

MAKING OUTSIZED CONTRIBUTIONS FOR ENSURING BLACK PROGRESS IN ENGINEERING RESEARCH AND EDUCATION:

Report Assessing the Collective
Research and Talent Activities of
the 15 ABET-accredited HBCU
Schools of Engineering

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In this Report “The 15 HBCUs” refers to the 15 ABET-accredited Schools of Engineering at Historically Black Colleges and Universities.

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SYNOPSIS:

In this Report, “The 15 HBCUs” refers to the 15 ABET-accredited Schools of Engineering among Historically Black Colleges and Universities.

This Report launches a dialogue to advance national policies and public-private partnerships to build on the collective research and talent strengths of the 15 ABET-accredited HBCU Schools of Engineering. In advancing this dialogue, this Report has tapped the involvement of major corporations to examine the ability of The 15 HBCUs to meet industry innovation needs and to explore opportunities for enhancing the capacities of The HBCUs in research, talent development, and Pre-K-12 STEM pipeline activities.

This Report documents the significant outsized contributions and strong value proposition of The HBCUs for serving the needs of Black students in STEM fields and meeting the evolving, increasing talent challenges and emerging technologies needs for our nation. The analysis in this Report validates the relevancy of the 15 ABET-accredited HBCU Schools of Engineering to address our nation’s STEM challenges and contribute to advancing leading areas of disruptive technologies of importance to industry.

Despite the high value that The HBCUs bring to our nation, each of The 15 HBCUs must overcome a legacy of underinvestment that requires immediate attention for them to reach their full potential in research, talent development, and Pre-K-12 STEM pathway activities. That potential includes building on The HBCUs’ current successes in teaching 21st-century subject matter and leading and collaborating in research with the Department of Defense (DOD)/federal government agencies, the business community, and larger universities to increase the magnitude and volume of each.

This Report also suggests that a disproportionate share of Black households with children living under conditions of striking levels of poverty, income inequities, and low-performing K-12 schools are within The HBCU Territorial Network (i.e., nine states plus the District of Columbia) where The HBCUs are located. This defines a strategic imperative for the nation to enhance Pre-K-12 STEM talent pathway-building activities within this specific geography.

We must emphasize that our nation faces a companion challenge on the global economic stage: a talent need that numerically can only be met by a team that reflects the diverse faces of America. Only through the necessary focus on developing the depth and breadth of its Pre-K-12 STEM pipeline can the nation ensure its global competitiveness.

This Report Embraces Three Goals:

1. To understand the curricula being taught, and where possible ensure that what is being taught is aligned with the 21st-century employment market
2. To understand the research capabilities of our schools and strengthen how they are viewed individually, but most importantly, as a “Collaborative Engine” that leads, as well as partners with other universities and centers of research and innovation on projects funded by various sources ranging from DOD to the Business Community
3. To inspect the current in-state Pre-K–12 pipeline to determine where our intervention and transfer of STEM context and content might influence student and family awareness and respect for STEM and improve student classroom performance so that when they reach 12th grade, they are STEM interested and STEM ready

Key Themes Guiding This Report:

- Bring opportunity to talent
- Meet each HBCU where it is today and help it move forward
- Forge a new culture of collaboration and commitment to working together across The 15 HBCUs

Our HBCU Territorial Network offers incredible assets for assisting the nation in this STEM pipeline imperative, plus valuable strengths for expanding America’s research and development capacity. This network of research and talent strengths represents a formidable opportunity for collaboration with federal agencies, corporations, and other universities. This possibility points to the need for meaningful collective approaches at the national state and local levels. It means redefining the concept of inclusion as seen through the lens of America, recognizing that the nation needs the talent produced by our 15 HBCU Territorial Network to win. The focus here is not on affirmative action.

Instead, investing in these schools is an act of strategic patriotism on behalf of the future of the United States.

The MITRE Corporation provided funding support to TEconomy to undertake this Report.

INTRODUCTION

Our nation's economic future and global competitiveness are strongly rooted in advancing innovation through science, technology, engineering, and mathematics (STEM).

Economic research studies find that more than half of U.S. economic growth since World War II has resulted from advancements in innovation from science and technology, with some recent estimates reported as high as 85%.¹

Moreover, the COVID-19 pandemic has placed a bright spotlight on the importance of science and technology for advancing innovations. In this national moment of social injustice and public health crisis, the novel vaccine technologies and anti-viral therapies being advanced to manage the disease represent a stirring example of the vision of opportunity seen through this spotlight. Innovations such as these build upon the complementary and robust roles of public-supported academic basic research and industry expertise in applied discovery, development, and clinical testing. Historically, this type of high-functioning innovation-led development has helped make the U.S. a global leader in the life sciences.

Yet, as the nation looks toward the future, its global leadership is at risk, and this Report reveals that a substantial portion of America's talent is excluded from contributing to the nation's STEM performance. The 2020 State of U.S. Science &



Today, more than ever before, the United States' economic prosperity and national security rests upon its capacity for continued scientific and technological innovation. That capacity depends on our ability to ensure that all Americans have lifelong access to high-quality education in science, technology, engineering, and mathematics (STEM).

National Science and Technology Council, Committee on STEM Education, December 2018

Engineering report, prepared by the National Science Board, finds: “the data clearly show the evolution of the United States in the global S&E enterprise. Increasingly, the United States is seen globally as an important leader rather than the uncontested leader.”² In testimony before the House Committee on Science, Space and Technology, the President of the National Academy of Sciences explained, “In an increasingly complex global economy, we simply cannot afford to let U.S. leadership in science slip away. In some cases, it already has.”³

One widely acknowledged weakness for the U.S., as well as a missed opportunity, is the lack of diversity across STEM education and in the STEM workforce. Persistent inequities

- 1 National Academies of Science, *Rising Above the Gathering Storm*, 2006, page 14; Washington Post, “Science and Engineering Report Shows Continued Loss of U.S. Dominance,” March 23, 2020.
- 2 National Science Foundation, National Science Board, *2020 Science & Engineering Indicators*, *The State of U.S. Science & Engineering*, January 2020, page 2.
- 3 “Maintaining U.S. Leadership in Science and Technology,” Statement of Marcia K. McNutt, President, National Academy of Sciences before the Committee on Science, Space and Technology, U.S. House of Representatives, March 6, 2019.



in STEM outcomes are faced by many minority groups, but for Black Americans the figures are striking. The 8th-grade standardized math scores for Black students stand well below the national average, and despite increases in recent years, the numbers are still below what White students achieved in 1990. While Black students account for 10% of all bachelor's degree recipients, they received just 4% of bachelor's degrees in engineering conferred in 2017.⁴⁴ At the same time, compared with their share in the overall labor force, Black workers are 39% less likely to work in science- and engineering-related occupations.⁵⁵ Although these groups are not the explicit focus of this effort, other communities of color such as Hispanics and Native Americans face similar issues of underrepresentation in many STEM education and workforce opportunities.

A unique and important national resource for addressing Black engagement in STEM fields are our nation's Historically Black Colleges and Universities (HBCUs). The more than 100 HBCUs were formed to serve Black communities when segregation was still legal, and they have continued to stand out among colleges and universities for their recognition that everyone deserves access to quality education. Today, HBCUs play a significant role as anchoring institutions within Black communities, offering access to educational and research opportunities for Black students in a highly supportive environment that embraces diversity, connections to the Black community, and affordability. This recipe is well-positioned for reversing the lack of diversity in STEM by meeting the needs of a wide range of Black students ranging from low-in-

come, first-generation students that are economically disadvantaged to those that are well-prepared educationally and economically and also want an HBCU experience. The HBCUs, in particular, must be the beneficiary of appropriate investments to operate at their capacities. This support is overdue and necessary for the United States to succeed in implementing a competitive national talent strategy for STEM workforce development.

Although the more than 100 HBCUs have made an enormous contribution to our nation, The 15 HBCUs with Schools of Engineering and engineering programs that meet the high standards set out by the Accreditation Board for Engineering and Technology (ABET) – referred to as The 15 HBCUs – are a true “national treasure for STEM research and education.” As Dr. Percy Pierre, the former President of Prairie View A&M University, and a principal architect of the “national minority engineering efforts” in the late 1960s to early 1980s, explains:

“Starting an engineering school and getting it accredited are separate and distinct issues ... Graduating from an accredited program was more advantageous to students competing for top jobs in industry; otherwise, students would have to settle for jobs at lower levels. More importantly, accreditation was essential to colleges in assuring students a quality education ... Faculty quality is considered the most important factor in accreditation ... Other important factors taken into account” for accreditation were quality of the laboratories, curriculum and student body.⁶

4 TEconomy Partners' analysis of National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS), Completions Survey.

5 TEconomy Partners' analysis of U.S. Census Bureau population data; U.S. Bureau of Labor Statistics, Current Population Survey data.

6 Percy A. Pierre, “A Brief History of the Collaborative Minority Education Effort,” in Slaughter, Tao and Pearson, *Changing the Face of Engineering: The African American Experience*, Johns Hopkins University Press, 2015, page 16.

THE 15 ABET-ACCREDITED HBCU SCHOOLS OF ENGINEERING ("THE 15 HBCUs")

- Alabama A&M University
College of Engineering, Technology
and Physical Sciences
- Florida A&M University-Florida State
University College of Engineering
- Hampton University School
of Engineering and Technology
- Howard University College
of Engineering and Architecture
- Jackson State University College
of Science, Engineering and Technology
- Morgan State University
School of Engineering
- Norfolk State University College
of Science, Engineering and Technology
- North Carolina Agricultural and Technical
State University College of Engineering
- Prairie View A&M University
Roy G. Perry College of Engineering
- Southern University College
of Sciences and Engineering
- Tennessee State University
College of Engineering
- Tuskegee University College of Engineering
- University of the District of Columbia
School of Engineering and Applied Sciences
- University of Maryland Eastern Shore
School of Business and Technology
- Virginia State University College
of Engineering and Technology

Beyond the value of their ABET accreditation, The 15 HBCUs stand out as research-intensive and research-active universities able to collectively stand as equal peers with the significantly larger R1 "very high research activity" Predominantly White Institutions (PWIs) dominating our nation's innovation-driving, academic research activities. With a combined \$88 million in annual engineering and computer sciences research activities, The 15 HBCUs are collectively comparable to the engineering and computer sciences research of leading PWIs such as the University of Pennsylvania, Vanderbilt University, Princeton University, Northwestern University, and Clemson.⁷

Among all HBCUs, these 15 HBCUs stand out as research leaders, representing 94% of the engineering research and 75% of the computer sciences research conducted by all HBCUs. Furthermore, the total university research at The 15 HBCUs across all fields stands at 70% of the non-life sciences research activities across all HBCUs and 55% when life sciences research is included.⁸

In recognition of the distinct value that the ABET-accredited HBCU Schools of Engineering represent, a coalition of corporations and government agencies came together more than 25 years ago to form Advancing Minorities' Interest in Engineering (AMIE) in collaboration with these schools. The purpose of AMIE is to foster collaborative partnerships with the ABET-accredited HBCU Schools of Engineering that attract, develop, recruit, and graduate minorities in engineering.⁹

⁷ Based on TEconomy analysis of National Science Foundation's Higher Education Research and Development Survey for 2018. Note FAMU-FSU College of Engineering research figures are derived from ASEE profile.

⁸ IBID; it is also important to note that many of the ABET-accredited HBCU Schools of Engineering also house other fields of sciences.

⁹ Today, these industry and government partners include: Abbott, Air Force Research Laboratory, Boeing, Boston Scientific, Career Communications Group, Corning, Dell EMC, Exelon, GM, IBM, Leidos, Lockheed Martin, Microsoft, MITRE, NAVSEA, NetApp, Northrop Grumman, National Security Agency, Oracle and the Applied Research Lab at Penn State.

Given the current national imperatives to both bolster our nation's global position in STEM as well as address the corporate need and value of increased diversity, the data gathering for this Report was launched in 2019 by a select group of major corporations, all members of the AMIE Board, to further understand our circumstances and present ideas for consideration to provoke long-term improvement in our posture. The goals of this effort, which we believe we have achieved, were as follows:

1. To understand the curricula being taught, and where possible ensure that what is being taught is aligned with the 21st-century employment market
2. To understand the research capabilities of our schools and strengthen how they are viewed individually, but most importantly, as a "Collaborative Engine" that leads, as well as partners with other universities and centers of research and innovation on projects funded

by various sources ranging from DOD to the Business Community

3. To inspect the current in-state Pre-K-12 pipeline to determine where our intervention and transfer of STEM context and content might influence student and family awareness and respect for STEM, and improve student classroom performance so that when they reach 12th grade, they are STEM interested and STEM ready.

The development of this Report has been overseen by five Executive Sponsors: Alicia Boler Davis, Senior Vice President, Global Customer Fulfillment, Amazon; Nicholas Donofrio, Executive Vice President, Innovation and Technology, IBM retired; Admiral Michael Mullen, (Ret) 17th Chairman, Joint Chiefs of Staff; Tyrone Taborn, Founder and Publisher, Career Communications Group; and Dr. Jason Providakes, CEO, MITRE, and Project Sponsor. Mr. Donofrio is also the Project Executive Mentor.

COVID-19 AND THE TRAGIC DEATH OF GEORGE FLOYD RAISED THE STAKES.

In the midst of preparing this Report, a new "national moment" was imposed that raised the imperative for addressing racial inequality and inclusion. The significance of this renewed national reckoning caused the bar to be raised on the goals of the Initiative to incorporate meaningful corporate collaborations to better leverage and further enhance the research, talent, and Pre-K-12 STEM capacities at each of The 15 HBCU Schools of Engineering.

First, the COVID-19 pandemic has raised the value of science on the national stage to a level not seen since the Russian launch of the Sputnik artificial Earth satellite on October 4, 1957, which at that time intensified America's focus on increasing our math and science capabilities in profound ways. Then, on May 25, 2020, the tragic death of George Floyd occurred and gave renewed impetus to the Black Lives Matter movement that has compelled a national reckoning with the systemic inequalities and prejudices suffered by Black and other racial minorities. The nation is coming to terms with the need to address the ongoing legacies of "separate but equal" in ways not seen since the Civil Rights movement. A new understanding throughout the populace that "those children" are "our children," and that the nation needs all of its able minds engaged in meeting the demand for a workforce with STEM-based skills. In one of the most prominent examples of how this moment is already reshaping the national narrative, an alumna

of one of these HBCU schools (Howard University) is now the Vice President of the United States.

The changing national political and cultural landscape and social climate have created the best opportunity in the last half century to simultaneously build stronger corporate partnerships with The 15 HBCUs in research and talent development and serve the national self-interest. This is *the time to advance meaningful change*, anchored by a focus on engineering, to raise the awareness of the outsized contributions and value of The 15 HBCUs. In this climate of racial equity consciousness, distinct from that seen in the history of our nation, the moment is ideal to spur corporate and government partnerships to enhance the research and talent development capacities of The 15 HBCUs, and in doing so, diversify and expand our national STEM competitiveness.

THE HIGH VALUE PROPOSITION OF THE 15 HBCUs

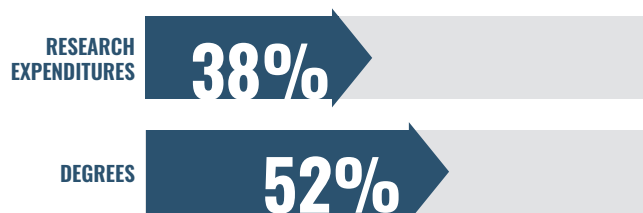
The 15 HBCUs collectively stand among the most select universities in engineering and computer sciences in the nation.

They meet the high standard of having ABET-accredited engineering and computer sciences programs within research and doctoral-focused institutions. Few individual institutions match the collective strength of The 15 HBCUs, including: the previously mentioned \$88 million in annual research funding, plus 1,527 bachelor's, 477 master's, and 51 PhD degrees granted in 2018.¹⁰ In fact, only 89 of the 333 U.S. universities that have earned ABET accreditation in one or more of the major engineering fields (i.e., chemical, civil, computer, electrical, industrial, or mechanical fields of engineering) generated at least \$50 million in engineering and computer sciences research expenditures in 2018.¹¹

Few PWIs can match the collective research and talent enterprise across the 15 HBCU Schools of Engineering: \$88 million in engineering and computer sciences research funding, 1,527 bachelor's degrees granted, 477 master's degrees granted, and 51 PhDs granted in 2018

Sources: NSF Higher Education R&D Survey for research expenditures; ASEE for FAMU-FSU College of Engineering research expenditures; National Center for Educational Statistics for degrees

THE 15 HBCUs' GROWTH IN ENGINEERING AND COMPUTER SCIENCES RESEARCH AND DEGREES, 2010-2018



Sources: NSF Higher Education R&D Survey for research expenditures; ASEE for FAMU-FSU College of Engineering research expenditures; National Center for Educational Statistics for degrees

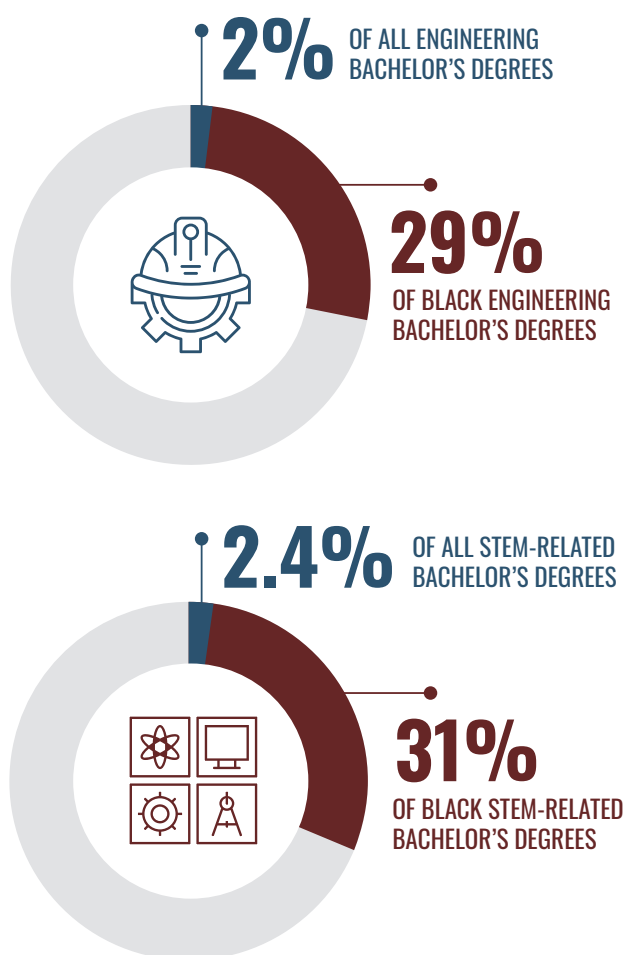
These 89 ABET-accredited schools of engineering represent a “who’s who” of PWIs, including major public universities such as UC Berkeley, University of Michigan, and Purdue along with private institutions such as Harvard, Stanford, MIT, and Johns Hopkins University. It is also a reality that those 89 PWI schools of engineering are not able to supply the engineering workforce required for the nation’s competitiveness, nor have they been effective in producing the diverse domestic graduate numbers required by U.S. defense agencies. The 15 HBCUs have demonstrated that they are a unique weapon for the nation and have continued to produce even though they

¹⁰ Based on aggregating research funding from the NSF Higher Education Research and Development Survey, except for the FAMU-FSU College of Engineering, which is a unique joint university School of Engineering that reports its research funding to American Society for Engineering Education and degrees from National Center for Education Statistics (IPEDS database)

¹¹ The 89 PWI institutions were identified based on analysis of the ABET listing of accredited programs on their website for major engineering fields of chemical, civil, computer, electrical, industrial, or mechanical engineering (<https://amspub.abet.org/aps/>) and data from the National Science Foundation’s Higher Education R&D (HERD) survey for 2018 for engineering and computer sciences research expenditures.



The 15 HBCUs compared to PWI Counterparts with ABET-accredited schools of engineering and more than \$50 million in annual engineering and computer sciences research



Source: National Center for Education Statistics for degrees

have consistently been underfunded and disproportionately overlooked.

To fully recognize the value of The 15 HBCUs, the collective research and talent generation strengths of The 15 HBCUs in serving Black engineering and computer sciences students are examined below in the context of these 89 ABET-accredited schools of engineering at PWIs with \$50 million or more in annual engineering and computer sciences research expenditures (the PWI Counterparts). Plus, a comparison of resources available to The 15 HBCUs to that of their PWI Counterparts is presented. Again, we remind you that the combined 15 HBCU Schools of Engineering have a collective \$88 million in research funding. Together, this analysis suggests the outsized contributions of The 15 HBCUs despite more limited resources.

The 15 HBCUs have realized healthy gains in research and talent generation over the past decade. Research at The 15 HBCUs across engineering and computer sciences rose by 38% from 2010 to 2018 along with the nearly tripling of computer science annual research expenditures from \$4.8 million to \$10.7 million from 2010 to 2018. Also, degrees granted by The 15 HBCUs across bachelor's, master's, and PhDs grew by 52%.¹³¹² The more than doubling of PhDs granted by The 15 HBCUs during the same time period demonstrates the focus of these institutions on being research universities.

In comparison to their PWI Counterparts, The 15 HBCUs collectively have an outsized impact on producing Black engineering graduates. With just 2% of all engineering graduates compared to their PWI Counterparts, The 15 HBCUs

12 Research growth based on NSF Higher Education Research and Development Survey, except for FAMU-FSU School of Engineering, which is based on ASEE data, and Degree growth based on National Center for Education Statistics (IPEDS database)



Source: Harvard Opportunity Insights Database

provide more than 29% of the bachelor's engineering degrees conferred to Black graduates. *For Black women, The 15 HBCUs produce an even higher share of bachelor's engineering degrees, conferred at 33%* compared to their PWI Counterparts. Taking into account the entirety of STEM offerings at a university-wide level for The 15 HBCUs compared to their PWI Counterparts (e.g., engineering, computer sciences, life sciences, geosciences, and physical sciences) the disproportionate generation of Black STEM graduates remains quite high: with 2.4% of all STEM-related bachelor's degrees granted, The 15 HBCUs at a university-wide level represent 31.1% of total Black bachelor's STEM degrees conferred, including more than one in three conferred to Black women (34.3%), compared to their PWI Counterparts.¹³

The 15 HBCUs on average serve a vastly lower-income student population and enable an impressive record of higher economic mobility rates for their students than their PWI Counterparts. More than 19% of all students at The 15 HBCUs come from families in the bottom 20% of income compared to 5% for all students at the PWI Counterparts. Given the quality of education and opportunity that The 15 HBCUs offer and the larger base of low-income students they serve, it is not surprising that they also promote much higher economic mobility rates – 59% greater than found at the PWI Counterparts – for students who originate in families in the bottom 20% who then go on to reach the top 20% of income earners.¹⁴ In other words, the social climate of inequality that existed in the nation when these schools were created still exists, yet the benefit to be achieved by the nation through investing enhanced resources in these institutions is substantial. HBCUs were originally created

BIDEN'S HBCU AGENDA

“While it hasn’t gotten much attention, Biden’s campaign pledge to deal with the long-standing disparity in research grants encourages HBCUs ... Biden, in the higher education plan he released during the campaign, including spending \$20 billion to help HBCUs and other minority-serving institutions catch up on having the state-of-the-art research facilities they need to compete with the larger [PWI] institutions, as well as another \$10 billion to create centers of excellence at colleges whose main focus is on educating students of color.”

Inside Higher Ed, November 16, 2020

to facilitate segregation, but today they provide both a climate of opportunity and outsized beneficial contributions to the nation.

More generally, polls of Black graduates find that HBCUs stand out across many dimensions of college life and future success compared to PWIs. According to Inside Higher Ed, about half of Black graduates from HBCUs said their college was “the perfect school” for them, compared to 34% of PWI Black alumni, and nearly half of Black graduates said they “couldn’t imagine a world” without the HBCU they attended, compared to 25% at PWIs.¹⁵

Further results from Gallup polling of Black graduates reveals the higher standing of HBCUs compared to PWIs for these Black students (see the tables below).

¹³ National Center for Education Statistics (NCES) IPEDS database

¹⁴ Data on income and mobility from the Harvard Opportunity Insights Database on Preferred Estimates of Access and Mobility Rates by College database. The mobility rate is defined as the percent of children who originate in a specific income quintile and end up as adults in a specific (often different) income quintile.

¹⁵ Jake New, “Positive News for HBCUs,” Inside Higher Ed, October 28, 2015.

For The 15 HBCUs, their sustained growth in research and talent generation and impacts on student lives come with much fewer resources than their PWI Counterparts. This is an issue that the Biden Administration acknowledged and pledged to tackle during the recent presidential campaign. As Inside Higher Ed reports: “Far more of the \$100 billion-plus HBCUs offer a higher quality college experience for Black students – Findings from Gallup survey of Black college graduates

	BLACK GRADUATE EXPERIENCE AT HBCUs	BLACK GRADUATE EXPERIENCE AT PWIs
My university prepared me for life after graduation	55%	29%
My professors cared about me as a person	58%	25%
While at college, I had a mentor who encouraged me	42%	23%
While in college, I had an internship or job that allowed me to apply what I was learning in the classroom	41%	31%

Black graduates of HBCUs are more likely to be *thriving in financial well-being and purpose well-being* compared with those from PWIs, according to Gallup polling.

	BLACK GRADUATES FROM HBCUs	BLACK GRADUATES FROM PWIs
Purpose Well-Being	51%	43%
Financial Well-Being	40%	29%

Source: Gallup, *Grads of HBCUs Have Well-Being Edge*, 2015.

federal agencies give higher education in research and development grants tend to go to the big – predominantly white – institutions ... But there is growing optimism the long-standing disparity may change. Little noticed during the campaign was a pledge by President-elect Joe Biden to take on the issue.”¹⁶

In producing the significant outcomes in research and talent generation, The 15 HBCUs – on a university-wide basis – consistently operate with vastly lower levels of resources per student than found at the PWI Counterparts. The most recent survey by the U.S. Department of Education on university finances for the 2017-2018 academic year finds that, on a university-wide basis, average instructional expenses per student stood 55% lower at The 15 HBCUs and average research expenses per student stood 82% lower at The 15 HBCUs.

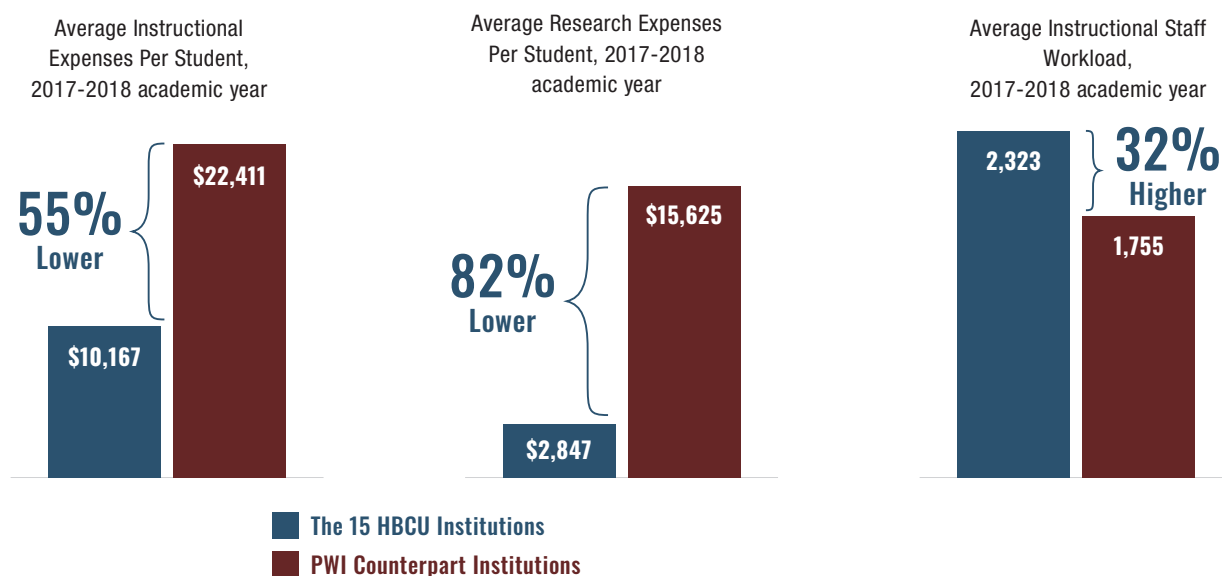
On top of this gap in operational resources, the instructional faculty at The 15 HBCUs are also asked to do more with less, relative to their PWI Counterparts. On a univer-

sity-wide average basis, The 15 HBCUs’ instructional staff had a 32% higher course load level, as measured by total 12-month instructional activity credit hours per faculty member, compared to the PWI Counterparts during the 2017-2018 academic year.

A closer look at revenues coming to The 15 HBCUs at a university-wide level, based on the most recent survey by the U.S. Department of Education on university finances for the 2017-2018 academic year, reveals the difference in resources results not only from lower tuition, but also much lower private and federal support. Since 12 of The 15 HBCUs are public universities (Public 12 HBCUs), we took a close look at the contrasting sources of revenues to the 51 PWI public research universities with research-intensive ABET-accredited Schools of Engineering (Public PWI Counterparts). Strikingly, the Public 12 HBCUs, on an average per-student basis, received just 50% of total revenues of their Public PWI Counterparts, or a difference of just over \$29,000 per

¹⁶ Kery Murakami, “Biden’s HBCU Research Agenda,” Inside Higher Ed, November 16, 2020

The 15 HBCU Institutions Collectively Operate with Vastly Lower Levels of Resources than their PWI Counterpart Institutions who have ABET-accredited schools of engineering and more than \$50 million in annual engineering and computer sciences research



Source: U.S. Department of Education, National Center for Education Statistics

Note: Data on instruction and research expenses and instructional staff workload is on university-wide basis and not just for schools of engineering.

student across all sources compared to these Public PWI Counterparts.

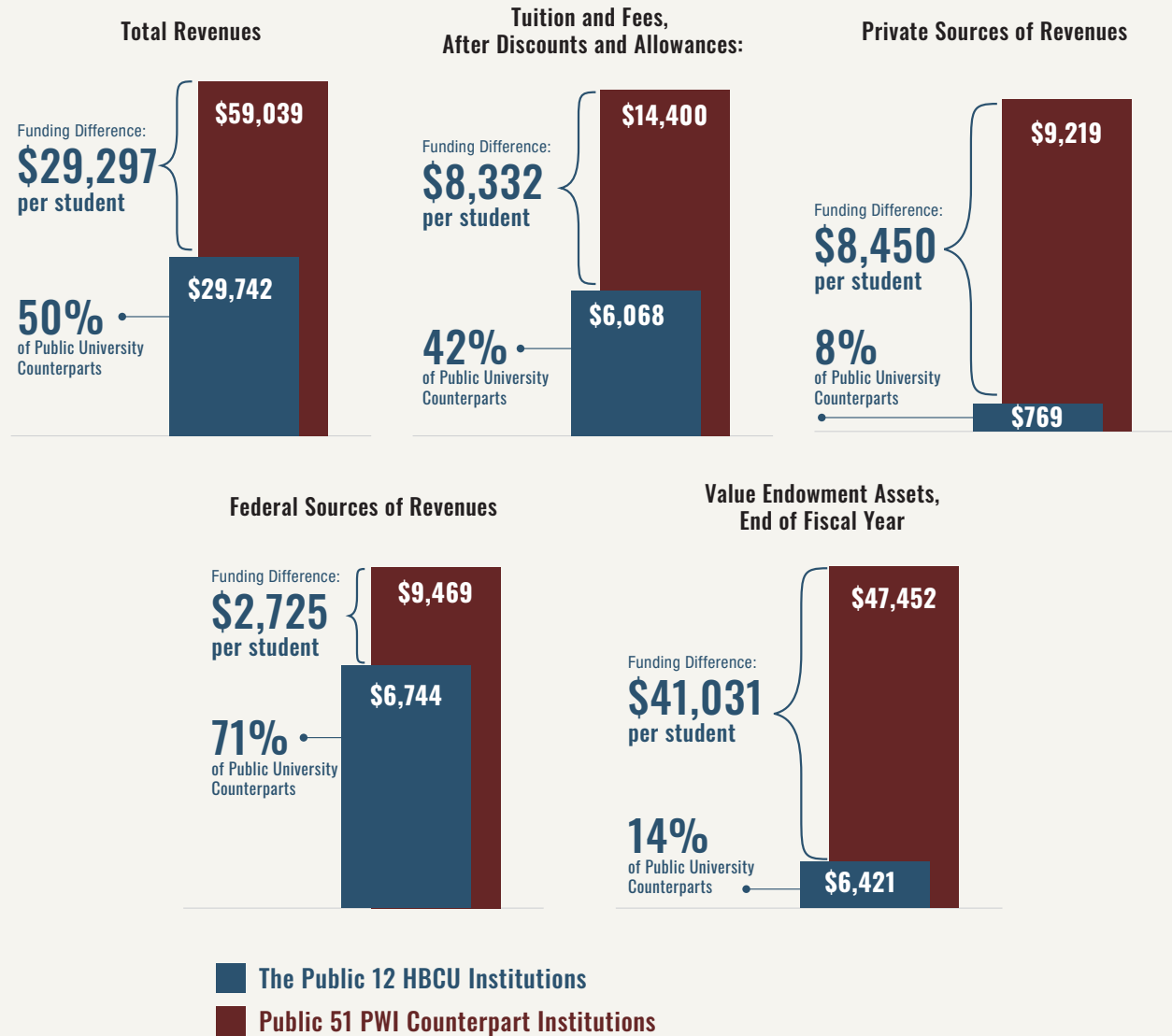
One key difference is the commitment to affordable education by Public 12 HBCUs compared to their Public PWI Counterparts. On average, Public 12 HBCUs generated \$6,068 per student from tuition and fees after deducting discounts and allowances compared to \$14,400 for the Public PWI Counterparts during the 2017-2018 academic year. This translates to the Public 12 HBCUs generating less than 50 cents for every \$1 dollar charged by the Public PWI Counterparts.

These inequities are compounded by large differences in the level of private support – including gifts, investment income, and private operating grants and contracts – flowing to Public 12 HBCUs, compared to their public PWI university Counterparts. With an average of \$769 in private support per student, Public 12 HBCUs received a mere 8% of the \$9,219 per student received by their Public PWI Counterparts in the 2017-2018 academic year.

Another source of disparities in funding is the huge gap in federal support between Public 12 HBCUs and their Public PWI Counterparts. For the 2017-2018 academic year, this gap in federal funding per student reached 71% or just under \$3,000 per student between Public 12 HBCU revenues and that of the Public PWI Counterparts.

Another important factor contributing to the funding gap is the level of endowment support existing at public universities with ABET-accredited Schools of Engineering relative to Public 12 HBCUs. The Public 12 HBCUs had only 14% of the levels of their Public PWI Counterparts in total endowment assets per student at the end of the 2017-2018 fiscal year. It is clear that federal action alone will not fully address the financial and resource effects of systematic racism or reverse decades of compounded inequities. *Private investments from corporations, philanthropies, and high net-worth individuals also need to be equalized to create a level playing field.*

The 12 Public ABET-Accredited HBCU Institutions in comparison to the 51 Public PWI Counterpart Institutions fall well behind in Revenues Per Student (data from the 2017-2018 academic year):



Source: U.S. Department of Education, National Center for Education Statistics

Notes:

- The 51 Public PWI Counterparts are Predominantly White public universities with ABET-accredited Schools of Engineering and at least \$50 million in annual engineering and computer sciences research expenditures.
- Data on revenues is on a university-wide basis and not just for schools of engineering.

THE 15 HBCUs ARE ON THE CUTTING EDGE OF EMERGING TECHNOLOGY PRIORITIES OF CORPORATE PARTNERS

Disruptive technologies are becoming a common feature of our global economy, and a mark of a top university is its ability to keep pace with these advances.

As the McKinsey Global Institute notes: “The parade of new technologies and scientific breakthroughs is relentless and is unfolding on many fronts ... some technologies do in fact have the potential to disrupt the status quo, alter the way people live and work, rearrange value pools, and lead to entirely new products and services.”¹⁷

The disruption associated with these technologies unfolds across multiple dimensions – the speed of advancement in disruptive technologies is extremely rapid, and at the same time extremely broad in reach. As a result, innovation in

science and engineering research is becoming less incremental and more concentrated in areas of convergence across broad sets of industry sectors. Increasingly, success in innovative technologies comes from integrating multiple technologies and business activities to generate new products and new solutions to market needs.

This focus on convergence stands out among the corporate partners involved in developing this Report. Working closely with Corporate Research Advisors (CRAs) from each of the sponsoring corporations, the authors of this Report identified a broad set of engineering and computer sciences technologies critical for both new product development and workforce development. Cutting across various industries, notable sectors and technologies include automotive systems, medical devices, aerospace and defense, government research and development, Internet of Things, and advanced computing and data sciences.

Among the leading areas of technology convergence across disruptive engineering and computer sciences fields identified across the diverse base of corporations involved in this Report were three broad technology areas with a number of highly rated specific technologies for both research and talent development:

Sponsor Corporations Participating in the Development of the Report

- *Abbott*
- *Amazon*
- *Boeing*
- *Boston Scientific*
- *General Motors*
- *IBM*
- *Lockheed Martin*
- *Microsoft*
- *MITRE*
- *Oracle*

¹⁷ McKinsey Global Institute, Disruptive Technologies: Advances that will transform life, business, and the global economy,” May 2013, page 1.



- Connectivity & Networking technologies led by cloud computing, Internet of Things, and cybersecurity
- Computing & Analytics technologies led by machine learning, natural language processing and artificial intelligence, high performance computing, computer vision and systems engineering, modeling and simulation
- Digital Systems technologies led by autonomous vehicles, smart infrastructure, and advanced robotics

Additionally, two areas of disruptive engineering and computer sciences technologies were more market-specific and of importance to a more limited range of participating corporations, including:

- Materials & Energy involving additive manufacturing, nano-meta materials, and nextgen batteries
- Medical Technologies involving brain-computer interfaces and neuromodulation, diagnostic devices, and implantables and prosthetics

A closer look at the collective research and talent activities by The 15 HBCUs finds a strong focus on these leading areas of disruptive technologies in engineering and computer science of importance to corporate partners. It demonstrates that despite operating on limited availability of public and private resources, The 15 HBCUs are highly responsive to these industry-valued,

disruptive, and innovative emerging technologies across their research and talent development efforts.

RESEARCH ALIGNMENT OF THE 15 HBCUs WITH BROAD AREAS OF DISRUPTIVE TECHNOLOGIES

A more detailed way to consider the research excellence and capacity of The 15 HBCUs is to examine the thematic focus areas present in their peer-reviewed publication activities.

Discussions with the CRAs indicated that a strong publication record in specific topics of relevance is a key measure of research strength that corporations look for to partner with universities, particularly with respect to seeking out leading faculty in relevant areas of research to form long-term collaborative relationships.

An analysis of nearly 8,000 peer-reviewed publications generated by The 15 HBCUs across their institutions since 2015 finds that these institutions are active in many specific publication fields associated with the disruptive technology areas, and that The 15 HBCUs stand out in many fields, with much higher levels of publication specialization compared to the national average.¹⁸

It is also possible to determine where The 15 HBCUs stand out in areas of applied core research competencies by

¹⁸ Publication specialization in a particular field is measured by the share of publications across The 15 HBCUs compared to all universities. If the ratio of relative shares is 1.0 then The 15 HBCUs equal the U.S. share and if greater than 1.0 then The 15 HBCUs are more specialized and have a higher publication intensity in that field than found nationally.

Table 1: Examples from Publications Activity of The 15 HBCUs' Leading Engineering and Computer Science Research Fields Across Disruptive Areas of Technology

Broad Disruptive Technology Areas in Engineering and Computer Sciences	The 15 HBCUs' Publication Analysis	
	Specialized Publication Field (Specialization Above 20% of U.S., 2015-2020/2Q)	High Level of Activity (50+ publications, 2015-2020/2Q)
Connectivity & Networking		<ul style="list-style-type: none"> Information Systems Electrical Engineering
Computing & Analytics	<ul style="list-style-type: none"> Applied Math 	<ul style="list-style-type: none"> Computer Sciences Applications
Digital Systems	<ul style="list-style-type: none"> Industrial Engineering Transportation Science Technology 	<ul style="list-style-type: none"> Electrical Engineering
Materials & Energy	<ul style="list-style-type: none"> Nuclear Physics Applied Physics Manufacturing Engineering Crystallography Composites Polymer Science Coatings Nanotechnology Optics 	
Medical Technologies	<ul style="list-style-type: none"> Biomaterials Chemical Engineering 	

Source: Web of Science, TEconomy analysis.

leveraging the unstructured text data and key terms found in research publication abstracts that go beyond the high-level categorization of publications by fields. The concept of core competencies is now widely understood as a critical factor for identifying where a university or corporation has the depth of know-how to drive innovation and stand out among the competition. As defined by Gary Hamel and C.K. Prahalad in *Competing for the Future*, a “competence is a bundle of skills and technologies representing the sum of learning across individual skill sets and organizational units.”¹⁹

Through the application of natural language processing technology and machine learning models, core research competencies found among The 15 HBCUs were identified by examining the latent thematic topics found across the “vocabulary” of text content present in the publications data. Using network analysis, it is then possible to identify where there are convergence areas of critical mass in research activity and technology themes across the landscape of The 15 HBCUs' publications.

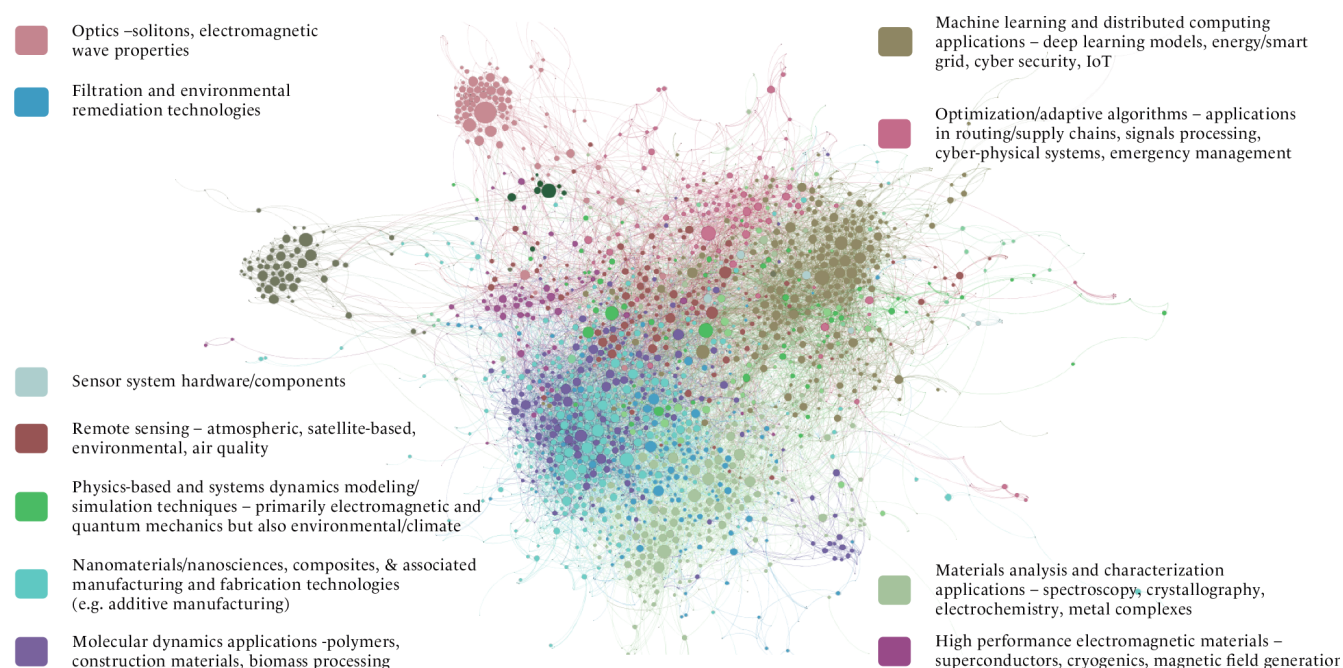
19 G. Hamel and C.K. Prahalad. *Competing for the Future*. Harvard Business School Press: Boston, MA, 1994, pp. 90 and 217.

For The 15 HBCUs, 11 areas of distinctive core research competencies emerge from the publications activities of the institutions that cut across many of the disruptive technology areas. The landscape mapping of activities revealed in Figure 1 points not only to the strengths in material sciences across characterization and analysis, high-performance electromagnetic materials, and broader materials used in manufacturing, but also extensive strengths in machine learning and distributed computing applications, optimization modeling, and physics-based systems dynamics modeling, and remote sensing.

A summary of the alignment of The 15 HBCU publications activities across the broad areas of disruptive technologies finds strong connections to industry-relevant technology priorities by the research activities at The 15 HBCUs:

- **Connectivity & Networking** – Activities in cybersecurity found within machine learning and distributed computing activities, plus electrical and electronic engineering capabilities aligned in device engineering applications involved
- **Computing & Analytics** – Significant levels of activity in current areas of emphasis for industry including machine learning, algorithm development, and modeling/simulation.
- **Digital Systems** – A wide range of systems engineering applications in electrical/electronics engineering and materials, primarily focused on embedded sensing and power electronics within aerospace, satellite, autonomous vehicles, and industrial controls platforms.
- **Materials & Energy** – Signature area of emphasis for research activities with a diverse portfolio of activity spanning from engineered/high-performance materials, optics, nanotechnology, bio-energy applications, and advanced materials analysis and testing.
- **Medical Technology** – Activity in biomedical engineering highly focused on custom biocompatible materials context.

Figure 1: Networking Mapping of Topic Clusters of The 15 HBCUs' Publications Activity, 2015-2020/2Q



Source: Web of Science; Network Analysis by TEConomy.

WORKFORCE DEVELOPMENT ALIGNMENT OF THE 15 HBCUs WITH BROAD AREAS OF DISRUPTIVE TECHNOLOGIES

In addition to ideas for future workforce development, CRAs have emphasized that what matters is not simply having core courses in key technology areas, but challenging students to put that knowledge to work and demonstrate the ability to integrate knowledge across technologies to solve real-world problems. In particular, industry noted:

- **There is great value to industry of students having a well-rounded undergraduate education that emphasizes the thought/design/processes behind engineering, particularly at a systems level, and focuses on students being able to apply the most relevant technology advances.** A general point

emphasized by industry is the need to expose students to the most pertinent technology areas and how they can be applied at a systems level.

- **Student experiences in real-world applications are essential for talent development.** Companies see significant value in hands-on projects and opportunities to see students in action, through engagements such as internships, co-ops, and capstone courses involving applied design projects. Student involvement in conference activities is also viewed as a positive that demonstrates a university's focus on relevant issues to industry.

To demonstrate the relevancy of the educational experience offered by The 15 HBCUs in broad areas of disruptive technologies, TEconomy reviewed the upper-level course offerings by The 15 HBCUs and their ability to engage students in hands-on experiential learning addressing real-world problems (see Figure 2).

Figure 2: Examples of relevant upper-level courses found at The 15 HBCUs in the broad areas of disruptive technologies

Connectivity & Networking	Computing & Analytics	Digital Systems	Materials & Energy	Medical Technology
<ul style="list-style-type: none"> • Digital Signal Processing • Applied Network Security and Intrusion Detection • Secure Distributed Computing • Applied Wireless Networking • Wireless Sensor Networks, Mobile Deployment 	<p>Significant levels of activity in current areas of emphasis for industry including:</p> <ul style="list-style-type: none"> • Machine learning • Algorithm development • Modeling/ simulation 	<ul style="list-style-type: none"> • Power Systems Integration & Performance • Simulation of Industrial Engineering Systems, Remote Sensing and GIS in Engineering • Microcontrollers and Embedded Systems • Digital VLSI Design, Industrial Robotics and Mechatronics • Advanced Material Handling Sys. • Modeling and Control of Autonomous Vehicles • Automation and Production Systems • Satellite Design • Design of Autonomous Aerial Systems 	<ul style="list-style-type: none"> • Nanomaterials Engineering • Applied Laser and Photonics Systems • Fuel Cell Fundamentals and Technologies • Solids Processing and Particle Technology • Biomass Conversion Processes for Energy and Chemicals • Composite Materials Engineering, Polymer Science and Engineering • Molecular Bioengineering • Flight Vehicle Performance 	<ul style="list-style-type: none"> • Tissue Engineering • Computer Aided Design and Control in Medicine and Surgery • Biomedical Engineering Micro-Devices and System • Bioelectronics

Source: TEconomy Review of The 15 HBCUs' Course Catalogs.

Figure 3: Presence of Capstone and Industry Experiential Learning Courses at The 15 HBCUs

Emerging Technology Area	Number of Schools Listing Senior Design/Capstone Engineering Courses	Number of Schools Listing Industry Immersion/Project Courses in Engineering	Number of Departments Listing Senior Design/Capstone Engineering Courses	Number of Departments Listing Industry Immersion/Project Courses in Engineering
Connectivity & Networking*	13	6	19	6
Digital Systems*				
Computing & Analytics	12	8	15	8
Materials & Energy	12	5	22	6
Medical Technology	3	2	3	2

Source: TEconomy Review of The 15 HBCUs' Course Catalogs

Note: All The 15 HBCUs offer capstone courses for their ABET-accredited engineering and computer sciences degrees

Altogether, TEconomy found over 132 upper-level courses at The 15 HBCUs in the broad areas of disruptive technologies. Examples of key topics encompassed in these upper-level course offerings, set out in Figure 2, demonstrate the breadth of their focus.

Among these upper-level course offerings in the broad areas of disruptive technologies, TEconomy found that the majority were centered around design projects, which often provide applied, experiential learning. This suggests the high degree to which The 15 HBCUs help their students prepare for the world of work (see Figure 3).

In summary, the evidence is clear that not only are The 15 HBCUs doing more with less, but they are delivering excellence and keeping pace with changes in emerging technologies in both research and workforce generation. This raises a question of critical importance for our nation's ability to remain competitive in a global economy: "What would be possible for The 15 HBCUs if the playing field of investment/sponsorship was leveled at a time when the nation needs every competitive advantage?"

A NATIONAL IMPERATIVE TO ADDRESS RACIAL AND ECONOMIC DISPARITIES BY ENHANCING PRE-K-12 STEM TALENT PIPELINE IN STATES WITH THE 15 HBCUs

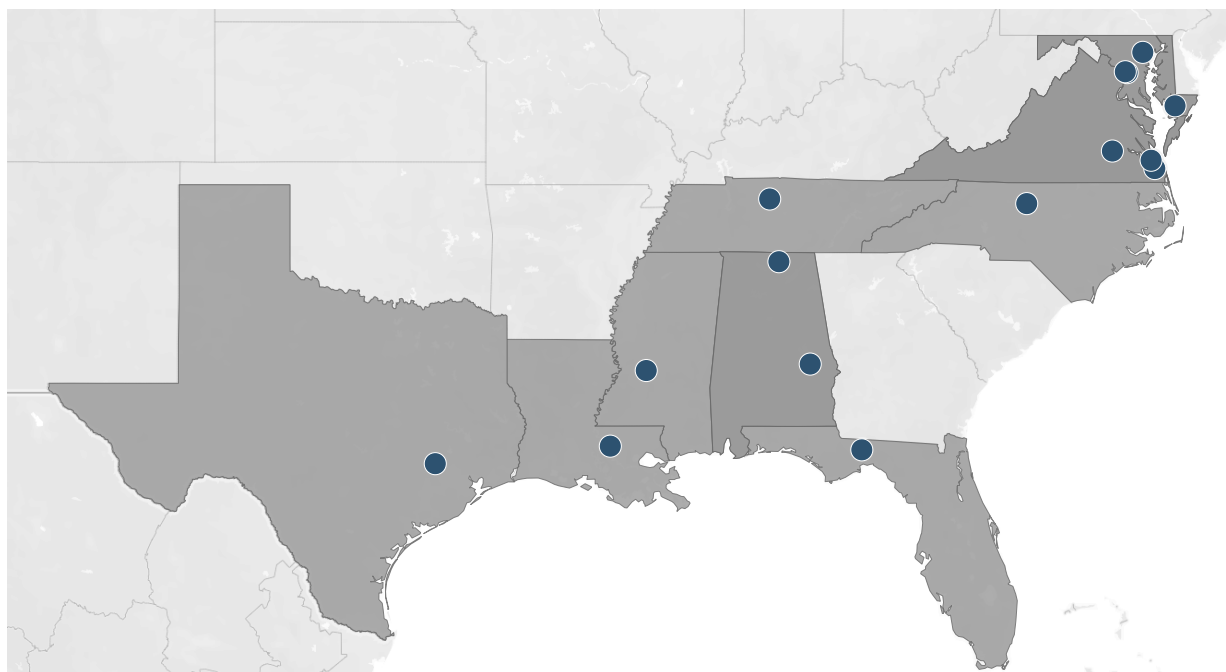
The locations of The 15 HBCUs are no accident.

States with these universities have significant Black populations and a legacy of segregation, which fostered the creation of HBCUs under the “separate but equal” context, yet they were never supported with equitable investment of resources (e.g., land, faculty, physical infrastructure, books, educational climate). For clarity, we have defined our geographic focus area as The 15 HBCU Territorial Network: Alabama, Florida,

Louisiana, Maryland, Mississippi, North Carolina, Tennessee, Texas, Virginia, and the District of Columbia (Figure 4).

More than 43% of our nation’s Black children are found in the nine states and the District of Columbia comprising The 15 HBCU Territorial Network. For The 15 HBCU Territorial Network, the share of Black children is nearly double the level found in other states – just over 20%

Figure 4: Map of The 15 HBCUs and their Respective Locations in the U.S. (i.e., The 15 HBCU Territorial Network)





of the children in The 15 HBCU states are Black compared to under 11% for non-HBCU states.²⁰

While each of The 15 HBCUs accepts students from out of state and internationally, a primary source of students for each school is its in-state population. The importance of this pipeline points to the opportunities for the nation for financing and leveraging the strong engagement of the faculty and students of the 15 HBCU communities to support Pre-K-12 STEM education more broadly. The 15 HBCUs play a particularly effective role in expanding economic opportunity and reaching students of color and other families with fewer economic resources.

Across the The 15 HBCU Territorial Network, racial disparities in poverty, income, and educational outcomes are staggering. In many ways, this geographic area represents a microcosm of the socioeconomic challenges and inequities still present throughout the United States. An analysis of income levels and poverty rates across this 15 HBCU Territorial Network reveals the substantially lower standard of living of Black children compared with White children within these regions:

- **Among households with children, median incomes for Black households are nearly half those for White households in The 15 HBCU Territorial Network:** In 2019, Black household incomes with children stood at \$46,031, based on weighting by population, across The 15 HBCU Territorial Network, compared to \$95,221 for White households with children.²¹ Across The HBCU 15 Territorial Network, the median incomes for Black households with children range from \$31,400 to \$71,700, while the median incomes for White households with children range from \$75,700 to \$247,900. Thus the disparities in income between Black and White incomes in households with children are significant within The 15 HBCU Territorial Network – ranging from 19% to 55% or a weighted average of 48%.
- **Approximately 30% of Black children in The 15 HBCU Territorial Network live below the poverty line, and the poverty rates for Black children are nearly three times higher than those for White children:** The share of Black children living below the poverty line ranges from 19% to 43%, and the weighted average of poverty rates for Black children is 30% in The 15 HBCU Territorial Network. Comparatively,

20 TEconomy Partners analysis of 2019 State Characteristics Population Estimates, U.S. Census Bureau, Population Division. Note: Black children are defined as non-Hispanic Blacks between ages 0-17 years old (so Black children under the age of 18).

21 Averages are weighted based on each state's population of children under 18 by race, based on 2019 U.S. Census Bureau data.

the weighted average poverty rate for White children is 10%, and the share of White children living below the poverty line ranges from 6% to 15% across The 15 HBCU Territorial Network. The percentage of Black children living below the poverty line is **between 2.2 and 3.3 times greater** than the share of White children living below the poverty line across The 15 HBCU Territorial Network.

Unfortunately, but not surprisingly, the educational achievement levels for Black K-12 students, who disproportionately come from lower-income and higher-poverty households, is also lagging across The 15 HBCU Territorial Network. The National Assessment of Education Progress (NAEP) reveals that Black K-12 students score lower than White students across the area, and that the gap grows from 4th to 8th grades across The 15 HBCU Territorial Network.²²

- Among 4th graders, differences between average scores among Black and White students in The 15 HBCU Territorial Network range from 21 and 28 points for reading, between 21 and 27 points in math, and between 29 and 34 points for science.²³

- Disparities between Black and White student NAEP scores also persist among 8th graders in The HBCU Territorial Network, reaching between 22 and 29 points for reading, between 26 and 39 points in math, and between 29 and 36 points in science.

At the high school level, these disparities continue across The HBCU Territorial Network. According to the 2019 NAEP, an estimated 50% of Black 12th graders nationally scored below basic achievement levels for reading, compared to 21% of White 12th graders. Black student graduation rates are below White students throughout the Territorial Network. Furthermore, the access to advanced college readiness courses by Black students in The 15 HBCU Territorial Network, as revealed by the number of students taking Advanced Placement classes, is well below that of White students.²⁴ Black students also participate in Advanced Placement STEM courses at a lower rate than their White peers and are also less likely to score at a college-ready level. This lagging performance on Advanced Placement tests in STEM courses for Black students is closely linked to their lower reading and math achievement in earlier grades.

22 The National Assessment of Education Progress (NAEP) is a congressionally mandated project administered by the National Center for Education Statistics (NCES) within the U.S. Department of Education and the Institute of Education Sciences (IES). It is the only assessment that measures what U.S. students know and can do in various subjects across the nation, states, and in some urban districts. Also known as The Nation's Report Card, NAEP has provided important information about how students are performing academically since 1969. For more information see <https://nces.ed.gov/nationsreportcard/about/>.

23 These ranges do not include the District of Columbia due to outliers. In Washington, D.C., the gap in NAEP test scores between Black and White 4th graders is 47 points for math and 54 points for reading. Among 8th graders, this gap rises to 63 points for math and 58 points for reading. Test scores for the science NAEP exam are unavailable for the District.

24 Based on College Board data

MEETING THE NATIONAL MOMENT – ADVANCING SUSTAINED AND HOLISTIC CORPORATE PARTNERSHIPS THAT ENHANCE THE RESEARCH, TALENT DEVELOPMENT, AND PRE-K-12 STEM PIPELINE FOR EACH OF THE 15 HBCUs

The changing national political and cultural landscape and social climate have spotlighted the necessity of addressing racial equity, diversity, and inclusion through meaningful and sustained efforts. No better way exists to advance STEM research and workforce development goals than to start with The 15 HBCUs, which have a proven track record of accomplishment.

This Report has validated the relevancy of the 15 ABET-accredited HBCU Schools of Engineering to address our nation's STEM challenges and contribute to advancing leading areas of disruptive technologies of importance to industry. Despite the high value that The 15 HBCUs bring to our nation, each of The 15 HBCUs must overcome a legacy of underinvestment that requires immediate attention to enhance their capacities in research, workforce development, and Pre-K-12 STEM pathway activities to their full potential. That potential includes building on The 15 HBCUs' current successes in teaching 21st-century subject matter, and leading and collaborating in research with the DOD/federal government agencies, the business community, and larger universities to increase the magnitude and volume of each.

The corporations involved in developing this Report have committed to meeting this national moment one university at a time. More specifically, each company involved in the initiative has committed to using a value-based approach to make a meaningful and sustained difference in enhancing the capacities of two or more of the 15 ABET-accredited HBCU Schools of Engineering.

These direct and strategic corporate partnerships with each of The 15 HBCUs are focused on advancing a holistic, relationship-building effort that simultaneously focuses on:

- Building relationships with faculty on research and workforce development activities
- Enriching the educational experience of students through more hands-on experiential learning opportunities
- Establishing meaningful and sustainable Pre-K-12 STEM education partnerships where there is a common interest

The goal is to meet each school where it is today to help it move forward through committed partnerships. Each of the participating corporations has accepted that the priority is to help the schools, and through doing so, help the nation and help our companies, in that order – whereby recruitment is a by-product, but not our priority. The driving focus for each participating company involved in developing this Report is to enhance each individual school's capacity, capabilities, and performance in three areas: curricula, research, and in-state Pre-K-12 STEM performance.

Looking forward toward larger-scale change, this effort by the corporations involved in developing this Report can help advance “living laboratories” as models for how corporations across the U.S. can partner effectively with universities. It is anchored in our top-down/bottom-up vision for sustained progress. From the top, corporations

work down through and with the universities, touching curricula and research capacities. The result will be experiential learning-infused degree programs and a competitive, collaborative university research partner. From the bottom

up, the result will help develop a sustainable Territorial Network pipeline of future college students that are STEM ready when college ready, and engaged with an HBCU community that has a “Welcome Home” mindset.

The companies involved in developing this Report are now working to enhance the capacities of each of The 15 HBCUs across research, talent development, and Pre-K-12 STEM pathway activities through an assigned and agreed-upon partnership with a sponsoring corporation involved in the initiative. The goal is to have each corporate partner focus on building a sustained and holistic partnership with individual HBCUs around research, workforce development and Pre-K-12 STEM pipeline expansion activities. Below are the assigned and agreed-upon corporate partnerships being advanced:

Participating Companies	Selected 15 HBCUs and the strengths that most directly influenced the partner matching:
Abbott	<ul style="list-style-type: none"> FAMU-FSU: Well-established biomedical engineering program with strong research capacity NCA&T: Well-established biomedical engineering program offering bachelor's and master's degrees and home to an NSF Engineering Research Center on metallic biomaterials Prairie View: Offers a bioengineering concentration in their ABET-accredited chemical engineering program and home to the Center for Computational Systems Biology, a multidisciplinary center to study complex biological processes
Amazon	<ul style="list-style-type: none"> Howard: Sizable and breadth of engineering and computer sciences degrees, and strong research intensity including computing and analytics Jackson State: Computer sciences and computer engineering accreditation along with data analytic strengths and active research program Tennessee State: Strong computer sciences talent pipeline and publications activities, along with a strong women's STEM focus
Boeing	<ul style="list-style-type: none"> Alabama A&M: Sizable and diverse range of engineering and computer sciences degrees and geographic alignment FAMU-FSU: Sizable and wide-ranging engineering program with strong research focus NCA&T: Sizable and wide-ranging engineering program with strong research focus
Boston Scientific	<ul style="list-style-type: none"> UDC: Growing biomedical engineering program FAMU-FSU: Well-established biomedical engineering program with strong research capacity
General Motors	<ul style="list-style-type: none"> NCA&T: Strengths in autonomous vehicles and material sciences Virginia State: ABET-accredited in manufacturing engineering
IBM	<ul style="list-style-type: none"> Hampton: Electrical engineering and computer engineering accreditation as well as student pipeline to top graduate programs Jackson State: Computer sciences and computer engineering accreditation along with data analytic strengths and active research program
Lockheed Martin	<ul style="list-style-type: none"> Morgan State: Sizable number of electrical engineering graduates along with geographic alignment Prairie View: Ongoing STEM collaborations, breadth of engineering and computer sciences degrees and research centers Tuskegee: Only accredited aerospace engineering program among The 15 HBCUs and active materials engineering research effort
Microsoft	<ul style="list-style-type: none"> Southern: Computer sciences accreditation and large master's program UMES: Growing computer sciences program and modern lab facilities
The MITRE Corporation	<ul style="list-style-type: none"> Alabama A&M: Sizable and diverse range of engineering and computer sciences degrees and geographic alignment Norfolk State: Only accredited optical engineering program among The 15 HBCUs, and sizable computer sciences master's and research effort
Oracle	<ul style="list-style-type: none"> Howard: Sizable and breadth of engineering and computer sciences degrees, and strong research intensity including computing and analytics Tennessee State: Strong computer sciences talent pipeline and publications activities, along with a strong women's STEM focus

LOOKING FORWARD—

STARTING THE DIALOGUE TO ADVANCE NATIONAL POLICIES AND PUBLIC-PRIVATE PARTNERSHIPS BUILDING ON THE COLLECTIVE STRENGTHS OF THE 15 ABET-ACCREDITED HBCU SCHOOLS OF ENGINEERING

The Biden Administration took office with a mandate for addressing racial inequality and inclusion. It is time now to think boldly on how to leverage the collective, collaborative strengths of The 15 HBCUs while focusing on how to enhance their multiple capacities to compete.

The 15 HBCUs represent a unique and proven asset with their focus on research and development and proven ability to meet well respected accreditation standards. These schools make enormous, outsized contributions to the generation of Black engineering, and overall STEM talent for our nation and collectively represent a significant base of research capabilities.

As a national treasure, these universities continue to be overlooked and slighted by being continuously asked to navigate a severely unlevel playing field, compared to their PWI Counterparts. They are doing more with less, and represent a national asset that offers a significant return on investment to fostering the open, collaborative, inclusive, and multidisciplinary thinking that our nation requires to stay competitive on the global stage.

CRITICAL IMPERATIVE TO BRING OPPORTUNITY TO TALENT AND LEARNING FROM PAST EXPERIENCE

Nicholas M. Donofrio, IBM Fellow Emeritus and Retired Executive Vice President of Innovation and Technology, and Executive Sponsor/Executive Mentor of this project, has challenged his peers at the National Academy of Engineering and across corporate America in the 50th Anniversary of the Flagship Quarterly of the Academy, it is time to “bring opportunity to talent and stop trying to move talent to opportunity.”

Biden’s Campaign Pledged Support for HBCUs Amid the National Reckoning with Systemic Racism

“One of the driving factors for [President] Biden doing that is recognizing that in order to meet the challenges of the moment, we need to be tapping in to the talent at our historically Black colleges and universities ...”

Inside Higher Ed, November 16, 2020



As Nicholas Donofrio explains:

“The pernicious, persistent effects of prejudice and privilege have unlevelled the playing field, channeling opportunity to collection points accessible to the few, not the many ... As a fledgling engineer at IBM, I witnessed first-hand the enormous potential in bringing opportunity to talent. In 1968, at the urging of Senator Robert F. Kennedy, IBM CEO Thomas J. Watson, Jr. literally moved opportunity to talent when IBM announced and opened its newest manufacturing plant in the [overwhelmingly Black and poor] Bedford-Stuyvesant section of Brooklyn. The ‘Brooklyn Plant’, as it was known, brought value to IBM and value and opportunity to a community that needed it.”²⁵

Only by further expanding The 15 HBCUs’ capacities in research, talent development and Pre-K-12 STEM outreach can we as a nation effectively bring opportunity to the millions of Black and other of color and White children being left behind through economic inequality and poverty. There is no quick fix beyond the hard work of advancing those HBCUs that have already taken the steps to fully contribute to our nation’s STEM needs through ABET accreditation and a notable focus on research and graduate education.

Keep in mind, The 15 HBCUs are not a club, but a core nucleus of universities among the HBCU community. In 1992, there were only nine HBCUs with Schools of Engineering with ABET-accredited engineering programs. In 2008, there were 12. And now in 2021, there are 15 HBCU Schools of Engineering with ABET-accredited engineering degree programs.

IDEAS FOR MOVING FORWARD

Our report, anchored in our data gathering and assessment, has enabled us to identify insights as to how to bring opportunity to talent and build upon the high value proposition of this special university community. Under the leadership and guidance of our Executive Sponsors a number of powerful opportunities were identified for future consideration.

Four forward-looking ideas embody the strategic approach being counseled by our project Executive Sponsors:

1. One forward-looking initiative would be to create a strategic, funding commitment over a multi-year period to sustain an impact on Black and Brown Pre-K-12 students to create an ongoing STEM-interested and STEM-ready pipeline of high school graduates.

Such an approach would ensure an ongoing high-performing stream of Black and Brown students who are STEM-ready when college eligible. It will have a directed intent to address the math, reading, and science disparity experienced by Black and Brown children in grades 4-5, when too many of our Black, Brown, and of color children tend to fall behind.

The specific geographic focus of the STEM Champion efforts recommended would be The 15 HBCU Territorial Network of nine states and the District of Columbia where The 15 HBCUs are located. This 15 HBCU Territorial Network is home to 40+% of America’s Black children.

²⁵ See Appendix for Full Article by Nicholas M. Donofrio, “Strengthen Innovation by Bringing Opportunity to Talent,” 50th Anniversary of National Academy of Engineering’s Flagship Quarterly Publication, *The Bridge*, 2020.

Strategic Approach Underlying this Report

Underlying the philosophy of our Report, as addressed by our Executive Sponsors and corporate sponsors, below are thoughts to guide future efforts.

Flowing from the influence of the theme “move opportunity to talent” is a companion theme of a “top down, and bottom up” approach. The “top” begins with the corporate partners down through the universities and “bottom up” begins with Pre-K-12 and up through college.

Our guiding principle: “Don’t go to an HBCU campus and ask for the best and brightest if you have not intentionally invested in the infrastructure and STEM talent pipeline to build a pathway for the best and brightest to our 21st Century workplace and marketplace. This is not about you! This is about America’s place in the global competitive marketplace, and this is the most opportune time to demonstrate parity and stand with dignity,” **Derek McGowan**

The unyielding strategic focus: “We have wasted time, squandered the lives of too many people, and hampered the competitiveness of our nation by moving talent to opportunity. Do not wait for talent to arrive at opportunity. We must move opportunity to talent, and must do so aggressively, like our survival depends upon it—and it may. Our pathway is clear. Move opportunity to talent through targeted investments in the infrastructure and pipeline.” **Nicholas M. Donofrio**

The assessment of our circumstances: “I have seen our national talent resources through the lens of a senior military leader and corporate board member. The diversity of people and talent are in our nation. Our failure to harvest and develop that talent is a disgrace and creates a competitive risk for our nation. Our airmen, marines, sailors and soldiers need leaders who look like them. Our laboratories and manufacturing floors need people who have benefitted from the educational system we have told the world we have, not for White people, but for all people. We can win on neither the military nor economic battlefield if we do not invest, from the beginning in our strongest inventory, our people. While I understand, value and respect our HBCU community, the focus of this project on our Pre-K-12 challenges is essential to the success of our nation. We cannot cherry-pick the best high school talent. We have to get involved at Pre-K and create an unending flow of talent...” **Admiral Mike Mullen, 17th Chair, Joint Chiefs of Staff**

2. A second forward-looking initiative would be to establish an Industry-Government-HBCU partnership to be a broad-based strategic approach to bringing opportunity to talent and building upon the high value proposition of this select group of universities.

This partnership would demonstrate that the collaborative impact of the research, talent, and Pre-K-12 STEM capacity of The 15 HBCUs is greater than the sum of the individual 15 HBCUs. Such an idea also strategically seeks to provoke The 15 HBCUs to establish a “community culture of collaboration” to effectively work together to harness their individual strengths. That “culture of collaboration” among The 15 HBCUs is also a means for enabling corporate and federal partners to more efficiently work with The 15 HBCUs. The purpose would be to support and enhance, not replace or diminish, ongoing efforts by The 15 HBCUs with corporations and federal partners.

Among proposed activities, such focus should consider:

- **Advancing Targeted Investments for a Wide Range of Capacity-Building Activities for Students and Faculty,** including experiential learning opportunities for students, summer work opportunities for faculty to understand evolving technologies, classroom opportunities for business subject matter experts to teach and interact with faculty and students, and real-time mentoring and networking.
- **Establishing an Equipment/Technical Sharing Platform** to level the playing field with PWIs who can tap their extensive alumni networks and existing corporate partnerships. This platform should include a clearinghouse of prime-condition equipment and supplies that may or may not be currently in use, as well as relevant patents, to be donated to The 15 HBCUs for use in research laboratories and classrooms, or for Pre-K-12 initiatives. The clearinghouse should offer information on opportunities for The 15 HBCUs to apply for equipment grants offered by Corporate America members to The 15 HBCUs. In addition, an Engineer-in-Residence Program should be considered to enable each of The 15 HBCUs to bring industry expertise directly to the campus to teach courses and collaborate on research at The 15 HBCUs to transfer knowledge, enhance product innovation, and establish deeper relationships between industry subject matter experts with faculty and their students.



- **Developing a PhD Pipeline to Increase the Pool of Black Professors and Deans**, which addresses a critical imperative if The 15 HBCUs are to reach their full potential in research activities and growing academic programs. It is important as well for Black undergraduate STEM students to have role models and professors who come from similar backgrounds and experiences – folks who look like them. Strategically, the growing base of PhD programs at The 15 HBCUs can be a feeder system into ensuring an increase in the number of Black professors. Corporate America can work with each of The 15 HBCUs to enhance efforts to get Black students into PhD tracks with scholarships, mentoring, and other support services. Graduate student research exchange programs can be established across the corporate community to provide opportunities for experiential learning and development of research projects with corporate research labs. For highly qualified PhD graduates, additional benefits can be provided by the corporate community for postdoctoral and entry-level faculty positions at The 15 HBCUs, including access to start-up research funding.

3. The third element of our vision is working with our federal government to define opportunities for their engagement to support the strategic value of The HBCUs.

Federal incentives for corporations to pursue these activities with The 15 HBCUs would help to further accelerate and deepen the base of corporate engagement. Similar to how our nation provides research and development incentives to companies, we also seek to support the range of innovation platform activities that will further enhance the research and development capacities at The 15 HBCUs. Additional

initiatives by the federal government that would enhance the capabilities of the Innovation Center include:

- **Creating an HBCU Enhanced Federal Research Contracting Platform.** This effort would complement all of the efforts by corporations to enhance the capacities at The 15 HBCUs including expanding the pool of Black professors and PhD pipelines, and ensuring student access to cutting-edge equipment and industry subject matter experts. Many of The 15 HBCUs do not have the organizational infrastructure required to manage contracts with federal agencies and corporations by offering timely processing and invoicing, and ensuring the full audited accounting systems for activities that are beyond traditional sponsored research grants. Some of The 15 HBCUs also struggle in having the in-depth research administration cores to identify, pursue, and manage these centers, as required for managing large funded center research grants.

One approach to tackling this infrastructure challenge might be to advance a federally-designated University Advanced Research Center (UARC) to serve all of the ABET-accredited HBCU Schools of Engineering. The value of a UARC-type model is that it would create the organizational capacity to contract with the DOD that can be leveraged for other federal agencies and corporations. Each of the nation's existing UARCs are structured as nonprofit organizations that offer core organizational capabilities for maintaining long-term strategic relationships with their DOD sponsors, and involve close collaboration with the educational and research resources available at their universities. The idea of creating a multi-univer-

sity collaboration is not unprecedented. The Systems Engineering Research Center (SERC) UARC, led by the Stevens Institute of Technology in New Jersey, represents a multi-university collaboration of now 22 universities and represents a networked national resource focused on meeting systems challenges of national and global significance through systems research.

- **Entrepreneurship, Innovation, and Commercialization Platform.** A core effort taking place across PWIs and some of The 15 HBCUs is attracting significant gifts from alumni and other sources to enrich student experiences in entrepreneurial thinking and commercialization of technology. Given the limited resources of HBCUs, this is often an area that is underfunded.

Federal involvement to advance such a platform is needed and with proper incentives can help attract complementary corporate involvement, such as the support of industry mentors or entrepreneurs-in-residence to work with student and faculty in more rapidly advancing commercialization goals. One example of an ongoing federal effort is the National Security Innovation Network to engage university students to serve their country through collaboration with the United States military to address real-world challenges that require both technical and entrepreneurial expertise. It offers a range of program activities such as Hacking for Defense Courses, acceleration activities, internships, and fellowships. Similarly, an enhanced federal effort around incentivizing Small Business Technology Transfer (STTR) programs across The 15 HBCUs could help partner students and faculty with emerging innovative small businesses working to commercialize technologies. Federal support can be dedicated to The 15 HBCUs for commercialization and entrepreneurial development effort as is done in Ohio through its statewide I-Corps@Ohio program developed to assist faculty, staff, and students from Ohio universities, colleges, and community colleges in validating the market potential of technologies and launching startup companies. Started in 2015, I-Corps@Ohio is modeled

after the National Science Foundation's (NSF) successful I-Corps (Innovation Corps) program, which has been proven to increase innovation, entrepreneurship, and industry collaboration.

4. A fourth forward-looking initiative is the recently launched STEM City by Career Communications Group.

STEM City USA is a digital community center designed to bring the resources needed for educational, health, and career success in one place. This new virtual community environment aims to close the digital divide that still plagues underserved communities today. STEM City USA combines the physical and digital worlds by creating unique Digital in the Moments (DIM). These DIMs are created with rich content that delivers an immersive experience where all lives collide and blend into a diverse digital community. Founded and powered by Career Communications Group (CCG), STEM City USA will build upon the successful best practices and proven content of the Black Engineer of the Year and Women of Color in Technology conferences, both of which operated in digital twin environments 2020-2021. Experts in creating DIM experiences for audiences, STEM City USA is designed to provide additional content surrounding health, training, mentoring, and lifestyle support.²⁶

These bold and ambitious forward-looking initiatives, set out in consultation with our project Executive Sponsors, are intended to open a dialogue among broader corporate and federal partners with The 15 HBCUs on effective mechanisms for change going forward. Our nation must embrace the high value proposition of The 15 HBCUs and address the challenge of overcoming a severely unlevel playing field compared to their PWI Counterparts. What is needed in this moment are transformative efforts that, in the words of Dr. Donofrio, "bring opportunities to talent."

²⁶ For more information on STEM City, see <https://www.youtube.com/watch?v=qwQpOPufywo>

APPENDIX –

**ARTICLE BY NICHOLAS M. DONOFRIO, “STRENGTHEN INNOVATION
BY BRINGING OPPORTUNITY TO TALENT,” 50TH ANNIVERSARY OF
NATIONAL ACADEMY OF ENGINEERING’S FLAGSHIP QUARTERLY
PUBLICATION, THE BRIDGE, 2020**

Strengthen Innovation and Inclusion by Bringing Opportunity to Talent



Nicholas Donofrio (NAE) is IBM fellow emeritus and retired executive vice president of innovation and technology.

Nicholas M. Donofrio

I have spent over 50 years as an engineer, technologist, and business leader committed to innovation. Innovation has been, is, and always will be the leading edge of economic, social, educational, and governmental success.

But we're holding innovation back. Not because, as conventional wisdom might suggest, we are failing to bring talent to bear on the challenges and opportunities before us. It's the opposite: We are failing to bring opportunity to talent. We must change that, now.

Experience has taught me that innovation is best defined by what it does, rather than what it is. Real and sustainable innovation

- starts by deeply understanding the problem, not by working backward from an answer;
- unlocks value by identifying opportunities and matching them with available skills and abilities; and
- relies on and welcomes everyone involved, not just a recognized "inventor" or "discoverer."

And innovation doesn't just "happen." It is enabled by environments and organizations that foster open, collaborative, inclusive, multidisciplinary thinking and working. Time and again, I have been reminded that the more open and inclusive the team, the more successful it is—because nobody

knows in advance which team member is going to supply a critical piece of the value puzzle.

As an engineer, I learned long ago that nature for the most part abhors gradients, concentration spaces, and vacuums, empty spaces. Nature tends to smooth things out as evenly as possible, to create equilibrium. Throughout my career, I have seen that ability is spread across all populations and geographies without regard to categories like gender, race, sexual orientation, ethnicity, or nationality. Talent abounds everywhere.

Opportunity, sadly, does not. The pernicious, persistent effects of prejudice and privilege have unlevelled the playing field, channeling opportunity to collection points accessible to the few, not the many. The civil rights movement and the civil unrest of the late 1960s brought this home for me as I was entering the workforce. As a fledgling engineer at IBM, I witnessed firsthand the enormous potential in bringing opportunity to talent.

In 1968, at the urging of Senator Robert F. Kennedy, IBM CEO Thomas J. Watson Jr. literally moved opportunity to talent when IBM announced and opened its newest manufacturing plant in the Bedford-Stuyvesant section of Brooklyn. The “Brooklyn Plant,” as it was known, brought value to IBM and value and opportunity to a community that needed it. While this simple but bold move was not perfect in everything it set out to do, it did succeed in bringing opportunity to talent.

Others have learned from and improved on IBM’s experience. For example, the 2017 NAE report *Engineering Technology Education in the United States* cites BMW’s plant in Spartanburg, SC as another successful example of moving opportunity to talent.

Wise engineering judgment—indeed, good judgment in general—is always informed by history and experience. But over time it has proven to be the exception instead of the rule. Too often, in all fields of endeavor, leaders try to spur innovation only by bringing talent

to opportunity. Why do we keep doing what we are doing hoping for different results? Why do we keep trying to move talent to opportunity instead of opportunity to talent?

The confluence of the coronavirus pandemic and George Floyd’s murder and its worldwide aftermath brings home, painfully and urgently, the vital imperative to bring opportunity to talent to foster social, economic, and technological innovation at every level.

During the pandemic’s widespread lockdowns and quarantines, the abrupt shift in where and how people work and learn has shown the power of technology: It’s no longer a matter of physical or virtual interactions; they’re now both points on the continuum of how people connect, learn, and work.

The outcry and awakening around social justice show how badly we lost our collective way after the progress of the civil rights movement—but also the incredible energy ready to remake and recreate our world. The only viable alternative is to lean into and build on this momentum to undo privilege and prejudice and strive harder for equality.

The unprecedented traumas and challenges of this historic time offer an opportunity like no other to welcome and embrace the potential in everyone to innovate. The options for everyone will be so much richer if we work to reblend our lives to be more thoughtful, meaningful, and inclusive. By committing and acting to bring opportunity to talent across all fields of endeavor, we will start a wave of social innovation that will serve the betterment of all.

It is time to spread opportunity as evenly as talent, and technology and industry can help us get there. Everyone must have the opportunity to be engaged, welcomed, and nurtured to be their best so that they can do their best and both contribute to and reap the rewards of innovation.

