in engineering and computer science. *Journal of Women and Minorities in Science and Engineering*, 26(3), 199–243.

Mahoney, M. M. (2017). *Moving toward an anti-deficit perspective: African American science, technology, engineering, mathematics (STEM) students at Hispanic-serving institutions (HSI)* [Unpublished doctoral dissertation]. California State University.

Malcolm. TV interview; 1964. Retrieved from https://youtu.be/cReCQE8B5nY.

Malcom, S. M. (1996). Science and diversity: A compelling national interest. *Science*, 271(5257), 1817–1819.

Martini, D. P. (2020). National Society of Professional Engineers. Accessed 5 Mar 2021. Retrieved from https://www.nspe.org/sites/default/files/Social%20Unrest%20Statement.pdf

Mathieu, R. D., Pfund, C., & Gillian-Daniel, D. (2009). Leveraging the NSF broader-impacts criterion for change in STEM education. *Change: The Magazine of Higher Education*, 41(3), 50–55.

McGee, E. O. (2009). *Race, identity, and resilience: Black college students negotiating success in mathematics and engineering* (Publication No. 3364621) [Doctoral dissertation, University of Illinois at Chicago]. ProQuest Dissertations.

McGee, E. O. (2020). *Black, brown, bruised: How racialized STEM education stifles innovation*. Harvard Education Press.

McGee, E. O., & Martin, D. B. (2011). "You would not believe what I have to go through to prove my intellectual value!" Stereotype management among academically successful Black mathematics and engineering students. *American Educational Research Journal*, 48(6), 1347–1389. DOI: 10.3102/0002831211423972

Mejia, J. A., Revelo, R. A., & Pawley, A. L. (2020). Thinking about racism in engineering education in new ways [Commentary]. *IEEE Technology and Society Magazine*, 39(4), 18–27.

Mejia, J. A., Revelo, R. A., Villanueva, I., & Mejia, J. (2018). Critical theoretical frameworks in engineering education: An anti-deficit and liberative approach. *Education Sciences*, 8(4), 158.

Moore, J. L., Madison-Colmore, O., & Smith, D. M. (2003). The prove-them-wrong syndrome: Voices from unheard African-American males in engineering disciplines. *The Journal of Men's Studies*, 12(1), 61–73. DOI: 10.3149/jms.1201.61

Moskowitz, P. (2017). *How to kill a city: Gentrification, inequality, and the fight for the neighborhood*. New York, NY: Public Affairs.

National Academy of Engineering. (2004). *The engineer of 2020: Visions of engineering in the new century*. The National Academies Press. DOI: 10.17226/10999

National Academy of Engineering. (2008). *The offshoring of engineering: Facts, unknowns, and potential implications*. The National Academies Press. DOI: 10.17226/12067

National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. (2007). *Rising above the gathering storm: Energizing and employing America for a brighter economic future*. The National Academies Press. DOI: 10.17226/11463

National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. (2010). *Rising above the gathering storm, revisited: Rapidly approaching category 5*. The National Academies Press. DOI: 10.17226/12999

Newman, C. B., & Jackson, M. B. (2013). Collaborative partnerships in engineering between historically black colleges and universities and predominantly white institutions. In *Fostering success of ethnic and racial minorities in STEM: The role of minority serving institutions* (chapter 13, pp. 181–191). New York: Routledge.

Pece, C. (2019). *Federal science and engineering obligations to academic institutions Increase 2%; support to HBCUs declines 17%* (Report No. NSF 19-314). National Center for Science and Engineering Statistics. Retrieved from https://www.nsf.gov/statistics/2019/nsf19314/nsf19314.pdf.

Reardon, S. F., & Fahle, E. M. (2017). Education. In "State of the union: The poverty and inequality report." Stanford center on poverty and inequality. *Pathways Magazine*, special issue, 20–23.

Rothstein, R. (2017). *The color of law: A forgotten history of how our government segregated America*. New York, NY: Liveright Publishing.

Slaton, A. (2010). *Race, rigor, and selectivity in U. S. Engineering: The history of an occupational color line*. Cambridge, MA: Harvard University Press.

Society of Hispanic Professional Engineers. (2020). *SHPE denounces systemic racism, injustice, and the continuing murder of Black Americans* [Press release]. Retrieved from https://www.shpe.org/uploads/images/general/PDF/SHPE-Public-Statement-on-George-Floyd.pdf.

Society of Women Engineers. (2020). Taking a stand for diversity and inclusion. *All Together*. Retrieved from https://alltogether.swe.org/2020/05/swe-statement-on-diversity-and-inclusion/.

Stanford Center on Poverty and Inequality. (2017). State of the union: The poverty and inequality report. *Pathways Magazine*, special issue. Retrieved from http://inequality.stanford.edu/publications/pathway/state-union-2017

Tatum, B. D. (2003). "Why are all the Black kids sitting together in the cafeteria?": And other conversations about race. Basic Books.

Upton, R., & Tanenbaum, C. (2014). *The role of historically Black colleges and universities as pathway providers: Institutional pathways to the STEM PhD*. American Institutes for Research.

Warren, C. (2020). Colleges must take a new approach to systemic racism. *Inside Higher Ed.* Retrieved from https://www.insidehighered.com/views/2020/06/09/defeat-systemic-racism-institutions-must-fully-integrate-truly-diverse-subject.

Wharton, D. E. (1992). *A struggle worthy of note: The engineering and technological education of Black Americans*. Westport, CT: Greenwood Press.

Wilder, C. S. (2013). *Ebony and ivy: Race, slavery, and the troubled history of America's universities*. London: Bloomsbury Publishing.