National Science Foundation

Directorate for Computer and Information Science and Engineering

Division of Computing and Communication Foundations

Division of Computer and Network Systems

Division of Information and Intelligent Systems

Management Response to

the Committee of Visitors Report

May 2020

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Introduction

The National Science Foundation (NSF) relies on the judgment of external experts to maintain high standards of program management, to provide advice for continuous improvement of NSF performance, and to ensure openness to the research and education community served by the Foundation. Committee of Visitors (COV) reviews provide NSF with external expert judgments in two areas: assessments of the quality and integrity of program operations; and program-level technical and managerial matters pertaining to proposal decisions. COV reviews are held approximately every four years.

The NSF Directorate for Computer and Information Science and Engineering (CISE) charged a COV to review program operations and program-level matters pertaining to proposal decisions in the Divisions of Computing and Communication Foundations (CCF), Computer and Network Systems (CNS), and Information and Intelligent Systems (IIS) over the period fiscal year (FY) 2014 through FY 2018. [The Office of Advanced Cyberinfrastructure (OAC) within CISE previously conducted a COV review covering the period FY 2013 through FY 2016; that COV meeting was held on November 28-30, 2017.) In particular, the COV was asked to comment on the quality and effectiveness of the merit review process; the selection of reviewers; the management of the programs under review; and the resulting portfolio of awards. In addition, the COV was asked to identify themes that cut across the divisions as well as programmatic opportunities at the CISE level that could enhance the directorate's ability to deliver on its mission.

The COV consisted of 24 members, including a chair and a CISE Advisory Committee member, and was composed of a diverse group with respect to institution type, geography, gender, ethnicity, and scientific representation. The COV was divided into three subcommittees, one for each of CCF, CNS, and IIS. Each subcommittee had a vice chair and was responsible for completing a report template for its assigned division. In advance of an in-person meeting, the COV was provided with a comprehensive set of materials for review, including 1) the previous COV report and management response; 2) CISE and division overviews; 3) annual reports presenting data for the covered period; 4) strategic documents; and 5) a sample of proposal jackets. Upon request, additional information was provided, including additional proposal jackets. The COV met in person at NSF on November 6-8, 2019. The meeting included breakout sessions on topics of interest to the COV. The COV completed a draft report on November 12, 2019. The CISE Advisory Committee accepted the COV's report on December 12, 2019.

The COV report concluded:

> *Overall, the CoV found CISE activities to be of exceptional quality: (a) management is grounded in effective processes and supported by an exceptional team; (b) the review process is robust and proactively refined to improve quality and efficiency; (c) reviewers and panelists are well-qualified and balanced; and, (d) the program portfolio addresses national priorities and relevant research, reflecting the agency's mission.*

The COV report includes extensive findings and offered ten recommendations, ordered by priority in the COV's view.

This management response to the COV report addresses each of the COV's recommendations in the order in which they were identified.

Management Response to Recommendations

> **Recommendation #1:** *To maintain US competitiveness in a changing global context, NSF should increase overall funding for CISE to be at least commensurate with the growth in competitive proposal pressure and the increasing costs of conducting research in Computer Science.*

NSF agrees with the COV on the importance of maintaining US competitiveness. The NSF Strategic Plan for 2018 to 2022[1] articulates a vision of "A Nation that is the global leader in research and innovation." CISE appreciates the significant intellectual opportunity and potential for impact in the fields we steward, and acknowledges the COV's concerns regarding rising demands on the directorate's resources, reflected, for example, in the increasing number of proposals submitted to our units. Addressing these issues requires several approaches, one of which is increasing budgets. Since FY 2018, the final year covered by the COV, the budgets of CISE and each of its units has increased, and the President's Budget Request for FY 2021 includes a proposal to increase the CISE budget further. See Table 1.

Table 1: Budgets of CISE units (dollars in millions)

	FY 2018	**FY 2019**	**FY 2020 Estimate**	**FY 2021 Request**
OAC	224	222	228	233
CCF	196	194	199	203
CNS	232	229	236	240
IIS	211	208	216	240
ITR	98	132	132	146
CISE Total	960	985	1,011	1,062

> **Recommendation #2:** *To improve portfolio balance and to allow enough agility to target emerging areas of research, CISE should realign or sunset programs more often.*

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[1] The NSF Strategic Plan, *Building the Future: Investing in Discovery and Innovation – NSF Strategic Plan for Fiscal Years (FY) 2018 – 2022*, can be found at https://www.nsf.gov/about/performance/strategic_plan.jsp.

CISE is taking steps to re-examine its portfolio of programs. We have sunset major programs: the Algorithms in the Field (AitF) program, the Critical Techniques, Technologies and Methodologies for Advancing Foundations and Applications of Big Data Sciences and Engineering (BIGDATA) program, and the Smart and Autonomous Systems (S&AS) program. We have evolved existing programs: Scalable Parallelism in the Extreme (SPX) to Principles and Practices of Scalable Systems (PPoSS); Spectrum Efficiency, Energy Efficiency, and Security (SpecEES) to Spectrum and Wireless Innovation enabled by Future Technologies (SWIFT); and CISE Research Infrastructure (CRI) to CISE Community Research Infrastructure (CCRI). And we have re-organized areas of our portfolio through the creation of the new Foundational Research in Robotics (Robotics) program. The initial community response to these efforts have been very positive.

Further, following the COV recommendations, CISE has now put in place a process to set periodic program review dates for each cross-cutting program that involves CISE, typically every three years. These reviews follow the principles outlined below:

1. All existing programs led by CISE should establish a date at which the program will be reviewed or sunset. A program review would mean an analysis of whether significant revisions to the program are warranted, including sunsetting of the program.
2. When CISE creates a new program, a lifetime or review date should be explicitly identified.
3. When CISE joins programs led by another directorate, participating CISE units should identify a date at which their continued participation will be re-evaluated.
4. Those cross-cutting programs that are intended to have stability in the long term [such as Secure and Trustworthy Cyberspace (SaTC), Cyber-Physical Systems (CPS), and Robotics] should be identified as such.

We have set these program review dates for all the cross-cutting programs in our portfolio.

> **Recommendation #3:** *To stay true to its original intent at a time of significant growth of junior faculty, CISE should consider introducing adjustments to the CAREER program.*

We thank the COV for their observations regarding the CAREER program. Since this is an NSF-wide program, we will share this observation with the NSF-wide CAREER Coordinating Committee for their consideration for eventual program revisions. In the meantime, CISE is planning to act on the observations made by the COV leading up to this recommendation:

- We agree with the COV findings that proposers are waiting longer to apply to the CAREER program, as compared to the 2000s and early 2010s – and there is benefit to counter this trend. To do so, we intend to work with our program directors (PDs) as well as the broader principal investigator (PI) community (including department heads/chairs) to update our messaging to potential applicants to the CAREER program; we will encourage PIs to apply early in their faculty careers (i.e., there is no need to wait two or three years, or longer, into one's appointment).
- The CISE Research Initiation Initiative (CRII) and CAREER programs have different goals, and we will re-emphasize these distinct goals to our PI community (e.g., at the annual CISE CAREER Grant-Writing Workshop). In particular, CRII is intended to support those early-career PIs who do not already have the necessary resources to start their independent research careers (e.g., those who do not have sufficient startup packages to recruit students and conduct research leading to preliminary results). By contrast, CAREER is intended to provide PIs with stable support over a

sustained duration (five years) to develop their careers as outstanding researchers/educators. CAREER is not meant to recognize proven scholarship, but rather to enable it. A CRII award should generally not be seen as a prerequisite for a CAREER submission.

- Between FY 2017 and FY 2019, CISE CAREER success rates have seen a steady increase, and we expect an improvement in success rates in FY 2020 as well. CISE is acutely aware of the increasing number of proposal submissions over the same period and has increased the amount of funds committed to CAREER awards. We will closely watch CAREER program indicators, including success rates, funds committed to the program, numbers of proposal submissions, and portfolio diversity (including that of institutions and PIs). We expect to see higher success rates in our CAREER proposals than in our core program proposals.
- We will continue to take due care of proposals from PIs who are on their final submissions allowed by CAREER program eligibility rules.

> ***Recommendation #4:*** *To improve the understanding and awareness of what constitutes broader impacts throughout the research community, CISE should pursue approaches that intentionally clarify and effectively evaluate the broader impacts of proposed work.*

Intellectual Merit and Broader Impacts have been the two review criteria for all NSF proposals for well over a decade. While the research community is well equipped to write an innovative and even transformative Intellectual Merit section, there remains a great deal of confusion over how to construct a compelling Broader Impacts section. NSF has chosen not to be overly prescriptive about what activities qualify as promoting broader impacts, as broader impacts can take many forms and are often contextualized differently within disciplines. However, solutions that clarify NSF language around this issue could lead to better proposals and more effective mechanisms by which reviewers can evaluate them.

Currently, there are over a half-dozen NSF webpages describing Broader Impacts, not to mention directorate-specific pages, NSF's *Proposal and Award Policies and Procedures Guide (PAPPG)*, internal reports, and external sites like the National Alliance for Broader Impacts (NABI). The problem is not one of quantity of guidance, but rather its clarity, consistency, and ease of access. To begin addressing this complicated issue, CISE is spearheading an effort to collate and clarify all NSF language around Broader Impacts into a single, easily accessible webpage.

This new webpage will not eliminate any of the above-mentioned resources, but instead act as a landing page for prospective PIs to navigate to the information most relevant to them. It will include links to the *PAPPG* section on merit review, the NSF Office of Integrative Activities page on merit review (which also contains the various internal and external reports), and the NSF Office of Budget, Finance, and Award Management page on merit review. Further, it will contain links to each directorate for discipline-specific examples. Finally, it will include a link to an updated frequently-asked questions (FAQ) that will clarify each subcategory of Broader Impacts activities [science, technology, engineering, and mathematics (STEM) education, innovation, etc.].

CISE is currently working to collect all of the digital content on broader impacts to create an outline of what this webpage will look like. Next, we will share this prototype across CISE for input before sharing with the NSF Deputy Assistant Directors across the directorates and the NSF Policy Office. Finally, the webpage will be constructed and communicated with the scientific community through various NSF outreach channels.

Recommendation #5: *To increase diversity, CISE should continue to develop and evaluate initiatives that promote the participation of under-represented groups in research, proposal review, and in the computing pipeline.*

CISE strongly encourages meaningful actions that address the longstanding underrepresentation of various populations — including women, African Americans, Hispanics, American Indians, Alaska Natives, Native Hawaiians, Native Pacific Islanders, and persons with disabilities — in computing and closely related fields. Without their participation, talents, and creativity, our Nation cannot meet its imperative for a globally-competitive, computationally-savvy workforce, and we cannot hope to achieve the appropriate scientific, technological, and economic innovations that will serve our highly diverse society.

Initiatives to broaden participation in computing (BPC) include programs designed to: (1) develop, evaluate, and disseminate interventions to directly support the participation of underrepresented groups; (2) support the inclusion of BPC efforts as an accepted and expected part of the research and education award portfolio; and (3) facilitate the inclusion of a broad, diverse community in all CISE programs. Through initiatives such as the BPC Alliances, CISE supports national resources that provide all students with opportunities to develop the computational competencies they will need as part of the 21st-century workforce. The Computer Science for All (CSforAll) program, a collaboration with our colleagues in the Directorate for Education and Human Resources (EHR), aims to build a rich knowledge base on the effective teaching and learning of computing skills and concepts, with particular attention to educational practices that are effective for students from underrepresented groups. The Computing in Undergraduate Education (CUE) program, another CISE-EHR collaboration, seeks to address the needs of undergraduate computer science programs that are preparing larger and more diverse student populations, including majors and non-majors, for careers involving basic competencies in computer science. The CISE BPC Pilot continues to engage a broader set of PIs in developing and implementing meaningful plans for BPC. Through individual PI plans and efforts to coordinate institutional efforts including departmental plans, the BPC Pilot seeks to achieve collective impact on the participation of underrepresented groups. CISE is also supporting the development of tools and resources (e.g., BPCnet[2]) to support departments and individual PIs to develop and monitor the effectiveness of BPC plans.

To build on its BPC strategy, CISE has funded several workshops to bring together faculty from Historically Black Colleges and Universities (HBCUs), Hispanic-Serving Institutions, and Native-Serving/Tribal Colleges. Through past and future convenings, we will identify ways to ensure more constructive engagement of Minority-Serving Institutions in CISE programs including participation in core programs and review panels. These CISE faculty (including those from Community Colleges) will continue to participate in cross-directorate programs (e.g., Inclusion Across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science, Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers, HBCU Excellence in Research, Research Experiences for Undergraduates, and Research Experiences for Teachers) that are designed to broaden participation across STEM disciplines.

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[2] The BPCnet Resource Portal can be found at https://bpcnet.org/.

CISE will weave feedback and accountability into all of its BPC efforts. The CISE Education and Workforce cluster will track progress towards equitable participation of underrepresented groups in computing and closely-related fields for students at all levels – from elementary school through doctoral programs – and in a diverse, globally competitive CISE research community and workforce.

> ***Recommendation #6:*** *To reduce load, introduce flexibility, and increase access to larger pools of qualified and diverse reviewers, CISE should consider the use of rolling proposal submissions for core programs.*

CISE has given careful thought over the last year to the implementation of rolling deadlines in its programs. The number of proposals submitted to CISE has been increasing steadily over the last several years and is correlated with an increase in the community of CISE academics seeking funding from NSF. Similar trends in proposals have been observed by other directorates, and these trends have motivated them to look for creative responses to some of the side effects of high proposal counts, such as the impacts on workload and success rates. Several directorates within NSF have switched to a "no-deadlines" model for many of their programs over the last three years.

CISE sees several reasons to consider switching to no-deadlines:

- Increased flexibility for the research community to submit proposals at a time of their convenience;
- Reduced number of proposals processed and increased proposal success rates (per the experiences of other directorates);
- Increased technical nimbleness and possibly higher proposal quality;
- Improved distribution of NSF staff workload throughout the fiscal year; and
- Improved workload trends for NSF staff and reviewers/panelists in the long term.

Since 2018, CISE and the community have taken several steps to explore the implementation of no-deadlines. The Computing Research Association (CRA) conducted a survey of the community in April 2018; of the 247 responses received, 73% were in favor of no-deadlines. CISE itself began a pilot of the no-deadlines approach in its SaTC program in FY 2019. Next, CISE assembled a task force in the spring of 2019 to better understand this issue. Among the findings identified by the task force were the need for consistent and well-planned messaging to the external community; the development of new tools for portfolio management and budget tracking; and an examination of the results from the SaTC program and other directorates' implementations of no-deadlines. In response to these findings, CISE assembled a second task force to identify specific tasks needed to implement the transition to and execution of no-deadlines. CISE also examined the experience with no-deadlines in SaTC and the Directorates for Geosciences, Biological Sciences, and Engineering (ENG). CISE management then convened a half-day meeting to review this history and weigh the opportunities and challenges associated with various paths forward.

CISE plans to implement no-deadlines in FY 2021 in several of its programs: SaTC (continuing and multi-directorate); CPS (joint with ENG); the new Robotics program (joint with ENG); and, most significantly, the Small projects competition in the CCF, CNS, and IIS core programs. CISE has chosen to focus on Small projects – and not to include Medium and Large projects – for several reasons: 1) Small projects represent the largest fraction of proposals we process, so shifting to no-deadlines here will have the

single greatest impact on our ability to serve our community; 2) by dealing with proposals of the same size class (up to $500,000 per proposal), we are seeking to minimize budget uncertainty associated with proposals arriving throughout a fiscal year and to maintain the robustness of our decision making in the face of that uncertainty; and 3) we have observed that the no-deadlines approach can result in a slightly higher number of proposals needing ad hoc reviews, and we seek to understand how that evolves for our Small proposals before transitioning to Medium and Large proposals.

CISE intends to publish a Dear Colleague Letter announcing this change along with a new CISE Core Program solicitation reflecting this change by the beginning of June 2020.

> ***Recommendation #7:*** *To enable analysis of pre/post-panel decision-making processes, CISE should introduce mechanisms to document reviewer selection practices and factors influencing fund/no-fund decisions.*

To assist PDs (especially new ones) in recruiting diverse reviewers for its merit review process, CISE will document best practices in reviewer recruitment and selection. CISE has tasked its PD Assist Group with developing this document. The PD Assist Group is a network of CISE PDs who meet regularly to promote learning and best practices – providing examples, templates, and suggestions – around common issues such as running panels and making and managing awards. The group began as the PD Onboarding Group, with the goal of providing mentorship to new staff, but evolved to the PD Assist group as more experienced PDs saw the benefits of participating. The PD Assist Group has been asked to identify principles for reviewer selection, brainstorm best practices, and document them. We will then disseminate these best practices among our PDs to promote their use.

In the documentation of CISE fund/no-fund decisions, the COV particularly flagged as an opportunity for improvement the cases of proposals rated "Competitive" by a review panel but ultimately declined. CISE has thus created a Review Analysis template for these cases that focuses on the reasons for the declination decision. CISE carefully considered the adoption of a template Review Analysis with a checklist of reasons for declinations, as suggested by the CCF subcommittee. After consultation with PDs and the NSF Policy Office, we have decided against adopting that approach as it may present an oversimplification of our decision-making process. CISE appreciates that the CCF subcommittee offered that suggestion after considering the workload burden on PDs. We believe that the approach we are adopting – the creation of a template focused on the rationale for the decline – will enhance the documentation of our decision-making process while still reducing workload for staff.

> ***Recommendation #8:*** *To improve program evaluation and reduce unnecessary burden, CISE should reconsider the need for CISE divisional annual reports and focus instead on regular data collection and longer-term trend analysis.*

CISE has participated in the development of an agency-wide COV dashboard to present data in a more standardized and useful way with focused alignment with the questions in the COV report template. The COV dashboard lists separately each question in the COV report template that can be answered quantitatively, and it links to the appropriate data for that question. The data can be queried and downloaded separately by fiscal year, or as a trend across multiple fiscal years. The data can also be visualized as tables and charts or as maps for geographical questions. In light of the development of the agency-wide COV dashboard, CISE will re-examine the need, content, and format of its annual reports going forward.

> ***Recommendation #9:*** *To enhance productivity in award selection and oversight, CISE should pursue efforts to develop needs-based tools that are integrated with existing business processes.*

Deploying improved tools to strengthen our operations, including improved management of our proposal portfolio, is a priority for the directorate. CISE has now announced a vacancy for a Data and Analytics Officer, a new position within the CISE Office of the Assistant Director. The Data and Analytics Officer will assist the directorate in preparing analyses to support planning, decision making, and oversight, and will also identify gaps in our existing tools and lead the development of new tools. This position will be in addition to the current data analyst position supporting the directorate. An important responsibility of the new position will be the development of tools to support our implementation of no-deadlines in several of our major programs.

CISE will also review its engagement with NSF-wide IT governance mechanisms. We plan to convene CISE personnel engaged with these mechanisms to strengthen internal coordination and identify CISE-wide priorities for consideration by the agency.

CISE also has a strong presence in Renewing NSF, an agency-wide reform and modernization effort. Renewing NSF has four pillars, one of which is focused on improving IT for internal and external stakeholders. CISE co-chairs the overall Renewing NSF effort, and CISE played a critical role in coordinating with the NSF Division of Information Services to develop the IT pillar. Among the bold steps under this pillar are a new mechanism to facilitate IT innovation within the agency, improved IT training, better service for external users, and the appointment of an agency-wide Chief Data Officer.

> ***Recommendation #10:*** *To attract highly qualified and diverse members of the CS research community as IPA rotators, NSF should address disincentives hindering their recruitment and consider mechanisms that would allow them to resume an active research agenda upon returning to their home institutions.*

CISE has been fortunate to attract highly qualified members of the research and education community to serve rotational assignments as PDs in recent years. That said, we acknowledge the challenges identified by the COV. Policies for Intergovernmental Personnel Act (IPA) rotators are set agency-wide, and CISE serves as a member of the agency-wide IPA Steering Committee. We will continue to share our experiences in recruiting and retaining IPAs through that body.

Conclusion

CISE agrees with the COV's finding that the COV review "comes at a time of significant opportunities and also significant challenges." Thanks to the COV and its recommendations, we are better positioned as a directorate to address these opportunities and challenges. The COV surfaced a number of topics warranting NSF and CISE attention, including budget; program portfolio; the CAREER program; broader impacts; broadening participation; rolling proposal submissions; reviewer selection; proposal decision documentation; administrative data; business tools; and the IPA mechanism. We are grateful to the members of the COV, particularly the Chair, Azer Bestavros, and the Vice Chairs, Mary Hall, Sonia Fahmy, and Julia Hirschberg, for their commitment, enthusiasm, and thoughtfulness. The COV's recommendations together with our responses above will allow us (a) to continue to refine our processes and practices to continually improve our service to the community and (b) support frontier

science and engineering as well as workforce development to enhance US competitiveness in computing, communication, and information technologies in the years to come.