U.S. Department of Energy: Computational Science Graduate Fellowship 1991–2021

A follow-up study of recipients and programmatic outcomes

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1.   Introduction

This report is an update on a 2017 study, *The U.S. Department of Energy Computational Science Graduate Fellowship, 1991–2016: A Follow-up Study of Recipients and Programmatic Outcomes.*[1] This new study examines Department of Energy Computational Science Graduate Fellowship (DOE CSGF) recipients through an extended five-year period ending in 2021, and includes fellows' outcomes and professional accomplishments, alumni's employment locations and achievements, and recipients' impact on national priorities through research and education.

As a nationally recognized program since its 1991 formation, the DOE CSGF continues to be considered a model of a successful program that addresses the challenging national workforce needs in computational science and engineering. The DOE CSGF has a particular emphasis on high-performance computing (HPC) that enables advancements in computational science and engineering (CSE) relative to areas of national importance.

The Krell Institute has managed the fellowship on behalf of the DOE since 1997. During its decades-long management tenure, Krell has worked in concert with DOE to anticipate changes to the science and technology landscape and to adjust the program accordingly. In recent years, the DOE CSGF developed a track to provide opportunities for developing essential mathematics and computer science professionals, and it also focused on diversity and inclusion efforts across all disciplines and fellowship activities. Both will be addressed in this report.

Some challenges simply cannot be anticipated: The global pandemic has, without question, impacted the program and its participants during the timeframe analyzed in this report. While the DOE CSGF mobilized to offer virtual experiences and interactions with a positive response, collective feedback proves that in-person access to this vibrant and engaged fellowship community remains one of its most valued attributes.

The DOE CSGF's core requirements remain consistent: Recipients must participate in multidisciplinary studies, carry out at least one 12-week DOE laboratory research practicum, and contribute to an annual program review where the fellows present their research for sponsor review.

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[1] https://www.krellinst.org/csgf/study

In conducting this study, the following methods were used: (1) a survey of all DOE CSGF recipients, both current and past, dating back to the program's inception in 1991; (2) interviews with a sample of alumni who completed the program between 2011 and 2018 and a sample of current fellows; and (3) an analysis of curricula vitae (CV) data collected from alumni and current fellows.

In this introductory chapter, we provide a brief background on the DOE CSGF program, its purpose, and its specific features. This is followed by a brief conceptual discussion of the field of computational science as to provide context for the role of the DOE CSGF relative to the science, technology, engineering, and mathematics (STEM) workforce in general. The remainder of this chapter provides a brief overview of the methods and data sources used in conducting the study, following by an outline of the contents of the report.

Background on the DOE CSGF Program

Sustaining national progress through scientific and technological discovery and innovation is paramount in preparing the country for challenges in scientific computing. This progress will require a workforce with a wide range of expertise in applied sciences and computing. Accordingly, the DOE CSGF looks to develop the kinds of talent necessary to meet these demands.

The DOE CSGF was designed to address DOE National Laboratory needs and the anticipated demand in the wider technical community for trained computational scientists. In fact, there is a serious need for highly skilled and technically agile people who can support the fast-moving research environment the nation requires. To that end, the DOE maintains a wide range of programs "designed to help students explore the array of opportunities offered by DOE."[2] Included among these important initiatives is the DOE CSGF.

For 30 years, the fellowship program has supported doctoral students in the pursuit of "novel scientific or engineering discoveries" using high-performance computing (HPC) resources.[3] It advocates taking advantage of innovations in emerging technologies to advance knowledge and practical applications. The DOE CSGF is especially on target since computational science has been

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[2] https://energy.gov/jobs/services/students-recent-graduates

[3] From the DOE CSGF application.

described as essential to advances throughout society and deemed one of the most important technical fields of the 21st century.[4]

The DOE CSGF is defined within the Advanced Scientific Computing Research (ASCR) program's mission "to discover, develop, and deploy computational and networking capabilities to analyze, model, simulate, and predict complex phenomena."[5] Additionally, a function of ASCR is to continue its leadership for the nation and the world "in supercomputing, high-end computational science, and advanced networking for science."[6] Sponsored by two entities within the DOE, the Office of Science and the National Nuclear Security Administration, the fellowship is aimed at training a workforce who can push the edge for U.S. science and innovation.

The DOE CSGF has emphasized the use of computation to understand natural phenomena and to address engineering problems since its inception. As such, the program's focus areas have been rooted more heavily in science and engineering disciplines. With the evolution of exascale computing and the challenges these technologies present, the DOE CSGF responded by expanding the program to provide opportunities for students interested in focusing on the use of mathematics and computer science in high-performance computing and data-intensive science.

To address the increasing workforce demand for those skilled to support and sustain these emerging, next-generation computing systems, the DOE CSGF added a mathematics and computer science (Math/CS) track in 2018. The track allows Ph.D. students in applied mathematics, statistics or computer science – in one of these departments or their academic equivalent – to focus on issues in high-performance computing as a broad enabling technology as opposed to any particular science or engineering application.

Examples of research areas of interest to DOE include algorithms, programming models, memory management, tools, statistics, uncertainty quantification, artificial intelligence, machine learning, quantum computing and neuromorphic computing. Even with this emphasis, Math/CS track fellows still complete the DOE CSGF's interdisciplinary program of study, which includes science and engineering coursework aimed at exposing them to the computational needs driving the development of new enabling technologies.

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[4] https://www.nitrd.gov/pubs/pitac/pitac_report_computational-science_2005.pdf

[5] https://sc.osti.gov/ascr/About

[6] https://science.energy.gov/ascr/about

In 2021, the track generated 75 applicants for 10 available fellowships, which made up roughly one-third of the incoming cohort. There are now four classes of Math/CS fellows – a total of 28 individuals equaling one-quarter of all program participants – engaged in research and collaboration to address and affect the present and future challenges of data-intensive science.

The DOE CSGF is highly competitive, with qualified applicants far exceeding the number of available awards. (For example, in 2021, there were 484 applicants who vied for the 32 fellowships awarded that year.) Eligibility is extended to senior undergraduate and first-year graduate students pursuing doctoral degrees in the physical, engineering, computer, mathematical, or life sciences.[7]

The DOE CSGF is open to U.S. citizens or lawful permanent residents who are planning full-time, uninterrupted study toward a Ph.D. at an accredited university in the United States. Selected doctoral students are provided support for up to four years of study. The fellowship screening and selection committees are composed of experts in related fields from academia, the DOE and other government agencies, and industry; many who are former DOE CSGF recipients.

The DOE CSGF has four principal objectives:[8]

1. To help ensure an adequate supply of scientists and engineers appropriately trained to meet national workforce needs, including those of the DOE, in computational sciences.

2. To raise the visibility of careers in the computational sciences and to encourage talented students to pursue such careers, thus building the next generation of leaders in the field.

3. To provide practical work experiences for the fellows that allows them to encounter the cross-disciplinary, team-based, scientific research environment of the DOE National Laboratories.

4. To strengthen collaborative ties between the academic community and DOE National Laboratories so the fellowship's multidisciplinary nature builds the national community of scientists.

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[7] Individuals who are employed may also apply for the fellowship, but they account for a very small percentage of applicants.

[8] http://www.krellinst.org/csgf/about-doe-csgf

The Field of Computational Science and Engineering

CSE is an evolving field that entails "the innovative and essential use of high-performance computation, and/or the development of high-performance computational technologies, to advance knowledge or capabilities in a scientific or engineering discipline."[9] CSE is a multidisciplinary area with connections across many fields. It focuses on the development of problem-solving methodologies and robust tools for the solution of scientific and engineering problems and, arguably, will continue to play a dominating role for the future of the scientific discovery process and engineering design. CSE encompasses the systematic development and application of computing systems and computational solution techniques for modeling, simulation, and analysis of scientific and engineering phenomena. With the emergence of HPC, CSE can be engaged to enable HPC applications and enhance science and engineering applications. Using HPC as an essential technology results in the nation's need for further specialized workforce training.

To model complex systems, scientists and engineers develop computer programs and application software necessitating massive amounts of calculations, the execution of which are possible only via distributed computing platforms or on high-performance computers or supercomputers. As a multidisciplinary field, CSE can be engaged both to enable HPC applications to important domain-specific problems and to confront "grand-challenge" science and engineering applications. Accordingly, it can lead to insights that might not be possible if relying on more traditional theory or experimentation alone.

The role and purpose of CSE in this environment is one of next-generation computing, supporting large-scale operations that cover "applications in science/engineering, applied mathematics, numerical analysis, and computer science. Computer models and computer simulations have become an important part of the research repertoire, supplementing (and in some cases replacing) experimentation. Going from application area to computational results requires domain expertise, mathematical modeling, numerical analysis, algorithm development, software implementation, program execution, analysis, validation, and visualization of results. CSE involves all of this."[10] More to the point, the DOE CSGF program was launched specifically to address the anticipated national demand for trained computational scientists.

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[9] From the DOE CSGF application.

[10] https://www.siam.org/students/resources/report.php

Methods and Data Sources

In this section, we provide a brief overview of each of the data collection methods used in this study, which included a survey, interviews, and an analysis of CV data.

Surveys

In September through October 2021, a survey was administered to all 529 DOE CSGF recipients for whom contact information was available. (A total of 565 individuals have participated since the program's inception; 7 alumni are now deceased, and there was no valid contact information for 29 recipients.) A total of 296 surveys were received, for an overall response rate of 56 percent. The response rate among alumni was 50 percent, with 213 alumni out of 422 completing the survey. The response rate among current fellows was 78 percent, with 83 fellows out of 107 completing the survey.

Westat worked collaboratively with Krell Institute to update the two survey instruments administered to DOE CSGF recipients in 2016 (one for alumni and one for current fellows). Copies of the survey instruments administered as part of this study are included in Appendix A.

In this report, we present frequencies for all survey items. In analyzing the survey data, we found item-level analyses of aggregate responses to be most useful, for those items in which differences in responses were observed on a descriptive basis, such differences are noted in the findings chapters. However, we did examine the degree to which alumni respondents differed based on when they participated in the program using tests of statistical significance. In doing so, we divided the entire set of 296 survey respondents into five distinct cohorts based on when they started the fellowship:

- Between 1991 and 2000

- Between 2001 and 2006

- Between 2007 and 2012

- Between 2013 and 2017

- Since 2018 (i.e., current fellows)

In conducting significance tests by cohort, we excluded the most recent cohort, which consists exclusively of current fellows.[11] Where significant differences were observed between any of the four alumni cohorts, these results are noted in the findings chapters.

Interviews

In October through November 2021, Westat conducted interviews by videoconference (e.g., Microsoft Teams or Zoom) with 20 DOE CSGF alumni who completed their fellowship between 2011 and 2018, as well as 10 current fellows. Although the DOE CSGF program dates back more than 30 years, the guiding principle of our sampling approach for alumni was to include those recipients who have had enough time for the benefits of their participation in the fellowship to have accrued but would still be able to accurately reflect on and describe their experiences and activities since completing the program. Similarly, in drawing a sample of current fellows, we included those who began their fellowship in 2018 and 2019 and excluded the most recent cohort of fellows so that respondents would have had sufficient opportunity to participate in each key component of the program (e.g., research practicum, annual program review meetings, etc.) addressed in the interviews. In drawing a stratified sample of interview candidates (i.e., 50 alumni and 25 current fellows), we took into account several characteristics (e.g., gender, field of study, practicum location, etc.) to ensure that each group reflected the overall makeup of those included in the sampling frame.

Interviews were conducted using a standardized protocol, which is provided in Appendix B. Each interview was recorded (with the participant's permission) and transcribed. As a first step, designed to ensure accuracy and completeness of the interview data, each transcript was reviewed by the interviewer to ensure that all key words, phrases, and acronyms were captured by the transcriber both accurately and in their entirety. For instances where the interviewer uncovered a missing word/phrase, an unspecified acronym, or other discrepancies, the interviewer reviewed the audio recordings to obtain the correct information and revise the transcripts accordingly so that they were accurate and complete in all areas.

In coding the interview data, we began with a deductive framework and added to and/or modified it as we encountered other important topics. Specifically, we developed an initial set of descriptive

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[11] A determination was made, in consultation with Krell, that although many items are similar across the alumni and fellow survey instruments, making comparisons between the two groups is not entirely valid given that fellows have not yet had the same extent of participation as alumni (e.g., some fellows included in the survey were only in their first year of the program).

coding categories based on constructs from the interview protocol and from prior years of data collection. The codes that were developed in advance were later refined to capture additional themes and insights that emerged from a closer examination of the interview data. One document for each interview was uploaded into NVivo, a text-based relational database that is designed for systematically organizing, managing, and analyzing qualitative data with rigor, as well as for allowing more transparency in the coding and analysis process. Once the documents were uploaded into NVivo, we developed a database specific to this set of interviews to allow for a more structured analysis of the interview data. The analysis and write-up focused on providing an overall summary of alumni and current fellows' responses to each of the areas addressed in the interviews. Consideration was also given to the relative frequency with which specific issues or topics were raised, as well as the extent to which different respondent types (i.e., alumni and current fellows) responded differently to the interview questions. In Chapters 3 and 4, we report key themes and patterns in the responses of the alumni and fellows as well as illustrative examples and anonymous quotes from individual respondents.[12]

Curriculum Vitae

Between September and October 2021, Krell Institute requested that all 529 DOE CSGF recipients for whom contact information was available provide an updated copy of their curricula vitae (CV). Fifty-seven percent of the 529 recipients (304 individuals) provided an updated CV. For alumni, the response rate was 53 percent (222 CVs), and for current fellows the response rate was 77 percent (82 CVs). The CVs were coded to capture recipients' productivity and accomplishments in the following areas:

- Publications, including:
    1. Journal articles
    2. Conference presentations, papers, posters/other presentations
    3. Reports
    4. Books and book chapters

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[12]Respondent quotes were edited for grammar and readability as needed, without modifying the participant's point of view.

5. Other products

- Awards or honors received

- Grants and/or contracts awarded

- Patents received

While a total of 222 alumni CVs were received as part of the data collection for this study, the data from these CVs were merged with data from CVs of additional alumni who provided a CV as part of the 2017 study but did not provide an updated CV in 2021. As a result, the total number of alumni for whom CV data was available for this study was 292.

In order to capture accomplishments since receiving the fellowship, coding was focused on publications, awards, grants, and patents received beginning with the calendar year after recipients began the DOE CSGF (e.g., for a fellow beginning the program in 2010, only their work from 2011 and later was coded).[13] A copy of the coding protocol used as part of this study is included in Appendix C.

The CV data for alumni and current fellows were analyzed separately due to the fact that only a limited number of current fellows included data that could be coded from their CVs because of the relatively short amount of time they have had to publish, receive awards, etc. In providing results from the CV analysis, which are included in Chapter 5 of this report, the main focus was on descriptive summaries of recipients' professional accomplishments, including the total number and average number of publications, awards, grants, and patents. However, in addition to analyzing levels of productivity, we examined the quality of journals in which DOE CSGF recipients published their work. In doing so, Westat used data from the Eigenfactor Project, which measures how influential a journal is in a given year, as determined in part by how frequently articles from that journal are cited.

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[13]Presentations made by recipients at the DOE CSGF annual program review during their fellowship were excluded, since this work is required of all recipients.

Outline of This Report

This report comprises four substantive chapters, each pertaining to a specific theme addressed in the study. Specifically, Chapter 2 presents information on the characteristics of all DOE CSGF recipients. Chapter 3 presents findings on alumni and current fellows' application and entry into the fellowship. Chapter 4 presents findings on alumni and current fellows' experiences in the program. Chapter 5 presents findings on alumni's career activities and accomplishments since participating in the program. Chapter 6 summarizes findings around the main themes in each chapter and provides conclusions.

Appendix A includes the two survey instruments administered to alumni and current fellows. The interview protocols can be found in Appendix B, and the protocol used in coding CVs is provided in Appendix C.

2.   Characteristics of DOE CSGF Recipients

This chapter presents information on the characteristics of all 565 recipients — 107 current fellows and 458 alumni[14] — of the DOE CSGF since the program began in 1991. The information in this chapter is based on administrative data maintained by Krell Institute and describes the complete set of DOE CSGF recipients, including those now deceased and those for whom updated contact information was not available.

Number of DOE CSGF Recipients

Figure 2-1 shows the number of DOE CSGF recipients for each year since 1991. The number of recipients in any given year has varied by year from a minimum of 6 (in 1995) to a maximum of 32 recipients (in 2021), with an average of approximately 18 fellows per year. This fluctuation is a direct reflection of available funding during each fellowship year rather than the number of qualified applicants.

Figure 2-1.   Number of DOE CSGF recipients, by year and cohort

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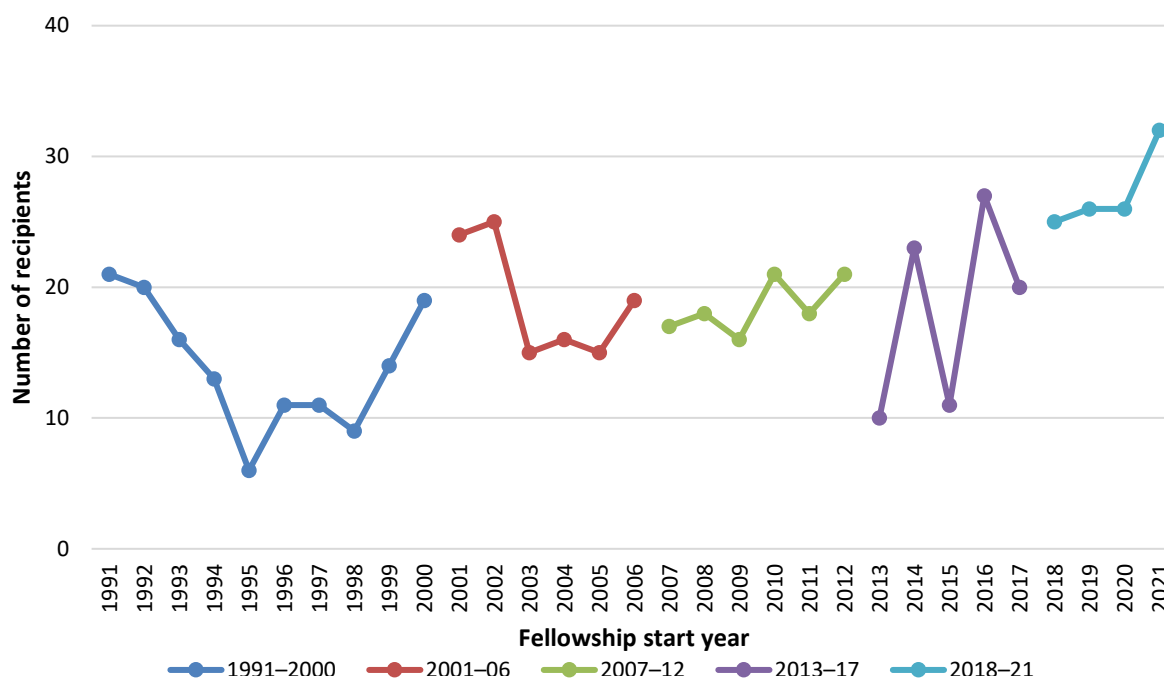
[14]This number includes 7 alumni who are deceased.

In order to examine any changes in the characteristics of DOE CSGF recipients over time, the total of 565 recipients were divided into five cohorts for the purposes of this study. While these cohorts are also included in Figure 2-1 above, Table 2-1 below shows the total number of recipients within each of the groups. In the remainder of this chapter, we use these five cohorts to examine the extent to which the characteristics of DOE CSGF recipients have varied over time.[15]

Table 2-1.   Number of DOE CSGF recipients, by cohort

	1991–2000	2001–06	2007–12	2013–17	2018–21
Total recipients	140	114	111	91	109

NOTE: The 2018–21 cohort consists of current fellows, with the exception of two recipients who have since left DOE CSGF. These two recipients are considered alumni for the purposes of this study.

Gender

Overall, 72 percent of DOE CSGF recipients have been men, and 28 percent have been women. As Figure 2-2 shows, the gender makeup of DOE CSGF recipients has changed over time. In the earliest years of the program, less than 20 percent of recipients were women. The proportion of women increased to 40 percent for those who entered the program between 2013 and 2017, and this proportion remained consistent for those who entered between 2018 and 2021.[16]

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[15] As indicated in Chapter 1, we also use these five cohorts in subsequent chapters of this report to examine the degree to which DOE CSGF recipients differed in their survey responses based on when they participated in the program.

[16] An option for DOE CSGF applicants to select "non-binary" in response to question on gender was added in 2021.

Figure 2-2. Gender makeup of DOE CSGF recipients, by cohort
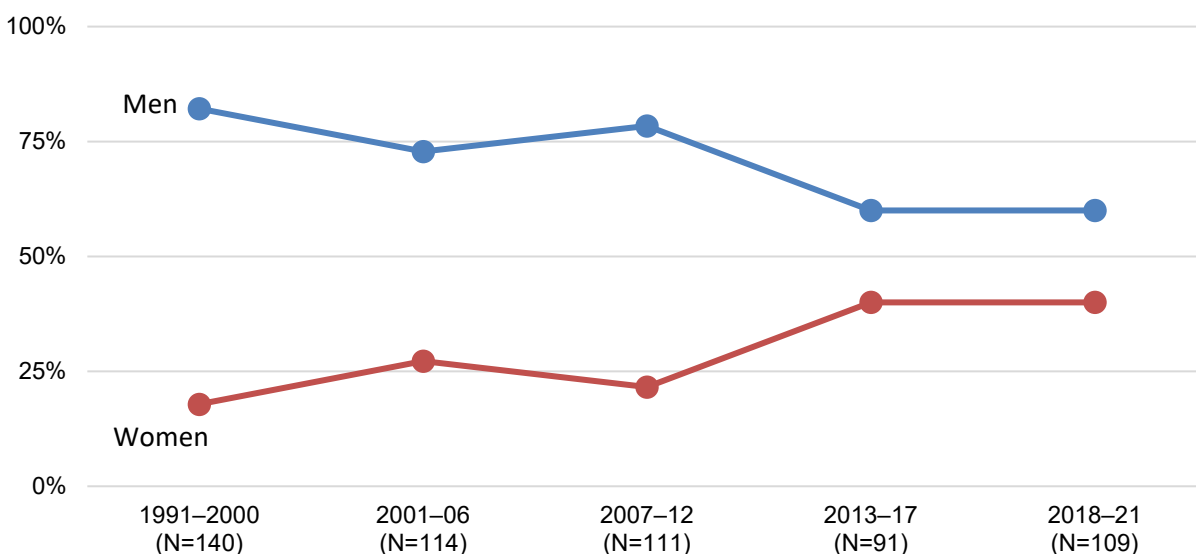
Field of Study

DOE CSGF recipients have pursued degrees in a wide variety of subject areas. For the purposes of this study, we categorized the specific degree field of all individual recipients into four main field categories: biology/bioengineering, mathematics/computer science, engineering, and physical science.[17] Table 2-2 shows the percentage of recipients within these four category groupings. Overall, engineering and physical science have been the most common degree field among DOE CSGF recipients (33 percent each), while the fields of mathematics/computer science and biology/bioengineering make up 21 percent and 13 percent overall, respectively.

Table 2-2. Percent of DOE CSGF recipients, by field of study

Field of study	Percent of recipients (N=565)
Engineering	33
Physical science	33
Mathematics/computer science	21
Biology/bioengineering	13

SOURCE: Administrative data maintained by Krell Institute and provided to Westat for inclusion in this study.

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[17]These include the recipients' degree field at the time of their entry into the program and does not account for any changes in individual recipients' degree field after entering the program.

Figure 2-3 shows how the proportion of recipients within each of the four field categories has shifted over time. More than 50 percent of recipients in the earliest cohort were in engineering, while 20 percent of those in the most recent cohort were in this field. For recipients starting the DOE CSGF between 2018 and 2021, physical science was the most common field (39 percent). In addition, the proportion of recipients in computer science/mathematics has increased substantially in recent years, from 16 percent for those in the 2013 to 2017 cohort to 32 percent for those in the most recent cohort. This increase can be directly attributed to the 2018 addition (and subsequent growth) of the Math/CS track.

Figure 2-3. Percent of recipients in each field of study, by cohort
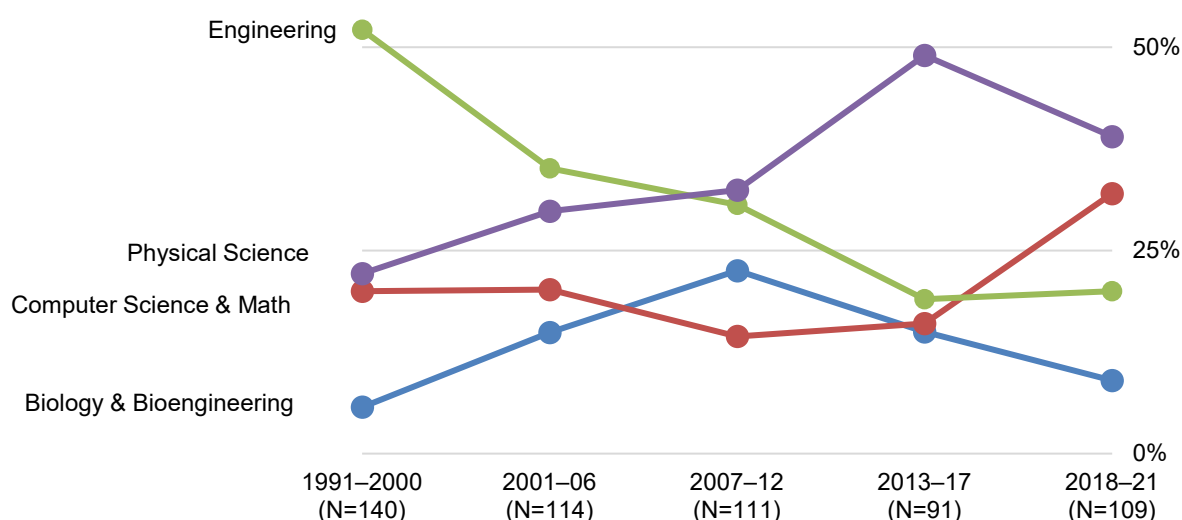
Institution Type

Overall, DOE CSGF recipients have attended 76 universities representing 33 states and the District of Columbia. Ninety-eight percent of recipients have been enrolled in R1 doctoral universities, according to the Carnegie Classification of Institutions of Higher Education.[18] Under the Carnegie Classification, R1 institutions are those with the highest level of research activity.

Across all years, just over half of DOE CSGF recipients (53 percent) attended private universities, while 47 percent studied at public institutions. As shown in Figure 2-4, while a larger proportion of recipients pursued doctoral degrees at public institutions in the earliest cohort, the proportion of

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[18]For more information on the Carnegie Classification of Institutions of Higher Education, see http://carnegieclassifications.iu.edu/classification_descriptions/basic.php.

public institutions to private institutions changed over the next three cohorts, with private institutions becoming increasingly represented. However, the most recent cohort is more equally balanced, with 51 percent at private institutions and 49 percent at public institutions.

Figure 2-4.   **Percent of recipients attending a public or private institution, by cohort**

| | 1991–2000 (N=140) | 2001–06 (N=114) | 2007–12 (N=111) | 2013–17 (N=91) | 2018–21 (N=109) |
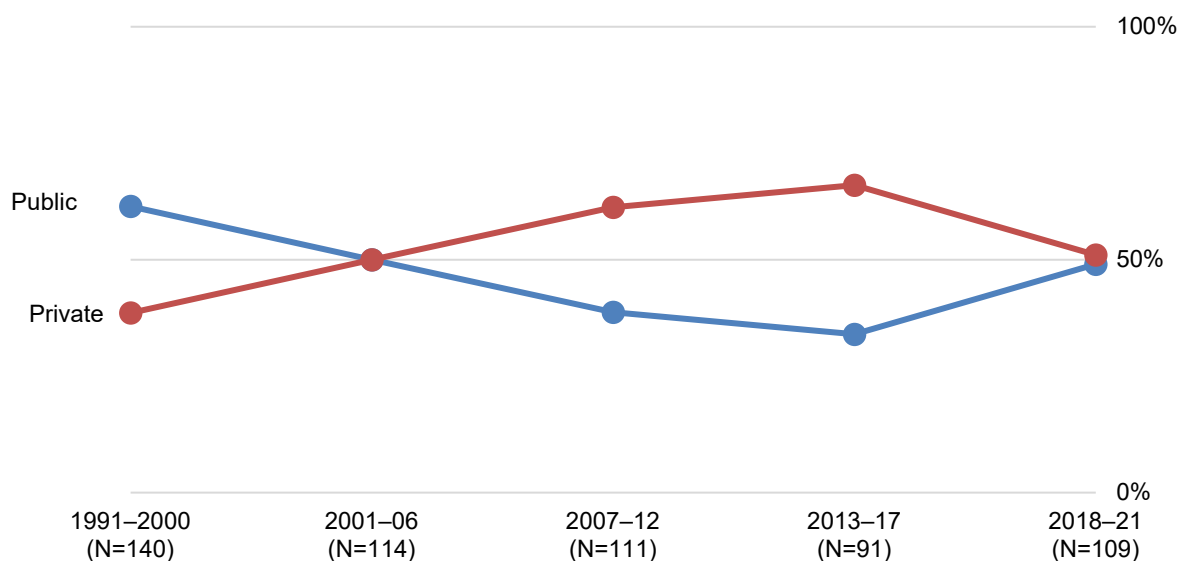
While a total of 76 institutions (25 private and 51 public) are represented by the 565 DOE CSGF recipients, six institutions account for more than 40 percent of all recipients. As Figure 2-5 shows, 12 percent of fellowship recipients have pursued doctoral studies at Massachusetts Institute of Technology (MIT), with the next most commonly represented institutions being Stanford University and the University of California, Berkeley (7 percent each). Three other institutions are also heavily represented: Harvard University, the University of Illinois Urbana-Champaign, and California Institute of Technology (Caltech). Each of these three universities account for at least 5 percent of the total number of recipients. In addition, across all 76 institutions represented by all fellows and alumni, the average number of recipients per institution is 7 and ranges from a single fellow to as many as 68 per institution.

Figure 2-5.   Percent of recipients attending specific institutions
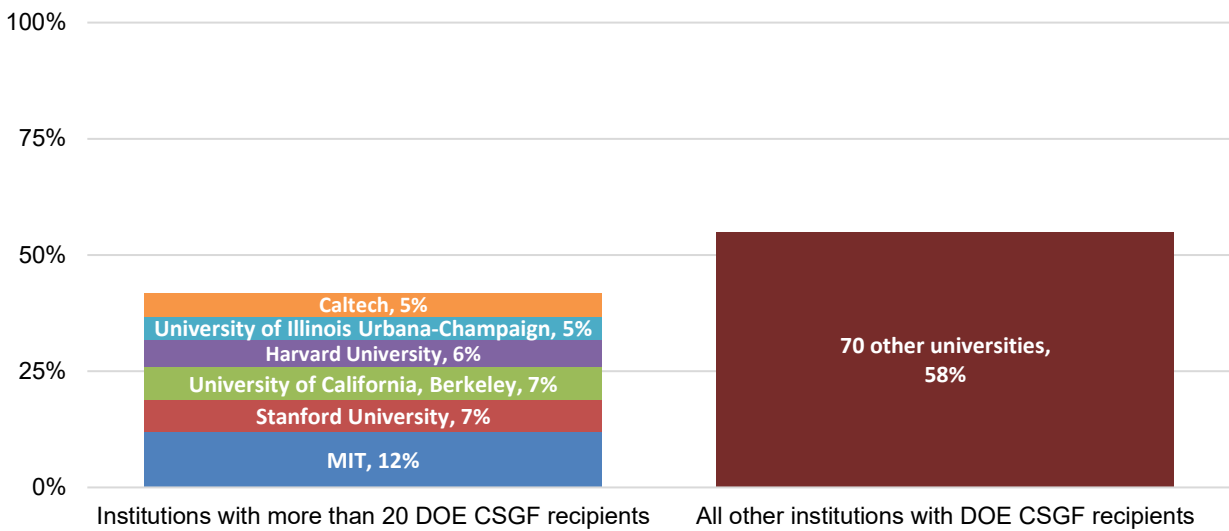
3. Findings on Recipients' Recruitment and Entry Into the DOE CSGF Program

This chapter presents findings on recipients' recruitment and entry into the DOE CSGF program. The findings included in this chapter are based on survey data collected from current fellows as well as interview data from a sample of alumni and current fellows. Topics that are discussed include the sources of information most important in recipients' decision to apply for the DOE CSGF, followed by findings on the extent to which recipients applied to other fellowship programs and what types of fellowship they pursued. The last section includes findings on recipients' reasons for accepting the DOE CSGF.

Sources of Information About the DOE CSGF Program

In the survey, fellows were asked their opinions about which source of information was most important in their decision to apply for the DOE CSGF. As Figure 3-1 shows, the most frequent source of information was an academic advisor or other professor, with 39 percent of all fellows selecting this option. The next most common sources were the DOE CSGF website (16 percent), former or current DOE CSGF recipients (13 percent), and DOE employees (12 percent). All other options included in the survey were cited by less than 10 percent of fellows.

Figure 3-1. Percent of current fellows reporting the source of information that was most important in their decision to apply for the DOE CSGF program (n=83)

Source	Percent
Academic advisor or other professor	39%
DOE CSGF website	16%
Former or current DOE CSGF recipient	13%
DOE employee (laboratory or otherwise)	12%
Fellow student	7%
DOE CSGF poster or mailing	6%
University career placement office	2%
Advertisement in a professional publication	1%
Departmental or organizational emails, listserv, etc.	1%
Other	3%
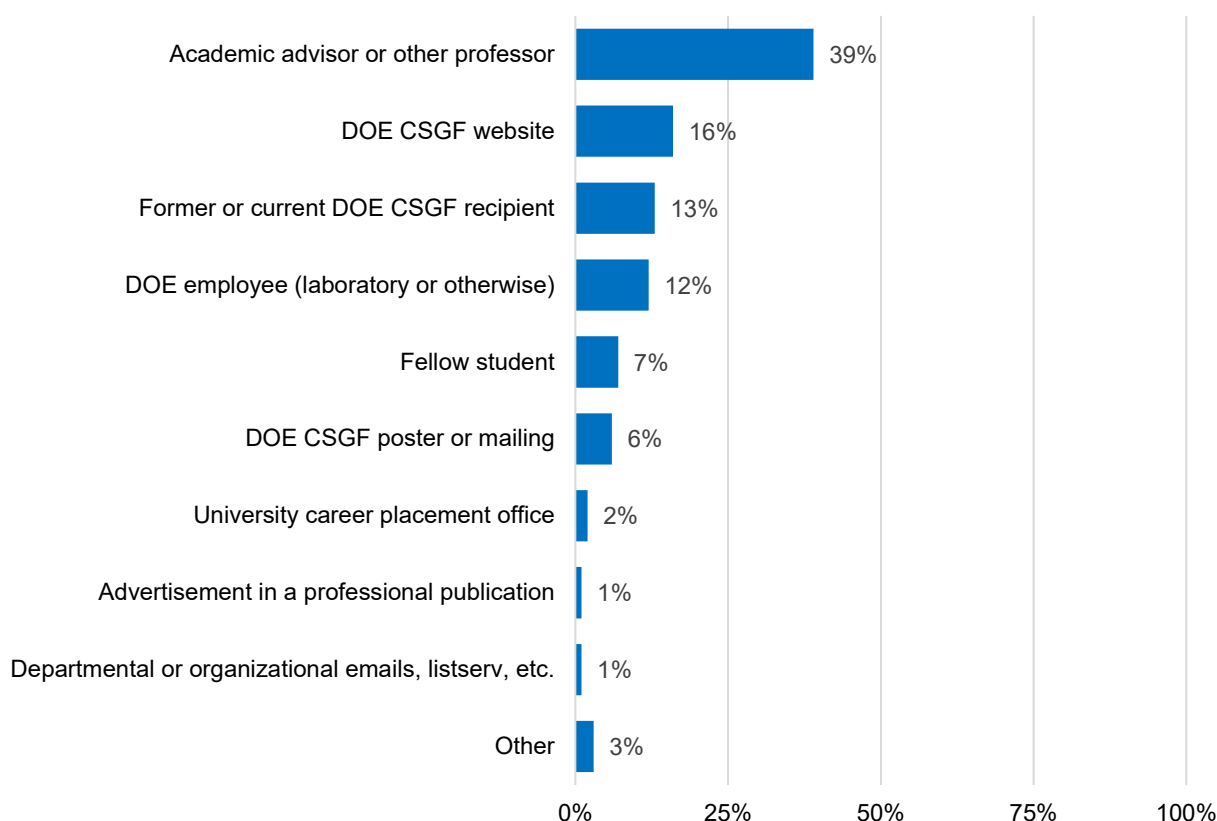
NOTE: Percents may not sum to 100 because of rounding.

Other Fellowship Programs Pursued by DOE CSGF Recipients

When asked in the survey about whether they had applied to any other fellowship programs in addition to the DOE CSGF, 73 percent of fellows (61 total) indicated that they had, while 27 percent (22 total) applied only to the DOE CSGF, as shown in Figure 3-2. As Figure 3-2 also shows, 43 percent of all 83 fellows who responded to the survey applied to and were accepted by at least one other fellowship program, while 30 percent of the 83 fellows applied to at least one other fellowship but were not accepted.

Figure 3-2.   Percent of current fellows who applied to other fellowship programs (N=83)

Applied to other fellowships	Accepted 43% / Not Accepted 30%
Did not apply to other fellowships	27%

0%   25%   50%   75%   100%
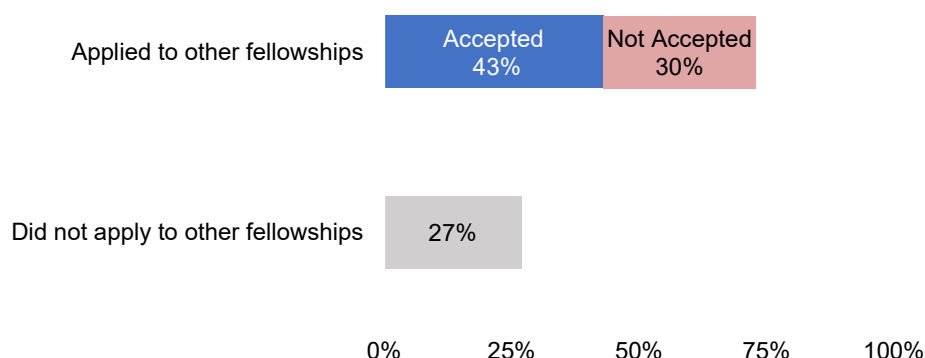
NOTE: Percents may not sum to 100 because of rounding.

The survey respondents (i.e., fellows only) who indicated that they had applied for fellowships other than the DOE CSGF were also asked about the specific category (or categories) in which they pursued a fellowship. As Figure 3-3 shows, 59 of the subset of 61 who had applied to at least one other program pursued a government-sponsored fellowship, while 17 respondents in that same group pursued a university-sponsored fellowship. In addition, 8 respondents indicated they pursued an industry-sponsored fellowship program, and 6 pursued a fellowship in a category other than government, university, or industry (e.g., foundations, nonprofit organizations, etc.).

Figure 3-3.   Of the current fellows who indicated they had applied for programs other than the DOE CSGF, number reporting the categories in which they pursued a fellowship, by number of applicants and number accepted into program (N=61)

Category	Applied	Number accepted
Government	59	28
University-sponsored	17	11
Industry	8	3
Other	6	1

■ Applied   ■ Number accepted
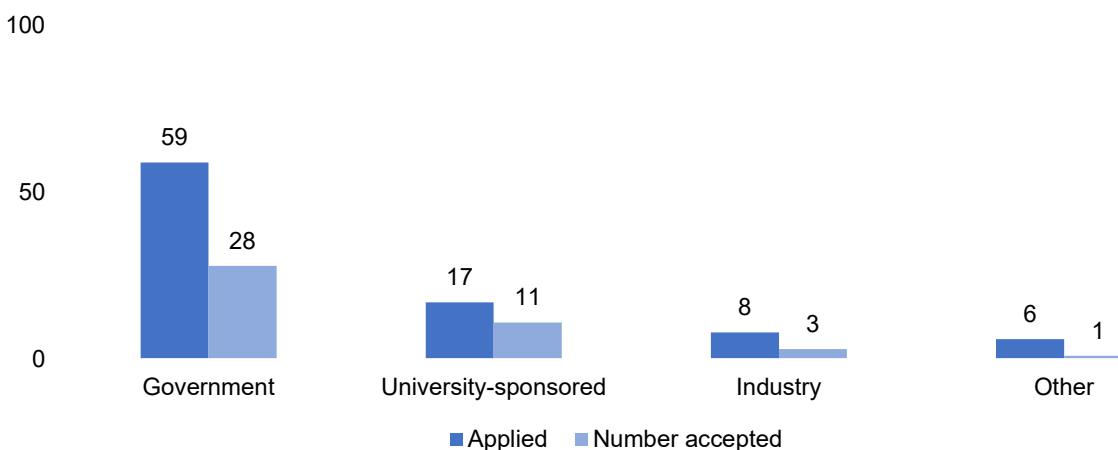
Reasons for Accepting the DOE CSGF

Fellows were asked in the survey to provide the three most important reasons for accepting the DOE CSGF. As Figure 3-4 shows, the most frequently cited reason was that the tuition support and stipend were appealing, which was cited by 69 percent of respondents, and the prestige of the DOE CSGF program, which was cited by 51 percent. Two other reasons were cited by more than one-third of respondents: 40 percent cited the ability to conduct a practicum at a specific laboratory, and 36 percent considered the program to be a stepping stone to their career. Each of the other reasons provided as options in the survey were cited by less than a third of the respondents.

Figure 3-4.   Percent of current fellows reporting the reasons that were most important in their decision to accept the DOE CSGF (n=83)
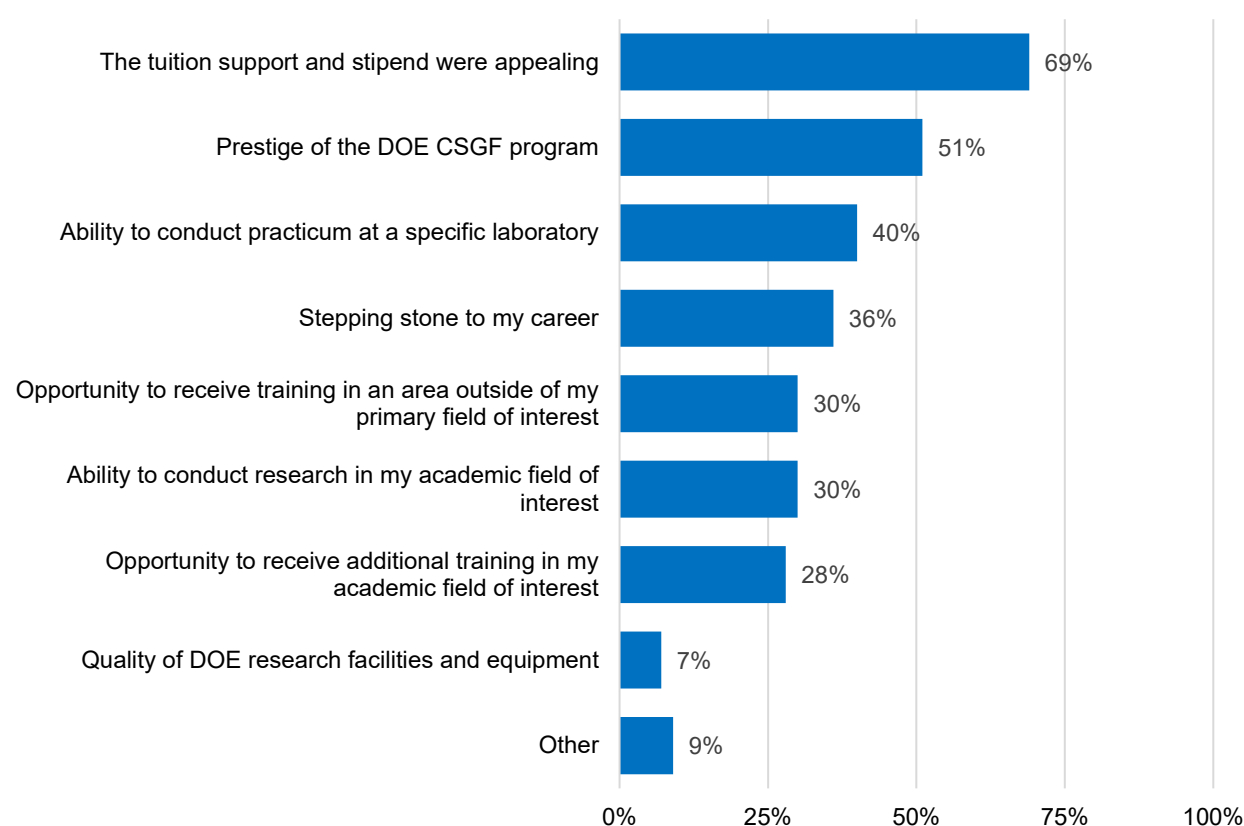
When asked in the interviews about why they decided to pursue and accept the DOE CSGF, both alumni and current fellows' interview responses were largely consistent with the survey findings. First, a majority of the alumni and fellows interviewed mentioned financial considerations, with most stating that the DOE CSGF offered a higher level of financial support and more years of support than other similar fellowships. For example, as one alum stated, "This was a four year

program, while most are two to three… and it had the most generous stipend," while another said, "Compared to some other fellowships out there, the incentives and benefits are a little bit nicer compared to, say, the National Science Foundation's [NSF] graduate fellowship." However, many found the combination of the financial benefits with some of the program's specific components the most appealing. "This was a little bit longer, a couple more benefits, the opportunity of working at the labs and doing practicum projects." According to another alum:

> *The benefits of the DOE CSGF really stood out from the other fellowships. The parts that were most attractive to me, one was that it was a smaller program and actually had a sense of community around it. I think the other ones are more like, 'Here's the fellowship, you do your thing.' There were the annual program reviews and then hand in hand with that was the opportunity to do a practicum. The National Lab system was not something that I really had considered or knew much about coming into grad school but even just within my first year and then through the application for the CSGF fellowship, I learned a little bit more, and that was something that I was interested in pursuing more.*

Many of the alumni and fellows interviewed also described how the fellowship was consistent with or would accommodate their interest in computational science, working on supercomputers or in HPC, and other related areas. One respondent stated, "It's somewhat broad, but computational science is what stood out to me. I saw computational science so I thought, 'let me take a closer look into this.'" Similarly, another stated, "I was applying to the battery of federal graduate [fellowship] programs, such as NSF, DOD [Department of Defense], all those things. I wanted to do quantum computing research and had done some HPC, so it seemed like I fit the bill for it." In addition, one fellow specifically cited the Math/CS track that was recently added to the program as appealing:

> *The CSGF in the past was targeted towards students in biology, chemistry, and physics. Being someone that's in the computer science department, it wasn't really an option for me to apply because I just didn't fit the same background as the other students. However, the first year I applied, they offered the new math and computer science track, so that was a big selling point for me, to be part of that first class for that track.*

In addition, while in the survey and interviews many respondents cited the program's prestige as a reason for accepting the DOE CSGF, several alumni and fellows described in the interviews how they were impressed or intrigued by the information they had received about the program. For example, as two others stated:

> *I was in the process of looking at different fellowships during my first year of my Ph.D., and obviously CSGF isn't the only one, but I went on the* [program's] *website and was looking at the various research topics and interests of the current fellows. It just seemed like they were all pretty accomplished, and that information was made more available than it was for the other fellowships.*

I was impressed by the fellow profiles that were available on the Krell website. I think other fellowships didn't have that information. It looked like a good fellowship because a lot of the current fellows are publishing, and it looked like in good journals and conferences. I naturally wanted to associate myself with the success that these current fellows were having.

4. Findings on Recipients' Experiences in the DOE CSGF Program

This chapter presents findings on recipients' DOE CSGF experiences. The findings included in this chapter are based on survey data collected from DOE CSGF alumni and current fellows as well as interview data from a sample of program alumni and current fellows. Topics that are discussed first include the key components of the DOE CSGF (i.e., research practicum, program review meetings, HPC, and mentoring) as well as whether recipients have contributed to the development of specific aspects of computing (i.e., scientific codes or software) and whether they took advantage of dedicated computing time on DOE supercomputers. These discussions are followed by findings on recipients' satisfaction with the program; the perceived benefits and impacts of their DOE CSGF participation; the impact of COVID-19 and the shift in program activities to a virtual setting; and diversity and inclusion. This chapter concludes with findings pertaining to the DOE CSGF community and fellows' plans after completing the program.

Research Practicum

The research practicum offers fellows an opportunity to experience the breadth, quality, and excitement of the country's DOE National Laboratories. This experience is designed to offer insight to fellows into how their scientific interests can translate to research areas important to the nation. With one 12-week DOE laboratory experience required of each fellow — and with 21 approved sites to choose from — the practicum is intended to be an intellectually broadening experience which enables fellowship recipients to learn about computation from some of the nation's top practitioners. The DOE CSGF's combination of graduate study, academic research, and practical experience at DOE facilities aims to produce individuals capable of significantly contributing to research and development in computational science, an increasingly important component of our nation's economic health and security.

The practicum process consists of four main activities: identifying a laboratory site, supervisor and project; proposing a practicum; preparing for the experience; and completing the practicum. The survey asked alumni and fellows about the extent to which they were satisfied with the support they received from their practicum supervisor and other staff at their practicum laboratory in a variety of areas. As shown in Figure 4-1, the majority of alumni for which each item was applicable reported

that they were satisfied or very satisfied with the assistance they had received. At least three-quarters of recipients indicated that they were satisfied or very satisfied with the following types of support received from staff at their practicum site:

— Generating ideas about research (81 percent)

— Direction during my research activities (86 percent)

— Obtaining specialized equipment for my research as needed (76 percent)

Figure 4-1.   Percent of alumni reporting levels of satisfaction with support received from practicum site supervisor and laboratory staff (N=213)

NOTE: Figure excludes those who indicated an item was not applicable for them. The Ns for this figure range from 171 to 213.

Figure 4-2 shows the percent of fellows reporting satisfaction with the assistance they received from their practicum supervisor and other staff at their practicum laboratory. As with alumni, the majority of fellows reported that they were satisfied or very satisfied with the assistance they had received on each item. At least three-quarters of recipients indicated that they were satisfied or very satisfied with the following types of support received from staff at their practicum site:

- Generating ideas about research (93 percent)

- Obtaining specialized equipment for my research as needed (84 percent)

- Gaining a better understanding of continued opportunities for collaboration (81 percent)

- Direction during my research activities (80 percent)

Figure 4-2. Percent of current fellows reporting levels of satisfaction with support received from practicum site supervisor and laboratory staff (N=83)

NOTE: Figure excludes those who indicated an item was not applicable for them. The Ns for this figure range from 61 to 63.

In the interviews conducted with alumni and fellows, the majority of each group described their research practicum experience as very positive. Respondents in both groups most commonly cited the opportunity to explore new areas or directions in their research, collaborate with experienced researchers and scientists, and access to resources such as supercomputers that they otherwise would not have had. The following quotes from four respondents represent the overall views expressed on this topic:

> *I really enjoyed the group I got to work with. My practicum advisor was excellent, and he really made sure that I was getting out of it what I was interested in, as well as having me talk to other people at the lab,*

getting exposure to different groups… I got to work on an interesting research project. I got to explore the different skill sets that I was interested in learning.

It was certainly valuable, and I liked it for several reasons. It gave me an opportunity to explore a scientific area that was not really part of my dissertation work but was something I was very interested in. And there weren't very many people at my institution who really worked in that area, so it was a really good opportunity to explore that area, to learn more about it, and to satisfy my own curiosity.

It was the first time when I had experience working with really large-scale high-performance computing. Up until that point, the scientific computing that I had been doing was mostly restricted to calculations that could be run on a single computer and maybe a high end computer but still a single computer. Through that experience, I had access to run computations at what was then the super computer that was at Argonne National Laboratory.

I did my practicum in a field that was pretty unrelated to my main research topic, and I'd specifically chosen it because I was interested in expanding my machine learning skillset. I'd done a lot of modeling sort of things, a lot of physics and astronomy-based things, but I hadn't really had an opportunity or a reason to learn about machine learning without doing the practicum project.

Program Review Meetings

Annual program review attendance is both a benefit and requirement of the DOE CSGF. The program review provides a forum for fourth-year and any other departing fellows to present plenary lectures on their research. Beyond that, the meeting is also structured to acquaint fellows with the DOE laboratories and practicum opportunities, and to allow first- through third-year fellows the opportunity to present their research in a poster forum. By holding the review in Washington, D.C. each summer, program sponsors also have an opportunity to meet the fellows and learn about their work and to evaluate the program. The meeting also encourages fellows to meet informally with one another and with DOE CSGF alumni attendees.

In the survey, both alumni and current fellows were asked about the extent to which they found various elements of the program review meetings useful. As Figure 4-3 shows, 89 percent of alumni indicated that overall they found the program review meetings useful or very useful to them. In addition, at least three-quarters of alumni also found each of the following elements useful or very useful:

    — Intellectual stimulation and exchange (91 percent)

- Interaction with researchers in other fields (90 percent)

- Opportunities to present research (88 percent)

- Insight into current and/or future big picture problems (84 percent)

- Networking opportunities (83 percent)

Figure 4-3. **Percent of alumni reporting on the usefulness of the elements of the annual program review meetings (N=213)**
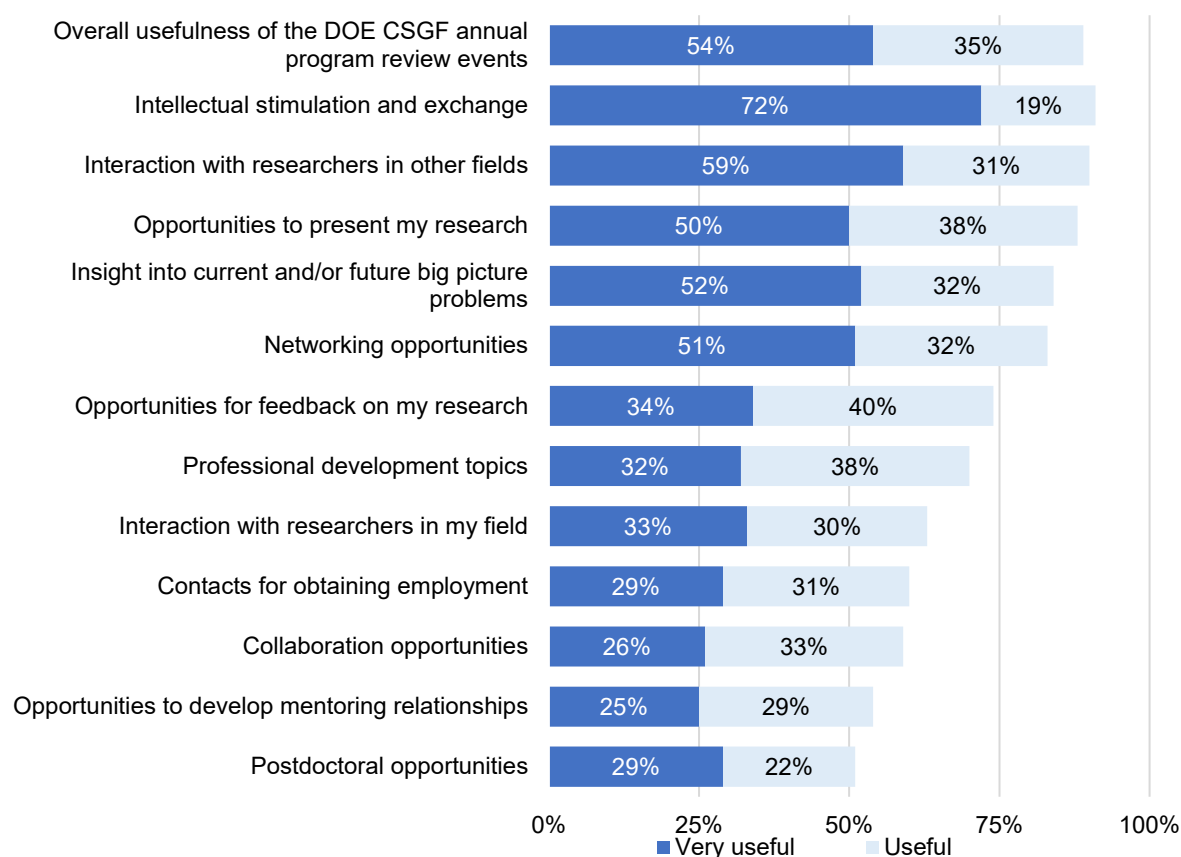
NOTE: Figure excludes those who indicated an item was not applicable for them. The Ns for this figure range from 198 to 213.

The results of statistical significance tests on alumni survey responses by cohort revealed differences on three of the items included above in Figure 4-3:

- Cohort 3 (2007–12) was more likely than cohort 1 (1991–2000) to indicate that contacts for obtaining employment was a useful or very useful element (77 percent versus 38 percent).

- Cohort 3 was more likely than cohort 1 to indicate that opportunities to develop mentoring relationships was a useful or very useful element (77 percent versus 40 percent)

- Cohort 3 was more likely than cohort 2 (2001–2006) to indicate that postdoctoral opportunities was a useful or very useful element (79 percent versus 41 percent).

Figure 4-4 shows the responses of fellows regarding the extent to which they found elements of the annual program reviews meetings useful. Eighty-seven percent of fellows indicated that overall they found the program review meetings useful or very useful to them. In addition, at least three-quarters of alumni also found each of the following elements useful or very useful:

- Insight into current and/or future big picture problems (91 percent)

- Intellectual stimulation and exchange (86 percent)

- Interaction with researchers in other fields (78 percent)

- Networking opportunities (78 percent)

- Opportunities to present research (77 percent)

Figure 4-4. Percent of current fellows reporting on the usefulness of the elements of the annual program review meetings (N=83)

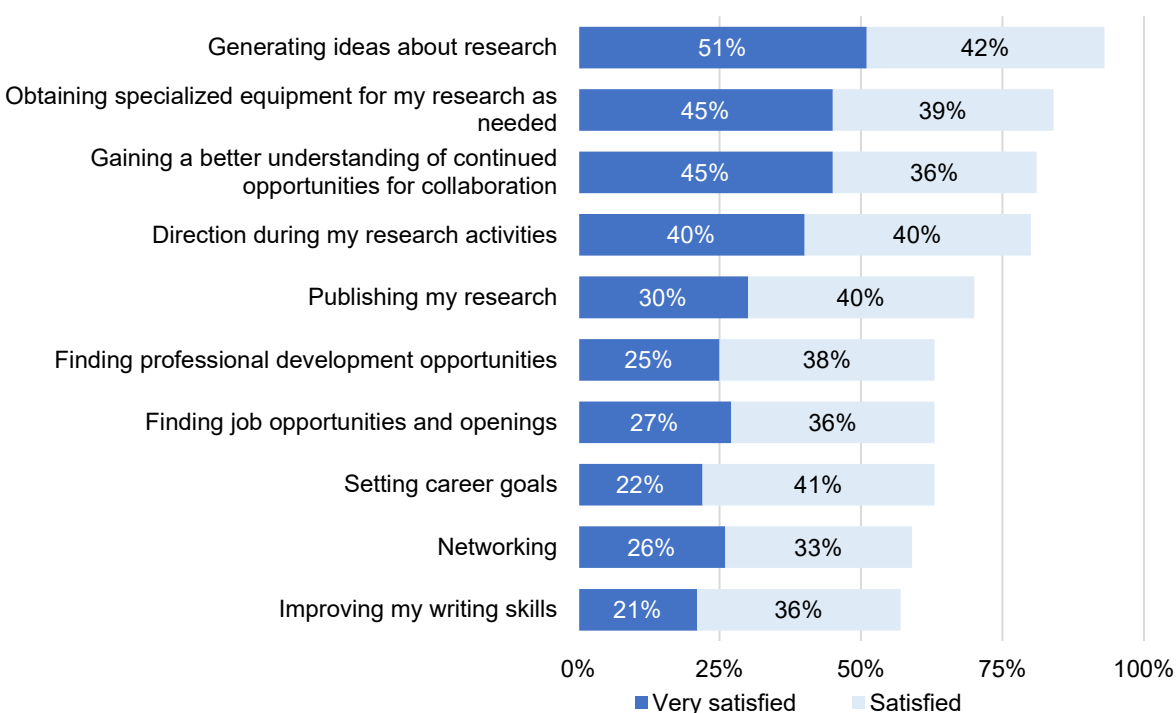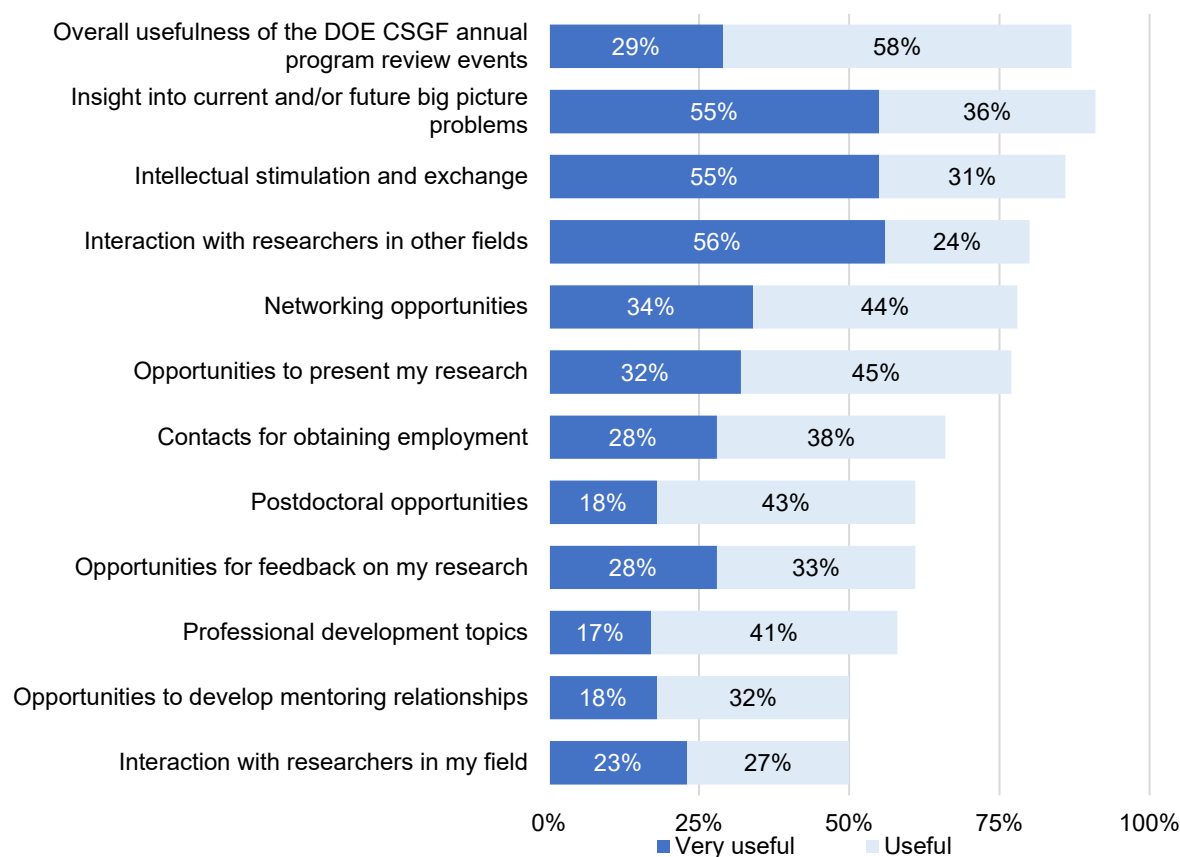NOTE: Figure excludes those who indicated an item was not applicable for them. The Ns for this figure range from 56 to 76.

The interview responses of both alumni and current fellows indicate that the program review is one of the most favorably viewed aspects of the DOE CSGF. Respondents in both groups described positive experience at the annual meetings and emphasized the opportunity to network with current fellows, alumni, and individuals from DOE laboratories and other professionals and to learn from these groups about new areas of research, resources, and professional opportunities. Several alumni and fellows also characterized the meetings as enjoyable and very well-run. The following quotes from five respondents represent the overall views expressed on this topic:

> *The annual program reviews were terrific. I looked forward to them every year and to the interactions that came from those. I just always came away learning so much. Not only from current fellows but from former fellows, and from people within the Department of Energy would come to meet with us and talk with us.*

I certainly found them useful. I liked learning about the resources that the other fellows were doing. They did a good job about having other scientists there to provide their feedback and their insight and to talk about their experiences and what different career options look like after the fellowship, they... At the annual meetings, one of the things that they regularly had was a, career recruitment session. They had folks there from DOE National Laboratories and some other organizations who would come and set up tables and hand out pamphlets, and you could go and talk to them about different kinds of [employment] options. That was the most valuable part of that experience.

The interaction with all the fellows, even just the current fellows. We were a very multidisciplinary group, and that diversity was just so important. I got so much exposure to areas of science and people's different perspectives that I would not have gotten at all if I wasn't in the fellowship. I think the diversity of perspectives was really key. And then seeing, hearing talks from folks within the Department of Energy, scientists from the labs, administrators in Washington, D.C., and so on, that was just exposure that I didn't get anywhere else.

You have a lot of smart, fun people who understand the context, and the technical talks are a lot of fun. I really appreciate the workshops that they provide. This is a very well designed meeting. I think they know who the audience is, and they also have some pretty clear objectives. They just make a really great natural environment to network, learn about each other's work, and even get inspired. So there's a lot of things I learned that I haven't gotten to, ideas that I've gotten from the meetings that I'd like to get to back to eventually if I get time.

Those were great opportunities. They were some of the best run conferences that I had gone to. Organizationally, they were run really well, and they did really great thinking about what would be good opportunities, what are good training experiences that you can make out of these conferences. For example, practicing talks, practicing giving posters in the right way, that was great. Also the fact that alumni came, that was fantastic, and [DOE] laboratory employees came, that was good. I thought they were fantastic conferences.

In addition, several of the alumni interviewed reported having attended the annual program review meetings since completing their fellowship. Among those who did not attend regularly, they typically stated that while they would prefer to attend, a combination of competing conferences and the meeting's location in Washington, D.C. (i.e., for those on the West Coast, etc.), made it challenging, those who have attended as alumni described it as rewarding and useful. For example, according to one alum:

I always find it fairly rewarding because it's interesting to see what research the fellows are doing. But also, having been through the program and having some portion of my career in the past, I can provide insights that I've gleaned over the years and talk about the different [career] options that I know about, what skills are really important, and about the kinds of connections that are useful to make in pursuing these different kinds of options.

High-Performance Computing

The DOE CSGF is a primary workforce development program for HPC. The evolution and broader availability of high-end computational resources — and the important scientific and engineering opportunities these machines and software provide — present a major challenge for the DOE CSGF. On one hand, requiring real knowledge and experience in high-performance computing as criteria for acceptance into the program would be overly restrictive. On the other, assuming fellows will get sufficient exposure in their diverse academic environments has proven to be unrealistic. For these reasons, the DOE CSGF has taken proactive steps to assist fellows in getting on the path to using HPC productively.

Both alumni and current fellows were asked in their surveys about their exposure to HPC during their fellowship. Alumni were also asked about the impact such exposure had on their career, and fellows were asked about the impact such exposure had on their career plans and research pursuits. As Figure 4-5 shows, a clear majority of alumni felt they had benefited from their experiences with HPC.

Figure 4-5.   Percent of alumni reporting the extent to which exposure to HPC has had an impact on their career (N-213)
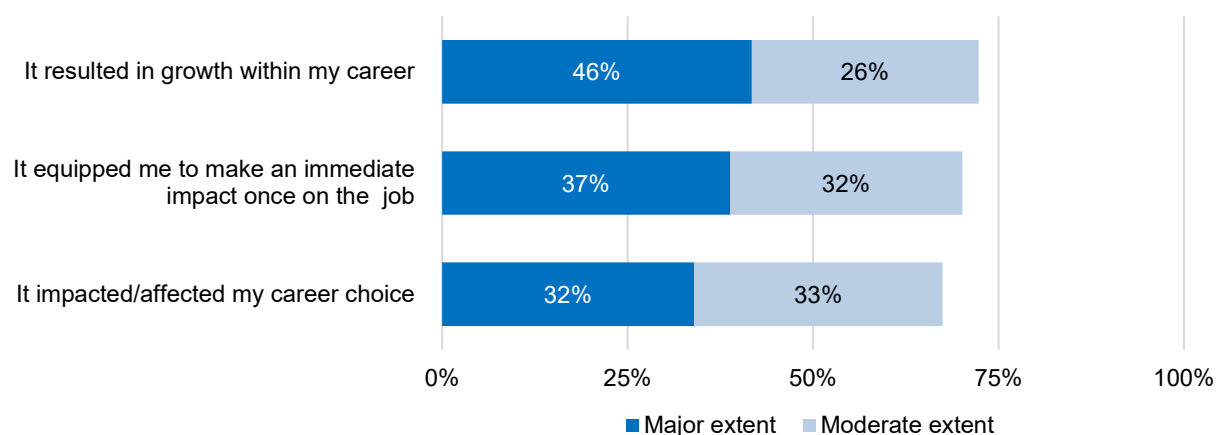
NOTE: Figure excludes those who indicated an item was not applicable for them. The Ns for this figure range from 201 to 206.

Figure 4-6 illustrates that, as with alumni, a clear majority of fellows indicated their exposure to HPC through the program has benefited them in several ways. More than two-thirds agreed either to a major extent or to a moderate extent on four of the five items, while two-thirds (67 percent) agreed either to a major or moderate extent that the program has provided insight into best practices for more efficient programming.

Figure 4-6. Percent of current fellows reporting the extent to which exposure to HPC has had an impact on their career plans and research pursuits (N=83)
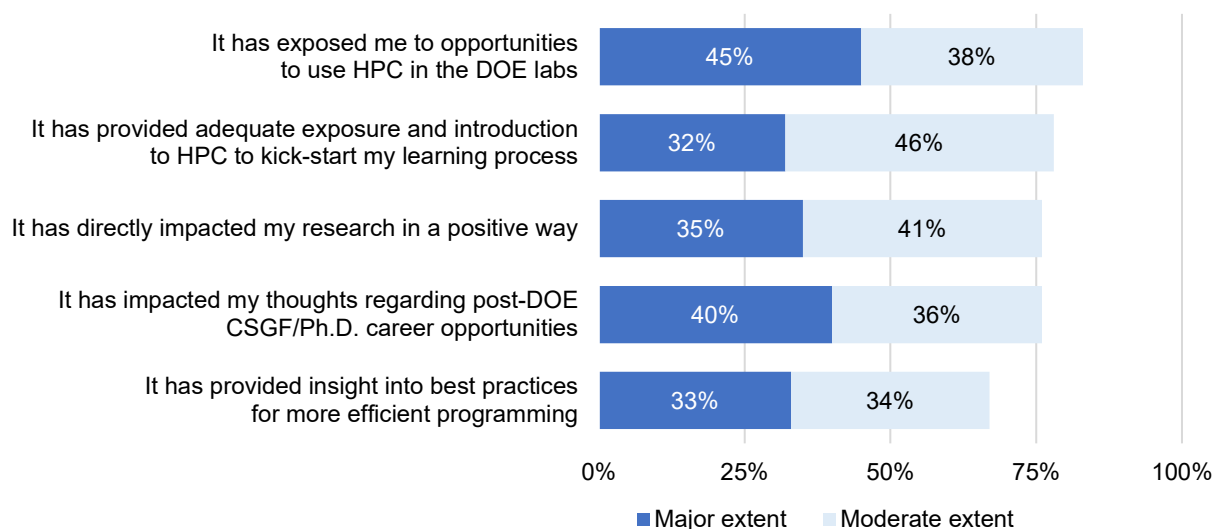
Item	Major extent	Moderate extent
It has exposed me to opportunities to use HPC in the DOE labs	45%	38%
It has provided adequate exposure and introduction to HPC to kick-start my learning process	32%	46%
It has directly impacted my research in a positive way	35%	41%
It has impacted my thoughts regarding post-DOE CSGF/Ph.D. career opportunities	40%	36%
It has provided insight into best practices for more efficient programming	33%	34%

NOTE: Figure excludes those who indicated an item was not applicable for them. The Ns for this figure range from 51 to 68.

Both surveys also asked recipients whether they had used HPC in their own research during their fellowship. As Figure 4-7 shows, 88 percent of alumni indicated using HPC either to some extent or to a large extent in their own research while a fellow.

Figure 4-7. Percent of alumni reporting levels of use of HPC in research while a fellow (N=213)

	To some extent	To a large extent
Yes	43%	45%
No	12%	
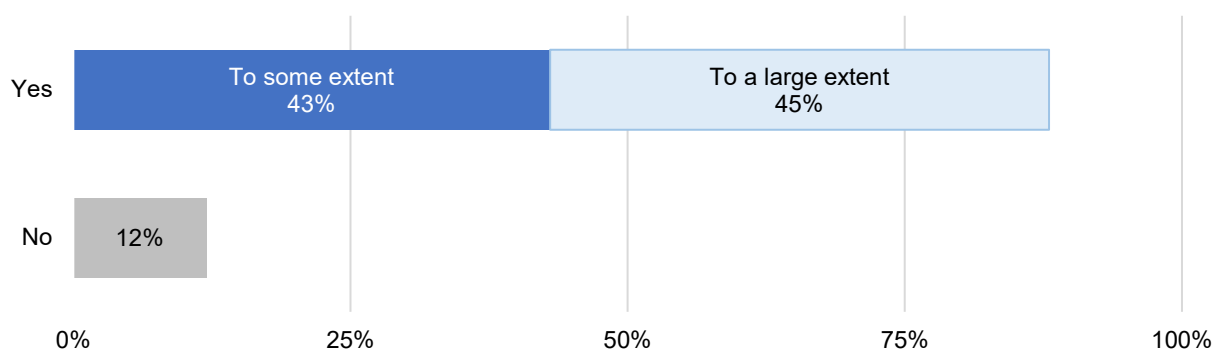
Figure 4-8 shows the results for fellows on the same item. Similarly, 84 percent of fellows indicating having used HPC either to some extent or to a large extent during their time as a fellow.

Figure 4-8. Percent of current fellows reporting levels of use of HPC in research (N=83)
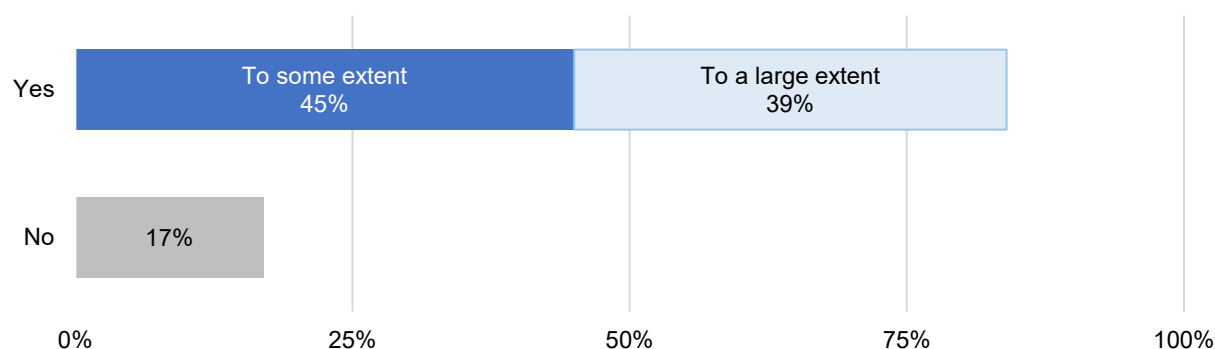
NOTE: Percents may not sum to 100 because of rounding.

In the interviews, most of the alumni and current fellows indicated they had used HPC during their time as a fellow, which is consistent with the survey findings above. When asked about the ways in which HPC influenced their work during their fellowship tenure, the alumni described how this exposure provided them with skills, experience, and insights that they were able to apply to their future work. For example, according to two alumni:

> *It provided me with experience and also insight into how those kinds of machines are programmed. Of course, I then later ended up working at* [DOE laboratory name] *where that machine was housed and then where a later generation of that machine was housed. My experience did help inform my understanding of the whole process of what went on at the computing facility, what kinds of applications were run, what their challenges were, and so on, and it also provided me with some skills and experience that I was then able to apply to other problems that I was working on as part of my dissertation work. Even though we'd never ran those on super computers as such, we did end up looking at larger problems and employing some of the same techniques that you use on supercomputers across multiple areas that I learned more about during my practicum.*

> *I started off in cosmology and planetary science groups in which, essentially, nobody did high-performance computing, so I was able to bring that expertise and sort of change what we at* [university name] *were able to do in the planetary science community, which was pretty cool. I don't think, without the CSGF and the experiences I had had, I would've been able to come in and do that as well.*

A few respondents indicated that, although their knowledge of HPC and the various resources that exist and how they are used have increased, it has not had a substantial impact on their research because it is not as relevant given the focus or nature of their specific research. For example, as one current fellow described:

> *I've definitely been made aware of lots of different computing resources that are out there. My practicum exposed me to that, as well as the annual program review, and I know other people at my lab at* [institution name] *that have used computing resources as well. I've been made aware of the opportunity to use them if I*

needed to in my work. But it hasn't necessarily influenced by work, not particularly. I couldn't do what I do on my own computing system, so I have to use some form of high-performance computing but the impact has not been as large of an extent as for other people, because the data that I work with aren't that large.

Mentoring

The DOE CSGF recognizes the importance of reciprocal mentoring relationships among alumni and current fellows, and this kind of community building is considered by the program as critical for knowledge sharing towards progress and innovation.

The alumni and fellows surveys included questions on mentoring, including the extent to which they received mentoring from supervisors or others affiliated with the DOE CSGF, the usefulness of the mentoring they received, and the types of mentoring they have provided to other recipients.

First, alumni were asked to indicate whether they had received various types of mentoring, guidance, or support from members of the scientific community, including other DOE CSGF recipients during and/or since their fellowship. Figure 4-9 shows the percentage of alumni who reported they had received various types of mentoring since they first began the DOE CSGF. For all but two of the specific types of mentoring, more than 50 percent of alumni reported receiving several types of mentoring support, with the largest percentages of alumni indicating they had received the following types of mentoring:

- Opportunities to collaborate on research in fields related to computational science and engineering (CSE) (85 percent)

- Opportunities to network with other scholars, publishers, editors, etc., in fields related to CSE (85 percent)

- Opportunities to present research in fields related to CSE (84 percent)

Figure 4-9.   Percent of alumni reporting the types of mentoring they received during and/or since their fellowship (N=213)

Type of mentoring	Percent
Opportunities to collaborate on research in fields related to computational science and engineering (CSE)	85%
Opportunities to network with other scholars, publishers, editors, etc., in fields related to CSE	85%
Opportunities to present research in fields related to CSE	84%
Guidance/support for publishing in fields related to CSE	74%
Guidance/support for obtaining employment in fields related to CSE	73%
Opportunities to co-author publications in fields related to CSE	66%
Advice regarding professional survival and politics	62%
Psychological or emotional support	58%
Guidance/support for obtaining grants, contracts, fellowships, or other resources in fields related to CSE	56%
Opportunities for developing and obtaining research grants in fields related to CSE	48%
Guidance/support for teaching, student advising, etc., in fields related to CSE	37%

Current fellows were also asked to indicate whether they had received various types of mentoring since the start of their fellowship. As Figure 4-10 shows, more than half of the fellows indicated they had received the following six types of mentorship and guidance:

- Opportunities to collaborate on research in fields related to CSE (78 percent)

- Opportunities to network with other scholars, publishers, editors, etc., in fields related to CSE (72 percent)

- Opportunities to present research in fields related to CSE (60 percent)

- Advice regarding professional survival and politics (59 percent)

- Guidance/support for obtaining employment in fields related to CSE (57 percent)

- Psychological or emotional support (51 percent)

Between 19 percent and 47 percent of fellows reported they had received the other types of support listed in Figure 4-10; however, it should be noted that several fellows had only been in the program for a short time at the time they completed the survey.

Figure 4-10.   Percent of current fellows receiving specific types of mentoring (N=83)
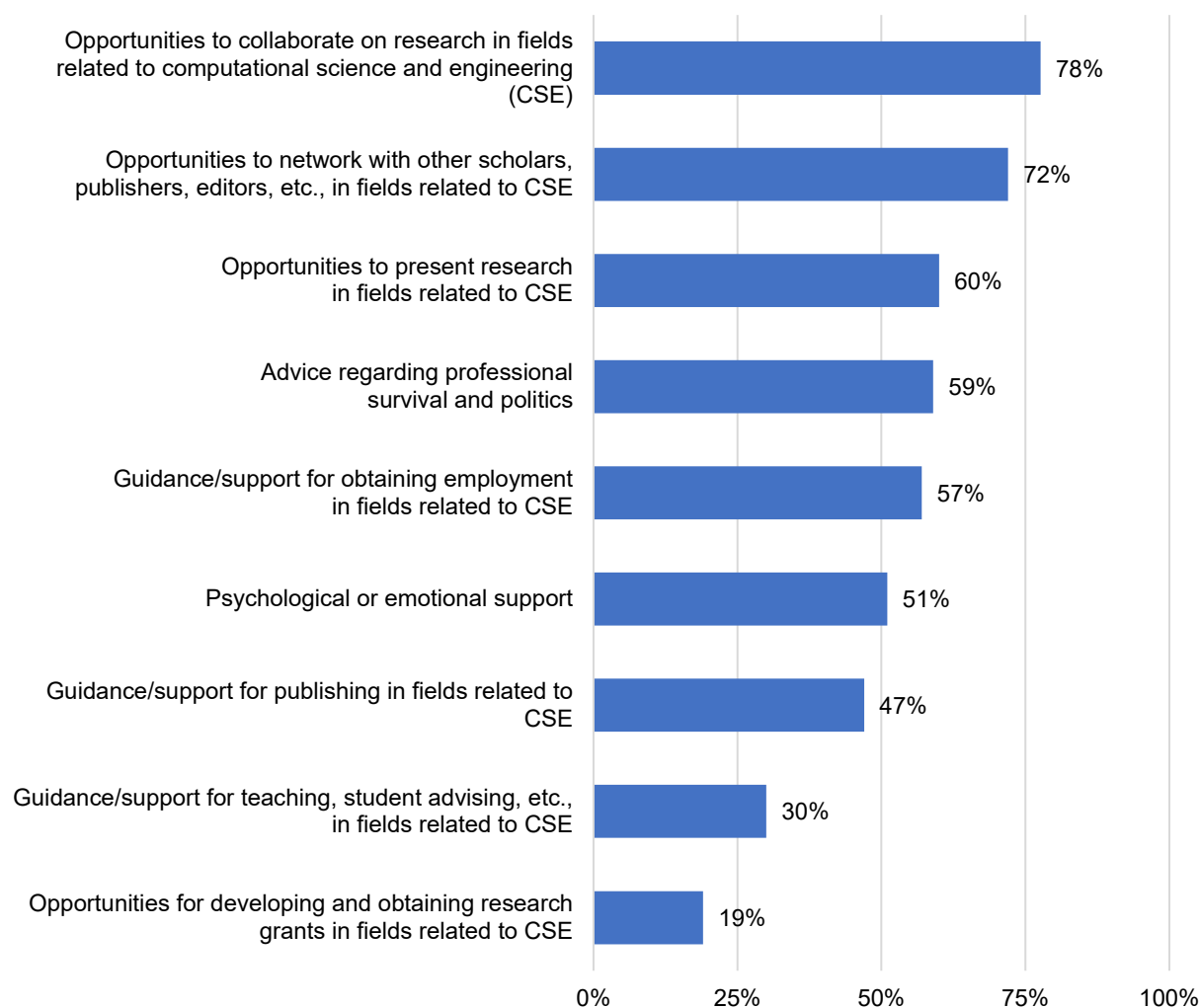
Figure 4-11 shows the responses of fellows to questions about the usefulness of each type of mentoring included in Figure 4-10 above. Overall, fellows had very favorable perceptions of the mentoring they received, with between 80 percent and 92 percent of recipients describing each of the specific types of mentoring as useful or very useful.

Figure 4-11. Percent of current fellows reporting on the usefulness of mentoring they received during their fellowship (N=83)
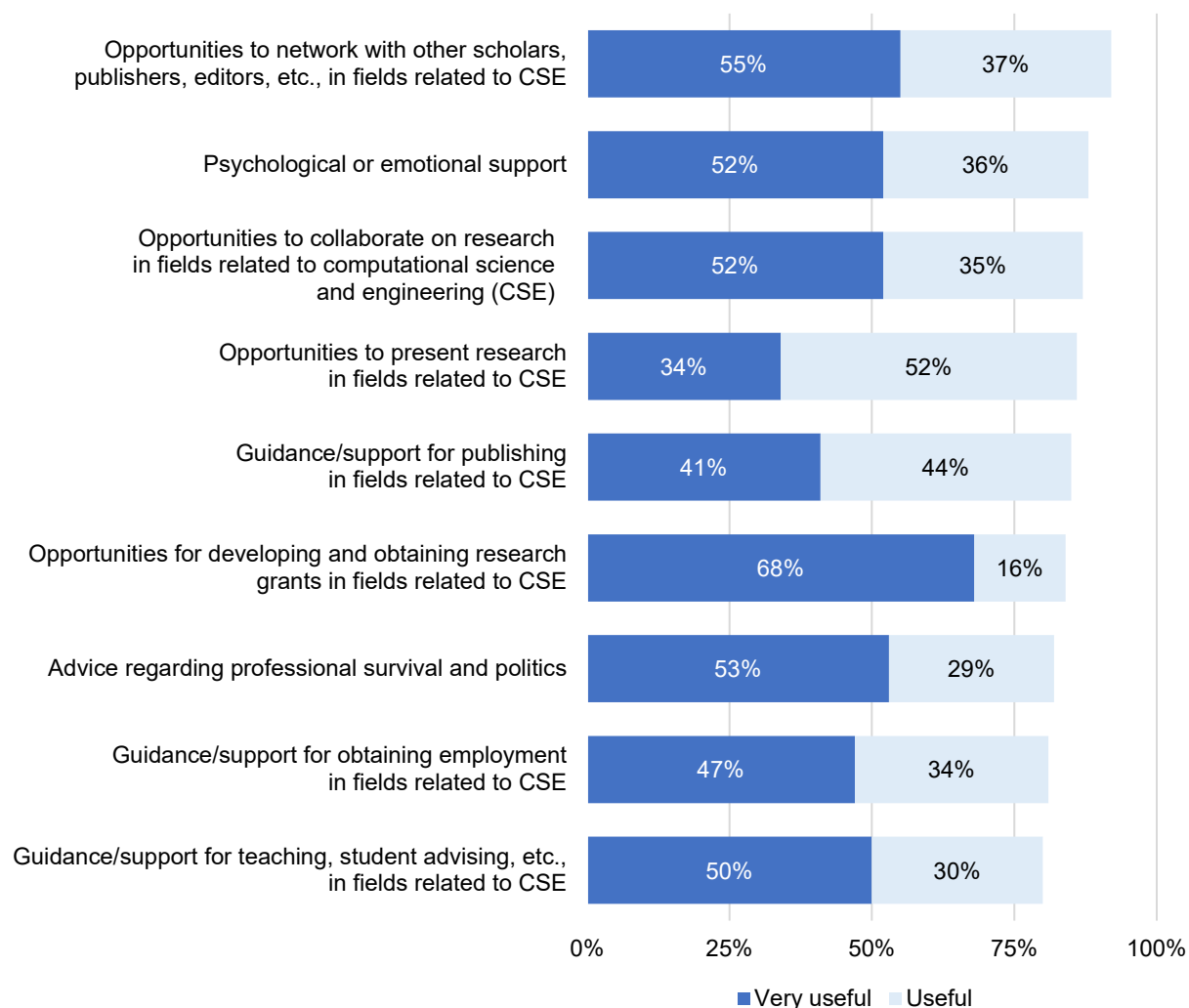
NOTE: Figure is limited to those who indicated they had received each type of mentoring during or since their fellowship. Ns for this figure range from 19 to 65.

In addition to being asked about the mentoring they received, the surveys also asked recipients to indicate whether they had provided these various types of mentoring support to members of the scientific community, including other DOE CSGF recipients. Alumni were asked to indicate whether they had provided the mentoring during and/or since their fellowship, while current fellows were asked to indicate whether they had provided each type of support so far. Figure 4-12 shows that more than half of alumni had provided all of the types of mentoring asked about it the survey since the start of their fellowship.

Figure 4-12. Percent of alumni reporting the types of mentoring they provided during and/or since their fellowship (N=213)
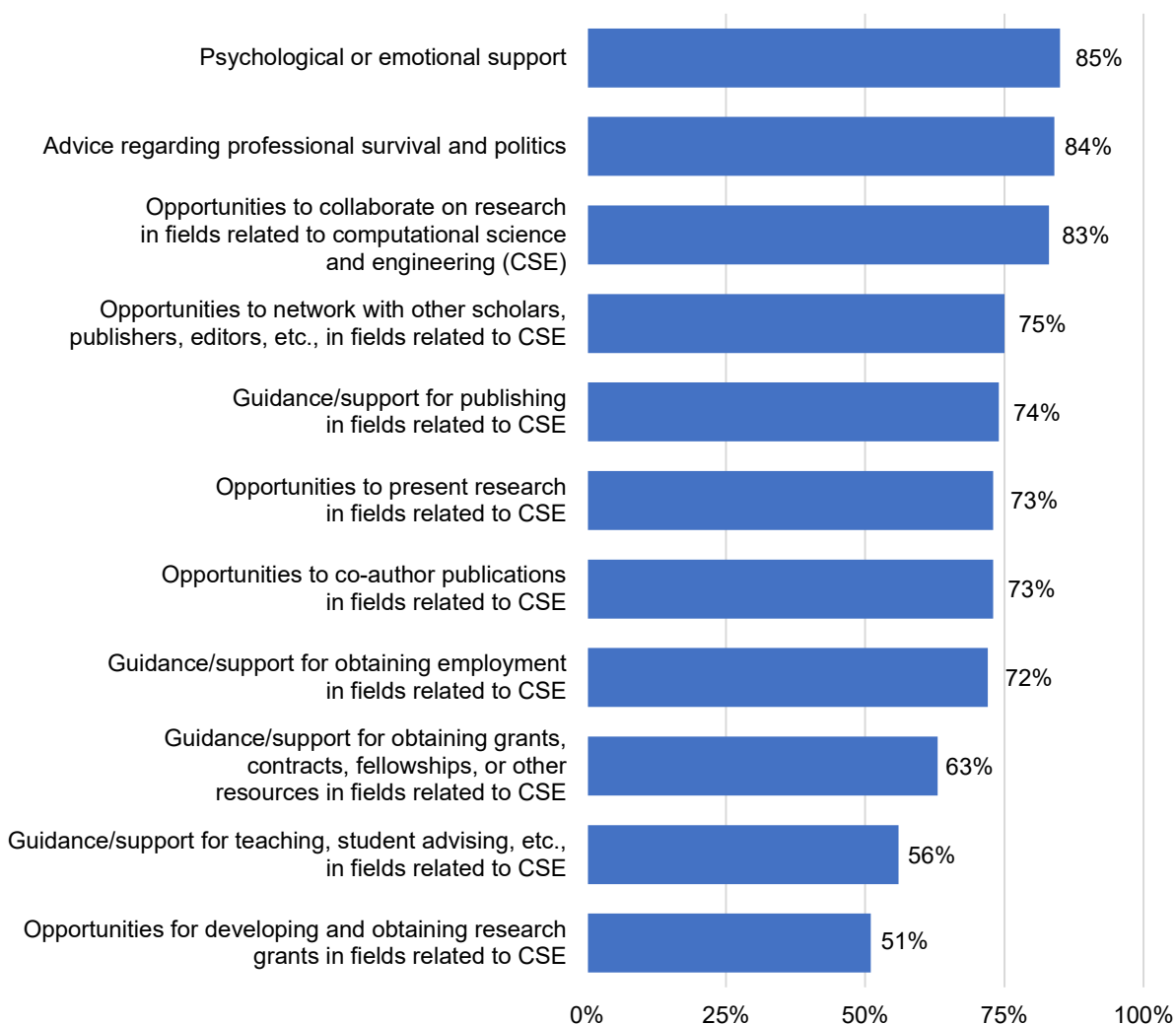
As shown in Figure 4-13, the percentages of current fellows that had provided mentoring was generally lower. With the exception of psychological/emotional support, which was cited by 55 percent, less than half indicated they had provided each of the mentoring types so far. As is the case with the responses of current fellows on the mentoring they had received, it is important to note that several respondents had only just started the program.

Figure 4-13.   Percent of current fellows reporting the types of mentoring they provided (N=83)
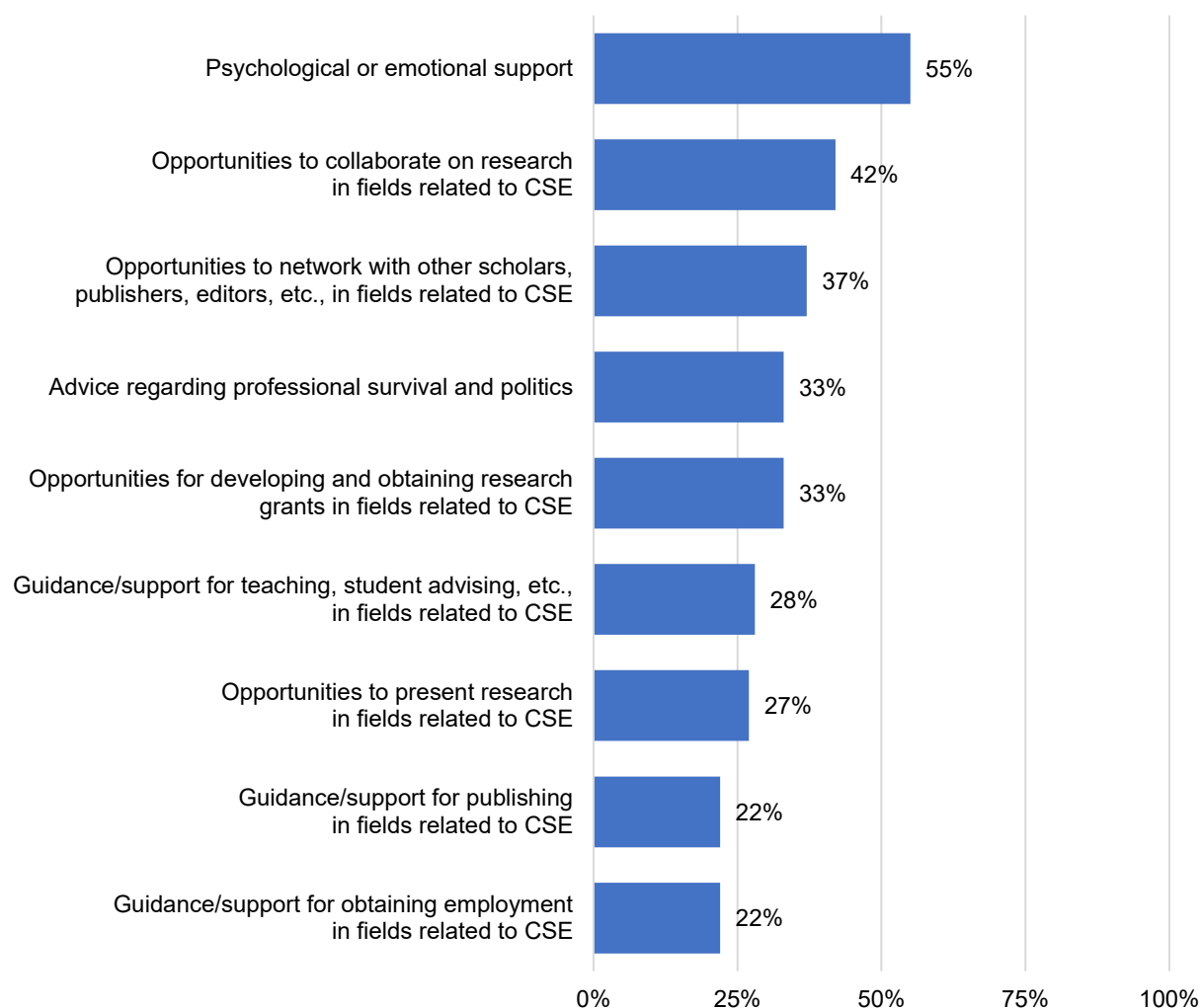
During the interviews, both alumni and current fellows reported positive and useful mentoring experiences during their time in the program. For example, as one alum stated, "I thought my mentorship was very strong. I thought it was actually much stronger than in an academic setting, no question. Everybody had much more time to work with you, and you work much more closely with them." More specifically, individuals from both groups reported receiving, primarily from their practicum advisor, a combination of mentoring on technical content or research approaches, on various career options, as well as specific guidance on how to pursue career opportunities. While many respondents emphasized the mentoring they received from their practicum advisor, several also described how the program offered mentoring through a range of sources and settings, both formal and informal, including other staff at the practicum sites, other fellows and alumni, and at annual program review meetings. The following quotes from three respondents further represent the overall views expressed on this topic:

The biggest impact in terms of mentoring that the fellowship had for me was with my practicum advisor. He did a really wonderful job about asking me about what my career plans are and what I wanted to get out of the practicum but then also following up with me later as I was starting to graduate and trying to figure out what I wanted to do in terms of postdoc or lab work. So he was really an excellent resource, as were some of the other individuals I met at [DOE laboratory name] *in a less formal capacity. Everyone was excellent when I reached out. The other part would be more of the informal peer relationships that you get out of the program. Less explicit mentoring, but more of, 'Oh, I know someone who works vaguely in this area, I'm just going to write them an email or message and see if they can help me with this random problem I'm having.'*

Most of the mentoring I received though is from my practicum mentor, and my practicum mentor was fantastic. She is extremely successful and has a fantastic career, and she gave lots of good technical advice about just how to do research. I learned a lot about how she approaches problems but she also gave a lot of great advice just career-wise, how to network and talk to people at meetings. It was everything, from reading papers, to talking to other kind more senior scientists, and whatnot. It was fantastic mentoring through my practicum mentor… But then there was mentoring through the annual meetings. They had small workshops. Some of the guidance work was technical, and they gave some great hands on stuff around HPC. Other parts that I remember being very helpful was one workshop on just writing. Technical writing is extremely important, and I really appreciated that. I think there were a lot of informal opportunities. The program has multiple generations of fellows. As a fellow, you can always find folks to talk to that could give some advice.

Certainly the two scientists I work with on the two practicums, they were definitely valuable mentors to me. I've learned a lot technically from them and, just as importantly, I learned a lot about how the DOE laboratories worked, how they were organized, the different areas of emphasis, how things get done. The second practicum, my advisor there, he helped me quite a bit in just making some connections that ultimately snowballed into the position I accepted after I graduated, which was at a Department of Energy laboratory. All of that mentoring was very good but it also goes back to the sense of community in the fellowship. There was a lot of informal interaction with previous fellows who had been through the program, also current fellows, which felt like mentoring to me. We would share things with each other, and all of that I think was just really important for getting the landscape of the Department of Energy.

Contribution to Aspects of Computing

The DOE CSGF provides education and training with the aim of making recipients uniquely positioned to contribute to the advancement of computing activities. The survey asked recipients to indicate whether they had contributed to and/or led work in the development of three specific aspects of computing, including development of scientific codes, scientific software suites, and open source scientific software. Both alumni and current fellows were asked to indicate whether they had contributed to and/or led such work both prior to and during their fellowships. Alumni were also asked to indicate their involvement in such aspects of computing since completing their fellowship.

Figures 4-14 and 4-15 show the percentages of alumni and current fellows, respectively, indicating they had contributed to and/or led each type of work at each relevant time period. For both alumni and fellows, the development of scientific codes was the most common type of work in which they were involved at all time periods. Scientific software suites was the next most prevalent among both alumni and fellows, with approximately two-thirds of alumni having contributed to or led this type of work since completing their fellowship, while over half of current fellows reported doing so at this point during their fellowship.

Figure 4-14. Percent of alumni who have contributed and/or led development of each type of product (N=213)
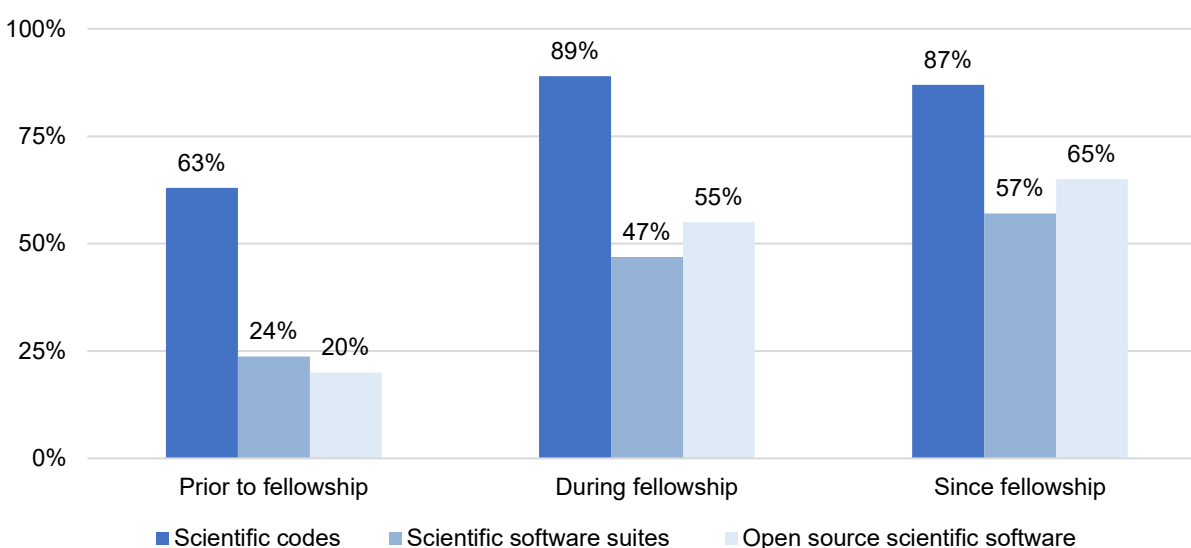
Figure 4-15. Percent of current fellows who have contributed and/or led development of each type of product (N=83)

Legend: Scientific codes ■ | Scientific software suites ■ | Open source scientific software ■

Data points:
- Prior to fellowship: Scientific codes 70%, Scientific software suites 23%, Open source scientific software 35%
- So far during fellowship: Scientific codes 76%, Scientific software suites 34%, Open source scientific software 52%
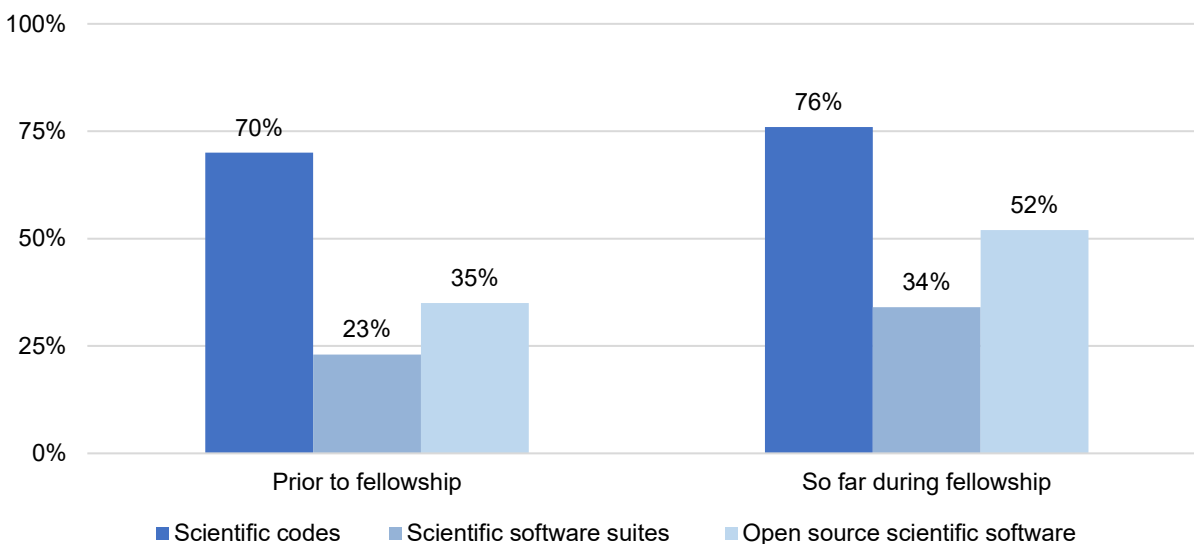
Supercomputers

In addition to HPC generally, the survey asked alumni and current fellows to indicate whether they had taken advantage of dedicated computing time on DOE supercomputers. Alumni were asked to report on their use of such resources before, during, and since their fellowship, while current fellows were asked to report whether they had used the resource prior to and so far in their DOE CSGF tenure. As show in Figure 4-16, while only a small percentage had done so prior to the fellowship, nearly two-thirds of alumni reported that they had dedicated computing time on a DOE supercomputer at some point during their fellowship. In addition, just under half have utilized these resources since completing the program.

Figure 4-16. Percent of alumni who have taken advantage of dedicated computing time on DOE supercomputers (N=213)
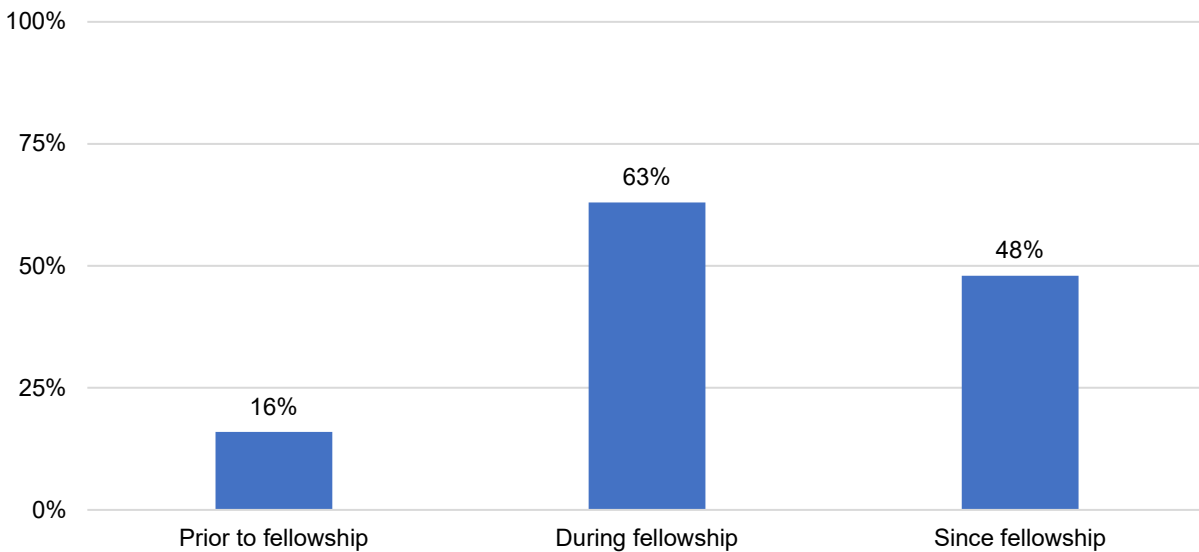
For current fellows, 29 percent had utilized dedicated computing time prior to the start of their fellowship, while just over half had taken advantage of this while in their fellowship (Figure 4-17).

Figure 4-17. Percent of current fellows who have taken advantage of dedicated computing time on DOE supercomputers (N=83)
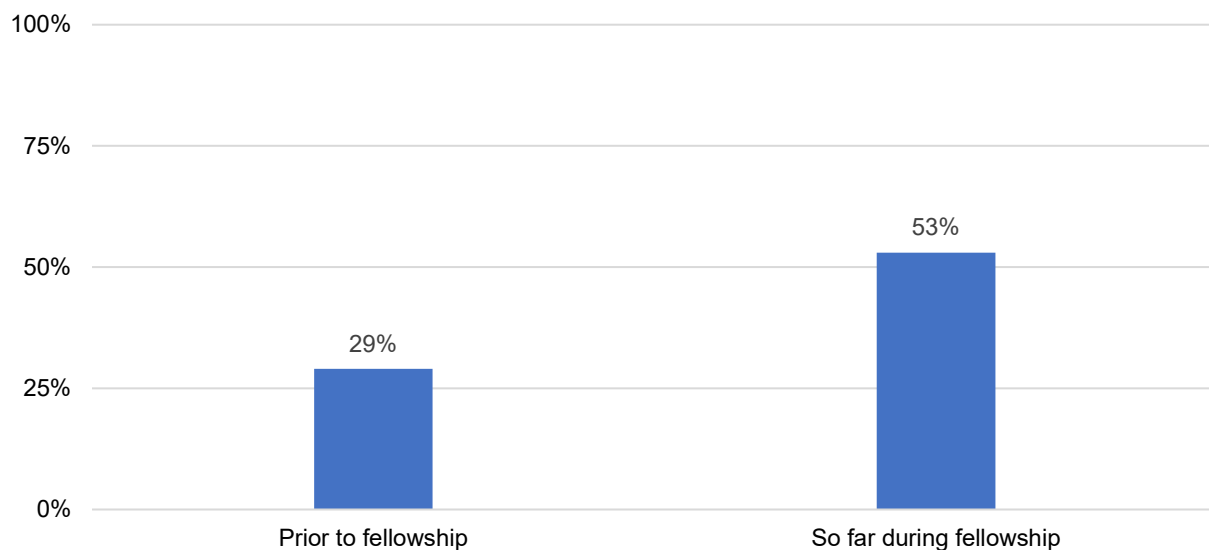
Overall DOE CSGF Satisfaction

Both alumni and current fellows were asked in the survey about the extent to which they were satisfied with various aspects of the DOE CSGF.[19] With regard to alumni, as Figure 4-18 shows, three-quarters or more indicated they were satisfied or very satisfied with all the aspects of the DOE CSGF asked about in the survey. Most notably, at least 90 percent of alumni indicated satisfaction with the following elements:

- — Access to facilities, equipment, and other resources (93 percent)

- — Annual DOE CSGF program review events (92 percent)

- — Networking opportunities (92 percent)

- — Communication with other DOE CSGF recipients (90 percent)

- — Research training (90 percent)

Figure 4-18.   Percent of alumni reporting levels of satisfaction with specific elements of the DOE CSGF program (N=213)
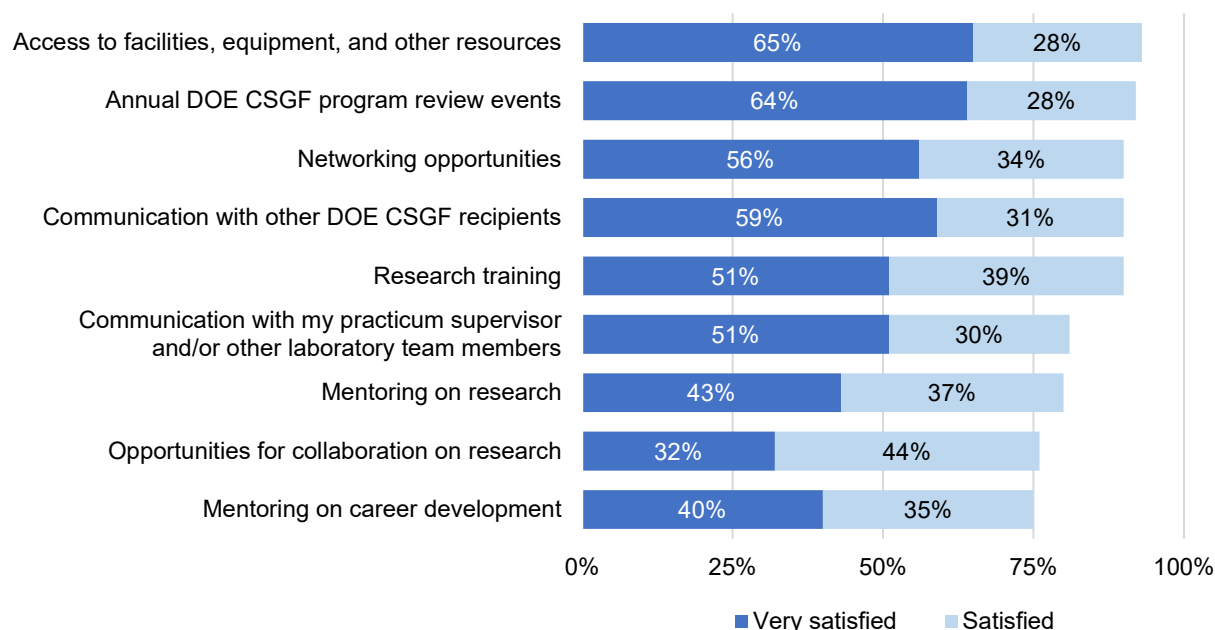
NOTE: Figure excludes those indicating an item was not applicable to them. Therefore, Ns range from 195 to 213.

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[19]For current fellows, the question was worded to ask how satisfied they had been so far with the program.

Figure 4-19 shows the results for the same set of items for current fellows. Two-thirds of more of fellows indicated they were satisfied or very satisfied with all the aspects of the DOE CSGF asked about in the survey. More than 80 percent of alumni indicated satisfaction with the following elements:

— Access to facilities, equipment, and other resources (89 percent)

— Research training (88 percent)

— Communication with my practicum supervisor and/or other laboratory team members (86 percent)

— Mentoring on career development (80 percent)

Figure 4-19. Percent of current fellows reporting levels of satisfaction with specific elements of the DOE CSGF program (N=83)
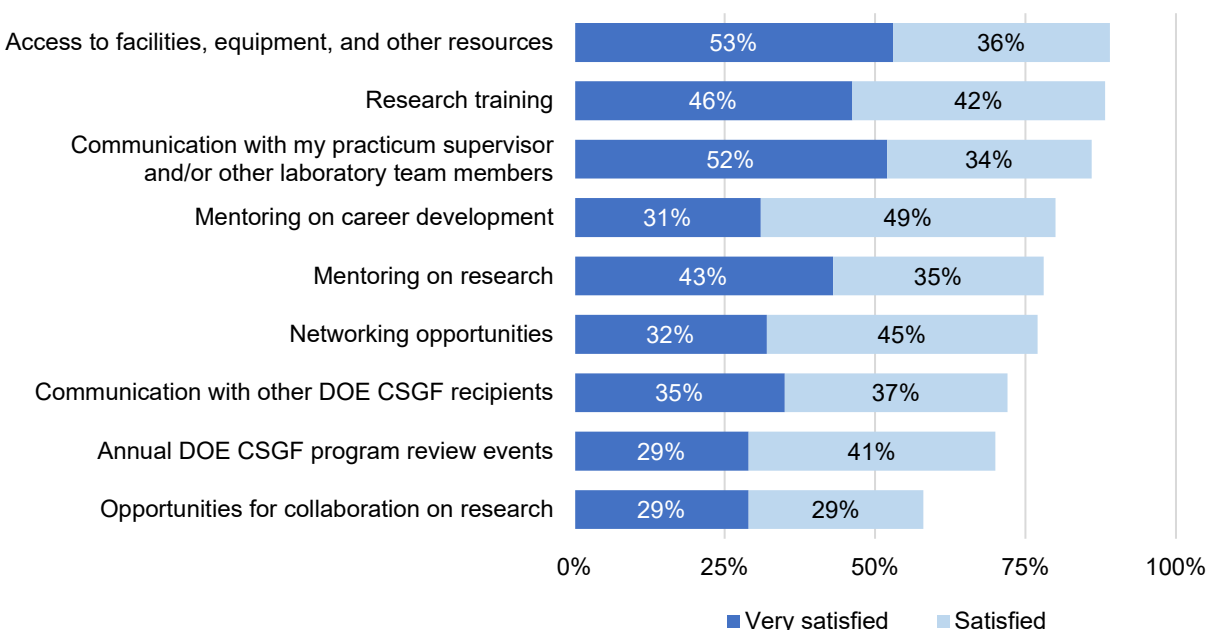
NOTE: Figure excludes those indicating an item was not applicable to them. Therefore, Ns range from 197 to 213.

The surveys also asked alumni and current fellows to select up to three aspects of the DOE CSGF that were most important to their overall satisfaction with the fellowship. As Figure 4-20 shows, the following three elements were most commonly identified and were each cited by over 40 percent of recipients as one of their top three:

- Annual DOE CSGF program review events (54 percent)

- Communication with other DOE CSGF recipients (47 percent)

- Communication with my practicum supervisor and/or other laboratory staff (44 percent)

Figure 4-20. Percent of alumni reporting on aspects of the program that were most important to their satisfaction with the DOE CSGF program (N=213)

NOTE: Respondents could select up to three responses.

The results of statistical significance tests on alumni survey responses by cohort revealed differences on two of the items included above in Figure 4-20:

- Cohort 4 (2013–17) was more likely than cohorts 1 (1991–2000), 2 (2001–06), and 3 (2007–12) to indicate that research training was one of the most important aspects (89 percent versus 51, 57, and 54 percent, respectively).

- Cohort 1 was more likely than cohorts 2 and 4 to indicate that communication with other DOE CSGF recipients was one of the most important aspects (78 percent versus 43 and 44 percent, respectively).

Figure 4-21 shows the results for current fellows on the aspects that were most important to their satisfaction with the program. When compared to alumni, the current fellows who responded to the survey were less uniform in their responses on which aspects of the program were most important to them. That is, none of the aspects was cited by more than half of fellows, however, none of the

aspects was cited by less than 20 percent of fellows. The following three aspects were the most commonly cited by fellows as important:

- Communication with my practicum supervisor and/or other laboratory team members (45 percent)

- Research training (41 percent)

- Access to facilities, equipment, and other resources (40 percent)[20]

Figure 4-21. Percent of current fellows reporting on aspects of the program that were most important to their satisfaction with the DOE CSGF program (N=83)

NOTE: Respondents could select up to three responses.

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[20] In considering the results in Figure 4-21, it should be noted that more than half of current fellows have not experienced an in-person program review, with the last in-person program review having occurred in summer 2019.

Perceived Benefits and Impacts

The survey asked both alumni and current fellows to indicate the extent to which they felt DOE CSGF participation had benefited them in a variety of ways. Figure 4-22 shows the percentage of recipients reporting the ways in which the DOE CSGF had benefited them to a major or moderate extent. Across almost all items, the majority of recipients indicated their participation has had a moderate or major impact on them. More than 80 percent of recipients reported they had majorly or moderately benefited in the following ways:

- Enhanced my knowledge of HPC (90 percent)

- Improved the overall quality of my research (88 percent)

- Enhanced my computing capabilities (87 percent)

- Increased my subject matter knowledge/expertise in other areas (i.e., other than computing capabilities) (86 percent)

- Improved my research skills and/or techniques (86 percent)

- Positively influenced the specific direction of my current research (83 percent)

- Increased my confidence in performing cutting-edge research (82 percent)

Figure 4-22.   Percent of alumni reporting benefits from participation in the DOE CSGF program (N=213)

Figure 4-23 shows the results for current fellows on the items that ask about the ways in which the program had benefited them to a major or moderate extent. While smaller percentages of fellows cited each benefit, as compared to alumni, all but one of the benefits (i.e., improved my mentoring skills) was cited by a majority of fellows. More than 80 percent of recipients reported they had majorly or moderately benefited in the following ways:

— Enhanced my computing capabilities (86 percent)

— Enhanced my knowledge of high-performance computing (HPC) (81 percent)

— Increased my subject matter knowledge/expertise in other areas (i.e., other than computing capabilities) (81 percent)

Figure 4-23. Percent of current fellows reporting benefits from participation in the DOE CSGF program (N=83)
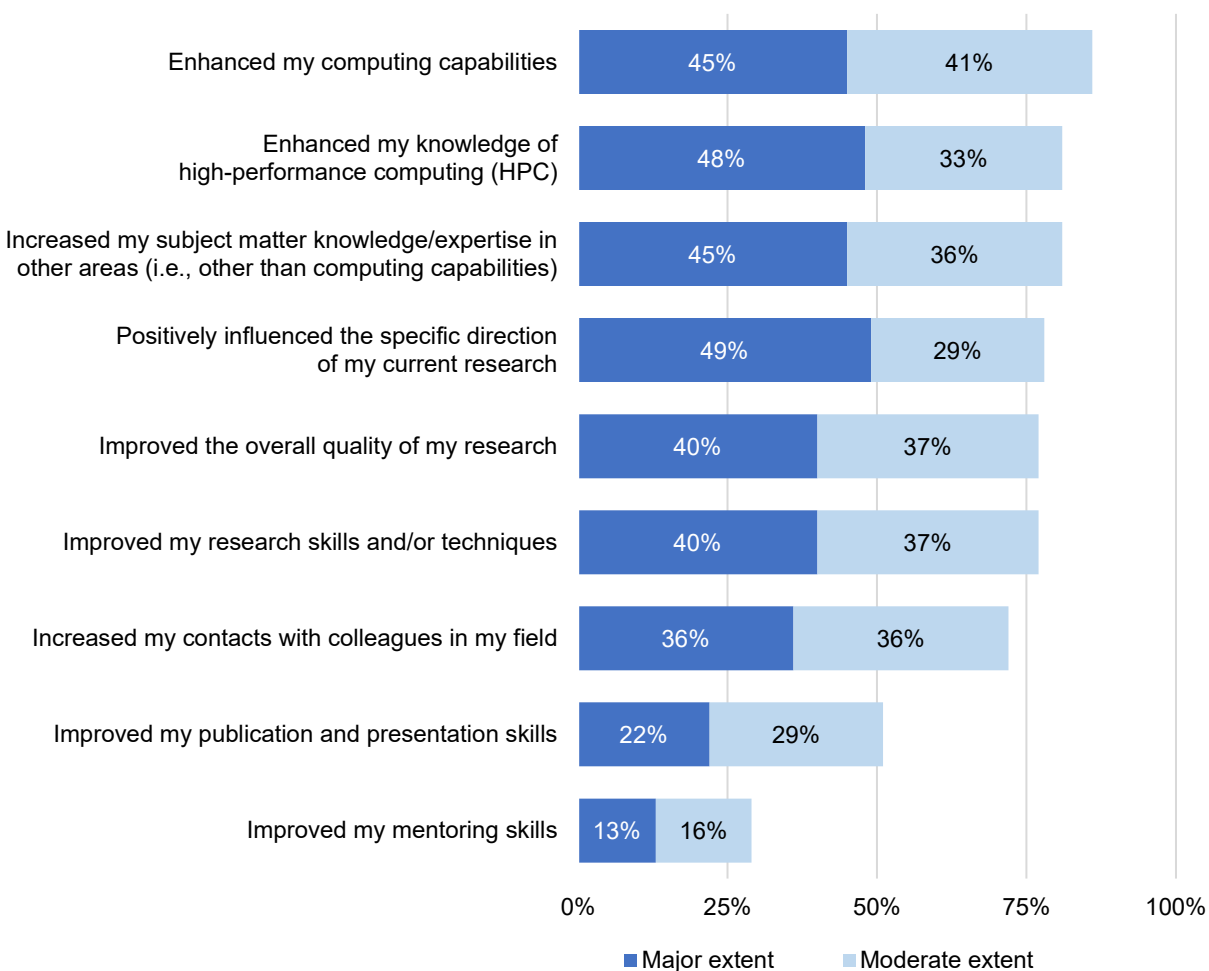
The survey also asked both alumni and fellows about the extent to which they agreed with various statements regarding the ways DOE CSGF participation has impacted them. As shown in Figure 4-24, 80 percent or more of alumni agreed or strongly agreed with all of the statements regarding the impacts of their fellowship involvement. Most notably, 98 percent agreed or strongly agreed that accepting the DOE CSGF was the right decision for their career.

Figure 4-24. Percent of alumni reporting on the impacts of their participation in the DOE CSGF program (N=213)
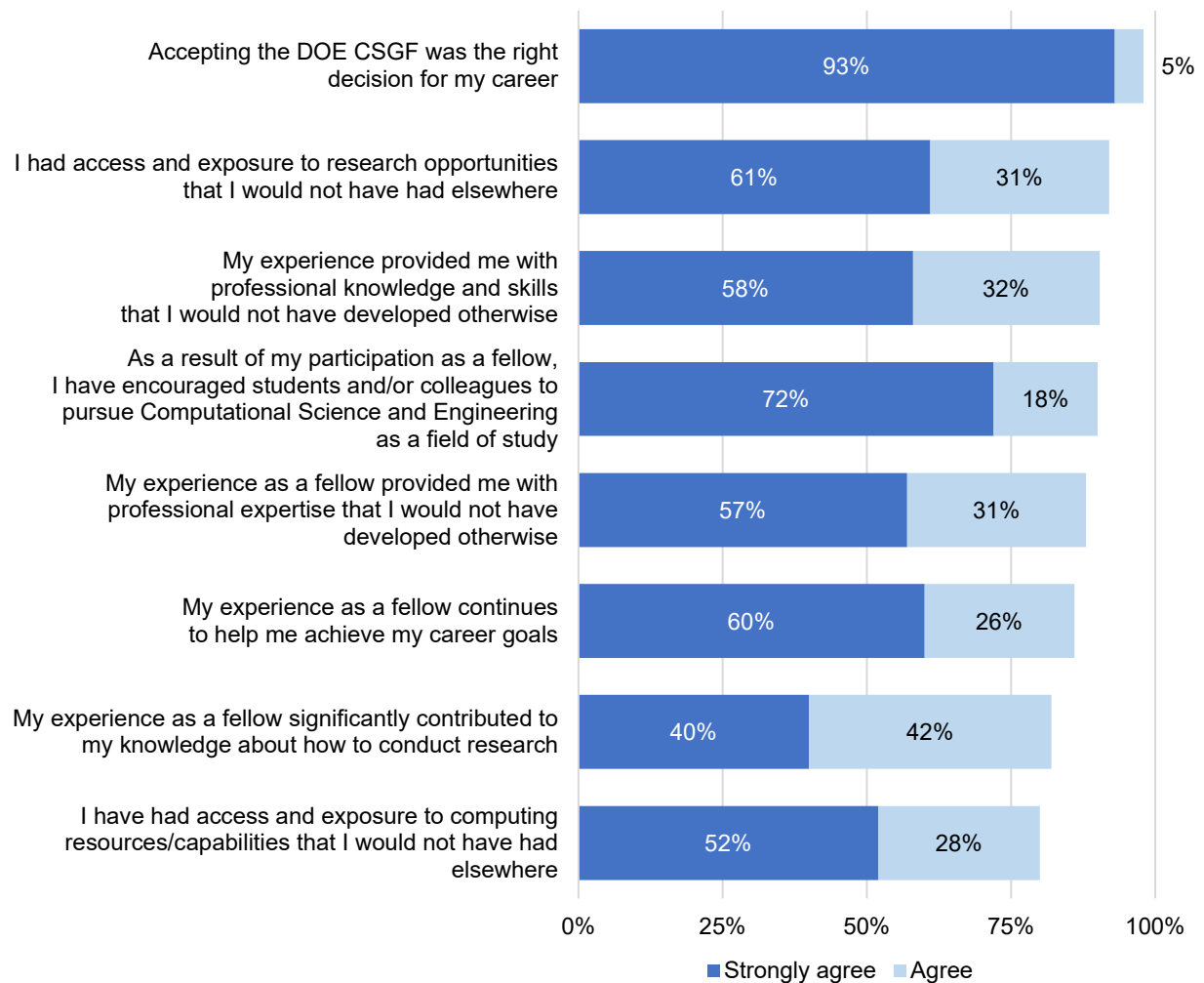
Figure 4-25 shows the results for fellows on the items that ask about the extent to which they agreed with statement regarding the ways the program has impacted them. Two-thirds of more of fellows agreed or strongly agreed with all of the statements, with 91 percent agreeing or strongly agreeing that accepting the DOE CSGF was the right decision for their career.

Figure 4-25. Percent of current fellows reporting on the impacts of their participation in the DOE CSGF program (N=83)
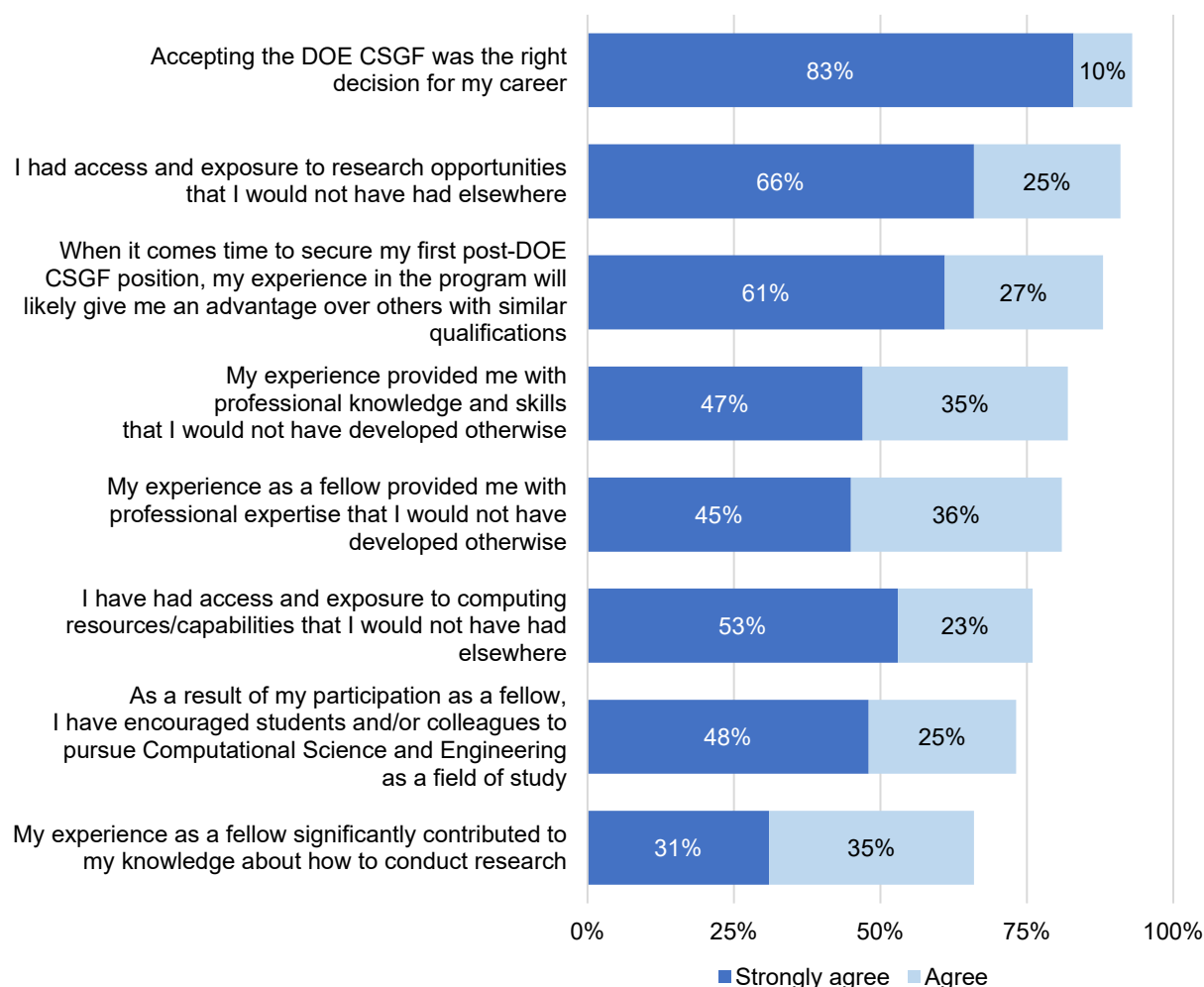
When asked in the interviews and survey about impacts, alumni primarily described impacts in the following four areas:

- Career goals or direction

- Skills and content expertise (i.e., in computing and related areas)

- Flexibility in pursuing research

- Collaboration and research networks

The next sections provide the findings for each of these four areas, with the first area drawing on both survey and interview data and the other three based on interview data.

Career Goals or Direction

Alumni who indicated in the survey that they were employed at a DOE laboratory or other Federal setting were asked about the factors that influenced their decision to work in these settings. As Figure 4-26 shows, the factor most commonly cited was the opportunity to conduct interdisciplinary, team-based work (88 percent). The next most common factors were the opportunity for career advancement (73 percent) and the opportunity to contribute to the greater good/public service (69 percent). Additional factors, which were cited by less than half of this subset of respondents, included geographic reasons and personal or family reasons, which were cited by 45 and 23 percent, respectively.

Figure 4-26.   Percent of alumni reporting the factors that influenced their decision to work in a DOE laboratory or Federal setting (N=84)
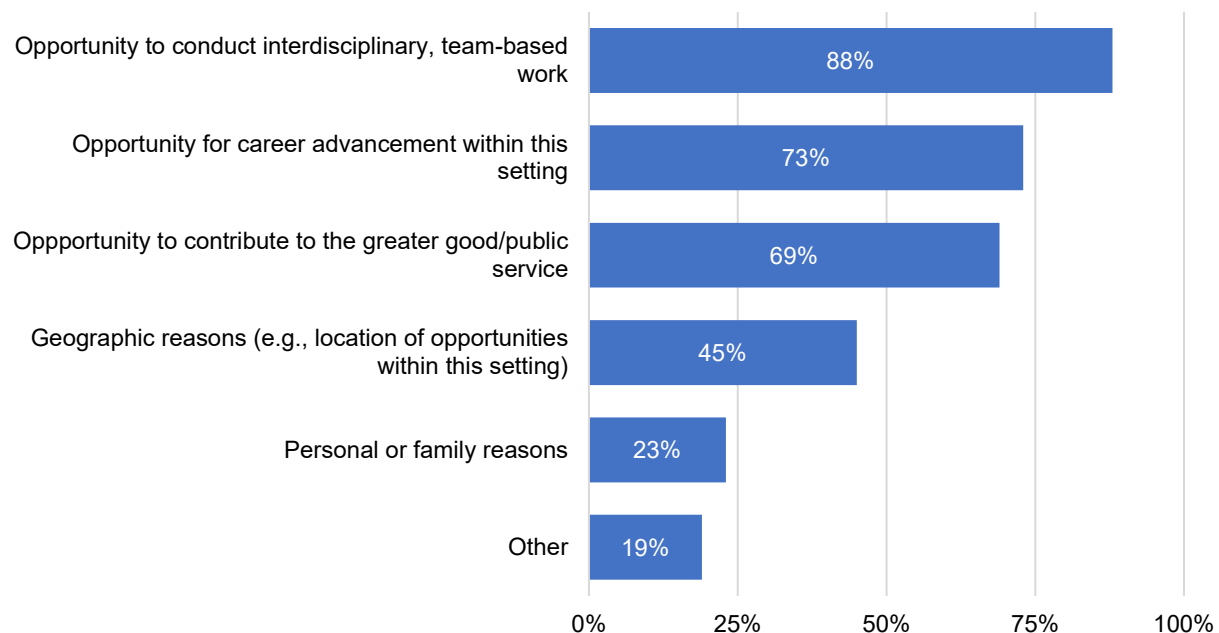
NOTE: Figure is limited to alumni indicating that they had been employed (in the past or presently) at a DOE laboratory and/or another Federal setting.

During the interviews, several alumni who are currently at a DOE lab described the direct impact of the DOE CSGF program on their decision to work in this setting. The following quotes from four alumni represent this group of respondents' views on this topic:

The fellowship certainly influenced my trajectory. In an obvious sense, the fact that I am this connected to the Department of Energy scientific community was heavily influenced by the fact that I received the fellowship. In a number of different ways. Obviously the fellowship itself is funded by the Department of Energy, but in

addition, having the practicum experience and then just being generally in that environment with other Department of Energy scientists certainly influenced the decision I made about where to apply for postdoctoral positions when I graduated. Then I ended up at a DOE National Laboratory, so it heavily influenced the trajectory of my career.

The most significant impacts were getting exposure to the DOE research complex, the labs, how universities are funded through DOE grants, and just understanding the scope of what the Department of Energy does, what kind of research they do. All of that exposure really just opened my eyes to what kind of work is being funded through the Department of Energy. I had some idea of that before going into the fellowship but I came out of the fellowship with a much deeper understanding of that. Ultimately, it led me to accept a staff position at a Department of Energy lab, [where] *I have been a staff scientist for several years now. If it weren't for the fellowship, I don't think that would've been on my radar screen. The fellowship not only introduced me to that opportunity, I think it prepared me very, very well for working in that environment and understanding what the needs of our government are in terms of science and research.*

Both of the practicums that I did were in areas of research different from my thesis research, and I think that was actually very good. They were broadening experiences for me. I got to meet other scientists from other areas, get exposure to more diverse viewpoints. Ultimately, those experiences were really beneficial. They also introduced me more, not only to the technical work of the labs, but also the culture of the labs and just how some of the research within the Department of Energy works. That certainly played into my decision to go back to a Department of Energy laboratory after I graduated and had a big role in that.

I had no idea [working in a DOE lab] *was a potential career path for me or that I would be interested in it, and I probably would not have had I not interned or done my practicum at* [DOE laboratory name] *and gotten exposure to the types of problems they work on. I absolutely would not have ended up at a National Lab. I was pretty sure that the only options were academia or go work in finance or something, which was not appealing to me.*

Alumni who indicated in the survey that they were employed in settings other than a DOE laboratory or other Federal setting (i.e., industry, alumni, not-for-profit, self-employed, or other) were asked about the factors that influenced their decision to work in those settings. As Figure 4-27 shows, nearly all of this subset of respondents cited intellectual interest (93 percent). The next most commonly cited factors were the opportunity for career advancement (62 percent) and income associated with working in this setting (53 percent). Additional factors, which were cited by less than half of this subset of respondents, included geographic reasons (49 percent), prestige associated with working in this setting (43 percent), and personal or family reasons (41 percent).

Figure 4-27. Percent of alumni reporting the factors that influenced their decision to work in a non-DOE laboratory/Federal setting (N=145)
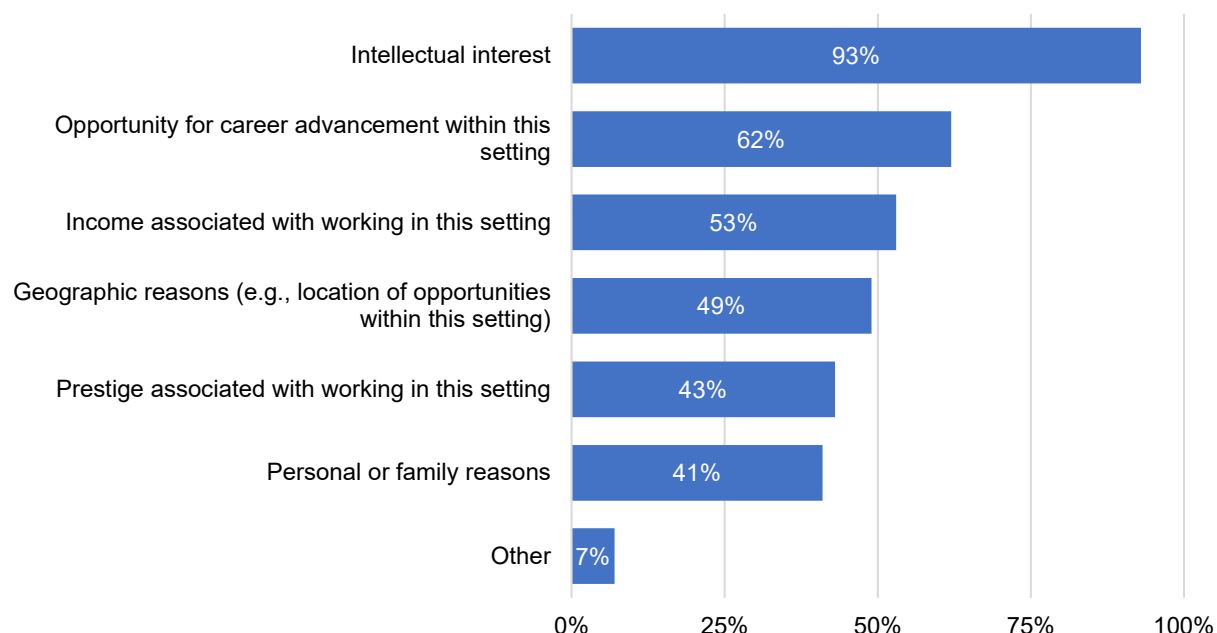
NOTE: Figure is limited to alumni indicating that they had been employed (past or present) at a DOE laboratory and/or another Federal setting.

Among those alumni interviewed who did not pursue work in a DOE lab, several indicated that the DOE CSGF program influenced their career plans by leading them to give serious consideration to working in a DOE lab. They described how the reasons for their choosing to work in other settings were more about those specific settings and not about the labs. For example, as one alum in academia described:

> *I have a little more autonomy as a professor. I also like the teaching and mentoring the Ph.D. students. There are elements of that at the labs, and my own practicum mentor very regularly had interns, so there are definitely opportunities for that. But there's some things that just weren't at the labs that were at the university. Again, like training your own Ph.D. students. That's not easy but when it works out well, it's very rewarding. And then the opportunity to teach, I do enjoy teaching, so some of those things edged out the lab a bit.*

In addition, other alumni who are currently employed in other settings described how the program influenced the direction of their research both during graduate school and in their professional career. For example, one alum stated:

> *It actually changed my academic direction by a fair bit during graduate school. The program of study is one of the most underrated features of the CSGF. In terms of classes and techniques, this is a fellowship that makes*

you take classes outside of your main field, and one such class was quantum computing, which probably was one of the earliest classes that was offered in the field. Now I do a lot of research on quantum computation and other forms of computation… The fact that I took a course in alternative computing, like quantum computing, early on was very formative and enabled me to do a lot of other types of computing research that I do now. That's been very key for my research.

Skills and Content Expertise

Most of the alumni interviewed described how the program enhanced their skills and content expertise, both in areas such as HPC but also other academic domains (i.e., outside of their degree field) that they otherwise would not have been exposed to, as well as their ability to work effectively across disciplines. The following quotes from four of the alumni represent the overall views expressed on this topic:

Finding people from physics, from chemistry, from engineering, from computer science, from math, bringing all those different elements of the sciences together was something I really, really enjoyed. It made my experience much richer than I would've gotten if I didn't have the fellowship.

The computational techniques that we learned at the time and some of the courses in computational science that we were made to take as part of the fellowship have influenced me and my research for quite some time. The HPC experience was great, even though [as an academic] *I have not personally used leadership-class resources. We use maybe a couple of tiers below that but it was very useful training for using those things. Some of my graduate students do use the leadership class machines… It taught me many of the key computational ideas in the field, and what many of the key resources are.*

It has certainly given me an appreciation for the scale of research efforts within the government, which is something that I had never thought about before. They did a really good job of educating us, not just on the history of the Department of Energy, but the history of basically nuclear research in the US, which is an interesting topic that I wouldn't have thought twice about if I weren't part of this program. It has given me a lot of insight into what government research is like and what the structure of government research is like that is just invaluable, especially if you're going to be in a field that's primarily based on high-performance computing.

I work on pretty crosscutting topics. I definitely didn't know about this sort of space until I did my practicum. I get to think about computation a little more broadly rather than being quite as science focused, as I was in my Ph.D. work. So the program definitely both showed me [computational science] *was a thing and gave me the tools to be able to actually do my job now.*

Flexibility in Pursuing Research

Some alumni stated that the program allowed them flexibility to pursue various topics, which was helpful for their careers and enhanced their research without regard to typical constraints, such as funding. For example, as three of the alumni stated:

> *The fellowship did what it promised to do in the sense that it provided me with funding, and as a result, I was able to pursue the research that I found most interesting, and I was able to do that without being dependent on choosing an advisor who had funding for me… The fellowship also provided travel funding, not only to go to the annual program review, but also to attend other conferences that I found very valuable and interesting as well.*

> *It's the stability of funding and being able to pursue what I think are the most interesting topics. I was able to pick the problems that I thought were interesting and actually use computation to help answer them. Being able to go after basic science questions and use computational tools more broadly, it really made my research very compelling in the field.*

> *I'm in a field that's very interdisciplinary anyway, so my thinking might have moved this way with or without the fellowship but the fellowship has definitely helped me. I've been building this general approach. The fellowship has definitely encouraged that way of thinking, and I've found that very profitable for my own creativity and expanding my thinking. That is both from the freedom that the external funding provides and from the freedom that the fellowship encourages to communicate with others across disciplinary boundaries.*

Collaboration and Research Networks

Several alumni stated that the program had helped them collaborate with a range of other professionals across different settings and provided them access to a broader network of researchers with whom they can exchange ideas, work together on grant proposals, and carry out other research activities. As three of the alumni stated:

> *In terms of opportunities, I've networked* [as an academic] *with a lot of people at the labs over the years, we have written many papers together, I have lots of cross-lab papers. I'm part of a large DOE center right now, and I wouldn't have had that opportunity had I not worked at the labs at some point. I continue to have many grants with the labs and I continue to think about things in computational science. So it's influenced me in many, many different ways.*

> *It certainly broadened my professional network of researchers and colleagues that I can reach out to and interact with and ask for help, or even just have discussions. I've had folks that were many years ahead of me in the program reach out, and I've reached out to folks and said, 'Hey, you're doing computing over here, is that something you think that someone like me would like? We've talked before, you know what my research*

interests are.' I don't think I would have anything like that community without the program, and I think that it is really important as far as tightening the community in such an interdisciplinary field where otherwise you can get very siloed.

The program provided lots of channels for us to interact with each other. The fellows, they're all very curious, high energy people, and they just kind of create this environment for us to interact, and ideas just start going. I'm still kind of surprised by some of the collaborations a little bit. The collaborations make sense, but just being in this kind of community, it just lowered a lot of the barriers. I have a hard time seeing a lot of these collaborations popping up otherwise because the program covers a large number of disciplines, and it would be a really low probability accident to have met some of the people that I work with, let alone start putting together grant proposals and working on projects together.

Impact on Meeting DOE's Workforce Needs

An additional area of impact that alumni were asked about in the interviews was the extent to which the program, based on their perceptions, has been successful in meeting the DOE's workforce needs in the areas of CSE. Most of the alumni indicated that the program had been effective in this respect, and the following quotes from five alumni represent the views expressed on this topic:

I work with other CSGF fellows at [DOE National Laboratory name], *and I think it's pretty universal that we feel the fellowship prepared us very well for what the Department of Energy workforce needs are. I think a lot of us have said, 'The fellowship really helped us to hit the ground running when we got to the labs.'*

We need more programs like the CSGF. It's definitely true that we are in a period of just astonishing growth. We have so much work to do at [DOE National Laboratory name]. *We're hiring a ton of people, and it's a real difficult challenge bringing in folks and providing adequate training and support and mentoring. I think a program like CSGF, that's exactly the solution that helps get us there.*

The program has been very successful. It is obviously limited in its scale by available funding, so it can only support so many fellows every year. I think it's been pretty effective, especially through practicums and other aspects of the fellowship, in retaining a fairly substantial portion of the graduates of the fellowship within the DOE scientific community. And then others have gone on to do other really important work for the national scientific enterprise. It's had a substantial impact, in my sort of anecdotal experience, in that I know a number of people who are leaders in the DOE scientific community who are former fellows.

It does a great job of training people to think about things through a computational lens, as well as disseminating information on where the future of the field is going. I think another underrated part is, through the program, I could become the computational expert in my [university department], *so I can teach people how to use supercomputers. It's a byproduct, I think it helps more than just me, it helps students who end up working in adjacent fields.*

I don't have a whole lot of data on it, but I can certainly say that within the Department of Energy CSGF community, I know many more folks who went on to do post docs, some of the named post docs at the various Department of Energy labs, and at least early career research at these labs. There are many more people within the DOE program that have gone on to do that with their careers. I would also say they certainly do a good job of making you aware, as a researcher, of the opportunities within the DOE, and they're very keen to hire people from the program into the DOE if you apply.

Some alumni indicated in the interviews that although the program was taking the right steps with regard to meeting workforce needs, there were other types of barriers beyond the DOE CSGF program. First, several mentioned location, with one alumni stating, for example, "Honestly, the only thing that took me away from [working at a lab] was location, it's that there's only a few Department of Energy labs" while another said, "Most National Labs are in somewhat remote locations, so that's an element that's less appealing." The other factors mentioned included an overall lack of students in the STEM pipeline and aspects of the DOE labs that make them a less appealing setting in which to work. According to two of the alumni:

There's a lot of merit to the way that DOE is doing it. You train the leaders, you give them resources, and you put them in a network so that they can collaborate. It's a very sound strategy to train leaders and give them the tools and interconnect them so that they can kind of work together to help shore up some of the pipeline issues… A lot of the fellows [who are academics], *we produce our own kind of Ph.D. graduates, and the stuff I've picked up through this program gets passed along to my own students, so there is this multiplier effect that way. But I don't know how to necessarily fix all the issues. Some of this is a STEM pipeline thing. A lot of the computing problems happen just because not enough people are going into* [science]... *They're kind of lost already at middle school. I feel like the CSGF program is a very important part of the solution, but I think the computing gaps in the workforce, a lot of that needs to go all the way down to probably middle school or something, to not lose a lot of potential talent. We need to recruit them or retain them much earlier on. I don't have a solution to that, it's just that part of the solution needs to happen a lot earlier than with a program like CSGF.*

The program has helped substantially, and it's probably the best thing that the DOE can do. I think training the people to meet these needs is very useful… But the program recognizes there is some drain, right? Some of us, including myself, have not stayed in the DOE system and so we go off and do other things. I don't necessarily think that's a bad thing, but it is a thing. There are questions not related to the fellowship that that DOE should be asking about why we're not staying… There are technical gaps but there are also personnel gaps. There should be some thought placed upon personnel gaps at DOE that the program can help with, but DOE has to think about a lot more. How are they creating an environment that is inclusive for a variety of people?

COVID-19

Current fellows were asked in the survey about the impacts of COVID-19 and any modifications to in-person learning on their progress toward completing their Ph.D. and their experience in the DOE CSGF program. As Figure 4-28 shows, 68 percent of fellows agreed or strongly agreed that the shift to virtual learning had an impact on progress toward completing their degree. In addition, only 12 percent agreed or strongly agreed that participating in program review meetings virtually provided them with a sense of community with the fellowship. Although these two items indicate adverse effects on fellows' experience due to COVID-19, a clear majority (70 percent) agreed or strongly agreed that if their practicum participation was virtual, they were able to make connections at the National Laboratories and receive positive mentoring.

Figure 4-28. **Percent of current fellows reporting the extent to which their experience in the DOE CSGF program has been impacted by modifications to in-person learning as a result of COVID-19 (N=83)**
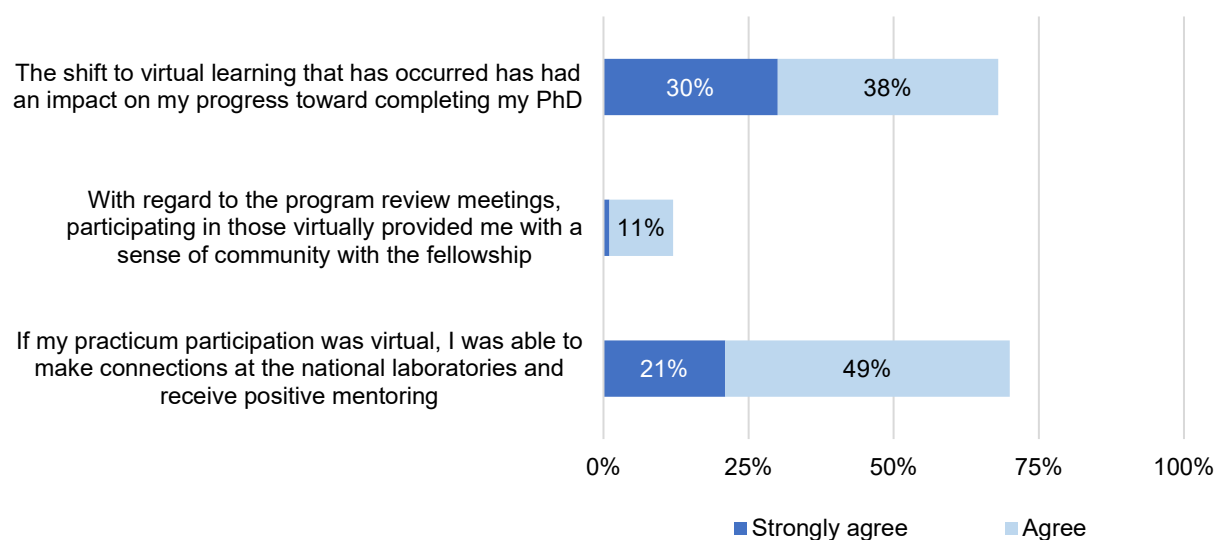
NOTE: Item only appeared on fellows survey. For the second item, 1 percent of respondents strongly agreed.

Current fellows were also asked in the interviews about the impacts of COVID-19. While in the survey, a majority of fellows agreed that the shift to virtual learning impacted their progress toward their degree, in the interviews, they reported generally minimal effects on their progress. Most indicated that this was because they had already completed much of their coursework prior to any shifts to virtual learning and that they could carry on with most aspects of their research remotely. "I was done with most of my classes by the time the pandemic started, and in terms of my I research, I can do that remotely. I'm reliant on various computing resources, but I can tap into those remotely,

so there wasn't that much of an impact." Another responded, "I'm lucky because my work is computational and, for my coursework, I had finished a lot of what needed to be in person during my first year, and during that first virtual semester the first six weeks were in person, so it was pretty easy to convert over." Similarly, according to another fellow:

> *I don't think that it's really impacted me except for the only thing that I really shifted around because of the pandemic was the placement of the practicum relative to completing my course of study. I ended up doing the practicum during spring, with the hope that I would be in the physical lab a lot more in the summer. I rearranged the spring semester to do the practicum during spring instead of summer, and that made me have to delay a class. I still have one class left in my program of study that I'm planning on doing next spring since it's only offered in spring. That was the one downside, pushing out coursework to the third year.*

With regard to the annual program review meetings, the fellows described how the shift to a virtual setting made the events less engaging compared to in-person events, how it was more difficult to communicate or have meaningful interactions with others, and how there was less of a sense of community. The following quotes from three others represent the views expressed on this topic:

> *It was hard because during the day it was mostly talks and in terms of the people in the audience, that part was quite anonymous. It was like a webinar. You couldn't see who else was there, and so the only time you would see anything of anyone was when they asked a question and their name would show up… It makes it a little bit different. It's hard to feel like you're watching with other people, to have that sense of community. But I don't know exactly how they would have approached that differently.*

> *The virtual meetings, there was no interaction. They had a list of speakers, and those speakers prerecorded their presentation or their talks, and then we all just sat and listened. You didn't even have to be there, you could just put your screen on and then do other things… It was less interaction because I wasn't able to see any faces. I wasn't able to see any fellows. And I wasn't able to talk directly to other fellows, or even to the speaker. If I wanted to ask a question or had a follow up question in any way, I would submit via a written chat to a moderator and they would ask the question, and that's very different from my experiences at the in-person program reviews.*

> *There was some sense of community with the fellowship. It wasn't as great as it had been when it was in-person, but I guess that's to be expected. It was good to see familiar faces and get updates and things like that. I think the best was done with the situation but there's more of an opportunity to interact with the fellows in-person. You don't just see their work, you also talk to them in down times or during meals, things like that. Seeing someone there in front of you, a tangible person, it changes the experience a bit.*

While many of the current fellows described the drawbacks of having the annual program review events conducted virtually, most indicated in the interviews that there were no adverse impacts on their practicum and that they were able to establish and maintain important connections and receive mentoring from their advisor and others that led to enhancements in their skills and knowledge. As

one fellow stated, "I had meetings three times a week with my primary advisor during the practicum, and we also had weekly meetings with his larger research group. So I was able to interact with them in that capacity." According to two other fellows:

The most pleasant surprise of everything being switched to virtual was just how much I did get out of the practicum experience. I gained a lot of skills as a result of just having the time to spend on it and also having the resources of the people that I work with at the [DOE National Laboratory], *and the fact that they have so much data available. You can just pull down a bunch of reference data sets and use those and search them really quickly. Just having access to that system and those resources was a really great experience. A lot of things would have been easier if I could have gone and just knocked on somebody's door and asked for help with them immediately, but I think that still it was really helpful.*

There wasn't an impact but I think that's more because I wasn't a first year fellow when this happened. I was at the end of my second year, so I naturally had a good footing into my dissertation topic, what I wanted to accomplish. My relationships with my advisor and others had already been established, so working remotely wasn't a big deal. Really, it didn't feel like it was much different than working in my office at the university, from the perspective of getting work done. I don't think I was limited in any way. Maybe one caveat to that would be that natural interactions with other students in your lab group, and perhaps outside of your lab group, can help further ideas and help progress your research in sort of different ways, and that was limited. But beyond that, no impacts.

In addition, a few of the fellows described some advantages of the shift to virtual learning on various aspects of their education and fellowship experience, specifically in how they communicate with others, with whom they communicate, and how often. For example, as two fellows stated:

There are pros and cons of going virtual, with cons obviously being that in-person conversations and interactions are better. But the funny thing about going remote is that you don't have to wait for, say, the annual review to see somebody because you know that you're just never going to see them unless you send them an email or something, and then you end up scheduling a Zoom meeting and staying in touch more outside of, say, conferences or reviews or things like that.

The practicum being virtual made it so that I was a lot more flexible in the types of groups that I would have chosen to work with. Also, it made it so that it was just very natural to speak with collaborators. The data set that I used was generated by researchers at [another institution], *so it was very natural to just talk with them over Zoom. I don't know how often that would have happened if it was pre-pandemic. Before then, it was sort of a big to do to get on a Zoom call with people that are working on your data set or whatnot. Now it's very normal to just hop on a Zoom with someone. I think that all of that's been great, as well as just the level of connection that I've been able to maintain. That's also been a benefit because we've continued to meet via Zoom the same way we did during the practicum, with no feeling that it's interrupted, or the project or the paper is hindered by me no longer being at a lab in person, which makes it blend.*

Diversity and Inclusion

Both alumni and fellows were asked a set of questions that addressed whether they felt comfortable and included as a member of the DOE CSGF community and the extent to which the program creates a diverse and inclusive climate that is welcoming of individuals of all backgrounds. As shown in Figure 4-29, 93 percent agreed or strongly agreed that they felt comfortable and included, while 81 percent agreed or strongly agreed that they program has actively taken steps to make them feel comfortable and included. When asked whether the DOE CSGF program could do more to make them feel comfortable and included, only 12 percent agreed or strongly agreed with the statement.

Figure 4-29.   Percent of alumni reporting the extent to which they felt included and the extent to which the DOE CSGF program creates a diverse and inclusive climate (N=213)
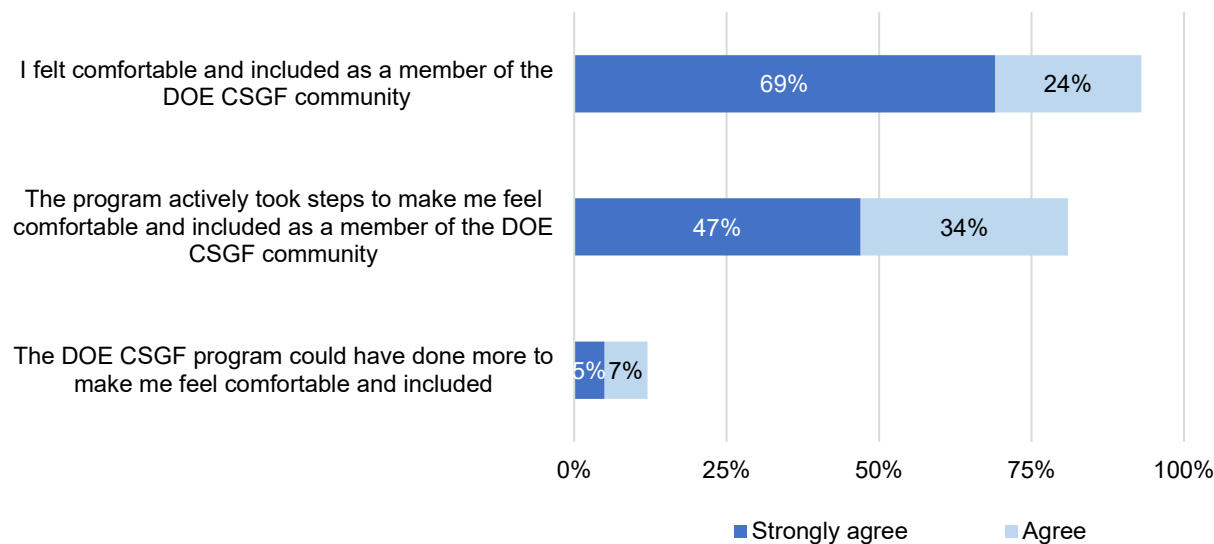

Figure 4-30 shows the results for fellows on the items that address diversity and inclusion. Ninety-two percent agreed or strongly agreed that they feel comfortable and included, while 70 percent agreed or strongly agreed that they program actively takes steps to make them feel comfortable and included. When asked whether the DOE CSGF program could do more to make them feel comfortable and included, 23 percent of fellows agreed or strongly agreed.

Figure 4-30. Percent of current fellows reporting the extent to which they feel included and the extent to which the DOE CSGF program creates a diverse and inclusive climate (N=83)
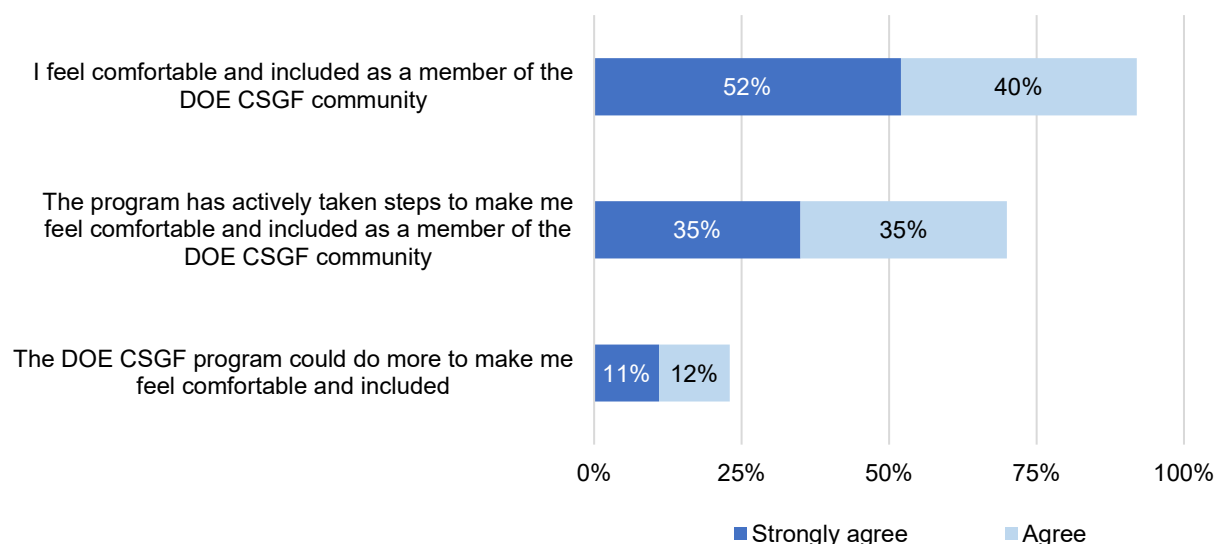
In their responses to the interview questions around diversity and inclusion, both alumni and current fellows generally felt that the DOE CSGF community was diverse and thus did not have any concerns about a lack of diversity. While many interview respondents indicated they did not identify as a minority, there were several women included, as well as those with disabilities, who addressed the questions from these perspectives. Nearly all of the respondents, both alumni and current fellows, reported that they felt included as a member of the DOE CSGF community. For example, one alum replied, "I've definitely experienced my fair share of unpleasant environments, but the CSGF was always one that I thought did a good job of internal policing, as well as just accepting people who are largely good human beings." In the words of one current fellow, "I feel a hundred percent included and represented and everything. I really appreciate that, it is part of the reason I like the in-person events so much, because there is actually half women there, and I thought this is how it should be." According to another alum:

> I always felt inclusivity within the community of CSGF, and it was clear to me that it was really an area of focus. The fellowship was thinking about that, they were thinking about how to really build a community of scientists where we could all learn from each other, where we could all get exposure to different perspectives, and I just always felt very, very supported by that. We were encouraged not to get too stuck in our boxes of whatever perspective we were coming from, whether that's a cultural background or our technical backgrounds. I think the fellowship was very intentional in trying to break us out of that, and I think it worked. It worked really, really well.

Some of the alumni observed that diversity was somewhat more limited in earlier years of the program but that recipients had become more diverse over time. As two alumni stated:

> *If I look at the fellows list, it is much more diverse and inclusive than it was when I was younger. I was certainly one of the few women on the fellowship back in the day, which didn't feel strange to me, but that was always true. Now, there are many, many more fellows from different backgrounds, so I think the fellowship does well… The fellowship is wonderfully inclusive and has done a lot of great work in that area.*

> *High-performance computing, from its earliest days, has had an old boys' club vibe. I don't really know much about the fellows from the early years of the program. More recently, I definitely sense among the new incoming fellows over the last couple of years much greater diversity along a lot of axes. The program was a lot more gender diverse before it was more race diverse, before it was more disability diverse but it's gotten more diverse along all those axes.*

Moreover, some of the alumni felt that while diversity within the program may be somewhat limited, it is not a major problem and reflects larger issues, i.e., beyond the DOE CSGF, with one stating:

> *I think obviously the community does, just like as a whole beyond just CSGF, skew. At CSGF, I never felt actively excluded, or I didn't get some of the weird vibes that you can get in toxic culture areas. I think a lot of that came from alumni and other people like that setting the tone as you came up through the years. So I think really keeping an eye on the accepted pool and having these larger classes is probably really helpful in terms of continuing to set expectations internally of what is and is not acceptable.*

Many of the interview respondents, both alumni and fellows, had the impression, based on their observations of the makeup of the fellows or other related factors, that the program was actively taking steps to create diverse pools of recipients. "Presumably, the [program] looks at factors related to diversity when making selections. I don't really have any insight into that part of the process, but my feeling at the time was that they really seemed to have made an effort to have a diverse selection of awardees, and I expect that that has continued." Similarly, two others stated:

> *I have not gone through the application review process on the other side personally but I know that some of it does take into account looking at people holistically and, as a broader component, what they can bring to the community. I think keeping whatever metrics are in place so far and really emphasizing them going forward would be important.*

> *I don't know what efforts were being conducted by the program to promote diversity but I can say that when joining the program, I certainly was happy to see that there was more gender diversity than anticipated in a high-performance computing, Department of Energy, research scientist-type program. As the years progressed, it certainly seemed like there was greater ethnic diversity and military status diversity, and things like this that I had noticed more. It's a relatively small pool, right? It's only about 10 or 20 people a year but I*

observed that. I don't know what efforts went into that, I don't know if it was recruiting focus or just a more well-rounded applicant evaluation process, but I felt like it was trending upwards in my time there.

Additionally, one alum did offer suggestions for minor changes that could be made by the program, which involved giving consideration to diversity when selecting the individuals to lead events at the annual program reviews:

> *I would think about what type of alums to bring back and invite for making those keynote speeches. When thinking about who's holding all of these sessions, we see some of the same people come back year after year, which is great because they are wonderful people and good at what they do. But maybe bring in more people so that we can have both the people everyone knows and loves and new faces as well, with a mind for diversity from the top to the bottom.*

Community

With regard to community, alumni were asked to report the extent to which they had stayed in touch with others affiliated with the DOE CSGF since completing the program. As shown in Figure 4-31, 62 percent indicated that they had stayed in touch with other DOE CSGF recipients, while 41 percent reported staying in touch with their practicum supervisor, and one-third also reporting they stayed in touch with other staff at their practicum laboratory.

Figure 4-31. **Percent of alumni reporting the extent to which they have stayed in touch with other DOE CSGF affiliates (N=213)**
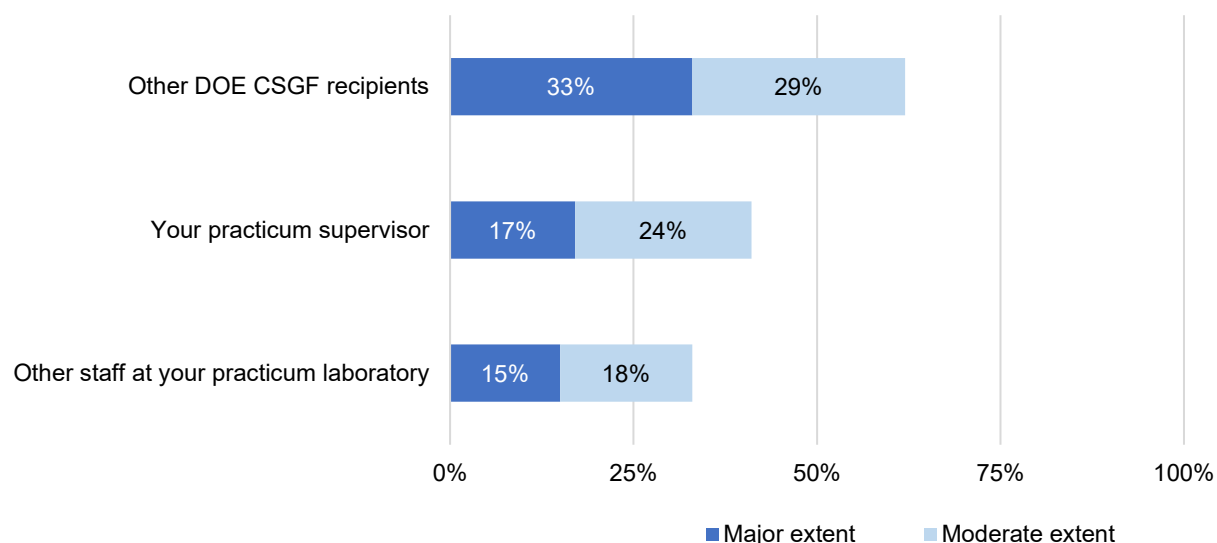
NOTE: Item only appeared on alumni survey.

The issue of community was also addressed in the interviews with alumni, and many cited the DOE CSGF community as one of the best aspects of the fellowship. Generally, the alumni stated that the fellowship allowed them to make connections with others in the field and to collaborate with a broader range of individuals, with several indicating that this was not something they had anticipated when beginning the program. "I didn't expect there to be a community associated with a fellowship, which was a really wonderful, pleasant surprise. I think I had more exposure to the sort of NSF type fellowships where you just get your pot of money and go on." The following quotes from three other alumni further represent the respondents' overall views on this topic:

The community is the best feature. It was an excellent opportunity to network with other people in the field. For example, I now have a grant with another DOE CSGF fellow in my year. I have had grants with other DOE CSGF fellows in the past. So it's an excellent networking opportunity to get to know other people that are also working on similar things at a high level.

I had a really positive experience, and I got a lot more than I was anticipating [as a result of] community aspect. That's pretty clear in the advertisements, but that's really been a part that's special about the program and very different. There's a lot of other prestigious fellowship programs, and that's great, I'm not criticizing it, they'll provide funding and support. But the CSGF is very, very different. They provide a lot of those resources but then there is this community building and network infrastructure. You're part of this big group of multigenerational community of scientists.

I'm in academia, and I haven't been working directly with folks within the DOE network, but I have connections to folks I met at my practicum… Once I started making those connections, then there's connections of connections, and then some of these folks—of course people move around—they've left the labs. But just becoming part of that DOE system has continued to play out. I've also collaborated with some other alums since I have some papers and grant proposals with other alums. The cool thing is I didn't even overlap with some of these other alums. These collaborations wouldn't have happened if it weren't for the kind of connection we have through this fellowship program.

As part of the questions around community, both alumni and current fellows were asked in the survey about whether they had ever recommended that someone else apply for the DOE CSGF. Ninety-eight percent of alumni indicated they had recommended at least one person to apply to the fellowship. As Figure 4-32 shows, while many recipients did not know the outcome of the applications that had occurred as a result of their recommendation, 27 percent of alumni recommended at least one applicant who was accepted to the DOE CSGF.

**Figure 4-32.** Percent of alumni reporting the status of potential applicants to whom they had recommended the DOE CSGF program (N=209)
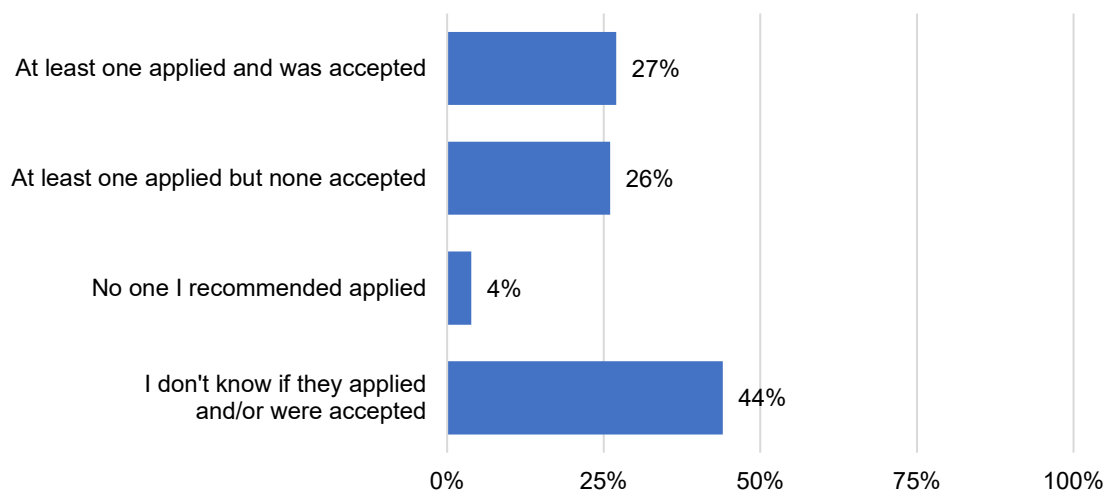
NOTE: Figure is limited to respondents indicating they had recommended the program to at least one potential applicant.

Among fellows who responded to the survey, a similar proportion (92 percent) recommended to others that they apply. Figure 4-33 shows the results for fellows on the items that ask whether they had ever recommended that someone else apply for the DOE CSGF.. As with alumni, although many fellows did not know the outcome of the applications that had occurred, 13 percent recommended at least one applicant who was accepted.

Figure 4-33. Percent of current fellows reporting the status of potential applicants to whom they had recommended the DOE CSGF program (N=76)
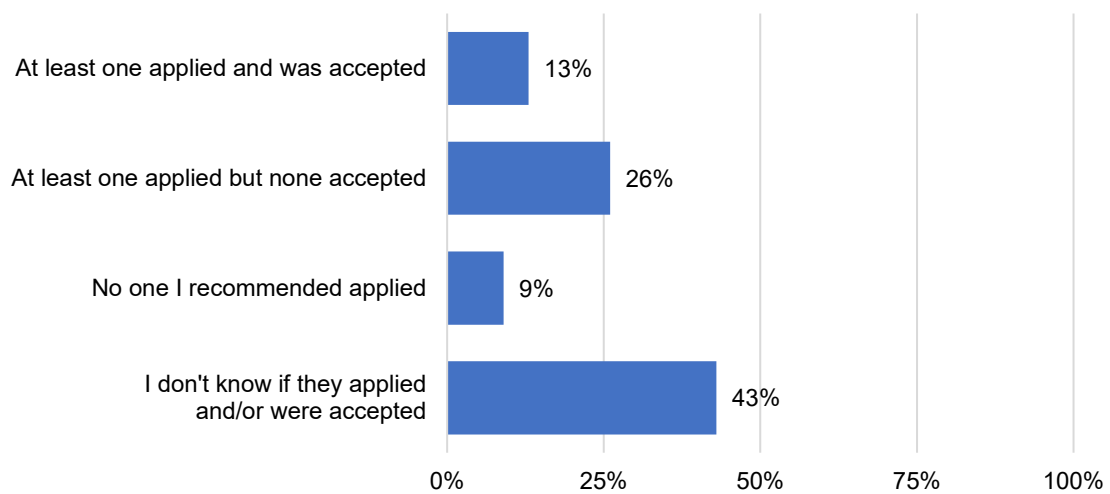
NOTE: Figure is limited to respondents indicating they had recommended the program to at least one potential applicant.

Current Fellows' Plans After DOE CSGF Completion

Current fellows were asked several questions in the survey about their plans after completing the DOE CSGF and the role the fellowship might play in those plans. First, they were asked to predict the extent to which their status as a DOE CSGF recipient would be beneficial when it came to securing their first post-DOE CSGF position, and 88 percent agreed that this status would likely give them an advantage over others with similar qualifications (Figure 4-34). Only two percent disagreed with the statement, while another 8 percent neither agreed nor disagreed.

Figure 4-34. Percent of current fellows agreeing that participation in DOE CSGF would help them secure their first position (N=83)

Neither agree nor disagree 8%

Disagree/strongly disagree 4%

Agree/strongly agree 88%
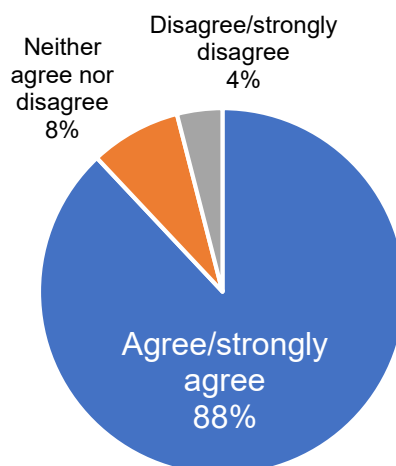
NOTE: Item only appeared on current fellows survey.

Next, fellows were asked to select the types of employment and the setting in which they planned to apply after completing their fellowship. As Figure 4-35 shows, both postdoc(s) and full-time employment were cited by at least three-quarters of fellows, which suggests that most fellows were considering both options.

Figure 4-35. Percent of current fellows reporting the types of employment they planned to pursue after completing the DOE CSGF program (N=83)

Postdoc	78%
Full-time employment	76%
Other	0%
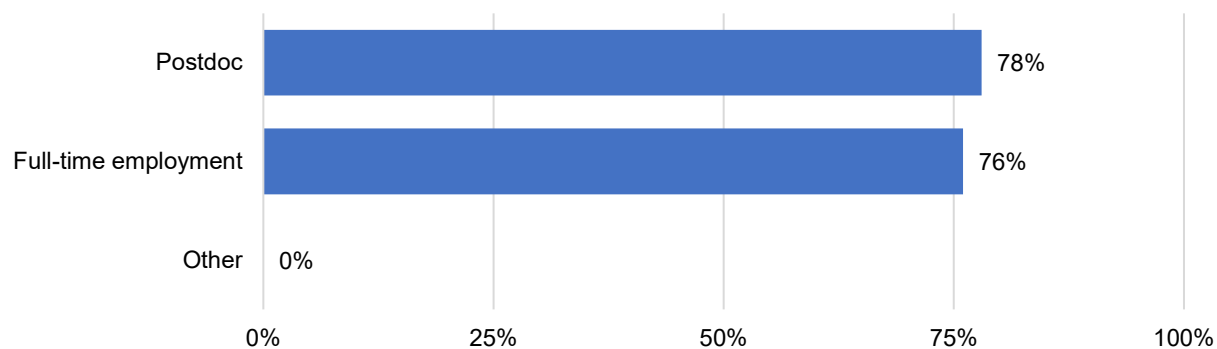
NOTE: Fellows could select multiple responses.

When asked to indicate the specific setting in which they planned to seek employment or postdoc positions after their fellowship, DOE laboratories and industry were most common. Eighty-eight percent of fellows said they were planning to apply to a DOE laboratory after their fellowship, while 65 percent were planning to apply to a position in industry, and 61 percent indicated they were planning to apply to positions in academia (Figure 4-36).

Figure 4-36. Percent of current fellows reporting the professional settings in which they planned to apply for employment after completing the DOE CSGF program (N=83)
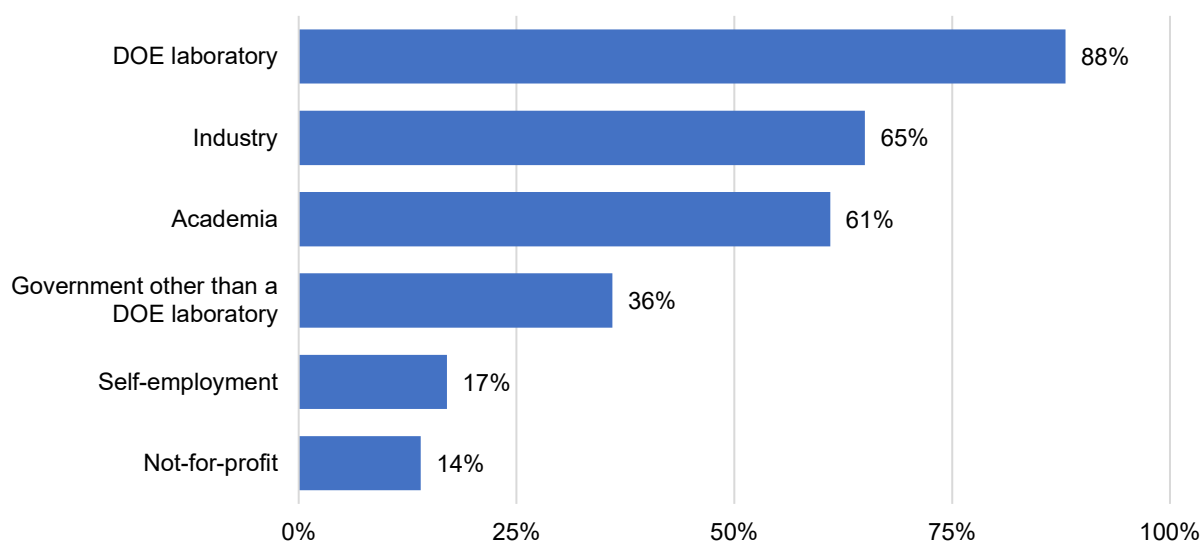
NOTE: Fellows could select multiple responses.

Finally, fellows were asked in the survey to report the extent to which they agreed with various statements regarding the DOE laboratory opportunities they felt were available to them after fellowship completion. As shown in Figure 4-37, a majority of fellows agreed or strongly agreed with each of the statements regarding employment at a DOE laboratory. Most notably, while a substantial majority agreed or strongly agreed that career opportunities available at DOE laboratories are intellectually challenging (92 percent) and that they would actively pursue a position at a DOE laboratory if one were available (85 percent), a smaller majority agreed or strongly agreed that the career opportunities at DOE laboratories offer competitive salaries (59 percent).

Figure 4-37.   Percent of current fellows reporting on their perceptions of the opportunities available at DOE laboratories (N=83)
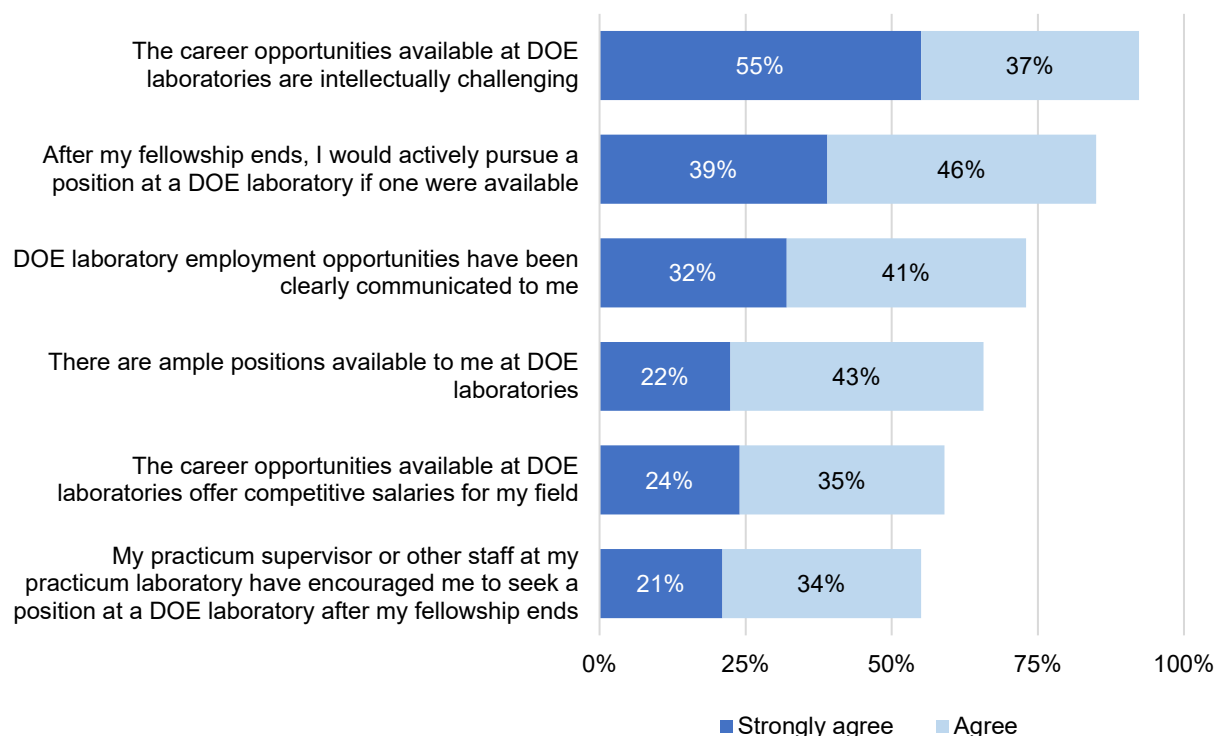
NOTE: Item only appeared on current fellows survey.

When asked in the interviews about their plans for after completing the program, most of the fellows described how they were not certain about which employment setting they preferred but at this point it was most likely that they would pursue a position in a DOE lab. The following quotes from two of the fellows represent the overall views expressed on this topic:

I would say right now that [a DOE lab] *is where I would be leaning towards. The ability to keep working on some similar type of research areas that I am right now, without having to take on some of the added responsibilities that would come with, say, at a university. It's not a complete night and day difference between how people are working at the lab and the universities but I'd say at the labs, at least at* [name of laboratory where practicum was completed], *they seemed to enjoy their work a lot more than the average person at the university. Outside of strictly DOE or university academic type research, I'm not opposed to looking at something more in industry in terms of computing. You don't know what opportunities are going to present themselves or what connections you might make along the way. There might be something out of the blue that you never anticipated.*

I came into my Ph.D. with the plan of get my Ph.D. and then go and work in industry in some R&D [research and development] *position. But I'm pretty open to the specific application. Ideally, I would like to be in some research type environment and have the computational aspect of it, those are both pretty important to me. I hadn't really known much about the National Labs or considered them at all prior to*

coming to grad school, and prior to exposure to the fellowship program. I would say that the combination of hearing more about them and the exposure through the fellowship program has certainly peaked my curiosity. I have no idea for sure but I think if you asked me right now, I would probably try to work in a National Lab at least as a postdoc for two or three years. And then, if I like it, either stick around or potentially move on to industry again, hopefully staying in some R&D type role. I'm not opposed to working at other types of federal labs but I think that the National Labs with the DOE are probably the fit that makes the most sense, given my interests and their expertise and research focus. Again, nothing solid but that's my plan, and it has certainly has been influenced by the opportunities afforded by the fellowship, and I think the fellowship definitely lowered the barrier to entry to this route.

Meanwhile, some of the fellows discussed how they were more inclined to pursuing academia or other settings, but that they would be satisfied working at a lab. For example, as one stated:

I would say my preferences are in the order of academia, lab, then industry, but I do think having the experience with the lab has definitely pushed that up the scale. I still have this top choice [of academia] *but I think I would be very happy at a National Lab, whether that's a DOE lab or otherwise. I definitely think I would enjoy the government lab environments. I enjoyed my time at my practicum a lot and particularly some of these labs that have some sort of affiliations with universities as well. It does seem like a great environment, and the practicum did help push me to be more aware of that than industry.*

5. Findings on Recipients' Career Activities and Accomplishments Since Participating in the DOE CSGF Program

This chapter presents findings on recipients' career activities and accomplishments since participating in the DOE CSGF. The findings included in this chapter are based on survey data collected from alumni and curricula vitae (CV) data collected from alumni. The first part of this chapter presents findings on alumni activities and accomplishments reported by survey respondents. Topics included degree completion, employment, and other types of professional activities and accomplishments since completing the DOE CSGF program. The second part of this chapter presents findings on alumni activities and accomplishments based exclusively on information reported in CVs. It includes results on the number of awards, grants, and patents received by alumni and the number of publications produced by alumni. Also included in this section are results from a bibliometric analysis, which provide information on the level of prestige and influence of the journals in which DOE CSGF alumni have published.

Degree Completion

Survey respondents were asked if they had completed their Ph.D. Of the 213 alumni who responded to the survey, 189 (89 percent) indicated they had earned their Ph.D., while another 21 (10 percent) reported they were still working toward completion. Three alumni (1 percent) indicated they were no longer pursuing a doctoral degree.

Employment Since Completing the DOE CSGF

In the survey, alumni were asked if they had been employed since completing their fellowship and in what type of professional setting (e.g., DOE laboratory, industry, academia, etc.). Of the 213 alumni who completed a survey, 194 reported they had been employed since completing their fellowship, including postdoc positions. As shown in Figure 5-1, the majority of DOE CSGF alumni indicated that their first position was either in academia (40 percent) or at a DOE laboratory (32 percent).

Figure 5-1. Percent of alumni reporting the professional settings of their initial employment (N=194)

Academia — 40%
DOE laboratory — 32%
Industry — 19%
Government (other than DOE lab) — 3%
Not-for-profit — 3%
Self-employed — 2%
Other — 2%
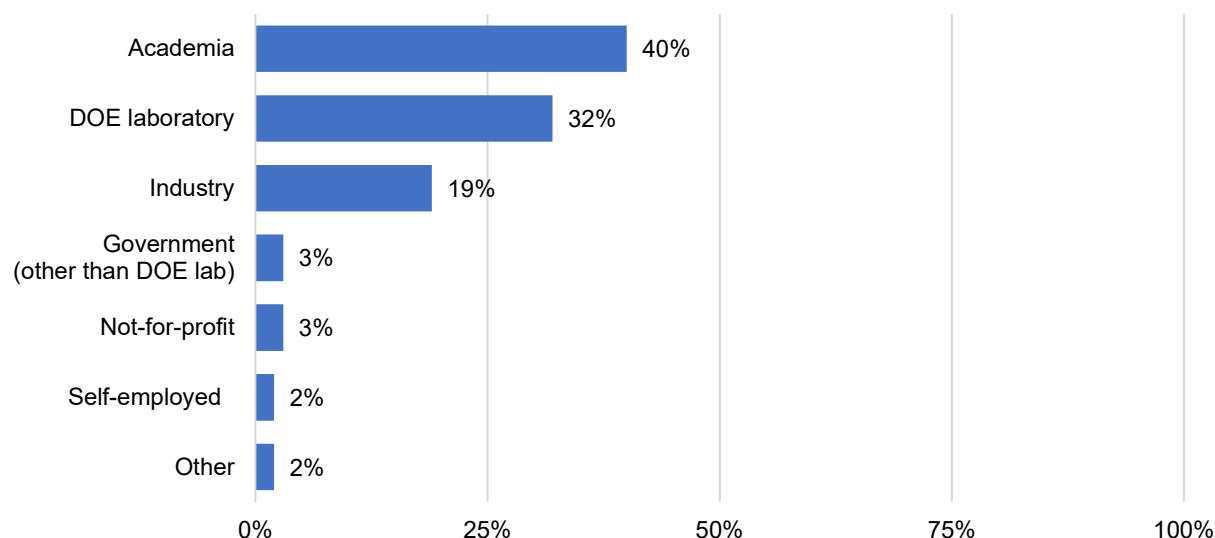
NOTE: Figure is limited to alumni indicating they had been employed since completing their fellowship.

## Influence of DOE CSGF on Obtaining Initial Employment

The survey asked alumni about the extent to which being a DOE CSGF recipient influenced their employment following the fellowship. First, alumni were asked about the extent to which they agreed with the statement, "When it came to securing my first post-DOE CSGF position, my experience in the program gave me an advantage over others with similar qualifications." Of the 194 alumni who indicated they had been employed since completing the fellowship, 86 percent agreed or strongly agreed with this statement.

The survey also measured the extent to which alumni found specific program elements useful in obtaining that position. As shown in Figure 5-2, 79 percent indicated they found the DOE CSGF overall to be useful or very useful in securing their first positon. A clear majority of respondents reported the following elements to be useful or very useful in obtaining their first position:

— The area(s) I researched while a fellow (85 percent)

— Contacts initiated on my own (84 percent)

— Publications for which I received credit while a fellow (72 percent)

— Prestige of the DOE CSGF program (70 percent)

— Presentations I gave while a fellow (58 percent)

— Contacts initiated by my employer (52 percent)

Figure 5-2. **Percent of alumni reporting on the usefulness of program elements in obtaining initial employment after completing the DOE CSGF (N=194)**
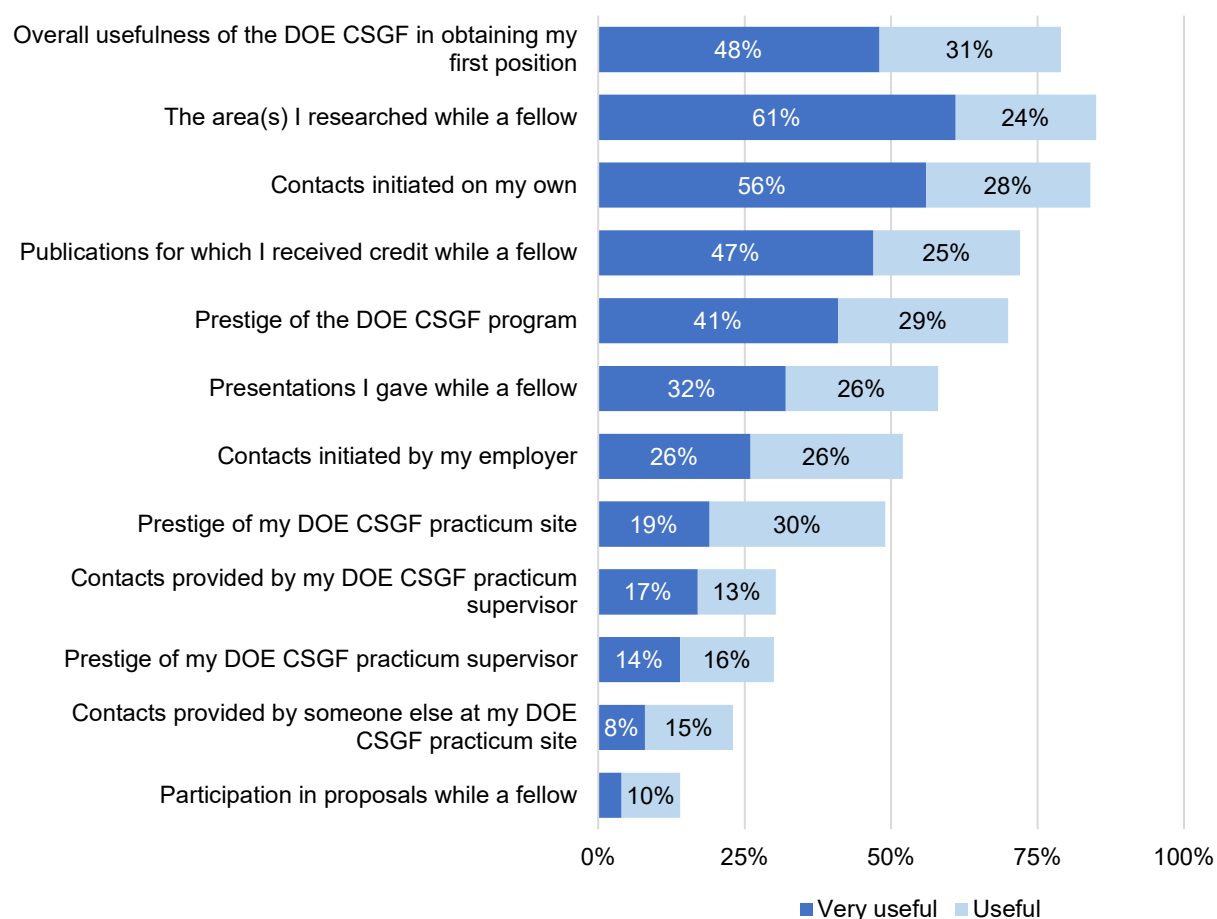

NOTE: The percents shown for the specific items reflect the responses of those alumni who indicated they had been employed since completing the fellowship and exclude those who selected not applicable to the specific item. The Ns for the specific items in the figure ranged from 108 to 188. For the last item, participation in proposals while a fellow, 4 percent reported this element was very useful.

Professional Settings in Which Alumni Have Been Employed

Alumni who indicated that they had been employed since completing the fellowship were asked in the survey to report all the professional settings in which they had worked. As Figure 5-3 shows, the most common setting in which alumni (i.e., those who responded to the survey) had worked is academia (55 percent), followed by industry (40 percent) and DOE laboratories (39 percent).

Figure 5-3.   Percent of alumni reporting the professional settings in which they had worked since completing the DOE CSGF (N=194)
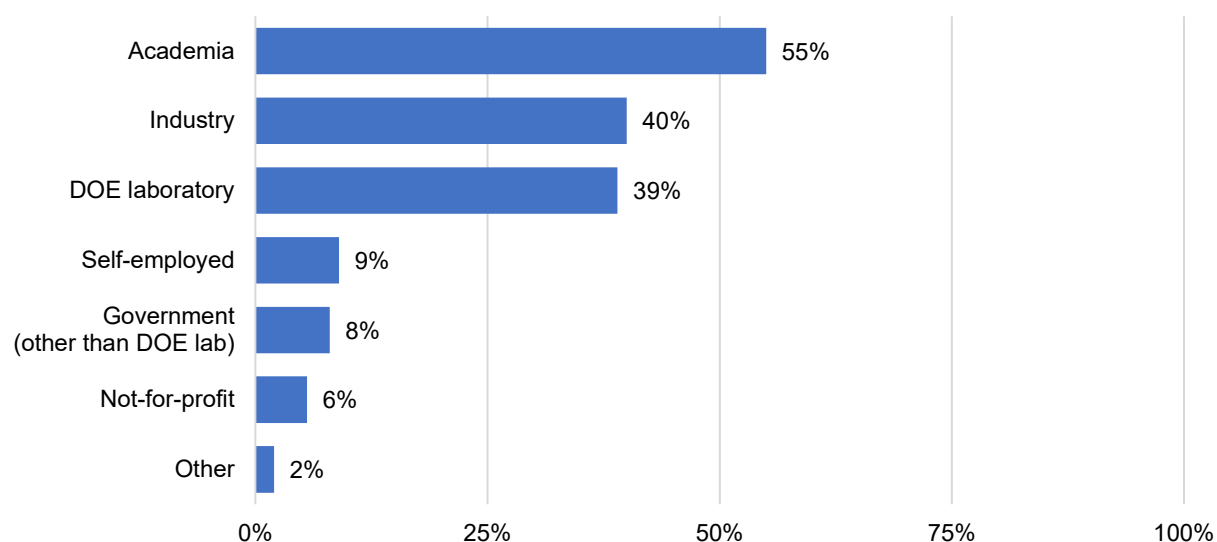
NOTE: Respondents could select multiple sectors.

Professional Settings in Which Alumni Are Currently Employed

Krell Institute maintains current employment data for all 458 alumni (i.e., excluding 7 individuals who are deceased), and this information is presented below in Figure 5-4. As shown, when including all alumni, industry is the most common setting in which alumni are currently employed (37 percent), followed by academia (27 percent). While 14 percent are currently at a DOE laboratory, a combined total of 20 percent are employed at either a DOE laboratory, at DOE (e.g., as a program manager), or have another government appointment. With regard to the four percent in the Other/Unknown category, these include 15 individuals for whom current employment information is not known, 1 who is retired, and 2 who are self-employed.
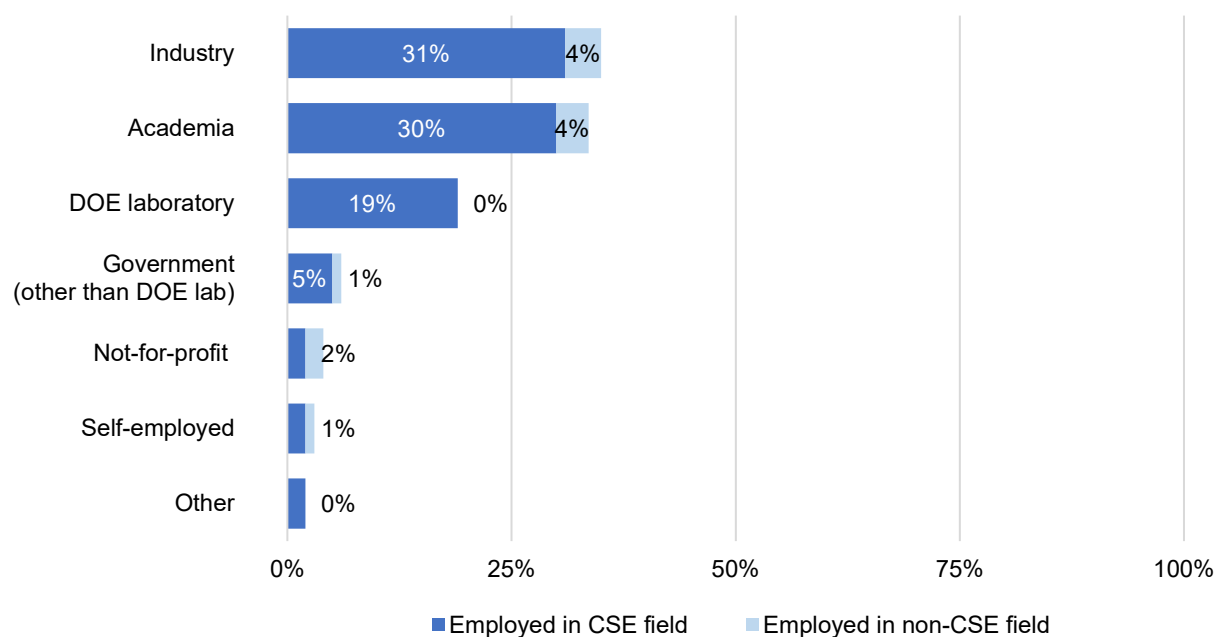
Figure 5-4.   Percent of alumni currently employed in each professional setting (N=451)

Setting	Percent
Industry	37%
Academia	27%
DOE Laboratory	14%
Graduate student	8%
Other Government/DOE appointment	6%
Non-profit	4%
Other/Unknown	4%
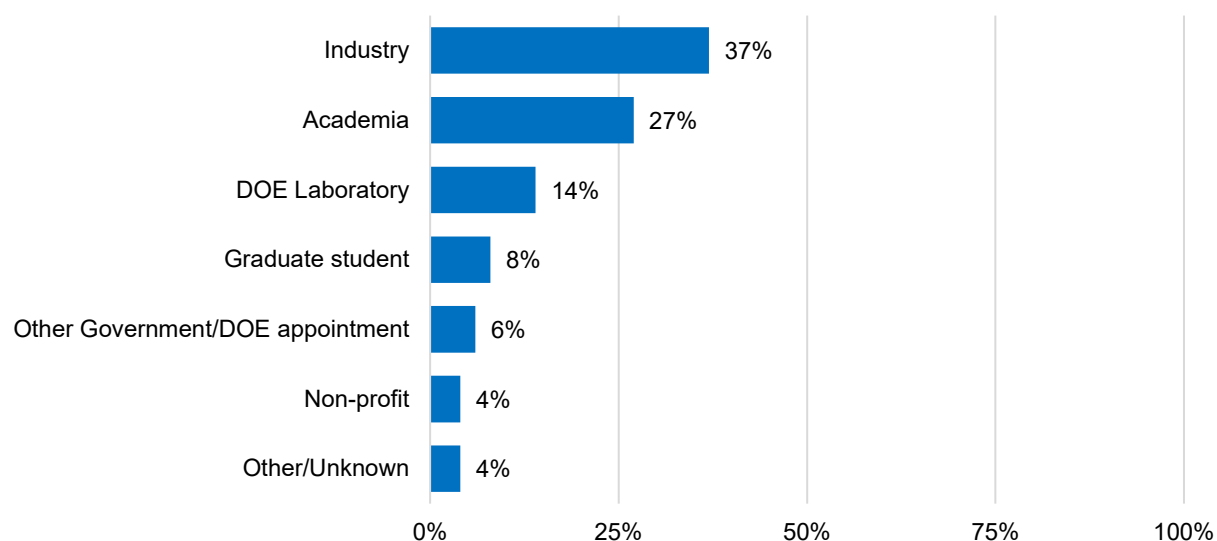
NOTE: Categories differ slightly from those in the survey-based employment figures in this chapter since the source is Krell administrative data. The total of 451 included in this figure represents the entire set of 458 DOE CSGF alumni, with the exception of the 7 alumni who are deceased.

Overall, 90 percent of alumni who responded to the survey reported that their current position was in a computational science and engineering (CSE) field.. Figure 5-5 shows the specific employment setting for those 172 alumni who reported that their current position was in a CSE field. As also shown in Figure 5-5, many of those in non-CSE fields were clustered within private industry and academia.

Figure 5-5.   Percent of alumni employed in a CSE field, by professional setting (N=194)

NOTE: Figure is limited to alumni indicating that they were currently employed. For each of the last three categories (i.e., not-for-profit, self-employed, and other) **2 percent were employed in a CSE field.**

Level of Satisfaction in Current Position

The survey asked alumni about the level of satisfaction with their current position and about whether they occupied a leadership role within their current organization. Figure 5-6 shows that more than three-quarters of the 192 DOE CSGF alumni who are currently employed agreed or strongly agreed with the statements regarding their satisfaction with current employment, and nearly three-quarters of respondents had a leadership role within their current organization.

Figure 5-6.   Percent of alumni reporting level of satisfaction with their job (N=192)
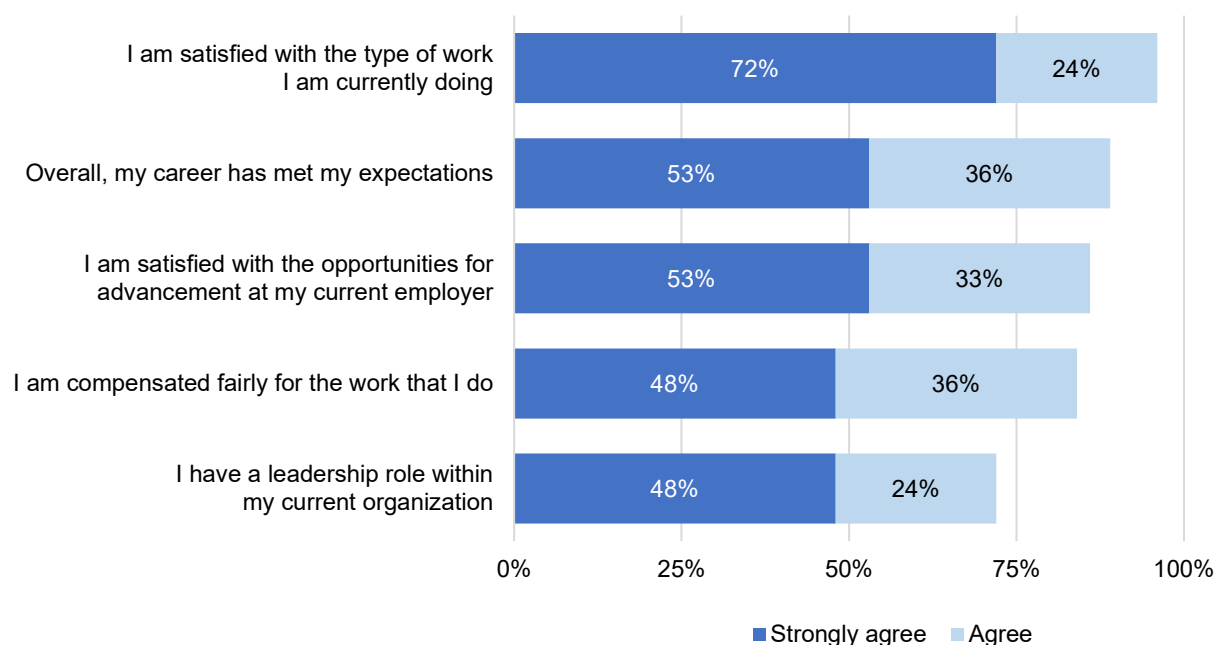
NOTE: Figure is limited to alumni indicating that they were currently employed.

Professional Activities and Accomplishments

Alumni were asked in the survey to reflect on the extent to which they had engaged in specific professional activities and the frequency with which they had made various professional accomplishments. With regard to activities, as shown in Figure 5-7, the majority of alumni indicated they had engaged in all of the professional activities they were asked about. Most notably, more than 80 percent indicated that they had engaged in the following activities to a moderate extent or to a major extent since completing their fellowship:

— Engaged in interdisciplinary research (87 percent)

— Achieved their overall career goals (87 percent)

— Contributed to innovative ideas in their field (82 percent)

Figure 5-7. Percent of alumni reporting the extent to which they engaged in professional activities (N=213)

With regard to accomplishments, the survey asked alumni to report how often (if at all) they had made specific professional accomplishments in the last five years (or since completing their fellowship if less than five years out). Figure 5-8 shows that more than half of alumni had participated in each of several types of presentations or invited talks at least once in the past five years or since completing their fellowship, with the exception of organizing a seminar or workshop in their research area, which was cited by 49 percent.

Figure 5-8. Percent of alumni reporting how often they had made professional accomplishments (N=213)
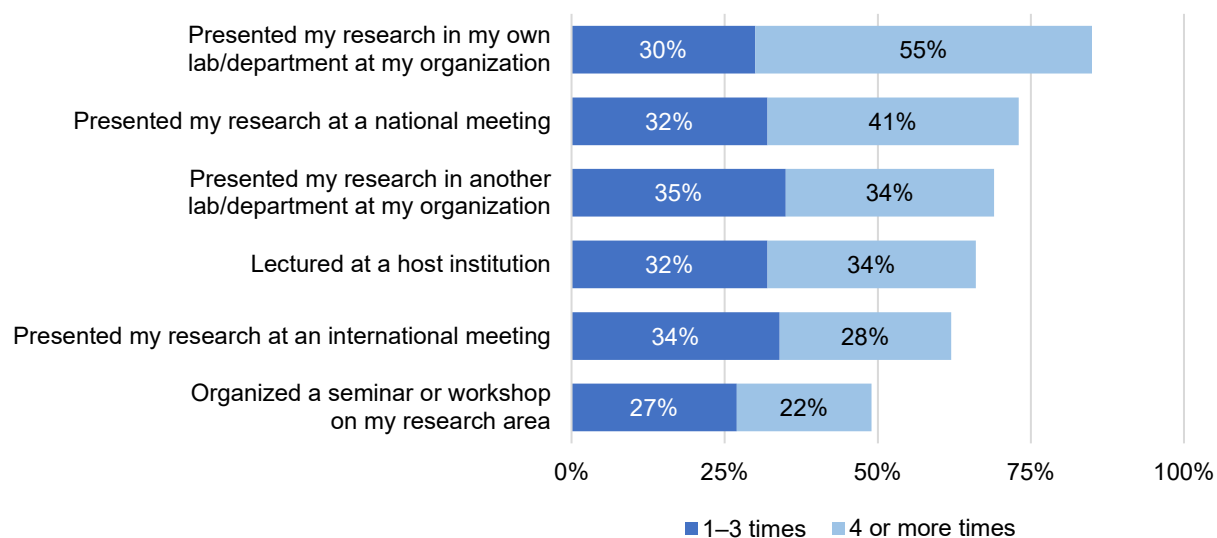
Figure 5-9 shows how often alumni had authored various types of publications in the last five years (or since completing their fellowship if less than five years). Eighty-three percent reported having authored or co-authored at least one peer-reviewed journal article within that timeframe, with 51 percent indicating they authored four or more journal articles. Smaller percentages of alumni had authored or co-authored at least one technical report (46 percent) or book chapter (19 percent), while 5 percent had authored or co-authored a book.

Figure 5-9. Percent of alumni reporting how often they had authored publications (N=213)
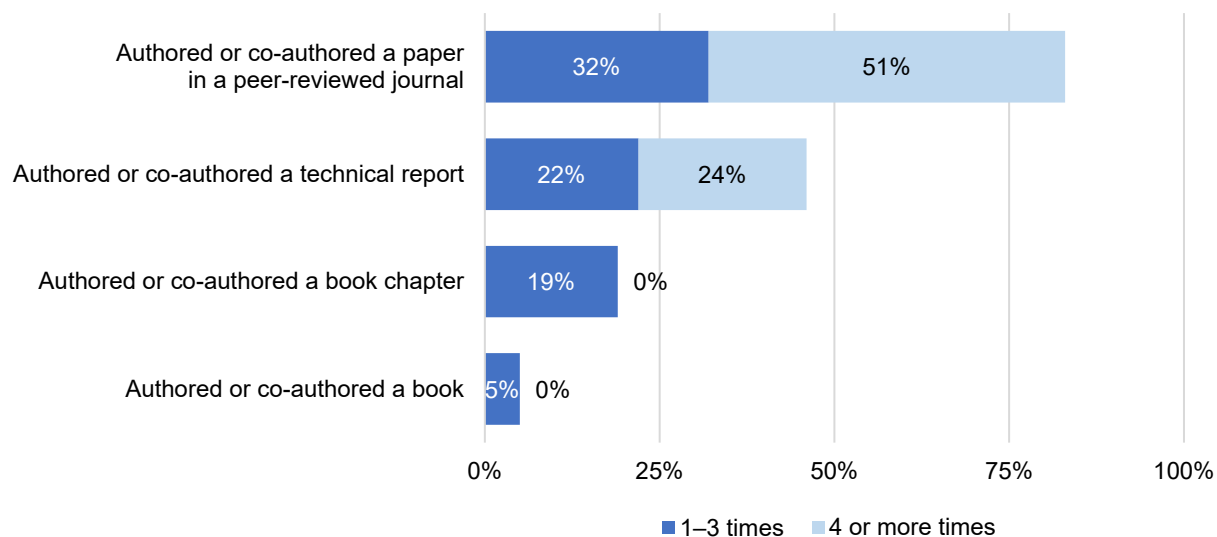
Alumni were also asked in the survey about the frequency with which they had made various other professional accomplishments. As shown in Figure 5-10, 88 percent of alumni had served formally or informally as a mentor to others at least once in the last five years or since completing their fellowship. Similarly, 51 percent had received competitive funding for their research at least once, 40 percent had received a professional award related to their research, and 37 percent had assumed a management position within their organization. Other types of professional accomplishments that were reported less frequently by alumni included developing or prototyping a marketable product (26 percent) and receiving a patent (19 percent).

Figure 5-10. Percent of alumni reporting how often they had made other professional accomplishments (N=213)
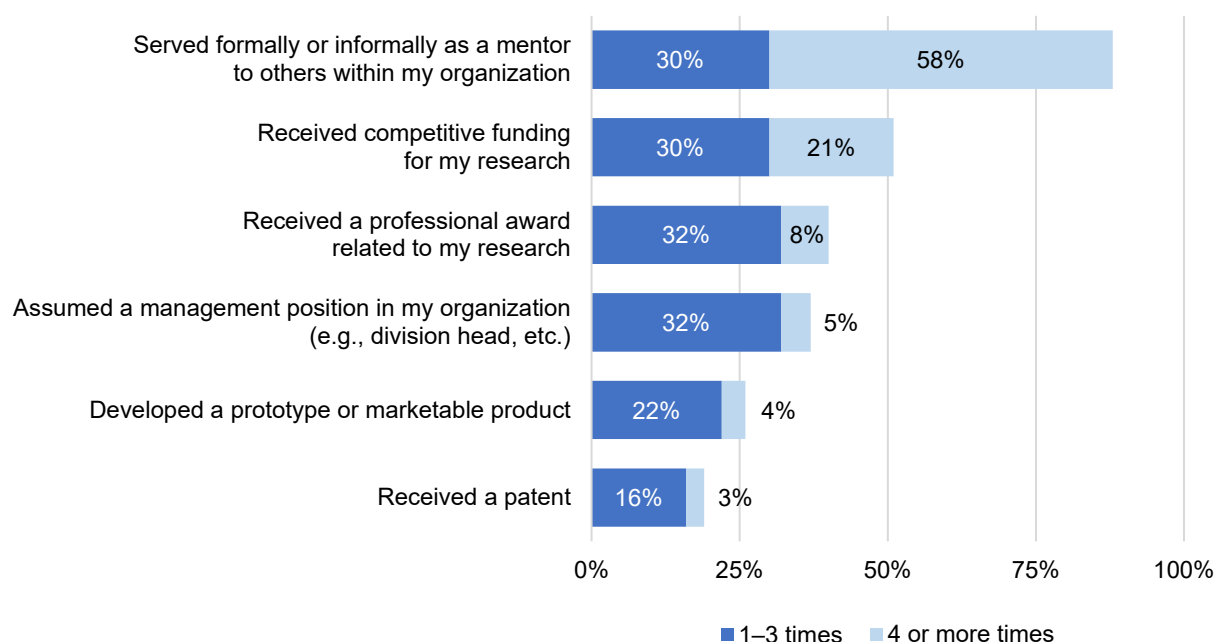
Membership in Professional Associations

Alumni were asked in the survey to report the number of professional organizations or societies to which they currently belonged. Sixty-three percent of the 213 alumni who completed the survey indicated they belonged to at least one professional organization. As Figure 5-11 shows, 26 percent of alumni reported membership in a single professional organization, while 41 percent were members of multiple organizations.

Figure 5-11. Percent of alumni reporting the number of professional organizations to which they belonged (N=213)
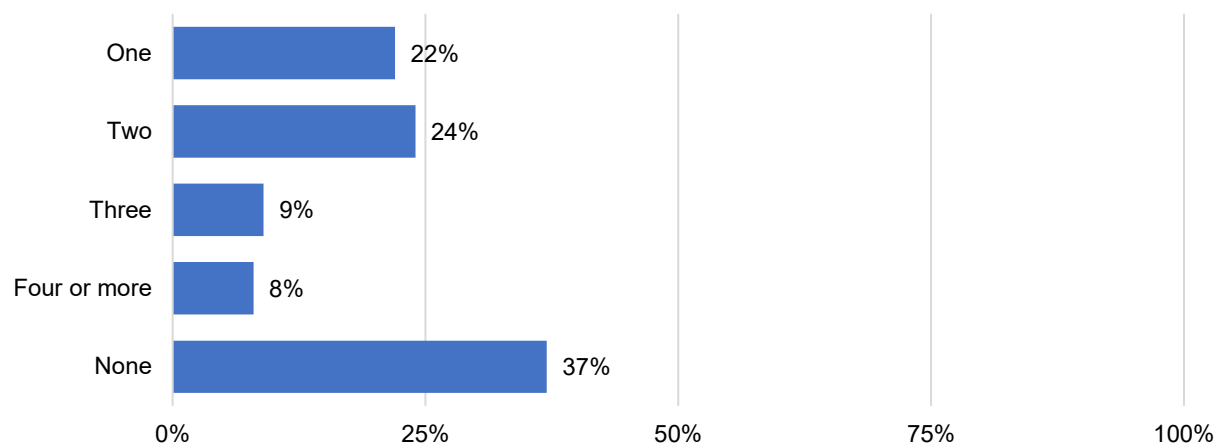
Alumni who reported membership in at least one professional organization or society were also asked about the leadership positions they had held within those organizations. As shown in Figure 5-12, 32 percent of alumni surveyed indicated they had held at least one leadership position, with the most common roles being committee service (24 percent) and organizational officer and section officer (7 percent each).

Figure 5-12. Percent of alumni reporting the leadership positions they held in professional societies or organizations (N=134)
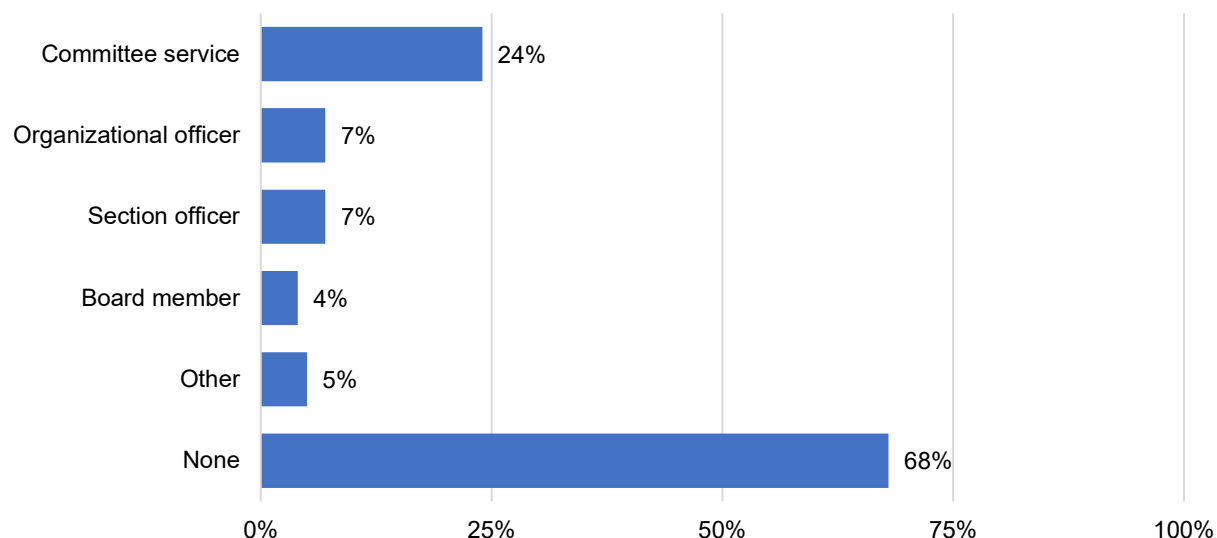
NOTE: Figure limited to respondents indicating membership in at least one professional organization. Respondents could select multiple leadership positions.

Alumni Activities and Accomplishments Reported in CVs

In addition to collecting information about professional activities and accomplishments through the survey and interviews, we analyzed both the publication output of the 292 alumni[21] who submitted CVs (or similar documentation) as well as the extent to which alumni received awards, grants, or patents.[22]

Awards, Grants, and Patents Received by DOE CSGF Alumni

With regard to the extent to which alumni received awards, grants, or patents, we found the following:

— Among those alumni who submitted CVs, 200 listed at least one award received since the start of their fellowship.[23] The average number of awards listed was 3.2 per alum, and the number of awards listed by individual alumni ranged from 1 to 33.

— Seventy alumni listed one or more grants or contracts awarded to them since the start of their fellowship. The average number of grants/contracts listed was 6.8 per alum, while the number of grants/contracts listed by individual alumni was between 1 and 34.

— Forty-three alumni listed a total of 228 patents; however, it should be noted that 95 of these were listed on a single CV. Excluding this outlier, the average number of pending and/or issued patents per researcher was 3.1, with the number of patents listed on individual CVs ranging from 1 to 15. In addition, for the 207 patents for which issuer information was available, all but four were granted in the United States. The majority of

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[21]For the current 2021 study, a total of 222 alumni CVs were received in 2021. As noted in Chapter 1, we merged the data from these 222 CVs with data from CVs from additional alumni that were collected as part of the 2016 study but did not provide an updated CV in 2021. As a result, the total number for whom CV data was available for this study is 292.

[22]We also examined the same information for current fellows, of whom a total of 82 provided a CV. Given the limited number of current fellows for whom this type of information was available, and the relatively limited timeframe in which current fellows have had to publish or receive awards, grants, or patents, we did not combine the professional output of the two groups. While the findings in this chapter focus on alumni, the results for the 82 current fellows who submitted a CV are as follows: 30 fellows listed a combined total of 103 conference presentations, papers, or proceedings, while five fellows listed awards received since beginning their fellowship. With regard to publications, 27 listed at least one article published since beginning their fellowship, and the number of articles per fellow ranged from 1 to 24, with an average of 3.8 articles per fellow. In addition, 38 fellows listed government experience prior to beginning the DOE CSGF, which included internships and related experiences at DOE labs or other government agencies, as well as military service.

[23]Coding was limited to any awards received in the next calendar year after the start of the fellowship. For example, for a fellow beginning the DOE CSGF program in the fall of 2005, only awards received in 2006 or later were included in the analysis.

patents listed on alumni CVs had been granted at the time of coding (182 of 207 for which information was available), while the remaining 25 were still pending.

Publications Produced by DOE CSGF Alumni

Alumni CVs included a substantial number of journal publications and similar productivity. Of the 292 for whom CV data was available, all 292 listed at least one product, including journal articles, conference presentations, papers, or proceedings, reports, books, and book chapters. As Table 5-1 shows, journal articles were the most common type of publication listed, followed by conference presentations, papers, posters/other presentations. The vast majority of products alumni included in their CVs were unique. In other words, while these may have been collaborative works, they did not collaborate on such publications with other DOE CSGF alumni who submitted a CV. However, there was a small number of products that appeared in more than one CV.

Table 5-1.   Number of alumni products, by type

Product type	All listed in all curricula vitae	Unique products
Journal article	4,925	4,884
Conference presentations, papers, posters/other presentations	4,718	4,718
Report	187	187
Book chapter	123	122
Book	22	22
Other	55	55
Total	**10,030**	**9,988**

Journal Articles

Journal articles were the most common type of publication or product listed by DOE CSGF alumni, making up more than half of all publications. Of the 292 alumni who submitted a CV, 268 included at least one journal article for which they were the sole author or co-author, for a total of 4,884 unique articles. Figure 5-13 shows the number of unique articles authored by one or more DOE CSGF alumni in each year. Unsurprisingly, the number of articles generally increased year to year as the cumulative pool of DOE CSGF recipients grew over time.

Figure 5-13. Number of journal articles published by DOE CSGF alumni, by year (N=4,475)

Year	Number
2020	356
2019	324
2018	288
2017	276
2016	424
2015	413
2014	368
2013	304
2012	273
2011	247
2010	189
2009	175
2008	169
2007	135
2006	117
2005	89
2004	86
2003	46
2002	37
2001	30
2000	30
1999	28
1998	29
1997	10
1996	9
1995	8
1994	9
1993	7

Number
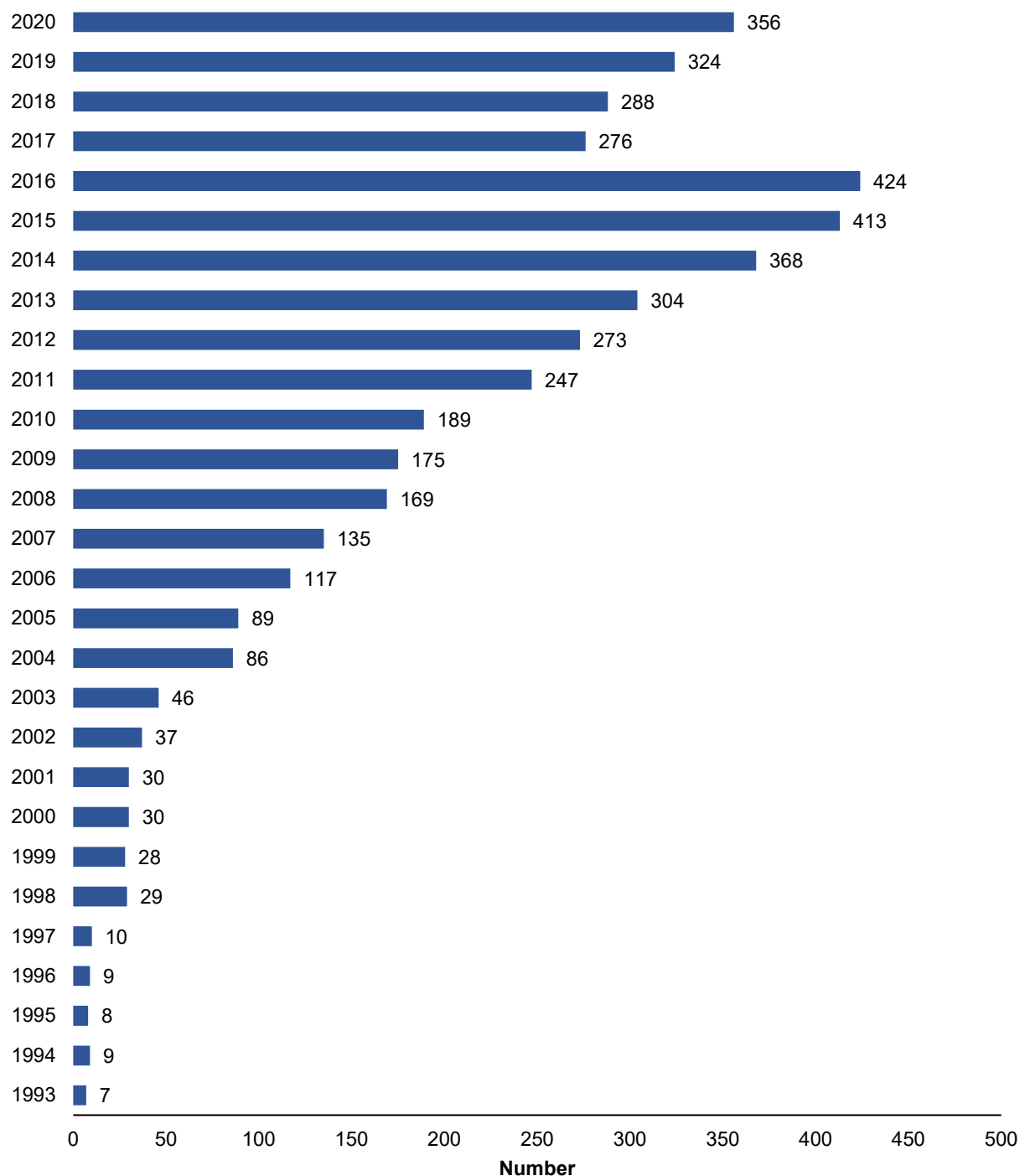
NOTE: Figure is limited to unique articles for which publication date information was listed in the CV. As a result, 165 articles for which the publication year could not be determined or were currently in press are not shown. Data from 2021 (244 articles) are not shown, since the number does not reflect a full 12-month period. In addition, the decrease in the number of articles beginning in 2017 is likely due to the inclusion of data from CVs of alumni that were collected as part of the 2016 study but did not provide an updated CV in 2021 (i.e., any journal articles produced by this subset of alumni in the years since 2016 would not be reflected).

Conference Presentations, Papers, Posters/Other Presentations

Table 5-2 shows the number of journal articles published by each of the four cohorts of alumni (i.e., 1991–2000; 2001–06; 2007–12; and 2013–17). Overall, each DOE CSGF alum had an average of 18.2 contributions to journal articles. This includes duplicate instances where two or more DOE CSGF alumni collaborated on a single article. However, given that only articles published in the calendar year following the start of their fellowship were coded, it is important to consider production of fellows by their year of entry into the program. As would be expected, fellows in earlier cohorts had higher average production than those who received their fellowship in more recent years.

Table 5-2.   Number of journal articles published by alumni, by cohort

Fellowship start years	Number of DOE CSGF recipients	Average number of journal articles
1991–2000	55	30.9
2001–06	70	25.3
2007–12	80	12.7
2013–17	63	6.3
Overall	268	18.2

After journal articles, conference presentations, papers, posters, and other presentations were the next most common type of publication or product listed by DOE CSGF alumni. Of the 292 alumni who submitted a CV, 256 included at least one conference presentation, paper, poster or other presentation for which they were the sole author or co-author. Figure 5-14 shows the number of conference presentations, papers, posters, and other presentations authored by one or more DOE CSGF alumni in each year. As with journal articles, the number of these products generally increased year to year as the cumulative pool of DOE CSGF recipients grew over time.

Figure 5-14.   Number of conference presentations, papers, posters/other presentations produced by DOE CSGF alumni, by year (N=4,473)

Year	Number
2020	327
2019	455
2018	408
2017	400
2016	289
2015	318
2014	249
2013	274
2012	252
2011	222
2010	198
2009	165
2008	142
2007	148
2006	130
2005	98
2004	87
2003	82
2002	51
2001	47
2000	33
1999	35
1998	18
1997	20
1996	8
1995	9
1994	5
1993	3
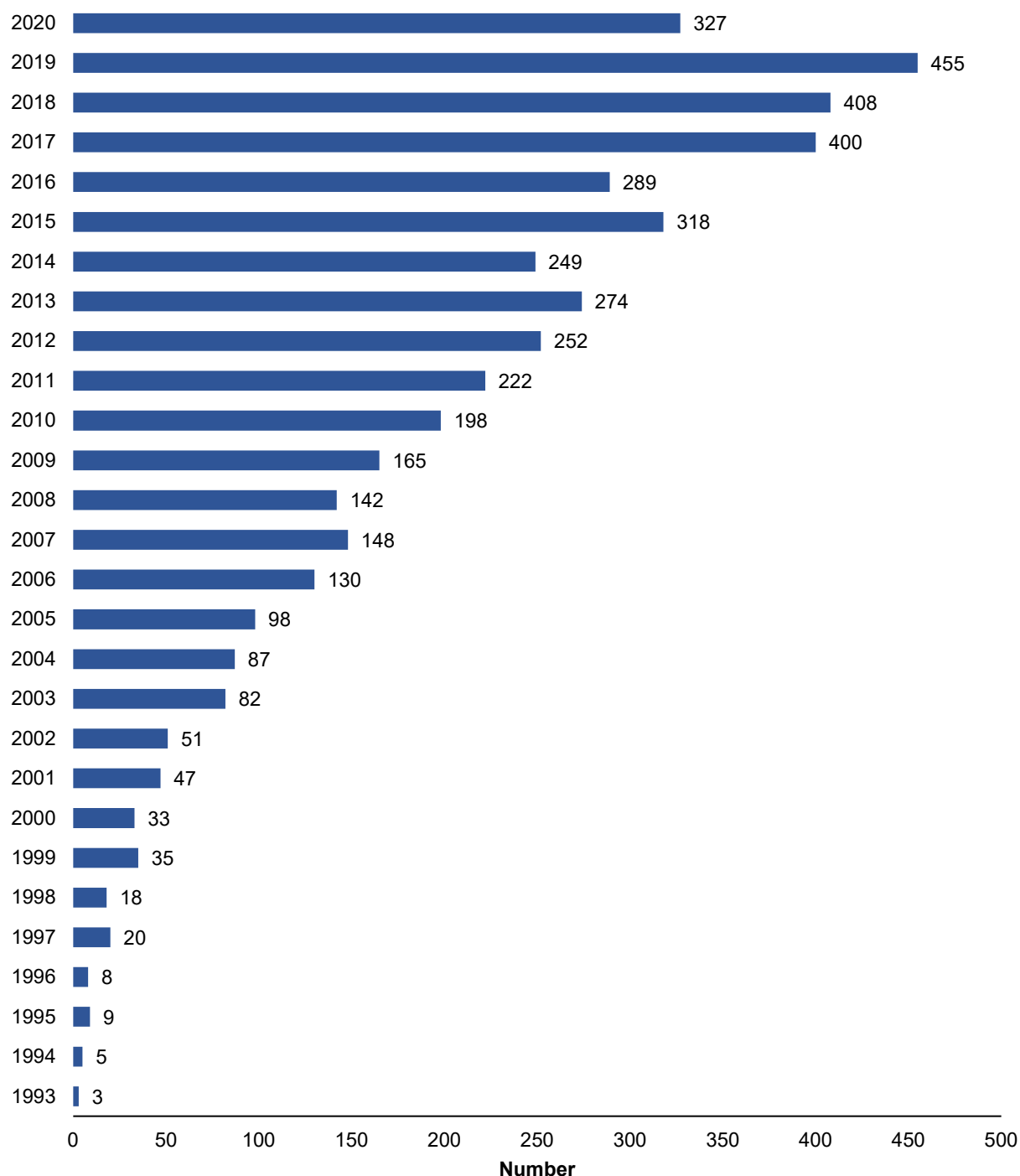
Number

NOTE: Figure is limited to unique products for which the year was listed in the CV. As a result, 17 products for which the year could not be determined are not shown. Data from 2021 (228 products) are not shown, since the number does not reflect a full 12-month period. In addition, fluctuations in the number of products in recent years may be due to the inclusion of data from CVs of alumni that were collected as part of the 2016 study but did not provide an updated CV in 2021 (i.e., any conference presentations, papers, posters or other presentations produced by this subset of alumni in the years since 2016 would not be reflected).

Table 5-3 shows the number of conference presentations, papers, posters, and other presentations produced by each of the four cohorts of alumni. Overall, each DOE CSGF alum had an average of 18.4 contributions to these types of products. As would be expected, fellows in earlier cohorts had higher average production than those who received their fellowship in more recent years.

Table 5-3.   Number of conference presentations, papers, posters/other presentations produced by alumni, by cohort

Fellowship start years	Number of DOE CSGF recipients	Average number of journal articles
1991–2000	55	28.9
2001–06	62	25.5
2007–12	76	11.9
2013–17	63	10.1
Overall	**256**	**18.4**

Journal Influence

In examining the research productivity of DOE CSGF alumni, we looked not only at how many journal articles were produced and how often alumni published, but where they had published their work. More specifically, we examined the extent to which alumni published their research in journals considered to be influential, based in part by how frequently articles in those journals are cited by other researchers.

In conducting this bibliometric analysis, we used two types of publicly available measures obtained from the Eigenfactor Project. These two journal-level measures, the Eigenfactor score (EF) and the Article Influence score (AI) provided insight into the prestige and influence of the journals in which DOE CSGF alumni had published since beginning their fellowship.[24] The EF score quantifies the influence of a given journal in a given year, while the AI score provides the average per-article influence for a journal in a given year. In other words, each of these scores provides a measure that, while controlling for other factors, indicate the extent to which articles published in that journal are cited.[25]

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[24]In bibliometric analysis, impacts can be measured at the level of an individual author, article, or journal based on citations. Thus, we use the term journal-level measure here to distinguish from author- or article-level measures. In short, journal-level measures indicate the influence of the *journal* in which an article is published, as opposed to the influence of the *article* itself. While the author- and article-level measures provide more precise estimates of impact, they are typically not publicly available.

[25]For greater detail on how EF and AI scores are developed, see http://www.eigenfactor.org/about.php.

EF and AI data were publicly available only for the period of 1997–2015 and were limited to journals in Thomson Reuters' Journal Citation Reports (JCR) for each year. Therefore, not all journal articles listed in the CVs provided by the 292 DOE CSGF alumni with at least one journal article listed were included in our analysis. Figure 5-15 outlines how the complete citation dataset generated from the CV coding was reduced to arrive at the final dataset for our analysis of journal influence. Alumni listed a total of 4,884 unique journal articles in CVs (this number excludes duplicate entries in CVs where multiple alumni co-authored a single product). Of the total 4,884 articles, we identified those that (1) indicated the specific date (i.e., year) of publication, and (2) were published between 1997 and 2015 (since, as indicated above, EF and AI data are not publicly available for articles published in other years). These steps reduced the number of articles included in our dataset to 2,443.

Figure 5-15.   Final dataset for analysis of journal influence

Both the EF score and the AI score are scaled such that the average score for any given journal is 1. Therefore, a journal with an EF of 5 is considered to have five times the influence of the average journal included in the dataset in that year. Similarly, a journal with an AI of 5 means the average article within that journal has five times the influence of the average article.

Of the articles published by DOE CSGF alumni for which data were available, the majority (83 percent) were published in journals with above average EF scores. The EF for journals in which DOE CSGF alumni published articles ranged from less than .1 to 206.7. Excluding the 25 articles in journals without a precise EF reported in the database (i.e., those labeled <.1), the average EF was

23.7. In other words, on average, DOE CSGF alumni published articles between 1997 and 2015 in journals with 24 times the influence of the average journal during that time.

The Eigenfactor Project also provides a percentile rank for each journal. The percentile ranking is useful in identifying the relative influence of journals in which DOE CSGF alumni were published each year. As Figure 5-16 shows, most articles (1,791, or 73 percent) published by DOE CSGF alumni were in journals with EF scores in the top 10 percent. Another 301, or 12 percent, were in journals with EF scores between the 81st and 90th percentile.

Figure 5-16. Eigenfactor (EF) score percentile rankings of journal articles published by DOE CSGF alumni
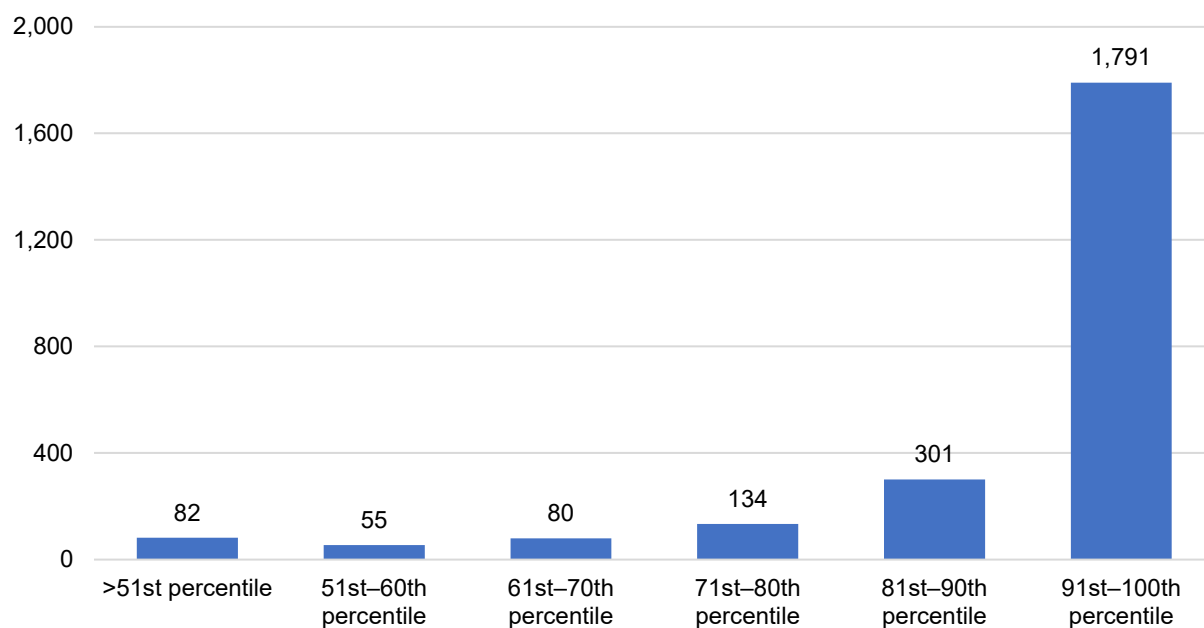
AI provides a slightly different means for determining the level of influence of journals in which DOE CSGF alumni published articles. This measure can be interpreted as the average per-article influence within a given journal for that year. Like EF, the AI is scaled so that an AI of 1 indicates a journal has the same per-article influence as the average journal in the full JCR.

Among the 2,443 articles published by DOE CSGF alumni included in our bibliometric analysis, 74 percent were published in journals with above average AI scores (i.e., greater than 1). AI scores ranged from less than .1 to 22.2. Excluding the six articles with an AI of <.1, the average AI was 2.19. In other words, based on the AI measure, DOE CSGF alumni published in journals that were slightly more than twice as influential than average.

The percentile rankings for AI present a similar picture to the ranking based on EF scores. As shown in Figure 5-17, more than two-thirds (69 percent) of articles published by DOE CSGF alumni between 1997 and 2015 were in journals with AI scores in the top two deciles, with the largest number (962) published in journals in the top 10 percent.

Figure 5-17. Article Influence (AI) score percentile rankings of journal articles published by DOE CSGF alumni
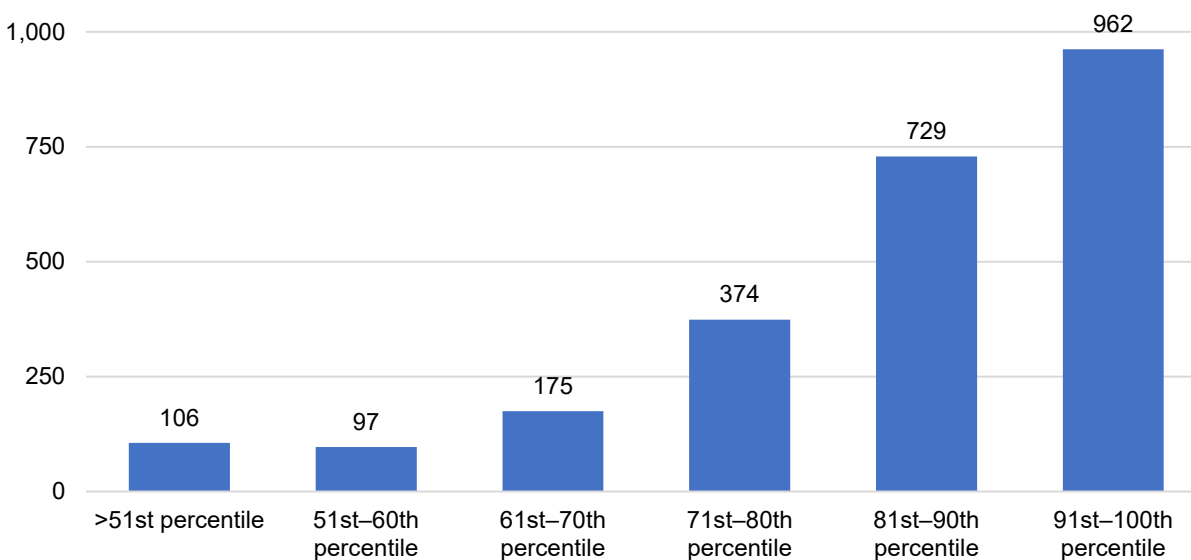
Taken together, the results from the EF and AI scores and percentile rankings indicate that articles produced by DOE CSGF alumni across the period of 1997 to 2015 were overwhelmingly published in highly influential journals.

6. Summary and Conclusions

In this final chapter we draw on the various data collection and analysis methods used to provide a summary of findings within each of the main areas addressed in the study: characteristics of DOE CSGF recipients; recruitment and entry into the program; experiences in the program; and career activities and accomplishments. This is followed by our conclusions on what these findings suggest about the extent to which the DOE CSGF program continues to address national priorities by contributing to the development of America's advanced technological workforce.

Characteristics of DOE CSGF Recipients

The DOE CSGF has provided 565 fellowships since its inception in 1991, including 107 current fellows. Recipients have been increasingly diverse over time with regard to gender and the specific fields of study in which they pursued a degree. We examined several characteristics of the total alumni and fellow population, including their gender and the field in which they pursued (or are currently pursuing) a Ph.D. With regard to gender, 72 percent of the 565 recipients have been men, however, women have increasingly made up a larger proportion of recipients and have comprised 40 percent of those who received the fellowship since 2013. The 565 recipients have pursued degrees in a wide variety of fields of study, with the most common being engineering and physical science fields, followed by mathematics/computer science and biology/bioengineering. The proportion of recipients within each of these major fields of study has shifted somewhat over time; whereas more than 50 percent in the early years of the program were in engineering, the proportion of recipients in the physical sciences and mathematics/computer science have increased in recent years (with the latter increasing as a result of the program's addition of a mathematics/computer science track) and are now the most represented fields.

The DOE CSGF has drawn a large number of highly qualified applicants, and those who have received the fellowship typically attend the nation's most prestigious universities. The 565 alumni and current fellows collectively represent 76 universities across 33 states and the District of Columbia. Practically all fellows have attended R1 doctoral universities, according to the Carnegie Classification of Institutions of Higher Education (i.e., those with the highest level of research activity). While the 565 fellows represent 76 institutions (about half of which are private and the other half public), six universities account for nearly half of all recipients: Massachusetts Institute of

Technology; Stanford University; the University of California, Berkeley; Harvard University; the University of Illinois Urbana-Champaign; and California Institute of Technology.

Recruitment and Entry into the DOE CSGF Program

The most frequent source of information for fellows when applying to the program was their professors or academic advisors. When asked about why they applied to the program in both the survey, 39 percent of respondents indicated that their professors or academic advisors was the most important influence on their decision to pursue a fellowship. Other sources of information included the DOE CSGF website (16 percent), former or current DOE CSGF recipients (13 percent), and DOE employees (laboratory or otherwise) (12 percent). In addition, fellows described in the interviews how they were impressed or intrigued by the information they accessed on the DOE CSGF program's website, particularly information about individual fellows and their professional accomplishments.

Recipients cited the DOE CSGF's unique combination of benefits and support as a factor in their decision to pursue the fellowship, with many fellows choosing the DOE CSGF over other programs. When asked whether they had applied to fellowships other than the DOE CSGF, nearly three-quarters of fellows overall indicated they had, and among those who had applied to other fellowships, just over half were accepted to at least one other program. In the survey, two reasons for why they decided to accept the DOE CSGF were cited by at least half of fellows. First, two-thirds indicated that the program offered generous financial benefits, with many also noting in the interviews that the DOE CSGF offered more financial support relative to other fellowships and four full years of funding, as opposed to three years, which was typical of other programs. Second, just over half of survey respondents cited the program's prestige. As for other important factors, 40 percent cited the ability to conduct a practicum at a specific laboratory, while 36 percent viewed the program as a stepping stone for their career. In the interviews, fellows were most likely to cite these same factors but also described how the fellowship was consistent with their interests in CSE and working on supercomputers or in HPC.

Experiences in the DOE CSGF Program

DOE CSGF recipients reported very positive experiences in each of the four key components of the DOE CSGF — research practicum, program review meetings, high-

performance computing (HPC), and mentoring. For the research practicum, both alumni and fellows reported high levels of satisfaction with the various support provided to them at their practicum site. Recipients were most satisfied with the opportunity to generate ideas about their research, obtain specialized equipment for their research, gain a better understanding of continued opportunities for collaboration, and receive direction during their research activities. With regard to the program review, virtually all recipients indicated in the survey that they found various elements of this component useful, particularly the opportunities for intellectual stimulation and exchange, interaction with researchers in other fields, to present their research, to network, as well as to gain insight into current and/or future big picture problems. Some current fellows reported adverse effects of COVID-19 and the shift to a virtual setting on the extent to which the program review meetings were useful and engaging, however, this subset of respondents generally felt the program had done what it could within the limitations of meeting in a virtual environment. When asked about HPC, more than 8 out of 10 alumni and current fellows indicated they had used it during their time as a fellow, with large majorities of each group reporting that had benefited from their experiences with it. On the mentoring component, nearly all recipients indicated that they had received high levels of support and that the specific opportunities provided to them were useful. Current fellows were asked in the survey about which specific aspects of mentoring that were most useful, and they most often cited opportunities to network with others in fields related to CSE, opportunities to collaborate on research in fields related to CSE, and psychological or emotional support. The interview responses of alumni and fellows around each of the four key program components were largely consistent with the survey findings, with respondents consistently describing their experience with each component as not only useful to their development as a scientist but also enjoyable and rewarding.

Survey data indicate that most recipients contributed to the advancement of computing activities and that their participation in the DOE CSGF resulted in their first exposure to dedicated computing time on a DOE supercomputer. The survey asked both alumni and fellows about whether they had contributed to the development of scientific codes or software and the extent to which they took advantage of dedicated computing time on DOE supercomputers. Nearly 9 out of 10 alumni reported that they had contributed to and/or led the development of scientific codes both during the fellowship and since completing the fellowship, while about half of alumni contributed to and/or led the development of scientific software suites and open source scientific software. With regard to supercomputers, while relatively small percentages of alumni and current fellows reported having had dedicated computing time on a DOE supercomputer prior to entering the program, over half of both alumni and fellows had utilized these resources during the program, while nearly half of alumni had done so since completing the fellowship.

Both alumni and fellows expressed high levels of satisfaction with the fellowship overall and cited a range of positive impacts because of their participation. In the survey, more than three-quarters of respondents indicated being satisfied with the access to facilities, equipment, and other resources that the program provided. Similar proportions were also satisfied with the networking opportunities and research training that they had been exposed to through the program. As for the impacts of their participation, alumni described in the interviews how the DOE CSGF influenced their career goals and direction, including the desire to work at a DOE laboratory. They also described how they experienced professional growth in their skills and content expertise and greater flexibility in pursuing research, and how the program led to the establishment of research networks that resulted in greater collaboration on research efforts among alumni.

With regard to diversity and inclusion, an overwhelming majority of both alumni and current fellows reported they felt comfortable and included as a member of the DOE CSGF community and that the program creates a diverse and inclusive climate that is welcoming of individuals of all backgrounds. More than 9 out of 10 alumni and fellows agreed that they felt comfortable and included, while at least two-thirds of each group agreed that the program has actively taken steps to make them feel comfortable and included. In their responses to the interview questions on this topic, both alumni and current fellows generally felt that the DOE CSGF community was diverse and thus did not have any concerns about a lack of diversity, with many alumni observing that although diversity was somewhat more limited in the initial years of the program, recipients had become increasingly diverse (i.e., along several dimensions, including gender, race, and disability) over time.

Data from the survey and interviews suggest that there is an active DOE CSGF community, with most alumni indicating that they had stayed in touch with others and had recommended the program to others. In addition, many alumni described the DOE CSGF community as one of the best aspects of the program. Over 60 percent of recipients reported that they had stayed in touch with other DOE CSGF recipients, and over 40 percent reported that they had stayed in touch with their practicum supervisor. In the interviews, alumni described how the DOE CSGF's strong community component allowed them to make important connections with others in the field and to collaborate with a broad range of individuals, neither of which would have occurred if not for their participating in the program.

Career Activities and Accomplishments since Participating in the DOE CSGF Program

A large majority of DOE CSGF alumni have been employed since completing their fellowship and in a range of professional settings including academia, industry, and DOE laboratories. Most alumni felt that their participation in the DOE CSGF was an important influence on their ability to obtain their first professional position. Of the 213 alumni who completed a survey, 194 (91 percent) reported that they have been employed since completing their fellowship (including post-doc positions). Forty percent of these 194 alumni indicated that their first position was in academia, while close to one-third reported that their first position was at a DOE laboratory. When asked about the extent to which being a DOE CSGF recipient influenced their employment following the fellowship, 86 percent of alumni respondents agreed that their experience in the program gave them an advantage over others with similar qualifications in securing a position. In the survey, alumni also indicated that, along with contacts they initiated on their own, several elements of the fellowship were especially useful in obtaining their first position, including the area they researched while a fellow, the publications for which they received credit while a fellow, and the prestige of the DOE CSGF program.

With regard to current employment, the vast majority of all DOE CSGF alumni are currently employed in a CSE field. The most common setting in which alumni are currently employed is industry, followed by academia and DOE laboratories. Alumni also reported having made a range of professional accomplishments since completing the fellowship. In addition to asking in the survey about their initial employment, administrative data maintained by Krell on all alumni were used to examine the professional setting in which they are currently employed. These data show that although alumni work in a range of settings, industry is the most common employment setting, at 37 percent, while 27 percent of alumni are working in academia, and 14 percent are working at a DOE laboratory, with another 6 percent in another DOE position or at another government agency (i.e., for a combined total of 20 percent currently working in some form of public service). Moreover, 90 percent of alumni who responded to the survey reported that their current position was in a CSE field, and more than three-quarters reported both being satisfied in their current position and nearly three-quarters having a leadership role within their organization. When asked in the survey about the extent to which they have engaged in specific professional activities and accomplishments, large majorities reported a wide range of activities and accomplishments. These included achieving their overall career goals, engaging in interdisciplinary research, contributing to innovative ideas in their field, addressing key knowledge gaps in their field,

contributing to a scientific breakthrough in their field, and advancing within their current organization.

Alumni have received a large number of professional awards, grants, and patents and have published research at an impressive and steadily compounding rate. In addition to collecting information about the professional activities and accomplishments of alumni through the survey and interviews, we analyzed both the publication output of the 292 alumni for whom curriculum vitae (CVs) were available, as well as the extent to which alumni received awards, grants, or patents. Among the 292 alumni who submitted a CV, 200 listed at least one award received, with an average of 3.2 awards per alum. Seventy alumni listed one or more grants or contracts, with an average of 6.8 grants/contracts per individual. With respect to patents, 43 alumni listed a total of 228; although nearly half of these (i.e., 95) were listed on a single CV, the average number of pending and/or issued patents per alum after excluding this outlier was 3.1. Our analysis of the publication output of the 292 alumni for whom CV data was available showed that all 292 alumni listed at least one publication including journal articles, books, book chapters, reports, and conference presentations, papers, or posters. A total of 10,030 products were produced by the 292 alumni for whom CV data were available, with journal articles being the most common and comprising nearly half (i.e., 4,925) of this total. With regard to journal articles in particular, the average number per alum was 18.2 and, not surprisingly, the number of articles generally increased year to year as the cumulative pool of DOE CSGF alumni grew over time.

Articles produced by alumni were overwhelmingly published in highly influential journals. In examining the research productivity of DOE CSGF alumni, we looked not only at how many publications were produced and how often alumni published, but where they have published their work. More specifically, we used two types of publicly available measures obtained from the Eigenfactor Project. These two journal-level measures, the Eigenfactor score (EF) and the Article Influence score (AI), provided insight into the prestige and influence of the journals in which alumni published their research, based in part by how frequently articles in those journals are cited by other researchers. These bibliometric data were available for 2,443 of the 4,884 journal articles produced by DOE CSGF alumni (these include articles that indicated the date of publication and were published between 1997 and 2015, since EF and AI data are not publicly available for articles published in other years). Of these 2,443 articles, the majority (83 percent) were published in journals with above average EF scores, with an average EF score of 24. This means that, on average, DOE CSGF alumni published articles between 1997 and 2015 in journals with 24 times the influence of the average journal during that time. The Eigenfactor Project also provides a percentile rank for each journal, which is useful in identifying the relative influence of journals in which DOE

CSGF alumni were published each year. Nearly three-quarters of the articles (73 percent) published by DOE CSGF alumni were in journals with EF scores in the top 10 percent. Another 12 percent were in journals with EF scores between the 81st and 90th percentile. While AI provides a slightly different means for determining the level of influence of journals in which DOE CSGF alumni published articles, the results were similar to the EF scores.

Conclusions

For more than 30 years, the DOE CSGF has provided training and support to students in an effort to address national priorities around workforce development. Since the Department of Energy launched the DOE CSGF program in 1991, the program has supported the training of 565 individuals in the field of CSE. Currently funded by a partnership within the DOE between the Office of Science and the National Nuclear Security Administration, the DOE CSGF is designed specifically to help meet the ever-increasing demand for computational scientists. As a recent article in the *SIAM Review* (Society for Industrial and Applied Mathematics) notes,[26] the past two decades have seen tremendous growth in the CSE community, including a dramatic increase in both the size and breadth of intellectual perspectives and interests, resulting in a corresponding broad set of needs, which have important implications for educational programs. Included among these are the need for 1) CSE core researchers and developers, i.e., those engaged in the conception, analysis, development, and testing of CSE algorithms and software (which also include subgroups of those focused on broadly applicable methods and algorithms and those focused on methods and algorithms motivated by a specific domain of application) and 2) CSE domain scientists and engineers, i.e., those primarily engaged in developing and exploiting CSE methods for progress in particular science and engineering campaigns.

This study of the DOE CSGF program was intended to address important questions concerning the benefits that accrue to DOE as the sponsoring organization, the recipients themselves, and the overall research community and workforce in CSE. It builds on the last follow-up study of DOE CSGF recipients, published in 2017, which demonstrated that the DOE CSGF had made important contributions to the nation's CSE workforce. When considering all of the data collected as part of the current study, it is clear that DOE CSGF remains a critical contributing factor in workforce development. Most notably, through a combination of survey and interview data, alumni revealed

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[26] Rude, U., Willcox, K., McInnes, L. C., & De Sterck, H., (2018). Research and education in computational science and engineering, *SIAM Review, 60 (3),* 707-754. Retrieved from: https://epubs.siam.org/doi/pdf/10.1137/16M1096840

how they experienced professional growth in their skills and expertise and greater flexibility in pursuing research, as well as how the program led to established research networks that resulted in greater collaboration on research efforts among alumni.

As part of this study, a greater focus was placed on two topics, including recipients' perceptions of the extent to which the DOE CSGF program has enhanced the visibility of and interest in working in DOE laboratories and the extent to which, based on recipients' experiences, the program has been successful in meeting the DOE's workforce needs in CSE. With regard to the former, both alumni and fellows described how their participation directly influenced their decision to work in a DOE laboratory after completing their Ph.D., with many indicating that this specific path was largely unknown to them, or not something that they had anticipated pursuing, when they began the fellowship. With respect to the issue of meeting DOE's workforce needs, most alumni felt strongly that the DOE CSGF program had been effective by providing high-quality training experiences and helping to retain a substantial portion of the fellowship's graduates within the DOE scientific community.

Otherwise, the key findings of this study are largely consistent with those from the 2017 study. First, the data from this study indicate the DOE CSGF is a highly sought after fellowship that draws some of the most promising students in science, technology, engineering, and mathematics, typically from the nation's most prestigious universities. Many who enter the program choose the DOE CSGF over other fellowships based on its prestige and level of financial support relative to other programs. These data also highlight the effective outreach strategies employed by the DOE CSGF in attracting top talent. In addition, the responses of alumni and current fellows to a set of survey and interview questions that were included for the first time in this study indicate that the program actively takes steps to include a diverse set of individuals within the relatively small number of recipients each year and works to create an environment in which those from various backgrounds feel supported and different perspectives are valued.

The program also received continued high praise from alumni for its unique benefits. Alumni reported not only a highly satisfying experience in each key component of the program but also that it provided opportunities that were unmatched by other fellowships, through exposure to HPC, access to DOE laboratories and scientists, as well as the chance to be mentored by top researchers in the field. They described how their interests in the field of CSE and in pursuing full-time employment at a DOE laboratory were strengthened through their exposure to these programmatic features, and many indicated that these opportunities and experiences were critical to obtaining employment in the field. Based on the data collected as part of this study, the various opportunities

provided to students by the DOE CSGF reflect a successful model that offers a broad scope of training and development.

In addition, data from this study indicate that many DOE CSGF alumni remain involved in the program long after their fellowship support ends, by actively recruiting new fellows and providing guidance and professional development for current recipients and by developing relationships and collaborations with fellows that outlast their time in the program. The annual program review meetings serve as a forum for mentoring and career guidance and help reinforce a sense of community among current and former participants. In addition, many alumni continue to be involved in the program review component and engage in other activities that extend beyond formal programmatic activities. These include the establishment of formal and informal research networks and research collaborations between DOE CSGF alumni, both of which illustrate the connectedness of the computational science community that the fellowship fosters.

Once again, our inclusion of more objective measures of recipients' accomplishments revealed how prolific DOE CSGF alumni have been in helping to advance the nation's science and technology goals into the future. The fact that alumni have received a large number of professional awards, research grants, and patents and that they have published research in prestigious journals at an impressive and compounding rate serves as evidence of their contributions to the broader scientific community through the generation of new knowledge and innovations.

Lastly, by surveying DOE CSGF alumni dating back nearly three decades and interviewing alumni who have spent up to a decade in full-time employment, we were able to document the many long-term career benefits of program participation. Among these were the substantial proportion of DOE CSGF alumni who transition directly to permanent employment at DOE laboratories, with many choosing to work in this setting due to its stimulating environment, the research opportunities that are available, and the opportunity to make a direct contribution to the national scientific enterprise. Meanwhile, other alumni found employment in highly specialized positions in academia, where many are directly involved in educating and training future scientists, or in industry, where they are often in leadership positions and therefore have the capacity to contribute directly or indirectly to the development of the next generation of scientists and to help spread the influence of the DOE CSGF program more broadly.

Appendix A. Survey Instruments

Instructions
- **This survey may take up to 20 minutes to complete. If at all possible, please allow enough time to finish in one sitting. After you have submitted the survey, you will not be able to re-enter or adjust your responses.**
- **Each of your responses is important and it is critical that you answer every question to the best of your ability using the options provided.**
- **The identity of all individuals who participate in the survey will be kept confidential. Overall results will be shared with the DOE, however individual responses will not be reported.**
- **Please contact the Krell Institute with any questions regarding your participation in this survey.**

Your submission is requested by Wednesday, September 29, 2021. Thank you for taking the time to complete this survey.

Recruitment and Entry Into the DOE CSGF Program (Recruitment)

* 1. Which <u>one</u> of the following sources of information about the DOE CSGF program was **most influential** in your decision to apply?

○ Student colleagues

○ Academic advisor or other professor

○ University career placement office

○ Departmental or organizational emails, listserv, etc.

○ Former or current DOE CSGF recipient

○ DOE employee (laboratory or otherwise)

○ DOE CSGF exhibit, presentation or poster at a professional meeting

○ DOE CSGF exhibit, presentation or poster at a university career fair

○ DOE CSGF poster or mailing

○ DOE CSGF website

○ Advertisement in a professional publication

○ Other (please specify below)

* 2. At the time you applied for the DOE CSGF, did you also apply for other fellowship programs?

○ Yes

○ No

Recruitment and Entry Into the DOE CSGF Program (Other Fellowships)   A-3

* 3. In applying for fellowships, was the DOE CSGF program your first choice?

○ Yes, I initially applied only for the DOE CSGF

○ No, I applied for other programs at the same time

○ No, I applied for other programs first and for the DOE CSGF later on

* 4. In which of the following categories did you **apply** for fellowship programs other than the DOE CSGF?
(Please select all that apply.)

☐ Government

☐ University-sponsored

☐ Industry

☐ Other (please specify)

[   ]

* 5. Were you offered a fellowship through another program (other than the DOE CSGF)?

○ Yes

○ No

Recruitment and Entry Into the DOE CSGF Program (Other Offers)   A-4

* 6. Taking into account those you applied for, in which categories were you **offered** a fellowship other than the DOE CSGF? *(Please select all that apply.)*

☐ Government

☐ University-sponsored

☐ Industry

☐ [Insert text from Other]

7. Please name the fellowship(s) you were offered in addition to the DOE CSGF.

Recruitment and Entry Into the DOE CSGF Program (Acceptance)

* 8. What were your **three most important** reasons for accepting the DOE CSGF?

☐ Opportunity to receive additional training in my academic field of interest

☐ Opportunity to receive training in an area outside of my primary field of interest

☐ Ability to conduct research in my academic field of interest

☐ Prestige of the DOE CSGF program

☐ Quality of DOE research facilities and equipment

☐ Stepping stone to my career

☐ Ability to conduct practicum at a specific laboratory

☐ The tuition support and stipend were appealing

☐ Other (please specify)

Experience in and Satisfaction With the DOE CSGF Program (Practicum Assessment)   A-6

* 9. Which of the following best describes the status of your DOE CSGF practicum?

○ I completed my practicum

○ I am currently on practicum

○ I will begin my practicum in the future

Experience in and Satisfaction With the DOE CSGF Program (Practicum)

* 10. How satisfied have you been with the assistance you received from your **practicum supervisor and other laboratory team members** on each of the following topic*s?*

	Very satisfied	Satisfied	Somewhat satisfied	Not at all satisfied	Not applicable
Generating ideas about research	◯	◯	◯	◯	◯
Direction during my research activities (e.g., next steps and how to solve them)	◯	◯	◯	◯	◯
Obtaining specialized equipment for my research as needed	◯	◯	◯	◯	◯
Improving my writing skills	◯	◯	◯	◯	◯
Publishing my research	◯	◯	◯	◯	◯
Networking	◯	◯	◯	◯	◯
Finding professional development opportunities	◯	◯	◯	◯	◯
Setting career goals	◯	◯	◯	◯	◯
Finding job opportunities and openings	◯	◯	◯	◯	◯
Gaining a better understanding of continued opportunities for collaboration	◯	◯	◯	◯	◯

Experience in and Satisfaction With the DOE CSGF (APR)

* 11. To what extent do you find the annual DOE CSGF program review meetings to be useful in each of the following ways?

	Very useful	Useful	Somewhat useful	Not at all useful	Not applicable
Collaboration opportunities	○	○	○	○	○
Interaction with researchers in my field	○	○	○	○	○
Interaction with researchers in other fields	○	○	○	○	○
Opportunities to develop mentoring relationships	○	○	○	○	○
Intellectual stimulation and exchange	○	○	○	○	○
Opportunities to present my research	○	○	○	○	○
Opportunities for feedback on my research	○	○	○	○	○
Contacts for obtaining employment	○	○	○	○	○
Postdoctoral opportunities	○	○	○	○	○
Networking opportunities	○	○	○	○	○
Professional development topics	○	○	○	○	○
Insight into current and/or future big picture problems	○	○	○	○	○
Overall usefulness of the DOE CSGF annual program review events	○	○	○	○	○

Experience in and Satisfaction With the DOE CSGF Program (HPC)

* 12. To what extent has DOE CSGF-directed exposure to **high-performance computing (HPC)** while a fellow benefited you in each of the following ways?

	Major extent	Moderate extent	Minor extent	Not at all	Not applicable
It has provided adequate exposure and introduction to HPC to kick-start my learning process	○	○	○	○	○
It has provided insight into best practices for more efficient programming	○	○	○	○	○
It has directly impacted my research in a positive way	○	○	○	○	○
It has exposed me to opportunities to use HPC in the DOE labs	○	○	○	○	○
It has impacted my thoughts regarding post-DOE CSGF/-Ph.D. career opportunities	○	○	○	○	○

* 13. During your fellowship period, have you used high-performance computing **in your own research**?

○ Yes, to a large extent

○ Yes, to some extent

○ No

* 14. Please indicate if and when you have **contributed to AND/OR led** the development of the specific aspects of computing listed below. *(Please select a response for each row-column combination.)*

	Prior to my time as a fellow	**During** my time as a fellow
Scientific codes	▲▼	▲▼
Scientific software suites	▲▼	▲▼
Open source scientific software	▲▼	▲▼

* 15. For both of the time periods listed below, please indicate if you took/have taken advantage of dedicated computing time on **DOE supercomputers**.

	Yes, I did/have	No, I did/have not
Prior to my time as a fellow	○	○
During my time as a fellow	○	○

Experience in and Satisfaction With the DOE CSGF Program (Mentoring Assessment - Rec'd.)

* 16. Please indicate if you have **received** mentoring, guidance or support from your practicum supervisor, laboratory team members, or other DOE CSGF recipients in each of the following areas.

	Yes	No
Opportunities to collaborate on research in fields related to computational science and engineering (CSE)	○	○
Guidance/support for publishing in fields related to CSE	○	○
Opportunities for developing and obtaining research grants in fields related to CSE	○	○
Opportunities to network with other scholars, publishers, editors, etc., in fields related to CSE	○	○
Opportunities to present research in fields related to CSE	○	○
Guidance/support for teaching, student advising, etc., in fields related to CSE	○	○
Guidance/support for obtaining employment in fields related to CSE	○	○
Advice regarding professional survival and politics	○	○
Psychological or emotional support	○	○

Experience in and Satisfaction With the DOE CSGF Program (Mentoring Usefulness)

* 17. For each of the supports you indicated that you **received** in the prior question, please indicate the extent to which you have found the support to be useful.

	Very useful	Useful	Somewhat useful	Not at all useful
Opportunities to collaborate on research in fields related to computational science and engineering (CSE)	○	○	○	○
Guidance/support for publishing in fields related to CSE	○	○	○	○
Opportunities for developing and obtaining research grants in fields related to CSE	○	○	○	○
Opportunities to network with other scholars, publishers, editors, etc., in fields related to CSE	○	○	○	○
Opportunities to present research in fields related to CSE	○	○	○	○
Guidance/support for teaching, student advising, etc., in fields related to CSE	○	○	○	○
Guidance/support for obtaining employment in fields related to CSE	○	○	○	○
Advice regarding professional survival and politics	○	○	○	○
Psychological or emotional support	○	○	○	○

* 18. Please indicate if you have **provided** mentoring, guidance or support to members of the scientific community, including other DOE CSGF recipients, in the following areas.

	Yes	No
Opportunities to collaborate on research in fields related to computational science and engineering (CSE)	○	○
Guidance/support for publishing in fields related to CSE	○	○
Opportunities for developing and obtaining research grants in fields related to CSE	○	○
Opportunities to network with other scholars, publishers, editors, etc., in fields related to CSE	○	○
Opportunities to present research in fields related to CSE	○	○
Guidance/support for teaching, student advising, etc., in fields related to CSE	○	○
Guidance/support for obtaining employment in fields related to CSE	○	○
Advice regarding professional survival and politics	○	○
Psychological or emotional support	○	○

Experience in and Satisfaction With the DOE CSGF Program (Overall)

* 19. Please indicate how satisfied you have been with each of the following aspects of the DOE CSGF.

	Very satisfied	Satisfied	Somewhat satisfied	Not at all satisfied	Not applicable
Research training	○	○	○	○	○
Access to facilities, equipment and other resources	○	○	○	○	○
Mentoring on research	○	○	○	○	○
Mentoring on career development	○	○	○	○	○
Communication with my practicum supervisor and/or other laboratory team members	○	○	○	○	○
Communication with other DOE CSGF recipients	○	○	○	○	○
Annual DOE CSGF program review events	○	○	○	○	○
Opportunities for collaboration on research	○	○	○	○	○
Networking opportunities	○	○	○	○	○

* 20. Please indicate **up to three** aspects of the DOE CSGF program that have been most important to your overall satisfaction.

☐ Research training

☐ Access to facilities, equipment and other resources

☐ Mentoring on research

☐ Mentoring on career development

☐ Communication with my practicum supervisor and/or other laboratory team members

☐ Communication with other DOE CSGF recipients

☐ Annual DOE CSGF program review events

☐ Opportunities for collaboration on research

☐ Networking opportunities

Experience in and Satisfaction With the DOE CSGF Program (Overall)

* 21. To what extent has your participation in the DOE CSGF program benefited you in each of the following ways?

	Major extent	Moderate extent	Minor extent	Not at all
Enhanced my computing capabilities	○	○	○	○
Enhanced my knowledge of high-performance computing (HPC)	○	○	○	○
Increased my subject matter knowledge/expertise in other areas (i.e., other than computing capabilities)	○	○	○	○
Improved my research skills and/or techniques	○	○	○	○
Improved the overall quality of my research	○	○	○	○
Positively influenced the specific direction of my current research	○	○	○	○
Improved my publication and presentation skills	○	○	○	○
Improved my mentoring skills	○	○	○	○
Increased my contacts with colleagues in my field	○	○	○	○

* 22. To what extent do you agree with each of the following statements about your DOE CSGF participation?

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
My experience has provided me with professional knowledge and skills that I would not have developed otherwise	○	○	○	○	○
I have had access and exposure to research opportunities that I would not have had elsewhere	○	○	○	○	○
I have had access and exposure to computing resources/capabilities that I would not have had elsewhere	○	○	○	○	○
Accepting the DOE CSGF has been the right decision for my career trajectory	○	○	○	○	○
As a result of my participation as a fellow, I have encouraged students and/or colleagues to pursue Computational Science and Engineering as a field of study	○	○	○	○	○
My experience as a fellow has significantly contributed to my knowledge about how to conduct research	○	○	○	○	○
My experience as a fellow has provided me with professional expertise that I would not have developed otherwise	○	○	○	○	○
When it comes time to secure my first post-DOE CSGF position, my experience in the program will likely give me an advantage over others with similar qualifications	○	○	○	○	○

Impact of COVID-19

* 23. In responding to these statements, consider the potential impacts of COVID-19 and any modifications to in-person learning on your experience in the DOE CSGF program.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strong disagree	Not applicable
The shift to virtual learning that has occurred has had an impact on my progress toward completing my PhD.	○	○	○	○	○	○
With regard to the program review meetings, participating in those virtually provided me with a sense of community with the fellowship.	○	○	○	○	○	○
If my practicum participation was virtual, I was able to make connections at the national laboratories and receive positive mentoring.	○	○	○	○	○	○

24. In the text box below, please describe any positive outcomes or unforeseen benefits that occurred as a result of virtual learning and/or practicum experiences.

Diversity and Inclusion

This next set of questions address the topic of diversity and inclusion. The DOE CSGF program is interested in learning more about the extent to which individual fellows feel adequately represented and the extent to which the program is creating a diverse and inclusive climate that is welcoming of individuals of all backgrounds.

* 25. In responding to these statements, please consider your feeling of inclusion as a member of your race, ethnicity, gender, disability status, veteran status, or any others that you feel are important.

	Strong agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
I feel comfortable and included as a member of the DOE CSGF community.	○	○	○	○	○
The program has actively taken steps to make me feel comfortable and included as a member of the DOE CSGF community.	○	○	○	○	○
The DOE CSGF program could do more to make me feel comfortable and included.	○	○	○	○	○

26. In the text box below, please describe any additional thoughts you have regarding the extent to which you feel included in the DOE CSGF community as a member of your race, ethnicity, gender, disability status, veteran status, or any others that you feel are important.

Experience in and Satisfaction With the DOE CSGF Program (Referral Assessment)

* 27. Since beginning the DOE CSGF, have you recommended to any others that they apply for the fellowship?

○ Yes

○ No

Experience in and Satisfaction With the DOE CSGF Program (Referrals)

* 28. As it relates to those you recommended apply for the fellowship, please consider the following statements and choose the one that best describes the outcome of your effort.

○ At least one of the individuals I recommended went on to apply for the fellowship and **was accepted**

○ At least one of the individuals I recommended went on to apply but none were accepted

○ None of the individuals I recommended to the program have applied

○ I don't know if any of the individuals I recommended to the program have applied and/or were accepted

If applicable, please name the individual(s) that you recommended and who was/were accepted into the DOE CSGF.

Career Opportunities and Plans After the DOE CSGF Program (Professional Activities)

* 29. How many professional societies or associations do you currently belong to?

○ None

○ One

○ Two

○ Three

○ Four or more

If applicable, please name the societies/associations to which you belong.

Career Opportunities and Plans After the DOE CSGF Program (Professional Leadership)

* 30. Which of the following specific types of leadership positions/roles, if any, have you held within these professional societies or associations? *(Please select all that apply.)*

☐ I have not held any leadership positions or roles

☐ Organizational officer (e.g. president, vice-president, treasurer, etc.)

☐ Board member

☐ Section officer

☐ Committee service

☐ Other (please specify)

Career Opportunities and Plans After the DOE CSGF Program   A-23

* 31. Upon completing the DOE CSGF program, which of the following types of career opportunities do you plan to pursue? *(Please select all that apply.)*

☐ Postdoc

☐ Full-time employment

☐ Other (please specify)

[   ]

* 32. In which of the following sectors do you plan to search for a post-fellowship/-Ph.D. position? *(Please select all that apply.)*

☐ DOE laboratory

☐ Government other than a DOE laboratory

☐ Academia

☐ Industry

☐ Not-for-profit

☐ Self-employment

☐ Other (please specify)

[   ]

* 33. To what extent do you agree with the following statements about career opportunities available at DOE laboratories after your fellowship ends? *(Please select one answer per row.)*

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Not applicable
DOE laboratory employment opportunities have been clearly communicated to me	○	○	○	○	○	○
There are ample positions available to me at DOE laboratories	○	○	○	○	○	○
The career opportunities available at DOE laboratories are intellectually challenging	○	○	○	○	○	○
The career opportunities available at DOE laboratories offer competitive salaries for my field	○	○	○	○	○	○
My practicum supervisor or other staff at my practicum laboratory have encouraged me to seek a position at a DOE laboratory after my fellowship ends	○	○	○	○	○	○
After my fellowship ends, I would actively pursue a position at a DOE laboratory if one were available	○	○	○	○	○	○

Background/Personal Information

* 34. What is your ethnicity?

○ Hispanic or Latino

○ Not Hispanic or Latino

○ I prefer not to answer

* 35. What is your racial background? *(Please select all that apply.)*

☐ American Indian or Alaska Native

☐ Asian

☐ Black or African American

☐ Native Hawaiian or Other Pacific Islander

☐ White

☐ I prefer not to answer

☐ Other (please specify)

[   ]

36. What is your gender?

○ Man

○ Transgender

○ Woman

○ I prefer not to answer

○ Other (please specify)

[   ]

* 37. What is your military status? (Please select all that apply)

☐ Active Duty

☐ Military dependent

☐ Military spouse

☐ National Guard/Reserves

☐ Never served

☐ Veteran

☐ I prefer not to answer

☐ Other (please specify)

[   ]

* 38. Are you a first-generation college student?

○ Yes

○ No

○ I prefer not to answer

* 39. Do you have a long-lasting or chronic condition (physical, visual, auditory, cognitive or mental, emotional, or other) that substantially limits one or more of your major life activities?

○ Yes

○ No

○ I prefer not to answer

* 40. Have you submitted your CV (and/or résumé, personal URL or LinkedIn page) to Krell staff in response to recent email requests?

○ Yes

○ No

Final Data Verification (CV Submission)   A-27

41. If readily available, please upload your CV or résumé here.

| Choose File | Choose File | No file chosen

42. And/or, if applicable, copy and paste your LinkedIn or personal URL here.

Survey Submission

Please click "Submit Your Survey" to indicate that you have completed the response process. Note that your submission is then final and cannot be modified.

Survey Introduction

Instructions
- **This survey may take up to 25 minutes to complete. If at all possible, please allow enough time to finish in one sitting. After you have submitted the survey, you will not be able to re-enter or adjust your responses.**
- **Each of your responses is important and it is critical that you answer every question to the best of your ability using the options provided.**
- **The identity of all individuals who participate in the survey will be kept confidential. Overall results will be shared with the DOE, however individual responses will not be reported.**
- **Please contact the Krell Institute with any questions regarding your participation in this survey.**

Your submission is requested by Wednesday, September 29, 2021. Thank you for taking the time to complete this survey.

Overall Satisfaction

* 1. Please indicate **up to three** aspects of the DOE CSGF program were most important to your overall satisfaction while a fellow.

☐ Research training

☐ Access to facilities, equipment and other resources

☐ Mentoring on research

☐ Mentoring on career development

☐ Communication with my practicum supervisor and/or other laboratory team members

☐ Communication with other DOE CSGF recipients

☐ Annual DOE CSGF program review events (formerly known as conferences)

☐ Opportunities for collaboration on research

☐ Networking opportunities

Experience in and Satisfaction With the DOE CSGF Program (Practicum/APR)

* 2. While a fellow, how satisfied were you with the assistance you received from your **practicum supervisor and other laboratory team members** on each of the following topic*s?*

	Very satisfied	Satisfied	Somewhat satisfied	Not at all satisfied	Not applicable
Generating ideas about research	◯	◯	◯	◯	◯
Direction during my research activities (e.g., next steps and how to solve them)	◯	◯	◯	◯	◯
Obtaining specialized equipment for my research as needed	◯	◯	◯	◯	◯
Improving my writing skills	◯	◯	◯	◯	◯
Publishing my research	◯	◯	◯	◯	◯

* 3. While a fellow, how satisfied were you with the assistance you received from your **practicum supervisor and other laboratory team members** on each of the following topic*s?*

	Very satisfied	Satisfied	Somewhat satisfied	Not at all satisfied	Not applicable
Networking	◯	◯	◯	◯	◯
Finding professional development opportunities	◯	◯	◯	◯	◯
Setting career goals	◯	◯	◯	◯	◯
Finding job opportunities and openings	◯	◯	◯	◯	◯
Gaining a better understanding of continued opportunities for collaboration	◯	◯	◯	◯	◯

* 4. While a fellow, to what extent did you find the annual DOE CSGF program review meetings (formerly known as conferences) to be useful in each of the following ways?

	Very useful	Useful	Somewhat useful	Not at all useful	Not applicable
Collaboration opportunities	○	○	○	○	○
Interaction with researchers in my field	○	○	○	○	○
Interaction with researchers in other fields	○	○	○	○	○
Opportunities to develop mentoring relationships	○	○	○	○	○
Intellectual stimulation and exchange	○	○	○	○	○
Opportunities to present my research	○	○	○	○	○
Opportunities for feedback on my research	○	○	○	○	○

* 5. While a fellow, to what extent did you find the annual DOE CSGF program review meetings (formerly known as conferences) to be useful in each of the following ways?

	Very useful	Useful	Somewhat useful	Not at all useful	Not applicable
Contacts for obtaining employment	○	○	○	○	○
Postdoctoral opportunities	○	○	○	○	○
Networking opportunities	○	○	○	○	○
Professional development topics	○	○	○	○	○
Insight into current and/or future big picture problems	○	○	○	○	○
Overall usefulness of the DOE CSGF annual program review events	○	○	○	○	○

Experience in and Satisfaction With the DOE CSGF Program (HPC)

* 6. For each of the time periods listed below, please indicate if you used dedicated computing time on **DOE supercomputers**.

	Yes, I did/have	No, I did/have not
Prior to my time as a fellow	○	○
During my time as a fellow	○	○
Since my time as a fellow	○	○

* 7. While a fellow, did you use high-performance computing **in your own research**?

○ Yes, to a large extent

○ Yes, to some extent

○ No

* 8. To what extent did DOE CSGF-directed exposure to **high-performance computing (HPC)** while a fellow benefit you in each of the following ways?

	Major extent	Moderate extent	Minor extent	Not at all	Not applicable
It impacted/affected my career choice	○	○	○	○	○
It equipped me to make an immediate impact once on the job	○	○	○	○	○
It resulted in growth within my career	○	○	○	○	○

* 9. Please indicate if and when you have **contributed to AND/OR led** the development of the specific aspects of computing listed below. *(Please select a response for each row-column combination.)*

	Prior to my time as a fellow	**During** my time as a fellow	**Since** my time as a fellow
Scientific codes			
Scientific software suites			
Open source scientific software			

Experience in and Satisfaction With the DOE CSGF (Mentoring Assessment - Rec'd.)

* 10. Please indicate if and when you have **received** mentoring, guidance or support from your practicum supervisor, laboratory team members, or other DOE CSGF recipients in the following areas. *(Please select all that apply in each row.)*

	During my time as a fellow	**Since** my time as a fellow	Not at all
Opportunities to collaborate on research in fields related to computational science and engineering (CSE)	☐	☐	☐
Guidance/support for publishing in fields related to CSE	☐	☐	☐
Opportunities for developing and obtaining research grants in fields related to CSE	☐	☐	☐
Opportunities to co-author publications in fields related to CSE	☐	☐	☐
Opportunities to network with other scholars, publishers, editors, etc., in fields related to CSE	☐	☐	☐
Opportunities to present research in fields related to CSE	☐	☐	☐
Guidance/support for obtaining grants, contracts, fellowships, or other resources in fields related to CSE	☐	☐	☐
Guidance/support for teaching, student advising, etc., in fields related to CSE	☐	☐	☐
Guidance/support for obtaining employment in fields related to CSE	☐	☐	☐
Advice regarding professional survival and politics	☐	☐	☐
Psychological or emotional support	☐	☐	☐

Experience in and Satisfaction With the DOE CSGF (Mentoring)

* 11. Please indicate if and when you have **provided** mentoring, guidance or support to members of the scientific community, including other DOE CSGF recipients, in the following areas. *(Please select all that apply in each row.)*

	During my time as a fellow	**Since** my time as a fellow	Not at all
Opportunities to collaborate on research in fields related to computational science and engineering (CSE)	☐	☐	☐
Guidance/support for publishing in fields related to CSE	☐	☐	☐
Opportunities for developing and obtaining research grants in fields related to CSE	☐	☐	☐
Opportunities to co-author publications in fields related to CSE	☐	☐	☐
Opportunities to network with other scholars, publishers, editors, etc., in fields related to CSE	☐	☐	☐
Opportunities to present research in fields related to CSE	☐	☐	☐
Guidance/support for obtaining grants, contracts, fellowships, or other resources in fields related to CSE	☐	☐	☐
Guidance/support for teaching, student advising, etc., in fields related to CSE	☐	☐	☐
Guidance/support for obtaining employment in fields related to CSE	☐	☐	☐
Advice regarding professional survival and politics	☐	☐	☐
Psychological or emotional support	☐	☐	☐

Experience in and Satisfaction With the DOE CSGF Program (As Fellow)

* 12. Please indicate how satisfied you were with each of the following aspects of the DOE CSGF while a fellow.

	Very satisfied	Satisfied	Somewhat satisfied	Not at all satisfied	Not applicable
Research training	○	○	○	○	○
Access to facilities, equipment and other resources	○	○	○	○	○
Mentoring on research	○	○	○	○	○
Mentoring on career development	○	○	○	○	○
Communication with my practicum supervisor and/or other laboratory team members	○	○	○	○	○
Communication with other DOE CSGF recipients	○	○	○	○	○
Annual DOE CSGF program review events (formerly known as conferences)	○	○	○	○	○
Opportunities for collaboration on research	○	○	○	○	○
Networking opportunities	○	○	○	○	○

Experience in and Satisfaction With the DOE CSGF Program (Bigger Picture)

* 13. To what extent did your participation in the DOE CSGF program benefit you in each of the following ways?

	Major extent	Moderate extent	Minor extent	Not at all
Enhanced my computing capabilities	○	○	○	○
Enhanced my knowledge of high-performance computing (HPC)	○	○	○	○
Increased my subject matter knowledge/expertise in other areas (i.e., other than computing capabilities)	○	○	○	○
Improved my research skills and/or techniques	○	○	○	○
Improved the overall quality of my research	○	○	○	○
Positively influenced the specific direction of my current research	○	○	○	○
Improved my publication and presentation skills	○	○	○	○

* 14. To what extent did your participation in the DOE CSGF program benefit you in each of the following ways?

	Major extent	Moderate extent	Minor extent	Not at all
Improved my mentoring skills	○	○	○	○
Increased my experience using specialized equipment	○	○	○	○
Increased my confidence in performing cutting-edge research	○	○	○	○
Increased my contacts with colleagues in my field	○	○	○	○
Helped me pursue a new direction within my field of interest	○	○	○	○
Helped me address a topic previously unexplored within my field of interest	○	○	○	○
Helped me address key gaps in knowledge within my field of interest	○	○	○	○

* 15. To what extent do you agree with each of the following statements about your DOE CSGF participation?

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
My experience provided me with professional knowledge and skills that I would not have developed otherwise	○	○	○	○	○
I had access and exposure to research opportunities that I would not have had elsewhere	○	○	○	○	○
I have had access and exposure to computing resources/capabilities that I would not have had elsewhere	○	○	○	○	○
Accepting the DOE CSGF was the right decision for my career	○	○	○	○	○
As a result of my participation as a fellow, I have encouraged students and/or colleagues to pursue Computational Science and Engineering as a field of study	○	○	○	○	○

* 16. To what extent do you agree with each of the following statements about your DOE CSGF participation?

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
My experience as a fellow significantly contributed to my knowledge about how to conduct research	○	○	○	○	○
My experience as a fellow provided me with professional expertise that I would not have developed otherwise	○	○	○	○	○
When it came to securing my first post-DOE CSGF position, my experience in the program gave me an advantage over others with similar qualifications	○	○	○	○	○
My experience as a fellow continues to help me achieve my career goals	○	○	○	○	○

Experience in and Satisfaction With the DOE CSGF Program (Networking)

* 17. To what extent have you stayed in touch with each of the following people involved in your DOE CSGF experience?

	Major extent	Moderate extent	Minor extent	Not at all
Your practicum supervisor	○	○	○	○
Other staff at your practicum laboratory	○	○	○	○
Other DOE CSGF recipients	○	○	○	○

* 18. Since completing the fellowship, how many annual DOE CSGF program review meetings (formerly known as conferences) have you attended?

○ None

○ One

○ Two

○ Three

○ Four or more

* 19. While a fellow or since completing the DOE CSGF, have you recommended to any others that they apply for the fellowship?

○ Yes

○ No

Experience in and Satisfaction With the DOE CSGF Program (Referrals)   A-40

* 20. As it relates to those you recommended apply for the fellowship, please consider the following statements and choose the one that best describes the outcome of your effort.

○ At least one of the individuals I recommended went on to apply for the fellowship and **was accepted**

○ At least one of the individuals I recommended went on to apply but none were accepted

○ None of the individuals I recommended to the program have applied

○ I don't know if any of the individuals I recommended to the program have applied and/or were accepted

If applicable, please name the individual(s) that you recommended and who was/were accepted into the DOE CSGF.

Diversity and Inclusion

This next set of questions address the topic of diversity and inclusion. The DOE CSGF program is interested in learning more about the extent to which individual fellows have felt adequately represented and the extent to which the program creates a diverse and inclusive climate that is welcoming of individuals of all backgrounds.

* 21. In responding to these statements, please consider your feeling of inclusion as a member of your race, ethnicity, gender, disability status, veteran status, or any others that you feel are important.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
I felt comfortable and included as a member of the DOE CSGF community.	○	○	○	○	○
The program actively took steps to make me feel comfortable and included as a member of the DOE CSGF community.	○	○	○	○	○
The DOE CSGF program could have done more to make me feel comfortable and included.	○	○	○	○	○

22. In the text box below, please describe any additional thoughts you have regarding the extent to which you felt included in the DOE CSGF community as a member of your race, ethnicity, gender, disability status, veteran status, or any others that you feel are important.

Career Since Participating in the DOE CSGF Program (Ph.D. Completion)

* 23. Have you completed/earned your doctoral degree?

◯ I completed/earned my doctoral degree

◯ I am still in progress toward completing my doctoral degree

◯ I am no longer pursuing/did not earn a doctoral degree

Career Since Participating in the DOE CSGF Program (Ph.D. Detail)

* 24. Please indicate the year in which you earned or anticipate earning your doctoral degree.

* 25. Please indicate the field in which you earned or intend to earn your Ph.D.

Career Since Participating in the DOE CSGF Program (No Ph.D.)

* 26. Please indicate why you are no longer pursuing a doctoral degree.

Career Since Participating in the DOE CSGF Program (Assess Any)

* 27. Including self-employment and postdocs, have you been employed in **any** position since completing your DOE CSGF?

   ◯ Yes

   ◯ No

Career Since Participating in the DOE CSGF Program (All)   A-46

* 28. Including postdoc positions, where have you been employed since finishing your DOE CSGF? *(Please select all that apply.)*

☐ DOE laboratory

☐ Government other than a DOE laboratory

☐ Academia

☐ Industry

☐ Not-for-profit

☐ Self-employed

☐ Other (please specify)

_____

DOE/Other Government Career Motivation

29. What were the most important factor(s) that influenced your decision to work at a DOE laboratory or in a Federal career setting (past or present)? Please select all that apply.

☐ Opportunity to contribute to the greater good/public service

☐ Opportunity to conduct interdisciplinary, team-based work

☐ Opportunity for career advancement within this setting

☐ Personal or family reasons

☐ Geographic reasons (e.g., location of opportunities within this setting)

☐ Other (please specify)

Career Since Participating in the DOE CSGF Program (First)   A-48

* 30. Including postdoc positions, where were you **first** employed after completing your DOE CSGF?

○ DOE laboratory

○ Government other than a DOE laboratory

○ Academia

○ Industry

○ Not-for-profit

○ Self-employed

○ [Insert text from Other]

* 31. Rounding to the nearest whole number, how many years did you hold (or have you held) your **first** position?

[   ]

* 32. How useful did you find each of the following factors in obtaining your **first** position after the DOE CSGF?

	Very useful	Useful	Somewhat useful	Not at all useful	Not applicable
Contacts initiated by my employer	○	○	○	○	○
Contacts initiated on my own	○	○	○	○	○
Contacts provided by my DOE CSGF practicum supervisor	○	○	○	○	○
Contacts provided by someone else at my DOE CSGF practicum site	○	○	○	○	○
Prestige of the DOE CSGF program	○	○	○	○	○
Prestige of my DOE CSGF practicum supervisor	○	○	○	○	○
Prestige of my DOE CSGF practicum site	○	○	○	○	○
Publications for which I received credit while a fellow	○	○	○	○	○
Presentations I gave while a fellow	○	○	○	○	○
Participation in proposals while a fellow	○	○	○	○	○
The area(s) I researched while a fellow	○	○	○	○	○
Overall usefulness of the DOE CSGF in obtaining my first position	○	○	○	○	○

* 33. Including self-employment and postdocs, are you **currently** employed?

○ Yes

○ No

Career Since Participating in the DOE CSGF Program (Assess Current)

* 34. Is your **current** employer the same as your first employer?

   ◯ Yes

   ◯ No

Career Since Participating in the DOE CSGF Program (Current-Basic)

* 35. Where are you **currently** employed?

○ DOE laboratory

○ Government other than a DOE laboratory

○ Academia

○ Industry

○ Not-for-profit

○ Self-employed

○ [Insert text from Other]

* 36. Rounding to the nearest whole number, how many years have you held your **current** position?

Non-DOE/Government Career Motivation

37. What were the most important factors that influenced your decision to work in this setting? Please select all that apply.

☐ Intellectual interest

☐ Prestige associated with working in this setting

☐ Income associated with working in this setting

☐ Opportunity for career advancement within this setting

☐ Personal or family reasons

☐ Geographic reasons (e.g., location of opportunities within this setting)

☐ Other (please specify)

Career Since Participating in the DOE CSGF Program (Current-Detail)

* 38. Are you currently employed in a Computational Science and Engineering field?

○ Yes

○ No

* 39. To what extent do you agree with each of the following statements about your **current** position?

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
I am satisfied with the type of work I am currently doing	○	○	○	○	○
I am satisfied with the opportunities for advancement at my current employer	○	○	○	○	○
I have a leadership role within my current organization	○	○	○	○	○
I am compensated fairly for the work that I do	○	○	○	○	○
Overall, my career has met my expectations	○	○	○	○	○

Career Since Participating in the DOE CSGF Program (Professional Activities)

* 40. **Since completing your DOE CSGF**, to what extent have you accomplished each of the following professional activities?

	Major extent	Moderate extent	Minor extent	Not at all
Engaged in interdisciplinary research	○	○	○	○
Pursued a new theoretical direction or addressed a topic previously unexplored in your field	○	○	○	○
Contributed to a scientific breakthrough in your field	○	○	○	○
Contributed to innovative ideas in your field	○	○	○	○
Addressed key knowledge gaps in your field	○	○	○	○
Advanced within your employing organization	○	○	○	○
Achieved your overall career goals	○	○	○	○

* 41. **During the past five years (or since the end of your DOE CSGF if fewer than five years)**, how often have you engaged in each of the following professional activities?

	Once	Two or three times	Four or five times	Six or more times	Not applicable
Organized a seminar or workshop on my research area	○	○	○	○	○
Lectured at a host institution	○	○	○	○	○
Presented my research in my own lab/department at my organization	○	○	○	○	○
Presented my research in another lab/department at my organization	○	○	○	○	○
Presented my research at a national meeting	○	○	○	○	○
Presented my research at an international meeting	○	○	○	○	○
Authored or co-authored a paper in a peer-reviewed journal	○	○	○	○	○
Authored or co-authored a book chapter	○	○	○	○	○
Authored or co-authored a book	○	○	○	○	○
Authored or co-authored a technical report	○	○	○	○	○

* 42. **During the past five years (or since the end of your DOE CSGF if fewer than five years)**, how often have you engaged in each of the following professional activities?

	Once	Two or three times	Four or five times	Six or more times	Not applicable
Received competitive funding for my research	○	○	○	○	○
Received a patent	○	○	○	○	○
Received a professional award related to my research	○	○	○	○	○
Developed a prototype or marketable product	○	○	○	○	○
Assumed a management position in my organization (e.g., division head, etc.)	○	○	○	○	○
Served formally or informally as a mentor to others within my organization	○	○	○	○	○

Career Since Participating in the DOE CSGF Program (Professional Leadership)

* 43. How many professional societies or associations do you currently belong to?

○ None

○ One

○ Two

○ Three

○ Four or more

If applicable, please name the societies/associations to which you belong.

Career Since Participating in the DOE CSGF Program (Professional Leadership)

* 44. Which of the following specific types of leadership positions/roles, if any, have you held within these professional societies or associations? *(Please select all that apply.)*

☐ I have not held any leadership positions or roles

☐ Organizational officer (e.g. president, vice-president, treasurer, etc.)

☐ Board member

☐ Section officer

☐ Committee service

☐ Other (please specify)

_____

Background/Personal Information

* 45. What is your ethnicity?

○ Hispanic or Latino

○ Not Hispanic or Latino

○ I prefer not to answer

* 46. What is your racial background? *(Please select all that apply.)*

☐ American Indian or Alaska Native

☐ Asian

☐ Black or African American

☐ Native Hawaiian or Other Pacific Islander

☐ White

☐ I prefer not to answer

☐ Other (please specify)

[   ]

* 47. What is your gender?

○ Man

○ Transgender

○ Woman

○ I prefer not to answer

○ Other (please specify)

[   ]

* 48. What is your military status? (Please select all that apply)

☐ Active duty

☐ Military dependent

☐ Military spouse

☐ National Guard/Reserves

☐ Never served

☐ Veteran

☐ I prefer not to answer

☐ Other (please specify)

[   ]

* 49. Are you a first-generation college student?

◯ Yes

◯ No

◯ I prefer not to answer

50. Do you have a long-lasting or chronic condition (physical, visual, auditory, cognitive or mental, emotional, or other) that substantially limits one or more of your major life activities?

◯ Yes

◯ No

◯ I prefer not to answer

* 51. Have you submitted your CV (and/or résumé, personal URL or LinkedIn page) to Krell staff in response to recent email requests?

◯ Yes

◯ No

Final Data Verification (CV Submission)

52. If readily available, please upload your CV or résumé here.

Choose File   **Choose File**   No file chosen

53. And/or, if applicable, copy and paste your LinkedIn or personal URL here.

Survey Submission

**Please click "Submit Your Survey" to indicate that you have completed the response process.
Note that your submission is then final and cannot be modified.**

Appendix B. Interview Protocols

U.S. Department of Energy Computational Science Graduate Fellowship (DOE CSGF) – 2021 Follow Up Study

Interview Protocol – CURRENT FELLOWS

Instructions and Consent

Thank you for agreeing to participate in the Krell Institute's follow-up study on the Department of Energy Computational Science Graduate Fellowship (DOE CSGF). This interview is an important component of the study since it collects information from current and past DOE CSGF recipients on their experiences, education, and career trajectory.

More specifically, the interview questions will address the following topics:

- Your application and entry into the CSGF program
- Your experiences while as a fellow and the activities you participated in (e.g. perceptions of program components such as research practicum and mentoring; perceptions on diversity and inclusion)
- Your satisfaction with and perceptions of the program
- Your career plans (e.g., what type of field you anticipate working in after completing the program)

The interview should take about 1 hour to complete. Before we get started, there are a few things I would like to mention:

- As part of this study, we are conducting interviews with approximately 10 current CSGF fellows. As such, you are one of 10 individuals who have been randomly selected to participate from a sample of 30.

- Your participation in this interview is voluntary. If there are questions that you do not want to answer, or if you decide you no longer want to participate, just let me know.

- The identity of all individuals who participate in the interviews will be kept confidential. The overall results of the interviews will be shared with the Krell Institute and with the DOE, but there will be no reporting of individual responses. We will not use anyone's name or describe anyone in a way that they could be personally identified.

- If at any point after this interview you have any questions about your participation in the study, please contact me or the Krell Institute.

- With your permission, I would like to audio-record our conversation today to make sure that I can accurately represent your viewpoints. Also, we may use

quotes from you or other participants in our reports; however, participants' names will not be linked to any responses.

- After our interview, I will transfer the audio file to a password protected network drive. The file will not be shared with the Krell Institute, DOE, or anyone else other than authorized Westat staff. Once the study is completed, all audio files will be destroyed. Do I have your permission to record this interview?

- Do you have any questions before we begin?

- If you don't have any questions, I am going to turn on the audio recorder now.

Questions

A. Entry into the DOE CSGF Program

1) Why did you apply for the DOE CSGF? What initially drew you to the program?

B. Experience in the DOE CSGF Program (Part 1 – Specific Program Components)

2) Please describe your **research practicum experience(s)** so far and the opportunities you have had to collaborate with DOE laboratory researchers and others. Have these experiences been consistent with what you expected? If not, how have they been different than expected?

3) In what ways, if any, have you used **high-performance computing (HPC)** in your research while you have been a fellow? In what ways, if any, has your exposure to HPC while a fellow influenced your work?

4) Please describe the types of **mentoring** that have been made available to you as part of the fellowship. Are there any areas in which you could benefit from additional mentoring?

5) Please describe your experience with the annual DOE CSGF **program review meetings**. In what ways, if any, have these experiences been useful?

C. COVID-19

This next set of questions asks about the potential impacts of COVID-19 and any modifications to in-person learning on your experience in the DOE CSGF program.

7) First, do you feel that the shift to virtual learning that occurred has had any impact on your progress toward completing your PhD? If so, how?

8) With regard to the program review meetings, did participating in those virtually provide you with a sense of community with the fellowship?

> *[For those who began in 2018 and 2019, i.e., prior to COVID]*

> Are you able to compare your in-person experience(s) in program review meetings with your virtual experiences?

9) With regard to the practicum experience, did participating virtually provide you with interesting research projects? Given that your participation was virtual, were you able to make connections at the national laboratories and receive positive mentoring?

10) Were there any positive outcomes or unforeseen benefits that occurred as a result of virtual learning and/or practicum experience(s)?

D. Diversity and Inclusion

This next set of questions address the topic of diversity and inclusion. The DOE CSGF program is interested in learning more about the extent to which individual fellows feel adequately represented and the extent to which the program is creating a diverse and inclusive climate that is welcoming of individuals of all backgrounds.

11) First, how comfortable and included do you feel as a member of the DOE CSGF community? In addressing this question, please consider your feeling of inclusion as a member of your race, ethnicity, gender, disability status, veteran status, or any others that you feel are important.

PROBES:

[For those who do not feel comfortable/included]

> Let's talk about the reasons why you feel this way.

> What could the program do to make you feel more comfortable and included?

[For those who feel comfortable/included]

> What, if anything, has the DOE CSGF program done to help you feel that way?

> Is there anything the program could do to create a more diverse or inclusive environment?

E. Experience in the DOE CSGF Program (Part 2 – General)

12) Overall, considering your experience so far, has the DOE CSGF experience been consistent with what you expected? If not, how has it been different than expected?

13) Based on your experiences so far, what do you consider the best features of the program? *[For each factor mentioned]* Why?

> Another way of wording this: Is there something that has stood out or excited you most about your time as a fellow? What has been the most significant outcome of your DOE CSGF experience? What would you say has been your most significant achievement or contribution during your fellowship tenure at this point?

14) A core part of the DOE CSGF mission is the development of an interdisciplinary community of scholars and leaders in Computational Science and Engineering (CSE). Have your activities (actually or potentially) contributed to or helped to build the CSE community? Have your activities broadened CSE and related professional participation? (These might include, for example, formal or informal collegial or student mentoring or professional development initiatives or activities.)

F. Career Plans

15) At this point, what type of field do you anticipate pursuing work in, once you have completed your degree/fellowship (e.g., DOE laboratory or other Federal government workplace; industry; academia; etc.)?

[For those who provide a specific answer to Q15]

> 16) What factors have influenced your current plan to pursue work in this field? To what extent has your experience in the DOE CSGF affected your interest in pursuing work in this field? How has the DOE CSGF fit into your overall academic direction and goals? Did your involvement in the fellowship impact/change the trajectory of your research/academic direction/goals in any way?

*[For those who currently plan a **non**-DOE laboratory/Federal workplace career]*

> Have you considered working in a DOE laboratory, government agency or other line of Federal service? Are there any aspects of the DOE labs that make working there less appealing than other settings?

G. Improvements to the DOE CSGF Program

17) Based on your overall experience so far as a DOE CSGF fellow, what program element enhancements or improvements would you recommend, if any?

18) Is there anything else you would like to share with us regarding your experience in the DOE CSGF program?

**U.S. Department of Energy Computational Science Graduate Fellowship
(DOE CSGF) – 2021 Follow Up Study**

Interview Protocol – ALUMNI

Instructions and Consent

Thank you for agreeing to participate in the Krell Institute's follow-up study on the Department of Energy Computational Science Graduate Fellowship (DOE CSGF). This interview is an important component of the study since it collects information from current and past DOE CSGF recipients on their experiences, education, and career trajectory.

More specifically, the interview questions will address the following topics:

- Your application and entry into the CSGF program
- Your experiences while as a fellow and the activities you participated in (e.g. perceptions of program components such as research practicum and mentoring; perceptions on diversity and inclusion)
- Your satisfaction with and perceptions of the program
- Career activities and accomplishments since completing the program (e.g., what field you currently work in and why, etc.)

The interview should take between 45 minutes to an hour to complete. Before we get started, there are a few things I would like to mention:

- As part of this study, we are conducting interviews with approximately 20 CSGF alumni. As such, you are one of 20 individuals who have been randomly selected to participate from a sample of 50.

- Your participation in this interview is voluntary. If there are questions that you do not want to answer, or if you decide you no longer want to participate, just let me know.

- The identity of all individuals who participate in the interviews will be kept confidential. The overall results of the interviews will be shared with the Krell Institute and with the DOE, but there will be no reporting of individual responses. We will not use anyone's name or describe anyone in a way that they could be personally identified.

- If at any point after this interview you have any questions about your participation in the study, please contact me or the Krell Institute.

- With your permission, I would like to audio-record our conversation today to make sure that I can accurately represent your viewpoints. Also, we may use

quotes from you or other participants in our reports; however, participants' names will not be linked to any responses.

- After our interview, I will transfer the audio file to a password protected network drive. The file will not be shared with the Krell Institute, DOE, or anyone else other than authorized Westat staff. Once the study is completed, all audio files will be destroyed. Do I have your permission to record this interview?

- Do you have any questions before we begin?

- If you don't have any questions, I am going to turn on the audio recorder now.

Questions

A. Entry into the DOE CSGF Program

1) Why did you apply for the DOE CSGF? What initially drew you to the program?

B. Experience in the DOE CSGF Program (Part 1 – Specific Program Components)

2) Looking back on your **research practicum experience(s),** how would you describe the opportunities you had to collaborate with DOE laboratory researchers and others. Were these experiences consistent with what you expected when you began your fellowship? If not, how were different than expected?

3) In what ways, if any, did you use **high-performance computing (HPC)** in your research while you were a fellow? In what ways, if any, did your exposure to HPC while a fellow influence your work?

4) Please describe the types of **mentoring** that was made available to you as part of the fellowship. Did this mentoring inform or direct future work? Are there any areas in which you would have benefited from additional mentoring?

5) Please describe your experience with the annual DOE CSGF **program review while you were a fellow**. In what ways, if any, were these experiences useful? To what extent have you attended these meetings as an alumnus? If yes, were your experiences as a alumnus useful?

C. Experience in the DOE CSGF Program (Part 2 – General)

6) Overall, considering your experience, was the DOE CSGF experience consistent with what you expected? If not, how was it different than expected?

7) Based on your fellowship experience, what do you consider the best features of the program? *[For each factor mentioned]* Why?

> Another way of wording this: Is there something that stood out or excited you most about your time as a fellow? What was the most significant outcome of your DOE CSGF experience? What would you say was your most significant achievement or contribution during your fellowship tenure?

8) A core part of the DOE CSGF mission is the development of an interdisciplinary community of scholars and leaders in Computational Science and Engineering (CSE). Have your activities (actually or potentially) contributed to or helped to build the CSE community? Have your activities broadened CSE and related professional participation? (These might include, for example, formal or informal collegial or student mentoring or professional development initiatives or activities.)

D. Career Since Participating in the DOE CSGF Program

9) In what professional field do you currently work (i.e., DOE laboratory or other Federal government workplace; industry; academia; etc.)?

10) Did you anticipate you'd be working in [field/category] prior to the fellowship? (If no, what were you considering?) What factors influenced your decision to pursue work in your chosen field? To what extent was your experience in the DOE CSGF a factor in your decision to pursue work in this field? How did the DOE CSGF fit into your overall academic direction and goals? Did your involvement in the fellowship impact/change the trajectory of your research/academic direction/goals in any way?

> [*For those who are working in industry or academia*]

> Have you ever worked in, or did you ever consider working in, a DOE laboratory, government agency or other line of Federal service?

> Were there any aspects of the DOE labs that made working there less appealing?

11) What effect has your experience as a DOE CSGF recipient had on your career? What effects, if any, did your experience as a fellow have on you personally? Is there any other information regarding your experience that you think would be useful for understanding DOE CSGF effects?

12) The DOE has specific workforce needs in the areas of computational science and engineering problems. There are workforce gaps in the computing sciences that the DOE CSGF attempts to address. Do you think that the DOE CSGF program has been successful in meeting some or all of these DOE workforce needs? What might be done to maximize its effectiveness?

E. Diversity and Inclusion

This next set of questions address the topic of diversity and inclusion. The DOE CSGF program is interested in learning more about the extent to which individual fellows felt adequately represented and the extent to which the program creates a diverse and inclusive climate that is welcoming of individuals of all backgrounds.

13) First, how comfortable and included did you feel as a member of the DOE CSGF community as a fellow? In addressing this question, please consider your feeling of inclusion as a member of your race, ethnicity, gender, disability status, veteran status, or any others that you feel are important.

PROBES:

[For those who did not feel comfortable/included]

>   Let's talk about the reasons why you felt this way.

>   What could the program have done to make you feel more comfortable and included?

[For those who felt comfortable/included]

>   What, if anything, did the DOE CSGF program do to help you feel that way?

>   Is there anything the program could have done to create a more diverse or inclusive environment?

F. Improvements to the DOE CSGF Program

14) Based on your overall experience with the fellowship – past and present – what program element enhancements or improvements would you recommend, if any?

15) Is there anything else you would like to share with us regarding your experience in the DOE CSGF program?

Appendix C. Curriculum Vitae Coding Protocol

Variable	Details/values	Notes
ID	Krell unique identifier	
Coder		
Publication type Title of Publication Title of journal (If applicable) Year of Publication	Book Book chapter Journal article Report Conference presentation Other, specify	For each publication
Award name Award year		For each award
Grant start year Grant end year Amount	 Dollar amount of total award	For each grant/contract
Patent number Patent year Award field/discipline (if applicable)		For each patent
Fellowship name		Possibly could be coded for all if survey data on this is incomplete - needs to be coded for all if we want additional variables.

Westat