Broader Impact Area #3

Enhance Infrastructure for Research And Education

This report describes discussions regarding the broader impact criteria enhance infrastructure for research and education. The discussions took place during the National Science Foundation's (NSF) Broader Impacts Summit held on June 22-23, 2010.

1 Definition of Broader Impact Area: Enhance Infrastructure for Research and Education

The Broader Impact Criterion of Enhance Infrastructure for Research and Education is aimed at examining the extent to which projects create organizational or physical structures to support education or research. Organizational structures can include collaborations between disciplines and institutions, academic institutions and industry or government, or between U.S. and international partners. Physical structures can include computation and computing resources such as databases, networks, or digital libraries. These activities can serve to provide the infrastructure enabling non-partners to utilize the resources in support of their own research. Likewise, any of the aforementioned structures can be used to support educational activities as well.

2 Current Exemplary Activities that Enhance Infrastructure for Research and Education

The breadth of research areas within the computer science discipline made it difficult to narrow the list of exemplary activities to include a few examples. Therefore the group identified categories that can be used to describe the types of broader impact activities that can enhance infrastructures for research and education. The majority of the discussion revolved around the nature of the categories, rather than specific examples, however the list below includes the examples that were presented during the large group session as well as a few examples that were mentioned during the group breakout discussions.

2.1 Shared Resources

- The TeraGrid [1] is the world's largest cyberinfrastrure for open scientific research combining resources from eleven partner sites. In this project high-performance computers, data resources and tools are integrated using high-performance network connections. This infrastructure provides researchers with access to discipline-specific databases, computing capacity, and online and archival data storage.

- The Southern California Earthquake Center [2] is an example of a shared data repository. The mission of the center is to gather data on earthquakes, integrate data into a physics-based understanding of earthquakes and to communicate to society useful knowledge for understanding earthquake risk. This center was described as exemplary because it is organized around a particular research area with distributed researchers around the country who collaborate to build a shared collection of data available for public use.

2.2 Government and Industry Partnerships

- The Industrial Partnership Program at Oak Ridge Laboratory [3] is similar to the TeraGrid project however this project supports collaborations between industry and the government, i.e. Oak Ridge Laboratory. The availability of these systems enables companies, who may not have the computational power themselves, to solve complex computational problems. This project also requires that projects that are not proprietary make their scientific results available to educate the broader scientific and research community.

2.3 Availability of Research Specific Tools

- Carnegie Mellon University hosts a Testbed for Repeatable, Easy to Control Wireless Networking Experiments [4]. Wireless networking research is challenging because traveling signals are affected by physical environment, including movement by people and objects. This emulator testbed is a complex system that enables researchers to evaluate their wireless networking research efforts. The emulator testbed is available over the Internet for research and educational purposes. This project is matches this Broader Impact criterion because it provides a computing resource that is available to researchers not affiliated to the originating research group.

2.4 Organizational Structures

- Computing Research Association (CRA) organization is structured to provide several programs that support the computing community [5]. One activity is published online highlights of computing-related research. This activity serves to inform the broader community about why the research described is important to society. Another project, CI Fellows [6], is organized to maximize the cross-flow of postdoctoral researchers by requiring that any institution host no more than two postdoctoral researchers and that no more than two researchers matriculate from a single institution. The CRA-Women (CRA-W) [7] and Coalition to Diversity Computing (CDC) [8] programs also serve to broaden the participation of underrepresented minorities in computing.

- As examples of project spanning multiple criteria the group discussed the Advancing Robotics Technology for Societal Impact Alliance (ARTSI) [9] and Alliance For The Advancement of African American Researchers In Computing (A4RC) [10] alliances. The alliances goals are similar in that they seek to support underrepresented minorities in computing however they are both also examples of organizations who perform services such as hosting conferences and providing student support groups, thereby providing organizational structures enabling students to conduct research and improve the quality of their education.

3 Other Examples of Activities that Enhance Infrastructures for Research and Education

Instead of discussing specific examples of activities within this criterion, the group focused on understanding the types of activities that would be beneficial to the broader community. This shift in conversation was due to the vast breadth of computing sub-disciplines represented in the group as well as an acknowledgement that there is no single activity capable of meeting each individual researchers needs. However at a higher level of granularity we discussed the value of researchers sharing novel systems that others may be able to use thereby reducing the amount of funding and effort required to duplicate systems. Best practices, information repositories and other enabling technologies that would enable researchers with fewer resources to participate in the research community and use current technology were regarded as exemplary types of infrastructural activities.

Likewise, tools that supported researchers disseminating their findings, data, data sets, knowledge, or artifacts were also greatly desired. Suggestions included dissemination tools such as collaborative spaces, websites, and course or lab materials for universities to share as well as the availability of researchers to serve as speakers to educate the broader community or K-12 students. From an organizational perspective, there was discussion on the use of organizations making their services available for to help researchers make contact with non-research entities to make their services available. For example, an organization might facilitate outreach if they enable a researcher to partner with a museum to create an exhibit based upon research.

4 Characteristics of a Good Broader Impact Activity

Broader Impact can be achieved through a variety of activities with multiple goals. One example goal discussed BI activities that provide insight into why the research matters. Such activities can attract interest from students, funding institutions and the broader public. Activities should also have scientific and business (where applicable) impact. Infrastructure activities should be generic enough for the research community to use for their own purposes and should serve to bring the community together through shared experiences.

The best activities should solve a problem, address a specific need, or help mitigate a challenge to the research community. The activity should be structured to provide an impact to more than those involved in the project. Creating the infrastructure was described as one part of an activity marketing and publicizing the resource was described as another important component. The resource will underutilized if the broader community is unable to access it.

5 Suggestions to NSF

The wide variety of proposals submitted, NSF-wide, make it difficult to apply the same measures of a BI activity to each proposal. Factors that may affect the amount or type of BI activity that can take place include the experience level of the PI, project proposed, or institutional supports. Due to this wide variance of these factors two areas were agreed upon for reviewer evaluation; potential for success and impact.

5.1 Potential For Success

Potential for success, examines the accessibility of the proposed infrastructure. To be of use to the broader community resources should be easy to find and freely available. Information regarding accessibility can be detailed in a dissemination plan and included in the funding proposal. The activities proposed should have the potential to bring the research community together while addressing a genuine research or education need. Explicitly describing the need (or problem to be solved) as well as how the proposed activity addressed the need enables reviewers to more easily evaluate the potential an activity has to succeed in this area.

Additional considerations for reviewers include whether or not an implementation or dissemination plan is included in the proposal. Budgetary issues should also be taken into consideration. For example, if a PI proposes to create a computational resource without requesting enough funds to support the resource the proposer may be considered overly ambitious. A suggested means of addressing this issue is to require BI Implementation Plans as a component and budget item (where appropriate) of the proposal.

5.2 Impact

The impact of an activity can be more challenging to evaluate because the impact may not be evident until after the lifespan of the project. For example, a project may propose to create a database usable by other researchers however the proposal is for 12 months of research funding and the resource will not be available until month 13. In these instances it is suggested that reviewers evaluate the activities proposed rather than the impact. These activities can include documentation for future users or specific features implemented to support future use. For resources that are available possible measures include the number of actual users or other site statistics such as download counts or successful logins. It was also suggested that reviewers examine outcomes of the PI's previous broader impact activities. For example, if a PI has a track record of making data sets, or open source code, available this should be a positive consideration for reviewers. This information can be included along with descriptions of previous research of the PI's.

5.3 Definition of Broad & Incentives

In addition to the issues regarding proposal reviews a common question raised was "How broad is broad?" Researchers were uncertain of how far-reaching the proposed activity needs to be in order to be categorized as "broad". The scope of "broad" may be in reference to the research community in which the project lives, closely related research communities, and extend to the broader public. Though the NSF requires BI statements to complete a proposal there was a consensus that there should be additional incentives or rewards for PI's who genuinely address this criterion. Researchers acknowledged that prestige is a motivator and suggested that there be some rewards, aside from receiving the proposed funding, attached to Broader Impact activities.

5.4 Outstanding Issues

Along with the suggestions for reviewers there are outstanding issues to which there were no answers put forth. The answers to the following questions may be addressed in proposals differently depending upon the PI, institutional support for BI, and the project proposed. Ideally, there would be a means to evaluate each proposal in the aforementioned areas however the issues listed below should also be taken into consideration:

- Does the Broader Impact have to be tightly coupled with the proposed Intellectual Merit?
- Does the Broader Impact have to be integrated with Intellectual Merit?
- Should a PI be able to submit the same Broader Impact component for multiple proposals? Currently, this is not permissible for Intellectual Merit statements.
- If departments or institutions do not support Broader Impact activities, how can faculty, especially those pre-tenure, engage meaningfully in BI activities?
- During a time when budgets are being reduced, where do the funds for Broader Impact activities come from? It was noted that budget cuts may likely be applied to a broader impact activity. For example, a 20% budget cut may impact documentation, user support, and maintenance, which may have a dramatic effect on BI, even though the project was completed.

5.5 Challenges Associated with Providing an Infrastructure

Providing an infrastructure to support education and research is important however there are challenges that can prevent an infrastructure from being effectively utilized. In addition to the short term goal of creating the resources there must also be planning and funding to ensure that the resources are maintained. Researchers may be hesitant to adopt a resource outside of their control if they do not trust that the reliability or robustness of the resource will meet their needs. To fully embrace and utilize the resources the community must be confident that the resource will be maintained, updated, and available in the future. One question posed regarding an understanding of which entity, NSF, the PI, or the community-at-large, is responsible for the resource maintenance beyond the lifetime of the project? Additionally, for resources involving the use and sharing of data it will is necessary to address intellectual property rights and information anonymity issues.

6 Names and Organizations of Participating Members

Moderator - Andrew Bernat, Computing Research Association
Moderator - Peter Steenkiste, Carnegie Mellon University
Documenter - Radu Mihail, University of Kentucky
Documenter - Shelby Darnell, Clemson University
Writer - Quincy Brown, University of Maryland College Park, CI Fellow
Susan Winter, National Science Foundation
Shawoen Wang, University of Illinois at Urbana-Champaign
Arun Chauhan, Indiana University
Gene Cooperman, Northeastern University
Midge Cozzens, Rutgers DIMACS
Marina Fomenkov, UC San Diego
Michael Smith, UC Berkeley
Ilias Tagkopoulos, UC Davis
Wallapak Tavanapon, Iowa State University
Chris Yang, Drexel University
Nikos Pitsianis, Duke University
Pamela Jennings, National Science Foundation
Suzy Tichenor, Oak Ridge National Laboratory
Maxine Brown, University of Illinois at Chicago
Michael Clancy, UC Berkley
Regan Moore, UNC Chapel Hill
Loretta Moore, Jackson State University
Christian Poellabauer, University of Notre Dame
Richard Salter, Oberlin College

7 References

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[4] http://www.cs.cmu.edu/~emulator/
[5] http://cra.org/
[6] http://cifellows.org/
[7] http://www.cra-w.org/
[8] http://www.cdc-computing.org/
[9] http://artsialliance.org/Latest/Four-new-HBCUs-join-ARTSI
[10] http://www.a4rc.org/