Evaluation of the Computing Community Consortium

A Qualitative and Quantitative Analysis of Perspectives on the CCC Project

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The SRI project team would like to express its gratitude to the Computing Research Association for the opportunity to conduct a project on a unique and potentially significant topic of interest in the field of computing research: the evaluation of the Computing Community Consortium. Many aspects of this project presented unique and complex challenges to evaluation methodology and analysis. We hope that we were able to rise to that challenge.

Our team would also like to recognize the tremendous volunteer contributions made by all of the individuals who provided data and insight for this project, from the current and former members of the CCC Council, the current and former leaders in the CISE Directorate, and the numerous computing researchers who responded to the surveys deployed as part of this evaluation. These individuals provided extremely valuable intellectual rigor and incisive observations about the nature of the computing research community and the potential futures for that community. The information provided in the interviews and surveys proved to be a truly unique resource, and we hope that we have used it appropriately. Of course, any errors in attempting to convey accurately the information provided for this project should be attributed to our team rather than to any individual contributor.

Finally, we would like to point out that the CCC Director, Dr. Erwin Gianchandani, spent many hours facilitating this effort, reviewing our plans and designs, and asking pointed questions to elicit the best results from this project. His input and guidance helped us to avert a number of potential problems in the execution of this project.

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I. INTRODUCTION AND EXECUTIVE SUMMARY

This report summarizes the work of SRI International's Center for Science, Technology and Economic Development, in collaboration with the CCC Council and the staff of the Computing Research Association, to summarize and evaluate the results so far of the Computing Community Consortium. Since the CCC is an organization that is still evolving, and its scope of interests and activities have changed since its inception, this evaluation should be seen as relatively tentative. In the final analysis, this evaluation may best serve as a baseline to be used in evaluating future progress of the CCC or its successor organizations.

A. PROJECT SCOPE AND KEY TERMINOLOGY

This report summarizes efforts undertaken from approximately February to December 2010, and reflects our findings on the status of the CCC at approximately the end of that timeframe. The SRI team met with staff of the CRA and other stakeholders in the formation of the CCC in February and March to determine the project scope and establish the evaluation plan.[1] These discussions led to the decision to pursue a mixed-method evaluation approach, where both qualitative and quantitative forms of data collection and analysis are used, and the results of each are used to inform the other.

Note that while some data and findings are relevant to the CIFellows Project, a particular activity of the CCC, that activity is the subject of a separate evaluation report conducted as part of this project.

Throughout the report, the following key terms are used:

The CCC Council refers to the individuals who are appointed to lead the overall CCC organization and lead execution of its activities. The Council does not provide governance of the CCC—that function is served by the Board of Directors of the CRA. This report also refers to activities and actions undertaken by "the CCC." In general, the term "CCC" is synonymous with the "CCC Council," as the CCC has no formal membership beyond the Council itself.

The "computing research community" is not specifically defined by the CCC or by this document. It refers broadly to all U.S.-based research personnel involved in investigating

[1] In particular, the SRI team held a discussion with Ed Lazowska, CCC Chair, and had conversations with others who contributed to the original proposal by the CRA to the NSF on the CCC.

fundamental scientific and technical phenomena related to computing and its applications and methods. Computer science is interpreted to be a subset of computing research.

B. ORGANIZATION AND STRUCTURE OF THE REPORT

This report is presented in two major sections, each of which stands alone but also provides a particular perspective on the CCC.

This section summarizes the process and results of the CCC evaluation project and offers some preliminary findings from that effort.

The following section summarizes the results from a qualitative evaluation, where the CCC is treated as a case study and key stakeholders are interviewed to provide insights into the inception, evolution, and outcomes of the CCC.

The third section summarizes the results of two surveys conducted for this project: one which surveyed participants in CCC visioning activities, and one which surveyed a broad sample of researchers who could be identified as members of the "computing research community." In this section, we provide the method for deriving the survey population, the survey methodology, a profile of the pool of respondents to each survey, and then summary statistics on the responses received. We do not attempt, in any systematic or statistically significant way, to draw causal relationships between specific subsets of the survey data.

The fourth section presents our findings, including some recommendations on areas where the CCC could improve its effectiveness through further investments in time and attention.

C. DESCRIPTION OF EVALUATION METHODOLOGY

After preliminary research on the nature and history of the Computing Community Consortium, SRI developed an evaluation methodology with the following parameters.

First, this evaluation is a formative (as opposed to summative) evaluation. A summative evaluation is one which takes a retrospective view on the program being evaluated, and focuses on whether the program accomplished its goals or fulfilled its purpose. A formative evaluation is one which takes place while the program is still in development, and is intended to identify opportunities to improve the program during the implementation phase. While the CCC shows signs that it is reaching a steady-state phase in its operations, this evaluation covers the period when the CCC was still in flux. To date,

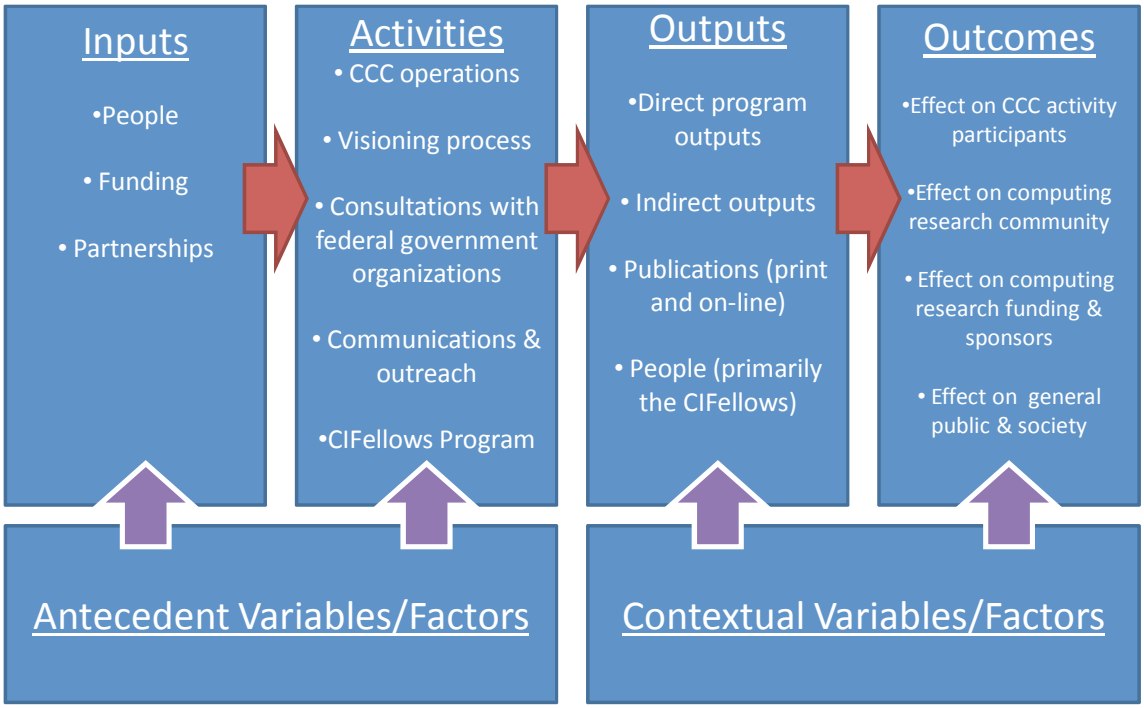
the CCC's operations and activities have evolved through a process of "learning-by-doing." One goal of this evaluation is to estimate how well the CCC has defined its role and mission, and whether further evolution is needed to ensure that the organization can achieve its stated goals. This formative evaluation can also serve as the basis for designing a summative evaluation, to be conducted at a later date.

Second, an evaluation strategy which incorporates only quantitative methods would present a very incomplete picture of the CCC's performance to date. Quantitative data analysis is best suited for studying phenomena which are relatively stable, meaning that their behavior might be predicted through a well-developed framework or theory. Since the CCC over the past three years has been in a state of growth and flux, a purely quantitative approach would omit important contextual and environmental conditions which affected the performance of the CCC to date. Some of the CCC's activities and outputs can be represented in quantitative terms, and the impact of those activities can be measured using survey research. This evaluation looks at the CCC as an ongoing process, which is often best captured using case research.[2] Therefore, this evaluation combines both quantitative and qualitative data analysis.

The qualitative component of this evaluation is also important because the CCC is intended to be a unique organization in the computing research community. In fact, few analogues to the CCC exist in any scientific discipline. The CCC is not a government-chartered advisory board, such as the former President's Information Technology Advisory Committee (a group which reviewed the interagency Networking and Information Technology Research and Development initiative, until that responsibility was transferred to the President's Council of Advisors on Science and Technology). It is not a standards development organization, such as the Internet Engineering Task Force. The CCC also does not yet possess a standing in the community equal to an organization like the Computer Science & Telecommunications Board of the National Academies (which has a much longer history than the CCC, and the benefit of the prestige of the National Academies complex). Since it is difficult to find another organization to which the CCC can be compared, case research is needed to understand the unique nature and functions of the CCC.

To provide a framework for data collection and analysis, SRI has developed the following logic model to describe the CCC's operations and potential outcomes.

[2] See Yin (1992), "The Case Study Method as a Tool for Evaluation," Current Sociology, 40:121-137.



The evaluation strategy also recognizes that this evaluation faces a number of limitations:

- **Measurement:** A number of the CCC's strategic goals are long-term, somewhat intangible, and focus on areas affected by organizations besides the CCC. Therefore, measurement of the actual outcomes and impact of the CCC will be tentative, incomplete, and perhaps inconclusive. This evaluation will use proxy measures to represent outcomes where direct measures are not possible, but even these proxy measures may be inaccurate.

- **Project scope:** The CCC's strategic goals include objectives where the CCC's impact may be too diffuse to be captured feasibly. The CCC is intended to influence the entire computing research community, but there is no clear definition of the exact composition and size of that community. For example, it will be impossible to measure the effect of the CCC on the overall level of excitement within computing research. Again, this evaluation will measure the CCC's effect on certain populations which may serve as a proxy for the greater computing research community.

- **Attribution:** Even to the extent to which certain aspects of the CCC's outcomes can be measured, we recognize that outcomes are influenced by a myriad of external factors. For example, the "success" of the CCC at facilitating the development of a research vision and pushing for its implementation in a funded research program can be affected by: the quality of the leaders of the visioning activity; the participation by the most appropriate people in the visioning workshops; the ability of the participants

to produce a coherent and persuasive visioning document; the acceptance of that document by agency officials who decide on research funding; and the possible parallel efforts by organizations other than the CCC. Therefore, the extent to which a particular outcome is achieved or not achieved could be entirely unrelated to the underlying performance of the CCC as an organization.

- **Timeframe:** Certain of the CCC's activities have been launched relatively recently, such as the CIFellows Project. Therefore, the current evaluation project cannot measure the outcomes of such activities, but can only project possible outcomes based upon available data.

To the extent possible, we have attempted to mitigate these limitations. We also assert that any findings from this project should be viewed as tentative and interpreted only with great care, due to the above limitations.

D. SUMMARY OF PRINCIPAL FINDINGS

Taken as a whole, the qualitative and quantitative evaluation components produced some findings about the nature of the CCC and its ability to achieve its stated strategic goals.

1. THE CCC IS ITSELF AN "EXPERIMENT" IN THE COMPUTING RESEARCH COMMUNITY

The CCC can be viewed in a way as an experiment in how the computing research community can improve the development and promotion of new research visions. The CCC is intended to serve as "a voice and catalyst" for a community that has never had an organization which has played a role as a "designated spokesperson," and in fact (according to community members) has resisted actively any attempts to unify the community around specific initiatives or priorities. This is related in large part to the fact that the computing research field is itself relatively young and immature, having emerged as a recognized discipline only within the past 40 or 50 years. This means that the CCC itself is a research project, in that it is attempting to see how it can best catalyze the formation of new research visions when those visions have yet to be defined and process is still in testing.

The CCC also exhibits some characteristics of what the research policy community is calling "potentially-transformative research." There are few generally-accepted definitions of potentially-transformative research (PTR). The NSF's internal Working Group on Facilitating Transformative and Interdisciplinary Research adopted this definition in 2007:

> *Transformative research involves ideas, discoveries, or tools that radically change our understanding of an important existing scientific or engineering concept or educational practice or leads to the creation of a new paradigm or field of science, engineering, or education. Such research challenges current understanding or provides pathways to new frontiers. Transformative research results often do not fit within established models or theories and may initially be unexpected or difficult to interpret; their transformative nature and utility might not be recognized until years later.*

Based upon comments of knowledgeable observers, the CCC is an attempt to pursue a different model of research prioritization and planning within the computing research community. In this attempt, it is challenging some past assumptions about how research should progress (e.g. by facilitating broadly-coordinated efforts of subcommunities of researchers, rather than through individual investigator-initiated projects). The CCC has produced some useful findings, notably in determining (contrary to the initial opinions of some stakeholders) that some of the existing models of research planning found in other disciplines (such as the Decadal Surveys in physics and astronomy) are not appropriate for computing research.

Finally, it is likely that the full results and value of the CCC's activities may not be recognizable for quite some time. The CCC has produced numerous outputs, including white papers, visioning activity reports, and new efforts such as the CIFellows Project. At least some of those outputs have led to broader impacts (e.g., shaping new research funding programs, influencing the agendas of individual researchers, identifying and nurturing emerging leaders in the computing research community). The most significant outcomes of the CCC's efforts, particularly where its "visioning activities" are concerned, by nature will not be fully realized until they have time to absorbed by the research community.

From an evaluation perspective, potentially-transformative research is extremely difficult to measure and assess. The best evidence of the outcomes of a "potentially-transformative" project is not in its direct outputs, but in how it leads to new modes of thinking, analysis, and conceptualization about a particular research problem or challenge. By that measure, the CCC is already facilitating the emergence of new forms of organization and new pathways for the future in determining how the nation should support and pursue computing research.

2. THE CCC IS A "WORK-IN-PROGRESS"

The CCC underwent tremendous change during its first two years of existence. In fact, the fundamental underlying purpose and mission of the group changed in a substantial way even before the CCC award was made. The decision at the NSF to form the CCC was

motivated at least in part to provide strategic direction for the newly-created GENI initiative. That connection weakened rapidly as the GENI initiative itself changed, and the CCC became an organization with a much broader purpose. Therefore, this evaluation is effectively an attempt to measure a moving target. Only within the past 24 months has the CCC advanced to a point where it is able to state its mission in explicit terms, and attempted to link its activities to particular outcomes.

The CCC also exhibits characteristics similar to a start-up venture in its earliest stages of development. For example, the CCC has yet to undergo a transition from its founding leadership to a new generation of managers, although this process is underway (starting with the hiring of a full-time CCC Director). The CCC also is still very much in the "investment" phase—its activities are funded primarily through the original NSF grant award, and the organization has not diversified its financial support. The CCC is still forging its own identity and attempting to communicate that identity to its key constituencies, which indicates that the CCC as an organization is in somewhat of a process of self-discovery.

3. THE CCC IS MAKING MEASURABLE PROGRESS TOWARDS ACHIEVING SOME GOALS

The data collected during this project show that there is clear evidence of the CCC having an impact on the computing research community. Though that evidence is still tentative in some cases due to the short timeframe since the formation of the CCC, one interesting aspect of this evidence is that the CCC may even be producing benefits that were not originally envisioned by the organization itself, based on the CCC's early documentation.

Most notably, the CCC seems to be having an influence over the computing research community at an individual level. The CCC's major activity, the visioning workshops and efforts, are often developed using a "bottom-up" approach that depends on the individual motivations of particular researchers. Those activities also tend to affect the community at the level of the individual researcher. Participants in those efforts report that their involvement has led them to modify their own research plans, to work with new collaborators, to follow up on the results of CCC activities, and to think about their own contributions to research visions. Even though the CCC is now beginning to have an impact on research activities at the institutional level (influencing support for robotics research, for example), this individual impact may ultimately be more significant and should not be underestimated.

The CCC is also engaging a wider range of stakeholders in computing research, although this effort is still in its early stages. The CCC has interacted extensively with the Office of Science and Technology Policy within the Executive Office of the President, as evidenced by the solicitation and use of the CCC White Papers by OSTP personnel and mentions of the CCC on the OSTP blog. CCC Council members directly supported the work of the

President's Council of Advisers on Science and Technology, with several members serving on the task force to review the interagency Networking and Information Technology Research and Development program in 2010. The CCC also engaged the NIH community through its Health IT workshop, and is following up on that engagement. The CCC is also attempting to identify emerging subcommunities of computing research around cutting-edge topics, although those attempts are also in their earliest stages, as illustrated by recent "Outrageous Ideas and Visions" session organized by the CCC at the 2010 Conference on Innovative Data Systems Research.

A third important outcome of the CCC's efforts may be in its influence over an emerging class of leaders within the computing research community. The CCC's activities provide unique opportunities for researchers to build and shape larger visions for their research interests, and especially opportunities for more junior researchers to lead those visioning experts. Observers point to researchers such as Prof. Ellen Zegura and Prof. Henrik Christensen as individuals who have gained higher stature in the community by leading particular visioning activities. To the extent that the CCC may help provide more such opportunities in the future, it could play a key role as the "proving ground" where new community leaders can volunteer their efforts, develop their leadership skills, and make new contributions to the direction of the community.

4. THE CCC CAN BE A PLATFORM THAT INFLUENCES THE DEVELOPMENT OF THE COMPUTING RESEARCH COMMUNITY AS WELL AS COMPUTING RESEARCH

While the above findings reflect in large part the input of the stakeholders who are very familiar with the CCC, our evaluation also solicited input from two key groups: computing researchers who have participated in CCC visioning activities (but may not be aware of the entire spectrum of CCC activities), and members of the computing research community in general. The evaluation study deployed surveys aimed at these two populations to try to capture a broader set of views on the current and potential value of the CCC to the computing research community.

Some specific findings from the survey are of particular significance in light of the findings listed above:

- Based on the survey responses, many computing researchers hold the view that the computing research community is doing fairly well at generating new research visions. However, an even larger share sees the value of having an organization within the community dedicated to developing such visions. In particular, they agree that such an organization is needed if it can create compelling visions which attract the interest of students and galvanize public support for computing research. This indicates broad acceptance that the mission of the CCC is viewed as valuable to the community.

- For those researchers who participated in a CCC visioning exercise, a substantial majority feel that the CCC was effective in convening researchers to discuss and develop compelling new research visions. There is some concern about the success of the CCC in following up on those activities and leveraging the visions to influence funding agencies, students, and public opinion. The survey of the broader computing research community also suggested that awareness of the CCC is still below 50 percent. Of the range of CCC activities, the CIFellows Project seems to have the greatest visibility within the community. This suggests that more attention should be paid to how the CCC can communicate and support follow-on activities related to its visioning activities.

- While there was some uncertainty about whether the CCC is successful in having a broader impact on the public, it is important to note that the CCC seems to be changing behavior within the computing research community itself. Participants in past CCC visioning activities reported that such participation led them to pursue new research collaborations, adjust their own research plans, and to engage in follow-on conversations with their colleagues about the visions. While the impact of the CCC's activities on the general public may be difficult to measure and could take years to observe, it seems that the CCC is having a more substantial and immediate impact on computing researchers' own behaviors.

E. CONCLUSION

The findings above suggest that the CCC can be viewed as a research effort as well as an effort to improve the research environment for computing. From that perspective, the organization should be evaluated based not only on its direct results, but also on its indirect contributions to the community in which it operates and on the members of that community. A number of such indirect effects can be identified:

- The CCC has helped individual subcommunities to organize and pursue new visions of their own research with beneficial effects. For example, the CCC visioning activity on robotics has helped the leaders of that activity to raise awareness of the research area among funding sponsors, and contributed to the development of new funding initiatives.

- The CCC provides a new and useful resource for the policy community and the research funding agencies which differs substantially from other organizations. By virtue of its membership and structure, the CCC Council can provide rapid feedback on policy issues related to computing research. The Council also contributes expertise to related efforts. For example, when the President's Council

of Advisers on Science and Technology conducted a review of the interagency NITRD program in 2010, many members of the working group for that review were drawn from the CCC Council.

- The CCC enables a new form of collective action within the computing research community. According to the informed observers interviewed, the community has resisted in the past efforts at organized self-advocacy. The community seems to be more welcoming of such efforts today, and the CCC can contribute substantially by providing a platform for such efforts.

- The CCC is helping to change community behavior by promulgating new visions that influence researchers' own ideas, collaborations, and communication. This illustrates how the CCC is encouraging researchers to change how they view their own research fields and their own efforts to pursue research interests.

The total impact of all of these effects is difficult to capture and quantify in a systematic fashion. The CCC continues to evolve and learn, and is challenged to operate in an environment that is very dynamic and complex. It may also take years before it is possible to determine whether the effects were beneficial to the entire community The data collected for this evaluation cannot predict the precise benefits that will be gained. Still, those data do indicate that the CCC is enabling positive forms of change within the computing research community, using modalities that have not been attempted in computing research across such a broad scope of domains.

In this sense, the CCC is a form of sociological experimentation, but one that could have very significant benefits if the experiment is allowed to run its course. At the very least, the preliminary results indicate sufficient promise to merit continuation of the CCC effort. As one stakeholder summarized, "It may be too early to say if the CCC is a good idea…but it's definitely too early to say that it **isn't** a good idea."

II. QUALITATIVE ANALYSIS OF THE CCC: PURPOSE, PERFORMANCE AND FUTURE

In our evaluation plan, we proposed to conduct a qualitative analysis of the Computing Community Consortium's activities and outcomes. A qualitative approach is appropriate in this case for two reasons:

- As we noted in our evaluation plan submitted to the CRA, "Since the CCC over the past two years has been in a state of growth and flux, a purely quantitative approach would omit important contextual and environmental conditions which affected the performance of the CCC to date…This evaluation looks at the CCC as an ongoing process, which is often best captured using case research."

- An analysis of the seven goals of the CCC, as articulated by the CCC Council, showed that they involve objectives where progress cannot be measured in purely quantitative terms. For example, there is no obvious method for quantifying the progress the CCC has made to "create within the computing research community more audacious thinking." These concepts can be described and observed only in subjective terms, which makes a qualitative assessment more appropriate.

This section of the report describes our evaluation methodology for the qualitative phase of the evaluation, and presents the results of that phase in three aspects: evaluation of the formation of the CCC, evaluation of the activities undertaken by the CCC, and evaluation of the challenges facing the CCC for the future.

A. QUALITATIVE EVALUATION METHODOLOGY

In keeping with accepted methods in qualitative research, we adopted a case-based approach using semi-structured interviews. The case method provides formal guidance for presenting the "story" behind a particular organization, program, or similar phenomenon, by capturing qualitative data with a level of richness and detail that cannot always be achieved with standard quantitative methods (such as surveys). The case method has been adopted as an accepted methodology for evaluation purposes, and the benefits of this method have been analyzed for nearly 20 years.[3]

For this evaluation, we identified a number of individual who have been key stakeholders in the activities and outcomes of the CCC, or who have been principal actors in the

[3] As one example, see Yin (1992), "The Case Study Method as a Tool for Evaluation," *Current Sociology*, **40**:121-137.

formation and operations of the CCC Council. These stakeholders were divided into three groups:

- Current and former members of the CCC Council
- Individuals outside of the CCC Council who played a major role in one or more CCC activities (e.g. visioning activities, white papers, the CIFellows Project)
- Representatives of the sponsors of the CCC (individuals representing the interests of the National Science Foundation in CCC operations)

After reviewing the groups and a list of interview candidates with the CRA, we selected approximately 35 individuals, who were then contacted to request interviews. 23 interviews were conducted, each lasting approximately one hour, using a standardized interview protocol to guide the discussions. A copy of the interview protocol is included in Appendix A.

The statements of the interview subjects were captured in real-time nearly verbatim. After all of the interviews were completed, the interview notes were reviewed and excerpts were coded based on themes which emerged from the entire corpus of interviews. To attempt to correct for bias in the coding process, the notes were coded initially by an individual who had not participated in any of the interviews and who had no prior background knowledge about the CCC. That coding was then supplemented by additional excerpts coded by the project team.

In addition to the interviews, the project team reviewed a number of documents relating the background and activities of the CCC, which the CCC submitted to the National Science Foundation (such as annual reports, quarterly reports, and the presentation to the Reverse Site Visit committee). Where appropriate, materials from those documents were included in the coding process.

We present below the results of this analysis as a narrative description of the history, current operations, and potential futures for the CCC, as related by the stakeholders interviewed in this project. To protect the confidentiality of the interview subjects, none of these statements are attributed directly to any individuals, and in some cases the statements of the interview subjects are summarized rather than quoted verbatim. Our project team takes responsibility for any errors or omissions in transcribing the comments made during the interviews.

B. VIEWS ON THE PURPOSE AND FORMATION OF THE CCC

As recently as August 2009, the CCC Council itself described the CCC as an "experiment."[4] Therefore, for much of the three years since the date of the NSF award, the CCC has been evolving. In terms of this evaluation, one aspect to be considered is whether or not the CCC has established itself as a legitimate and sustainable organization with the ability to perform the activities it has committed to conducting. This section evaluates the outcome of the CCC's formation.

1. DEFINING A MISSION FOR THE CCC

As noted in the CRA's proposal to the NSF for the formation of the CCC, the original vision for the CCC solicitation incorporated two key assumptions, among others:

1) the models of long-term research planning in other scientific communities (notable astronomy and physics) could be effectively and usefully applied to the computing research community, and

2) the CCC's activities would support the Major Research Equipment and Facilities Construction process for obtaining funds to support the Global Environment for Networking Innovations (GENI) initiative.

Within the terms and conditions of the cooperative agreement between the NSF and the CRA for the CCC, one specific responsibility of the CCC was the naming of a GENI Science Council that would "work with the broad computing community to gather input and to integrate and synthesize the community's interests in a coherent Science Plan for GENI." Clearly, the future of the GENI initiative was considered an important component of the CCC's activities.

At the same time, the CCC was intended to address issues beyond the GENI initiative. The Cooperative Agreement also states that

> *The purpose of the Computing Community Consortium (CCC) is to provide a voice for the national computing research community. The CCC will facilitate the development of a bold, multi-themed vision for computing research and education and will communicate that vision to a wide-range of major stakeholders.*[5]

[4] "Computing Community Consortium Implementation Plan For the Period Beginning October 2009," CCC document dated August 11, 2009, accessed at http://www.cra.org/ccc/resources.php on 12 January 2010.

[5] National Science Foundation, "General Programmatic Terms and Conditions for NSF 06-551 Cooperative Agreement," no date, p. 1.

According to principals involved in the formation of the CCC, it became apparent during the development of the CRA's proposal that the two assumptions mentioned above were not appropriate. Regarding the first assumption, one researcher noted that "Computing research is a young field which offers very different dynamics from math & physics." Therefore, the type of planning used in those well-established, mature disciplines is not necessarily suitable for computing research.

Also, the CCC did not find broad support for the idea that future computing research would require large-scale instrumentation, as the GENI initiative was intended to provide, and therefore there was no pressing need for a long-term plan that would govern the use of such instrumentation. As a result, as stated by one member of the inaugural CCC Council, the decision was made early on to broaden the scope of the CCC beyond GENI. The CCC's sponsors at the CISE Directorate of the NSF agreed with this decision, according to several stakeholders.

The mission of the CCC, as stated in the CRA's proposal to the NSF, is as follows:

> *The challenge for the Computing Community Consortium (CCC) is to catalyze the computing research community to debate longer range, more audacious research challenges; to build consensus around research visions; to articulate those research visions; to evolve the most promising visions toward clearly defined initiatives; and to work with funding organizations to move the challenges and visions toward funding initiatives.*[6]

Discussions with CCC stakeholders show that there is a general consensus about the mission of the CCC and its implications for the strategy and activities pursued by the Council. CCC is described as a "facilitator" or a "catalyst," with the strong connotation that the organization should assist the computing research community in developing its research agenda without substantially influencing the content of that agenda. The CCC Council itself emphasized that it "does not pick winners and losers."[7] As described by one early member of the CCC Council,

> *The CCC was not intended to make decisions as much as to help communities within [computing research] come together and have workshops, write white papers, and let these things come up to CRA and NSF, where they can help decision makers see some very crisp and compelling directions for [computing research] and priorities for funding.*

[6] See Computing Community Consortium, *Strategic Plan: Version 9*, June 30, 2009, at p. 2.

[7] CCC Council, 'Finding and Advancing Visions in Computer Science & Engineering: version 1,' June 16, 2010, available at http://cra.org/ccc/advancing.vision.php.

Another CCC stakeholder characterizes the role of the CCC as providing what might be termed "governance" for the computing research community, but not in the conventional sense of that term. In this view, "governance" is a process by which each individual subcommunity within the computing research community identifies research ideas offering the greatest promise over the next five to ten years, and then forms self-organizing teams to pursue those ideas. Setting strategy in this way differs from the traditional NSF model where individual PIs propose many different ideas simultaneously, and the NSF and its review panels determine which ones merit investment by the NSF.

Relatively early in the CCC's development, the CCC Council created a visioning process that supports this mission. The process is driven by proposals submitted by members of the computing research community in response to a general call, although in some instances, those proposals are solicited more directly by the CCC Council, or the Council itself initiates a visioning activity with outside leaders. The CCC Council emphasizes on its Web site that it plans to support "all reasonable ideas that have potential."

While this process seems to be relatively straightforward in abstract terms, implementing the process requires a balance between potentially-competing approaches. As one CCC Council member highlighted, the CCC should "on the one hand try to nurture and encourage sub-communities in computer science to come up with big ideas, and at the same time avoid being…a filter for those ideas." The CCC's solution so far has been to try to fund as many different visioning efforts as possible and practical, and to maintain an open attitude towards new visioning ideas. At the same time, the CCC has also taken a more proactive role in the visioning process. For example, in some cases the CCC has selected topics for visioning activities and actively recruited members of the community to become leaders of those activities. In such cases, however, the actual outputs of the visioning process are generated by the participants and not by the CCC Council.

2. ESTABLISHING THE CCC AS AN ORGANIZATION

The CCC Council encountered both successes and challenges during its initial start-up period after the October 2006 award by the NSF. In December 2006, the CRA moved quickly to name 18 leading researchers as members of the Interim CCC Council. The CCC accomplished one of its first objectives, the formation of the GENI Science Council, in March 2007. The inaugural Council members were appointed in June 2007, with Prof. Ed Lazowska serving as its Chair.

As with any start-up organization, the CCC Council encountered a few difficulties early on. One problem, which was not foreseeable, was that Prof. Lazowska was unable to perform his duties as Chair due to illness starting in August 2007 through approximately the end of 2007. One stakeholder described the impact of his absence thus: "I think Ed makes the

CCC. [When] Ed…couldn't do much, and nothing happened. Once he came back, lots happened."

From another perspective, a CCC Council member explained that this setback eventually proved to be constructive. "The CCC wasn't very well-structured or -organized, and Ed did everything. Then he was out of commission, and that showed that it wasn't sustainable if he did it alone. More people stepped up and that was a net positive for the group."

Although the CRA was the only organization to submit a proposal in response to the NSF's solication to form the CCC, stakeholders were also asked if other existing organizations could perform the role outlined in the CCC's mission. This question sought to determine if the CCC's activities are duplicative of any other group in the computing research community. A summary of responses is given below:

- The Computer Science and Telecommunications Board (CSTB) sometimes issues reports that offer visions on future directions for computing research in areas such as broadband networking and information security.[8] Several stakeholders pointed out that while the CSTB has extremely strong credibility and a reputation for acting as a neutral advisory group, it has a very formal deliberative process which makes it relatively slow to produce results. NSF stakeholders noted that they use the CSTB to provide very specific types of advice, and that usage is very different from the role expected of the CCC. The CSTB is seen as a body that can weigh carefully the complex social and policy concerns related to computing and communications science and technology, while the CCC is designed to be more responsive to requests and provide a quick assessment of the "sense" of the computing research community regarding specific research-related topics.

- The Advisory Committee of the CISE Directorate (CISE AC) is another potential candidate for providing ideas on new research topics for computing research. The CISE AC has several constraints. In particular, it is subject to the Federal Advisory Committee Act, which makes its discussions subject to public scrutiny. Stakeholders feared that such transparency might inhibit the free flow of emerging ideas. Also, stakeholders within and outside the NSF noted that historically, the CISE AC has provided recommendations on specific issues and programs of interest to the CISE Directorate, but not necessarily on issues of broader concern to the computing research community. Finally, the CISE AC is constrained by the fact that it advises the CISE Directorate, while computing research has an impact on other parts of the NSF and other agencies as well.

[8] See, for example, National Research Council (2002), *Broadband: Bringing Home the Bits*, Washington, DC: The National Academies Press; and National Research Council (2010), *Biometric Recognition: Challenges and Opportunities*, Washington, DC: The National Academies Press.

- One long-time participant in the CCC speculated whether the role of the CCC could be played by the NSF itself, particularly the CISE Directorate. However, this individual also pointed out that the NSF does not have a culture that supports such a role (in contrast to DARPA, which has in the past created innovative new research visions through its program offices), and it is not nimble enough to shift with the progress in the research field. For example, the CCC can receive and review a proposal for a new visioning activity within one month and initiate the effort to make the vision happen, which is far shorter than the timeframe in which the NSF can act. In addition, the CCC is better able to integrate diverse perspectives from the entire computing research community compared to the NSF. One CCC stakeholder noted that, due to its nature, the NSF tends to focus primarily on universities and may miss critical input from industry. The CCC Council, on the other hand, is able to integrate input from its industry members. Also, as a sponsor of research, the NSF needs to be very careful to avoid the appearance of supporting a particular research community or vision. The CCC, as an independent body under the auspices of the CRA, has greater latitude be proactive and take risks in its visioning activities.

- A final potential option would have been to forego the creation of the CCC, and to give the funding and responsibilities of the CCC directly to the CRA. Stakeholders presented mixed views on this possibility. One NSF stakeholder emphasized that the CCC was intended to do something that had never been attempted before in the computing research community, and that "organizationally, whenever you need something new to be done, you don't typically go to existing organizations and ask them to turn themselves around to do [that] new thing." Others pointed out that the constituency of the CRA is not identical to the community that the CCC attempts to represent. The CRA membership includes virtually every computer science department in every major U.S. research university, plus some industrial laboratories. However, only a fraction of those departments are housed at universities which conduct fundamental computing research in a substantial way. At the same time, computing research is an activity that reaches into many departments beyond computer science. Therefore, as one NSF stakeholder put it, "Spinning off the CCC as part of the CRA made good sense."

One of the perceived organizational challenges faced by the CCC was the issue of human resources. In its proposal to the NSF, the CRA estimated that the only compensated labor involved in the CCC's activities would be the CCC Council Chair, paid to devote 50 percent of his or her time to CCC responsibilities, and the Director of the CRA, who would be paid to commit 25 percent of his time to the CCC. All other persons involved in the

CCC—Council members, visioning task force leaders, and workshop participants—would volunteer their time to the CCC.

Initial experience quickly revealed the limitations of that plan. First, the unforeseen absence of Prof. Lazowska showed that it would be helpful to have someone dedicated to sharing responsibilities with the CCC Council Chair. Prof. Susan Graham of the University of California at Berkeley was named Vice Chair of the Council to provide that back-up, demonstrating the capability of the CCC to quickly adapt to unforeseen circumstances. The efforts of Prof. Graham helped to ensure that the CCC continued to develop in the absence of Prof. Lazowska—a key contribution which had not been part of the original proposal to the NSF.

Prof. Lazowska's role quickly expanded so that he, in the estimation of several observers, began spending more than the equivalent of 50 percent of his time on CCC business. One factor contributing to his workload was the lack of an official CCC Director. Shortly after its formation, the CCC Council attempted to recruit a director, but was unable to find any suitable candidates. Instead, the position was filled by Dr. Andrew Bernat, at the time and currently the Executive Director of the CRA. By his own admission, Dr. Bernat had to juggle a number of responsibilities at the CRA as which made it difficult at times for him to devote the necessary attention to CCC operational issues. There was also a concern that since the CCC Council was organized as a "standing committee" of the CRA rather than as an organic part of the CRA, there might be instances where Dr. Bernat's responsibilities to the CRA might conflict with the interests of the CCC. Members of the CCC Council state that this happened very rarely, and such instances were resolved efficiently. Still, NSF stakeholders reportedly emphasized that the lack of a full-time, dedicated manager of CCC activities was a serious limitation on the CCC's potential.

The CCC Council opened a new attempt to recruit a CCC Director, and in early 2010 named Dr. Erwin Gianchandani to the position. In the view of multiple stakeholders, Dr. Gianchandani is a valuable asset to the CCC and fills a critical role for the organization. One member of the CCC Council pointed out that Dr. Gianchandani's academic background in biomedical engineering, rather than in computer science, is also an important benefit. As a relative "outsider" to the traditional computing research community, Dr. Gianchandani is perceived as a neutral party who has no vested interested in any particular research agenda or visioning activity that the CCC may choose to support.

3. RELATIONSHIP OF THE CCC TO THE NSF

One final aspect of the CCC's formation that required careful attention was the relationship between the CCC and its sponsor, the CISE Directorate at the NSF. This was complicated by the perceived association of the CCC with the GENI initiative, which itself

was a controversial topic within the computing research community. One representative of the NSF mentioned that some portion of the community originally saw the CCC as being "part of GENI, and not trusting it." Another stakeholder stated that some computing researchers believed that "the CCC was set up just to 'save' GENI." One interviewee believes that this issue is still a barrier to the CCC attaining full acceptance in the computing research community.

From an organizational point of view, this issue seems to have been resolved through the joint efforts of the CISE Directorate (under Assistant Director Jeanette Wing) and the CCC Council. In particular, the potentially-controversial association with GENI was defused somewhat by reorganizing the GENI Science Council as the Network Science and Engineering (NetSE) Council, which used the CCC visioning process to develop a NetSE Research Agenda that was broader than the original concept of a GENI Science Plan. While the CCC Council still maintains contact with the GENI Project Office, the CCC has very little formal association with GENI.

While the creation of the "NetSE" effort helped to distinguish the CCC from GENI, several stakeholders felt that NetSE was not in itself a very successful effort. One interviewee claimed that the NetSE concept was created and promoted by the CISE Directorate of the NSF, and "never really resonated with the community." Another senior computing researcher notes that the networking research community is extremely fragmented, and therefore attempting to develop a unified research agenda in networking research would be difficult under the best of circumstances. The overall perception is that the NetSE effort helped to discharge the CCC's formal obligation to the NSF to help the GENI initiative, but that it has had little substantive impact.

The fact that the CCC is funded entirely by the NSF's CISE Directorate makes its status in the community somewhat precarious. One stakeholder felt that it might appear inappropriate that the NSF took funding that could be devoted to research, and spent it on an organization that then went out to try to attract more funding for computing research. This could contribute to a perception that the CCC is simply an extension of the wishes of the NSF. Another interview respondent pointed out that if the CCC collaborated with multiple funding agencies, it could demonstrate that its role is focused on facilitating collaboration and coordination, rather than being linked to a specific agency. According to CCC Council members, the organization is pursuing relationships with other research sponsors more aggressively.

One of the principal participants in the formation of the CCC points out that the relationship with the NSF does not involve advocacy. While the NSF provides the funding for CCC, the CCC spends that money on facilitating idea generation, not on lobbying for additional funds. The authority and credibility of the CCC derives from the stature of the CCC Council members within the computing research community, and the decision by the

NSF to fund the CCC only supplements that credibility. Since the objective of the organization is to develop new research visions, there is no inherent conflict of interest between the goals of the CCC and the needs of the computing research community or the NSF.

As noted in its annual report, the principal leaders of the CCC Council (the Chair, Vice Chair, and Executive Director) plus selected other members hold biweekly conversations with representatives of the CCC's sponsor, the CISE Directorate. According to participants in those conversations, the CISE Directorate does offer input on the strategic direction of the CCC Council and receives status updates on its activities. However, the CCC Council is not required to follow exactly the guidance provided by the CISE Directorate, and therefore the CCC is able to maintain some degree of organizational independence, despite its dependence on the NSF for financial support.

C. EVALUATION OF CCC ACTIVITIES AND PERFORMANCE

Over the past three years, the CCC has pursued a set of formal activities intended to help it to execute its strategy and to achieve the objectives defined by the CCC Council. One such activity, the CIFellows Project, is addressed in a separate report under this project. This section will provide a qualitative evaluation of four aspects of the CCC's activities:

- The visioning RFP process and its outputs and outcomes
- The CCC White Papers
- CCC outreach and communication efforts, including both those aimed at the computing research community and those aimed at the broader public
- Internal organizational, managerial and operational aspects of the CCC

1. CCC VISIONING ACTIVITIES

As noted in its self-assessment document from July 2009, the "visioning RFP process" is the most visible activity undertaken by the CCC. It is also the process that was highlighted most prominently in the original CRA proposal to the NSF.

Despite the fact that the visioning process is a core activity of the CCC, a review of CCC documents offers no clear definition of what constitutes a "vision," primarily because, as stated in the white paper issued in September 2006 to introduce the CCC to the computing research community,

> *Compelling visions take many forms. History has amply demonstrated the importance of entrepreneurial, grassroots efforts as creative engines in computing research. History has also demonstrated the value of large teams, large facilities, and large amounts of funding.*

The concept of a "research vision" is frequently associated in CCC documents with the idea of "challenges." Again, the mission statement of the CCC states, "The challenge for the Computing Community Consortium (CCC) is to catalyze the computing research community to debate longer range, more audacious ***research challenges***; to build consensus around research visions…" (emphasis added).

The CCC Strategic Plan states in part that

> *The computing research community must do a better job in the future than we have in the past of envisioning longer range, more audacious* ***research challenges****. We must frame our research in these terms, and also in the context of* ***societal grand challenges*** *that will catalyze broad-based research investment and public support and that will attract the best and brightest minds of a new generation*…(emphasis added).

It also defines the CCC's second strategy as "Encourage computing researchers to envision more audacious ***research challenges***" (emphasis added).

Therefore, ***the concept of a "research vision" appears to involve the articulation of long-standing, complex "challenges" which can motivate important research efforts, and which also address significant societal needs.***

The primary output of each CCC visioning activity is a report that summarizes the results of any workshops conducted as part of the activity, and articulating a "research agenda" that can express the research vision in operational terms. Various CCC stakeholders offered personal assessments on how certain CCC visioning activities have been more "successful" than others. As one stakeholder noted, "if you don't have some [visioning activities] that are 'failures' in some way, then you're not stretching the envelope." A key objective of this project was to determine what constitutes "success" in the context of a visioning activity.

Among the stakeholders interviewed, a substantial number expressed the view that a visioning activity is viewed as successful if it can help attract both human resources and funding to pursue the research agenda. As one Council member put it, "A vision has to attract researchers far beyond core set of proposers, and attract interest of funding agencies." Another argued that a key outcome of an activity should be stimulating more people to go into computing research. Therefore, the criteria for success include a human (social) dimension and a financial dimension.

On the human side, the objective of a visioning activity appears to be the development of a particular research community (or sub-community) around the research vision, beyond the simple agglomeration of a collection of researchers. "If you can capture early on an emerging research area and get people who might be spinning in different directions to form a research community, then that's a huge success," according to one stakeholder interviewed in this project.

At the same time, others pointed out that there may be other less tangible and less obvious benefits derived from a visioning activity that also contribute to "successful" outcomes. For example, visioning activities may motivate new collaborations among researchers, or may persuade researchers to more fruitful and valuable research directions. In the long run, those intangible benefits may have a greater impact on the research community, and result in more fruitful outcomes, than simply garnering more funding for specific research initiatives.

For example, one stakeholder argued that the process of developing a vision could be as significant as the end result. This individual noted that others define "success" of a visioning activity as the quality and impact of the report on that activity, but stated, "I guess that's important to those communities that want to build themselves up on some way, but it's less critical to me. Just having that kind of activity happening is the important thing." Another stated that "There is a tangible benefit about just getting people together to do explicit visioning. There really aren't venues for that besides the CCC."

This reflects the view expressed by the CCC Council that one of its primary challenges is to catalyze debate, not simply achieve consensus. At the same time, another stakeholder pointed out that this emphasis on the convening of a community (or sub-community) may prove a limitation to the scope of a "vision." In the view of this individual,

> *Instead of grand visions where the community comes together, what happened more was that the sub-communities of [computer science] did their own visioning exercises…It was hardly visioning for the field; it was vision for the sub-communities. I think it's due to the way that the community thinks of the field of [computer science] right now.*

On the financial side, several stakeholders stated that a valid measure of success would be the extent to which a visioning activity led to the creation of a new funding program for research devoted to that vision, at the NSF or any other agency. One stakeholder argued that "If you can trace a path from the CCC to a solicitation, like an emphasis within a solicitation, then that's a fair method of assessing its impact. Looking at how the funding portfolio changed and seeing where the CCC had an impact, that's reasonable." That statement was echoed by several other stakeholders, in particular from current and former members of the CCC Council.

Several other stakeholders believe that using the funding issue as a criterion for success is potentially misguided. One stakeholder admitted that tracing the language in a visioning report to a solicitation would be a valuable measure of success, but that in most program solicitations, "…it's hard to find that language, or see where concepts came from. There's a more vague idea of thought leadership—shaping the paradigms that researchers are using to come up with ideas."

The inherent difficulty to make a direct link between an articulated research vision and a funding program presents a challenge to the CCC in how it can substantiate its contribution to the community. As one staff member at the NSF put it, "The problem is that the impact [of a visioning activity] on the policy process is **not** visible, and that may discourage [workshop] participants—but they don't understand that dynamic." A CCC Council member also brought up the difficulties of attribution. "There are many variables that go into whether something is fundable, and CCC involvement is a small one. It's more due to a national need being involved—like robotics is now viewed as being critical to energy or transportation, so that kind of applied research may be more fundable due to exogenous things."

Other stakeholders expressed more strongly the view that the success of a visioning activity should not be measured by looking at new funding programs. One such view was that "Looking at the dollars is an easy metric—but it doesn't address whether it was the right thing to put money into." Another stated,

> *I don't see the input into a program as the benefit of a visioning exercise at all. I would say that's an over-utilized expectation. Whenever there is an NSF workshop on whatever topic, usually new areas, you always hear people ask if there is going to be a program on that topic. We don't create new programs that simply. A workshop doesn't simply lead to a program. I always ponder why that's the only thing people seem to see as a good result. I think it's because there is clarity in that. They can see it. They know where to send their proposal.*

Many stakeholders pointed to the Robotics visioning activity as a "successful" example of the CCC's efforts. The indicator of success highlighted by those stakeholders is the dissemination of the research agenda and roadmap written by the visioning leaders, and the fact that the leaders later held a symposium at the U.S. Capitol for Congressmen and their staff. This appears to have contributed to the formation of a "Robotics Caucus" within the Congress, which advocates on behalf of more funding for robotics research. It also resulted in a mention of robotics in the annual joint memorandum on R&D budget priorities, issued by the Office of Management & Budget and the Office of Science and Technology Policy in August 2010: For FY 2012, OMB and OSTP directed federal R&D agencies in this memo to "Support R&D in advanced manufacturing to strengthen U.S.

leadership in the areas of *robotics*, cyber-physical systems, and flexible manufacturing" (emphasis added).[9] The OSTP later linked this decision to the emergence of a "newly energized and collaborative Federal robotics community," which is likely to result in a number of solicitations starting with an inter-agency solicitation for proposals on robotics technology research and development under the Small Business Innovation Research program that was issued in fall 2010.[10] The robotics visioning activity appears to qualify as a success when judged by these two key outcomes: motivating a community of researchers, and generating new funding opportunities.

The Health IT visioning activity is another example that several stakeholders pointed to as a potential "success story." One participant in that activity highlighted the correlation between that visioning activity and a later solicitation from the Office of the National Coordinator for Health IT (within the Department of Health and Human Services) for "Strategic HealthIT Advanced Research Projects," or SHARP. However, this person also believes that this solicitation did not include any "audacious" ideas or topics that were raised during the workshop, and only rehashed the same topics that have been included in similar programs in the past. It is possible that the SHARP solicitation simply reflected decisions made by the research sponsors before the CCC workshop was held, based on the timing of the solicitation's release. In contrast, a later program announcement from NSF/CISE on "Smart Health and Wellbeing" *does* reflect ideas raised during the Health IT visioning activity, and therefore may be evidence of the CCC's influence on future funding opportunities in Health IT.

A more fundamental question to consider is the extent to which the CCC-supported visioning activities *should* be successful. Clearly, having success stories helps to support the argument that the CCC plays a needed role in the computing research community. At the same time, some stakeholders cautioned against relying too much on measurable indicators of success as a method for evaluating the impact of the CCC. As one pointed out, "If you invite people to think big, then you have to accept the fact that sometimes they will fail (they won't produce anything), or they might lead to new ideas among participants but not a new program." Another stated very simply that "We should assume that everything is going to fail, and be pleasantly surprised when they succeed."

In summary, evaluating the "success" of any of the CCC's visioning activities is a difficult and complex task. It is tempting to use a measure as simple and direct as whether or not language from a visioning document appeared in a later agency program solicitation. Numerous informed stakeholders point out that very few visioning activities would meet that criterion, not due to a deficiency in the visioning process but due to the complexities of program development and research funding policy in agencies.

[9] See http://www.whitehouse.gov/sites/default/files/omb/assets/memoranda_2010/m10-30.pdf, Appendix A.
[10] See http://www.whitehouse.gov/blog/2010/09/15/rtd2-research-robotics for the OSTP note, and http://grants.nih.gov/grants/guide/pa-files/PAR-10-279.html for the solicitation.

Since the research visions facilitated by the CCC are expected to address "audacious research challenges," one evaluation strategy is to examine the visioning documents themselves and assess whether they are adequately "audacious." As will be discussed in Section D below, measuring the "audacity" of a research topic or idea is extremely problematic. Assessing a visioning activity based on the audacity of its outcome may require waiting ten years or more for the vision to come to fruition. The CCC Council suggested identifying how many visioning activities produce actionable roadmaps, and then assessing the extent to which those roadmaps might be adopted as the basis for agency funding programs.[11] Even that relatively near-term measure requires waiting two to three years for topics to make their way into agency budget plans—certainly longer than the CCC's three years of existence.

It may be more useful to evaluate visioning activities based on their performance as a focusing mechanism for the computing research community, and especially for specific sub-communities. If, as a number of stakeholders claim, the computing research community is highly fragmented and at times working at cross purposes, then a key benefit of the visioning process would be to unite sub-communities, encourage communication across boundaries within the community, and catalyze a different mode of collaboration among researchers. Therefore, the more appropriate measure of the "success" of a visioning activity is the degree to which it leads researchers to assemble in groups that would not have formed otherwise, around topics that are compelling enough to motivate those researchers to pursue a new research agenda. One stakeholder reports that a visioning activity can be evaluated based on whether it produces a "substantive" agenda, and especially whether it is "something just from the ringleader or…something bigger." This suggests that one metric of "success" might be the emergence of new research collaborations after the visioning activity, where those collaborations are focused on topics outlined in the research vision. The results from surveys conducted for this project, presented later in this report, offer evidence that such collaborations are being catalyzed by CCC activities.

One could reasonably argue that if a visioning activity engenders sufficient enthusiasm among its participants, then those participants could be a more effective force than the CCC Council itself for promoting that vision in research agencies. For example, while the CCC Council has been very supportive of follow-on activities related to the Robotics visioning activity, Council members admit that some of the tangible accomplishments stemming from that activity are the result of the effective advocacy efforts of the visioning activity leaders rather than direct intervention by the Council. If the CCC can catalyze the formation of a new research subcommunity, its influence will be amplified by the size and reach of the members of that subcommunity.

[11] CCC Council, "Computing Community Consortium Implementation Plan for the Period Beginning October 2009," dated August 11, 2009, at p. 11.

2. CCC WHITE PAPERS

Over the past three years, the CCC has published a series of "white papers," each focused on a particular topic or aspect of computing research. The white papers have become a significant activity within the CCC, and one of the most tangible outputs of the CCC. 29 of those white papers are available from the CCC website (at http://www.cra.org/ccc/initiatives.php) under the title "Computing Research Initiatives for the 21st Century." (Note that the most recent eight white papers are themselves part of a series organized around the topic of data analytics.)

Many of the stakeholders interviewed for this project point out that the white paper activity was not anything that the CCC Council had planned to undertake when it was formed, and that the entire effort has evolved in large part due to serendipitous circumstances. According to these individuals, the genesis of the white paper activity was a series of discussions between Prof. Lazowska and Tom Kalil in late 2008 and early 2009. Mr. Kalil at the time was a member of the transition team for the incoming administration, as part of the working group for the Office of Science and Technology Policy. Mr. Kalil recommended that Prof. Lazowska could build a better argument for the support of research and development by recruiting leading scientists who could explain the contribution of computing research to U.S. social and economic well-being. Prof. Lazowska recruited members of the CCC Council and other leading researchers to put together pieces that described those contributions across multiple domains, and in very short order delivered a series of white papers describing the potential benefits of research in areas such as robotics, computer security, smart grid technology, and personalized medicine.

The CCC Council has continued to organize the production of white papers, as it discovered that they fill an important need for both the computing research community and the policy community. The white papers "are intended to do outreach and find ways to communicate, and find ways to promote funding. They can present ideas…in ways that the NSF can't," as noted by one stakeholder.

The white papers are qualitatively different from the outputs of the CCC visioning activities. One stakeholder emphasized that "The white papers are not research agendas—no researcher would look at them and say that characterizes the tech landscape. They are meant to make a compelling case to a policymaker." Another noted that the papers "are very useful reflections…They are a nice way to capture holistic arguments and goals." Rather than outlining a specific research agenda, the white papers distill the current state of research in a key area down to a few pages, and provide the arguments for increasing federal support for that area of computing research activity.

The white papers are viewed as a very successful and valuable output of the CCC Council. Their success is measured in terms very different from the visioning activity. For example, stakeholders within the NSF reported that the white papers on topics such as "Big Data" and cybersecurity contributed to decisions to focus more cross-directorate NSF funds towards those topics. Another stakeholder familiar with recent developments at DARPA confirms that the "Reenvisioning DARPA" white paper helped to convince the new director of DARPA, Dr. Regina Dugan, to launch a specific effort to repair the relationship between DARPA and research universities, with beneficial results for both parties.

Several stakeholders emphasized that the special nature and structure of CCC enhanced its ability to deliver effective white papers. One stakeholder discussed how the speed with which the CCC could produce the white papers made them valuable to policymakers. In this case, speed is not important in the sense of delivering the papers by a specific deadline, but in that the CCC produced them *in advance of* a specific need. The white papers were therefore available as reference material when the topic of computing research came up in policy discussions. Another stakeholder, involved in science policy advocacy, states that he regularly uses the white papers as "calling cards" to pass out to policymakers as a quick, succinct mode of communicating important ideas about research.

Several CCC Council members pointed out that another key factor in the "success" of the white papers was that they were produced by well-established, recognized leaders in the field assembled by the CCC Council. This lends the white paper activity a level of credibility that few other organizations could offer. Therefore, the white papers are viewed positively in part because they are not developed through an inclusive, consensus process, but because they are the product of a small set of articulate researchers who can write persuasively on a technical topic. One stakeholder did raise the concern that, due to the "closed" nature of the process by which the white paper topics and authors are selected, they could lead observers to complain that the CCC relies too much on the same set of researchers for these products, rather than inviting broader participation in developing new white papers.

Another stakeholder believes that the white papers themselves have transformed the role of the CCC. Through this effort, the CCC has "become a voice in a different way, trying to help the government to articulate what is important, and to explain it to people who aren't specialists. This is a role that has become more important than when we started, because it's an opportunity that we didn't have when we started." Although an unforeseen development, the white paper effort leverages some of the key capabilities of the CCC, such as its agility, responsiveness, and its access (through the personal networks of the Council members) to leaders in the computing field.

3. CCC OUTREACH AND COMMUNICATION

Outreach and communication activities have been an essential part of establishing the CCC. If the CCC wants to be "a widely accepted catalyst and voice for the computing research community" (goal 0 of the CCC Strategic Plan), then it must be broadly representative of that community. Achieving that status requires the national community to be aware of the CCC, and to view the CCC as a credible organization with the authority to speak on behalf of computing researchers. The CCC also aims to communicate the "challenges, needs and thrusts" of future computing research to "the broader national audience," which requires raising awareness about CCC activities beyond the computing research community.

There was some disagreement among stakeholders over the level of importance of the CCC's general outreach activities. One stakeholder who characterized the CCC as a "catalyst" for visioning also noted that "…many catalysts…are not part of the reaction—they can be silent and live on to do the next thing. Brand recognition is not all that important." In contrast, another stated that "It's more effective and makes a stronger statement when a group of well-respected people collectively make a statement under a vehicle like the CCC, so in that sense, yes, the brand is important. It allows us to be authoritative when CCC makes a statement."

To strike the right balance and address this issue effectively, the CCC Council needed to examine the target populations to whom it would reach out, and what kinds of communications are appropriate for those groups. The Council began to address this issue during its start-up phase, hiring a public relations agency to conduct a study that might help guide future outreach efforts. CCC stakeholders interviewed for this project identified various target populations:

- The general U.S. public
- The international computing research community
- Students interested in computing research and research careers
- The U.S. computing research community
- The computer science community in top-tier research universities
- Computing researchers in industrial research laboratories
- Policy-makers and program managers in federal agencies

The CCC is working towards developing a differentiated strategy for communicating with each group. Much of the organization's early efforts were aimed at building awareness about the CCC in the computing research community. This was the focus of Prof. Lazowska's early talks at technical conferences and universities on the CCC. The CCC has also built greater awareness through its involvement in CRA activities, such as the Snowbird Conference (reaching leaders of in academic computing research) and the CRA Career Mentoring Workshop (reaching students and junior faculty).

More recently, the CCC Council has worked to gain coverage of CCC-related topics in the general media, such as assisting journalists John Markoff and Steve Lohr of *The New York Times* in developing articles on computing topics. The CCC white papers are another form of outreach, targeted more specifically at policymakers. Those efforts are also supplemented by the work of the CRA, and particularly Peter Harsha, in reaching out to government agencies and the Congress. In fact, one stakeholder referred to the CCC White Papers as "the intellectual backing" for some of the policy positions advocated by the CRA.

One long-time participant in CCC Council activities expressed concerns about how the CCC needs to build this differentiated strategy. In discussing the white papers, the participant stated that

> *[our] problem isn't execution—it's how do we build up the customer base who will make requests [for white papers]. So, visibility of the service amongst the policy community is key. Visibility among computer researchers might increase visioning—but if people don't know about CCC, they probably don't know about policy in general. Therefore, they may be unsuited for visioning.*

Given the CCC's limited resources, the Council has chosen to prioritize specific outreach efforts to maximize the effective use of those resources. One example of this is the Council's decision to forego formal outreach programs to the international community, reasoning that there are enough domestic concerns to occupy the Council's full time and attention. Another is the CCC Council's decision to stay away from addressing STEM education issues—not because the issue is unimportant, but because there are other organizations which are able to invest greater resources in that issue.

Outreach to the private sector, and particularly the industrial laboratories, is one area where Council members expressed mixed views. One senior member of the Council argued that there is little reason for the CCC to reach out to the industrial laboratories. He asserted:

> *First, there aren't that many actual researchers in the corporate R&D organizations—the vast majority of their staff are working on tough*

> *problems in product development. At Microsoft Research, which is now the largest corporate computing research group, they only have about 100 researchers. Second, the research agenda for a corporate lab is driven by the needs of the company, and so CCC would have little influence on what they do.*

Another CCC stakeholder, one with substantial private sector experience, had a different view:

> *Historically, the industry research labs have been a key source of the germs of new directions for the research community. It's a kind of reverse transfer—sometimes, the right thing to do with a research result is to push it back to the university to work on it more. We do have people in industry on the CCC, but maybe we need to go out and get the industry members to get involved. One thing that's very important to the community is that hybridization—getting an idea from industry, getting it back to universities, democratizing that and then letting them take it. The NSF isn't equipped to do that.*

More than one stakeholder expressed concern that, perhaps due to the nature of the NSF, the CCC spends an inordinate amount of attention on the state of university-based computing research. The fact that the CCC Council includes industrial representation helps to ensure that its view of the research community is broader and more inclusive.

4. CCC ORGANIZATION, MANAGEMENT AND EXECUTION

The Computing Community Consortium is governed both by its relationship to the Computing Research Association, and by the terms of the Cooperative Agreement between the CRA and the NSF. According to the audit records of the CRA, the organization has spent the following funds on the operations and activities of the CCC (including indirect costs):

Fiscal Year Ending	Amount Expended
June 2007	$165,904
June 2008	$855,124
June 2009	$1,062,242
June 2010	$1,081,378
Total as of June 2010	$3,164,648

We note these figures not as part of any financial analysis of CCC operations, but simply as a reference point for the scale of the formal resources consumed by the CCC. With just over $3 million, the CCC funded over a dozen workshops, reviewed numerous visioning workshop proposals, held its quarterly meetings, and supported the production of white papers and special talks and sessions at technical conferences. While these financial figures do not include the in-kind contribution represented by the substantial hours volunteered by the CCC Council members, they support the assertion by one stakeholder (and echoed by several others) that the CCC can accomplish quite a bit "with lower overhead and perhaps on a faster schedule" compared to similar organizations.

Overall, the CCC has faced challenges in defining its purpose, implementing its strategy, dealing with the effort to get sufficient human resources organized to support the organization, and trying to develop new processes and modes of interaction with the NSF and the computing research community. There is a consensus among stakeholders and some external parties that the CCC has succeeded in overcoming those challenges, and is showing progress in accomplishing several of its goals. As noted by the Reverse Site Visit Committee:

> *The CCC provides vital national functions. It successfully helps policy-makers understand the role of computing research in progressing important societal issues. It helps develop new leaders in the computing research community. It accelerates the pace of the computing and information sciences by convening appropriate internal communities and encouraging them to set appropriately ambitious goals. The reviewers note the success of the CCC white papers, the huge interest in the Computing Innovation Fellows program from both faculty members and applicants, and the CCC's close and useful connections with the National Science Foundation.*

One stakeholder provided a personal view of key indicators of "success" in executing the CCC's mission:

> *First, did the vision statements that emerged from the workshops come to pass in the form of new programs as a result of the CCC community? Second, did a richer set of savvy leaders evolve in the community's subgroups because they were influenced by CCC? Third, whether we maintain people we would have otherwise lost; if we keep people in the research pipeline (for ex: the CIFellows vehicle). If a researcher leaves the field for more than two years, he or she has difficulty returning to the research community. Fourth, if we have more diverse funding from a wider set of agencies. Fifth is outreach: if we communicate the importance of computing to the public (citizens, students). Computing technology applies to virtually all fields; it is uniquely ubiquitous. We need to keep this message front and center for citizens and students.*

As we have discussed above, many of these "metrics" are difficult to capture and calculate precisely, and there is a serious attribution problem (in that the metrics may reflect the influence of entities other than the CCC). Also, the progress towards achieving these objectives will need to be assessed in the long term. It is not realistic to expect the CCC to have clear evidence of "success" three years from its inception. Instead, it is more appropriate to assess whether the CCC now has the necessary resources, processes and experience to make significant progress in these areas going forward. One statement by a stakeholder in the NSF offers one such assessment:

> *They are out of the toddler phase, and really able to achieve something now. They have their vision straight, they understand what implementation strategy should be, they have a director, and support from the NSF. Ed [Lazowska] is very well respected, and served well as first leader. They have a good relationship with the White House, and on and on. They are placed well.*

When asked about whether the CCC's activities so far indicate that it is "successful," one principal participant in the formation of the CCC gave this opinion:

> *It may be too early to say if the CCC is a good idea…but it's definitely too early to say that it **isn't** a good idea. It has been doing enough good work and had enough impact to show that it's not a waste of money—in fact, it's been a very good use of money. My reaction is that we should renew [funding]…and then take up the question later.*

D. FUTURE DIRECTIONS AND CHALLENGES FOR THE CCC

Since this evaluation was designed to provide a mid-stream review of the CCC and its operations, we addressed both forward-looking perspectives on the CCC as well as views on its history and current status. A number of stakeholders suggested that the CCC is at a possible inflection point, where it can start to consider new strategies for pursuing its goals, and to be more proactive and deliberate in its activities. This view is consistent with recent actions by the CCC Council, such as its decision to engage with a professional facilitation/strategy consulting firm to lead its June 2010 quarterly meeting. This section provides a framework for defining some of the issues that the CCC could consider for its next phase of evolution.

1. RELATIONSHIP OF THE CCC TO OTHER FEDERAL AGENCIES

Several stakeholders believe that the CCC should make a strong effort to reach out to research funding agencies other than the National Science Foundation. These stakeholders

also feel that the CCC has not succeeded in building strong relationships with those agencies, although they also note that the CCC Council has had other priorities during that period—such as achieving a strong relationship with its sponsors in the NSF. A few stakeholders noted that the CCC does enjoy a very strong relationship with the Office of Science and Technology Policy in the Executive Office of the Presidency, which can be a strategic asset when it talks to the other funding agencies.

Some stakeholders believe that the CCC must address this issue soon if it wants to achieve its stated goals. For example, one interview subject expressed strong concern that the CCC's visioning activity in Health IT would fail due to the lack of strong relationships with NIH, which funds most of the research in that area. This person further believes that the CCC Council lacks a fundamental understanding of the dynamics of the NIH funding environment, which will further hamper the visioning activity for Health IT.

One possibility would be for the CCC to convince other funding agencies to sponsor the CCC's own operations and activities. Most stakeholders who were asked about that possibility stated that while it could be a long-term goal, there are other ways in which the CCC could benefit from collaboration with those agencies. Even representatives of the NSF stated that some kind of outreach to other agencies would be helpful. As one put it, "Just because 82 percent of federal computer science funding comes from [the CISE directorate] doesn't mean that the CCC should be beholden to CISE." Even if agencies do not fund the CCC directly, they could help the CCC achieve its goals by investing money in research programs that align with the topics which emerge from CCC visioning activities.

One CCC stakeholder emphasizes that this does not mean that the CCC should lobby agencies directly for funding of specific programs. While this person admits that "there is a lot of overlap between government relations at the CRA and the CCC," it is not appropriate for the NSF (as the sponsor of the CCC) to appear to be "funding activities to generate more funding." Instead, the objective of the CCC would be to develop a research agenda that can be handed to a program manager, and ensure that the research agenda has the content and tools which enable the program manager to make a budget request and secure resources to pursue that research agenda.

This process is not necessarily as straightforward as it may appear. This same stakeholder warned that while most researchers want to wait until funding is available before developing a research agenda, the reality in federal agencies is that it is difficult to predict when resources become available. Therefore, each CCC's visioning activity may develop a research agenda even though no funding is in sight, just so that the agenda is ready in case funding does become available. One stakeholder framed the problem in this way:

> *One problem is the structure of the discipline—you can't get action unless there are ideas that ripe for leveraging. But also, you can't get the support for these ideas unless they are there. Without the CCC, no one would be able to even approach these ideas—there are no contacts inside the agencies with that responsibility. So even if there's one good idea every two years, without the Council it would NEVER be exploited.*

This perspective was echoed by stakeholders from the NSF. One commented that the CCC's efforts to reach out to other agencies will ultimately benefit the NSF as well. Such efforts could help the NSF and partner agencies to "work better together. It's the creation of an environment from which innovation can more easily happen." Another pointed out that, as a U.S.-focused organization, the CCC can also argue to other agencies that IT research funding can be linked explicitly to U.S. competitiveness. Since most professional societies and many science advocacy groups are international in scope, they cannot make the same arguments without alienating their own membership.

The CCC Council recognizes the potential benefits working to convince other federal research agencies to "buy into" the ideas in various CCC outputs—especially its visioning outputs and white papers. The challenge lies in how the Council builds strong relationships with those agencies, which will enable it to be more influential. One stakeholder framed that challenge in this way:

> *Writing a white paper is not enough—you still need to convince someone to invest in that area. For that, you need bandwidth with the policy community—you need to be in communication on **other** policy issues with those policymakers, so that they see that the CCC has value beyond just selling a few ideas. If you don't have those ongoing conversations and relationships, policy people will see you as just another interest group and not as a credible adviser. This demands that the Council form and maintain relationships with a broad range of policymakers, and those relationships have to **endure**.*

Again, this statement raises the point that the CCC can achieve its goals in this area only with sustained effort over an extended period of time. It also emphasizes that research visions alone are not going to attract federal research investments. The CCC's ability to influence the establishment of new funding programs in computing research depends not only on the quality of its outputs, but on other attributes such as the CCC's reputation and "brand." This aspect of outreach to a broader set of agencies, especially those that do not operate in the same mode as the NSF, suggests that the CCC may need to explore new ways to ensure that it produces research visions that are seen as compelling by program managers. In one stakeholder's words:

> *The challenge of really influencing funding agencies is huge. An outside body really can't do as good a job of that compared to the program manager.…What you want is more of a focus on out-of-the-box ideas that aren't currently on the radar of those agencies. The CCC should focus on the gaps where the agencies are weak.*

2. RE-ENVISIONING THE VISIONING ACTIVITIES: THE CHALLENGE OF "AUDACITY"

Starting with the CRA's original response to the NSF's program announcement on the formation of the CCC, the term "audacious" has been used repeatedly in describing the types of research visions that the CCC will help to define. In its proposal, the CRA asserted that the CCC would be "a mechanism to promote continued innovation by enhancing the ability of the computing research community to envision and pursue long-term, **audacious** computing research goals."[12] The proposal also stated that one of the five goals of the CCC would be to "Create within the computing research community more **audacious** thinking." This goal for the CCC appears to be motivated by the perception that the computing research community as a whole has shifted to pursuing incremental research projects rather than proposing bold new ideas. As the CCC Council put its Strategic Plan from August 2009,

> *The computing research community must do a better job in the future than we have in the past of envisioning longer range, more audacious research challenges. We must frame our research in these terms, and also in the context of societal grand challenges that will catalyze broad-based research investment and public support and that will attract the best and brightest minds of a new generation.*[13]

In attempting to explain the perceived lack of "audacious thinking" in the computing research community, a few of the interview subjects elaborated on their beliefs as to what has caused this lack of audacity in the field:

- **Funding environment.** *Now one of the things that is on my mind is that we've gone through a period with a real shortage of funding in CS research. There was a time when we got a lot of DARPA money, but [the] new DARPA director made it very short-term-deliverable driven. NSF has picked up slack to a certain extent, but it took a while. Meanwhile when everyone was scrambling over a small pot of money, the field became very risk-averse. People did what they thought they had to for funding. There is a whole generation of young researchers who are risk-averse, who have been*

[12] NSF Proposal No. 0637190, "The Computing Community Consortium," Submitted by the Computing Research Association, D. Reed, A. Bernat, S. Graham, A. Jones and E. Lazowska, co-Principal Investigators.
[13] "Computing Community Consortium Strategic Plan," version 9: June 30, 2009.

taught how to write proposals and pick research problems in this mold. We need to encourage people to think more long term, to take more intellectual risks.

- **Rigidity within computer science.** *What's really important is to make sure that the field continues to think big, to fluidly respond to research changes and context. But when you have well-established ideas, like we have in computer science with well-established frameworks and methodologies, it's easy to do incremental projects and papers and citations. That stuff is really important. Audacity is a way of saying that sometimes we need to step back, in the same way that biologists say they want to cure cancer. We need to make sure that we keep setting those stretch goals.*

- **Peer review.** *The peer review process has a lot of pressure and a low percentage of proposals get funded. Since people know that, maybe this leads to self-censorship so that leads to fewer audacious ideas.* (Or, as stated more directly by another stakeholder, "*The merit review process is conservative; therefore, people are incented to be dull.*"

- **Complacency.** *The community has gotten a little conservative in its research; we need to pull the research community out of its comfort zone. Workshops are good at bringing groups together to have discussions (that wouldn't normally talk to one another).*

- **Constraints on time and resources.** *I wonder if the issue is just a lack of time [for computer researchers] to pursue big ideas properly.*

When asked to attempt to define "audacity" in the context of a research vision, stakeholders did not mention attributes related to the quality of the idea behind the vision or its intellectual merit. Instead, most stakeholders framed these questions in terms of the expected impact of an "audacious" vision on the community itself:

> *NSF does a good job of funding single-PI stuff. I want to get people to think about something that [goes] beyond their little project and [becomes] a project for the whole community. DARPA can do that but NSF can't. In CCC, it's not how audacious is the idea, but how to make that idea bigger than me.*

In a similar vein, several other stakeholders suggested that audacious ideas are those which are able to inspire and attract researchers who can form their own subcommunity.

> *One thing meant by "bolder" is "bigger." If you are young field that is all investigator driven—one investigator, one student—how much can you accomplish? If you start putting together teams, linking a systems person to a theory person to an application person, you can do bigger things. Focus on grand challenges. That's bigger, that's bolder. This whole idea of trying in a*

> *different way from what we do now. Bring people together who normally don't talk to each other…We are bound to have more audacious kinds of research going on if you can get people talking.*
>
> *We need people to think bigger. That may require the CCC to pull different people together, to build ideas and put them together. That ultimately is what we hope to see come out of the visioning ideas—bigger than what people would come up with on their own.*

The comments also raise the point that the CCC must do more than bring researchers together to develop visions—it must identify the right mix of participants for those activities. Diversity is clearly one consideration, in that some stakeholders feel that visions should encompass multiple streams of research and break down barriers between existing subcommunities. Another issue is how the CCC can identify the types of researchers who can be successful in "boundary-spanning" activities. For example, one stakeholder mentioned that the Health IT visioning activity was very productive thanks in part to the participation of people who had a background in biomedical research as well as computing research. In this sense, the CCC has the ability to identify people from across the entire research community (and not only the computing research community), and in particular recruit participants whom this stakeholder identified as "hinge people"—those whose research experience and interest lie at the intersection of two or more fields.

If the success of the CCC's visioning activities depends to some extent on identifying the right set of visioning participants, this further suggests that the CCC will need to be very deliberate and rigorous in choosing topics that are likely to attract a diverse range of researchers. Several stakeholders from the NSF argued that this requires the CCC to be even more proactive—as one put it, "The [CCC] has been mostly opportunistic, and we'd prefer it to be more strategic." Another asserted that the CCC should do more work to identify gaps in the existing computing research agenda, and promote visioning activities which address those topics. The NSF stakeholders also argued that this type of proactive visioning is something that only the CCC can undertake. One stated that "Something like the health IT effort is what we need, because it wouldn't have happened without the CCC to be there."

For their part, the current and former members of the CCC Council argue that they are already making changes to be more strategic in their approach. One commented that "the CCC Council **is** proactive. We have invited outsiders who present at meetings—to see if these should be new visions." However, this individual also agreed that "Even if we like them, we still need the community to form behind the vision."

When asked about future directions for the CCC, one former member of the Council agreed with this kind of strategic direction:

> *We should try to identify new sub-fields. I would like for us to identify a few areas in education that we can stand behind and make a difference. I would like to see us identify a small number of high priority areas in computer science education and push hard at R1 schools.*

Another long-time participant in the CCC pointed out that the CCC could do more data-gathering and analysis to guide the identification of new topics for visioning:

> *One thing you notice is that there are groups of people who want publication outlets—they start to try to put together journals and workshops. Those are signs that a field is emerging. We could be more systematically looking at those sorts of things.*

While the CCC's framework for visioning appears to be functional, based on the outputs from those activities, another stakeholder suggested that the CCC Council should "find out if we have enough seed ideas to flow into that process." This individual believes that the CCC is not doing very well at identifying individual ideas which are "audacious"—the typical CCC visioning activity already has a subcommunity associated with it. The CCC could find a way to identify those emerging ideas before they gain widespread attention, but in that researcher's view, "The CCC just isn't at a maturation point where we can do that."

A more radical suggestion from a few stakeholders is that the CCC should try to determine if it should develop one or more alternative visioning processes, other than the one currently outlined on the CCC Web site. These stakeholders raised the possibility that there might be some topics which are not appropriate for the kind of broad, inclusive visioning process that the CCC has created. They emphasize that this does not mean that the CCC Council should abandon the existing process, but rather that it should experiment with other models of visioning. As one of these stakeholders stated,

> *My observation is that visioning activities do not work well if they are overly democratic. Really key decisions on investing in technology end up coming down to a single person. The computing research community has not gotten to the point where it can put that much trust in one person, so the visioning has been more democratic—but they don't produce products that are sharply focused and impactful.*

One CCC Council member has asserted that other activities by the CCC, such as the white papers and some of the workshops organized outside the visioning process(such as Health IT), themselves constitute less-democratic approach to visioning. Others stated that such activities may point towards new visions but do not, by themselves, constitute new visions

for computing research. As discussed later in this report, this indicates a potential lack of consensus about what constitutes a "vision" in the context of the CCC.

Another stakeholder noted that the CCC faces a serious challenge in trying to differentiate its visioning activities and outcomes from the many other conferences and meetings that involve members of the computing research community. While the CCC has added content to its Web site to describe its concept of visioning more fully, this stakeholder argued that the community may still lack an understanding of why the CCC's visioning activities should receive more attention:

> *It wasn't clear to me the role that the CCC workshops had in contrast to all the other workshops that the same small group of people are tapped to attend. I would question that this is the right mechanism for visioning?*

These perspectives argue for a more fundamental form of experimentation by the CCC Council—experimentation with alternate approaches to the visioning process. The CCC also appears to be developing some efforts in this direction as well. Recently, the CCC has reached out to certain technical conferences in the computing research community to organize what it calls "Research Frontiers" sessions. For these sessions, the CCC will work with the program committee of the conference to carve out a session where researchers can present written papers that address long-term, more speculative research challenges and topics. The Council hopes to encourage the submission of papers on

> *"wacky" new directions that are not yet fully worked out or thought through, discussions on what the specific field represented by the conference should be doing and in what direction it should be headed.*

Furthermore, the CCC Council provides an incentive for submissions in the form of "prizes" that would be awarded to the best presentations of the best papers, as selected by the conference program committee in collaboration with the CCC. One key aspect of this approach is that it will produce written outputs, and a record of the "wacky" ideas discussed, in contrast to the status quo where such discussions usually occur in informal settings such as conference hallways, where there is no record of what is discussed.

In looking at the future of the CCC's visioning activities, one stakeholder was supportive of this kind of experimentation:

> *I do hope that [in 5 years], we'll have maybe three mechanisms for this kind of thing—the visioning mechanism, but at least two other ways of getting this kind of thing done and having it up and running. The White Papers don't really do that—[they] are not changing behavior in the community itself.*

3. LEADERSHIP AND SUCCESSION PLANNING

The individuals interviewed for this project, both within and outside of the CCC, recognize without equivocation that the CCC has benefited from the leadership of some of the most well-respected, accomplished and influential research leaders in computer science. A number of the members of the CCC Council, past and present, share what one stakeholder called "the activism gene"—the natural tendency to want to become leaders in the community. It is difficult to say to what extent this was due to self-selection (that leaders in the community saw the CCC as a vehicle for enabling more effective leadership) and to what extent it was a deliberate strategy by the CCC Council. Certainly, as one stakeholder emphasized, the nature of the CCC's activities requires that Council members "have a lot of contacts and leadership in the community." One individual noted that the successful execution of the CIFellows Project was due in large part to the ability of one of the project's leaders, Dr. Peter Lee, to reach out and recruit researchers to serve as reviewers of the fellowship applications.

As with any start-up entity, the CCC must address the issue of succession planning as part of its long-term strategy. One stakeholder suggested that "When the CCC was young, it had to establish credibility. Now that it is more established, maybe it's time to bring in younger leaders." A senior member of the Council agreed that "I would like to strengthen the bench, to convince some [more junior] people that [serving on the CCC Council] is worth their time and not just wait until they are my age." Several stakeholders noted that the NSF Reverse Site Visit committee had brought up this same issue.

> *[The reviewers] said that every time we need someone on a committee, we get the same old names recommended. To enrich the pool, you grow the next generation. I don't think we have spent enough time on this yet to say that we have a plan or even a notion of how to do it, but it is on the agenda now.*

The issue is becoming more of an imperative, as some of the senior leaders involved in the original CCC proposal are at or beyond retirement age. Several stakeholders were very concerned about how the CCC seemed to stall when Professor Lazowska was temporarily unable to serve as Chair of the Council. One stakeholder from the NSF commented that

> *Ed Lazowska is one of the reasons the CCC is so successful…He keeps eye on the ball; he knows how to get people to do things. He is willing to work any time anywhere. That's great for the CCC now, and great for Ed, but in the long term I don't know how sustainable it is.*

A number of individuals believe that this issue is especially challenging in the computer science field, compared to other disciplines. Several stakeholders voiced their concern that the computing research community lacks the kind of commitment to serving the

academic community that is found in other, more mature disciplines. Apparently, the culture of the computer science field today does not consider service, particularly in a policy role, to be a valued activity. One stakeholder voiced a common complaint: "We often try to protect junior researchers from service activities so that they can be better researchers." As a result, according to another stakeholder, "There is a reluctance among computer scientists to step into leadership—they love what they do in the lab and they have a lot of success there. It's not viewed as part of something you do, unless you are *not* successful in the lab." This is an issue which has also been a challenge for the CISE Directorate at the NSF, according to stakeholders from that organization:

> *Service to the community is undervalued by senior people, and it's not seen as including policy or NSF service… We need to get the full professors & endowed chairs to see the value of this kind of activity. Look at other directorates here [at the NSF]—they get very senior people to fill [leadership] positions, but we can't.*

One interview subject offered the view that leadership and succession issue requires the CCC to focus beyond the core concept of "service." "It's not just cultivating new leaders, but also getting them to be more open to new ideas and diverse topics." In this person's view, it should be a priority to "bring voices into the CCC that are different from where they have looked in the past." A potential liability of consistently recruiting "senior" researchers is that "the technology is moving so fast that the people who are senior today can't evaluate the state-of-the-art in research ideas." Working with a range of professional societies, including ones like the Association for the Advancement of Artificial Intelligence (AAAI) or the American Medical Informatics Association (AMIA), might help to ensure that the Council represents a broad spectrum of research interests.

The CCC Council has been aware of this issue, and taken some steps to address it. Council members point out that a more junior and diverse array of researchers have been placed on the Council or taken leadership roles in important CCC initiatives. For example, Prof. Ellen Zegura of Georgia Tech was a co-chair of the NetSE visioning activity (the follow-on to the GENI Science Council), and she was not considered an "experienced" faculty member at the time. Ran Libeskind-Hadas is another Council member who both comes from a non-research institution (Harvey Mudd College) and is younger than the average Council member. Various individuals credited Prof. Ed Lazowska for reaching out to those researchers beyond the most senior ones. A former Council member commended the CCC Council members for this, saying that

> *…they have been very good about bringing in younger people. When I started, the average color of hair was gray. There were a lot of us who weren't going to be in the field long. Just being conscious of that and reaching out will help.*

One possible strategy for addressing this issue is to use CCC visioning activities as both a mentoring opportunity and, to some extent a selection mechanism, for spotting and developing emerging leaders in the research community. One stakeholder asserted, "To be placed in the role of a chair to get them to work together is a learning experience. So we need to expose more people to that earlier on. The visioning activities give the CCC Council exposure to researchers whom they might not be aware of." Another stakeholder does believe that "when they have a visioning effort, they do select people who will have the opportunity to have some on-the-job leadership training."

At this time, there is no apparent systematic process for approaching the visioning activities as a venue for identifying and developing future CCC Council members. One stakeholder from outside the Council feels that "The [visioning] process right now is not a grooming exercise—you need a process to make people look bigger and more broadly." Another states that

> *I'm a big fan of leadership training, and so as a general matter I think it's wise for organizations to invest in that. I haven't seen the CCC do that. The people on the Council already know how to do that stuff. It's hard, because…it's unclear to see how the CCC would do that.*

As the CCC Council has more experience with the dynamics of the visioning process, that experience may reveal ways in which the process itself helps research community leaders to emerge on their own. As one senior stakeholder put it, "I think one kind of test is that really good visioning activities become all-consuming for the leader—none are really part-time efforts." Those researchers who step up as leaders of a visioning activity, and who take on the role of "champion" or "evangelist" for that activity, are likely to be good people to recruit as future candidates for the CCC Council.

4. POSITIONING OF THE CCC WITHIN THE COMPUTING RESEARCH COMMUNITY

For the long-term, the CCC is working to address its relationship to the broader computing research community, and extending out to related research communities. At least some portion of the CCC Council's discussions so far has focused on defining its own role with more clarity and coherence. The interviews revealed that there is not absolute consensus on this issue, but there does seem to be a common understanding and a foundation for making that role more explicit. This could help the CCC to set the parameters to guide any potential changes to its structure and strategy in the future.

The NSF Cooperative Agreement governing the CCC states that "The purpose of the Computing Community Consortium (CCC) is to provide a voice for the national computing research community." Stakeholders from the CCC Council all pointed out that the statement calls the CCC "*a* voice" for the community, not "*the* voice" for the community.

There was a distinct difference between that position and the view of some of the NSF stakeholders, who want the CCC to be a more authoritative voice that does act as a single representative of the community. One of those stakeholders stated flatly that

> *…at NSF, it's good to have one voice for the whole community…To have multiple voices, as far as advocating for field in DC, is a terrible idea. The last thing any field wants is to have many voices, especially if they're not saying the same thing.*

The CCC Council is very sensitive about trying to strike a balance between acting as an advocate on behalf of the community, and acting simply as a facilitator and liaison to the community. The 2010 Annual Report reflects this caution: "We need to indicate what's important—without telling our field what to do." One of the stakeholders commented that "A key challenge is how to build consensus when the community as a whole tends to resist that." Certainly, the fragmented nature of the computing research community at present makes it difficult for the CCC Council to claim that it represents the sense of the community. The CCC Council members appear concerned that if they try to take on that role, they may ignore important perspectives or alienate significant segments of the community.

Another point of concern for the future is whether or not the CCC itself should become a lasting institution within the community. A few stakeholders admitted upfront that they are opposed philosophically to institution-building and that the CCC should be very careful about whether it tries to become permanent. As one such individual stated, "If it lasted forever, it would turn out poorly. I see this as an experiment. I'm not sure we need an institutionalized revolution." Another commented,

> *It wouldn't bother me to see [the CCC] replaced by something else. As long as it's functioning successfully and continues to raise the bar, then it can be extended. Institutions should be revisited and reevaluated, but I see lots of room for it to grow.*

A different stakeholder argued that the CCC's role in the community "has to keep changing—we can't just keep throwing out more visions. The pent-up demand to produce visions may taper off. If that happens, it may mean that the CCC's job is done."

A few other stakeholders suggested that the CCC could continue to exist for some time into the future, but that the need (and the organization) might eventually shrink to a smaller scale. One stakeholder affiliated with the CCC and the CRA suggested that the CCC could help to establish "best practices" in the community for identifying new research visions and setting a research agenda through a collaborative process, but then rely on the community to do that work. In this model, the CCC might devolve into an all-volunteer task force that advises sub-communities on how to conduct visioning activities. Another

suggested that the CCC could be absorbed into the CRA, perhaps maintaining its status as a standing committee but at a much lower funding level.

Funding will be one constraint on the future form and direction of the CCC. The stakeholders interviewed proposed a number of potential funding models. A few suggested that the CCC would always be funded by the NSF, as CISE would need to be able to consult with the CCC about new directions for research programs. Other stakeholders felt that it would be unrealistic to expect CISE to support the CCC in perpetuity. Some of these suggested that the CCC could approach multiple sponsors for support, including other government agencies and corporate research organizations, although this would be somewhat difficult. Even the proponents of that funding model believe that it would require the CCC to have a much more limited scope of operations.

Almost all stakeholders mentioned the idea that the CCC's key role is to convene the community in ways which enable it to identify promising research which is not supported by current funding programs, and get sponsors to at least recognize those topics if not add money to them. One stakeholder suggested that "The CCC could be judged successful if, in 5 or 10 years, we can help bring some of these large organizations to consensus on these important areas and encourage cooperation." However, a critical consideration would be whether the CCC's efforts would boost overall research funding along with computing research funding. "If it's a zero sum game, it's unappetizing to attract money from another field to computer science." An alternative view of the CCC is that the CCC should generate agendas, and then leaders in the community would take up the responsibility of attracting funding based on each agenda.

One stakeholder from the NSF offered a more expansive view of what the CCC could accomplish in the future—as a facilitator of a more complex ecosystem of organizations that plan, fund, and implement research visions and agendas:

> *I see potential for great influence in building the innovation ecology. If that should slow down, then maybe [that's] because there's a reason to stop it. There is a wonderful study about how bills [become] laws. Very few bills become laws, because [most] just can't pass through all of the hurdles. But political science studies show that just having the national discussion about a topic changes the way people think about it. The metric is not how many bills get passed—no, it's about how many national debates we have about the topics. It's not about what gets in the program solicitation, it's about whether we [are] having community debate around the right topics.*

III. QUANTITATIVE ANALYSIS OF THE CCC

In addition to the qualitative exploration of the CCC as a case study, this evaluation project attempted to provide more concrete and specific metrics that at least indicate if the CCC is making progress towards its stated goals. Since the CCC's purpose is to serve as a voice for the computing research community, this part of the evaluation attempts to gather data directly from the members of that community. To collect such data, two surveys were designed and deployed.

- One survey was distributed to researchers who had participated in at least one CCC-supported visioning activity. This survey collected feedback about the effectiveness of those activities and their impact on the researchers' own plans, as well as opinions about the need for an organization like the CCC within the computing research community.

- A second survey was distributed to researchers whom we identified as likely members of the computing research community. This survey collected data on the respondents' views about the value to the community of activities like those undertaken by the CCC, as well as their awareness of the CCC and its outputs.

The methodology for the survey is described below. The two survey instruments are included in Appendix A attached to this report.

A. QUANTITATIVE EVALUATION METHODOLOGY

The CCC and the SRI project team agreed to use a Web-based survey as the primary data collection method for the quantitative evaluation. A Web-based survey was deemed the most appropriate survey tool, as computing researchers could be expected to be familiar with navigating Web-based documents and systems, and could also be reasonably expected to read their e-mail on a regular basis. Also, a Web-based survey was the most efficient and economical method for deploying the survey instrument rapidly to a large population, when compared to a mail or a telephone survey. Finally, the Web-based survey system selected—an open-source tool called LimeSurvey—would enable the SRI research team to transfer the data directly into an appropriate analytical software environment for processing the data collected.

1. SURVEY POPULATION CONSTRUCTION: CCC VISIONING PARTICIPANTS

The CCC Director provided files listing the attendees at various CCC visioning activities, as well the Library of Congress symposium on "Computing Research that Changed the

World." While the symposium was not a visioning activity, participants in that symposium who are computing researchers are familiar with the CCC through that event. Therefore, they were categorized as qualified to comment on actual CCC activities. Table 1 below is a partial list of the visioning activities from which the participant names were gathered.

Table 1: Visioning Activities Selected to Identify Participants

Activity	**Dates**
Big data computing-Data-intensive computing symposium	March 2008
Computer science & global development	Aug. 2009
Advancing computer architecture research	Feb. 2010
Cross-layer reliability workshops	March, July, October 2009
Cyber-physical systems summit	April 2008
Global resources for online education	April and July 2009
Health IT	October 2009
NetSE visioning workshops	June through September 2008
Robotics visioning workshops	June and August 2008

Due to inconsistent documentation for the visioning activities, some attendee lists included only names and affiliations of the participants. Also, due to the timeframe of the activities, some participants had changed jobs by the time SRI received the files. Therefore, the project team conducted a comprehensive Web search to obtain up-to-date e-mail addresses of the names of individuals on the list. Removing duplications across the lists (for individuals who attended more than one activity) yielded a list of 782 names. We then removed all individuals affiliated with a government agency. This was done to remove the potential bias in responses from research funding agency staff, which could be very different from research performers (as we were unable to differentiate easily between program managers and researchers within government agencies). This resulted in a list of 681 names. Of those individuals, we were able to find e-mail addresses for 628. This was the final pool of individuals invited to complete the CCC Visioning Participant Survey.

2. SURVEY POPULATION CONSTRUCTION: COMPUTING RESEARCH COMMUNITY

To gauge the sentiment of the CCC's key constituency, this project attempted to survey the computing research community in the United States regarding its views on the current

ability of the community to carry out some of the functions of the CCC, and also awareness of the CCC and its activities. The immediate challenge posed by this approach is how to define the "computing research community." Several different approaches were proposed. One was to survey the members of particular professional societies in computing. There is no society that is limited to researchers—most include computing or engineering professionals as well (e.g. Association for Computing Machinery and IEEE). Surveying the membership of the CRA might be too expansive, as the CRA includes a number of universities which do not conduct significant research. Also, due to the fact that the CCC's activities tend to include cross-disciplinary work (e.g. Health IT), we could not simply compile a list of all faculty in computer science departments in U.S. universities. This required the development of a proxy sample which approximated the computing research community.

To create the proxy sample, the project team downloaded from the NSF Awards database (at http://www.nsf.gov/awardsearch/) information on all PIs and co-PIs who were awarded grants by the NSF's Computer and Information Science and Engineering directorate for the years 2008 through May 2010 (when this sample was constructed). The team reasoned that this set of individuals could be identified positively as computing researchers, as they were conducting research funded by CISE. Also, as CISE provides the largest share of federal funding for computer science research, the CISE awardees list would be the most comprehensive list available from a single validated source. We chose to limit the search to awards made since 2008, as it was unlikely that an awardee would exit the computing research community so soon after receiving CISE funding.

Using the CISE awardee list had other benefits. CISE in recent years has funded several programs that are interdisciplinary in nature, such as the Information Technology Research (ITR) program and CreativeIT. This meant that our dataset of awardees might capture researchers from outside of traditional computer science but who were involved in computational or related research in other fields. An initial analysis of the sample extracted from the awards database revealed researchers from departments such as physics, psychology, aeronautical engineering, geoscience, and biology. Also, while the principal PIs on NSF grants tend to be senior faculty members, the co-PIs could be junior faculty or post-doctoral researchers, or in some cases industrial researchers. An analysis of the job titles of the individuals in the sample showed that a substantial portion of them listed job titles such as assistant professor, research associate, and lecturer. Also, a smaller but significant number of the individuals indicated an industrial affiliation (such as IBM, Intel Research, Lucent Bell Laboratories, Google and Microsoft).

This data extraction generated a list with over 5,600 names. We eliminated all names for which e-mail addresses were not available, or where the e-mail address was corrupted. This led to a final survey population of 5,057 individuals.

3. SURVEY DEVELOPMENT AND DEPLOYMENT

For each survey, the SRI project team consulted with representatives of the CCC to determine the appropriate metrics to be used in the evaluation, and how measures of those metrics could be collected via the surveys. The team then generated the survey instruments. The CCC reviewed a PDF version of each survey instrument, which provided both the questions and the skip logic for each survey.

A pre-test of both survey instruments was conducted by inviting SRI staff to fill out the survey, including some researchers in SRI's Computer Science Laboratory. The purpose of the pre-test was to validate that the questions in the survey instrument could be interpreted consistently by respondents and that the answers appeared to correlate closely with expected values. The survey instruments were revised once following the pre-test, and were approved by representatives of the CCC.

Once the final survey instruments were uploaded to LimeSurvey, invitations to complete the survey were e-mailed to the members of the survey populations. The invitations notified the recipients that the survey was being conducted by SRI International on behalf of the Computing Research Association, and that the survey was part of an evaluation project associated with the NSF award which funded the CCC. In the case of the computing research community survey, the invitation e-mail did not include any reference to the CCC, as that would bias the responses to the questions regarding awareness about the CCC.

To protect the confidentiality and privacy of the survey respondents, SRI retained all of the survey data collected on its own premises and computing infrastructure. The responses were processed, and only aggregated response data were released to the CCC and CRA. The survey instruments did include some open-ended response fields for free-text answers. This report provides some examples of those verbatim responses, but they have been sanitized to remove any information that might link a response to an individual respondent.

B. PROFILE OF SURVEY RESPONDENTS

The following section provides an overview of the demographics of the response populations for both the CCC Visioning Participants survey and the Computing Research Community survey.

1. CCC VISIONING PARTICIPANTS SURVEY

At the time of data analysis for this report, the CCC Visioning Participants survey had generated 87 completed surveys and 37 partially-completed surveys, for an overall response rate of 19.7 percent (N=628). Of the partially-completed surveys, only five were complete enough to provide valid data for this analysis. Therefore, the final sample size was 92 respondents, yielding an effective response rate of 14.6 percent.

A primary concern in the design of this survey methodology was to ensure that the final sample was roughly comparable in composition to the survey population, in terms of the institutional affiliation of the members of the population. In particular, it was imperative to ensure that there was sufficient response from major research universities with leading computer science departments. To verify this, we classified all respondents by their institutional affiliation, using the following categories:

Taulbee 1	12 universities identified in the CRA's Taulbee survey as having the top-ranked computer science departments[14]
Taulbee 2	12 universities identified in the CRA's Taulbee survey as having the 2nd-ranked computer science departments
Taulbee 3	12 universities identified in the CRA's Taulbee survey as having the 3rd-ranked computer science departments
Other	Any other institutions, including universities, community colleges, industrial research organizations, not-for-profit research institutes, and non-U.S. institutions

The table below compares the survey population of CCC visioning participants with the sample.

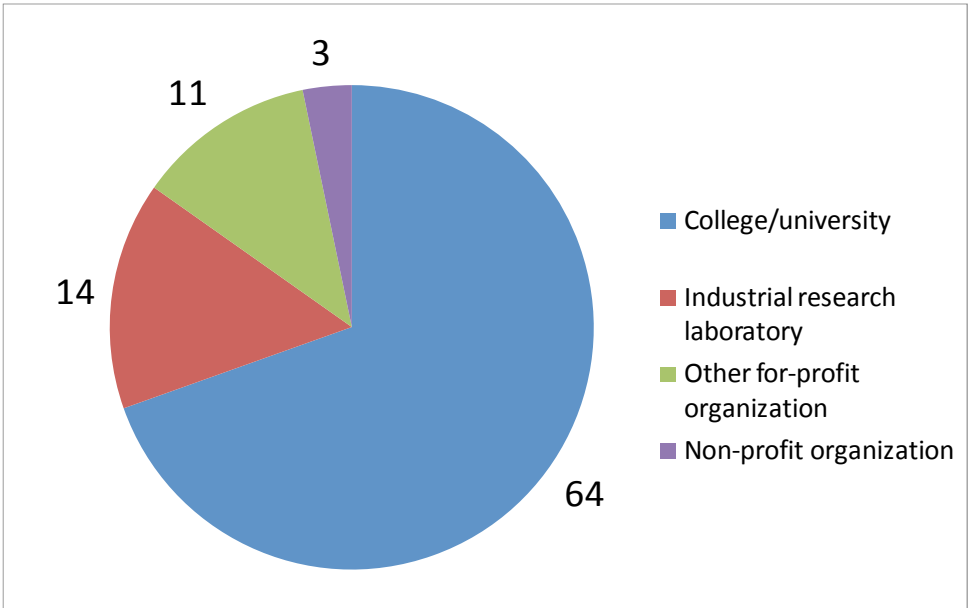
[14] See http://www.cra.org/resources/taulbee/ for an explanation of the Taulbee Survey. The university rankings are derived from Goldberger et al (1995), *Research Doctorate Programs in the United States: Continuity and Change*, Washington, DC: National Academies Press.

	Population		*Sample*	
Type	**N**	%	**N**	%
Taulbee 1	177	26%	20	22%
Taulbee 2	84	12%	12	13%
Taulbee 3	43	6%	4	4%
Other	377	55%	56	61%

This seems to indicate that the structure of the sample by institution type is roughly comparable to the population, although it shows a relatively small N for Taulbee 2 and Taulbee 3 institutions. This structure was deemed acceptable, as the Taulbee 1 institutions are those which are identified as focusing substantially on research, as opposed to focusing primarily on instruction. Also, as the Taulbee taxonomy is based on data from the previous NRC evaluation of research doctorate programs (the more recent evaluation did not produce reliable results for computing research doctoral programs)[15]

The following figures provide demographic details on the 92 qualified respondents.

Figure 1: Respondents by Type of Employer

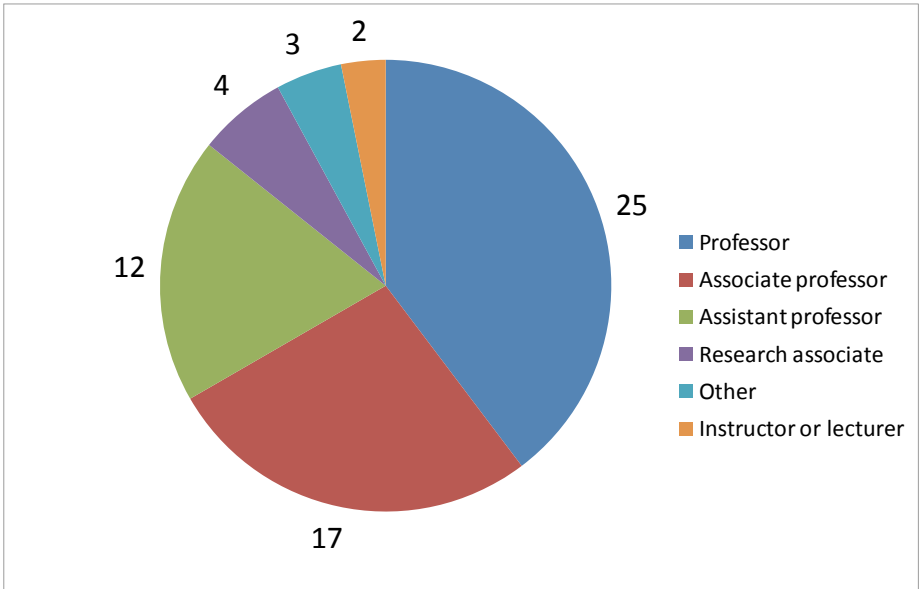


[15] In 2010, the National Research Council published a revised ranking of research doctorate programs in the United States. The CRA and other organizations have pointed out several problems with the methodology when evaluating computer science programs. Therefore, we are basing our taxonomy on an earlier ranking.

The sample consists mostly of academic researchers, which is consistent with the description of the computing research community given by members of the CCC Council interviewed during this project. The share of private sector participants seems higher than expected, however. Most observers of trends in corporate R&D have reported that in most corporations, the number of employees conducting "basic research" has declined dramatically over the past ten years. The possible exceptions to this trend are Microsoft and Google. Consistent with that observation, of the 14 respondents who identified their employer as an industrial research laboratory, 7 were from Microsoft.

The universities with the most respondents in the sample were the University of Washington (5 respondents) and Carnegie-Mellon University and Princeton University (4 each).

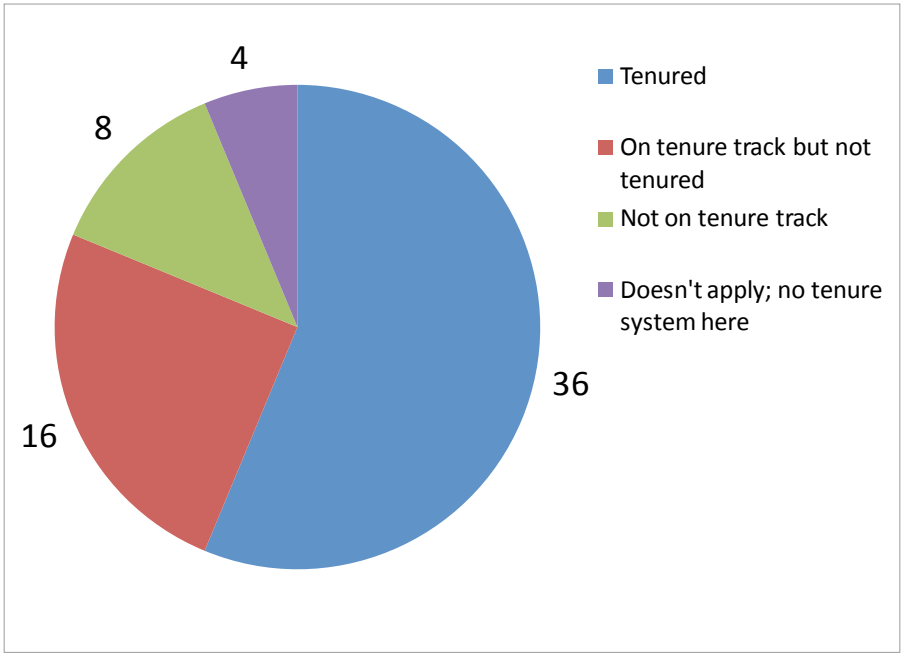
Figure 2: Respondents by Academic Rank (College/University only)



Note: One respondent did not provide an answer.

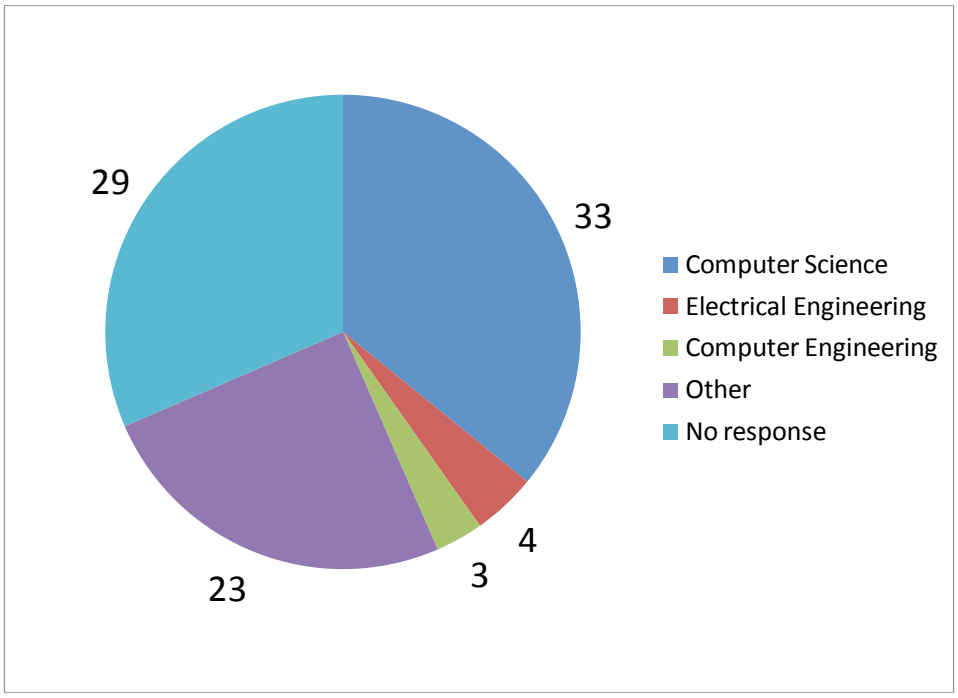
Of the 64 respondents who self-identified as academic researchers, the largest share hold the title of full professor. Again, it is expected that more senior faculty would be involved in CCC's visioning activities, in view of the comments from the interviews that junior faculty are encouraged to focus on research rather than service-oriented activities. Still, the number of respondents with the rank of assistant professor indicates that some junior faculty are joining in these activities. Respondents who listed their rank as "Other" were full-time research or technical staff at universities.

Figure 3: Respondents by Tenure Status (Academic respondents only)



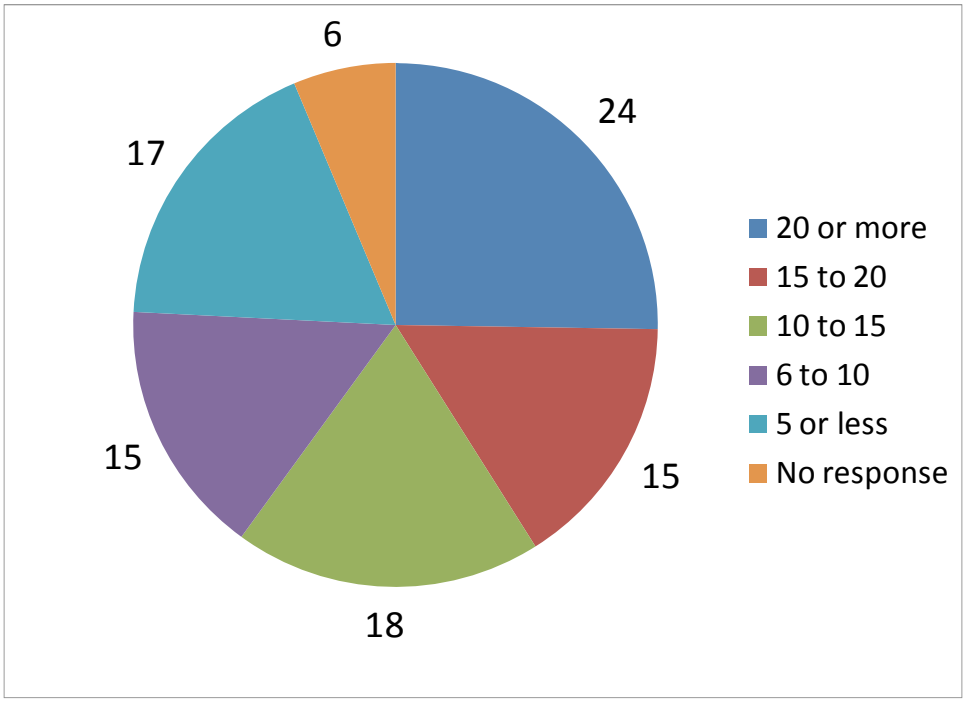
Again, consistent with the expectation that more senior faculty would have the freedom to engage in visioning, the majority of academics in the sample were tenured faculty. Of the 64 academic respondents, 16 (25 percent) are in the tenure process, and 8 (12.5 percent) are in non-tenure track positions.

Figure 4: Respondents by Department



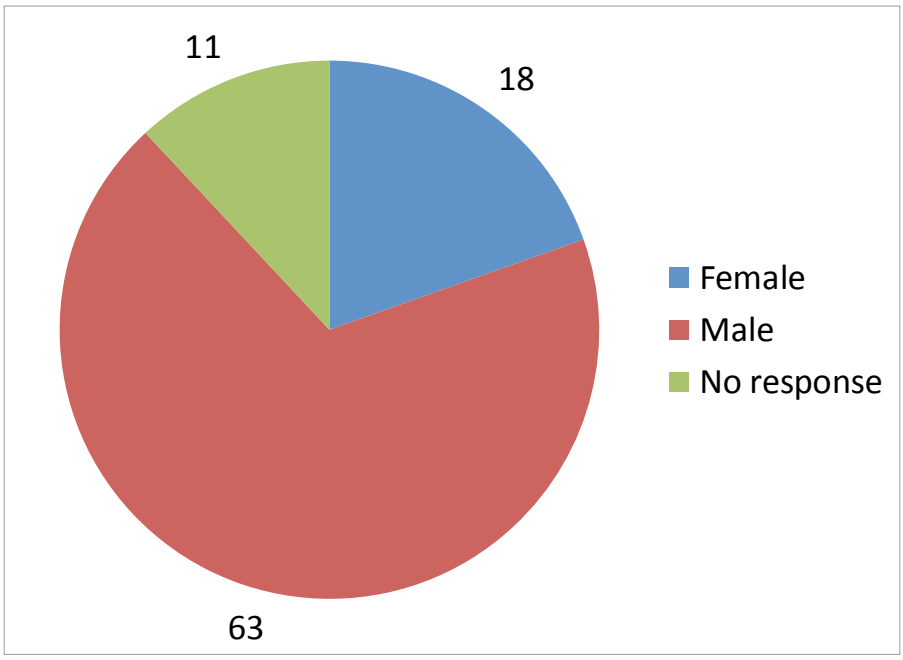
As might be expected for a group of computing researchers, the most common department for the academic participants was computer science. However, over 40 percent of those who indicated a departmental affiliation were outside of computer science or computer engineering. Those who wrote in their department names covered a fairly wide range of disciplines, including mechanical engineering (4), education (3), astrophysics (1), biomedical informatics (1), and genetics (1). This indicates that the visioning workshops were able to attract participants from a number of disciplines.

Figure 5: Respondents by Experience (Years since receiving Ph.D.)



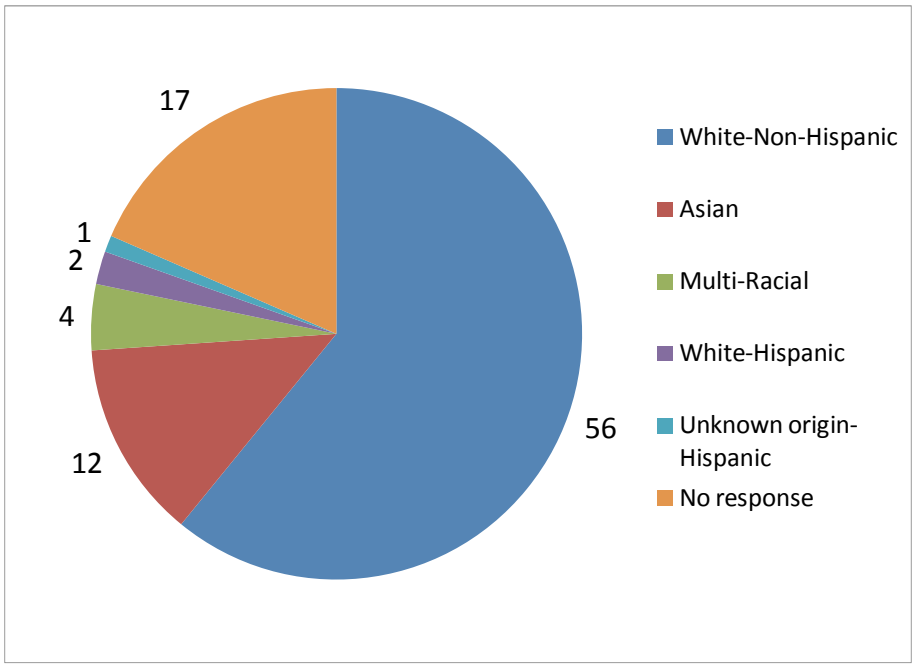
This survey used "number of years since Ph.D. awarded" to approximate each respondents number of years of experience as a full-time researcher. One interesting characteristic of this sample is that it appears to be fairly evenly distributed across the listed cohorts of respondents based on experience, although slightly weighted towards more senior researchers. The sample also illustrates the pattern observed by interview subjects where the computing field has more of its junior members in higher-ranking positions. Looking only at the respondents in academia, 13 of the 17 respondents with 20 or more years of experience hold the title of professor. For those with 15 to 20 years of experience, 4 out of 8 respondents are professors. In the 10 to 15 years' range, 8 of 15 respondents are professors. There was also one respondent (out of 11) with 6 to 10 years of experience who is a professor.

Figure 6: Respondents by Gender



The computing research community has discussed extensively the gender imbalance in the community. This sample also reflects that imbalance, with only 18 of 92 respondents (or just under 20 percent) listing themselves as female.

Figure 7: Respondents by Race/Ethnicity



Also reflecting documented demographic trends in the community, the majority of the members of this sample are white. The second largest ethnic group in the sample are Asians. Hispanics are a very small number, and no respondents listed their ethnicity as "Black or African-American." Note that 17 respondents declined to list their ethnicity, and so these figures are somewhat unreliable.

2. COMPUTING RESEARCH COMMUNITY SURVEY

At the time of data analysis for this report, the Computing Research Community survey had generated 779 completed surveys, for an overall response rate of approximately 14 percent. A number of partially-completed surveys were returned. However, those surveys were so incomplete as to not be usable for this project.

A preliminary study of the members of the sample revealed that at least some share were researchers from fields unrelated to computing research. In many cases, these researchers were co-PIs on grants where the funding was apparently awarded primarily to the PI, and the co-PIs were providing subject matter expertise. For example, one co-PI came from the Department of Dance and Performance at one institution. In this case, the CISE award funded a project to use motion capture software to provide a digital record of the choreography of a dance. Therefore, the dance professor was not directly conducting computing research.

To eliminate cases such as this from the sample, two filters were applied to the pool of respondents.

- First, any respondents who indicated that they were members of one of the professional societies listed on the survey (see survey instrument in the Appendix) were included in the final sample. It was surmised that if a researcher outside of a computing-related field joins a computing-related academic society, then that researcher's interests most likely intersect with computing research.

- Second, any respondents who indicated that they were a member of a computing-related academic department, but excluded in the previous step, were added to the final sample.

- Third, any respondent whose e-mail was from a "*.com" domain was reviewed individually for inclusion in the final sample. Since industrial researchers generally do not apply to the NSF for funding, this step was taken to try to maximize the input gathered from private sector respondents.

The result is a list of 706 respondents who are included in the final sample for analysis, out of 779 members in the response pool.

It is difficult to state with certainty that the response sample to this survey is precisely representative of the computing research community, since there is no common definition of who belongs in that community. Still, given that the population was constructed from a list of researchers who have received funding from the CISE Directorate at NSF, one would expect that all of the respondents engage in some kind of research related to information science and engineering.

	Sample	
Type	**N**	%
Taulbee 1	107	15.2%
Taulbee 2	86	12.2%
Taulbee 3	82	11.6%
Other	431	61%

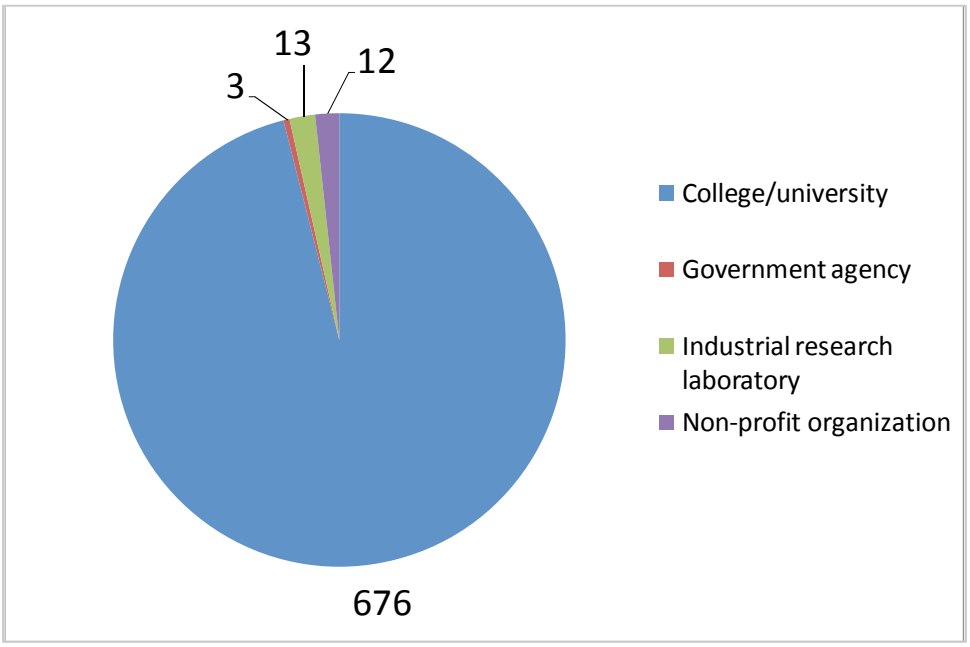
Also, as might be predicted from comments received during the interviews, the top universities account for a disproportionate share of the respondents in the sample. Although each of the three Taulbee cohorts contains only 12 institutions, they account for 275 members of the sample, or approximately 39 percent. In this sample, there were 181 academic institutions which are from outside those three cohorts, accounting for 412 members of the sample. In terms of academic affiliations, this sample contains a "long tail," in that only 12 institutions have more than 10 respondents each. The list of the institutions with the greatest level of representation is shown below.

Institution	**# of Respondents**
Carnegie Mellon University	23
University of Texas at Austin	15
University of Illinois at Urbana-Champaign	15
Texas A&M University	14
Cornell University	14
University of California at San Diego	13
Purdue University	12
University of Maryland at College Park	12

Institution	# of Respondents
University of Massachusetts at Amherst	12
Georgia Institute of Technology	11
University of Washington	10
Virginia Polytechnic Institute and State University	10

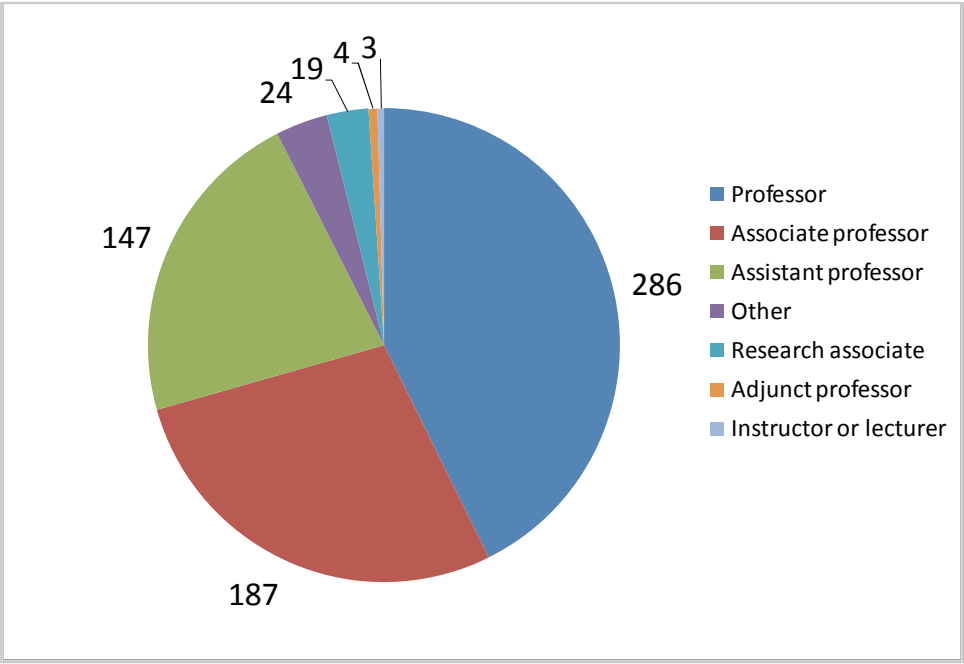
The following figures provide demographic details on the 706 qualified respondents. Note that not all respondents provided answers to all of these survey items.

Figure 8: Respondents by Type of Employer



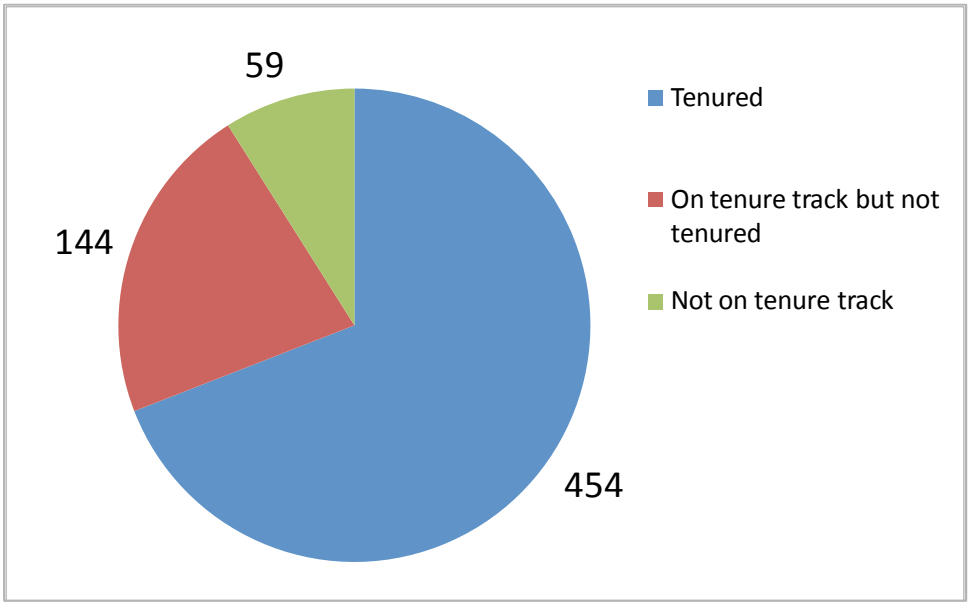
As would be expected for a sample drawn from the NSF awards database, the sample is heavily weighted towards academic researchers. This was unavoidable, as the survey population contained few industrial researchers, and e-mail addresses were not obtainable for most of those researchers. The non-profit organizations included professional societies and research institutes such as SRI International. The government agency individuals came from state government agencies, as federal government employees are not generally eligible for NSF funding.

Figure 9: Respondents by Academic Rank (College/University only)



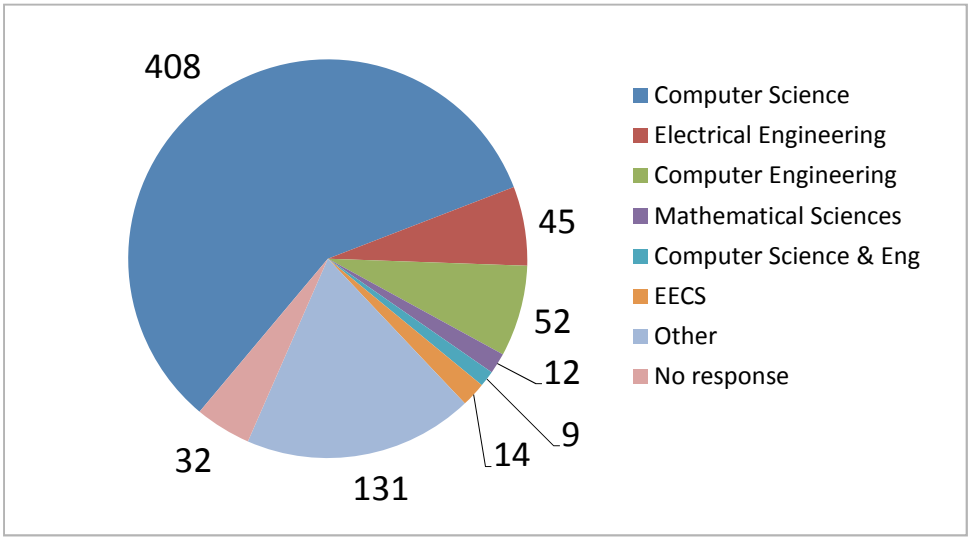
Over 40 percent of the respondents from academia indicated that they hold the rank of professor. Again, this is reasonable given the fact that the PIs who are awarded grants by the NSF tend to be more prominent in stature, and have past research experience. Still, by including co-PIs in our survey population, more than 25 percent of the final sample indicate academic titles that are more associated with junior faculty.

Figure 10: Respondents by Tenure Status (Academic respondents only)



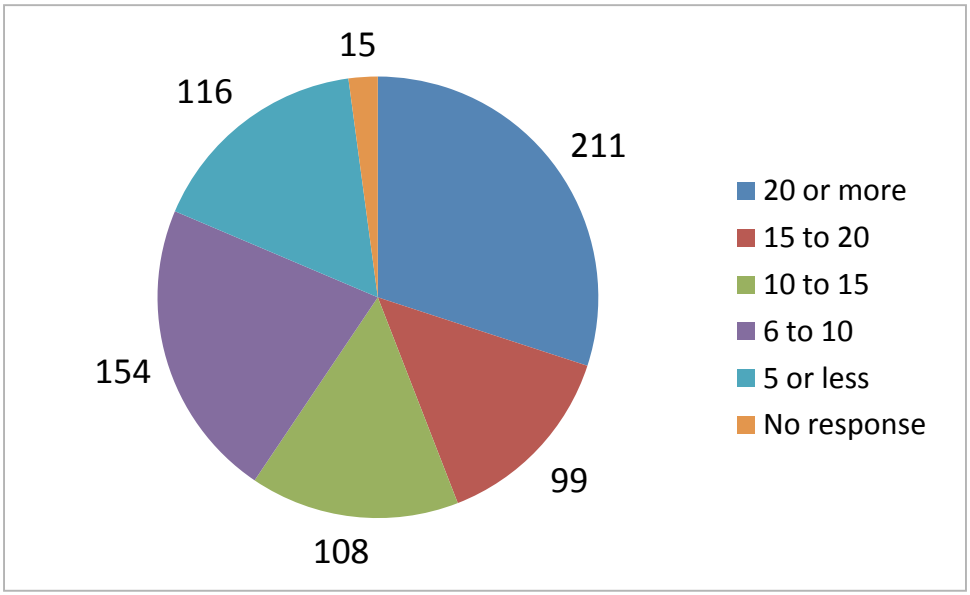
Consistent with the chart above, approximately 70 percent of the respondents currently hold tenure.

Figure 11: Respondents by Department



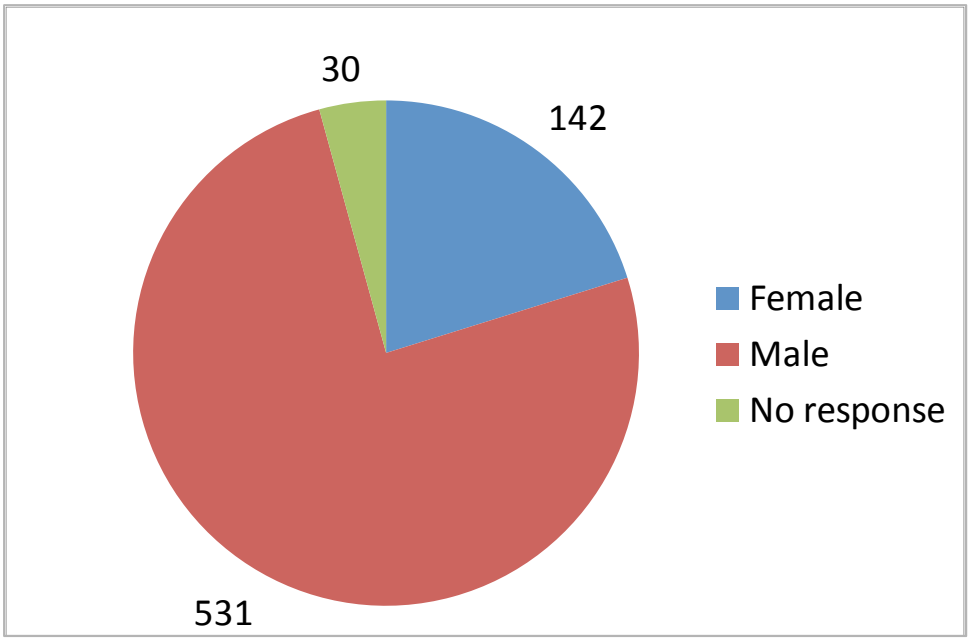
Again, given that the awards database was restricted to CISE awardees, it is logical that most of the respondents would be from computer science departments, or departments closely affiliated to computing. The large number of "Other" responses reflects the diversity of fields touched by computing. Examples of other departments represented in the sample include aeronautical engineering, biomedical engineering, communication, linguistics, microbiology, operations research, and physics.

Figure 12 Experience (Years since receiving Ph.D.)



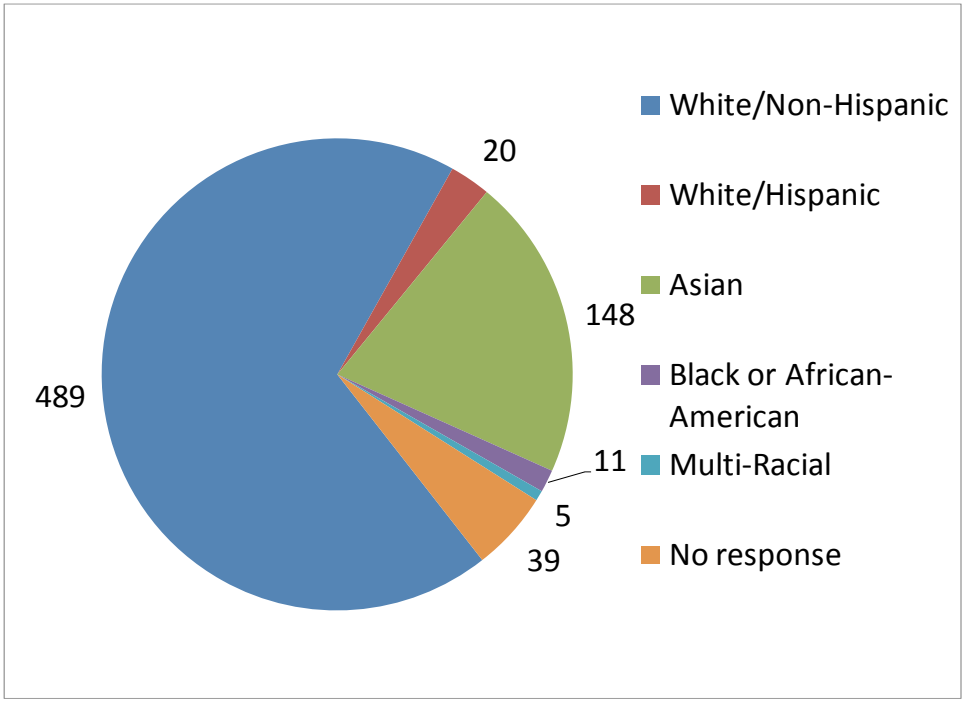
This chart shows that while the sample was somewhat weighted towards more senior researchers (those with 20 or more years since their date of Ph.D.), there was a fairly even distribution of respondents across other cohorts. Those with 6 to 10 years since receiving their Ph.D. were the second largest cohort, representing approximately 22 percent of the sample.

Figure 13: Respondents by Gender



Reflecting the demographic structure of the computing field, the response sample was overwhelmingly male.

Figure 14: Respondents by Race/Ethnicity



As respondents were allowed to indicate more than one category of race or ethnicity in their response to this question, the above chart does not sum to the actual number of respondents. It shows that the most common race indicated by respondents was "White," followed by "Asian," with very few respondents indicating other ethnicities.

C. RESULTS OF PARTICIPANTS SURVEY

This section of the report summarizes the major findings of the survey of CCC Visioning Activity participants. These findings should be interpreted in the context of the limitations of the sampling method used, as described above.

1. PARTICIPATION IN THE VISIONING ACTIVITIES

Table 2 below shows how many of the respondents to this survey participated in each CCC visioning activity. All major activities are represented, although none have sufficient respondents to justify an analysis for each specific visioning activity. It should be noted that based on comments made during the interviews, the respondents' perceptions of the value and success of a particular activity is likely to be influenced by each respondent's opinion of how well each particular activity was led and managed.

When asked how they heard about the visioning activity in which they participated, the largest share of participants (over 40) reported that they received a direct invitation from the conference organizers. Approximately 20 others stated that they learned about the visioning activity through colleagues. (There is some ambiguity here, as in some cases the conference organizers were the respondent's colleagues.) Approximately were involved in planning the activity or had a connection to the CCC or CRA. Of potential interest is that approximately 10 respondents participated in an activity after seeing a public notice of some kind (posting to an e-mail list, article on the Web, or finding the general call for participation).

On the topic of what influenced them to join in the activity, a large number of the respondents (over 30) mentioned some variation on the idea that the topic of the activity is important to the field, to the nation, or to society, and that they wanted to have a role in shaping the agenda or to make sure that they learned about the direction of the field. Some sample comments of this type were:

"*I have a deep commitment to my field and its potential for improving human quality of life, yet have seen funding and vision in it decline over the years and wished to help to improve matters.*"

"*Chance to help raise awareness of need for attention for a key challenge and build community consensus.*"

"*The need for basic research in important areas of computing that affect the society at large.*"

Table 2: Participants by Visioning Activity

Answer	**Count**
Network Science and Engineering	5
Theoretical Computer Science	8
Big Data Computing	10
Robotics	15
Cyber-Physical Systems	7
Global Development	11
Free and Open Source Software	1
Global Resources for Online Education	11

Answer	Count
Cross-Layer Reliability	13
Discovery and Innovation in Health IT	8
Advanced Computer Architecture Research	5
Interactive Technologies	3
Total number of participants	86
Number of respondents who participated in two activities (*None of the respondents participated in more than two visioning activities*)	8

The next most commonly-cited factors were the quality and reputation of the other participants, and the respondent's personal interest in the visioning topic. As one respondent wrote, "The people who seemed to be already involved in the initiative exemplified the credibility of the effort." Another mentioned "The stature and vision of the other people involved, and the chance to have an impact on the direction of the field." For a few, the act of collaborating and working to reach consensus was itself a motivation to participate. One researcher state, "Interested in learning the process of bringing attention to research areas, and collaborating with colleagues on the process."

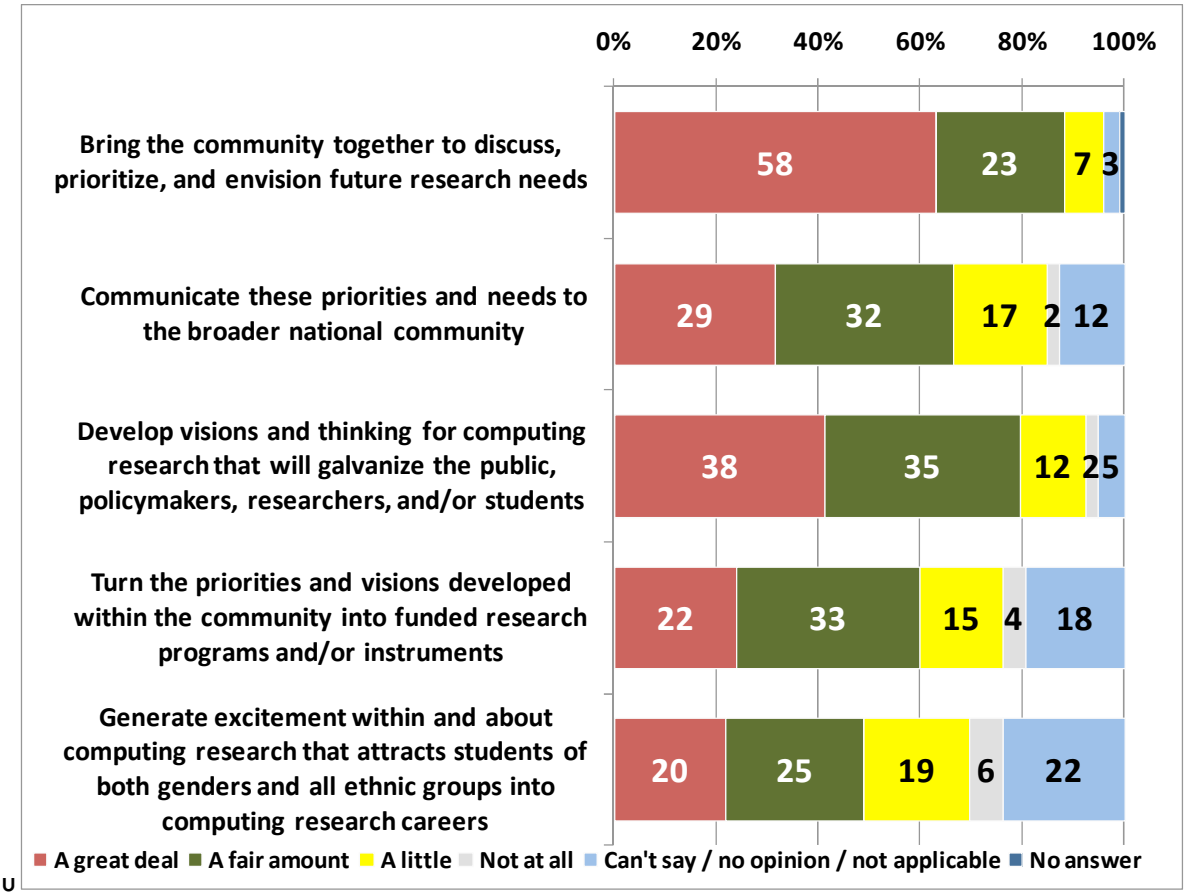
Only one respondent mentioned the CCC explicitly as an influencing factor, specifically "the degree of visibility the CCC has."

2. EFFECTIVENESS OF THE VISIONING ACTIVITIES

To develop the question below, the survey instrument borrowed language directly from the CCC Strategic Plan to see if respondents could make a connection between a visioning activity and one of the CCC's goals.

Figure 15

Looking over your experience in participating in one or more of CCC's visioning activities, how effective were these activities in contributing to each of the following functions of the Computing Community Consortium?



The responses reflect broad satisfaction with how well the activities supported the CCC's goals. Over 80 percent of respondents felt that their activity was at least fairly effective in promoting the CCC's primary goal of bringing the community together to discuss, prioritize and envision future research needs. Approximately the same number were also satisfied with how the activities contributed to developing research visions. A somewhat smaller share (between 50 and 65 percent) of respondents were satisfied with how well the activities helped to turn those priorities and visions into funded programs, or their ability to generate excitement in potential future computing researchers.

Respondents who stated that the visioning was "a little" or "not at all" effective in contributing to a particular CCC function were invited to provide the reasoning behind that response. (Note that for most topics, a relatively small number of respondents gave that response.) Below are a few representative comments that ways in which the visioning activities are not supporting the CCC's objectives:

On bringing the community together to discuss, prioritize, and envision future research needs:

> *The group brought together was, for the most part, "the usual suspects" -- those who the organizers knew well. It did not include enough diverse perspectives.*

On communicating these priorities and needs to the broader national community:

> *I am aware of no communication efforts to the broader community beyond a paper summarizing the conclusions that the organizer felt were important, which were in most cases, their own line of research.*
>
> *It was not well thought out from these perspectives; moreover, the funding agencies were not engaged during or after the meeting in a forceful manner at the right level of seniority for multiyear decision making.*
>
> *I am not sure if more is being done to communicating these priorities, but I don't think the report by itself will be sufficient to communicate the vision. People need to know about it and perhaps presentations (not just a slide deck, but real presentations) would be more effective.*

On developing visions and thinking for computing research that can galvanize the public, policymakers, researchers, and/or students:

> *Most students have never heard of the CCC or its vision, let alone be influenced by it.*
>
> *I saw little new visionary thinking. Most of the resulting document cited conclusions from other visioning documents…Little or no discussion centered on whether and how the visions discussed would affect anyone other than NSF and the research community, specifically those attending the workshop.*
>
> *While we prioritized visions of the community, I am not sure we knew how to codify them for the public and policymakers.*
>
> *I was very proud of the output of our group…I'm simply not clear how much it is galvanized the public, policymakers, researchers, and students. I would like to see the final report referenced more frequently, and I don't know how to go about doing that.*

On turning the priorities and visions developed within the community into funded research programs and/or instruments:

> *I haven't seen much evidence that CCC has directly contributed to decisions about what should be funded (outside of a small influence at NSF).*
>
> *I answered "a little" as I have not seen any evidence of changes in research programs in any of the funding agencies as a result of the prepared report.*
>
> *Everyone at the event was super excited, but it's harder to keep up the motivation level and then follow up. I think that having a follow up event in 1-2 years or so can really help that.*

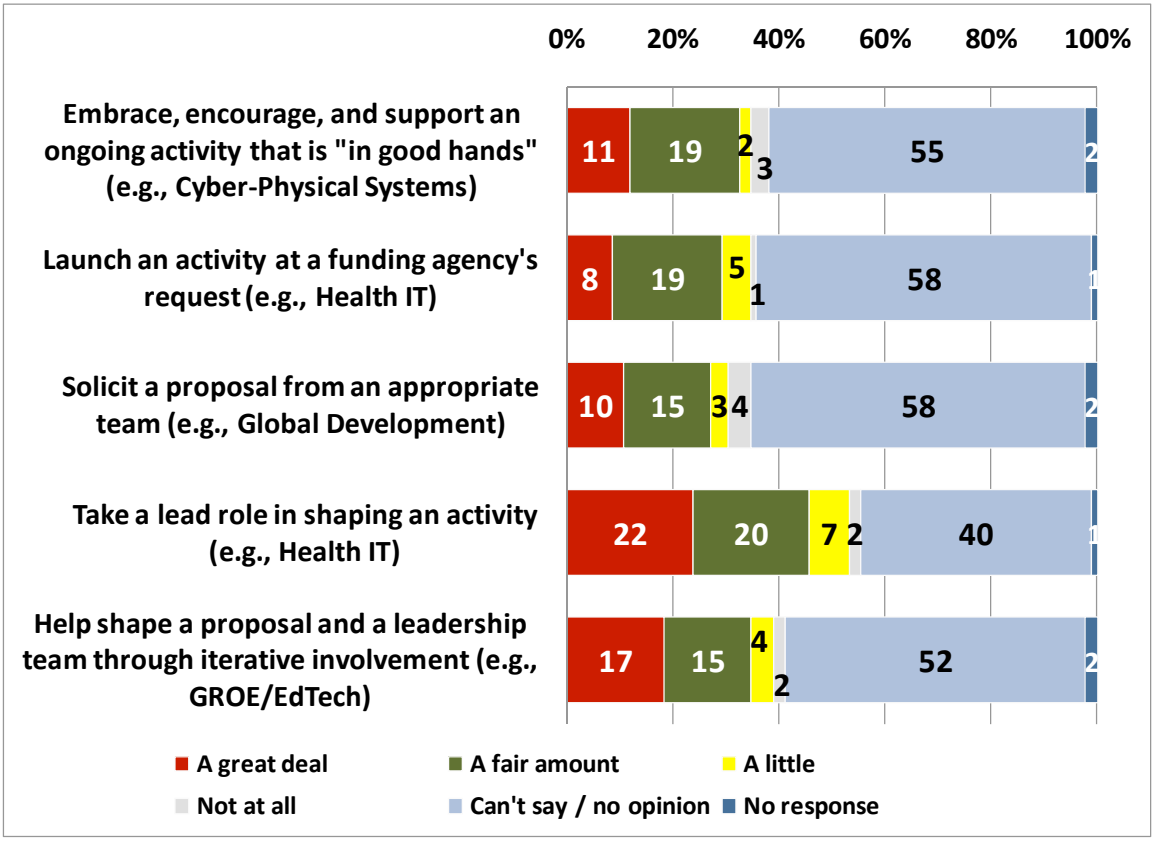
On generating excitement within and about computing research that attracts students of both genders and all ethnic groups into computing research careers:

> *The gender imbalance in the Computing Sciences doesn't seem like something that will be positively affected in the short term by things like visioning exercises.*
>
> *I haven't seen any evidence that CCC is particularly dedicated to promoting diversity. However, I'm not sure that is particularly within its domain and quite possibly should be happening at the university level.*
>
> *I think the workshop missed a big opportunity to connect with young researchers, educators, and students, who grew up in the digital generation.*
>
> *I am not sure prospective students would know where to find the report. They need to be exposed to the concepts.*

These comments seem to reflect some of the flaws pointed out during the qualitative evaluation. Although the objectives of the CCC may be valid, they can be difficult to operationalize. While participants seemed to believe in general that the visioning activities contribute to those objectives, the more critical comments may offer guidance for efforts to improve the visioning process or designing alternative processes. For example, the CCC could help the visioning leaders to develop better approaches to communicating their visions to a broader audience. Also, reaching out to students and potential future researchers could leverage the visions by applying them to motivate or inspire a future generation of researchers.

Figure 16

In your specific experience, how effective has the CCC been in performing each of the following roles for its visioning activities? (Note that most visioning activities had quite different foci and objectives, so that CCC may have performed only one or two of the following roles in a specific activity. Please check "can't say/no opinion" when a particular role is not applicable to your experience.)



In the question for the above table, participants were asked to evaluate the performance of the CCC itself in how it facilitated these visioning activities. In almost all cases, the respondents felt that they were not qualified to make that judgment. In all likelihood, a respondent would need to be fairly closely involved in the planning of a visioning activity to be able to evaluate these types of contributions by the CCC.

Of those who did respond to these questions, most expressed satisfaction with the ability of the CCC to support and facilitate key aspects of the visioning process. Again, those who were dissatisfied (who indicated they felt that the CCC was only "a little" or "not at all" effective at performing one of the roles listed) were invited to provide specific comments regarding that opinion. Relatively few respondents offered such feedback. Almost all of the detailed feedback appeared to be related to the respondents' experiences in the Health IT visioning activity:

On Health IT as an "ongoing activity:"

> *The meeting in fact revealed the chasm among different federal agencies. I don't have the confidence that NSF in particular is encouraged to participate in future Health IT research. The enormity of challenges in health IT, as many NSF sponsored researchers can tell, has not been appreciated by people within health IT. (I have been funded by NSF for the past 10 years.) The spectacular failure (to the tune of ten billion dallars) of the UK's experience in deploying health IT was rarely mentioned. Part of the meeting seemed to focus on what is possible in technical sense (more processors, more bandwidth). The failures in health IT have not been about processing speed and bandwdith. So I don't think the ongoing activity is in "good hands".*

On soliciting a proposal from an appropriate team:

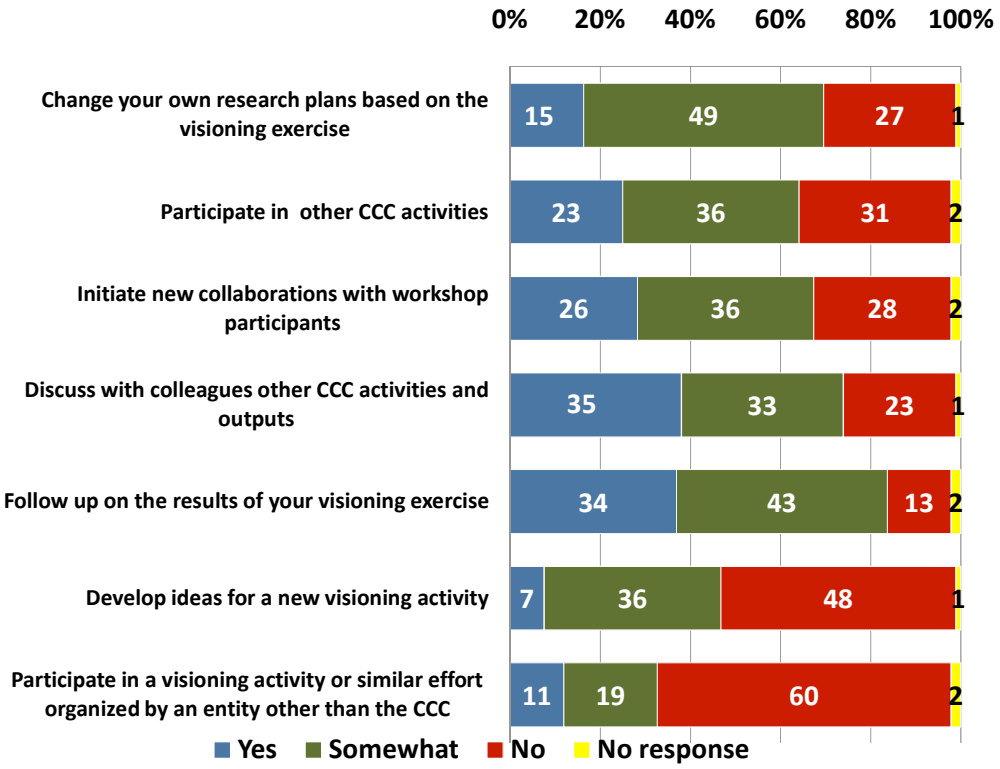
> *Attendance at the event I joined was heavily weighted with academics and lacked end-user balance. More end users with intimate knowledge of "the problem to be solved" would have helped a lot.*

On taking a lead role in shaping the Health IT activity:

> *Very little of the innovative thinking from the Health IT meeting (vis patient-centered, persuasive technologies) made it into any of the resulting RFPs -- which seemed largely to reward the current dominant players (strongly favoring AI-based approaches, use of machine learning to reduce cognitive load on physicians and etc.).*
>
> *There has been NO communication from CCC to the participants of the HIT Workshop in Oct. 2009. The white paper on the CCC/CRA website was not announced to participants. There has been zero communication from CCC.*

The respondents were also asked a question on how their participation in a CCC visioning activity has affected their personal research plans and activities, and their attitude towards future CCC activities or other visioning efforts. The responses are shown in the chart below.

Figure 17
Has your participation in one or more CCC visioning activities encouraged or inspired you to do any of the following:



The respondents in this item seemed to indicate that their participation in the CCC visioning activity had some effect on their personal research career, and also encouraged continued interest in and engagement with the CCC. In particular, nearly 70 percent indicated that the visioning activity at least somewhat influenced their own research plans, and also facilitated the development of new collaborations. This appears to be indicative of the kind of "transformative" effect identified during the interviews—that the visioning activities are most effective when they change the researchers' own behaviors.

A significant share of respondents (approximately 80 percent) indicated that they continued to be interested in the outcomes of their visioning activities. A smaller but still significant share reported that they also talked about the activity with colleagues, and were motivated to participate in future CCC activities.

A relatively small share indicated that they were motivated to propose their own visioning activities, or to participate in similar activities by other organizations. Of those who participated in other activities, most indicated that they took part in later NSF-sponsored workshops on related topics. A few participated in activities sponsored by other

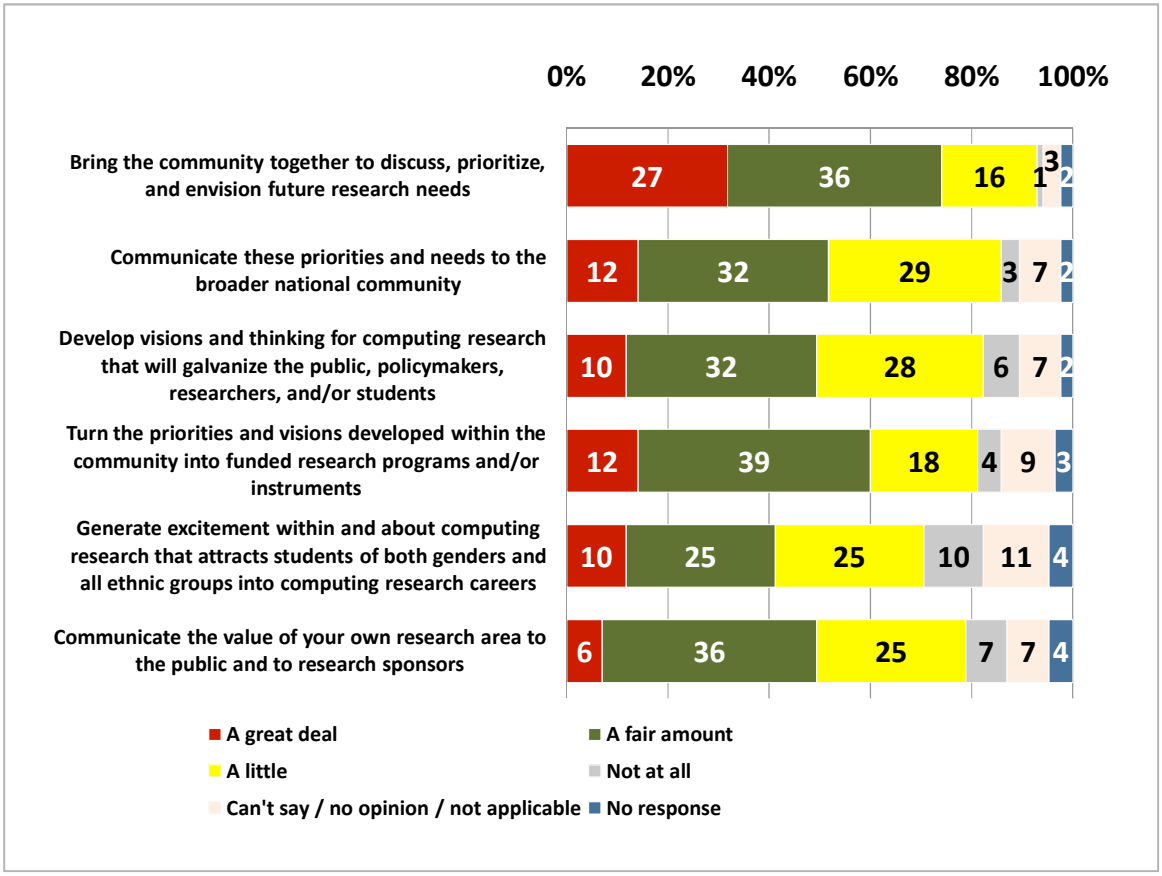
organizations, including the Army Research Office, ACM, and NIH. One also indicated later participation in developing the robotics research roadmap.

3. VIEWS ON THE CURRENT STATUS OF THE COMMUNITY

The CCC visioning participants were asked to provide their views on their assessment of the computing research community's ability to perform some of the functions that the CCC is intended to perform. The results are given in the chart below.

Figure 18

In your judgment, to what degree is the computing research community in the U.S. successful in efforts to carry out the following activities?



These answers indicate that the respondents have some confidence in the ability of the computing research community to organize itself to discuss future research topics and priorities, with over 70 percent indicating that the community is able to organize "a great deal" or "a fair amount." There was slightly less confidence that the community could turn those priorities into research funding. About half of the respondents felt that the community could at least do a fair job in developing visions, communicating priorities to the nation, and describing the value of each researcher's own work to the public.

The respondents displayed the least confidence in the ability of the community to generate excitement about computing research topics among a broad, diverse range of students. This seems to correlate with recent concerns about declining enrollment in computer science degree programs in U.S. universities, and the continuing challenge of outreach to increasing representation in computing research for women and ethnic minorities.

4. NEED FOR AN ORGANIZATION LIKE THE CCC

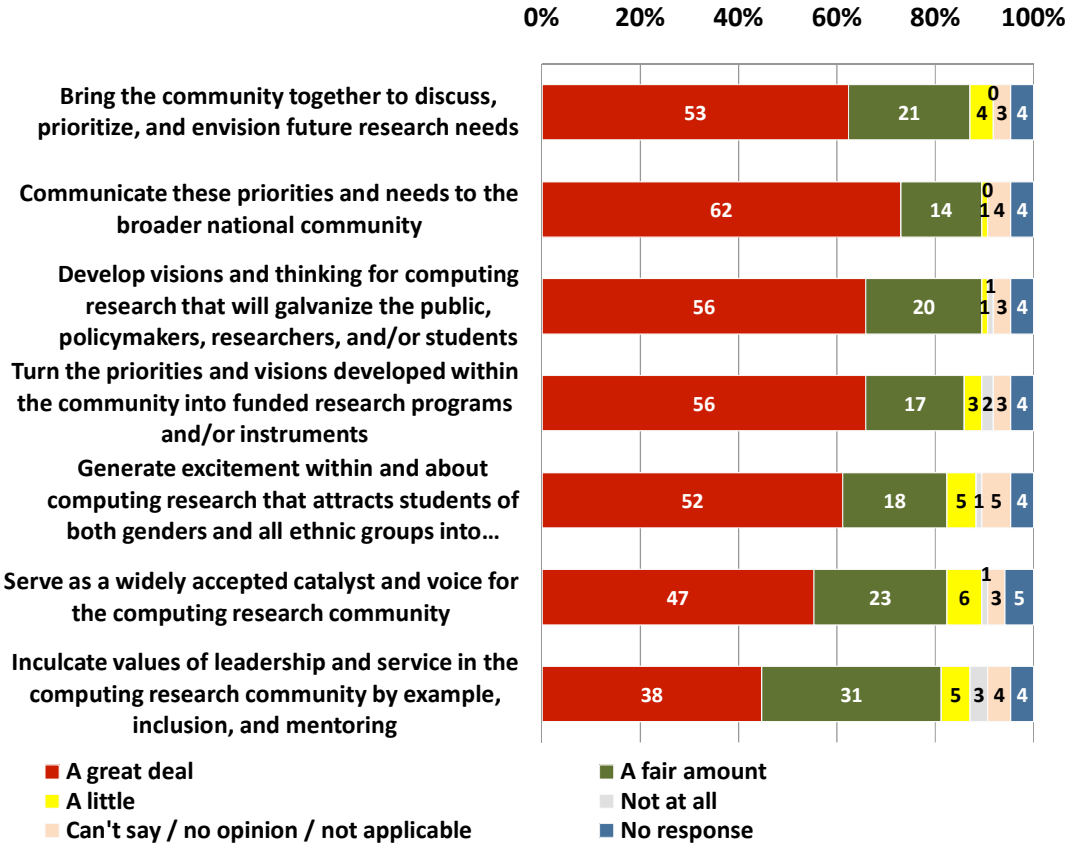
Based on the above question, the respondents were asked more specifically for their views on whether the computing research community could benefit from having an organization that would support the activities mentioned. While the question did not identify that organization as the CCC, the open-ended responses and the context of the question make it reasonable that the CCC is viewed as one such organization.

In the previous item, the respondents indicated that the community is already doing fairly well in performing these activities. This item shows that even with that view, a substantial majority of respondents agreed with the need for a designated organization that could lead such efforts. Over 75 percent of respondents felt that there was "a great deal" of need for an organization to perform at least one such function. Support was strong for an organization to help bring the community together to discuss priorities, to develop visions based on those priorities, and to turn the visions into research programs.

Support was greatest for an organization that could help in communicating research needs and priorities to the nation. In these areas, well over 80 percent of respondents felt that there was "a great deal" or "a fair amount" of need for a designated organization.

A slightly smaller number of respondents supported designating an organization to help in generating more excitement among students about computing research. There was less agreement that the community needs an organization which acts as a "catalyst and voice" for the community, and especially less agreement on the need for an organization to "inculcate values of leadership and service" in the community. Still, more than 80 percent of respondents felt that there was at least "a fair amount" of need for an organization addressing these issues.

Figure 19
As a follow-on to the previous question, how necessary is it to have within the U.S. computing research community an organization designated to perform one or more of the following activities?



D. Results of Community Survey

The survey of the computing research community attempted to derive some sense of the community's views on its ability to self-organize in performing the functions assigned to the CCC, and on the status of the community regarding its ability to generate visions that are supported internally and communicated externally. This survey was structured deliberately so that the respondents would not be led immediately to associate those functions with the CCC.

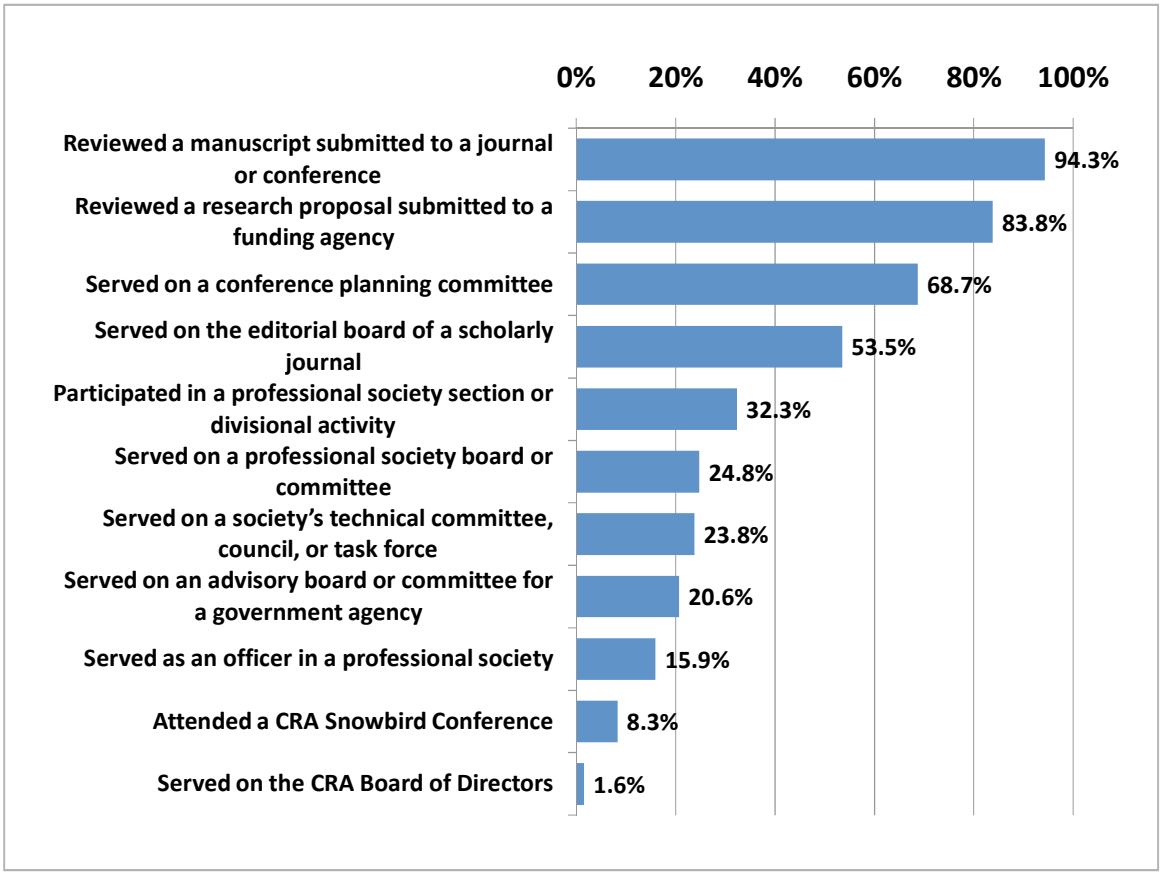
1. Involvement in the Computing Research Community

First, the respondents were asked to report on their own involvement in various service-oriented activities in the computing research community. The results are shown below. The

respondents reflect a moderate level of commitment to service. A substantial number of respondents have served as reviewers, but a minority have participated in professional society activities, or served in a leadership capacity in professional societies or in organizations supporting government agencies.

Figure 20

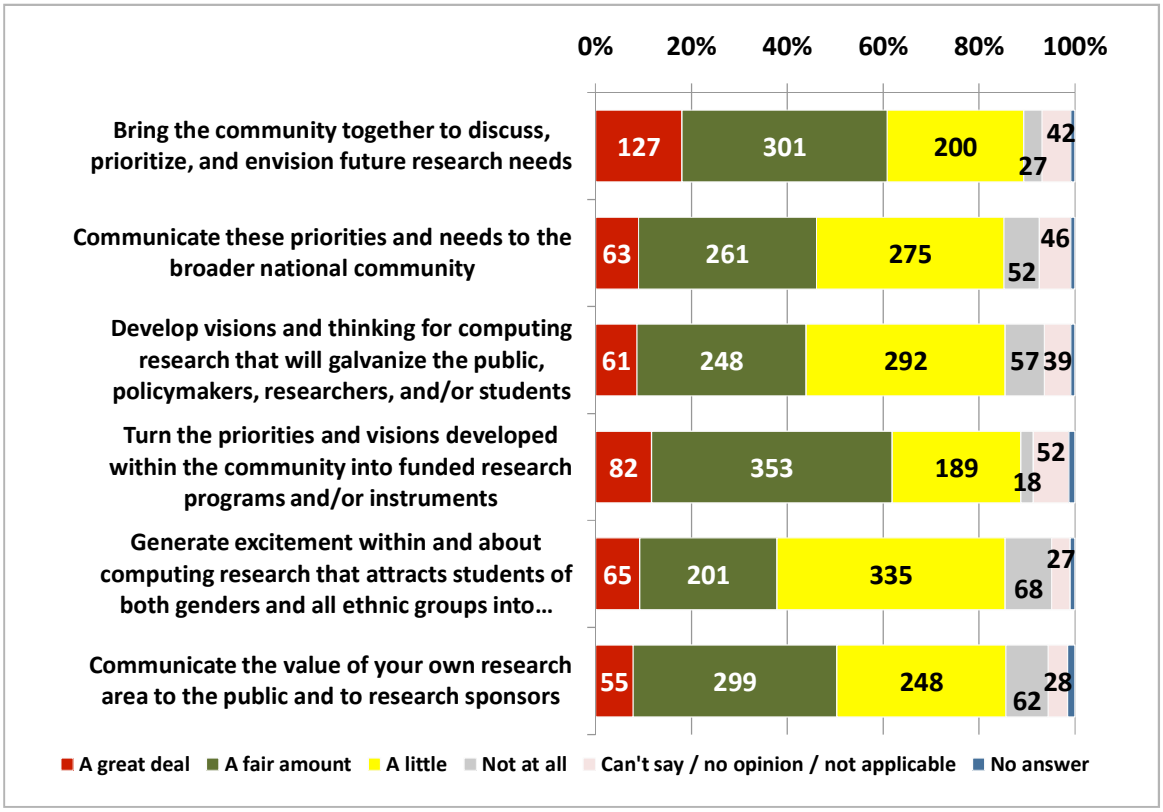
What services have you provided to computer research professional societies and related organizations during past five years?



2. VIEWS ON THE CURRENT STATUS OF THE COMMUNITY

The survey recipients were then asked for their views on how well the computing research community was already performing key functions undertaken by the CCC.

Figure 21
In your judgment, to what degree is the computing research community in the U.S. successful in efforts to carry out the following activities? In thinking about your responses to this question, compare the computing research community's current functioning with that of other research communities with which you are familiar, such as physics, engineering, medicine, or the biological sciences.



At least 60 percent of respondents felt that the community was doing at least fairly well in convening the community to discuss and prioritize future research needs, and in turning priorities and visions into funded research programs. However, approximately 25 percent of respondents think that the community is only "a little" effective in these functions.

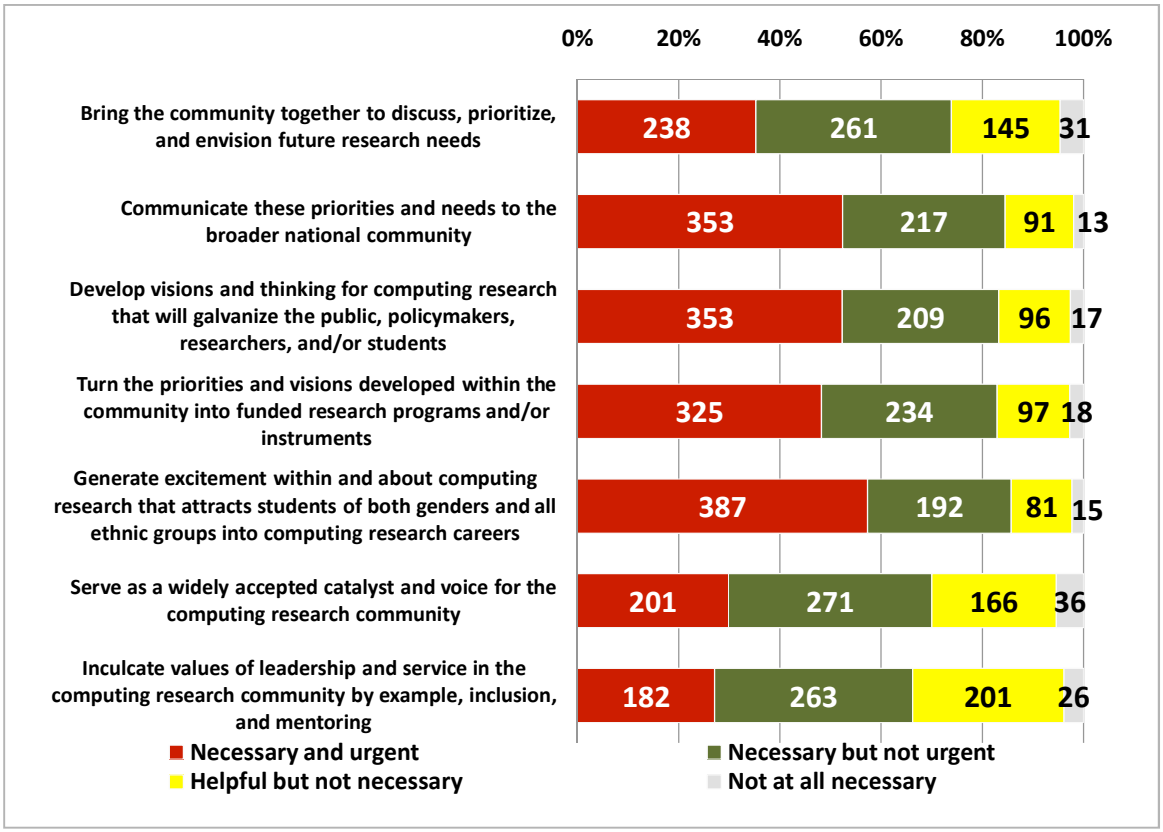
The respondents displayed less confidence in the community's ability to develop visions that can galvanize the public, policymakers, researchers and students. They also viewed the community as less effective at communicating research needs and the value of research to the public. Less than 50 percent of respondents felt that the community did at least fairly well in those functions.

Finally, similar to the CCC participants surveyed, relatively few community respondents (less than 40 percent) felt that the community was doing at least a fairly good job of generating excitement about computing research to attract students to research careers.

The survey recipients were then asked to decide if the community could benefit from having an organization designated to pursue the seven strategic goals of the CCC. The survey instrument did not mention the CCC in this item or in any prior item, and so these responses were meant to gauge whether an organization like the CCC was viewed as helpful, rather than evaluating the CCC itself.

Figure 22

As a follow-on to the previous question, how necessary is it to have within the U.S. computing research community an organization designated to perform one or more of the following activities?



In keeping with the responses to the previous survey item, the respondents felt the greatest need for an organization to "generate excitement within and about computing research that attracts students…" Since the respondents felt that the community was least successful in performing this function on its own, it is logical that they would indicate that some kind of organizational leadership is needed. Over 85 percent of respondents felt that an organization which addresses this objective is "necessary."

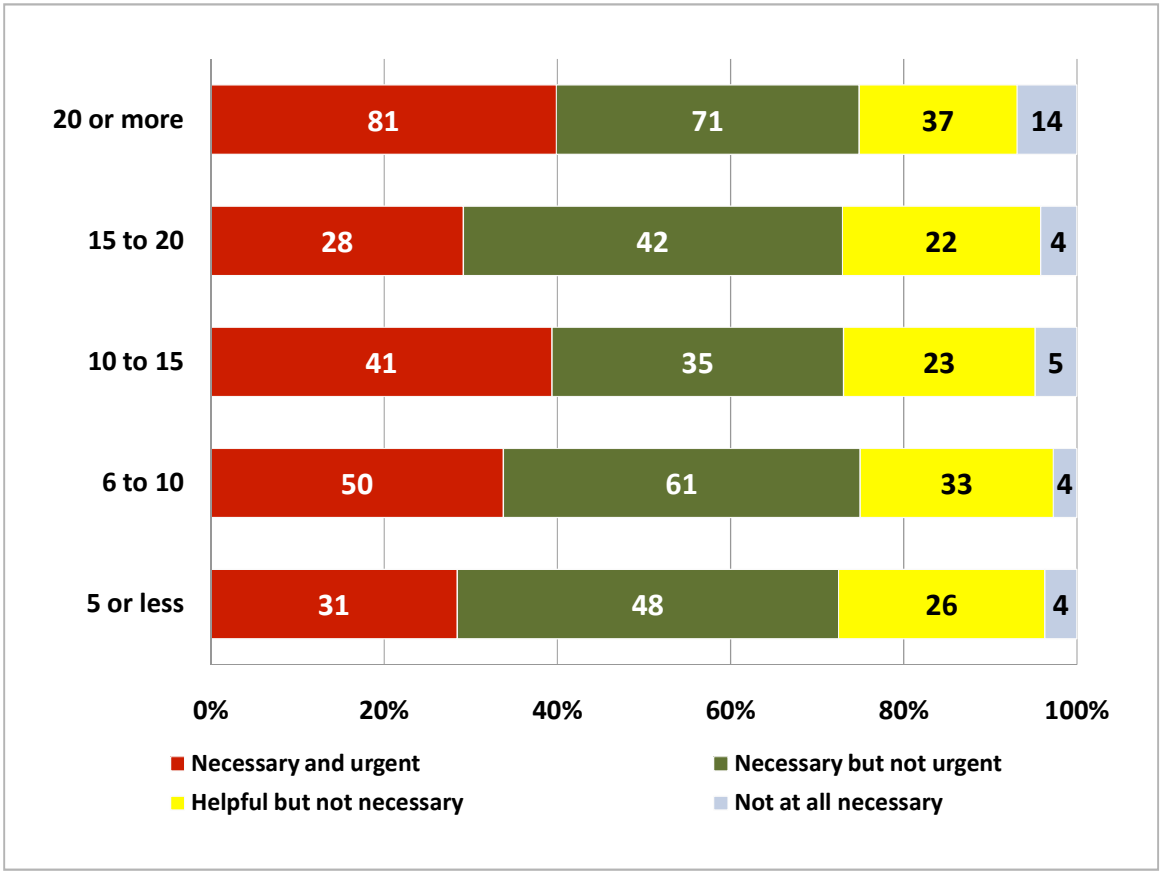
The respondents also expressed strong support for the idea that an organization is needed to develop visions for computing research to galvanize the public, communicate future research priorities and needs to the nation, and develop funded research programs around those visions and priorities. Approximately 84 percent of respondents felt that an organization is needed in these three areas of concern.

Support was somewhat lower, but still strong, for the other goals. Approximately 74 percent of respondents felt that the community needed an organization to bring researchers together to discuss, prioritize and envision future research needs. Approximately 70 percent felt that the community needed an organization to serve as a voice or a catalyst for computing research. Finally, 66 percent indicated that it is necessary to have an organization that inculcates values of service and leadership in the community. Even on this last point, the fact that the respondents felt that assigning that responsibility to a designated organization, rather than leaving it solely up to the community and its research institutions, seems significant.

As an exploration of the data, we attempted to see if there was some difference in support for this idea between various cohorts within the computing research community. The interviews for the qualitative component elicited some claims that the computing research community used to do a fairly good job of identifying and prioritizing research needs, when it was a smaller community and had strong leadership from institutions such as DARPA. One could surmise that more senior researchers would feel that the community is still doing reasonably well at this function without a designated responsible organization. Therefore, we took the responses to the item on whether an organization is needed to bring the community together to discuss, prioritize and envision research needs, and broke down those responses by the level of experience of the respondents.

The results show remarkable consistency across all cohorts in the share of researchers who feel that such an organization is necessary. That share ranged between 72 percent and 75 percent for each cohort. This indicates that the perceived need for such an organization is not a generational issue, but is consistent among both junior and senior researchers.

Figure 23 (Analysis by years of experience)
As a follow-on to the previous question, how necessary is it to have within the U.S. computing research community an organization designated to perform one or more of the following activities?

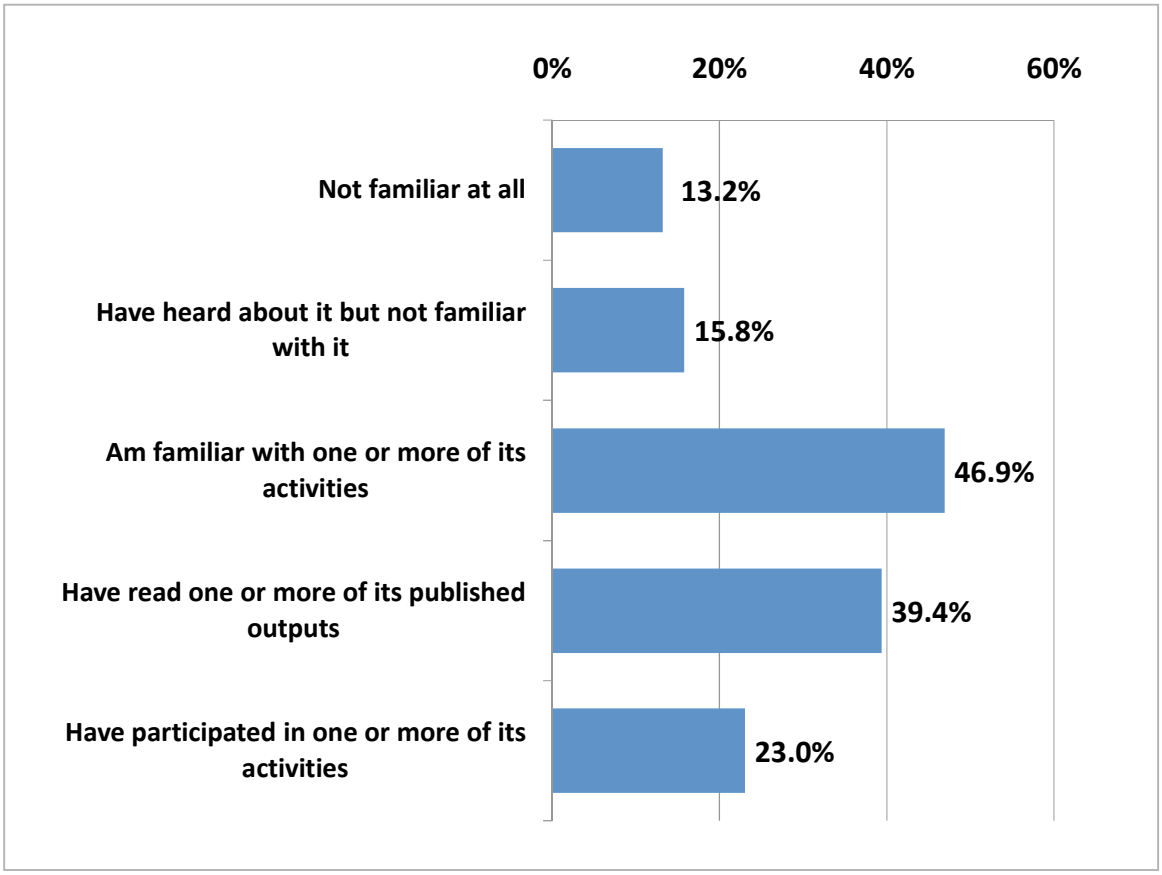


3. AWARENESS OF THE CCC AND CRA

The next few survey items attempt to determine how widely the CCC is recognized by members of the computing research community. The survey first asked respondents for their familiarity with the Computing Research Association. The CRA, as a much older and more established organization, provides a helpful baseline to determine the level of general awareness among respondents about the institutions of the computing research community. As expected, a relatively low share of respondents was unfamiliar with the CRA. Note that respondents could select more than one of the options for this item.

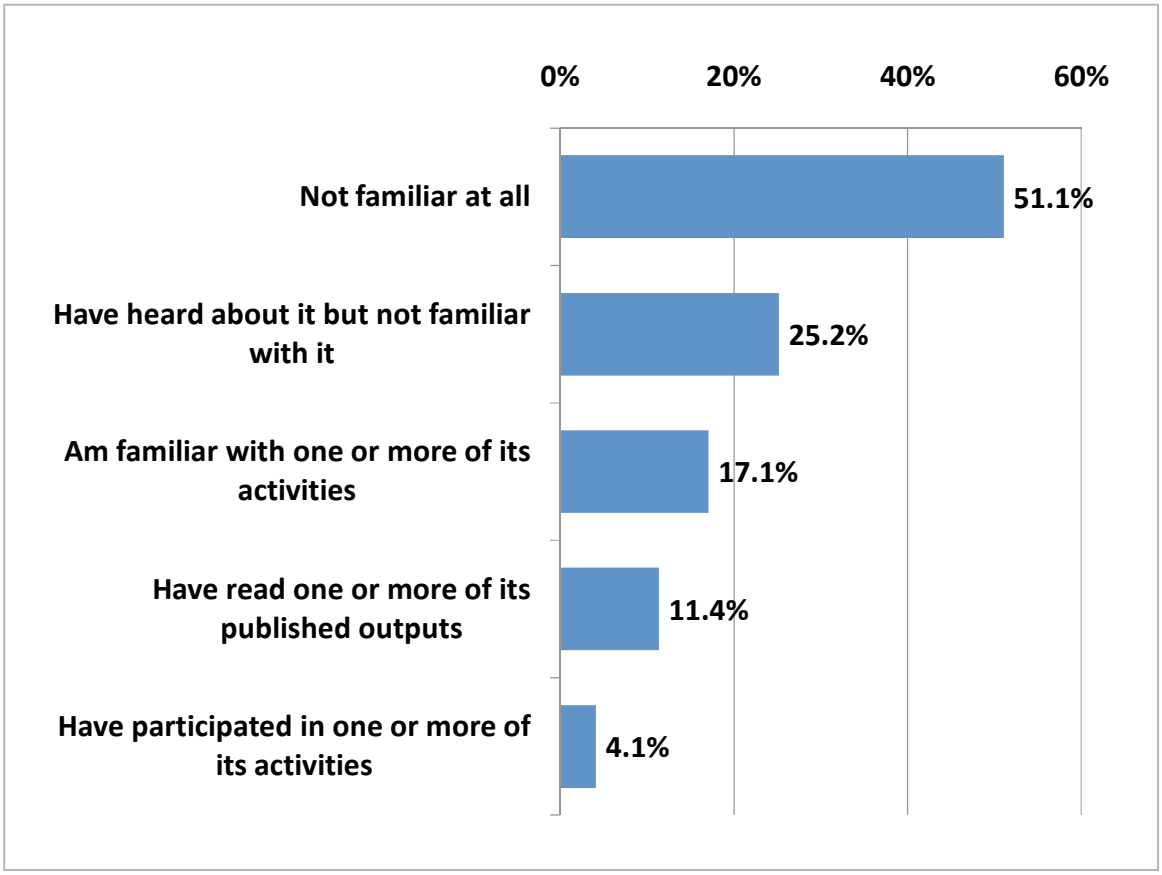
Figure 24

What is your level of familiarity with the Computing Research Association (CRA)?



The respondents were then asked a similar question about their level of familiarity with the CCC.

Figure 25
What is your level of familiarity with the Computing Community Consortium (CCC)?

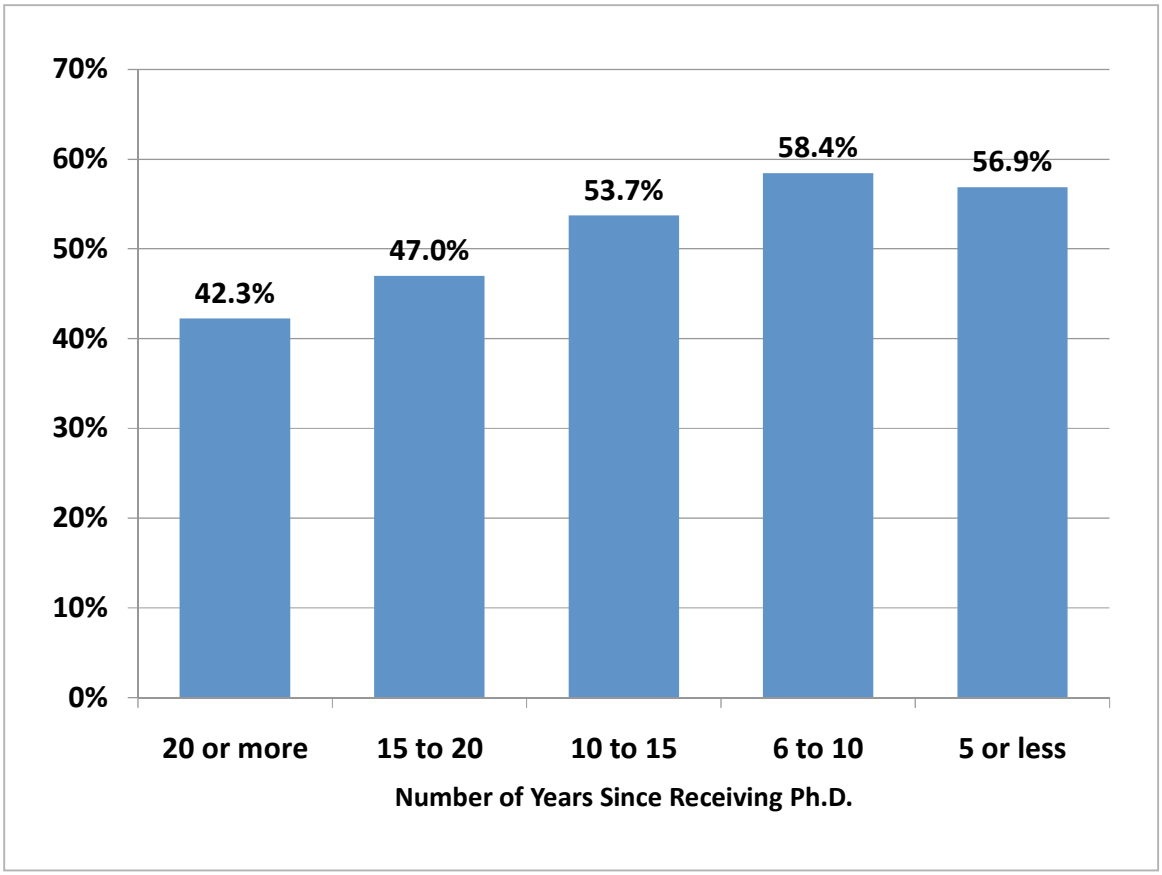


This indicates that the CCC still faces a challenge in getting its "brand" recognized across the community. Over 50 percent of respondents showed no familiarity with the CCC. Another 25 percent had only heard of the CCC but did not seem knowledgeable about what the CCC does. If the CCC desires to be more well-known throughout the community, it still requires more effort in this area. It should be noted, however, that the analysis of the nature of the survey respondents revealed that a substantial number are not members of computer science or computer engineering departments. Since regular CCC communications typically are distributed by the CRA, which only counts computer science and computer engineering departments as members, the CCC is reaching out to an audience beyond the CRA membership.

Some of the principals involved in the CCC who were interviewed for this project indicated that the CCC has initially focused on raising awareness among key leaders in the computing research community. While age of the researcher is not an exact proxy for determining "senior leadership," we assume that researchers with more years of experience are more likely to hold positions of influence (formal and informal) in the community. To evaluate the progress along this path, we looked at the number of

respondents who stated that they are *unfamiliar* with the CCC, and broke out that pool by years of experience.

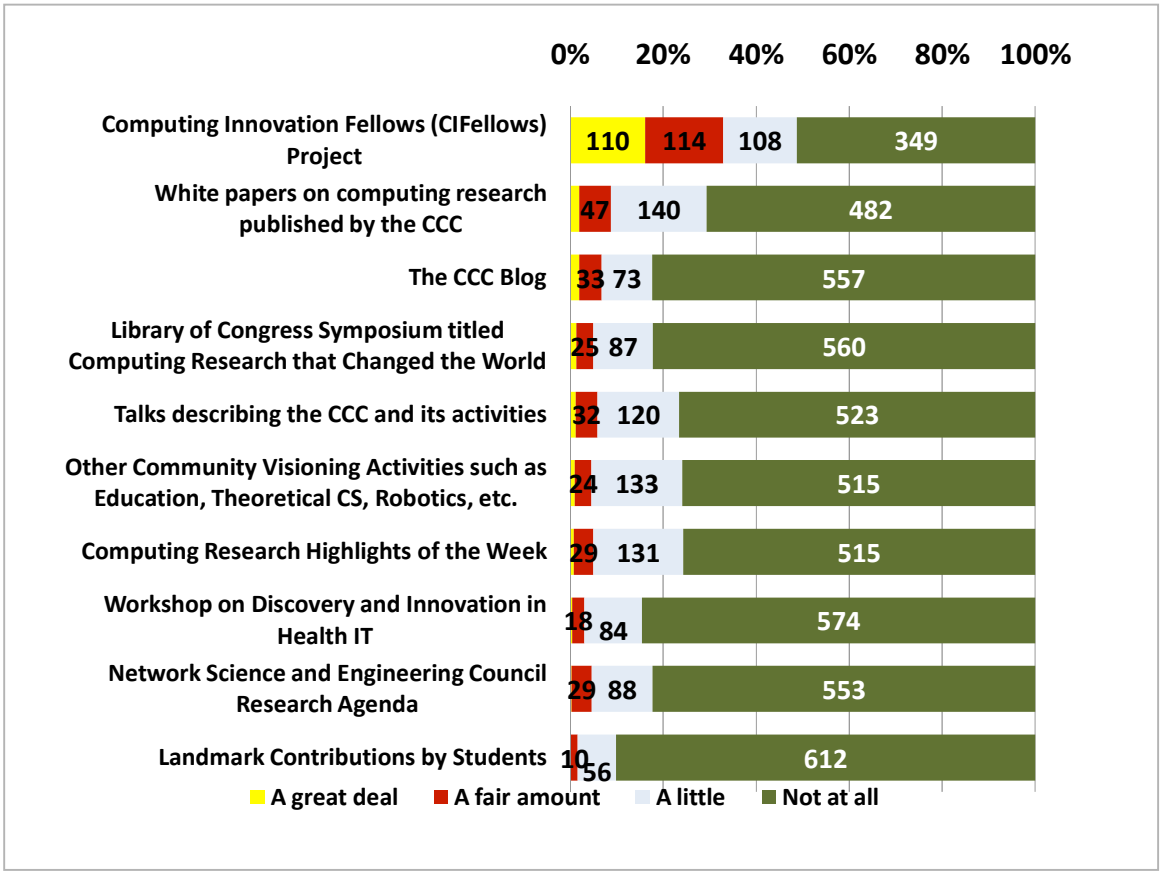
Figure 26
What is your level of familiarity with the Computing Community Consortium (CCC)?
(% responding "Not familiar at all")



This indicates that a larger share of more experienced researchers are at least familiar with the CCC, and also that awareness seems broader among researchers with more years in the research community. Still, over 40 percent of the most senior researchers reporting that they are not at all familiar with the CCC.

We then asked the survey recipients if they were familiar with particular CCC activities, on the premise that some may have heard of the activities without necessarily associating them with the CCC. Those responses are shown below.

Figure 27
The following are some of the major activities of the CCC. Please check your level of familiarity with each



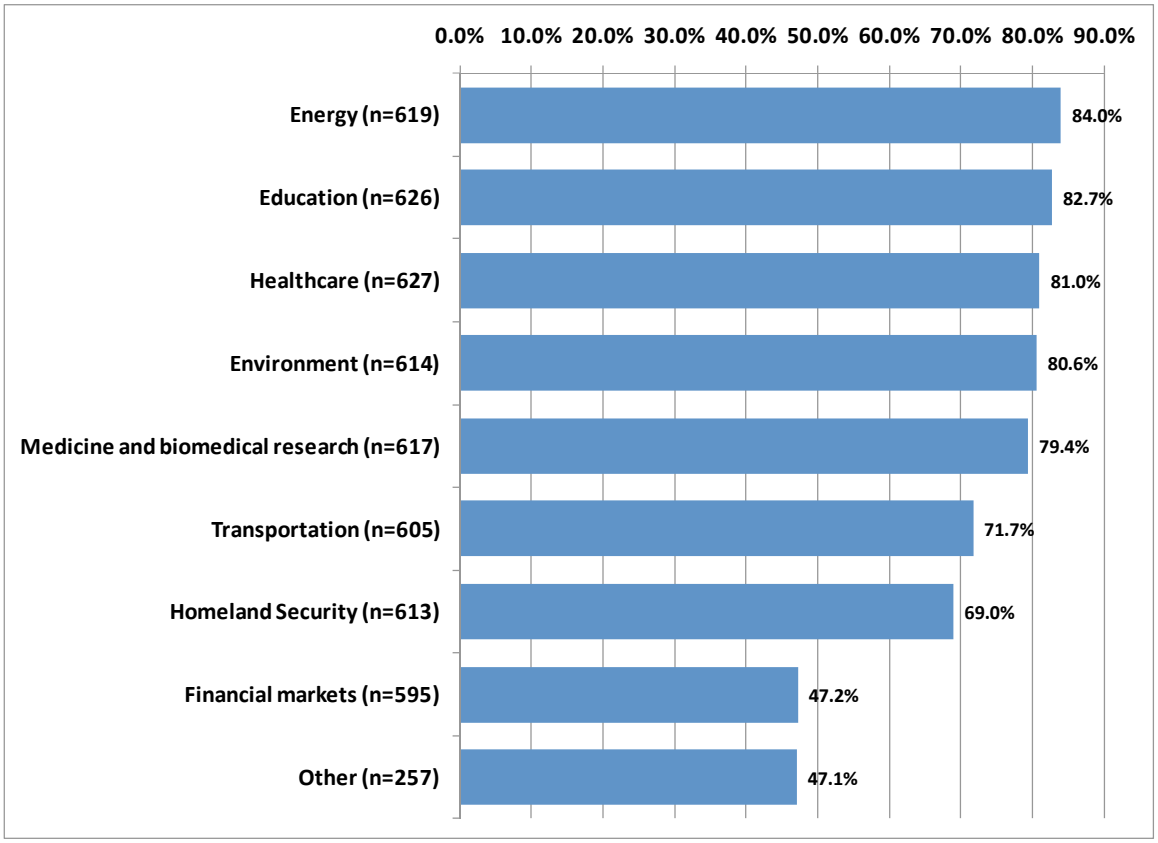
The CIFellows Project is clearly the most prominent and visible activity of the CCC, with approximately 50 percent of respondents reporting that they are familiar with the activity, and nearly 20 percent stating that they are greatly familiar with it. (As another indication of this visibility, over 1,000 computing researchers registered to be potential mentors to CIFellows after the Project was launched.) Among its other activities, the CCC white papers apparently have broadest reach, with approximately 30 percent of respondents indicating familiarity with that activity. Across the other activities, more than 75 percent of respondents stated that they are "not at all" familiar with those activities.

4. VIEWS ON COMPUTING RESEARCH FOR SOCIETAL OBJECTIVES

As data to help the CCC with future planning, the survey also asked recipients about the idea of directing computing research to support more progress in areas of national and societal concern. This item attempted to determine if members of the computing research community felt that research activities should be directed towards particular goals or outcomes of societal concern.

Figure 28

Should a concerted effort be made by the computing research community to foster directed research efforts and funding applicable to the following areas of national concern?



These data show that energy is viewed as a high priority. Moreover, directed research in energy issues was supported by 520 of the total response pool, which shows that a majority of the respondents are in favor of the more general idea that at least some computing research should be directed at broader national and societal issues. There was also broad support for directing research towards issues related to education, healthcare, environment, and biomedical research. Relatively few researchers felt that there would be a benefit from directing research towards financial markets.

A number of respondents indicated a few other areas of potential directed research covering a broad range of issues, including wireless technology, K-12 education (as opposed to education in general), software assurance, software productivity, privacy, agriculture, and sustainability. However, a few pointed out that computing research by its very nature can be applied to many areas of interest beyond computing itself, and that broadening the potential impact of computing research is a desirable goal. One such respondent wrote:

Just about everything we do is influenced to a greater or lesser extent by computing. We should be continuing to develop our field in all ways, but we should be looking into effective interactions with other disciplines for the benefit of all. Some areas that are not mentioned above include communication, art and music and theatre, psychology (and its potential contributions to HCI, for example), law and other areas that are heavily information dependent, all areas of information access, including libraries of all types. We need to have computing recognized as a discipline that brings problem solving approaches to all kinds of endeavors, and we should also recognize what we can learn from other disciplines.

IV. CONCLUSION

The findings above suggest that the CCC can be viewed as a research effort as well as an effort to improve the research environment for computing. From that perspective, the organization should be evaluated based not only on its direct results, but also on its indirect contributions to the community in which it operates and on the members of that community. A number of such indirect effects can be identified:

- The CCC has helped individual subcommunities to organize and pursue new visions of their own research with beneficial effects. For example, the CCC visioning activity on robotics has helped the leaders of that activity to raise awareness of the research area among funding sponsors, and contributed to the development of new funding initiatives.

- The CCC enables a new form of collective action within the computing research community. According to the informed observers interviewed, the community has resisted in the past efforts at organized self-advocacy. The community seems to be more welcoming of such efforts today, and the CCC can contribute substantially by providing a platform for such efforts.

- The CCC provides a new and useful resource for the policy community and the research funding agencies which differs substantially from other organizations. By virtue of its membership and structure, the CCC Council can provide rapid feedback on policy issues related to computing research. The Council also contributes expertise to related efforts. For example, when the President's Council of Advisers on Science and Technology conducted a review of the interagency NITRD program in 2010, many members of the working group for that review were drawn from the CCC Council.

- The CCC is helping to change community behavior by promulgating new visions that influence researchers' own ideas, collaborations, and communication. This illustrates how the CCC is encouraging researchers to change how they view their own research fields and their own efforts to pursue research interests.

In summary, we find that the following:

- The CCC has made effective use of its available resources in carrying out its mission and activities. The CCC's funding is modest relative to the amount of work it has accomplished. It should be noted that the CCC has been able to leverage its resources by capitalizing on the volunteer efforts of many accomplished volunteers, many of whom are luminaries in the field. This has amplified the reach, capabilities, and reputation of the CCC.

- The CCC has undertaken a wide range of activities beyond its original sponsorship of community-driven visioning activities. It has produced white papers which are useful in explaining the value of computing research to outsiders, particularly in the policy community. It has organized and implemented the CIFellows Project, which helped to retain postdoctoral researchers as members of the computing research community and advanced their careers and abilities. While the CCC has taken on these additional activities in an opportunistic fashion, simply by recognizing a need and then responding to that need, all of the activities are consistent with the organization's mission and strategic goals.

- In its outputs, the CCC has been prolific. It has organized multiple visioning activities, produced a range of white papers, created the process for funding and mentoring CIFellows, supported the activities of numerous visioning activity leaders and CCC Council members, all while helping Council members to publicize the organization through talks, presentations, and other interactions. It should be noted that the CCC committed itself very early in its formation to begin producing outputs and to be transparent in its operations, by publishing its own strategic plan and Council meeting minutes on the Web site.

- In terms of outcomes, we believe that it is too early to be able to capture the full impact of the CCC's activities on the computing research community and on the field. Much of the CCC's initial period of existence was consumed by the process of forming the group and determining its strategy—a necessary phase to ensure the organization's effectiveness, but one which necessarily meant that its impact was limited for some time. The survey data show promising signs that the CCC is having an effect on the behavior of computing researchers, especially by catalyzing new collaborations between investigators and providing ideas for new research directions to be pursued. There are also clear instances where the CCC's visioning activities have been an important input into decisions on the funding of computing research and the focus of that funding. Not all CCC activities have produced such promising effects, but given the dynamics of the field and the complexity of the research funding environment, the CCC produced some notable outcomes in a short period of time.

We also identify some areas where the CCC could focus some of its future efforts to produce potential increases in its effectiveness. One of the most problematic aspects of this evaluation was that the CCC lacks a clear, explicit definition of its primary output—new "research visions." The qualitative data in particular show that there is some ambiguity among stakeholders over what a vision should contain, and what impact it can be expected to have. Providing greater clarity about what does or does not constitute a "research vision" would help an assessing if the visioning activities produce their intended

outputs, which in turn would aid in linking those outputs to tangible (and possibly intangible) outcomes.

The CCC also may benefit from diversifying its sources of funding and its interactions with research sponsors. While the CCC so far has done significant work in defining and stabilizing its relationship with the NSF (its most important stakeholder), the CCC Council members and other recognize that the organization now needs to reach out to other funding agencies so that its visions can have broader visibility and effect. Also, the decision to put aside work on international outreach and collaboration might be revisited, as the CCC is producing visions which could also be useful to researchers in other countries.

The survey data and interviews show that the computing research community sees public outreach regarding the value of its research as a top priority. Therefore, outreach and education (regarding the future of computing research) should be a key part of the CCC's agenda for the future. We find that the CCC has used the emerging capabilities of social media on the Internet to increase its reach and visibility effectively. A preliminary analysis of pageviews of the CCC web site revealed that visitors to the site originate from throughout the United States and many foreign countries as well. We note that since the hiring of the CCC Director, Dr. Gianchandani, the CCC has increased dramatically the frequency of postings on the CCC Blog, the diversity of media produced (including some video interviews, etc.), and also received recognition from outside organizations (notably on the OSTP blog). We are aware that the CCC Council engaged a public relations firm to work on its messaging and outreach strategy, but we are not sure how the Council plans to follow up on that strategy.

A final key area of concern is the CCC's succession strategy. As noted above, the CCC's effectiveness is enhanced greatly by the efforts of a very active CCC Council and the contribution in particular of Prof. Lazowska. The CCC Council has brought in more junior faculty as members to promote their standing as potential future leaders in the computing research community, but there is opportunity for the CCC to address this issue more systematically. The survey data show that the CCC can encourage greater interest and service to the community through its visioning activities as well. It is possible that those activities will have a particular impact on graduate students and younger researchers who participate, and so engaging that newer generation of researchers is particularly important.

This evaluation attempted in part to answer the question of whether the CCC represents a good use of resources for the computing research community. Answering this question requires assessing the outcomes of CCC efforts, and our first observation is that it is too early to provide a definitive answer. The total impact of all of the CCC's activities is difficult to capture and quantify in a systematic fashion. The CCC continues to evolve and learn, and is challenged to operate in an environment that is very dynamic and complex.

It may also take years before it is possible to determine whether the effects were beneficial to the entire community The data collected for this evaluation do cannot predict the precise benefits that will be gained. Still, those data do indicate that the CCC is enabling positive forms of change within the computing research community, using modalities that have not been attempted in computing research across such a broad scope of domains.

In this sense, the CCC is a form of sociological experimentation, but one that could have very significant benefits if the experiment is allowed to run its course. CCC stakeholders clearly have mixed feelings about whether or not the CCC should become a permanent, ongoing institution within the community. At the very least, the preliminary results indicate sufficient promise to merit continuation of the CCC effort, especially so that the results of this experiment can be more fully analyzed and assessed at a later time. As one stakeholder summarized, "It may be too early to say if the CCC is a good idea…but it's definitely too early to say that it *isn't* a good idea."

Appendix A: Survey Instruments

Computing Research Community Survey

Welcome
Thank you very much for agreeing to respond to this national survey of the computing research community. The survey is part of a larger study being conducted by SRI International under contract to the Computing Research Association, and funded by the National Science Foundation's Directorate for Computer and Information Science and Engineering under NSF Grant Nos. 0637190, 0937060 and 1019343. A primary purpose of the study is to identify ways in which the computing research community can be more effective in achieving goals such as envisioning future research needs and communicating the value of computing research to the public and to research sponsors. By completing the survey, which will require only about 10 minutes of your time, you will be contributing significantly to future advances in computing research and education and to their positive impact on society.

Privacy Notice
Information from this data collection system will be retained by SRI International, a non-profit research institute, on behalf of the Computing Research Association. Data will be disclosed outside of SRI only in an aggregated form, to mask the connection between individual responses and the personal identifying information of the respondent. Data submitted using this survey instrument will be used in accordance with criteria established by NSF for monitoring research and education grants, and in response to Public Law 99-383 and 42 USC 1885c. If you have any questions or concerns about this survey, please contact the study director, Dr. Jeffrey Alexander, at jeffrey.alexander@sri.com.

Background information

The following information will help us interpret your responses to subsequent questions. All your responses to this questionnaire are strictly confidential and will not be released to anyone outside our small survey project team.

1 Which of the following kinds of organizations is your current primary employer?

Please choose **only one** of the following::
College/university
Industrial research laboratory
Other for-profit organization
Non-profit organization
Government agency
Other:

2 What is your current academic rank?

Only answer this question if the following conditions are met:
° Answer was 'College/university' at question '5 [employment]' (By which of the following kinds of organizations are you currently employed?)
Please choose **only one** of the following:
Professor
Associate professor
Assistant professor
Adjunct professor
Instructor or lecturer
Research associate
Other

3 What is your current tenure status?

Only answer this question if the following conditions are met:
° Answer was 'College/university' at question '5 [employment]' (By which of the following kinds of organizations are you currently employed?)
Please choose **only one** of the following:
Doesn't apply; No tenure system here
Tenured
On tenure track but not tenured
Not on tenure track

4 What is your primary departmental affiliation?

Only answer this question if the following conditions are met:
° Answer was 'College/university' at question '5 [employment]' (By which of the following kinds of organizations are you currently employed?)
Please choose **only one** of the following:
Computer Science
Computer Engineering
Electrical Engineering
Mathematical Sciences
Other

5 Which of the following academic degrees have you received to date?

Please choose **all** that apply:
Ph.D
M.D.
J.D.
M.B.A.
M.S./M.A.
B.S./B.A.

6 Please indicate the number of years since your Ph.D. was conferred.

Only answer this question if the following conditions are met:
° Answer was at question '9 [degrees]' (Which of the following academic degrees have you received to date?)
Please choose **only one** of the following:
5 or less
6 to 10
10 to 15
15 to 20
20 or more

7 What is your current job title or position?

Please write your answer here:

Your involvement in the in the computing research community

8 To what professional societies related to computer research do you currently belong?

Please choose **all** that apply:
Association for the Advancement of Artificial Intelligence (AAAI)
Association for Computing Machinery (ACM)
Institute of Electronics and Electrical Engineers (IEEE)
Society for Industrial and Applied Mathematics (SIAM)
USENIX Association (The Advanced Computing Systems Association)
American Medical Informatics Association (AMIA)
Other:

9 What services have you provided to computer research professional societies and related organizations during past five years?

Please choose **all** that apply:

Participated in a professional society section or divisional activity
Served as an officer in a professional society
Served on a professional society board or committee
Served on a society's technical committee, council, or task force
Served on a conference planning committee
Served on the editorial board of a scholarly journal
Reviewed a manuscript submitted to a journal or conference
Attended a CRA Snowbird Conference
Served on the CRA Board of Directors
Reviewed a research proposal submitted to a funding agency
Served on an advisory board or committee for a government agency
Other:

Your perceptions of the current status of the computing research community

10 In your judgment, to what degree is the computing research community in the U.S. successful in efforts to carry out the following activities? In thinking about your responses to this question, compare the computing research community's current functioning with that of other research communities with which you are familiar, such as physics, engineering, medicine, or the biological sciences.

Please choose the appropriate response for each item:

	Not at all	A little	A fair amount	A great deal	Can't say / no opinion
Bring the community together to discuss, prioritize, and envision future research needs					
Communicate these priorities and needs to the broader national community					
Develop visions and thinking for computing research that will galvanize the public, policymakers, researchers, and/or students					
Turn the priorities and visions developed within the community into funded research programs and/or instruments					

	Not at all	A little	A fair amount	A great deal	Can't say / no opinion
Generate excitement within and about computing research that attracts students of both genders and all ethnic groups into computing research careers					
Communicate the value of your own research area to the public and to research sponsors					

11 Please explain briefly the basis for your judgment that the computing research community is "not at all" or "a little" successful in its efforts to "bring the community together to discuss, prioritize, and envision future research needs."

Only answer this question if the following conditions are met:

° Answer was 'A little' or 'Not at all' at question '13 [communityfunctioning]'

Please write your answer here:

12 Please explain briefly the basis for your judgment that the computing research community is "not at all" or "a little" successful in its efforts to "communicate these priorities and needs to the broader national community"

Only answer this question if the following conditions are met:

° Answer was 'Not at all' or 'A little' at question '13 [communityfunctioning]'

Please write your answer here:

13 Please explain briefly the basis for your judgment that the computing research community is "not at all" or "a little" successful in its efforts to "develop visions and thinking for computing research that will galvanize the public, policymakers, researchers, and/or students."

Only answer this question if the following conditions are met:

° Answer was 'Not at all' or 'A little' at question '13 [communityfunctioning]'

Please write your answer here:

14 Please explain briefly the basis for your judgment that the computing research community is "not at all" or "a little" successful in its efforts to "turn the priorities and visions developed within the community into funded research programs and/or instruments."

Only answer this question if the following conditions are met:

° Answer was 'Not at all' or 'A little' at question '13 [communityfunctioning]'

Please write your answer here:

15 Please explain briefly the basis for your judgment that the computing research community is "not at all" or "a little" successful in its efforts to "generate excitement within and about computing research that attracts students of both genders and all ethnic groups into computing research careers."

Only answer this question if the following conditions are met:

° Answer was 'Not at all' or 'A little' at question '13 [communityfunctioning]'

Please write your answer here:

16 Please explain briefly the basis for your judgment that the computing research community is "not at all" or "a little" successful in its efforts to "communicate the value of your own research area to the public and to research sponsors"

Only answer this question if the following conditions are met:
° Answer was 'Not at all' or 'A little' at question '13 [communityfunctioning]'
Please write your answer here:

17 As a follow-on to the previous question, how necessary is it to have within the U.S. computing research community an organization designated to perform one or more of the following activities?

Please choose the appropriate response for each item:

	Not at all necessary	Helpful but not necessary	Necessary but not urgent	Necessary and urgent	Can't say / no opinion
Bring the community together to discuss, prioritize, and envision future research needs					
Communicate these priorities and needs to the broader national community					
Develop visions and thinking for computing research that will galvanize the public, policymakers, researchers, and/or students					
Turn the priorities and visions developed within the community into funded research programs and/or instruments					
Generate excitement within and about computing research that attracts students of both genders and all ethnic groups into computing research careers					
Serve as a widely accepted catalyst and voice for the computing research community					
Inculcate values of leadership and service in the computing research community by example, inclusion, and mentoring					

18 Please briefly explain the basis for your judgment that having an organization within the computing research community which will "bring the research community together to discuss, prioritize, and envision future research needs" is "not at all necessary" or "helpful but not necessary."
Only answer this question if the following conditions are met:
° Answer was 'Not at all' or 'A little' at question '17 [orgneed]'
Please write your answer here:

19 Please briefly explain the basis for your judgment that having an organization within the computing research community which will "communicate these priorities and needs to the broader national community" is "not at all necessary" or "helpful but not necessary."
Only answer this question if the following conditions are met:
° Answer was 'Not at all' or 'A little' at question '17 [orgneed]'
Please write your answer here:

20 Please briefly explain the basis for your judgment that having an organization within the computing research community which will "develop visions and thinking for computing research that will galvanize the public, policymakers, researchers, and/or students" is "not at all necessary" or "helpful but not necessary."
Only answer this question if the following conditions are met:
° Answer was 'A little' or 'Not at all' at question '17 [orgneed]'
Please write your answer here:

21 Please briefly explain the basis for your judgment that having an organization within the computing research community which will "turn the priorities and visions developed within the community into funded research programs and/or instruments" is "not at all necessary" or "helpful but not necessary."
Only answer this question if the following conditions are met:
° Answer was 'A little' or 'Not at all' at question '17 [orgneed]'
Please write your answer here:

22 Please briefly explain the basis for your judgment that having an organization within the computing research community which will "generate excitement within and about computing research that attracts students of both genders and all ethnic groups into computing research careers" is "not at all necessary" or "helpful but not necessary."
Only answer this question if the following conditions are met:
° Answer was 'A little' or 'Not at all' at question '17 [orgneed]'
Please write your answer here:

23 Please briefly explain the basis for your judgment that having an organization within the computing research community which will "serve as a widely accepted catalyst and voice for the computing research community" is "not at all necessary" or "helpful but not necessary."
Only answer this question if the following conditions are met:
° Answer was 'Not at all' or 'A little' at question '17 [orgneed]'
Please write your answer here:

24 Please briefly explain the basis for your judgment that having an organization within the computing research community which will "inculcate values of leadership and service in the computing research community by example, inclusion, and mentoring" is "not at all necessary" or "helpful but not necessary."

Only answer this question if the following conditions are met:
° Answer was 'Not at all' or 'A little' at question '17 [orgneed]'
Please write your answer here:

25 In your opinion, is there a need for a postdoctoral program in computing research in the U.S.?

Please choose **only one** of the following:
No, not at all
Yes, but only operated intermittently, such as to provide recent Ph.D.s in computing research positions in times of weak labor markets
Yes, on an ongoing basis
Yes, on an ongoing basis but only with other limitations, such as limiting the duration of each postdoctoral position to one or two years (please specify any limitations you wish to name)
Only answer this question if the following conditions are met:
Answer was 'Yes, on an ongoing basis but with other limitations' at question 25

26 What is your level of familiarity with the Computing Research Association (CRA)?

Please choose **all** that apply:
Not familiar at all
Have heard about it but not familiar with it
Am familiar with one or more of its activities
Have read one or more of its published outputs
Have participated in one or more of its activities

27 What is your level of familiarity with the Computing Community Consortium (CCC)?

Please choose **all** that apply:
Not familiar at all
Have heard about it but not familiar with it
Am familiar with one or more of its activities
Have read one or more of its published outputs
Have participated in one or more of its activities

Your perceptions of the role of the CCC in the computing research community

As you are probably aware, the Computing Community Consortium (CCC) was established as a mechanism to "provide a voice for the national computing research community," and to "facilitate the development of a bold, multi-themed vision for computing research and education that will communicate that vision to a wide range of major stakeholders." The following questions deal with your knowledge of the CCC's activities and your views about the extent to which the computing research actually needs an organization like the CCC to undertake specific activities to help achieve these goals.

28 The following are some of the major activities of the CCC. Please check your level of familiarity with each:

Please choose the appropriate response for each item:

	Not at all	**A little**	**A fair amount**	**A great deal**
Talks describing the CCC and its activities				
White papers on computing research published by the CCC				
The CCC Blog				
Computing Research Highlights of the Week				
Landmark Contributions by Students				
Library of Congress Symposium titled *Computing Research that Changed the World*				
Computing Innovation Fellows (CIFellows) Project				
Network Science and Engineering Council Research Agenda				
Workshop on Discovery and Innovation in Health IT				
Other Community Visioning Activities such as Education, Theoretical CS, Robotics, etc.				

29 Please suggest briefly how the CCC could be more effective in achieving its goals

Please write your answer here:

30 Should a concerted effort be made by the computing research community to foster directed research efforts and funding applicable to the following areas of national concern?

Please choose the appropriate response for each item:

	Yes	No
Healthcare		
Medicine and biomedical research		
Financial markets		
Education		
Energy		
Environment		
Transportation		
Homeland Security		
Other (please specify below)		

31 Please specify in any other areas of national concern besides those listed above in which the computing research community should make a concerted effort to foster directed research efforts and funding:

Please write your answer here:

Demographics

These questions are used for classification purposes only. They are not used to link your answers to your personal identity.

32 What is your sex?

Please choose **only one** of the following:
Female
Male

33 Are you Hispanic or Latino?

Please choose **only one** of the following:
Yes
No

34 What is your racial background?

Please choose **all** that apply:
American Indian or Alaskan Native
Native Hawaiian or Pacific Islander
Asian
Black or African American
White

35 What is your age?

Please choose **only one** of the following:
Under 30
30 to 39
40 to 49
50 to 59
60 to 69
70 or older

CCC Community Visioning Exercise Participant Survey

Welcome
Thank you very much for agreeing to respond to this survey of participants in the Computing Community Consortium's Special Initiatives and Community Visioning Activities. The survey is part of a larger study being conducted by SRI International under contract to the Computing Research Association, and funded by the National Science Foundation's Computer and Information Science and Engineering Directorate under NSF Grant Nos. 0637190, 0937060 and 1019343. A primary purpose of the survey is to learn of your experiences as a participant in one or more CCC activities or initiatives in order to assess their value and improve their effectiveness. By completing the survey, which will require only about 20 minutes of your time, you will be contributing significantly to future advances in computing research and teaching and to their positive impact on society.

Privacy Notice
Information from this data collection system will be retained by SRI International, a non-profit research institute, on behalf of the Computing Research Association. Data will be disclosed outside of SRI only in an aggregated form, to mask the connection between individual responses and the personal identifying information of the respondent. Data submitted using this survey instrument will be used in accordance with criteria established by NSF for monitoring research and education grants, and in response to Public Law 99-383 and 42 USC 1885c. If you have any questions or concerns about this survey, please contact the study director, Dr. Jeffrey Alexander, at jeffrey.alexander@sri.com.

Background information

The following information will help us interpret your responses to subsequent questions. All your responses to this questionnaire are strictly confidential and will not be released to anyone outside our small research project team.

1 Which of the following kinds of organizations is your current primary employer?

Please choose **only one** of the following:
College/university
Industrial research laboratory
Other for-profit organization
Non-profit organization
Government agency
Other: _____

1a What is your current academic rank?

Only answer this question if the following conditions are met:
° Answer was 'College/university' at question '5 [employment]' (By which of the following kinds of organizations are you currently employed?)
Please choose **only one** of the following:
Professor
Associate professor
Assistant professor
Adjunct professor
Instructor or lecturer
Research associate
Other

1b What is your current tenure status?

Only answer this question if the following conditions are met:
° Answer was 'College/university' at question '5 [employment]' (By which of the following kinds of organizations are you currently employed?)
Please choose **only one** of the following:
Doesn't apply; no tenure system here
Tenured
On tenure track but not tenured
Not on tenure track

1c What is your primary departmental affiliation?

Only answer this question if the following conditions are met:
° Answer was 'College/university' at question '5 [employment]' (By which of the following kinds of organizations are you currently employed?)
Please choose **only one** of the following:
Computer Science
Computer Engineering
Electrical Engineering
Mathematical Sciences
Other

2 Which of the following academic degrees have you received to date?

Please choose **all** that apply:
Ph.D
M.D.
J.D.
M.B.A.
M.S./M.A.
B.S./B.A.

3 Please indicate the number of years since your Ph.D. was conferred.

Only answer this question if the following conditions are met:
° Answer was at question '9 [degrees]' (Which of the following academic degrees have you received to date?)
Please choose **only one** of the following:
5 or less
6 to 10
10 to 15
15 to 20
20 or more

4 What is your current job title or position?

Please write your answer here:

Your participation in CCC community visioning exercises

5 How did you first learn about the CCC community visioning exercises?

Please write your answer here:

6 What influenced you to participate in a visioning exercise?

Please write your answer here.

7 In which of the following visioning exercises have you participated?

Please choose **all** that apply:
Network Science and Engineering
Theoretical Computer Science
Big Data Computing
Robotics
Cyber-Physical Systems
Global Development
Free and Open Source Software
Global Resources for Online Education
Cross-Layer Reliability
Discovery and Innovation in Health IT
Advancing Computer Architecture Research
Interactive Technologies

Your assessment of the effectiveness of the visioning exercises in serving the computing research community

8 Looking over your experience in participating in one or more of CCC's visioning exercises, how effective have these exercises been in accomplishing each of the following functions of the computer research community?

Please choose the appropriate response for each item:

	Not at all	A little	A fair amount	A great deal	Can't say / no opinion
Bring the research community together to discuss, prioritize, and envision future research needs					
Communicate these challenges and needs to the broader national community					
Create within the computing research community research visions and thinking that will galvanize the public, policymakers, researchers, and students					
Help turn the needs and visions developed within the community into funded research programs and/or instruments					
Generate excitement within computing research and use that excitement to attract students of both genders and all ethnic groups into computing research careers					

8a Please explain the basis for selecting "not at all" or "a little" for effectiveness of visioning exercises to "Bring the research community together to discuss, prioritize, and envision future research needs."

Only answer this question if the following conditions are met:
° Answer was 'A little' or 'Not at all' at question '14 [cccgoal]'
Please write your answer here:

8b Please explain the basis for selecting "not at all" or "a little" for effectiveness of visioning exercises to "Communicate these challenges and needs to the broader national community."

Only answer this question if the following conditions are met:
° Answer was 'Not at all' or 'A little' at question '14 [cccgoal]'
Please write your answer here:

8c Please explain the basis for selecting "not at all" or "a little" for effectiveness of visioning exercises to "Create within the computing research community research visions and thinking that will galvanize the public, policymakers, researchers, and students."

Only answer this question if the following conditions are met:
° Answer was 'Not at all' or 'A little' at question '14 [cccgoal]'
Please write your answer here:

8d Please explain the basis for selecting "not at all" or "a little" for effectiveness of visioning exercises to "Help turn the needs and visions developed within the community into funded research programs and/or instruments."

Only answer this question if the following conditions are met:
° Answer was 'Not at all' or 'A little' at question '14 [cccgoal]'
Please write your answer here:

8e Please explain the basis for selecting "not at all" or "a little" for effectiveness of visioning exercises to "Generate excitement within computing research and use that excitement to attract students of both genders and all ethnic groups into computing research careers."

Only answer this question if the following conditions are met:
° Answer was 'Not at all' or 'A little' at question '14 [cccgoal]'
Please write your answer here:

8f Please explain the basis for selecting "not at all" or "a little" for effectiveness of visioning exercises to "Serve as a widely accepted catalyst and voice for the computing research community."

Only answer this question if the following conditions are met:
° Answer was 'Not at all' or 'A little' at question '14 [cccgoal]'
Please write your answer here:

8g Please explain the basis for selecting "not at all" or "a little" for effectiveness of visioning exercises to "Inculcate values of leadership and service in the computing research community by example, inclusion, and mentoring."

Only answer this question if the following conditions are met:
° Answer was 'Not at all' or 'A little' at question '14 [cccgoal]'
Please write your answer here:

9 In your specific experience, how effective was CCC in accomplishing each of the following roles? (Note that most visioning experiences had quite different foci and objectives, so that CCC was significantly engaged in only one or two roles in each exercise. Please check "can't say/no opinion" when a particular role was not appropriate to your workshop experience.)

Please choose the appropriate response for each item:

	Not at all	A little	A fair amount	A great deal	Can't say / no opinion
Embrace, encourage, and support an ongoing activity that is "in good hands" (e.g., Cyber-Physical Systems)					
Launch an activity at a funding agency's request (e.g., Health IT)					
Solicit a proposal from an appropriate team (e.g., Global Development)					
Take a lead role in shaping an activity (e.g., Health IT)					
Help shape a proposal and a leadership team through iterative involvement (e.g., Global Resources for Online Education)					

9a Please explain the basis for selecting "not at all" or "a little" for effectiveness of CCC's role in visioning exercises to "Embrace, encourage, and support an ongoing activity that is "in good hands" (e.g., Cyber Physics Systems) ."

Only answer this question if the following conditions are met:

° Answer was 'Not at all' or 'A little' at question '22 [cccroleeffective]'

Please write your answer here:

9b Please explain the basis for selecting "not at all" or "a little" for effectiveness of CCC's role in visioning exercises to "Launch an activity at a funding agency's request (e.g., Health IT) ."

Only answer this question if the following conditions are met:
° Answer was 'Not at all' or 'A little' at question '22 [cccroleeffective]'
Please write your answer here:

9c Please explain the basis for selecting "not at all" or "a little" for effectiveness of CCC's role in visioning exercises to "Solicit a proposal from an appropriate team (e.g., Global Development) ."

Only answer this question if the following conditions are met:
° Answer was 'Not at all' or 'A little' at question '22 [cccroleeffective]'
Please write your answer here:

9d Please explain the basis for selecting "not at all" or "a little" for effectiveness of CCC's role in visioning exercises to "Take a lead role in shaping and activity (e.g., Health IT) ."

Only answer this question if the following conditions are met:
° Answer was 'Not at all' or 'A little' at question '22 [cccroleeffective]'
Please write your answer here:

9e Please explain the basis for selecting "not at all" or "a little" for effectiveness of CCC's role in visioning exercises to "Help shape a proposal and a leadership team through iterative involvement (e.g., Global Resources for Online Education) ."

Only answer this question if the following conditions are met:
° Answer was 'Not at all' or 'A little' at question '22 [cccroleeffective]'
Please write your answer here:

10 Has your participation in one or more CCC visioning exercises encouraged or inspired you to do any of the following:

Please choose the appropriate response for each item:

	No	Somewhat	Yes	Can't say / no opinion
Change your own research plans based on the visioning exercise				
Participate in other CCC activities				
Initiate new collaborations with workshop participants				
Discuss with colleagues other CCC activities and outputs				
Follow up on the results of your visioning exercise				

	No	Somewhat	Yes	Can't say / no opinion
Develop ideas for a new visioning activity				
Pursue greater involvement in another professional activity (please describe below)				

10a Please explain your answer for "Pursue greater involvement in another professional activity"
Only answer this question if the following conditions are met:
° Answer was 'Somewhat' or yes' at question '30 [particaffect]'
Please write your answer here:

11 What recommendations do you have for increasing the value of future CCC visioning exercises?
Please write your answer here:

Your perceptions of the current status of the computing research community

12 In your judgment, to what degree is the computing research community in the U.S. accomplishing each of the following functions? In thinking about your responses to this question, compare the computing research community's current functioning with that of other research communities with which you are familiar, such as physics, engineering, medicine, or the biological sciences. engineering, medicine, or the biological sciences.
Please choose the appropriate response for each item:

	Not at all	A little	A fair amount	A great deal	Can't say / no opinion
Organizing itself to bring the community together to discuss, prioritize, and envision future research needs					
Communicating these challenges and needs to the broader national community					
Developing research visions and thinking that will galvanize the public, policymakers, researchers, and students					

	Not at all	A little	A fair amount	A great deal	Can't say / no opinion
Turning the needs and visions developed within the community into funded research programs and/or instruments					
Generating excitement within computing research that attracts students of both genders and all ethnic groups into computing research careers					
Communicating the value of your own research to the public and to research sponsors					

12a Please explain briefly the basis for your "not at all" or "a little" judgment for the computing research community's accomplishment of "organizing itself to bring the community together to discuss, prioritize, and envision future research needs."

Only answer this question if the following conditions are met:
° Answer was 'A little' or 'Not at all' at question '13 [communityfunctioning]'
Please write your answer here:

12b Please explain briefly the basis for your "not at all" or "a little" judgment for the computing research community's accomplishment of "communicating these challenges and needs to the broader national community"

Only answer this question if the following conditions are met:
° Answer was 'Not at all' or 'A little' at question '13 [communityfunctioning]'
Please write your answer here:

12c Please explain briefly the basis for your "not at all" or "a little" judgment for the computing research community's accomplishment of "developing research visions and thinking that will galvanize the public, policymakers, researchers, and students."

Only answer this question if the following conditions are met:
° Answer was 'Not at all' or 'A little' at question '13 [communityfunctioning]'
Please write your answer here:

12d Please explain briefly the basis for your "not at all" or "a little" judgment for the computing research community's accomplishment of "turning the needs and visions developed within the community into funded research programs and/or instruments."

Only answer this question if the following conditions are met:
° Answer was 'Not at all' or 'A little' at question '13 [communityfunctioning]'
Please write your answer here:

12e Please explain briefly the basis for your "not at all" or "a little" judgment for the computing research community's accomplishment of "generating excitement within computing research that attracts students of both genders and all ethnic groups into computing research careers."

Only answer this question if the following conditions are met:
° Answer was 'Not at all' or 'A little' at question '13 [communityfunctioning]'
Please write your answer here:

12f Please explain briefly the basis for your "not at all" or "a little" judgment for the computing research community's accomplishment of "communicating the value of your own research to the public and to research sponsors"

Only answer this question if the following conditions are met:
° Answer was 'Not at all' or 'A little' at question '13 [communityfunctioning]'
Please write your answer here:

13 As a follow on to the previous question, how great is the need in the U.S. for a specific organization to accomplish each of the following functions for the computing research community??

Please choose the appropriate response for each item:

	Not at all	A little	A fair amount	A great deal	Can't say / no opinion
Bring the research community together to discuss, prioritize, and envision future research needs					
Communicate these challenges and needs to the broader national community					
Create within the computing research community visions and thinking that will galvanize the public, policymakers, researchers, and students					
Help turn the needs and visions developed within the community into funded research programs and/or instruments					
Generate excitement within computing research and use that excitement to attract students of both genders and all ethnic groups into computing research careers					
Serve as a widely accepted catalyst and voice for the computing research community					

	Not at all	A little	A fair amount	A great deal	Can't say / no opinion
Inculcate values of leadership and service in the computing research community by example, inclusion, and mentoring					

13a Please briefly explain the basis for your "not at all" or "a little" response for the need to "bring the research community together to discuss, prioritize, and envision future research needs"

Only answer this question if the following conditions are met:
° Answer was 'Not at all' or 'A little' at question '20 [orgneed]'
Please write your answer here:

13b Please briefly explain the basis for your "not at all" or "a little" response for the need to "communicate these challenges and needs to the broader national community"

Only answer this question if the following conditions are met:
° Answer was 'Not at all' or 'A little' at question '20 [orgneed]'
Please write your answer here:

13c Please briefly explain the basis for your "not at all" or "a little" response for the need to "create within the computing research community visions and thinking that will galvanize the public, policymakers, researchers, and students"

Only answer this question if the following conditions are met:
° Answer was 'A little' or 'Not at all' at question '20 [orgneed]'
Please write your answer here:

13d Please briefly explain the basis for your "not at all" or "a little" response for the need to "help turn the needs and visions developed within the community into funded research programs and/or instruments"

Only answer this question if the following conditions are met:
° Answer was 'A little' or 'Not at all' at question '20 [orgneed]'
Please write your answer here:

13e Please briefly explain the basis for your "not at all" or "a little" response for the need to "generate excitement within computing research and use that excitement to attract students of both genders and all ethnic groups into computing research careers"

Only answer this question if the following conditions are met:
° Answer was 'A little' or 'Not at all' at question '20 [orgneed]'
Please write your answer here:

13f Please briefly explain the basis for your "not at all" or "a little" response for the need to "serve as a widely accepted catalyst and voice for the computing research community"

Only answer this question if the following conditions are met:
° Answer was 'Not at all' or 'A little' at question '20 [orgneed]'
Please write your answer here:

13g Please briefly explain the basis for your "not at all" or "a little" response for the need to "inculcate values of leadership and service in the computing research community by example, inclusion, and mentoring"

Only answer this question if the following conditions are met:
° Answer was 'Not at all' or 'A little' at question '20 [orgneed]'
Please write your answer here:

14 In your opinion, is there a need for a postdoctoral program in computer science in the U.S.?

Please choose **only one** of the following:
No, not at all
Yes, under all circumstances
Yes, but with the duration of an individual postdoc position restricted to a short timeframe (1-2 years)
Yes, but only to retain recent computing research Ph.D.s in the field in times of weak labor markets
Yes, but only under other conditions (please specify)
Make a comment on your choice here:

Demographics

These questions are used for classification purposes only. They are not used to link your answers to your personal identity.

15 What is your sex?

Please choose **only one** of the following:
Female
Male

16 Are you Hispanic or Latino?

Please choose **only one** of the following:
Yes
No

17 What is your racial background?

Please choose **all** that apply:
American Indian or Alaskan Native
Native Hawaiian or Pacific Islander
Asian
Black or African American
White

18 What is your age?

Please choose **only one** of the following:
Under 30
30 to 39
40 to 49
50 to 59
60 to 69
70 or older