A Call to Action for Racial Justice and Equity in Engineering

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I wish to express my appreciation to President John Anderson and to Percy Pierre, Chair of the Racial Justice and Equity Committee, for inviting me to deliver the Special Lecture at this 2020 Annual Meeting of the National Academy of Engineering. I also want to thank the members and staff of the Committee for their assistance in developing this address. I am honored and humbled to join you in this session.

It is certainly no secret to anyone participating in this virtual annual meeting that we are living in one of the most crucial periods in the history of our nation. It is at least, one of the, if not, the most crucial periods in my lifetime. I was born in the waning years of the Great Depression and I was too young at the time to fully understand World War II, although I remember certain aspects of it. I was born and raised in Topeka, Kansas and attended one of the pre-Brown vs. Board of Education of Topeka black elementary schools and endured the discrimination and exclusion faced by black and brown inhabitants of that city. I have a vivid memory of the struggle for civil rights in this country, the tragic and violent deaths of Emmet Till, Medgar Evers and Martin Luther King, Jr., the Watts riots, the assassinations of the Kennedys and the turmoil over the Vietnam War. I was a member of the commission chaired by Warren Christopher to investigate the use of force by the Los Angeles Police Department in the wake of the Rodney King beating and know the fear that black people have when stopped and interrogated by police officers.

At this point in our history we are faced with many critical and potentially cataclysmic events and crises. There are three that come to my mind immediately. The first is climate change, a global event that threatens the very survival and existence of our species and all other animal and plant species on earth, in addition to the air we breathe, the water that sustains us and the earth itself. The second threat are the novel pandemics, which have the power to imperil our lives, and dramatically change the way we live, work, and interact with one another. The third, and the one I wish to speak with you about today, is the one that jeopardizes our democracy, productivity, and well-being and puts into question whether we can all live together peaceably and harmoniously in a just and equitable American society. And that is the crisis caused by the ignominious history of racism and anti-blackness, the unwillingness to acknowledge and accept the humanity of black people, that has crippled our nation for 400 years. A common thread that runs through each of these monstrous and intractable problems is the fact that engineers have a role to play in identifying and developing answers for their solutions.

The broad, demonstrative, multiracial, multicultural reaction to the tragic and senseless murders of George Floyd, Breonna Taylor, and Eric Garner at the hands (and knee) of police officers, and the killing of Ahmaud Arbury by armed vigilantes has led to a wide variety of actions among the many institutions that have expressed alarm and have pledged to work to not only identify and remove systemic and structural barriers to the inclusion and success of Black individuals in their organizations, but to also strive to improve the circumstances of Black Americans in the larger society. The names of slaveowners have been removed from buildings at universities throughout the country. The statues of Confederate generals, the Stone Ghosts of the South as they were called by journalist Trymaine Lee, have been toppled. Among the institutions that have expressed allegiance to the Black Lives Matter movement and have vowed support for anti-blackness efforts are professional engineering associations, honorary societies, and STEM-related organizations. Even NFL players are displaying signs that say "End Racism" or "Black Lives Matter" on their helmets, shoes, and uniforms. All of these are extremely encouraging developments because for far too long many of the organizations and institutions that are now on board have been on the periphery of racial justice movements and have, at most, provided rhetoric but little in the way of action in addressing the inequities, discrimination, and implicit biases that exist and persist in their midst. It is my intent in this address to point out why I believe that a cultural transformation is necessary in the profession of engineering and in many of its institutional arrangements and practitioners if we are to participate meaningfully in the efforts to create a more racially just and inclusive American society.

At this critical moment in our nation's history, we need more than words that renounce racism and anti-blackness, we need actions to abolish racism and anti-blackness. Not only must we be mindful of the words of Martin Luther King, Jr., who wrote these words, "The arc of the moral universe is long, but it bends toward justice" but also the words added by the late Supreme Court justice, Ruth Bader Ginsburg, "but only if there is a steadfast commitment to completing the task."

When I was chancellor of the University of Maryland, College Park, I co-taught a class in the African American Studies Department. On the first day of the class, I went to the blackboard and wrote what I somewhat lightheartedly referred to as Slaughter's Theorem. It read, "Black Studies is for White students; Math, Physics and Chemistry are for Black students." There is no doubt that I could have been accused of unbridled hyperbole at the time, but I believed what I had written. I believe it even more today.

White Americans must come to understand and, hopefully, appreciate the lived experiences of Black Americans throughout the history of our presence in this country. From the egregious and repressive 245 years of slavery that has left a legacy that continues to haunt us all today, the aborted period of Reconstruction, the Fugitive Slave Act, the slave patrols, the lynching of black men and women for meaningless or non-existent reasons, the bombing of the 16th Street Baptist Church in Birmingham, Alabama that killed the four little black girls, and discriminatory practices in employment, education, health care, housing, and the criminal justice system, the story of blacks in America needs to be known. The negative effects of the history of white

supremacy are evident today in the Covid-19 pandemic in which Black Americans are disproportionately affected medically and economically. It is not hard to understand why the rise in the presence of white supremacists today makes us fear for the lives of our children and grandchildren. No longer should any of us accept the excuse, "I didn't know." White Americans must come to understand the harm that white supremacy has on them just as it has on the black people for whom it is targeted. In short, White Americans must come to understand what James Baldwin meant when he said, "To be black in America is to be in constant rage." And fittingly, I believe it was Abraham Lincoln who declared, "Justice will not be served until the unaffected are as outraged as those who are affected." So long as some behave as though they are unaffected by the systemic and structural racism embedded in the manner in which our society has and continues to operate, the meaningful and difficult conversations, the conversations not for the purpose of assigning guilt or blame but rather to finding understanding and agreement, will not occur. But they must occur if we are to rid ourselves of the fear of the other, the yoke that prevents us from becoming a nation where everyone is treated with dignity and respect, and there is, hopefully, regard for the opinions of others. And engineers must be at the table where these conversations take place.

We are also at a moment when this country can ill afford to ignore the talents that exist in those persons who have been historically underrepresented, under-recognized and underappreciated in science, technology, and engineering. We must recognize that America cannot and will not maintain a prominent position in the STEM skills so long as anyone is prevented or impeded from the fullest possible opportunity to participate and contribute to our scientific, technological and engineering activities and achievements. Our economy, productivity and welfare of our citizens depends upon it. Given the inevitability of future pandemics and the current and impending consequences of climate change, our very survival depends upon preparing and marshalling all the talent we can possibly develop. We must, then, as NAE member Nick Donofrio insists, make sure that opportunity is there to meet the talent.

I have long contended that diversity drives innovation. Former NAE president, Bill Wulf pointed out that "sans diversity, we limit the set of life experiences applied, and as a result, we pay an opportunity cost—a cost in products not built, in designs not considered, in constraints not understood, in solutions not offered, in processes not invented." He went on to say that "Members of a diverse group each experience life differently and that these differences in experience constitute the gene pool from which creativity springs." And in the very same vein, his successor as NAE president, Charles Vest, said, "A diverse technical workforce … is more likely to conceive, design and develop products, processes, and systems that perform well in the marketplace." It is my belief that the discipline of engineering has to a large extent ignored these truths and failed to recognize or, perhaps, admit that diversity drives innovation.
But mere diversity is not enough. While diversity is necessary it is not sufficient to ensure that an institution practices equity and inclusion. As Stephanie Farrell, the 2018 president of ASEE said, "Diversity is about counting heads; equity is about making heads count." We must commit ourselves to make engineering a professional discipline that is an example of equity and inclusion.

While the reality of what I have just mentioned applies to all those who have been prevented, in one way or another, from the opportunities to fully participate and succeed in the STEM disciplines, the situation has been particularly acute for Black Americans. For 400 years, anti-blackness and crippling policies and practices of structural and systemic racism, often sanctioned by local, state, and federal policies and laws, have prohibited them from being viewed as equals in the realm of true Americans. While most Americans are aware of the many significant contributions that Black Americans have made in fields such as music, art, literature, and poetry, the same is not true for science and engineering. All too often their achievements in these areas have been unknown or unrecognized, or if known, have been disregarded or denigrated. That was true for Benjamin Banneker (1731-1806), a self-taught mathematician, clock builder, almanac creator and surveyor, who assisted in surveying the original boundaries of Washington, DC and whose astronomical observations and studies were devalued and discredited by Thomas Jefferson. It was true for Norbert Rillieux (1804-1896), one of the earliest chemical engineers and inventor of the multiple-effect evaporator, for Elijah McCoy (1844-1929), engineer and inventor of lubrication devices for steam locomotives, for Lewis Latimer (1848-1928), who in 1881 was issued a patent for the process for developing the carbon filament for light bulbs prior to joining Thomas Edison in 1885 in the design and creation of the first incandescent bulb, and for Garrett Morgan (1877-1963), inventor of the three-position traffic light. How many members of the Academy know that Mark Dean, a co-inventor of the personal computer, holds three of the nine original patents for the IBM PC, that James West invented the microphone technology on the cellphone you have in your pocket or that black engineers Drs. Gilda Barabino, Shirley Ann Jackson, Gary May, Daryll Pines and Gregory Washington are presidents of some of America's most highly regarded research universities? Yes, Black Americans have been and are contributors to this country's might and capabilities in science, technology, and engineering. If we were to eliminate the systemic racial impediments that crush the aspirations and potentialities of so many Black Americans our nation would not only be more just and equitable, but it would also have an even greater capacity for innovation and productivity. We must let opportunity meet talent.

It is no secret that the field of engineering ranks well behind medicine, law, and many other professions when it comes to the commitment to and practice of social justice activities. For the most part, engineering education has not afforded engineering students with the exposure to the liberal arts and social science courses that would prepare them for seeing engineering in terms of its service to humanity. But I contend that the Grand Challenges of Engineering, the 14 global problems identified by the Academy will require more than science and mathematics to solve. They will require a profound understanding of matters such as the politics, economics, cultures, languages, religions, aspirations, fears, and histories of the societies and people who will be affected by and who will be the users of the technologies developed by engineers to address and solve those problems. Engineers must have an appreciation for ethics and consider the questions of who benefits from and who is disadvantaged by the devices, machines, systems, processes, and organizations that we are responsible for creating. No longer should anyone tolerate the design of a highway, bridge or light rail system that displaces a black neighborhood or business community to advantage white suburbanites on their commutes to and from the central city. Engineers need to recognize our social responsibilities in helping to

make health care more affordable and available for the poor and underserved, apply our critical thinking and problem solving abilities to the inequities in performance and success of minority children in our public educational systems, and address the crucial problems that exist in our criminal justice systems. To do so we must employ the Engineering Habits of Mind that were formulated by the NAE and the NRC in 2009:

- Being Creative
- Working and Negotiating in Teams
- Adopting optimistic mindsets when problem solving and designing
- Thinking not only about individual technologies, but also about how the systems within these technologies operate, and importantly,
- Considering the ethical nature of engineering and its products

Speaking of the Grand Challenges, Racial Justice and Equity Committee member, Gary May, suggested that we add a 15th Grand Challenge of Engineering, "Achieving Diversity, Equity, and Inclusion." His suggestion was seconded by all.

A colleague at the University of Southern California, Professor Anthony Maddox, and I co-founded a Center in the USC Rossier School of Education. The Center for Engineering in Education, which we refer to as simply CEE because we are both Electrical Engineers, was conceived in response to the fact that the Next Generation Science Standards, science standards developed through a collaborative, state-led process, provide for the first time that engineering design be included in the science curriculum for all K-12 students. While we applaud the inclusion of engineering principles and concepts in elementary and secondary school science courses, we recognize that teachers in those settings are not likely to have had the necessary background and preparation to teach engineering design. Therefore, one of the priorities of the Center is the development of teacher education curricula that can prepare classroom teachers for this purpose. We believe that personalized learning with the aid of the intelligent introduction and use of technology will be the principal way formal, nonformal and informal learning will take place in the future. We also support the idea of expanding STEM to STEAM, where the "A" is usually thought to refer to the Arts. But we contend that the "A" could easily be interpreted as "Anything" because of our belief that engineering thinking can inform and improve teaching and learning in every discipline and endeavor. Considering the current emphasis on the need for addressing social justice and systemic racism, we have coined STEEM, S_T_E_E_M, where the additional "E" calls for "Equity" to be included as an essential component of STEM education. The "E" could also stand for "Empathy", or "Ethics", both of which are much-needed ingredients in our society today.

By the way, a few years ago the National Science Foundation reported that research had shown that a larger proportion of black and brown K-12 students aspire to become engineers than do their white peers. But at the same time, another study revealed that only four percent of black and brown high school graduates have taken the requisite courses to enroll in engineering study in college. This is due to the facts that many of these students have attended under-resourced schools in economically depressed areas, have lacked exposure to role models and mentors, and have faced discouragement from administrators, counselors, and teachers. I

know this from experience because it happened to me and many like me in my generation. That it occurred back then could be considered shameful, the fact that it continues today borders on the criminal.

Corporate America has a major responsibility in ensuring that its structures and operations are free of discriminatory practices in hiring, promotion, and all employment procedures and policies. As a rule, the topics of diversity, equity and inclusion have been absent from the board agendas of our major corporations. This is particularly true for Silicon Valley and many other high-tech companies whose record of racial justice can only be described as failure and who must come to understand their obligations in the efforts to eliminate the digital divide as well as the inequities inherent in the hardware and software that they produce. Corporations that employ engineers should provide substantial support to minority student organizations like the National Society of Black Engineers (NSBE), the Society of Hispanic Professional Engineers (SHPE), and the American Indian Science and Engineering Society (AISES). They should also provide scholarships, internships, and summer employment opportunities to needy black and brown undergraduate engineering students to address the high cost of education. It is also important for corporations and industrial establishments to provide sustained support to minority-serving organizations such as the National Action Council for Minorities in Engineering, Inc. (NACME), the largest private provider of scholarships for black, brown, and indigenous engineering students, the National GEM Consortium (GEM), which enables qualified students from underrepresented communities to pursue graduate education in science and engineering, the Advancing Minorities Interest in Engineering organization (AMIE) and the Career Communications Group's Black Engineer of the Year Award program and BEYA Stem Conference, actions that would prove their commitment to racial justice and inclusion.

Higher education is amid a perfect storm consisting of a pandemic deemed to change forever the way colleges and universities operate, a society characterized by political partisanship, social and racial divisiveness as well as the presence and impending threats of catastrophic climate change. How it responds to these "wicked" manifestations and the accelerating racial and ethnic demographic changes occurring in the nation, will determine how it teaches and educates the leaders and productive citizens of tomorrow and who will be the recipients of that education.

Although numerous encouraging transformations have taken place, I find many of the moralistic pronouncements by some of our most prestigious educational institutions, in the wake of the recent Black Lives Matter demonstrations, to be disingenuous and off-putting. A good friend of mine refers to them as virtue signaling. For too many years, these institutions have had the opportunity and the responsibility to address the structural racism that marginalizes Black Americans and deters them from the opportunities available to others but have failed to do so.

Given the increasing presence of black and brown students in the college-age population, the concomitant decline in the proportion of white students, in addition to the potential decrease in international students due to the pandemic and changes in immigration policies, colleges and

universities must diversify their undergraduate enrollees or ultimately close their doors. The same imperatives, regrettably, do not exist for graduate students and faculty.

The dearth of black, brown, and indigenous persons on the faculties of our major research universities is higher education's Achilles heel and its shame. This is particularly true for the STEM disciplines. While the presence of black tenure and tenure-track faculty in most large research universities harbors around six percent, it is two percent or less in science and engineering departments. Since in many engineering programs, 75 percent or more of graduate students are non-residents, these depressing figures are unlikely to improve. Our colleges and universities can and must do better. I hope they will develop the resolve to do so.

Engineering schools can start by reaching out to Historically Black Colleges and Universities (HBCUs) and Hispanic Serving Institutions (HSIs) to develop relationships with their faculties and students. They should be proactive in efforts to recruit a more diverse set of faculty members rather than waiting for responses to ads in academic journals and newsletters. They should find ways to inform and encourage black, brown, and indigenous engineering undergraduates to consider graduate study in preparation for an academic career. They must recognize the importance of removing those structural impediments within their own organizations that discourage minority students and impair their ability to succeed. They must reevaluate their core values and become equity-minded rather than deficit-minded in their approach to ensuring a fair and equitable educational experience for all students. Importantly, they should focus less on being elite and, instead, strive to be excellent in the broadest sense of that word. Change must begin within.

An important first step was taken a few years ago when Yannis Yortsos, the Dean of the USC Viterbi School of Engineering spearheaded an effort that led to more than 200 engineering schools and colleges to sign a pledge to provide increased opportunity to engineering careers for underrepresented groups and to ensure educational experiences that are inclusive and prevent marginalization of any groups of people. They further affirmed the importance of these aims as a reflection of their core values and as a source of inspiration for drawing a generation to the call of improving the human condition.

What about the National Academy of Engineering? What must it do besides expressing its grave concerns about the treatment of Black Americans, addressing the structural racism that cripples our economy and productivity and proclaiming its intent and resolve to examine its own operations, policies and procedures as well as determine how it can improve the circumstances of underrepresented and marginalized persons in society? It must be pointed out that the NAE has a long record of involvement in efforts to increase the presence of underrepresented minority students in engineering. At the behest of Percy Pierre, the same Percy Pierre who chairs the present-day Racial Justice and Equity Committee, the Academy hosted a conference supported by the Sloan Foundation in 1973, a conference that led to the creation of what came to be known as the Minority Engineering Effort and the founding of organizations such as NACME, GEM and the Mathematics, Engineering, Science Achievement Program (MESA). This seminal event received strong support from the CEOs of corporations like General Electric, IBM,

and DuPont, and the presidents of major universities such as Purdue, Notre Dame and MIT. Sadly, the same levels of financial support and interest from these bodies occur only episodically now as attention to the topic of increasing minority representation in engineering has waxed and waned with changes in political administrations and economic fluctuations.

At the beginning of the Minority Engineering Effort the Academy formed the Committee on Minorities in Engineering, which spawned several, important initiatives, some of which continue today. At the beginning of the 21st Century, NAE founded the Action Forum on the Engineering Workforce and since then has supported a number of studies and research efforts that have been instrumental in illuminating the problems causing underrepresentation and identified potential approaches to their solution.

The Racial Justice and Equity Committee that President Anderson has formed recently has been asked to consider a set of initiatives, consistent with the NAE's mission, initiatives that will advance diversity, equity and inclusion both within the Academy and in the larger community. It is the belief of the Committee that a cultural transformation must take place within the engineering profession, including the NAE, if we are to provide a meaningful and sustainable contribution to the efforts to quell systemic and structural racism in engineering and in society. For this to happen we must all remember that the NAE is us, each of us in this virtual annual meeting, all 2250 plus members of the Academy. All of us must ask ourselves the hard question of am I doing enough to help make the discipline of engineering a just and inclusive profession and am I making sure that my work does not add to the inequities and injustices that abide in society.

I believe that the events of the past few months, where white supremacy and anti-blackness have been on display in ways not seen heretofore in the 21st Century, have opened a window of opportunity that we cannot afford to allow to close without making major strides in guiding the discipline of engineering toward becoming a more diverse, pluralistic and inclusive profession. Furthermore, I feel a sense of urgency for us to do so. It is the kind of urgency represented by the "No Trespassing "sign in the Kansas countryside. The sign reads, "If you want to cross this field you better do it in 9.9 seconds; the bull can do it in 10 flat."

I will conclude by simply saying that none of us can continue to hide behind the timeworn excuse of "I am too busy." Instead, we must adhere to Martin Luther King, Jr's mandate, "We must use time creatively and always remember that the time is ripe to do right.

Thank you very much!