Broader Impact Area #5: Highlighting Benefits to Society

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Overview

This report documents the discussion of the 5th broader impact criteria, highlighting benefits to society, held during the 2010 National Science Foundation (NSF) Broader Impacts Summit. The discussion specifically focused on how to more clearly define research efforts fitting this criteria and outline ways to improve the review process for proposals that address this criterion. This report will propose a definition of criterion five, and continue with a discussion of activities that currently and could potentially fit this criterion well. Following this will be a summary of the characteristics of a good broader impact activity, and will conclude with suggestions for the promoting and reviewing of broader impact activities by NSF.

1. Definition of Broader Impact Area: Benefits to Society

Highlighting benefits to society activities are those that aim to have an effect on public groups, organizations, or state or federal policy. These activities can also be considered if it increases quality of life for the public. Examples of these kinds of activities include increasing accessibility, and addressing applied problems in health, education, politics, or other human centered issues.

2. Current Exemplary Benefits to Society Activities

The most exemplary broader impact activities, which highlight benefits to society, are those that are directly addressing societal issues. Because of the multitude of domains in which computational research can address societal issues, the area can be broadly applicable to current computational research. The types of research that fall under this category are computational solutions to applied research problems, activities that increase economic competitiveness, encourage partnerships with non-academic organizations and industry, increase the scientific literacy, national security, or quality of life for the public, or influence policy on local, state, or federal levels.

2.1. Solving Applied Problems

The group at large agreed that the most exemplary research activities that satisfy criteria number five are those that deal with solving "applied" or "human centered" problems. These are problems that typically affect quality of life in areas such as public safety, the environment, health, equity and social justice, or accessibility. For

example, the work of Richard Ladner's AccessComputing Alliance and other accessibility related projects [1] promotes the universal design of technology, instruction, and environments for disabled students who are extremely underrepresented in the computing field. Juan Gilbert's Prime III [5] accessible voting system is an electronic voting application that provides independent and confidential voting to the disabled. These efforts produce accessibility to areas of the public who are generally excluded from the design processes of new technologies. Another example is Danny Chen's computational geometry research [3,4], which has been used to develop cancer treatment and medical imaging technology to improve diagnosis and treatment techniques in the health industry. The markers for success for the broader impact of these activities were said to generally come from outside of the computer & information science & engineering (CISE) community. If results of the research activities can be accepted, used and recognized by the target community, allow for dissemination of findings outside of typical CISE venues, and excite fellow theoretical researchers in your concentration, then they are seen as having good broader impact.

2.2. Influencing Policy

Another area in which the group felt could be broadly impacted with research fitting criteria five, was work that influenced policy. There were a number of researchers within the group that dealt specifically with research that sought to effect policy from the state to the federal levels. Research done by Johnathan Lazar's Universal Usability Lab [11] focuses not only on accessibility within human computer interaction (HCI), but also how to affect public policy that governs the regulation of publicly available resources to ensure that they are fairly accessible to all. The methods recommended for this undertaking were to respond and become involved in proposed regulations through research by making contact with local policy makers, and serving on standards boards. The research activities should seek to inform local regulations and policy as well as inform others within the regulation and standards community of issues to be addressed as found by these activities. Also keep yourself informed and provide feedback when requests for comments (RFC's) are solicited with policy proposals.

2.3. Increasing Visibility to Increase Public Scientific Literacy

In addition to applied research, other activities that were put forth as great examples of broader impact activities are those that positively affect scientific knowledge. Activities that increase the scientific literacy of the public, such as speaking to government agencies and community groups about research relevant to social issues, and sharing personal stories to non-scientific communities about how you develop a career in scientific research, and educate them about how the research that you do can affect them.   A significant portion of this discussion revolved around how important visibility of research and results is. The kinds of activities that were suggested as high impact and successful were university level activities such as providing lab tours to K-12 or community groups to showcase

research, utilizing the university public relation's arm to disseminate results of socially impactful research, or with the creation of university supported start-ups, patent creation, and domain specific textbooks. The development of accessible artifacts that encapsulates research projects, such as facebook pages, online information sites, or videos describing research to the general public, were also given as examples. It was agreed that it is important to consider the short and long term goals of criteria 5 research and seek to develop this public dissemination pipeline to provide multiple outlets for getting research information to the general public.

2.4. Activities that Improve National Standing

What can also be achieved while pursuing research activities that benefit society are is the increase of development, and competition nationally. For example, activities associated with research that would enhance employment opportunities, increase productivity and efficiency, result in the development of new markets, increase workforce diversity, or result in cost saving benefits to parts of the national agenda were discussed. What was also proposed as a good example of improving competitiveness, was to increase partnerships between academia and industry, by creating collaborative programs such as personnel exchanges and intern programs, or providing employee training or sharing resources across the aisle.

3. Other Potential Benefit to Society Activities

When discussing new innovative broader impact activities that benefit society, the discussion turned to increasing the engagement and empowerment of citizens to participate in their own research activities, beyond just promoting increases in scientific literacy. Given the ways in which human centered research tends to impact specific groups of citizens, it was proposed that encouraging citizen science will impact society in a number of ways. By increasing the visibility of NSF funded research by, for example, disseminating research results to participants in your studies, or providing online spaces where your research can be tracked and discussed by non-academic groups, you could encourage citizens to expand on research ideas and think about ways to improve and affect change themselves. An example of this would be the Defense Advanced Research Projects Agency (DARPA) Urban Grand Challenge projects [6] or Netflix recommendation algorithm challenge [7] where these two groups successfully motivated groups of citizens to tackle complex engineering and computation problems. Another directly related effort is the living voters guide [8], which is an NSF funded project which was developed to promote civic engagement and debate about policy measures being proposed in Washington D.C. This research project uniquely provided participants with an instant perspective on the benefits to the overall community by promoting directed dialogue about the pros and cons of policy affecting their immediate community.

Another example of engaging citizens in research is the work done by Deborah Estrin at the Center for Embedded Network Sensing (CENS)][3]. The Urban/Participatory Sensing (URB/PART) research projects involved the use of mobile device sensors to allow university and community members to gather scientific data surrounding environmental concerns, civic engagement, and personal sensing to provide a novel way to collect data within naturalistic environments that was used to create or improve policy in their immediate area [10].

4. Characteristics of a Good Broader Impact Activity

The group came up with a number of ways to characterize good broader impact activities within research efforts being proposed to NSF. These activities should be broadly understandable proposals to address problems of a specific community. Specifically they should be appealing and accessible to the community that it is intended to serve, and provide demonstrable, tangible benefits to society (i.e. addressing a real need). They should also have a clear execution plan that allocates the proper amount of resources (budget, human capital, access) to the activities proposed, and have concrete evaluation plans in place to enable the evaluation of the extent to which impact was achieved. It should also be activities that are integrated with research activities and not something tacked on as an afterthought. As there was a significant focus on policy within the group it was determined that these activities should also seek to have some direct influence on institutional change, be that just within a university/college or a government institution (e.g. state government). Additionally the need to leverage existing resources and disbursements programs was recommended. This will allow for researchers to bring experiences to the community and have a direct line to the issues that are found within the community that is being served by the research.

5. Suggestions to NSF

Throughout the discussion a number of issues and challenges to pursuing broader impact activities and the ways in which these activities should be considered in the review process were introduced. What levels of responsibility should the primary investigator (PI) shoulder in the promotion and pursuit of broader impact activities within CISE research, as well as how the community as a whole can improve consideration of broader impact in research was discussed. The ways in which broader impacts should be considered by NSF review panels was also a part of the conversation, and recommendations were made to address this task.

5.1. Challenges in Broader Impact Activities

What was of the most importance in the discussion around challenges in proposing and completing good broader impact activities was positing ideas to improve broader impact in research projects and the best ways to encourage PI's to seriously consider their research's broader impact. A point of concern for many of those

present was the lack of emphasis on broader impact within the training and education process of academics, as well as the potential penalties that early career faculty could fall victim to in the pursuit of these goals.

In reference to the latter, the issue of what motivations should take precedence was central to this discussion. In the experience of many, research that is seen as too far-reaching from traditional computer science is discouraged. It was mentioned by one participant that their department equated applied work that addressed issues in an area such as biochemistry to a version of IT work, and these types of projects were considered to reflect badly in tenure packages. There was also the question of how new faculty should balance the needs of society with the desire of some department deans for more visibility within the CISE community as a metric for determine fitness for tenure. This led to the recommendation that more should be done to recognize broader impact activity as part of the academic and scientific portfolio. Given the challenges that come with applied research (i.e. the need for multiple iteration design processes which don't always yield return immediately, focus on other-domain knowledge building and application) an agreed upon suggestion involved the increased effort of NSF in providing support for promoting and awarding the development of exemplary broader impact activities within the scientific community. There were a few suggestions to address this concern. A recommendation that NSF encourage and work with institutions to set up offices such as the STEM partnership office at Northwestern University, which provide support for PI's who need to find resources and communities of need to collaborate with for broader impact research activities. These resources could assist early career faculty in connecting with currently available, and responsive, resources needed to conduct their activities, instead of trying to forge new collaborations or hunt for relevant populations. Another recommendation was to promote broader impacts in the culture of research training and education. Tasking professors, training new graduate students, with proposing their research with an eye toward what it's impact will be would better prepare future faculty to consider broader impacts while building their research portfolios and also ensuring intellectual merit.

To increase the motivation for PI's to seriously consider broader impacts, another suggestion was to give awards for exceptional broader impact activities that have been conducted by researchers in the CISE community. This will help attract other PI's to broader impact activities, and increase visibility of broader impact work. These awards could also be named after researchers that have already contributed to broader impacts in significant ways, allowing for the consideration of these awards to be more significant when reviewed in tenure packages of early career faculty. The idea was not to make these monetary awards similar to the NSF Early Career Award, but to have them be awards of recognition of excellence and appreciation. Another suggestion was to build a portfolio of previous broader impact activities that could be assessable to the discussion of a proposed database was also discussed. This database would contain a list of broader impact activities that are being currently done in research and outreach groups. It would also the activities that were currently available for those looking to contribute to broader

impacts with their research. The result of searching this database would pull up activity information such as a description of the project, the broader impact criteria or criterion it fits, any NSF proposal information, partner organizations involved, collaborator information, and contact information for those heading the activity. Questions that were raised about such a database, specifically:

1. Who would be responsible for maintenance? 2. Would proposals that fit in multiple areas be distinguished? 3. Do listed activities have to involve NSF?

5.2. Reviewing Guidelines

The overriding sentiment of the group in regard to reviewing broader impact was that this process would be very similar to the process for reviewing intellectual merit in research proposals. The general criteria for reviewing broader impact activities were that they had to have a clear execution plan, adequate resources, and a concrete evaluation plan. It was determined that the activities may or may not be novel, but if not novel should level existing programs or best practices. The framing of the broader impact should be something that can be found within the research proposal to ensure that it is considered in concert with the research activities that will be done. There were a number of questions surrounding how to provide reviewers with guidelines to properly evaluate the quality of broader impact activities in proposals. It was proposed that the overall score assigned to proposals be separated into two scores reflecting the quality of broader impacts activities outlined and the strength of intellectual merit. The balance of these two scores would be outlined by the program officer for the announcement, and they would be responsible for ensuring that PI's as well as reviewers understand the appropriate balance in their planning and reviewing process. The requirement for significance of broader impacts would have to take the size, scope, and purpose of the project in review into consideration. The argument was made that the questions asked in the NSF Merit Review Criteria document [9] can and should also be applied to the review of broader impacts. The questions that reviewers should ask themselves in considering broader impact fitness in proposals are:

1. Is the broader impact activity proposed appropriate to the proposal? 2. What type of institutional support and or institutional track record is there to convey support for the proposed activity? 3. Is the PI well equipped to do this broader impact activity? 4. How well conceived and organized is the proposed broader impact activity?

In order to prepare PI's to structure their proposals to address these questions, it was recommended that NSF include a link to resources for all five broader impact areas and resources to help investigators determine the proper impact activities that they can incorporate into their research. These resources should include guidelines for developing a broader impact activity. The solicitations should also more specifically tell PI's what they are required to include in the summary about broader impacts.

Recommendations were also made by the group, on how to evaluate and monitor progress reporting to determine outcomes of broader impact activities conducted between review periods as well as at the end of the grant period. The current reporting questions ask to describe the major research and education activities of the project, major findings from these activities, opportunities for training, development, and mentoring provided by the project, and the outreach activities the project has undertaken. It was proposed that these questions could be used to report on broader impact progress as well with a change to the fourth question in which you would explicitly describe the outcomes of the broader impact activities. To evaluate the results of broader impact activities, example evaluation metrics suggested were the costs of these activities (i.e. time), public policy changes, behavioral change (measured using pre and post surveys), number of jobs created, needs assessments, or by evaluating artifacts that were produced as a result of the research activities (i.e. videos, courses, software tools, survey instruments, new evaluation methods).

6. Conclusion

At the conclusion of our discussion it was generally agreed that given the mandate that NSF has been given to emphasize broader impacts in research, it is imperative that researchers take the implementation of broader impacts seriously. If researchers refuse to do this they will not be able to get funding. It is important to express to our colleagues that science is important, but the use of public money should result in public benefit. The advice that was given to those that are young researchers was to train yourself to consider broader impacts first and how your research will be able to fit. You should also seek to garner public support through representatives, public organizations and government bodies for your research. Be prepared and willing to pay the price for conducting applied research (e.g. learning new applied fields, their problems, and real applications). You should also build close connections with experts, professionals, and communities relevant to the research problems you are trying to address, and gain their trust by working on their key problems at the start of your partnership. Broader impacts can be achieved within a number of research areas, it just requires thinking correctly about what you are investigating. Utilizing the resources of colleagues who have successfully done this can be a tremendous help to you, and NSF is invested in the promotion and successful implementation of broader impact activities in research.

7. Names and Organizations of Participating Members

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sals1/ nsf.html)
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(http://research.cens.ucla.edu/urban/)
11. The Universal Usability Laboratory at Towson University
(http://triton.towson.edu/~jlazar/uulab.html)