2020 Conference on

Increasing Participation

of Minority-serving Institutions in NSF CISE Core Programs

Meeting Report

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AMERICAN SOCIETY FOR ENGINEERING EDUCATION

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2020 Conference on Increasing Participation of Minority-serving Institution in NSF CISE Core Programs: Meeting Report

American Society for Engineering Education
1818 N Street NW, Suite 600
Washington, DC 20036
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Meeting Report

September 2020

ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

Washington, D.C.

www.asee.org

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The conference attendees, a list of whom can be found in Appendix B, provided the substance on which this publication is built.

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Executive Summary

Minority-serving Institutions (MSIs) enroll close to 5 million students—almost 30 percent of all undergraduate students enrolled in U.S. colleges and universities—across more than 700 institutions (National Academies of Sciences, Engineering, and Medicine, 2019). Serving high proportions of nontraditional students and students of color, MSIs increase workforce readiness and contribute to increased representation of underserved groups in post-baccalaureate pathways (Penn Center for Minority Serving Institutions, 2014). Combined, Historically Black Colleges and Universities (HBCUs), Hispanic-serving Institutions (HSIs), and Asian American and Native American Pacific Islander-serving Institutions (AANAPISIs) yield one-fifth of U.S. science, technology, engineering, and mathematics (STEM) bachelor's degrees (National Academies of Sciences, Engineering, and Medicine, 2019). Despite growing evidence to suggest that "MSIs are valuable resources for producing talent to fulfill the needs of the nation's current and future STEM workforce…their contributions to STEM education and the workforce are often overlooked" (National Academies of Sciences, Engineering, and Medicine, 2019, p. 2).

Held in Arlington, Va., from February 3 to 5, 2020, the 2020 Conference on Increasing Participation of MSIs in National Science Foundation (NSF) Computer and Information Science and Engineering (CISE) Core Programs brought together more than 90 MSI science, computing, and engineering faculty and researchers with the goal of increasing the number and competitiveness of MSI researchers' proposals to proposals to CISE core programs.

The conference featured plenary sessions led by veteran MSI researchers and NSF representatives, who provided insights on CISE research opportunities, past MSI workshops, building successful partnerships, positioning institutions for success, and more. Breakout sessions facilitated conversations between attendees and NSF representatives, of whom there were more than 35 in attendance, offering valuable face time with NSF program officers and directors as well as opportunities to contribute recommendations on how NSF can better support MSI researchers. Networking opportunities provided pathways to build connections and collaborations with other MSI researchers in attendance.

Conference discussions highlighted several common research constraints among MSIs that hinder the ability of their faculty to effectively apply and compete for research opportunities: heavy teaching loads and low salaries; a lack of financial, institutional, and infrastructural support for research; and the shared sentiment among MSI faculty that there are limited rewards for pursuing research opportunities. A wealth of recommendations emerged for future conferences, MSIs, and NSF.

Recommendations for future conferences included:

- A session or workshop on best practices for proposal preparation;
- Increased opportunities for formal and informal networking;
- Additional pre-conference training for breakout session facilitators; and
- A session focused on NSF's broader impacts criterion.

Recommendations for MSIs included:

- Recognizing the value of collaborations and partnerships;
- Being more proactive in prioritizing research activities at home institutions; and
- Taking advantage of the numerous ways that MSI researchers can build rapport with NSF.

Recommendations for NSF included:

- Increasing training and professional development opportunities for MSI researchers and students;
- Offering increased support to help MSIs build collaborations and partnerships;
- Investing in efforts to make review panels more inclusive; and
- Cultivating mentors and champions for MSI researchers.

Introduction

Background

Minority-serving Institutions (MSIs) play a critical role in the U.S. economy and represent a diverse group of institutions in America's higher education landscape. The National Academies of Science, Engineering, and Medicine (2019) report that there are more than 700 MSIs in the United States, enrolling close to 5 million students—almost 30 percent of all undergraduates enrolled in U.S. colleges and universities. MSIs are diverse in their institutional characteristics, histories, and missions (Cunningham, et al., 2014). Serving high proportions of nontraditional students and students of color, MSIs increase workforce readiness and contribute to increased representation of these underserved groups in post-baccalaureate pathways (Rutgers Center for Minority Serving Institutions, 2014). There are seven types of MSIs, as designated by the U.S. Department of Education, detailed in Table 1.

Table 1. Historically defined and enrollment-defined** MSIs (adapted from Espinosa, et al., 2018).*

MSI TYPE	ACRONYM	FEDERAL DEFINITION
Historically Black Colleges and Universities*	HBCU	Any college or university established prior to 1964 whose principal mission was, and is, the education of Black Americans.
Tribal Colleges and Universities*	TCU	Institutions chartered by their respective Indian tribes through their sovereign authority or by the federal government with the specific purpose of providing higher education opportunities to Native Americans through programs that are locally and culturally based, holistic, and supportive.
Hispanic-serving Institutions**	HSI	Institutions where Hispanic students make up 25 percent or more of total undergraduate full-time-equivalent enrollment.
Alaska Native- and Native Hawaiian-serving Institutions**	ANNH	Alaska Native-serving Institutions are institutions that have at least 20 percent Alaska Native students. Native Hawaiian-serving Institutions are institutions that have at least 10 percent Native Hawaiian students. Collectively, these institutions are referred to as ANNH institutions.
Asian American and Native American Pacific Islander-serving Institutions**	AANAPISI	Institutions that have at least 10 percent enrollment of Asian American and Native American Pacific Islander students.
Predominantly Black Institutions**	PBI	Institutions that serve at least 1,000 undergraduate students; have at least 50 percent low-income or first-generation college-degree-seeking undergraduate enrollment; have low expenditure per full-time undergraduate compared with other institutions offering similar instruction; and enroll at least 40 percent African American students.
Native American-serving, Nontribal Institutions**	NASNTI	Institutions that have at least 10 percent enrollment of Native American students.

MSIs and the Future STEM Workforce

Combined, Historically Black Colleges and Universities (HBCUs), Hispanic Serving Institutions (HSIs), and Asian American and Native American Pacific Islander-Serving Institutions (AANAPISIs) yield one-fifth of U.S. science, technology, engineering, and math (STEM) bachelor's degrees (National Academies of Sciences, Engineering, and Medicine, 2019). In 2016, science and engineering fields accounted for about 30 percent of the bachelor's degrees that Black students earned at HBCUs and one-third of the bachelor's degrees that Hispanic students earned at HSIs. Beyond the undergraduate level, MSIs play a vital role in preparing students from underserved groups for doctoral-level studies in science and engineering. Between 2013 and 2017, about one quarter of Black science and engineering doctoral recipients earned their bachelor's degree from an HBCU; in the same timeframe, close to 40 percent of Hispanic science and engineering doctoral recipients earned their bachelor's degree from an HSI (Trapani & Hale, 2019). Despite growing evidence "suggest[ing] that MSIs are valuable resources for producing talent to fulfill the needs of the nation's current and future STEM workforce…their contributions to STEM education and the workforce are often overlooked" (National Academies of Sciences, Engineering, and Medicine, 2019, p. 2).

Limited Resources, Limited Research

The multifaceted returns on investment form MSIs, such as improving the upward social mobility of their students; expanding the talent pool for the STEM workforce; and supporting the prosperity of local, regional, and national economies (National Academies of Sciences, Engineering, and Medicine, 2019), justify public funding which they receive from the Higher Education Act via competitive or formula-based grants (Boland, 2018). However, for many MSIs this is currently insufficient to meet their needs. A 2011 Congressional Research Service report that focused on federal research and development funding at HBCUs provided examples of some specific challenges that HBCUs face in terms of limited resources, citing aging infrastructure, low salaries, limited access to state-of-the-art equipment and technology, limited faculty development funds, and meager endowments.

Due to scarce financial resources, a significant number of MSIs lack sufficient infrastructure and capacity to conduct research and effectively compete for private and public research funds. In 2015, HBCUs, HSIs, and TCUs received approximately 2.5 percent of the $30.5 billion allocated by the top six federal agencies funding STEM programming at higher education institutions (including NSF) to support science and engineering research, education, and infrastructure (National Academies of Science, Engineering, and Medicine, 2019)."

Advancing a More Diverse STEM Workforce

In February 2018, NSF published their strategic plan for Fiscal Years (FY) 2018 – 2022, which included the goal to foster the growth of a more capable and diverse research workforce and advance the scientific and innovation skills of the nation. At the same time, "our nation faces a demographic reality that signifies an essential need to increase racial and ethnic representation in a broad array of engineering programs in higher education institutions" (Anderson et. al, 2018, p. 1).

The National Academies of Sciences, Engineering, and Medicine (2019) refer to MSIs as "America's underutilized resource for strengthening the STEM workforce." How can these valuable institutions overcome their shared challenges of financial constraints, limited institutional capacity, and often inadequate research infrastructure to effectively compete for research opportunities and reach their full potential for contributing to the future STEM workforce?

The answer is not so simple. Although the overall number of engineering degree recipients from underserved student populations increased from 2011 to 2016, particularly among Black and Hispanic student populations, these increases are "not enough to close the gap in nearly every state between the share of engineering degrees and their representation in the college-age population of the state" (Anderson et. al, 2018, p. 94). Increasing diversity in engineering is no longer solely a question of equity, but a broader question of "economic vitality and national security" (p. 94). MSIs have the potential to greatly impact diversity in engineering, but doing so will require work. MSIs should work to develop programs, policies, and practices that encourage underserved student populations to persist in engineering, while also "examin[ing] the educational pathways for racial and ethnic students of color in engineering programs" (p. 1). As the 2019 National Academies report notes, "substantial resources are needed to help promote, sustain, and

advance the success of MSIs and their students" (p. 6). Advancing MSI success and research capacity will require a dedicated commitment from both internal stakeholders, such as MSI leaders and administrators, and external stakeholders, including non-MSI colleges and universities, public and private sector organizations, and public and private funding agencies.

Speaking specifically to public and private funding agencies, including NSF, the National Academies (2019) recommended the following:

1. Public and private funding agencies should continue to develop and expand grant competition programs that serve the nation's MSIs.
2. Given the institutional resources required to effectively compete for large grants and contracts, public and private funding agencies should reconsider the practicality of current competitive funding models for under-resourced MSIs.
3. Public and private funding agencies should issue new and expand current grant opportunities to support evidence-based research on MSIs, their students, and the socio-behavioral and sociocultural factors and conditions that impact the efficacy of programmatic interventions at these institutions (p. 9 – 10).

In support of these recommendations and NSF's strategic goal to foster the growth of a more capable and diverse research workforce and advance the scientific and innovation skills of the nation, the NSF CISE Directorate and the American Society for Engineering Education (ASEE) organized the 2020 Conference on Increasing Participation of MSIs in NSF CISE Core Programs, with the overarching goal of increasing the number and competitiveness of MSI proposals to CISE core programs.

About the Conference

On February 3 – 5, 2020, in Arlington, Va., the NSF CISE Directorate and ASEE hosted the 2020 Conference on Increasing Participation of MSIs in NSF CISE Core Programs with the goal of increasing the number and competitiveness of MSIs' proposals to CISE core programs. To that end, the two specific outcomes of the conference were to 1) increase awareness about NSF CISE core programs among attendees, and 2) determine a framework for more constructive engagement of MSIs in NSF CISE core programs. See Appendix A for more details about CISE core programs.

The conference brought together more than 90 MSI science, computing, and engineering faculty and researchers representing Historically Black Colleges and Universities (HBCUs), Hispanic-serving Institutions (HSIs), Tribal Colleges and Universities (TCUs), Native American Serving Non-Tribal Institutions (NASNTIs), and Asian American- and Native American Pacific Islander-serving Institutions (AANAPISIs), along with more than 35 NSF representatives. Appendix B provides a full list of attendees.

The 2020 MSI CISE Conference was comprised of plenary sessions, breakout group discussions, and numerous opportunities for networking with fellow MSI researchers and NSF representatives, providing opportunities for attendees to learn about CISE core programs, opening pathways for greater MSI engagement in CISE activities, and fostering collaborations to build MSI research capacity and increase the number and competitiveness of their CISE proposals. See Appendix C for the full conference agenda.

One Giant Multi-Dimensional Venn Diagram—Opportunities for MSIs Within CISE

Opening Remarks

Margaret Martonosi
Assistant Director
NSF CISE Directorate

While CISE is often identified with computer science, Martonosi noted that its purview also includes electrical engineering and data science. Other important current topics for CISE include industries of the future (e.g., artificial intelligence (AI), advanced manufacturing, quantum information sciences, and advanced wireless systems), cybersecurity, and computer science education. Furthermore, as a number of NSF's cross-cutting 10 Big Ideas—which NSF plans to fund at $30 million per Big Idea, per year, with four- or five-year grants each—overlap to some degree with CISE, the Big Ideas stand to offer additional opportunities for MSI researchers. Martonosi encouraged attendees to look up the 10 Big Ideas and find those that would be a good match for them and their colleagues. Martonosi also mentioned several NSF programs, including the Research Experiences for Undergraduates (REU) and NSF CAREER awards, which support early career faculty with a mix of research and education in their proposals. These grants are especially helpful for faculty whose schools can't afford large start-up packages.

Looking toward the future, Martonosi noted that CISE wants to increase its number of Graduate Fellows and added that CISE would love to see better representation of its topics in Engineering Research Centers (ERCs) and Science and Technology Centers (STCs). She encouraged attendees to apply to join NSF as rotators and, when asked about offering assistance to financially struggling students, said that the community needs to consider how it can improve support so as to increase the number of students going into computing research, adding that this is a particularly tough problem because "we don't in many cases even know what challenges they're facing."

CISE and Its Core Opportunities

David Corman
Program Director
CISE Computer Network Systems (CNS) Division

Sylvia Spengler
Program Director
CISE Information and Intelligent Systems (IIS) Division

Corman introduced CNS's two core programs: Computer Systems Research (CSR) and Networking Technology and Systems (NeTS). The CSR program supports research leading to next-generation high-performance, heterogeneous, power-efficient, environmentally sustainable, and secure computer systems. The scope of the program includes embedded and multicore systems and accelerators; mobile and extensible distributed systems; cloud and data-intensive processing systems; and memory, storage, and file systems. The program seeks innovative research proposals that will advance the reliability, performance, power, security and privacy, scalability, and sustainability of computer systems. CNS has partnered with various companies, including Intel and VMware, to work on real-world challenges. Results of the research enter the public domain. The division has also collaborated with entities in Finland and Japan.

CNS takes a systemwide perspective, evident in multidisciplinary programs like Cyber-Physical Systems (CPS) and Smart and Connected Communities (S&CC). CPS, with approximately 400 awards, has core research areas that can be applied across multiple applications. S&CC has grown substantially, from $22 million in FY

> ***"CISE is one giant multi-dimensional Venn diagram [in which] every piece of every core has lots of overlap."***
>
> **– Sylvia Spengler**
> Program Director
> *CISE IIS Division*

2019 to $40 million in FY 2020, and looks at autonomy, control, and human interaction with systems that include transportation, health, and infrastructure in urban and rural communities. Secure and Trustworthy Cyberspace (SaTC), CNS's largest non-hardware program with 924 active awards, looks at cybersecurity and privacy from sociological and technical standpoints. CNS's Industry-University Cooperative Research Centers (IUCRCs) are partnerships among government, universities, and industry.

Spengler broke down the IIS Division into three clusters: 1) robust intelligence, which is divided into six individual topics; 2) cyber-human systems; and 3) information integration and informatics. She noted that "CISE is one giant multidimensional Venn diagram [in which] every piece of every core has lots of overlap."

Spengler emphasized that it's important for researchers to be proactive, contacting program officers and sending summaries of ideas to make sure they reach the program with the right reviewers to give them the best chance of being funded. She further suggested that researchers volunteer as reviewers, adding that "every program officer [she knows] would drool to have you on their panels."

Corman stressed that what mattered to him was whether reviewers found a proposal to be competitive or highly competitive. By serving on a panel and learning what makes a successful proposal, Corman stated, "I would almost guarantee that your individual opportunity rate is going to go up." He went on to explain the value of planning grants. These awards of about $150,000 enable researchers to build up a team, learn about the program, and prepare a better proposal. Spengler noted that success rates vary between programs, although "the core is generally somewhere around 20 percent." (Appendix A provides more details about CISE core programs).

> *"It's important for researchers to be proactive, contacting program officers and sending summaries of ideas [... and to] volunteer as reviewers."*
>
> **– Sylvia Spengler**
> Program Director
> *CISE IIS Division*

Recommendations from Previous MSI Workshops

Ann Q. Gates
Executive Director
Computing Alliance of Hispanic-Serving Institution (CAHSI)
Director
Cyber-ShARE Center of Excellence
Professor and Vice Provost
University of Texas at El Paso

Jean Muhammad
Chair of Computer Science
Hampton University

Sarah EchoHawk
CEO
American Indian Science and Engineering Society

Hispanic Serving Institutions (HSIs) Workshop Insights

Ann Q. Gates reported on five detailed recommendations that emerged from a CAHSI community workshop on building CISE research capacity. CAHSI is one of eight alliances funded by the NSF INCLUDES program and the only one exclusively serving computing and Hispanics. The CAHSI workshop in question drew researchers from 18 HSIs and one nonprofit organization. The following recommendations emerged from the workshop, focused on how to increase the representation of Hispanics and HSIs in the CISE Directorate's portfolio.

1. **Provide planning grant opportunities for large programs to provide sufficient time for R1 (research intensive) institutions and MSIs to cultivate relationships and develop proposals.** Seed money would support building interdisciplinary teams and funding could free up faculty who have high teaching loads and cannot get release time.
2. **Reinstate the NSF Minority Institutions Infrastructure (MII) program.** Many HSIs lack the infrastructure needed to build research capacity and to develop and manage strong proposals. The MII program provided substantial funding and was flexible and broad in its scope of work.
3. **Enhance program officer and reviewer training efforts related to institutional context and implicit bias.** Reviewers from predominantly white institutions (PWIs) with intense research participation often have expectations regarding those who could be successful at research and

the conditions of the research setting. An NSF staff member with expertise in implicit bias should provide oversight and ensure that the panels do not exert bias in their decision making and that comments that may reflect implicit bias are challenged. In proposals involving partnerships between R1s and HSIs, the relationship between the institutions should be articulated with indicators of authentic partnerships, including the HSI budget allocation, research plans, and meaningful collaborative activities.

4. **On resubmission of proposals that were not funded, PIs should be able to explain how they addressed specific problems found in the initial proposal.** CAHSI workshop participants also requested specialized RFP tracks, such as an RFP focused on hiring Hispanic undergraduate and graduate students and providing research travel money to attend conferences.

5. **With many institutions now being labeled HSIs, they should be differentiated based on their proportion of Hispanic students and whether they are Tier 1 or Ph.D. granting.** Institutions should also be accountable not just for enrolling Hispanics but also how these students are served.

Historically Black Colleges and Universities (HBCUs) Workshop Insights

Jean Muhammad described two workshops involving 28 HBCU faculty and administrators that highlighted both shared problems and diversity among HBCUs. One of the topics discussed during these workshops was how these schools could collaborate on research proposals rather than being brought in "under" a PWI.

At the first workshop, attendees broke into six interest groups and came up with six abstracts of projects that HBCUs could work on together. The second workshop produced solid proposal drafts and a plan to complete them in 30 to 45 days. While all schools shared the burden of heavy teaching loads, collectively they overcame the hurdles. Larger HBCUs showed examples of their own grants that smaller schools could follow as a model, and experienced grant-writers shared lessons learned. HBCU faculty then broke into working groups to plan their future collaborations.

Tribal Colleges and Universities (TCUs) Workshop Insights

Sarah EchoHawk described a September 2019 workshop for TCU researchers that was developed with the following goals: 1) understand the barriers and challenges to conducting computer science research and securing funding across different types of institutions—Native-serving institutions and tribal colleges and universities; 2) identify collaborations, connect institutions and faculty to existing resources, and identify best practices and opportunities; and 3) develop an action plan to address critical issues impeding computer science research.

Attendees identified a need to mainstream the process for how four-year institutions collaborate with two-year institutions and tribal colleges to successfully conduct computer science research, engaging Native students in communities. They also felt a need to engage in interdisciplinary research, including computer science. Four-year institutions were most interested in understanding how to recruit and retain Native students in computer science courses and research. Two-year colleges and tribal colleges and universities cited a lack of institutional support for grant writing and conducting research. Two-year and tribal college faculty were also unfamiliar with developing and conducting the projects. Attendees called for effective collaborations between two- and four-year institutions, building a pathway and strengthening the preparation of Native students to advance beyond a two-year college.

Moving Forward with the Lessons of the Minority Institution Infrastructure (MII) Program

Malek Adjouadi
Professor and Director,
Center for Advanced Technology and Education,
Florida International University

Rita Rodriguez
Program Director
CISE Computer and Network Systems (CNS) Division

Anne-Marie Nuñez
Professor, Educational Studies
The Ohio State University (Moderator)

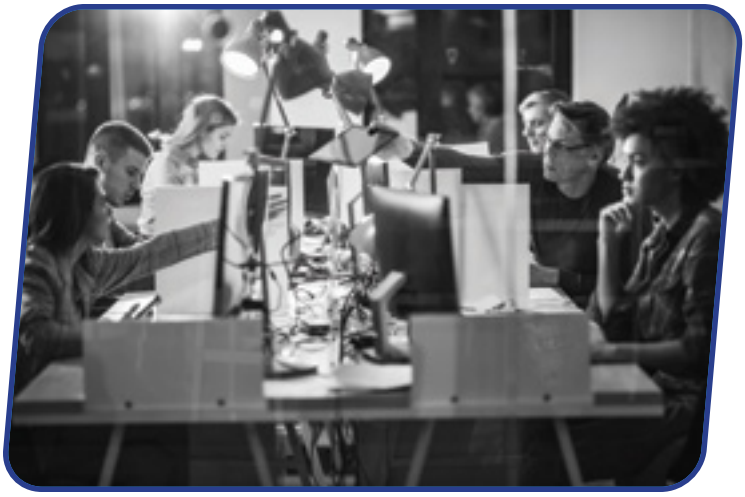
Adjouadi recalled the MII program, which he said supported most of the MSIs represented at the 2020 MSI CISE Conference. Rodriguez was a program director at NSF when Adjouadi, then an assistant professor at Florida International University, received a fiscal 1996 MII grant for graduate students to continue their research with the Center for Advanced Technology and Education (NSF-CATE), serving a strong graduate minority population. The research included real-time applications of computer vision, neural networks, and multidimensional and multispectral signal analysis and modeling. Adjouadi led an MII workshop that drew representatives from 43 institutions, including MSIs and PWIs.

Through a planning grant, Adjouadi explained, "I had the opportunity to visit MIT, Duke, Carnegie Mellon, to find out what was going on in those institutions and what kind of things that relate to my work that I could do to help my institution." MII supported the infrastructure that in turn supported Ph.D. students and "made us publish, and that made us competitive eventually when writing grants." It also served as a bridge to bigger programs, like Major Research Instrumentation (MRI) and the Centers of Research Excellence in Science and Technology (CREST).

Rodriguez voiced support for an MII program revival but would want to see how it is formed. "I really don't think it helps us very much just to work amongst ourselves… we need to collaborate." She suggested that MSIs be ambitious in seeking collaborators among established research universities. She would send advanced graduate students to European labs, which are ahead of the United States in brain research. A past program required partnerships between majority- and minority-serving universities, which encouraged relationships that otherwise wouldn't have formed.

Nuñez is working with CAHSI to investigate organizational culture that supports student success initiatives at HSIs. She asked Adjouadi what factors helped him work across institutions and how he would advise universities to support that. Adjouadi noted the struggle among female Hispanic faculty to achieve tenure. Young faculty members can be helped by creating conditions that allow them to pursue research. These include release time from heavy teaching loads and encouragement for them to collaborate with major researchers on a subcontractor or co-PI basis. NSF could require partnerships as a condition of awarding certain grants. Faculty, when weighing whether to grant tenure, should look at "how much that assistant professor is collaborating with industry, hospitals, other institutions. And then look at how much they got [in] funding. Whether they're PI or co-PI should not matter. And that's how collaborations can be built without 'what's in it for me, what's in it for you?'"

> *"I really don't think it helps us very much just to work amongst ourselves…we need to collaborate [with other institutions]."*
>
> **– Rita Rodriguez**
> Program Director, CISE IIS Division



How Can NSF Support MSI CISE Proposals?

Conference attendees participated in a structured breakout group discussion to respond to the following prompt: What can NSF do to increase the number and competitiveness of CISE proposals from MSIs? There were four breakout groups in total, each with a narrowed discussion topic:

1. Recommended Changes to the NSF Proposal Review Process
2. Recommendations for Programmatic Investments that NSF Should Make
3. Recommendations for Investments that NSF Should Make in Students and Young Faculty
4. Recommendations for Investments that NSF Should Make in Cultivating Internal-to-NSF Mentors and Champions

The following are recommendations recorded during the four breakout group discussions. Major themes that emerged include: the need for increased diversity in review panels; increased mentorship and training opportunities for MSI faculty; more financial and career support for both MSI faculty and students; and stronger collaboration structures for MSIs and partner institutions.

Recommended Changes to the NSF Proposal Review Process

A group of faculty administrators urged NSF to consider altering the structure of panels, using rubrics designed to level the playing field on how the panels are run and how proposals are scored. This should be done with an understanding of MSIs. They also recommended implicit bias training, with program officers making sure that panelists receive it. Such training would be beneficial to encourage a shift in attitude among reviewers toward finding reasons to fund, rather than to not fund, a project. When panels disagree on the value of a proposal, the group suggested arbitration using an outside expert. One suggestion for diversifying panels would be for NSF to create a system to recommend panelists outside a network of established scientists whom program officers regularly encounter. It's also incumbent upon the research community to introduce diverse panelists to program officers.

At universities lacking many experienced awardees, there may also be a need for help in setting up multi-layered reviews for purposes of feedback before proposals are submitted. This could take the form of review experts that could help make proposals more competitive.

Recommendations for Programmatic Investments NSF Should Make

This group offered several recommendations related to training, communications, and publicity. Related to training, the group urged funding for mentorship opportunities to foster and maintain relationships for MSI faculty with experienced PIs at other MSIs; sponsored program officer training at MSIs; training about how to find and contact your program officer and what's needed to ensure a response; help for those transitioning from an R1 graduate school to a career at a less resource-rich MSI; and training for review panelists to understand that successful research can be conducted without doctoral students—that is, in a less resource-rich environment. With respect to communications and publicity, the group said that attendees were unaware of NSF support in such areas as how to apply for and attend virtual and local trainings for proposal-writing workshops, how to be a panelist, how to get started with research without getting a full award, and MSI success rates and awards.

Recommendations for Investments NSF Should Make in Students and Young Faculty

This breakout group urged efforts to ease the teaching load on young MSI faculty to allow for more research time. It was suggested that money could be provided to bring in additional faculty to relieve existing instructors. Mentorship of MSI faculty by experienced awardees at other institutions could be considered a form of collaboration. Travel money would enable faculty to attend conferences and network with program officers. Ph.D.-granting institutions could build relationships with undergraduates at smaller MSIs to encourage the pursuit of graduate study and ease the students' transition to graduate-level research, thereby giving them a sense of belonging. The Cal-Bridge Program was cited as a model.

Support was also suggested for students working at national labs to gain experience while pursuing a Ph.D. Tuition support was suggested for undergraduates or community college students so they can complete their degrees and move to the next level. Schools with ample facilities and infrastructure, like high-performance computers, should be encouraged to open those

resources to researchers from smaller schools. A cohort of support for students at tribal community colleges is needed when they transfer to four-year schools and experience culture shock. "So, when they go to the four-year [school], they have somebody to work with… to talk to." Often students have to leave their own institution to participate in the Research Experiences for Undergraduates (REU) program. Could an effort be made for a fulfilling REU at the school a student attends?

The subject of making review panels more inclusive was raised by this group as well. How can someone who wants to be on a panel put his or her name in for consideration?

Recommendations for Investments NSF Should Make in Cultivating Internal-to-NSF Mentors and Champions

While mentorship of MSI faculty by successful PIs is important, "there needs to be more infrastructure around collaboration" between R1s and non-R1s. Mentors should understand the tenure models and different measures of success for individuals at smaller institutions. MSI faculty also need to understand how to negotiate both the budget and the research collaborations between R1s and non-R1s so as to make it a genuine collaboration, "as opposed to a superficial add-on" to demonstrate 'broader impacts'. NSF should more rigorously define the collaboration structure for MSI and partner institutions.

On mentoring, rather than just a vertical mentor-mentee relationship, there should be more horizontal structures, such as peer forums—a "bouncing board"—that can help assess which NSF programs offer the best fit for a researcher's proposal. To create more awareness of funding opportunities, bulletins could be tailored to particular types of institutions, like community or two-year colleges. A train-the-trainer program could send MSI faculty to learn from successful grantees—such as CAREER award recipients—and then return to their home institution with the "tacit knowledge" of how NSF runs.

The question was raised as to whether rotator positions seem to go to faculty from R1s, effectively depriving non-R1s of access to the special insights that rotators gain. NSF should bring in people trained in language appropriate for MSIs to clarify solicitations for the different proposals, and to more rigorously define the collaboration structure for MSI and partner institutions.

Building Successful Partnerships

S. Keith Hargrove
Dean of Engineering
Tennessee State University

With experience as a student, researcher, instructor, and administrator at HBCUs and flagship public institutions, Hargrove offered a broad perspective on how MSIs can bolster their research portfolios. He noted that, unlike at an R1, where an entire team prepares a proposal, an MSI researcher must be budget manager, proposal writer, and the one who communicates with NSF. After taking a position at Tuskegee University and seeing two proposals rejected, he reached out to the University of Michigan, where he became part of an ERC based there and learned how to write proposals. "After that, things just kind of worked out while I was at Tuskegee."

"You've got to be strategic in your relationship with NSF," Hargrove told attendees, urging them not to work in isolation. Researchers, he underscored, need mentors and advocates in the school's administration. Hargrove noted a correlation between NSF's 10 Big Ideas and NAE's 14 Grand Challenges of Engineering—"where the funding is." His school, Tennessee State University, selects topics among those that align with faculty strengths and also takes them into account in hiring junior faculty.

As dean of engineering, he has found that half of his faculty have no interest in performing research. For those who do, he tries to arrange release time from teaching, arguing that research aids college growth and brings in overhead money. Some of his younger faculty have benefitted from "cohort funding," such as HBCU-Up. MSIs should also pursue S-STEM (NSF Scholarships in Science, Technology, Engineering, and Mathematics Program) grants, which support undergraduate and graduate students as well as institutions. Hargrove recommended sending young faculty, graduate students, and Ph.D. students to work at national and defense laboratories, including Oak Ridge, Los Alamos, and the Naval Surface Warfare Center.

Industry partnerships, such as with aerospace giants Boeing or Lockheed Martin, represent an excellent strategy to leverage NSF funding. Much can be learned from partnering with R1 institutions, but as Hargrove warned, "be careful what you share." Every MSI adds contributory value to an R1 proposal. And if the grant is awarded, don't let the PI make your institution "invisible"—not given an appropriate role and recognition. "Contact your program manager, director, immediately,

because you should make that institution accountable," he cautioned. MSIs should also make sure their input is reflected in the project report filed by the lead institution.

Hargrove stressed the importance of seeking expert help from the school's administration on processing grants. In schools where administrative staff is spread thin, "that's a tough ask." With an eye to new initiatives that may increase outside funding, he is now seeking seed money to establish centers in biomedical engineering, data sciences, and advanced materials. For faculty development, he urges NSF to look at supporting nonprofit organizations like the National GEM (Graduate Education for Minorities) Consortium.

Hargrove recommended that MSIs planning to submit a proposal should consider enlisting a prestigious university or a national lab as a partner. Depending on the circumstances, this can enhance the credibility of the whole grant, adding, "sometimes you have to make some compromises." He has had successful partnerships with the University of Michigan and Georgia Tech. In both cases, he formed relationships with people who believed in the mission of MSIs. His own experience of working at General Electric and Boeing helped establish relationships at those companies.

Asked by an attendee how he obtained an S-STEM grant, Hargrove responded that even though he and an associate dean studied up on the program by serving on review panels, their first two proposals were rejected. Then he and a colleague went to see the program director and got the kind of deep feedback that enabled them to succeed on the third try. "Sometimes the reviewers don't believe that a great idea could happen at a certain type of school" or that the applicant can get it accomplished. "I think that in itself is problematic and a challenge."

What Do MSI CISE PIs Wish They'd Known Before Starting Their CISE Core Award?

Kinnis Gosha
Hortenius I. Chenault Endowed Associate Professor, Department of Computer Science
Morehouse College

Lydia Tapia
Assistant Professor, Department of Computer Science
University of New Mexico

Gloria Washington
Assistant Professor, Department of Computer Science
Howard University

Edward Dillon
Assistant Professor, Department of Computer Science
Morgan State University (Moderator)

Go or No-Go: Deciding Whether or Not to Pursue an NSF Solicitation

How do you make go or no-go decisions on pursuing an NSF solicitation and how can you tell if an opportunity is a good fit for you and your institution?

Gosha urged attendees to think through who they're going to be competing with. If you're not collaborating with strong co-PIs, it makes it a lot harder to go after the bigger awards. He referenced a recent proposal for an AI Institute that he submitted alongside Georgia Tech and some additional entities. He didn't think that he could get an award by himself at Morehouse College, strategizing that "this is going to be something that a bunch of big boys will go for, let me figure out who I can partner with and maneuver myself to work with them." There are so many solicitations out there and so many opportunities to get CISE funding. Gosha noted the importance of building rapport with program officers—once you kind of get your foot in the door and a program officer sees you on awards, the officer gets comfortable seeing you.

> ***MSIs can put a socially and culturally relevant spin on proposals and should capitalize on that.***

Tapia reflected on her experience submitting unsuccessful proposals until she got accepted into one of the NSF mentoring programs, where all the program directors were in a room. During the program, Tapia talked with the one of the program directors that had kept rejecting her proposals, who directed her to Sylvia Spengler. Spengler urged Tapia to serve on some panels, a wakeup call that helped Tapia figure out what's good in a proposal and what's not.

Washington emphasized the importance of the one-pager and getting in front of a program manager. She believes that MSIs have a unique niche, serving people whom everyone is trying to get to come to their schools. So, she doesn't like to think of other institutions as competitors. MSIs have the ability to put a socially and culturally relevant spin on proposals and should capitalize on that. Washington tries to get as many different examples of previously submitted proposals, to make sure hers fits into that standard, but then highlighting its unique niche.

Initial Program Implementation Challenges

What is the hardest part of program implementation once an NSF grant is awarded?

For Washington, the hardest part was Internal Review Board (IRB) approval.

For Tapia, speaking about a large multi-investigator award, it's who's doing what, how that team gets together, and how everybody's individual work goes to the larger group. This challenge can also be a fun aspect of large awards, she added.

For Gosha, the biggest challenge was the scope of what changes from the time that you submit to the time you actually get your money. For instance, if you want to hire personnel, it might have been someone that you thought you could sign on, but by the time you get the money, the person is gone. Or people you want to work with might be at another institution that has a different strategy or focus.

Gosha added the recommendation that institutions resubmit a proposal if they don't initially get funding, as is the practice of most research institutions. If you submit one time and don't get it, don't give up. Gosha has seen that CISE panels might not think that a certain school can do the work. When he writes proposals, he's cautious and urges people not to propose to do too much— "figure out what you're going to do and just do it very well." Add as much detail as possible and consider cutting down objectives (for instance, from three to two) to mitigate panel bias that you can't do the work.

Following Through with Planned Activities

How do you make sure that you do what you said in your proposal you would do?

Gosha recommended developing a spreadsheet or document of the whole proposal, breaking it down in bullet points—the things you need to be working on and the phases for those activities. If possible, a single-page document is ideal. When Gosha meets with his team, they always have something to look at to say, "Okay, well here are the boxes that we need to be checking. What are we doing to check these boxes?"

Tapia loves PI meetings, where everybody gets together so they know who's doing what and that progress towards those collaborative goals is being made. Communication among the PIs helps a lot.

Washington leans on graduate students, using Flying Donut software which allows her team to create milestones and check them off when they're done. She added that, in a perfect world, she would love to have an administrative person, but most budgets aren't big enough for that.

Negotiating Time as a Broadening Participation Component

How do you negotiate for your time when you are part of the broadening participation component in larger grants?

Gosha stated that since core awards often require broadening participation plans, PIs are now motivated to have collaborators that enhance their broadening participation in computing plans. Make the case that it's something your institution can help with. Gosha cautioned that the other institutions may ask you for access to your data and want to include you on their grant without any money, and he encourages asking to be co-PI on the grant.

Additional Insights from NSF Program Directors

When asked if NSF makes a distinction between proposals from two-year and four-year schools, the panelists stated that NSF has rules about who can apply to which kind of solicitation and goes out of its way to invite proposals from community colleges. Indeed, NSF has programs that specifically focus on them.

There's a specific solicitation for Research at Primarily Undergraduate Institutions (PUI) and Research at Undergraduate Institutions (RUI). If an institution qualifies as a PUI/RUI and it's clear that the projects are the sorts of things that can be done by undergraduate students, it is a classification that can be used for almost every kind of proposal that NSF has. This mechanism helps to level the playing field and has an impact on students, infrastructure, and an institution's research environment.

On dealing with difficult issues that may arise while carrying out a funded project, panelists noted that certain administrative problems, such as no-cost extensions, can either be handled via Fastlane or by sending an e-mail to the PI or program officer. You may have a disagreement with your project collaborators. Any kind of harassment must be reported to the program officer—but not mentioned in a proposal. Chances are you're not going to get awarded, because who wants a proposal that's going to cause trouble?

Pamela McCauley, NSF Innovation Corps (I-Corps™) program director, shared some mutually beneficial steps that NSF and MSIs can take. For the I-Corps program, she hosted an innovation-inclusion summit that brought HBCUs, HSIs, and TCUs together with I-Corps PIs, resulting in a number of facilitated relationships that she was then able to fund. She encouraged MSI researchers to search the awards database for programs that interest them and projects similar to those they've been thinking about and then reach out to that PI. She strongly encourages her own PIs to focus on collaborations with underrepresented institutions. If you form a relationship with program directors, they are likely to think of you the next time an R1 researcher looks for a collaborator. This type of collaboration highlights the need to build upon the work started at the innovation-inclusion summit.

Typical flaws found in proposals relate to not adhering to requirements spelled out in the solicitation. An applicant might fail to indicate whether the proposal is for a business or a small, medium, or large grant. Other gaps occur in the budget—failing to mention how many students will be supported, for instance, or not submitting a data management plan or post doctorate mentoring plan. NSF staff can sometimes fix the problems or contact the PI, but at other times the applicant risks having the proposal rejected without review.

The panel concluded with panelists making attendees aware that program officers communicate a great deal across directorates and divisions, and that a number of programs span various offices.

You Don't Have to Be the Stepchild of a Larger Institution—Opportunities for MSIs Beyond CISE

How to Transition from Set-Asides to Core Funding

Alan Arnold
Director of Research Development
MSI STEM R&D Consortium

Arnold presented an alternative to the traditional solicitation-proposal process, one that assures MSIs of a lead position in any funded project. MSIs currently benefit from so-called set-asides reserved for institutions that historically have received disproportionately low levels of funding. MSI researchers are also sought out as partners by PWIs to fulfill a broadening participation mandate. Arnold asserted that MSIs need not depend on HBCU and HSI programs: "You don't have to be the stepchild of a larger institution." Funded at $86 million over 10 years, the MSI STEM R&D Consortium serves the government as a procurement vehicle that matches agency needs with MSI research and development. The 60-plus members of the MSI STEM R&D Consortium include 36 HBCUs, 23 HSIs, four AANAPISIs, and one tribal college. The consortium's research capability system (RECAPSYS) networks with institutions and government agencies and develops "solution teams," which it markets to the government.

Partnerships for Innovation

Jesus Soriano Molla
Program Director, Partnerships for Innovation (PFI) Program
NSF

Soriano described the work of the Industrial Innovation and Partnerships (IIP) division of the Engineering Directorate, of which PFI is a part. Funded at about $290 million per year, PFI is the only NSF division that helps move technologies, outputs of research, and education grants, toward the marketplace—in the form of start-ups, entrepreneurial training, partnerships with industry, or large centers with industry and academia. Besides PFI, the division includes I-Corps, the Industry-University Cooperative Research Centers program, in which a university creates a center for industry-funded research. Through programs such as I-Corps, IIP advances its message of inclusion and innovation. Soriano urged attendees to apply for IIP internships, which award up to $55,000 to master's or Ph.D. students for a nonacademic internship at a policy think tank, national lab, industry—anywhere except at another university. IIP programs are aimed at accelerating, translating, demonstrating, and educating teams of researchers seeking to commercialize their technologies.

Lessons Learned from the ASEE/NSF Strategic Investments Summit

Ann Q. Gates
Executive Director
Computing Alliance of Hispanic-Serving Institution (CAHSI)
Director
Cyber-ShARE Center of Excellence
Professor and Vice Provost
University of Texas at El Paso

Gates recounted the highlights of the 2018 ASEE/NSF Strategic Investments Summit focused on boosting the research capacity of small and medium-size colleges and universities. Of 152 institutions across the country that each receive less than $17 million in annual research funding, the Summit Planning Committee invited 36. From this number, 31 accepted; half represented MSIs, the other half were from PWIs seeking to build research strength. The Summit brought together faculty and administrators—presidents, vice presidents of research, deans, and department chairs—as well as thought leaders to generate new knowledge around the question of "How do we engage the broader community and provide research opportunities?" The ultimate goal of the Summit was to develop the structure of what would become a virtual resource center to provide the kind of support for research faculty—identifying opportunities, proposal preparation, grant management—that larger institutions take for granted. A number of impactful talks approached the overall topic of funded research from multiple angles. Several themes emerged from the Summit that are familiar to 2020 MSI CISE Conference attendees: financial pressures on both institutions and students; shrinking government support for research; high teaching loads; lack of administrative and grants mentorship support; and little reward for actually doing research.

When responding to attendee questions, Gates spoke of the relevance of research to community colleges and

ways that they can be engaged. Working with larger institutions, faculty from community colleges have an opportunity to get funding. University of Texas at El Paso and the El Paso Community College (EPCC) have collaborated on a large number of joint educational proposals. EECO faculty and community college students participate in research and dissemination efforts through a regional research summit that includes other regional universities and colleges. Gates noted that one of the missing pieces at small and mid-size, teaching-oriented schools is mentoring of faculty on the research process. Reflecting on how to get NSF and other funding agencies to understand the needs of MSIs, she said that it's important for agencies to understand the differences among HSIs. "There are HSIs that are high enrolling, those that are not…It's important that RFPs consider the differences and consider what it means to serve Hispanic students as an HSI" When asked what Gates believes is the most impactful institutional support tool to increase student engagement in research, Gates said, for her, it's undergraduate research. If you engage students in undergraduate research, what they learn can be applied to their decision making in their everyday life, and it emphasizes the importance of graduate studies.

Positioning Your Institution for Success in Competing for CISE Core Awards

During the second and final breakout session of the conference, attendees participated in small group meetings to discuss and gain insights from NSF program directors on how to position their institution for success in competing for CISE core awards.

Recommendations included the creation of NSF-provided mentor-partner facilitators, increased support from NSF to facilitate partnerships and research contracts, and an NSF-mandated requirement that grantees have a management plan for broadening participation.

When discussing the question of how institutions with very limited resources can get started with computer science research, breakout group participants presented three "asks." First was a mentor-partner facilitator provided by NSF to help support cultural change leading to more research among community colleges or institutions with very limited resources. Second was that the mentor-partner facilitate the development of course-based research experiences. These can make a huge difference in students' lives.

Third, participants suggested "some small incentive" for R1s to collaborate with an MSI or institution with very limited resources. If the collaboration is authentic, builds agency within the smaller institution, and helps change that culture, such incentives could be effective.

The breakout groups offered several recommendations for changes that NSF should make to encourage partnering arrangements and make them more beneficial for MSIs. With building infrastructure being a key concern, one suggestion was formation of hubs, each led by a large and a smaller institution and drawing on resources such as the MSI STEM R&D Consortium. A second suggestion was the revival of the MII program. However, MSIs should take advantage of all forms of funding—including from foundations—to set up labs and facilities. NSF could encourage research contracts with industry where an industry representative comes to a university and helps develop a research track or curriculum. Infrastructure should include more access to data and a mechanism for the sharing of metadata.

NSF should require that grantees have a management plan for broadening participation. A database should be created identifying all personnel listed in awards. Senior personnel should be notified when they are listed on proposals and should be funded. When a need arises for training, NSF could provide funds for a workshop in which an NSF program director conducts training for several minority institutions in a region. NSF should avoid supporting partnerships that offer little money to MSIs and are unlikely to be sustainable once the grant has ended. Partnerships founded strictly on the basis of one institution's being an MSI is not enough; there must be synergy and a clear value in collaborating.

Key Insights and Future Directions

Common Research Impediments for MSIs

Heavy teaching loads and low salaries among MSI faculty often mean there's no time or bandwidth for conducting research.

Gasman (2013) confirms that HBCU faculty have large teaching loads, averaging four or more courses each semester. An additional consideration is that "because the majority of HBCU students are first-generation college students from low-income families and are often underprepared, faculty members spend additional time outside the classroom mentoring students" (p. 13). The basic teaching load for faculty at St. Thomas University (an HSI) was reported by Pickens (2010) as four courses per semester, adding that "at smaller universities, many faculty also assume additional course loads, heavy advising, committee responsibilities, and other duties," supporting Gasman's research (p. 73). In a survey completed by St. Thomas University faculty, lack of time was found to be the most common cause for not participating in research opportunities. Bernal and Ortiz-Torres (2010) found, in a survey conducted in the psychology department at the University of Puerto Rico (an HSI), that faculty at assistant and associate levels were often teaching 16 to 18 credit hours each semester.

Low salaries are also a chronic issue among MSI faculty that serve as a barrier to research. Citing a *Chronicle of Higher Education* study from 2011, Gasman (2013) reported that HBCU full professors earned "a little more than half of what their counterparts [at PWIs] earn at the national level" (p. 13). When comparing average faculty salaries in the 16 states in which HBCUs are located, Clery (2020) reported that HBCU faculty salaries are more than $30,000 lower, on average, than at land grant universities in the same states (p. 9). Overall, "the 2018-19 average salary for the 1862 land grant institutions was $105,535, compared with $66,831 for faculty in the 1890 HBCU land-grant institutions" (p. 8). Bernal and Ortiz-Torres (2010) noted that these low salaries can lead to faculty taking on extra courses or part-time work, which disincentivizes those who are interested in pursuing research but must prioritize earning additional income.

This theme emerged during a number of conference sessions and discussions, with calls for institutions and NSF to support funding that frees up faculty who have high teaching loads and no ability to get course reductions, and to create conditions that allow young faculty to pursue research, including release time from heavy teaching loads and bringing in additional faculty to relieve existing instructors.

There is often a lack of financial, institutional, and infrastructural support for research at MSIs.

Clery (2020) reported that, generally speaking, HBCUs have more limited financial resources and fragile funding than the land grant universities, which affects institutional budgeting processes.

Bernal and Ortiz-Torres's study (2001), which focused on the University of Puerto Rico, indicated that some key barriers to research were lack of clear research policies, classification as a teaching college, limits to research infrastructure (including space and equipment constraints along with a lack of support staff), and limited available research models. Without adequate research infrastructure, faculty interested in research are often at a disadvantage, not knowing where to find funding sources or opportunities and lacking the knowledge needed to write proposals.

Pickens (2010) acknowledged the challenge of shifting the culture at a teaching university to value research, emphasizing the importance of research administrators and professional development. In order to engage faculty, training and mentorship must take place. Faculty whose focus is on teaching and advising "may not have the skills or interests to pursue funded projects. Therefore, professional development and outreach activities are needed to motivate faculty to explore grants preparation" (p. 72).

At this conference, panelist Sarah EchoHawk (American Indian Science and Engineering Society) reported that TCU researchers felt two-year colleges and tribal colleges and universities lack institutional support for grant writing and conducting research. Two-year and tribal college faculty were also unfamiliar with developing and conducting the projects. Plenary speaker Keith Hargrove (Tennessee State University) acknowledged that, unlike at an R1, where an entire team prepares a proposal, an MSI researcher must be budget manager, proposal writer, and the one who communicates with

NSF. He stressed the importance of seeking help on grant processing from school administration, which may be tough in schools where administrative staff is spread thin. Panelist Gloria Washington (Howard University) echoed this sentiment, noting that, in a perfect world, she would love to have an administrative person who could help with grant activities, but most budgets aren't big enough for that.

MSI faculty feel that there are limited rewards for pursuing research opportunities.

At many MSIs, faculty teaching activities count more towards promotion and tenure than pursuing external funding. Pickens (2010) found that faculty were "less inclined to write grant proposals [due to] the perception that this effort would not be recognized for advancement and evaluation," adding that "not all universities recognize grant writing in the same way they recognize publishing or the development of new courses" (p. 73). Furthermore, grant writing is time consuming, does not offer a guarantee of funding, and may not be recognized in faculty evaluations.

When this topic was discussed during the conference, recommendations from panelists and attendees included: considering how much faculty are collaborating with industry, hospitals, and other institutions when weighing whether to grant tenure; training internal and NSF mentors to understand tenure models and different measures of success at smaller institutions; and encouraging faculty seeking tenure to collaborate with major researchers on a subcontractor or co-PI basis.

Future Directions

Recommendations for Future Conferences

Create a session or workshop on best practices for proposal preparation.

Multiple attendees requested more information on the proposal process and best practices to make NSF proposals more competitive. Attendees suggested creating a session or a workshop that reviews the NSF proposal process, explains the many different acronyms and terms used in reference to NSF proposals, provides tips to develop a successful proposal, and shares examples of successful proposals. This session or workshop could take place before the conference as an optional event.

Increase opportunities for formal and informal networking.

Attendees recommended building in more time for networking, with several suggesting a facilitated networking session with an activity to help attendees get to know each other and identify those with similar research interests.

Post-conference survey results indicated that attendees highly valued the networking opportunities during the conference. Much of the conversations that attendees had with NSF Program Officers centered around the proposal preparation and NSF review processes. Attendees gained information about the various program requirements and NSF funding priorities. Attendees also shared their research ideas with Program Officers to get input on possible funding opportunities for these ideas.

Conversations with other attendees focused on future collaborations, sharing advice and best practices, and sharing research ideas. Attendees were looking for potential collaborators on future proposals as well as advice on successful practices to manage fruitful collaborations with other institutions and organizations. Attendees shared and learned best practices on preparing and submitting competitive proposals to NSF and received advice for supporting other faculty members as they seek out federal funding. A few attendees mentioned discussing challenges they have faced attempting to develop competitive proposals, particularly at institutions with fewer resources, heavier teaching loads, and different institutional priorities.

Provide additional pre-conference training to breakout session facilitators.

A few attendees found that conversations in the breakout sessions sometimes veered away from constructive criticism and recommendations to improve the success rate of proposals from MSIs. They suggested giving the facilitators more training or preparation to keep the conversations on track. One attendee suggested developing a method for attendees to submit anonymous questions during the breakout sessions. Another attendee suggested providing better facilitation of movement into the breakout sessions so that each room had a relatively equal number of participants.

Offer a session focused on NSF's broader impacts criterion.

A few attendees suggested offering a session discussing NSF's definition of broader impacts, as well as how these activities can be effectively conducted with the help of MSIs. One attendee suggested that more NSF Program Officers from diverse backgrounds attend, to help create connections between MSIs and NSF and provide diverse perspectives on successful proposal submissions.

Recommendations for MSIs

Consider pursuing collaborations and partnerships when competing for grant funding.

One major theme that echoed throughout the conference was how important collaborations and partnerships are when competing for grants. Keith Hargrove (Tennessee State University) urged attendees to consider enlisting a prestigious university, industry giant, or national lab as a partner when submitting a grant proposal, which can enhance the credibility of the whole grant and increase the chances of being funded. Kinnis Gosha (Morehouse College) echoed this sentiment, urging attendees to think through who they're going to be competing with; if you're not collaborating with strong co-PIs, it makes it a lot harder to go after the bigger awards. Ann Gates (CAHSI, University of Texas at El Paso), also spoke to the value of partnerships, specifically for two-year institutions; by working with larger institutions, two-year institutions have an opportunity to get funding. Rita Rodriguez (NSF CISE Directorate), when voicing support for an MII program revival, stated, "I really don't think it helps us very much just to work amongst ourselves…we need to collaborate." She suggested that MSIs be ambitious in seeking collaborators among established research universities.

MSIs can learn a lot from partnering with R1 institutions but shouldn't forget that every MSI adds contributory value to an R1 proposal. If awarded, don't let the PI make your institution "invisible." For proposals involving partnerships between R1s and MSIs, the relationship between the institutions should be articulated with indicators of authentic partnerships. Pamela McCauley (NSF I-Corps) recommended that MSI researchers form a relationship with NSF program directors, so they are more likely to think of your institution the next time an R1 researcher is looking for a collaborator.

MSI researchers are often sought out as partners by PWIs to fulfill a broadening participation mandate, as noted by Alan Arnold (MSI STEM R&D Consortium), who asserted that MSIs don't necessarily have to depend on HBCU and HSI programs and should consider initiatives like the MSI STEM R&D Consortium, which serves the government as a procurement vehicle that matches agency needs with MSI research and development.

Leaders and administrators should be proactive in prioritizing research activities at their institutions.

"For MSIs to be competitive in the educational marketplace…they will require bold leadership and a purposeful commitment to innovate, especially in an era where neither federal nor private funding is plentiful" (National Academies of Sciences, Engineering, and Medicine, 2019, p. 7). Especially for non-research intensive MSIs, "presidents and senior leadership should take aggressive, proactive steps to better position themselves to compete for public and private STEM research grants and contracts, either independently or in collaboration with local, regional, and national partners" (p. 10).

Within your institution, work to develop "dynamic, multilevel mission-driven policies that affect and guide leadership priorities" (National Academies of Sciences, Engineering, and Medicine, 2019, p. 175). Acknowledge that not all faculty want to pursue research, but for those who do, try to arrange release time from teaching—research aids college growth and brings in overhead money! Support—don't disincentivize—students and young faculty who want to pursue research. When possible, offer travel support that enables faculty to attend conferences and network with NSF representatives, and tuition support for students seeking or engaged in research activities.

Build networks and reciprocal relationships with other MSIs. Larger, more research-intensive MSIs can share examples of their own grants that smaller schools could follow as models. Schools with newer facilities and infrastructure, like high-performance computers, can share facilities or offices with researchers from nearby, smaller schools.

Be proactive when engaging with NSF. Contact program officers and send summaries of ideas to make sure they reach the program with the right reviewers to give them the best chance of being funded. Don't wait for research opportunities to fall into your lap—seek them out!

Take advantage of the numerous ways that you can build rapport with NSF.

Participate in NSF review panels. Serving on review panels is a great way to get valuable face time with NSF representatives, gain a deeper understanding of what NSF is looking for in proposals, and learn what elements go into a successful proposal. Learn more about the CISE IIS Review Panel at https://www.nsf.gov/cise/iis/panelist/index.jsp.

Join NSF as a rotator. Rotators are temporary NSF program directors, typically hired from colleges and universities. They coordinate the evaluation of proposals and make recommendations about which proposals to fund. Serving as an NSF rotator is a great opportunity to build professional networks. NSF rotators retain their positions at their home institutions and return after a year or two, often with increased capacity to compete for NSF funds. More information on how to become a rotator can be found at https://beta.nsf.gov/careers/rotator-programs.

Look beyond the CISE Directorate. Consider additional avenues for funding, including the MSI STEM R&D Consortium, "cohort funding" like HBCU-Up for younger faculty, and S-STEM (NSF Scholarships in Science, Technology, Engineering, and Mathematics Program) grants, which support undergraduate and graduate students as well as institutions.

Recommendations for NSF

Offer increased support to help MSIs build collaborations and partnerships.

Many attendees urged NSF to increase support structures to help MSIs build research collaborations and partnerships. Suggestions included: requiring partnerships as a condition of awarding certain grants; encouraging research contracts with industry, in which someone from the industry can come to a university and help develop a research track or curriculum; not supporting partnerships that offer little money to MSIs and are unlikely to be sustainable once the grants have ended; developing a mainstreamed process for four-year institutions to collaborate with two-year institutions and tribal colleges to successfully conduct computer science research; offering "some small incentive" for R1s to collaborate with an MSI or an institution with very limited resources; forming hubs that are led by a large and a smaller institution and drawing on resources like the MSI STEM R&D Consortium; working to ensure that MSI faculty understand how to negotiate budget and collaborations with R1s and non-R1s, so as to make collaborations more genuine; and tailoring solicitations for upcoming research opportunities to specific types of institutions, such as community or two-year colleges.

To support collaboration and partnerships, attendees recommended that NSF offer planning grants to underserved institutions to help them increase their research capacity and position themselves for greater competitiveness for sponsored research funds. These planning grants could be comparatively small, flexible, and involve extensive interaction and guidance from NSF. There was also talk of reviving the Minority Institution Infrastructure (MII) Program, which positively impacted the research capacity of participating institutions, enabled grantees to visit research-intensive institutions and gain insights into what makes these institutions competitive, and served as a bridge to bigger NSF programs.

Increase training and professional development opportunities for MSI researchers and students.

Throughout the conference, attendees expressed the desire for more training opportunities to help them increase the number and competitiveness of their CISE proposals. Recommendations included: hosting workshops where NSF program directors train for several minority institutions in a region; training that offered information on how to find and contact your program officer and what's needed to be sure of getting a response; sponsored program officer training at MSIs; training for those transitioning from an R1 graduate school to a career at a less-resource-rich MSI; and training for review panelists to understand that successful research can be conducted in less-resource-rich environments.

Attendees said that they were unaware of NSF support in such areas as how to apply for and attend virtual and local trainings, how to be a panelist, and how to get started with research without getting a full award. These are also opportunities for training and professional development. Additionally, the question was raised as to whether rotator positions seem to go to faculty from R1s, effectively depriving non-R1s of access to the special insights that rotators gain. NSF should bring in people trained in language appropriate for MSIs to clarify solicitations for proposals.

Professional development and career support suggestions included: support for students working at national labs to gain experience while pursuing a Ph.D.; tuition support for undergraduates or community college students so they can complete their degrees and move to the next level; money to bring in additional faculty to relieve existing instructors so they can prioritize research; and travel money that would enable faculty to attend conferences and network with program officers.

Cultivate mentors and champions for MSI researchers.

Related to their requests for increased training opportunities, attendees also recommended that NSF be more active in cultivating mentors and champions for researchers representing MSIs and underserved groups. Suggestions included: mentor-partner facilitators provided by NSF to help support cultural change leading to more research among community colleges or institutions with very limited resources; facilitating mentorship of MSI faculty by experienced awardees at other institutions; and offering a train-the-trainer program that sends MSI faculty to learn from successful grantees—such as CAREER award recipients—and then returns them to their home institution with the "tacit knowledge" of how NSF runs. Mentors should understand the tenure models and different measures of success for individuals at smaller institutions, which will encourage meaningful collaborations with R1s and other institutions. Rather than just a vertical mentor-mentee relationship, there should be more horizontal structures, such as peer forums—a "bouncing board"—that can help assess which NSF programs offer the best fit for a researcher's proposal.

Invest in efforts to make review panels more inclusive.

Implicit bias training was mentioned more than once, with attendees noting that reviewers from PWIs with intense research participation often have expectations regarding those who could be successful at research and the conditions of the research setting. An NSF staff member with expertise in implicit bias could be brought in to provide oversight, challenge comments that may reflect implicit bias, and ensure that the panels do not exert bias in their decision making. Implicit bias training for panelists should be enforced by program officers. Though not explicitly calling for implicit bias training, panelist Kinnis Gosha (Morehouse College) alluded to review panel bias—urging attendees not to propose to do too much in their grant proposals to mitigate panel bias that you can't do the work.

A group of faculty administrators urged NSF to consider altering the structure of panels, using rubrics designed to level the playing field on how the panels are run and how proposals are scored, with an understanding of MSIs. It would be beneficial to encourage a shift in attitude among reviewers toward finding reasons to fund, rather than not to fund, a project. When panels disagree on the value of a proposal, the group suggested arbitration using an outside expert.

How can someone who wants to be on a panel put his or her name in for consideration? One suggestion for diversifying panels would be for NSF to create a system to recommend panelists outside a network of established scientists whom program officers regularly encounter, acknowledging that it's also incumbent upon the research community to introduce diverse panelists to program officers.

As ASEE Chief Academic Officer Jacqueline El-Sayed declared at the end of the conference, "this is just the beginning." To effectively grow a more capable and diverse research workforce and advance the scientific and innovation skills of the nation, the continued commitment of MSI leaders and administrators, non-MSI colleges and universities, public- and private-sector organizations, and public and private funding agencies like NSF will be vital. The 2020 MSI CISE Conference provided a wealth of recommendations that have the potential to increase the number and competitiveness of MSI proposals for NSF CISE core programs and beyond.

References

Anderson, E., Williams, K., Ponjuan, L., & Frierson, H. T. (2018). *The 2018 status report on engineering education: A snapshot of diversity in degrees conferred in engineering. Association of Public and Land Grant Universities.* Retrieved September 8, 2020, from *https://www.aplu.org/library/the-2018-status-report-on-engineering-education-a-snapshot-of-diversity-in-degrees-conferred-in-engineering*

Bernal, G., and Ortiz-Torres, B. (2009). Barriers to Research and Capacity Building at Hispanic-serving Institutions: The Case of HIV/AIDS Research at the University of Puerto Rico. *American Journal of Public Health, 99 Suppl 1(Suppl 1),* S60–S65. Retrieved June 29, 2020, from *https://doi.org/10.2105/AJPH.2007.121731*

Boland, W. C. (2018). The Higher Education Act and Minority Serving Institutions: Towards a Typology of Title III and V Funded Programs. Education Sciences, 8, 33. Retrieved July 1, 2020, from *https://eric.ed.gov/?id=EJ1175006*

Clery, S. (2020). What's Up... Or Down with Faculty Salaries? NEA Higher Education, 31(1), 1-37. Retrieved June 29, 2020, from *http://www.nea.org/assets/docs/NEAHE_Salary2020.pdf*

Cunningham, A., Park, E., and Engle, J. (2014, February). *Issue Brief: Minority-Serving Institutions: Doing More with Less. Institute for Higher Education Policy.* Retrieved June 30, 2020, from https://vtechworks.lib.vt.edu/bitstream/handle/10919/83120/MinorityServingInstitutions.pdf?sequence=1&isAllowed=y

Lists of Postsecondary Institutions Enrolling Populations with Significant Percentages of Undergraduate Minority Students. U.S. Department of Education. Retrieved June 30, 2020, from https://www2.ed.gov/about/offices/list/ocr/edlite-minorityinst.html

Espinosa, L. L., Kelchen, R., and Taylor, M. (2018). *Minority Serving Institutions as Engines of Upward Mobility.* American Council on Education. Retrieved July 1, 2020, from https://vtechworks.lib.vt.edu/bitstream/handle/10919/86902/MSIEnginesUpwardMobility.pdf?sequence=1&isAllowed=y

Federal Research and Development Funding at *Historically Black Colleges and Universities.* (2011, November 10). Congressional Research Service. Retrieved June 30, 2020, from https://www.everycrsreport.com/reports/RL34435.html

Gasman, M. (2013). The Changing Face of Historically Black Colleges and Universities. Penn Center for Minority Serving Institutions, Retrieved June 29, 2020, from http://repository.upenn.edu/gse_pubs/335

National Academies of Sciences, Engineering, and Medicine. (2019). *Minority Serving Institutions: America's Underutilized Resource for Strengthening the STEM Workforce.* The National Academies Press. https://www.nap.edu/catalog/25257/minority-serving-institutions-americas-underutilized-resource-for-strengthening-the-stem

National Science Foundation. (2018, February 12). *Building the Future: Investing in Discovery and Innovation - NSF Strategic Plan for Fiscal Years (FY) 2018 - 2022* (Rep.). National Science Foundation. Retrieved July 1, 2020, from https://www.nsf.gov/publications/pub_summ.jsp?ods_key=nsf18045

Pickens, J. (2010). Challenges of Implementing the NIH Extramural Associate Research Development Award (EARDA) at a Minority-Serving University. *Journal of Research Administration,* 41(3), 69-76. Retrieved June 29, 2020, from https://files.eric.ed.gov/fulltext/EJ945948.pdf

Rutgers Center for Minority Serving Institutions. (2014). *A Brief History of MSIs.* https://cmsi.gse.rutgers.edu/content/brief-history-msis

Trapani, J., and Hale, K. (2019, September 4). *Higher Education in Science and Engineering* (Rep. No. NSB-2019-7). National Science Board. Retrieved June 30, 2020, from the National Center for Science and Engineering Statistics website: https://ncses.nsf.gov/pubs/nsb20197

Appendix A: NSF CISE Core Programs

The CISE directorate supports "research and education in all areas of computer and information science and engineering, fosters broad interdisciplinary collaboration, helps develop and maintain cutting-edge national cyberinfrastructure for research and education, and contributes to the development of a computer and information technology workforce with skills necessary for success in the increasingly competitive global market" (https://www.nsf.gov/cise/about.jsp).

Via its four units, the CISE directorate offers a myriad of funding opportunities, including nine core programs:

- Division of Computing and Communication Foundations (CCF)
  - Algorithmic Foundations (AF) program
  - Communications and Information Foundations (CIF) program
  - Foundations of Emerging Technologies (FET) program
  - Software and Hardware Foundations (SHF) program
- Division of Computer and Network Systems (CNS)
  - CNS Core program
- Division of Information and Intelligent Systems (IIS)
  - Human-Centered Computing (HCC) program
  - Information Integration and Informatics (III) program
  - Robust Intelligence (RI) program
- Office of Advanced Cyberinfrastructure (OAC)
  - OAC Core Research (OAC Core) program

The following sections present an overview of CISE core programs using excerpts from the corresponding NSF web pages.

Algorithmic Foundations Program

The Algorithmic Foundations (AF) program supports potentially transformative projects in the theory of algorithms. AF projects should feature algorithmic innovation and rigorous analysis. NSF is interested in research on algorithms for problems that are central to computer science and engineering, as well as new techniques for the rigorous analysis of algorithms and computational complexity. AF supports theoretical research that bounds the intrinsic difficulty of problems to determine measures of complexity in formal models of computation, classical or new. The goal is to understand the fundamental limits of resource-bounded computation and to obtain efficient algorithms operating within those limits. Research on resources other than the traditional time and space measures, such as communication and energy, is also encouraged, as is research on tradeoffs between resource use and solution quality, such as running time vs. approximation error. In addition to the traditional sequential computing paradigm, AF supports research on the design and analysis of novel algorithms in parallel and distributed models, as well as computational models and algorithms that capture essential aspects of computing over massive data sets.

For more information, visit:
https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503299&org=CISE&from=home.

Communications and Information Foundations Program

The Communications and Information Foundations (CIF) program supports potentially transformative research that addresses the theoretical underpinnings of information acquisition, transmission, and processing in communications and information-processing systems. CIF projects strengthen the intellectual foundations of communications, information theory, signal processing, and statistical learning in a variety of network types such as wireless and multimedia networks, sensor networks, social networks, and biological and quantum networks. The CIF program supports basic research in communication theory, information theory, signal processing, network information theory, cross-layer research at the lower layers, as well as new paradigms that enlarge the scope of signal processing and information theory. Research that

will develop efficient, power-aware and hardware-friendly algorithms and research on signal/information processing algorithms for the new network science of distributed, decentralized, and cooperative algorithms is encouraged. Also, within scope is the derivation of efficient algorithms and fundamental limits for extracting information from massive and possibly corrupted data sets, including compressive sampling/sensing and active learning, and exploring new application domains. Research outcomes are expected to lead to more secure and reliable communications and advanced mathematical capabilities that are applicable throughout science and engineering.

For more information, visit:
https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503300&org=CISE&from=home.

Foundations of Emerging Technologies Program

Foundations of Emerging Technologies (FET) is a new program within CCF that aims to enable radical innovations in the theory, algorithms, software, hardware, and architecture of computing and communication systems through research at the intersection of computing and biological systems, nanoscale science and engineering, quantum information science, and other nascent, yet promising, areas. Interdisciplinary collaborations are highly encouraged, with the aim of pursuing foundational breakthroughs in computing and information science.

The FET program seeks potentially transformative projects in the research areas elaborated below:

- *Biological Systems Science and Engineering* explores opportunities at the intersection of biology and computer science, focusing on advancing our understanding of computing and communication processes in biological systems to recreate or use them as models for, or demonstrations of, innovative computing and communication systems.
- *Quantum Information Science* explores opportunities in quantum computing, quantum communication, and other quantum-based and related approaches for processing, communicating, and using information.
- *Nanotechnology for Computing and Communication* explores opportunities using nanotechnology to achieve the highest level of computational energy efficiency for general-purpose computing systems and to greatly extend the practical engineering limits of energy-efficient computation.
- *Probabilistic Devices* focuses on research in information processing and computing with devices having probabilistic aspects to their behavior.

For more information, visit:
https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505589&org=CISE&from=home.

Software and Hardware Foundations Program

The Software and Hardware Foundations (SHF) program supports potentially transformative research in the design, verification, operation, utilization, and evaluation of computer hardware and software through novel approaches, robust theories, high-leverage tools, and lasting principles. Such advances may offer formal methods, languages, logics, novel software and/or hardware artifacts, or algorithms to enable new or enhanced functionality, verification, usability, and scale.

The SHF program supports all aspects of the science and engineering of software, including:

- Research projects focusing on program analysis and synthesis, compositionality, verifiability and adaptability of software, as well as research on software analysis and testing techniques for all stages of the software life cycle.

- Fundamental research on formal and semi-formal methods for the specification, development, and verification of software and hardware systems.
- Fundamental research in both science and engineering of programming languages is highly encouraged.
- Foundational research in computer architecture and computer hardware and systems design, including, but not limited to, performance, energy efficiency, reliability, scalability, concurrency, and heterogeneity.
- Foundational research in high-performance computing that is aware of, driven by, and inspired by applications, as well as heterogeneity-aware and architecture-aware.
- Research on hardware architectures that are inspired by machine learning, neuromorphic computing (including those inspired by the human brain) and synergistic use of materials and device technologies, along with their efficient implementations.

For more information, visit:
https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503301&org=CISE&from=home.

CNS Core Program

The Computer Network Systems (CNS) Core program deals with all aspects of computer and network systems. The CNS Core program supports innovative research that considers technology trends and emerging challenges, while emphasizing a system focus and awareness of the types of requirements mentioned above.

Research of interest for this program include:

- Explores fundamental principles and creates innovative technologies, protocols, and systems that define the future or—more realistically—harness current and emerging technologies, trends, and applications;
- Produces practical abstractions, techniques, tools, artifacts, or datasets that address/enhance both general and functional requirements such as those outlined above;
- Reflects a clear understanding of what each component does and how it interfaces with the rest of the system and the environment.

Proposers should identify and describe the context of the proposed system(s), the objectives or capabilities envisioned, and their expected contribution to advance towards the goals. Three especially important example requirements are secure by design, robustness and manageability.

Although purely intellectual investigations are within scope, research that is anchored in current and future systems for societal needs is encouraged. In general, any topic having to do with augmenting, understanding, enhancing, or transforming computing and communication systems undertaken from a systems point of view is within scope.

For more information, visit:
https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505671&org=CISE&from=home.

Cyber-Human Systems Program

Cyber-Human Systems (CHS) supports research in human-computer interaction (HCI). CHS projects integrate knowledge from a range of computational and behavioral sciences in order to design new computing systems to amplify humans' diverse physical, cognitive and social capabilities to accomplish individual and collective goals; assess the benefits, effects and risks of computing systems; or understand how human, technical and contextual aspects of systems interact to shape those effects. Major CHS concerns include:

- Human-technology interfaces: This topic encompasses principles and technology for human-computer interaction, including haptic, tangible, gestural, wearable and voice interfaces; brain-computer interfaces; intelligent user interfaces; and methods for human interaction with AI systems.
- Computer graphics: This area includes advances in computer animation; rendering, modeling and simulation; and virtual and augmented reality.
- Computer technology for creativity: Novel computational methods for creating video, audio, text and other forms of media, and systems that support creative expression and ideation.
- Computer-based communication and collaboration: This includes technology-supported human-to-human communication; groupware and enterprise systems; crowdsourcing and digital labor markets; and systems for public participation in science, technology, engineering, and mathematics (STEM).
- Assistive and adaptive technology: Systems to improve access to information, work and entertainment by persons with physical, cognitive or social impairments; universal and ability-based design; and the study of individual, social and cultural factors impacting interactive systems' usability and outcomes.
- Social impacts of computing: Improving our understanding of the social impacts of computer technology and of how human-technology systems grow and evolve.
- Domain-specific human-computer interaction: Projects that advance CHS in the context of specific domains, such as health, education, families or work.

For more information, visit:
https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504958&org=CISE&from=home.

Information Integration and Informatics Program

The Information Integration and Informatics (III) program supports innovative research on computational methods for the full data lifecycle, from collection through archiving and knowledge discovery, to maximize the utility of information resources to science and engineering and broadly to society. III projects range from formal theoretical research to those that advance data-intensive applications of scientific, engineering or societal importance. Research areas within III include:

- General methods for data acquisition, exploration, analysis and explanation: Innovative methods for collecting and analyzing data as part of a scalable computational system.
- Domain-specific methods for data acquisition, exploration, analysis and explanation: Work that advances III research while leveraging properties of specific application domains, such as health, education, science or work.
- Advanced analytics: Novel machine learning, data mining, and prediction methods applicable to large, high-velocity, complex, and/or heterogenous datasets. This area includes data visualization, search, information filtering, knowledge extraction and recommender systems.
- Data management: Research on databases, data processing algorithms and novel information architectures.
- Knowledge bases: Includes ontology construction, knowledge sharing, methods for handling inconsistent knowledge bases and methods for constructing open knowledge networks through expert knowledge acquisition, crowdsourcing, machine learning or a combination of techniques.

For more information, visit:
https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503303&org=CISE&from=home.

Robust Intelligence Program

Robust intelligence encompasses foundational computational research needed to understand and develop systems that can sense, learn, reason, communicate, and act in the world; exhibit flexibility, resourcefulness, creativity, real-time responsiveness and long-term reflection; use a variety of representation or reasoning approaches; and demonstrate competence in complex environments and social contexts. The RI program accepts research proposals aimed at contributing deeper understanding and new insights in and across the disciplinary areas outlined below. Areas within RI include:

- Artificial intelligence (AI): All matters of learning, abstraction and inference required for intelligent behavior, and including architectures for intelligence, integrated intelligent agents, and multi-agent systems.
- Machine learning: The study of algorithms and models that are able to solve tasks by generalizing from data.
- Computer vision: The ability of systems to sense and reason about the visual world.
- Human language technologies: The ability of intelligent systems to analyze, produce, translate, and respond to human text and speech.
- Robotics: The design, construction, operation, and use of machines capable of carrying out a complex series of actions automatically.
- Computational Neuroscience: Theory and analysis of computational processes in the nervous system, including approaches to the above RI problem areas that are grounded in neural computation and neuroscience.

For more information, visit:
https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503305&org=CISE&from=home.

Advanced Cyberinfrastructure Core Research Program

The Office of Advanced Cyberinfrastructure (OAC) supports translational research and education activities in all aspects of advanced cyberinfrastructure (CI) that lead to deployable, scalable, and sustainable systems capable of transforming science and engineering research and education. Advanced CI includes the spectrum of computational, data, software, networking, and security resources, tools, and services, along with the computational and data skills and expertise, that individually and collectively enable the conduct of science and engineering research and education.

The OAC Core Research program seeks innovative proposals for translational research on the design, development, deployment, experimentation, and application of advanced research CI. OAC Core Research investments have one or more of the following key attributes:

- Multi-disciplinary: leveraging techniques from multiple disciplines and may require collaboration among investigators from relevant disciplines/ sub-disciplines.
- Extreme-scale: exploring pathways to leading-edge, leadership-scale research CI, from architecture to algorithms to models.
- Driven by science and engineering research: exploring scalable models, algorithms, techniques, and tools needed for fundamentally new science and engineering advances.
- An end-to-end solution: pursuing novel integrated systems that support complete research workflows.
- Deployable as robust research CI: exploring seamless pathways for integration into robust CI systems or operational scientific and engineering research applications.

For more information, visit:
https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505670&org=CISE&from=home.

Appendix B: List of Conference Attendees

Malek Adjouadi, *Florida International University*

Ali Ahmadinia, *California State University, San Marcos*

Bassey Akpan, *Texas College*

Emily Allen, *California State University, Los Angeles*

Alan Arnold, *MSI STEM R&D Consortium*

Kapila Attele, *Chicago State University*

Tahir Aziz, *Long Beach City College*

Gregory Barnett, *University of New Mexico*

Michael Bauer, *Leeward Community College*

Mohsen Beheshti, *California State University, Dominguez Hills*

Sambit Bhattacharya, *Fayetteville State University*

Sherrene Bogle, *Humboldt State University*

Clarissa Bowman, *San Juan College*

Quincy Brown, *AnitaB.org / Bowie State University*

Carrie Butler, *Hawaii Community College*

Tilanka Chandrasekera, *Oklahoma State University*

Yi Chung Chen, *Tennessee State University*

Ming-Hsing Chiu, *Dillard University*

David Cooper, *Cheyney University*

Monireh Dabaghchian, *Morgan State University*

Andisheh Dadashi, *University of New Mexico*

Frances Dancer, *Jackson State University*

Abdollah Dehzangi, *Morgan State University*

Felicia Doswell, *Norfolk State University*

Jennifer Ebert, *Union County College*

Sarah EchoHawk, *American Indian Science and Engineering Society*

Keith Edwards, *University of Hawai'i*

Andrea Edwards, *Xavier University of Louisiana*

Mohamed El-Sayed, *Eastern Michigan University*

Brittany Fasy, *Montana State University*

Ed Galindo, *North American Native Research and Education Foundation, Inc.*

John Garland, *Indigenous Education, Inc. – The Cobell Scholarship*

Ann Gates, *University of Texas at El Paso*

Lila Ghemri, *Texas Southern University*

Anteneh Girma, *University of the District of Columbia*

Angel Gonzalez-Lizardo, *Polytechnic University of Puerto Rico*

Kinnis Gosha, *Morehouse College*

Cyrus Grant, *Dominican University*

S. Keith Hargrove, *Tennessee State University*

Ian Her Many Horses, *University of Colorado, Boulder*

Alfonso Heras Llanos, *Southwestern Indian Polytechnic Institute*

Mary Ann Hoppa, *Norfolk State University*

Thorna Humphries, *Norfolk State University*

Steven Johnson, *Prince William Sound College*

Jea Joseph, *Oakwood University*

Eun-Young Elaine Kang, *California State University, Los Angeles*

Bernard Ku, *University of Texas at San Antonio*

Tracey Lanham, *Hodges University*

Juan Jenny Li, *Kean University*

Akhtar Lodgher, *Texas A&M University-San Antonio*

Ahmed Mahdy, *Texas A&M University-Corpus Christi*

Melanie Martin, *California State University, Stanislaus*

Derek Martinez, *University of New Mexico*

Subahasish Mazumdar, *New Mexico Institute of Mining and Technology*

Victor McCrary, *National Science Board / University of the District of Columbia*

Idongesit Mkpong-Ruffin, *Florida A&M University*

Selvarajah Mohanarajah, *University of North Carolina at Pembroke*

Patricia Morreale, *Kean University*

Rasha Morsi, *Norfolk State University*

Jean Muhammad, *Hampton University*

Deok Hee Nam, *Wilberforce University*

Raul Nedd, *Stella and Charles Guttman Community College*

Anne-Marie Nuñez, *Ohio State University*

Samuel Olatunbosun, *Norfolk State University*

Patricia Ordóñez, *University of Puerto Rico, Río Piedras*

Jose Ortiz, *University of Puerto Rico, Río Piedras*

Yi Pan, *Georgia State University*

Manuel Pérez-Quiñones, *University of North Carolina at Charlotte*

Enrico Pontelli, *New Mexico State University*

Joseph Robertson, *Mato Ohitika Analytics, LLC*

Homer Sharafi, *Prince George's Community College*

Cheryl Shiber, *Union County College*

Rose Shumba, Bowie State University

Dennis Sigur, *Dillard University*

Yolanda Singletary, *Orangeburg-Calhoun Technical College*

Bruce Smith, *Southwestern College*

Evelyn Sowells-Boone, *North Carolina A&T State University*

Ellen Spertus, *Mills College*

Ramaier Sriram, *Claflin University*

Elizabeth Starks, *University of Washington*

Simon Sultana, *Fresno Pacific University*

Samuel Tabi, *Wiley College*

Neva Tall Bear, *Little Big Horn College*

Lydia Tapia, *University of New Mexico*

Thanh Thieu, *Oklahoma State University*

Cesar Torres, *University of Texas at Arlington*

Son Tran, *New Mexico State University*

Vassilios Tzouanas, *University of Houston-Downtown*

Miguel Velez-Reyes, *University of Texas at El Paso*

Tuan Anh Vo, *Mt. San Antonio College*

Wanda Ward, *University of Illinois at Urbana-Champaign*

Gloria Washington, *Howard University*

Jane Watkins, *Limestone College*

Marsha Whiting, *American Indian Science and Engineering Society*

Janett Williams, *Hampton University*

Frances Williams, *Tennessee State University*

Delbert Willie, *Northern Arizona State University*

Jeong Yang, *Texas A&M University-San Antonio*

Marian Zaki, *Houston Baptist University*

National Science Foundation Staff

Shannon Beck, *CISE*

Edward Berger, *ENG/EEC*

Michelle Bushey, *MPS/CHE*

Fay Cobb Payton, *CISE/CNS*

David Corman, *CISE*

Ivory Dean, *CISE/CNS—AAAS Fellow*

Jeremy Epstein, *CISE/CNS*

Jeff Forbes, *CISE/CNS*

Erwin Gianchandani, *CISE*

Sharon Glivens, *CISE*

Tess Guebre, *MPS*

Natalie Hengstebeck, *CISE/CNS/OD—AAAS Fellow*

Brandon Jones, *GEO*

Joseph Keller, *CISE/IIS—AAAS Fellow*

Allyson Kennedy, *CISE/CNS*

Samee Khan, *CISE/CNS*

Margaret Martonosi, *CISE*

Pamela McCauley, *CISE*

Deepankar Medhi, *CISE/CNS*

Matt Mutka, CISE/CNS

Narcrisha Norman, EHR

Melissa Olson, MPS/CHE

Kitchka Petrova, CISE/CNS—AAAS Fellow

Regina Pope-Ford, ENG/EEC—AAAS Fellow

Stefan Robila, *CISE*

Rita Rodriguez, *CISE*

J. Maurice Rojas, *CISE/CCF*

Rebecca Shearman, *CISE/CNS—AAAS Fellow*

Joanna Shisler, *BIO*

Tonya Smith-Jackson, *CISE/CHS*

Jesus Soriano Molla, *ENG/IIP*

Simone Soso, *EHR/HRD—AAAS Fellow*

Sylvia Spengler, *CISE*

Sharon Swartz, *BIO*

Guebre X. Tessema, *MPS/DMR*

Peter Vishton, *SBE*

Ken Whang, *CISE/IIS*

Chinonye Whitley, *OD/OIA*

American Society for Engineering Education Staff

Rocio Chavela Guerra, Director, Education and Career Development

Jacqueline El-Sayed, Chief Academic Officer

Ray Phillips, Manager Logistics and Special Projects, Education and Career Development

Eric Wallace, Senior Project Manager, Education and Career Development

Appendix C: Conference Agenda

Monday, February 3, 2020

5:00 PM – 7:00 PM	**Registration**
6:00 PM – 7:30 PM	**Networking Reception** **Erwin Gianchandani,** Deputy Assistant Director, CISE, NSF **Victor McCrary,** National Science Board and Vice President for Research and Graduate Programs, University of the District of Columbia

Tuesday, February 4, 2020

7:00 AM – 5:00 PM	**Registration**
7:30 AM – 8:30 AM	**Breakfast**
8:30 AM – 9:00 AM	**Introduction/Setting the Stage** **Margaret Martonosi,** Assistant Director, CISE, NSF
9:00 AM – 9:30 AM	**Plenary: Overview of CISE and Its Core Opportunities** **David Corman,** Program Director, CISE, NSF **Sylvia Spengler,** Program Director, CISE, NSF
9:30 AM – 10:00 AM	**Panel Discussion: Recap of Previous Workshops** **Ann Gates,** Chair of the Computer Science Department, University of Texas at El Paso **Jean Muhammad,** Chair of the Computer Science Department, Hampton University **Sarah EchoHawk,** CEO, American Indian Science and Engineering Society
10:00 AM – 10:30 AM	**Panel Discussion: Moving Forward with the Lessons of the Minority Institution Infrastructure Program** **Malek Adjouadi,** Professor, Florida International University **Rita Rodriguez,** Program Director, CISE, NSF MODERATOR: **Anne-Marie Nuñez,** Professor, The Ohio State University
10:30 AM – 11:00 AM	**Networking Break**

11:00 AM – 12:00 PM	**Breakout Groups: What Can NSF Do to Increase the Number and Competiveness of CISE Proposals from MSIs?** • Recommended Changes to the NSF Proposal Review Process • Recommendations for Programmatic Investments NSF Should Make • Recommendations for Investments NSF Should Make in Students and Young Faculty • Recommendations for Investments NSF Should Make in Cultivating Internal-to-NSF Mentors and Champions
12:00 PM – 1:00 PM	**Working Lunch**
1:00 PM – 1:30 PM	**Report Out From Breakout Groups**
1:30 PM – 2:15 PM	**Plenary: Case Study of a Successful MSI/NSF Partnership** **S. Keith Hargrove,** Dean of Engineering, Tennessee State University
2:15 PM – 3:00 PM	**Panel Discussion: What Do MSI CISE PIs Wish They'd Known Before Starting Their CISE Core Award?** **Kinnis Gosha,** Hortenius I. Chenault Endowed Associate Professor, Department of Computer Science, Morehouse College **Lydia Tapia,** Assistant Professor, Department of Computer Science, University of New Mexico **Gloria Washington,** Assistant Professor, Department of Computer Science, Howard University MODERATOR: **Edward Dillon,** Assistant Professor, Department of Computer Science, Morgan State University
3:00 PM – 3:30 PM	**Networking Break**
3:30 PM – 4:45 PM	**Breakout Groups: Small Group Meetings with NSF Program Directors**
4:45 PM – 5:00 PM	**Concluding Remarks** **Fay Cobb Payton,** Program Director, CISE, NSF
5:00 PM – 6:30 PM	**Networking Reception With NSF Program Directors**

Wednesday, February 5, 2020

7:00 AM – 10:00 AM	**Registration**
7:30 AM – 8:30 AM	**Breakfast**
8:30 AM – 9:30 AM	**Plenary Session: How to Transition from Set-asides to Core Funding** **Alan Arnold,** Director of Research Development, MSI STEM R&D Consortium
9:30 AM – 10:00 AM	**Plenary: Lessons Learned from the ASEE/NSF Strategic Investment Summit** **Ann Gates,** Chair of the Computer Science Department, University of Texas at El Paso
10:00 AM – 10:30 AM	**Networking Break**
10:30 AM – 11:30 AM	**Breakout Groups: Positioning Your Institution for Success in Competing for CISE Awards** • Recommendations for Private- and Public-sector Partnerships that NSF Could Pursue • Recommendations for Changes NSF Can Encourage to Partnering Arrangements to Make Them More Beneficial for MSIs • How Can Institutions with Very Limited Resources Get Started with Computer Science Research? • How to Build Partnerships that Build MSI Research Infrastructure
11:30 AM – 12:00 PM	**Report Out from Breakout Groups**
12:00 PM – 1:00 PM	**Lunch and Closing Remarks**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