George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES)

Education, Outreach, and Training Strategic Plan
This report is based on the ideas of many members of NEES, the earthquake engineering community, and the earth science community and developed by:

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National Science Foundation
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Executive Summary

The National Science Foundation through award CMS-0337808 has provided the financial support and the leadership to develop the Education, Outreach, and Training (EOT) strategic plan for the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES). NEES is a state-of-the-art earthquake engineering experimental research facility consisting of 15 geographically distributed laboratories networked together and supported by advanced information technology infrastructure (NEESit). NEES’ capabilities such as telepresence, a curated data repository, and advanced information technology including simulation and visualization tools, provide an unparalleled opportunity to improve understanding of earthquake engineering concepts and to change the way these concepts are taught and disseminated. This strategic plan describes the framework and provides the guidelines for the development of the education, outreach, and training activities for NEES. The plan is built around eight strategies:

- Integrate NEES research and education activities
- Engage a diverse audience
- Attract a larger, more diverse group of students into earthquake engineering and other engineering fields
- Identify and implement mechanisms to speed transfer of NEES research results into practice
- Exploit synergism between the earthquake engineering, other engineering disciplines, and earth science communities
- Build upon successful existing programs
- Promote the value of EOT activities in the research community
- Continuously evaluate and improve EOT program quality and program activities

Examples of potential activities are described by scenarios throughout the plan. The plan includes a suggested timeline for developing activities, an estimate of resource needs, and a framework for program evaluation. The framework and guidelines will help the earthquake engineering community, teachers, researchers and NEES Consortium, Inc. (NEESinc) in the development of coordinated programs and activities that use the unique features of NEES to address the needs of the diverse earthquake-engineering constituency.
1. Introduction: Motivation for a Strong Education, Outreach, and Training Program

Over the last 40 years, and particularly since the establishment of the National Earthquake Hazards Reduction Program (NEHRP) in 1977, extensive progress has been made in the understanding of earthquake mechanisms, earthquake resistant design and loss mitigation strategies. While during this period new knowledge has resulted in improved hazard evaluation, building codes, construction practices and emergency response plans, the losses due to earthquakes have actually increased. Population growth and increased urbanization leading to densely populated developed regions, has resulted in increased exposure and ultimately increased losses. The Federal Emergency Management Agency (FEMA) estimates the annualized loss resulting from building damage, inventory loss and business interruption in the United States to be $4.4 billion (FEMA, 2001) and a 2003 report by the Earthquake Engineering Research Institute (EERI) estimates the total exposure to be $10 billion annually when impacts on utility and transportation infrastructure and indirect losses are included. A single large event could be devastating, with losses in the range of $100 billion to $200 billion (O’Rourke, 2003).

Controlling, and ultimately reducing, the losses from future earthquakes is a challenging problem requiring collaboration amongst researchers, educators, practitioners, policy makers, the business sector, and the public. The Grand Challenge of preventing future disasters requires the use of innovative new technology, a change in the research culture, cross-disciplinary interaction, broad dissemination of research findings and adoption of new methodologies into practice. As one avenue to achieving this Grand Challenge, the National Science Foundation (NSF) and the earthquake engineering community have developed a new resource with which the earthquake loss reduction community will be able to work together as never before to address the societal needs for earthquake risk reduction and mitigation.

The George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) is a national, networked, simulation resource that includes 15 geographically-distributed, shared-use, next-generation experimental research equipment sites (Table 1). This major research equipment facility, funded by NSF, is designed to advance earthquake engineering research and education through collaborative and integrated experimentation, theory development, data archiving, and model-based simulation. The NEES initiative, based on the concept of a collaboratory (Wulf, 1989), includes distributed research facilities, shared instruments, a community data system and an open community contribution system. The establishment of this networked community of researchers, students, and practitioners will have a profound impact on the progress and style of earthquake engineering research as participants from around the country, and likely around the world, collaborate on projects and share results in an interactive and standardized fashion. The information technology (IT) component of the collaboratory (NEESit) uses the newest and fastest communications technologies to network the NEES Equipment Sites together and to link participants across the U.S. in real time, allowing collaborative teams to plan and perform their experiments, as well as analyze, visualize and publish results. NEES maintains a curated repository for all researchers, educators, and members of the community to archive data including videos, drawings, photographs, graphics, reports and simulations as well as digital data captured from instruments.

![Figure 1: NEES integrated facilities and services enable new and innovative research and education. (Source: National Science Foundation)](image-url)
<table>
<thead>
<tr>
<th>Location</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Geotechnical Centrifuge Test Facilities</strong></td>
<td></td>
</tr>
<tr>
<td>University of California at Davis (nees.ucdavis.edu)</td>
<td>8.5-m radius centrifuge with capacity of 5-tons at accelerations of 75g and a uniaxial or biaxial shaking table</td>
</tr>
<tr>
<td>Rensselaer Polytechnic Institute (nees.rpi.edu)</td>
<td>150t-ton, 3-m radius geotechnical centrifuge with 2-D earthquake shaker and 4-degree-of-freedom (DoF) robot</td>
</tr>
<tr>
<td><strong>Field Experimentation and Monitoring Installations</strong></td>
<td></td>
</tr>
<tr>
<td>University of California at Los Angeles (nees.ucla.edu)</td>
<td>Mobile structural test facility for forced vibration and seismic monitoring of full-scale structural and geotechnical systems</td>
</tr>
<tr>
<td>University of Texas at Austin (nees.utexas.edu)</td>
<td>Mobile geotechnical testing facility comprised of large-scale shakers for the dynamic characterization of geotechnical structures</td>
</tr>
<tr>
<td>University of California at Santa Barbara, University of Southern California, and Brigham Young University (nees.ucsb.edu)</td>
<td>Two field laboratories permanently instrumented with accelerometer and liquefaction arrays for in-situ study of liquefaction, soil response and soil-structure interaction</td>
</tr>
<tr>
<td><strong>Large-scale Experimentation Facilities</strong></td>
<td></td>
</tr>
<tr>
<td>University of Minnesota (nees.umn.edu)</td>
<td>Multi-axial sub-assemble testing system comprised of 6 DoF crosshead and L-shaped reaction wall</td>
</tr>
<tr>
<td>University of Colorado at Boulder (nees.colorado.edu)</td>
<td>Fast Hybrid Testing system that combines real time testing physical experiments with online model-based simulation of the earthquake performance of structural components</td>
</tr>
<tr>
<td>Cornell University (nees.cornell.edu)</td>
<td>Lifeline Testing Facility: Split box soil container with large-stroke actuators for simulating large ground deformations on soil-structure interaction problems</td>
</tr>
<tr>
<td>University of Buffalo – SUNY (nees.buffalo.edu)</td>
<td>Large strong floor, reaction wall, and dynamic actuators facility for the testing of very large structures under seismic and dynamic excitations using Real-time Dynamic Hybrid Testing (see also Shaking Table Test Facilities)</td>
</tr>
<tr>
<td>University of Illinois at Urbana-Champaign (nees.uiuc.edu)</td>
<td>Multi-axial full-scale sub-structured testing and simulation facility comprised of three 6-DoF loading and boundary condition boxes and an L-shaped reaction wall for the study of full-scale subassembly systems</td>
</tr>
<tr>
<td>Lehigh University (nees.atloss.lehigh.edu)</td>
<td>Real time multi-directional testing facility for seismic performance simulation of large-scale structural systems</td>
</tr>
<tr>
<td>University of California at Berkeley (nees.berkeley.edu)</td>
<td>Reconfigurable reaction wall and hybrid simulation capability for the real time integration of physical testing and computer models</td>
</tr>
<tr>
<td><strong>Shaking Table Test Facilities</strong></td>
<td></td>
</tr>
<tr>
<td>University of Nevada at Reno (nees.unr.edu)</td>
<td>Three re-locatable biaxial shake tables that can be operated independently or dependently for the evaluation of distributed structural or geotechnical systems</td>
</tr>
<tr>
<td>University of California at San Diego (nees.ucsd.edu)</td>
<td>7.6 m by 12.2 m single DoF outdoor shake table for the performance of next generation seismic experiments on very large structural systems</td>
</tr>
<tr>
<td>University of Buffalo – SUNY (nees.buffalo.edu)</td>
<td>Two relocatable 6-DoF shake tables for the testing of large structures. The shake tables can placed adjacent or up to 30 meters apart (see also Large-scale Experimentation Facilities)</td>
</tr>
<tr>
<td><strong>Tsunami Wave Basin</strong></td>
<td></td>
</tr>
<tr>
<td>Oregon State University (nees.orst.edu)</td>
<td>Large basin testing facility for the study of tsunami-waves/structure interaction</td>
</tr>
</tbody>
</table>
NEES gives the earthquake engineering community unprecedented access to state-of-the-art laboratories, simulation programs, and data repositories. Through its innovative tools that permit the modeling and simulation of large-scale systems, NEES projects will result in a better understanding of seismic vulnerability and how it can be reduced. Two extensive research plans developed by the Earthquake Engineering Research Institute (EERI, 2003) and the National Research Council (NRC, 2003) lay out a vision of integrated basic and applied multi-disciplinary research for the next two or three decades. However, equally important outcomes of the NEES initiative are the translation of research results into practice, the education of the next generation of earthquake engineers, and the communication of the advances in earthquake engineering to stakeholders and the public at large. In addition, a high-quality training program is needed so that users of NEES tools and facilities as well the technical staff can make the most effective use of the sophisticated technology. In fact, the ultimate success of NEES relies upon a strong Education, Outreach, and Training (EOT) program. The EERI research and action plan specifies that EOT programs should constitute at least 6% of the budgeted activities for the earthquake engineering community.

The ultimate success of NEES will be demonstrated by its ability to impact society and reduce earthquake risk. The results of NEES research must be transferred to individuals and institutions that can take advantage of them and implement the knowledge gained (NRC 2003).

1a. Purpose and Audience for the EOT Plan

The main purpose of this NEES Education, Outreach, and Training (EOT) Strategic Plan is to outline a strategy for the use of the NEES EOT resources to best serve the needs of the earthquake engineering community. This is a challenging task due to the diverse community (summarized in Table 2) that NEES serves. In recognition of the importance and the challenges of a cohesive and successful education, outreach, and training program for the overall success of NEES, NSF through award CMS-0337808 provided funding to create the framework for its development, implementation and evaluation. The development of this plan included consultation and workshops with participants from NEES Consortium Inc. (NEESinc), NEES Equipment Sites, and NSF, as well as researchers, educators, practitioners, and EOT Directors from other centers and consortia. The results of these consultations have helped in the development of a comprehensive plan that is designed to:

- Provide the framework for the establishment of programs and activities that will help NEESinc along with researchers and educators to address the education, outreach, and training needs of the earthquake engineering community.
- Propose timelines for the implementation of activities to fulfill the education, outreach, and training mission of NEES.
- Establish a framework for the evaluation of the success of the EOT program and its activities and products.
- Establish mechanisms for the implementation of new programs and activities needed to address changes in the needs of the community.
- Provide linkages to other earthquake engineering, earth sciences, and EOT programs.
- Provide guiding principles that researchers can use in the submission of proposals under the NSF NEES Research (NEESR) program.
- Advise NEESinc in the development of EOT Human Resources.

1b. Vision for NEES Education, Outreach, and Training

Achieving significant progress toward the goal of reducing seismic vulnerability requires continual dialog with stakeholders to ensure communication of the important problems, rapid translation of research into practice, and education of a new generation of earthquake engineers who are prepared to attack these problems with new tools and innovative approaches. Thus, the vision for NEES EOT is a program that promotes broad participation in NEES from its diverse constituents and wide-spread dissemination and application of
NEES research results through a comprehensive program that offers services, activities and products. It is a program that exploits NEES information technology to engage a diverse audience with exciting, innovative, and interactive materials.

The NEES EOT program and its activities will enable investigators, practitioners and educators to synergize and integrate their efforts to:

- Speed the application of new knowledge into practice
- Fuse educational programs at all levels with research
- Adapt new approaches for delivering knowledge and inquiry-based learning experiences to a broad and diverse set of constituents
- Attract and help retain the best and the brightest from a diversity of disciplines and backgrounds to the field of earthquake engineering and other engineering disciplines
- Engage the earthquake risk mitigation community in identifying critical gaps in knowledge and significant opportunities for innovation and discovery
- Inform the public and policy makers

The staff at NEESinc will coordinate and promote a wide-ranging array of services, activities, and products, to address the needs of the multiple constituents of the EOT program. The activities and materials developed by NEESinc, NEES Equipment Sites, NEES Cyberinfrastructure Center (NEESit), NEES research teams, and a variety of partners in government, academia, industry and business, will be delivered at the regional and national, and possibly international, level. All developed EOT products will be stored in a centralized repository managed by NEESinc and available to the earthquake engineering community.

Figure 2: Success of the EOT program will require continual interaction between NEESinc and its EOT staff, and the members of NEES, the earthquake engineering community, the community at large and NSF. NSF provides funding to NEESinc, NEESit, NEES equipment sites and NEES researchers. The EOT staff members: (a) help NEESR potential investigators in integrating the EOT needs of the earthquake engineering community into their research plans, (b) collect and archive EOT examples, results and initiatives from NEESit, NEES equipment sites and NEESR, (c) promote results and initiatives to the large earthquake engineering community, and (d) compile and archive assessments and evaluations from all the NEES EOT activities.
<table>
<thead>
<tr>
<th>Constituent</th>
<th>Benefits</th>
</tr>
</thead>
</table>
| **Precollege education:** teachers, students, parents, and boards of education | To increase the number, quality and diversity of students entering college with interests in earthquake risk reduction and other engineering areas  
To develop and disseminate real-world applications of science, technology, engineering and mathematics that can be incorporated into curricula |
| **Undergraduate education:** university faculty, undergraduate students, undergraduate research assistants | To increase the number, quality and diversity of students selecting majors that lead to careers in earthquake risk reduction and other engineering areas  
To engage students in meaningful experiments  
To engage students in research experiences that may lead them to consider graduate education |
| **Graduate education:** university faculty, graduate students and post-doctoral fellows | To broaden access to experimental research and simulation facilities and opportunities for collaboration  
To improve planning and preparation of experiments through simulation, visualization and training modules |
| **Researchers and remote users of NEES:** national and international researchers | To increase access to meaningful research opportunities  
To broaden access to experimental research and simulation facilities and opportunities for collaboration  
To improve planning and preparation of experiments through simulation, visualization and training modules |
| **Practitioners:** engineers, architects, earth scientists | To speed the transfer of research results into practice  
To develop experimental models for the validation of emerging engineering design solutions  
To facilitate the archival of data on the performance of structures during earthquakes and the access to data and analyses that verify response of systems  
To broaden their participation in experimental research and development of research plans  
To develop a visualization capability to facilitate the design and construction process |
| **Laboratory managers and technicians:** those responsible for supporting NEES experimentation | To train in the use of the state-of-the-art information technology (IT) and collaboration tools |
| **Public-at-large and public-policy decision makers:** citizens, media personnel, lawyers, public officials and their staff | To improve the understanding of earthquake research and its relevance to people’s lives  
To provide decision makers with technically robust information for decision making |
| **All constituents**                                                        | To increase awareness of the need for earthquake engineering advancement |
1c. NEES Education, Outreach, and Training Program Goals

Achieving the EOT vision will require widespread interaction with NEES research by people at different education and age levels, and effective implementation of NEES research results by practicing engineers; practitioners in the design, construction and consulting industries; and local, state and federal government agencies. The set of goals for the NEES EOT Programs is broad enough to meet the needs of all constituencies, and yet focuses on the unique contributions that NEES can make. That is, rather than mount a comprehensive EOT program, which would duplicate education and outreach activities that exist in other organizations, NEES aims to be an exemplar of innovative methods that involve remote users of experimental and simulation resources. A key strategy is to partner with a variety of engineering, earth science, and education organizations to build on existing programs, using NEESit capabilities, NEES Equipment Sites, and the synergism within the earthquake engineering community to augment those programs. The goals also aim to engage the at-large community in shaping and growing the EOT program through assessing and promoting community needs.

While the divisions among education, outreach, and training activities are somewhat blurred, it is helpful to define some specific terminology for the purposes of clarifying goals and outcomes. In this plan, education activities are defined as those that integrate research and education through designing, producing, and disseminating instructional materials. Outreach activities are those that support increased participation by disseminating research results, reaching out to diverse audiences, identifying community needs, and promoting NEES and its activities. Training activities are defined as those that prepare researchers, practitioners and other potential users to interact with NEES Equipment Sites and NEESit tools. Table 3 describes the NEES EOT goals in these three program areas.

Table 3: Goals for the NEES EOT Program

<table>
<thead>
<tr>
<th>Education</th>
<th>Outreach</th>
<th>Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1 Promote and support the use of NEES Equipment Sites, NEESit tools, research and research results in undergraduate, graduate and K-12 education through development of an active NEES educational community.</td>
<td>O1 Promote interaction of practitioners with researchers and transfer of results of NEES research into practice through an active NEES professional community.</td>
<td>T1 Promote participation in NEES by providing training in the use of NEES Equipment Sites and telepresence, collaboration, data archiving, analysis, visualization, and simulation tools.</td>
</tr>
<tr>
<td>E2 Improve understanding and appreciation of earthquake engineering practice and research by developing and disseminating NEES-related instructional materials and analysis tools.</td>
<td>O2 Promote NEES by disseminating information about NEES laboratory facilities, tools, research activities and research results.</td>
<td></td>
</tr>
<tr>
<td>E3 Improve the teaching and learning of earthquake engineering in undergraduate, graduate and K-12 education by providing professional development in the use of NEES for educational and outreach activities.</td>
<td>O3 Increase the pool of outstanding and diverse students interested in earthquake engineering and supporting disciplines by taking advantage of NEES activities.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>O4 Advance earthquake engineering research by partnering with other organizations to identify and promote community needs in the areas of engineering, information technology, education, outreach, and public policy.</td>
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</tr>
</tbody>
</table>
2. Strategies for Realizing the Vision and Goals

To realize the NEES EOT vision, achieve its goals, and meet constituent needs, the NEES EOT plan relies on several strategies. These are:

- Integrate NEES research and education activities
- Engage a diverse audience
- Attract a larger, more diverse group of students into earthquake engineering and other engineering fields
- Identify and implement mechanisms to speed the transfer of NEES research results into active engineering practice.
- Exploit the synergism between the earthquake engineering, other engineering disciplines, and earth science communities
- Build upon successful existing programs through collaboration
- Promote the value of NEES EOT activities in the research community
- Continuously evaluate and improve NEES EOT program quality and program activities

These strategies make an efficient use of resources through partnering and building upon successful programs to address the complex needs of a diverse audience, while focusing on the unique benefits that NEES can provide. In addition, these strategies acknowledge the importance of enhancing cooperation and collaboration among all of the stakeholders in the reduction of seismic vulnerability.

2a. Strategy 1: Integrate Research and Education Activities

NEES provides a unique opportunity to integrate experimental and simulation research with graduate and undergraduate education, particularly for the many institutions that do not have extensive laboratory facilities. This type of integration gives context to subjects as they are studied; providing motivation for the presentation of theory. In addition, the use of research results in a curriculum keeps it current and provides opportunities for extension of topics. Combining NEES research with education will contribute to producing a new generation of earthquake engineers. This new generation of earthquake engineers should be skilled in integrating experimental design, execution, and results with information technology, data, theory, computation, visualization, and model-based simulation. These skills are needed by leaders in developing new design practices, methodologies and technologies for earthquake loss reduction.

Educational modules that use NEES experimental results and data to demonstrate earthquake engineering concepts such as soil-structure interaction or ductility of structural elements will serve to clarify and illustrate complex theory. Programs that involve undergraduate students in NEES research may be instrumental in encouraging students to pursue higher degrees. Examples include summer Research Experiences for Undergraduates (REU), or “mini-analyses” of data performed by a class or individual students to support ongoing research projects (a somewhat similar approach to SETI@home, a scientific experiment that uses Internet-connected computers in the search for extraterrestrial intelligence – SETI, 2003).

The NEESit teleobservation capabilities and curated repository can provide the basis for exciting interactive learning modules for students at all levels. The ability to share data and rapidly disseminate results will allow practitioners to accelerate the incorporation of new findings into practice. The unique features of NEES provide an unparalleled opportunity to significantly change the way engineering concepts are taught and disseminated. NEES, therefore, provides an opportunity to study how students can best learn using remote teaching and remote experimentation.

2b. Strategy 2: Engage a Diverse Audience

The Grand Challenge of reducing seismic risk and preventing catastrophic earthquake losses is a complex problem, the solution of which relies upon engaging multiple technical fields, policy makers and the general public. Engaging a diverse set of participants with a wide variety of ideas and perspectives leads to better solutions to any problem. Diversity among the leaders of a program increases the interest and appeal of the program.
to a wide variety of prospective participants. Thus, measures of success of the NEES EOT program include how well it meets the needs of its diverse audience and how successful it is in recruiting new and diverse participants to sustain and continue NEES activities and research. Reaching out to and serving the needs of a diverse audience must be a key element of all activities developed for the NEES EOT program. To ensure that NEES-related programs and activities will serve a diverse audience, there must be activities that are suited to both genders and a variety of ages; educational materials could be translated into other languages to widen their appeal. There must be technical materials aimed at practicing professionals as well as resources aimed at policy makers and the general public.

K-12 and higher education are major audiences for EOT. Activities directed at this audience may include research experiences, classroom activities, competitions, and remote interaction with experiments. Research has shown that hands-on activities cause students to be more engaged and to learn better (Felder and Silverman, 1988; NSF, 1996); developers of NEES activities and products should be aware of this aspect of learning and design their activities to be hands-on.

An equally important audience is the practitioner community whose engagement in NEES is essential to achieving the ultimate goal of reducing losses from future earthquakes. Practitioners may be engaged in NEES through activities such as identifying research priorities, participating in research design, and developing strategies for implementation of research results. Researchers who are less experienced with the equipment at the NEES facilities, for example young faculty or PhD students, need background information and training to help them develop meaningful research projects. Online training modules as well as short courses are needed to support the needs of this group.

**Scenario: Collective Evaluation of Large Data Sets**

Dr. Elena at the University of Oklahoma has been collecting large data sets of ground motion using the NEES geotechnical mobile testing facility. Due to small budgets and limited time, only a small amount of data has been analyzed during the last three years. To better use this valuable resource, Dr. Elena came up with a very attractive idea.

Collaborating with faculty at three minority serving institutions in Louisiana, California and Puerto Rico, she wrote a proposal to NSF intending to use the collective work of undergraduate and graduate students at the four institutions to evaluate the data as part of their senior projects and Masters theses in diverse disciplines (e.g., civil engineering, electrical engineering, and computer science). The NSF review panel liked the idea and the group of researchers received funding for three years to implement the program.

As a result of the project, researchers and students wrote several journal and conference papers related to soil behavior, and several students from Puerto Rico and Louisiana continued their graduate studies at the University of Oklahoma. Finally, through the NEES data repository, the earthquake engineering community gained access to detailed maps of local seismic response of 10% of the Southwest and Puerto Rico.

**source:** DLESE
Appendix I provides a table of proposed EOT activities along with suggested target audiences. As the NEES EOT plan evolves, it is important to recognize the needs of these different audiences and to maintain a balance of activities so that all audiences are served.

**Scenario: NEES Proposal Development**

Dr. J. Tolengo is an assistant professor at Washington State University in Pullman, Washington, and a team member working on a NSF NEESR small group proposal. As part of the educational component of the proposal, Dr. Tolengo is developing an ambitious portable display for middle and high schools and museums. The display, which is intended to attract students into science, mathematics and engineering, includes hands-on experiments, computer models, and interactive instruments. To accomplish all these activities, Dr. Tolengo contacted several NEES EOT partners: Incorporated Research Institutions for Seismology (IRIS), Digital Library for Earth System Education (DLESE), EarthScope, Mid-America Earthquake (MAE) Center, and Discover Our Earth.

The display is to include an IRIS AS1 Seismograph and web data access, MAE’s doll house, Discover Our Earth’s virtual computer experiments, and DLESE’s digital library. The display allows students to generate and monitor movement in the classroom as well as record global earthquakes and compare their data to data collected by other schools. Participants can interact with a computer simulation of the origin of an earthquake, observe the effects of seismic vibration on a doll house that has components that are designed with and without seismic considerations, explore different situations with the “What if?” option of the program, and investigate topics in more depth using the digital library. The display engages hands-on participants as well as more analytical students. To evaluate the success of the program, Dr. Tolengo developed an assessment methodology for students, teachers and museum visitors.

NSF could not support the proposal but the program director encouraged Dr. Tolengo to contact NEESinc. With local support, Dr. Tolengo developed his model and it is being displayed at Pullman High School, where teachers use it regularly. NEESinc and its EOT staff promoted Dr. Tolengo’s model throughout the country. Now several Midwest middle and high schools are developing similar classroom displays.
2c. Strategy 3: Attract a Larger, More Diverse Group of Students into Earthquake Engineering and Other Engineering Fields

It is well documented that an insufficient number of students in the United States are being attracted into science, technology, engineering and mathematics (STEM) careers (NSB, 2003), and undergraduate degrees in engineering comprise only 5% to 6% of total bachelor degrees awarded (Davis and Gibbin, 2002). In addition, there is a need to provide engaging materials to help students better understand STEM concepts. According to Before It’s Too Late: A Report to the Nation from the National Commission on Mathematics and Science Teaching for the 21st Century (NCMST, 2000), “students must improve their performance in mathematics and science if they are to succeed in today’s world and if the United States is to stay competitive in an integrated global economy.”

NEES has the potential to be a source of innovative engaging materials that illustrate STEM concepts. For the precollege community, NEES educational materials may include classroom activities and lesson plans, videos, computer simulations, or data sets. Activities might include visits to Equipment Sites, national student competitions, or remote interactions on an experimental project with NEES researchers.

It is important to recognize that professional development of pre-service and in-service teachers is key to integrating NEES materials into precollege education. One of the goals outlined by the National Commission (NCMST, 2000) is to “establish an ongoing system to improve the quality of mathematics and science teaching in grades K-12.” Components of this system include: creating summer institutes to provide professional development for K-12 teachers and a dedicated Internet portal so that teachers can make use of and contribute to an ever-expanding knowledge base about mathematics and science teaching. NEES may deliver teacher development by partnering with organizations such as the Mid-America Earthquake (MAE) Center, the Center for Earthquake Research and Information (CERI), and the University of California, Irvine Center for Educational Partnerships that have established summer institutes for teachers. In addition, the Research Experiences for Teachers (RET) programs could provide a synergistic environment where K-12 teachers learn concepts and the use of NEES facilities while NEES researchers and staff learn methodologies for the application of STEM concepts in the classroom. Through partnerships with organizations such as the Digital Library for Earth Systems Education (DLESE) and the National Science, Technology, Engineering, and Mathematics Education Digital Library (NSDL), NEES can ensure that instructional materials are readily available to teachers and students.

NEES EOT activities must include approaches to target under-represented students in engineering. Outreach and recruitment should be done at the university as well as the K-12 level. There are many effective organizations focused on outreach to underrepresented groups that have mature networks and partnerships, so it is reasonable to work first with these organizations before creating new NEES Scenario: Reaching out to a Diverse Audience

ABC Designs is an engineering design firm with offices in several cities around the United States. As a member of the National Consortium for Graduate Degrees in Engineering and Science, Inc. (GEM), ABC Designs sponsors a fellowship for Jorge, a talented senior who is graduating from California State University Los Angeles, to pursue an MS degree in structural engineering at the University of Minnesota. During the summer before attending graduate school, Jorge works at ABC Designs and gains experience with using the latest codes to design low-rise masonry buildings in high-seismic areas. At University of Minnesota Jorge is invited to participate in several NEES experiments at the MAST facility and takes several elective courses that focus on topics in earthquake engineering. After graduating Jorge lands a job at a top seismic design firm.

source: University of Illinois at Urbana-Champaign
programs targeting the same audiences. Several strategies include:

- **Partnering with minority serving institutions such as Historically Black Universities and Colleges (HBCU).** A number of HBCU have strong engineering programs. These universities have a tradition of excellence in minority education and are a natural place to recruit participants for proposed NEES EOT activities.

- **Recruiting from community colleges.** Community colleges provide an excellent, less-costly academic atmosphere to a great number of students, especially underrepresented students. NEES and the earthquake engineering community must work establish lines of collaboration with these institutions to broaden the base student population.

- **Collaborating with organizations and programs whose goal it is to increase and improve the participation of under-represented groups.** Under-represented groups in terms of gender, race, and ethnicity in STEM areas are needed to improve and maintain intellectual resources in earthquake engineering-related areas. Organizations dedicated to increasing participation of these groups include university outreach offices, often one in the college of engineering, as well as many of the organizations identified in Appendix III.

The pool of under-represented groups participating in STEM disciplines is small compared to the number of organizations that are trying to recruit. Successful recruitment will require that NEES can: 1) demonstrate to candidates that there are good employment opportunities waiting for them if they participate in its program, and 2) offer candidates support (financial, professional and emotional) while they are involved in the education process. NEESinc, NEES Equipment Sites, participating universities, and the whole earthquake engineering community must work together to attract and keep under-represented groups in earthquake engineering research, education and consulting.

**Scenario: Spiral Development**

At the Hinsdale Wave Research Laboratory (WRL) at Oregon State University (OSU), the outreach program started with short, one-hour tours of the facility guided by faculty and graduate students. In the next level of education and outreach (E&O) development, the WRL partnered with two K-12 E&O programs and the School of Education at OSU to develop curriculum and offer half-day classes on the science of waves and tsunamis. Soon the WRL had built a reputation among the local community and was inundated with requests for outreach activities. Recognizing the need to help WRL graduate students develop as teachers and to reduce time spent preparing for the many E&O activities that had become so popular, training materials and portable demonstrations were developed with input from local K-12 teachers.

In addition, a pilot project was established with a local physics teacher to involve more teachers and students in the laboratory activities. The program was further enhanced by the addition of web-based materials such as basic information about tsunamis in two languages, user-controlled live cameras, and virtual tours of the facility. With confidence and practical lessons learned from these early successes, the WRL is now building on these programs, having established an Research Experience for Undergraduates (REU) site in 2003, online brochures, links to resources for teachers and students, and plans to develop an Research Experience for Teachers (RET) site in 2006.

**source:** Oregon State University - NEES Equipment Site
2d. Strategy 4: Identify and Implement Mechanisms to Speed Transfer of NEES Research Results into Practice

To achieve the ultimate goal of reducing losses from catastrophic earthquakes, it is essential that the results of NEES research be converted into forms that can be adapted and demonstrated by innovative practitioners and code developers, and then adopted by the entire design and construction industry. Traditional avenues of technology transfer in which researchers publish articles in journals and present results at conferences are slow, and many years can elapse before a ground-breaking concept is integrated into practice. NEES must develop more efficient paths. In the last decade, the earthquake engineering community has had success with projects such as the SAC Steel Project (www.sacsteel.org/) using a different paradigm for technology transfer. In this paradigm, researchers, practitioners, building officials and representatives of regulatory agencies worked together from the beginning to define the problem, develop and execute the research program and disseminate the results. In fewer than 10 years, results had been produced and modifications made to codes and construction practices. This is just one example of a successful mechanism to speed the transfer of research into practice.

Involvement of practitioners in all phases of NEES research is critical for its success and realization of long-term benefits to society through risk reduction. Research internships provide another mechanism for practitioners to be directly involved in ongoing research projects. NEES’ unique IT infrastructure provides expanded opportunities for practitioners to observe experiments in a timely manner, either live or as archived videos. These videos could form the basis of lunch time professional development seminar series for engineers around the country, allowing them to observe experiments and become engaged in new developments in their field.

NEESinc in cooperation with other professional organizations should facilitate the involvement of practitioners in defining directions of future research and adapting research results into applications. The National Earthquake Engineering Research Centers (NEERC) as well as many other organizations have had success in using industry advisory committees to help guide research directions and outreach to the profession. NEES should consider this approach. Equipment sites may also benefit from developing advisory committees of regulators, policy makers and industrial representatives. Other approaches include NEES Annual Meeting presentations and sessions in which practitioners and researchers discuss the most pressing issues in the profession and applications of research to address those problems, inclusion of practitioners on evaluation teams, and more traditional approaches of presenting research results at professional meetings and conferences. A number of the NEESR proposals that were submitted in the first cycle included practitioners on the research teams or in an advisory capacity. NEES should encourage and facilitate the development of researcher/practitioner partnerships through activities that bring these two communities together. NEESinc plans to create an Industry Advisory Board. One role of this board could be to support program evaluation by providing industry perspectives of the accomplishments, impacts, and directions of NEES in the area of research and technology transfer.

2e. Strategy 5: Exploit Synergism between Earthquake Engineering, Other Engineering Disciplines, and Earth Science Communities

The earthquake engineering and earth science communities are natural research collaborators for a range of topics. They have complementary capabilities and share the goal of understanding earthquake phenomena. Both groups have a nationally distributed infrastructure, are heavily dependent on computing resources and engage in a variety of successful EOT activities. In the last few decades, the lines that separate areas of expertise have blurred as both disciplines have become interested in a greater understanding of ground motion and rupture dynamics. This deeper understanding of the phenomena leads to better constraints on probabilistic hazard models and improved input parameters for engineering design. For example, both seismologists and engineers are now concerned with issues of linear versus non-linear response of soils and they use some of the same networks of sensors and instrumentation to
measure these phenomena. Vibrator trucks designed for determining near-field engineering properties of soils also can be used as vibration sources for studies of whole basin response using standard seismic recorders; the first joint NEES/USGS/IRIS experiment was conducted in the summer of 2004 (CERI 2004). Furthermore, the same vibration sources can be used to determine detailed earth structure including imaging of active faults.

Collaboration in research facilitates the development of EOT activities, particularly for K-12 and informal education, where earth science and earthquake engineering are easier to combine than to present as separate subjects. Even at the undergraduate level, students are excited by examples of the effects of earthquakes on engineered structures, so the basics of earthquake engineering are commonly taught in introductory earth science and earthquake hazards classes. Engineering students benefit from an understanding of the basics of earthquake generation and wave propagation.

2f. Strategy 6: Build Upon Successful Existing Programs

The earthquake engineering and earth science communities boast a number of mature, successful education and outreach programs. Programs are quite varied and include activities such as research demonstrations, advisory boards, internships, summer research experiences, scholarships, distinguished lectureships, interactive software, curricular modules, teacher training, museum displays, digital libraries, school seismographs, and informational brochures and websites.

Organizations dedicated to recruiting underrepresented students into STEM fields (such as those listed in Appendix III) have well established partnerships with universities, industry and pools of potential applicants, and recognized programs for matching interested young people with sponsors and activities. Many of the NEES Equipment Sites already manage internships, teacher education programs, and other outreach programs that meet the needs of their local communities. NEES EOT can make the largest and most immediate impact by contributing with its unique facilities and tools to build upon these programs. This strategy has the benefit of using resources efficiently to extend and improve rather than recreate existing activities, thus accelerating the timeline to fully developing an EOT program.

To successfully implement this strategy NEES must build and maintain strong alliances with education and outreach managers at the national earthquake centers, professional organizations, earth science centers, supercomputer centers, and minority outreach organizations. In addition, inclusion of representatives of these organizations on the NEES EOT Committee will ensure long-term connections and continual dialog.

2g. Strategy 7: Promote the Value of EOT Activities in the Research Community

In an opinion piece entitled Science Can Save us: Outreach is a Necessary Strategy (2003), James Goltz discusses the importance of and barriers to outreach. J. Goltz advocates that, without outreach, potential users of scientific research are unlikely to use or even become aware of it. Barriers include
To encourage outreach, NEES and the earthquake engineering community must help in developing a culture in which university faculty, researchers and administrators understand the importance of outreach, and those who participate in outreach activities are recognized and rewarded for their contributions.

impressions by researchers that the time commitment and cost will detract from their research activities, that users will become aware of developments in the field without outreach, and that outreach activities produce insufficient rewards.

Many of the practitioners, researchers, and university professors who want to participate in outreach have little experience in communicating with a less technical or significantly younger audience. This serves as an additional barrier to outreach, making some individuals hesitant to participate and others less effective than they could be. Workshops and training materials focused on best practices for translating technical content into effective outreach materials and directed at improving the education and outreach skills of NEES members would help to remove this barrier. An excellent example is the RESEED program (www.reseed.neu.edu) that has trained over 500 retired engineers to provide in-class support to teachers as they teach science in elementary and middle schools.

Most of the reward mechanisms at universities and other research institutions are founded on publications and on the recognition of original contributions to the field. There is little consideration of adoption and dissemination of research results or the development of teaching and training activities. To encourage outreach, NEES and the earthquake engineering community must help in developing a culture in which university faculty, researchers and administrators understand the importance of outreach, and those who participate in outreach activities are recognized and rewarded for their contributions. Highlighting EOT activities through plenary speakers and sessions at the annual meeting, annual awards for outstanding EOT activities, newsletter articles, workshops at which users and researchers can build relationships and communicate needs and progress, and strong support of EOT activities by NEESinc, are just a few ways with which to develop this culture. An important tool in the recognition EOT activities is for NEESinc to become an active promoter of researchers and educators by nominating them for the NSF Presidential Awards for Excellence in Science, Mathematics and Engineering Mentoring (PAESMEM – see also Appendix IV).

**Scenario: Evaluations of Web-based Resources**

REU-developed resources were cataloged and made available to others in the NEES Digital Library. During the regular log tracking evaluation activities of the library, the following trend was observed: the resources developed by the students received a large number of hits during October. The evaluators tracked the hits and found that they were being accessed primarily by city and county governments.

One of the largest users happened to be the city where the REU research activity was undertaken, Berkeley, CA. The evaluators contacted the students and found that as a part of their research, they had interviewed city staff at Berkeley and had sent them the URL’s for the materials. The Berkeley staff found the materials so useful that they included them in their earthquake safety training activities. They promoted the materials to other surrounding communities who also used them in their training.

As a result of the evaluation activities, NEES developed a strong relationship with a new audience for their education and outreach programs. They began to explore the development of outreach programs to city and county governments, with a particular focus on use of student developed materials to support public safety and earthquakes.
2h. Strategy 8: Continuously Evaluate and Improve EOT Program Quality and Program Activities

The vision for the NEES EOT program and its scope are broad and far reaching. Continuous evaluation of the program, activities and services is necessary in order to ensure that, as a program, it stays on track and meets its goals. Evaluation is an important building block in the plan to reach the ultimate program outcomes of rapid adoption of research into practice, as well as the improvement of earthquake engineering education, teaching and educational practices.¹

Continuous evaluation of activities will ensure that NEES become a learning organization, one that continuously asks: how effective are our programs? How might we improve them? Are our stakeholders receiving the benefits we promised them? Planning-evaluation and formative-evaluation practices relate directly to the ability of the EOT to answer these questions. Formative evaluation means judging the worth of programs while program activities are forming or happening. Important to the process is the use of the resulting information in the organization’s decision-making processes. This is why it is important to integrate evaluation into the day to day activities of the EOT project team. This plan focuses early efforts on building internal evaluation capacities so that NEES can implement and sustain quality evaluations that produce the information necessary to improve services and the features of its programs.

3. Structuring, Evolving and Sustaining the Program

For over 20 years, EOT programs have been present at numerous federally funded sites throughout the United States. Over time these programs have grown and diversified to address a variety of educational needs. In 2003, the NEES EOT Strategic Plan Committee reviewed operating EOT programs. Representatives from an assortment of institutions with EOT programs presented their best practices, strategies, and evaluation data to the committee. The outcomes from these workshops provided insights that have and will continue to shape the NEES EOT programs and their scalability.

Compared to typical education and outreach programs affiliated with national laboratories and research centers, the NEES EOT program will be more decentralized, more complex, and thus require superior cooperation and coordination among the contributors. In addition to education and outreach, a complete and ongoing training program for both Equipment Sites and the IT infrastructure and tools is needed to support users of NEES facilities. NEES EOT activities will be initiated and put into operation by the sixteen NEES Equipment Sites, by NEESinc headquarters, by the NEES Cyberinfrastructure Center located at the San Diego Supercomputer Center, and by funded researchers. While the NSF-supported 10-year maintenance and operation funding for NEES includes support for three full-time EOT staff, no additional funds are earmarked for EOT activities. Thus, most activities will need to be funded from stand-alone proposals to funding agencies. Since NSF, not NEESinc, will be soliciting and selecting NEES research projects on a peer-reviewed competitive basis, independent educational projects will be funded that must be folded into the ongoing EOT programs. A continuous NEESinc effort to work with researchers before proposals are submitted, as well as after projects are awarded, will help to ensure that these funded projects are focused on NEES EOT goals.

With this prerequisite operational framework in place, structuring, evolving and ultimately sustaining the NEES EOT program are challenging tasks. This plan is mindful of the concern that the NEES EOT program could devolve into a collection of disconnected activities each with a different goal that, while laudable, is not necessarily in alignment with the larger NEES vision, goals and strategies. To develop guiding principles for directing future activities, many EOT programs and activities were reviewed and best practices for developing and sustaining a cohesive and successful program were summarized.

3a. Characteristics of a Successful EOT Program

Successful EOT programs share a number of attributes that NEES intends to emulate. The programs that have been reviewed all exhibit two key characteristics of their success:

- An effective structure
- An awareness of and a connection with the communities they serve

These characteristics include a number of important elements that complement the strategies laid out in this plan.

An effective structure provides an efficient means of creating and maintaining products and services. The structure:

- Provides a clear vision and purpose with clearly articulated goals, outcomes and tools for evaluation
- Builds on the strengths of the associated scientific program
- Starts small, with not too many activities at the beginning, and then expands
- Builds a reputation for high quality activities and products, based on the best educational practices (that is, a small number of quality products has a greater impact than a large number of mediocre products)
- Demonstrates long term commitment to the program, with sufficient follow-up on activities
- Pursues a variety of means to create positive publicity for the program
• **Leverages limited resources effectively by targeting audiences and products that have a high impact**
• **Develops access to adequate funding**

An awareness of and a connection with the appropriate communities ensures that the products and services meet the needs of the target communities. Successful programs:

• **Engage a committed community of professionals who create and communicate shared values**
• **Collaborate with other organizations**
• **Create a reward structure for excellent performance**
• **Target diverse communities**

These ideal attributes provide the foundation for the development of goals, objectives, priorities, and timelines as laid out in this plan, and are presented as guiding principles for development of EOT activities.

### 3b. Example Activities

To some extent the ultimate character and direction of the NEES EOT program will depend upon early successes in developing activities, partnerships, and funding; serving the highest priority needs of the community as they are reevaluated; evolution of information technology; the strengths of the EOT staff; and the types of research projects that are funded in the NEESR program. Appendix I presents a table of proposed activities with a summary of goals they meet, audiences they target and potential measures of success. Along with the scenarios presented in this plan, the following examples describe activities that may serve as elements of the NEES EOT program.

**EOT Web Presence**

A versatile and comprehensive web presence is an essential component of the NEES EOT. The NEESinc web site (www.nees.org) should provide general information on NEES activities, research projects and partnerships, as well as specially tailored information and services for various constituencies, such as earthquake engineering professionals, researchers, educators, students, the news media, and the public. The NEESinc web site should have multiple portals that are designed for specific audiences. Examples of this are FEMA for Kids (www.fema.gov/kids/) and USGS for Teachers (earthquake.usgs.gov/4teachers/) web portals. These alternative portals might include simplified access to telepresence tools, restricted access to the data repository for audience-appropriate data sets, and access to digital libraries. Equipment-site web sites will be encouraged to have a similar feel and navigation that includes an education and outreach, as well as a separate training component. They all should link to nees.org, to each other, and to the NSF NEES web site so that the components of NEESinc and the entire NEES program are seamlessly interconnected.

The web site might also provide workspaces for general community-wide discussion on ongoing projects, projects in the development stage, as well as on topics of continuing interest, such as instrumentation, experimental methods, or research applications. Other features consistent with the EOT goals might include:

• Access to online training programs, knowledge bases and tutorials on use of NEES resources, schedules and registration for instructional courses, and opportunities for internships
• Resource locators to find available facilities, equipment, resources and expertise, individuals with similar interests, opportunities for collaboration, and on-going projects, mentors

Powerful system integration tools and hypermedia engines that have been developed could provide the NEESinc web site with advanced flexibility and navigation capabilities. Consideration of web site capabilities and how to best integrate and build-upon existing state-of-the-art web-based tools and resources, should be a top priority. During the first year of operation, NEES EOT staff should bring together NEESit personnel, potential collaborators in the areas of digital libraries and open-source web-based applications, members of the Data Sharing and Archiving Committee and the Information Technology Committee, as well as representatives of key user communities to prepare plans and specifications for the site.
Scenario: Showcasing NEES Research Activities

A large, 0.9 m by 1.2 m, display made up of flat panel screens is mounted on the wall of the lobby of NEES headquarters, in the lobby of the National Science Foundation, and as part of the earthquake exhibit at the Smithsonian Natural History Museum. The NEESinc Activities Web Interface is capable of presenting real-time telepresence video data streams, archival video data streams, and the operational status of each of the Equipment Sites.

Thumbnail video images from each of the 15 NEES Equipment Sites are presented in a grid covering the display. For each NEES Equipment Site, the test status is indicated by a red-yellow-green-blue system, corresponding to "equipment offline", "holding for test equipment and sample preparation," "test scheduled to commence," and "live test underway." It also displays status information, including a countdown to test commencement. An interactive interface allows a user to click on a thumbnail to bring up a separate, larger window with several video streams, from a particular Equipment Site, tiled in the pane. A tool palette allows the user to zoom, pan, or tilt the video camera (if available for that particular NEES Equipment Site). The same activities web interface is accessible from anywhere in the world by clicking on a button on any NEES web site.

Digital Library

Digital libraries are proven educational resources that allow users to rapidly discover materials they need when they need them, and to connect them to real-time or archived databases. Cataloguing the many reports, datasets, curricular materials (lesson plans, course modules, class activities, etc.) and other products generated by research projects and NEES EOT staff should be a top priority to ensure access and widespread dissemination. There are a number of existing nationally recognized digital libraries aimed at various audiences such as earth science education (for example, DLESE and Electronic Encyclopedia of Earthquakes – E3), STEM education (National Science digital Library-NSDL), engineering education (National Engineering Education Delivery System-NEEDS, American Society of Engineering Education - ASEE EngineeringK12 Center), and researchers and practitioners (National Information Service for Earthquake Engineering - NISEE), that provide an integrated set of services for cataloging, searching, and retrieving information. The libraries provide a mechanism for educators to “publish” and share high quality materials with each other. For example, the Multimedia Educational Resource for Learning and Online Teaching (MERLOT) has demonstrated a rigorous peer review process for vetting their materials, which in combination with other services describing the pedagogical use of the materials has been successful in sharing high quality materials. The use of digital libraries by educators at all levels (e.g., K-12 to higher education) is growing as they become more visible and their partnerships with
educational organizations more effective. For example, DLESE is collaborating with organizations such as the National Science Teachers Association (NSTA) to make teachers aware of this resource through workshops, brochures, and presentations at regional and national meetings.

NEES is well positioned to build on and leverage the success of these digital libraries in order to build collections within existing libraries or its own library. By collaborating with various digital libraries NEES will be able to establish a digital library to meet specific user’s needs. For example, NEES can take advantage of federated search technologies so that users can search each of the libraries listed above as well as a NEES-specific collection. Collaborations with other libraries will help NEES rapidly deploy a library for its users – collaboration with DLESE will help establish effective use of metadata and mark-up languages, and by working with MERLOT, NEES can establish review procedures that reflect the needs of this interdisciplinary community of earth scientists and engineers.

Research Experiences

Providing targeted research experiences is one of the most efficient methods to attract and retain top students in STEM fields, interest minorities in research in STEM disciplines, and integrate research into education. Evaluation of research experiences indicates that they improve retention, help students gain confidence in their abilities, and help students improve technical, communication and leadership skills. A study of 2,200 University of Delaware alumni indicates that those alumni who did research as undergraduate students were more likely to attend graduate school and twice as likely to earn Ph.D. degrees (Gempesaw et al., 2004; Russell, 2004). The same study indicates that graduate students who helped supervise undergraduates gain valuable teaching experience and improved mastery of their subjects.

NEES EOT staff could help in the coordination and the evaluation of the research experience activities. Coordination will maximize resources and provide continuity in attracting an excellent and diverse pool of participants into the programs. The evaluation component not only will allow the proper documentation of the activity progress but also will assist researchers in planning and justifying the request for funding.

NSF sponsors several programs relevant to this area. The Research Experience for Undergraduate (REU) students provides students and faculty with the opportunity to collaborate in a hands-on research program in a mentor-protégé learning environment. The students learn about discovery and the research professors stimulate students’ interests and encourage students to consider graduate education in the field. The Research Experience for Teachers (RET) program promotes professional development of teachers and the translation of research results into classroom application. Teachers participate in research projects, develop educational modules and are encouraged to publish their work. This type of experience allows both the teacher and researcher to learn from each other in the development of novel education tools and methodologies. A Research Experience for High School (REHS) students, possibly within an RET, could help teachers test new approaches for integrating research with 9th through 12th grade curriculum, as well as serve as a means to recruit undergraduates in the earthquake engineering disciplines.

Research internships or visiting scholar experiences for graduate students, international students, junior faculty, and practicing professionals will enable participants to gain experience with NEES facilities and tools to establish working relationships for further collaboration. This type of research experience, which could range from a few days to an entire semester, also provides a venue to link industry and research in earthquake engineering. NEES participants may also benefits from established programs such as the NSF-supported IGERT program (see also Appendix IV). This program provides funds to promote integrative, research-based, graduate education and training activities in emerging areas of science and engineering. These are but a few examples of the many NSF programs that may support research experiences.
**Scenario: Dissemination Through a Digital Library**

Professor Lessing at Arizona State University teaches an introductory geotechnical engineering course. He would like to improve his unit on liquefaction because students have not done well on this unit in the past. He accesses the NEES digital library from www.nees.org. By typing in the keyword liquefaction, and indicating that he is interested in undergraduate level curriculum (grades 13-16), he is presented with eight results. One is a set of data generated from a NEES centrifuge test, and another is a simulation of lateral spreading. He selects a short in-class demonstration complete with a pre- and post-test assessment for inclusion in his course. Other results include a set of photos of liquefaction evidence and damage, and a computer program to calculate liquefaction potential. Through links to the Electronic Encyclopedia of Earthquakes, he finds excellent background material on total stress and effective stress.

**Curriculum Materials**

While the development of materials that integrate NEES research and its results into K-20 curriculum is very important because of its potential to significantly change the way students learn, it is perhaps one of the most challenging activities in the EOT plan. A complete curriculum module, developed by a team of scientists, K-12 educators and curriculum writers, that includes evaluation and dissemination, might require a budget of $100,000 to $250,000 per year for two to four years. This level of effort clearly requires supplemental funding from NSF, the Department of Education and other funding sources. Although NEESinc headquarters may not have direct control over the type and quantity of materials that are developed, it must act as a catalyst to ensure that this occurs by providing suggested topics for core modules and links to existing ones.

The San Diego Supercomputer Center (SDSC) and other collaborators in the Education, Outreach, and Training Partnership for Advanced Computation Infrastructure (EOT-PACI), have successfully developed and delivered educational programs and materials that incorporate computational and simulation tools and engage a diverse audience. Using partnerships with these organizations as a first step, NEES could facilitate the initiation of project teams and proposals through workshops focused on the development of curriculum materials to which researchers, educators, curriculum developers, computer scientists, and outreach specialists are invited. Promoting identified curriculum needs and making progress in meeting these needs (which includes writing proposals) should be an ongoing activity of NEESinc EOT staff’s duties.

**Training**

Researchers, practitioners, and remote users of NEES will require training to efficiently use the facilities to test and validate complex concepts and systems, and to access data and simulations. In addition, the multi-institutional collaboratory team research approach that serves as a fundamental building block of NEES is somewhat new to many researchers. NEESinc can support effective collaboration by providing training in organizational skills and strategies for teamwork and collaboration. NEES Equipment Site technicians and IT personnel must all have a good understanding of the NEESit architecture, system administration tasks, security, metadata and much more. Users must be trained on the collaboration tools, data and metadata standards, archiving capabilities, visualization and other capabilities of the system. To achieve the goal of expanding the number of researchers performing experiments at the sites, a whole generation of researchers who have had limited access in the past must improve their understanding of principles, limitations, logistics, and test scheduling and techniques associated with these large scale testing facilities. Proper training of faculty, researchers and students is an essential component in the submission of quality fundable proposals. Response was high for a November 2004 three-day workshop, sponsored by the two centrifuge sites, that introduced researchers to testing procedures, scaling laws, visualization and other aspects of centrifuge modeling.
It is envisioned that training will be available at different levels and delivered as both short courses and web-based training and instructional modules. At the lowest level, each NEES Equipment Site maintains a web site with detailed information about the capability of the equipment, instrumentation and other available resources. These web sites will also support virtual courses for training in the use of the equipment, addressing the needs of both participating researchers and students. At the intermediate level, both NEESinc EOT and NEES Equipment Sites will organize training sessions for researchers and students. In these training workshops, researchers, students and NEES Equipment Site staff will discuss issues related to the use of the sites and the development of proposals. At the highest level, interested researchers must visit a specific Equipment Site, tour the facility and discuss issues of interest with the NEES Equipment Site staff. A visiting researchers program will enable researchers and students to spend time at Equipment Sites and to establish relationships with NEES researchers for longer-term research collaboration.

NEES EOT staff should help coordinate and publicize training activities and respond to the needs and requests of NEES users and proposal developers. NEESinc should maintain a current inventory of documentation available to all researchers. This inventory should be searchable through the digital library. An evaluation component should be built into all training activities to ensure that training activities are continually revised to best meet the needs of the community. As an integral part of the success of NEES, training should be a collaborative effort of the earthquake engineering community, NEESinc, NEES Equipment Sites and NEESit.

Public Relations
In order for NEES to become a center of earthquake engineering resources for educators, public officials, the media and for the earthquake engineering community itself, NEES EOT will need to promote NEES activities and its successes to policy makers, funding agencies, research laboratories, international collaborators, educators and many others. The NEESinc EOT staff will need to ensure that training activities are continually revised to best meet the needs of the community. As an integral part of the success of NEES, training should be a collaborative effort of the earthquake engineering community, NEESinc, NEES Equipment Sites and NEESit.

Scenario: K-12 Teacher Professional Development Workshop

In an attempt to institutionalize NEES EOT programs in schools across the nation, NEESinc established a professional development program for middle and high school science teachers. One-week workshops aim to link NEES instructional activities and materials to curriculum needs and standards and to train teachers in the details of earthquake engineering. The workshops provide the needed expertise and tools for the easy implementation of activities in the classroom.

Participant teachers are given pre- and post-workshop assessments. After each workshop, workshop organizers work with teachers to measure the number of classes and students who use the workshop materials. Participants are given strategies to evaluate how students’ achievement is affected by the program and activities presented at workshops. Successful implementers are given support to coordinate additional workshops in their districts and are invited to successive workshops to share experiences, act as mentors, and develop new and better activities.

Source: EOT-PACI
to write and issue press releases, and develop engaging posters, pamphlets and related marketing materials aimed at a variety of audiences, which present NEES research results and use them to clarify earthquake engineering concepts and mitigation advances. Ideally NEES EOT staff will maintain a list of experts (and their areas of expertise) who can be called upon to represent the organization when there is a societal need. In addition, the staff should also maintain a list of media contacts, education media producers and public officials. These resources will not only help address the information needs of the community at large, but they will also provide a direct link for the members of the earthquake community when they need to communicate their findings and their products.

**Online Journal**

It is expected that NEES will greatly advance the rate of discovery and synergism in earthquake engineering research, education and practice. Furthermore, NEES requirements of shared data will put pressure not only on researchers to publish rapidly, but will also overcome the capacity of the traditional publication process due to the increase of data and discovery. One approach is to establish a NEES-supported online journal, edited by the earthquake engineering research and educational communities and managed by NEESinc. One of the main goals of the online journal will be to satisfy the needs of researchers to rapidly publish data as required by the NEES shared-data requirements while at the same time receiving recognition for creating the data.

**3c. Partnerships**

Results of research will be disseminated to researchers and practitioners through professional meetings, focused seminars and publications. Partnerships with agencies such as the United States Geological Survey (USGS) and the Federal Emergency Management Agency (FEMA), and professional organizations such as the Applied Technology Council (ATC), the Earthquake Engineering Research Institute (EERI), and the American Society of Civil Engineers (ASCE), to name just a few, will ensure a strong dissemination program. These organizations all have well-establish professional development, conference, and seminar programs.

Working closely with schools of education would encourage exploration and evaluation of innovative delivery and learning strategies. A first step in this area would be to approach schools of education at NEES Equipment Sites and the NEESit. Partnerships with organizations that target underrepresented students are essential to meeting NEES diversity goals. As an example, the Brown Foundation was instrumental in inviting and coordinating the participation of 50 students and teachers from the Black Future Leaders Organization of San Bernardino and Riverside Counties in the grand opening of the NEES Equipment Site operated by the University of California – Santa Barbara.

A NEES-IRIS (Incorporated Research Institutions for Seismology) partnership is an excellent example of the many benefits to be reaped from working together and building on existing programs. IRIS members have increasingly recognized the need to communicate the results of scientific research to the public more effectively, to advance science literacy for greater understanding of our rapidly changing and increasingly technological world, and to attract more students to study science. The IRIS E&O course of action is to provide products and programs for a variety of audiences, including the general public, K-12 students and educators, and post-secondary students at our nation’s colleges and universities. Programs range from those that impact large numbers of people for brief time periods to those that impact smaller numbers of people through extended interactions. IRIS’ E&O program also looks inward to develop the talent within the ranks of IRIS member institutions so that all may fully participate in building an education program of national scope and prominence. The goal is to help create a new generation of Americans with a greater understanding of earth science and seismology, and to help attract the best and brightest to engage in the geosciences. This approach is closely aligned with many NEES goals relating to K-12, informal and college education, and the engagement of consortium members. Both programs depend critically on leveraging limited
resources on a national scale and both can benefit by partnering on E&O activities that span earth science and earthquake engineering. Several existing IRIS E&O programs that would be particularly well suited to partnering with NEES are:

- **Professional development for teachers/college faculty** – NEES EOT staff could take an active part in existing workshops, assisting in planning, and modeling earthquake engineering activities for teachers and undergraduate college faculty.

- **Museum displays** - IRIS is developing a simple web-based museum display that would be particularly good for universities that want to showcase the interactive elements of NEES.

- **Freshman engineering design classes** - NEESInc members could act as faculty advisors for design challenges and NEES EOT staff could provide materials as needed.

- **Short science videos produced by American Institute of Physics’ Discoveries and Breakthroughs Inside Science program** – IRIS is currently one of their partners. NEESInc members could be encouraged to submit ideas for stories and NEES EOT staff could help to check completed stories for accuracy.

- **School seismograph program** – IRIS currently provides simple seismographs, along with supporting educational activities, to schools. NEES could develop additional earthquake engineering activities for this program.

Funding for the existing programs could be shared and separately handled by NEES and IRIS. The two consortia could also consider writing joint proposals for new EOT activities.

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**Scenario: A Partnership to Enhance Recruitment of Under-represented Students**

The National Consortium for Graduate Degrees for Minorities in Engineering and Science, Inc. (GEM) has as its mission the enhancement of the nation’s workforce by increasing the participation of African Americans, Hispanics and Native Americans at the master’s and doctoral levels in engineering and science. This consortium of more than 80 universities and over 50 employers acts as a recruiter, information clearinghouse and matchmaker to identify optimal partnerships between a student, employer and university. Each fellowship recipient receives a stipend along with a paid summer internship at a GEM employer worksite. GEM awards more than 450 fellowships annually and has an 80% success rate for awardees pursuing engineering degrees. It has been identified as an Exemplary Higher Education Program by the Building Engineering and Science Talent (BEST) Blue Ribbon Panel on Higher Education (2004) because it meets or exceeds a series of assessment criteria that correlate with highly effective programs.

Eleven of the 15 universities that host NEES Equipment Sites and many universities that have active earthquake engineering programs are already members of GEM. There are however, a limited number of organizations that would sponsor and mentor a student in the field of earthquake engineering. Through a partnership between NEES and GEM, five employers are identified to join GEM and sponsor ten earthquake engineering fellowships each year.
Appendix II. In a world where technology, the educational environment, and society is rapidly changing, it is difficult to predict what the EOT program will look like after it has matured for ten years. Therefore, the plan details only the first three years; at the end of that period an evaluation of what has been accomplished should be used to make adjustments as needed. Perhaps there will be a need for new programs, or a proposed program should be eliminated or modified. At that time, NEES should make detailed plans for the next four years, with an option for further plan revisions at the end of Year 7.

The goals for Year 1 focus on building infrastructure because EOT staff will not be in place until the middle of Year 1. These goals include:
- Coordinating and publicizing site-specific training activities
- Coordinating and expanding existing REUs, RETs and other internships
- Developing funds and partnerships
- Developing specifications for an attractive and engaging NEES web presence and beginning its implementation
- Negotiating partners and completing specifications for a digital library and working with NEESit to complete programming, including the University Consortium on Instructional Shake Tables (UCIST) and mini-MOST web site materials (see Dyke et al., 2002; 2003)
- Developing specifications and sources of funding for an EOT awards program
- Planning EOT activities at the NEES Annual Meeting
- Recruiting EERI student chapters to help develop NEES EOT related activities
- Developing outreach brochures
- Initiating an e-newsletter
- Reporting of EOT activities from Equipment Sites
- Working with the Consortium for Building Evaluation Capacity (CBEC) to set up and hold evaluation framework workshop to develop evaluation plan with metrics
- Initiating development of evaluation tools and data-collection support structure

3d. Evolving the Program: A Stepped Approach

In delineating an approach for evolving the program, two guiding principles stand out:
- Start small and then expand.
- Build a reputation for high quality activities and products, based on the best educational / outreach practices.

Initially it is important to focus resources on a few key high-impact activities that will attract an enthusiastic and devoted audience and serve as examples to developers of future activities, potential partners, and funders. It is a good practice to pilot activities on a small group and then to scale them up to a larger audience. Once initial activities are well established, then EOT staff can turn attention to expanding activities and developing new ones.

Scalability

At their inception EOT programs typically conduct needs assessments of the audiences they intend to serve and take stock of existing EOT programs at the institutional level. The results of these assessments are used to inform and prioritize the EOT programming development and timelines. Additionally, this tool provides guidance and direction in seeking funding opportunities and establishing partnerships. The NEES EOT should lay a solid foundation by strategically establishing programs that will align with the EOT goals and can be scaled-up with the EOT’s growth.

The uniqueness of the NEES organization, being geographically far-reaching, lends itself well to the establishment of a virtual office. Establishing this web presence at the onset of the NEES EOT and expanding it as programs and resources come online, will provide a central communication hub for all of the EOT’s endeavors. An e-newsletter with regularly scheduled delivery would serve the organization’s members and promote visibility. This would serve not only the NEES members but as the EOT programming increases, it would serve the EOT’s partners and participants.

Short-term Objectives: The First Three Years

A general timeline for proposed activities over the ten year award period for NEESinc can be found in
• Initiating coordination with other EOT programs: IRIS, EarthScope, SCEC, etc.
• Developing a strategy for evaluation and assessment

Year 2 goals include extending activities from Year 1:
• Coordinating and publicizing site-specific training activities
• Coordinating and expanding existing REUs, RETs and other internships
• Developing funds and partnerships
• Publishing newsletter
• Planning EOT activities at the NEES Annual Meeting
• Building databases and other structures to collect evaluation data
• Collecting baseline evaluation data (for example, annual reports of EOT activities from NEES Equipment Sites)
• Testing evaluation tools

During this period, the NEES EOT staff will engage in program development activities such as:
• Writing funding proposals for new NEES-specific REUs, RETs, and IGERTs
• Sponsoring a workshop or other activity to involve practitioners in developing a plan for technology transfer and research utilization
• Developing criteria and identify funding for research internships
• Identifying curriculum developers and advising on proposals for curriculum materials
• Identifying priorities, funding sources and developers for higher education visualization tools
• Locating funding for student travel grants (allowing students to visit NEES Equipment Sites and to present NEES-related research results at national and international conferences)
• Launching and promoting digital library
• Beginning development of database to match researchers and curriculum developers
• Evaluating effectiveness of EOT web presence and augmenting web site
• Securing funding for and announcing criteria for the EOT awards program
• Planning a K-12 summer teacher development workshop
• Developing first practice oriented seminar on NEES research
• Conducting needs assessment for design of activities listed above
• Identifying projects and partners as well as possible funding sources to work on assessment of student learning

Year 3 goals build on Year 1 and 2 by:
• Hosting the first NEES research internships
• Developing NEES international research internships
• Exploring a research experience for high school students
• Developing curriculum materials
• Hosting a K-12 summer teacher development workshop
• Hosting a conference on NEES research
• Identifying priorities, funding sources and developers for K-12 visualization tools
• Awarding first student travel grants
• Presenting first EOT awards
• Apply for funding of assessment of student learning outcomes
• Conduct ongoing needs assessment for new activities and projects
• Collect evaluation data

**Long-term Objectives: Year 4 and Beyond**
An evaluation should be completed during Year 4 to measure progress in developing EOT activities and reaching milestones, effectiveness of EOT strategies, effectiveness of the evaluation and assessment activities, allocation of resources, and sustainability of activities. In addition this evaluation needs to engage stakeholders in reevaluation of constituent needs. The results of this evaluation should be used to set priorities and milestones for the next three years.

The long-term objective is to ensure that activities are effective and sustainable and serving the highest priority needs of the community. Ultimately, successful EOT programs need to be embraced, adopted, and supported by state and local sources. With the end in mind, as NEES EOT initiates activities, the concern for sustainability must be taken into account as to how these programs will continue after the NEES funding cycle.
4. Staffing

The NEESinc EOT Department will be staffed by three full-time professionals: an EOT Manager, an Education and Outreach (E&O) Specialist and a Training Specialist. The EOT Manager will report to the Executive Director of NEESinc and will have overall responsibility for the NEES EOT programs, as well as public relations activities such as media releases and other communications to Congressional Committees, funding agencies and the public. In addition to taking the lead role in the development of proposals to augment EOT programs, the EOT Manager will build linkages and partnerships with complementary education and outreach programs operated by other organizations. The E&O Specialist will assist the Manager with program implementation and other associated activities. These activities include planning workshops; ensuring that EOT information on the web site is accurate, complete, and up-to-date; overseeing program and activity evaluation; and preparing brochures, one-page fact sheets, posters and other outreach materials. The Training Specialist will be a key player in a successful training program. The Training Specialist will coordinate and schedule Equipment Sites and IT training courses, arranging for appropriate training staff, the development and maintenance of training materials and the evaluation of training.

The Consortium Staff will be assisted by the NEESinc EOT Committee. The charge of the EOT Committee is to advise the Board of Directors on EOT programs and policies; advise and work with Consortium Staff to achieve NEES EOT goals; advise and coordinate with the Site Operations Committee, the Information Technology Committee and the Data Sharing and Archiving Committee on EOT needs and opportunities; and review the annual EOT budget. The composition of the EOT Committee includes educators, practitioners, and E&O directors from a variety of earthquake engineering and earth science organizations. It is recommended that the EOT Committee include representatives from at least a few EOT partner organizations.

While the oversight of the EOT program resides at NEESinc headquarters, each of the 15 NEES Equipment Sites is charged with delivering site-specific education, outreach, and training. At this time, each of the Equipment Sites has an EOT coordinator and has developed a preliminary plan for EOT activities. In addition to the education and outreach programs developed by NEESinc headquarters and the Equipment Sites, researchers on NEESR grants will be developing educational materials and modules, and outreach activities. Because of the nature of the NEESR proposal review and funding process, it is important to ensure that the associated education elements are not developed completely independently of NEES EOT programs. The goal is to provide some assistance and coordination from NEESinc headquarters so that these programs complement and build on EOT strategic goals.
5. Resources and Priorities

Ultimately the breadth of NEES EOT activities will be determined by success in attracting outside funds. The three NEES EOT Staff, with support from the NEESit staff, are sufficient to maintain a small program consisting of:

- Coordinating and publicizing ongoing activities such as research experiences and training programs (80% Full-Time Equivalent Staff - FTE)
- Exploring and developing partnerships (10% FTE)
- Grant writing to develop funds for larger activities (30% FTE)
- Maintaining web content (20% FTE – setting up the web site: 35% FTE)
- Maintaining digital library (50% FTE – setting up the web site: 30% FTE)
- Supporting researchers writing NEESR and other grants (20% FTE)
- Organizing annual meeting and other informational workshops (20% FTE)
- Publishing a quarterly e-newsletter (10% FTE)
- Developing media and other outreach materials (30% FTE)
- Maintaining on-line journal (20% FTE)
- Evaluating activity and program success (30% FTE)
- Attending meetings and conferences to promote activities and interact with other EOT professionals (10% FTE)
- Attending NEES EOT activities (10%)

Large scale initiatives such as development of curriculum modules (i.e., $100,000 to $250,000 effort depending on the complexity of the development) will require funding from NSF or other sources. Again, collaborations with other organizations will strengthen proposals and make possible leveraging of activities and resources. Priorities for developing initiatives and seeking external support, should be based upon the strategies presented in Section 2. High priority programs should integrate research and education (or outreach), engage a diverse audience, and build upon successful programs. High priority programs are those that meet the highest priority needs of the community, as identified through a program of periodic assessment.
Creating an effective evaluation plan for the NEES EOT program will be challenging given the large numbers and diverse nature of the various stakeholders in NEES as well as the potential diversity of the various EOT projects and activities that have yet to be implemented. Because of this challenge, evaluation for the project is best separated into three types of activities: those that

- Increase and improve the evaluation capacity of the NEES EOT division and its subsequent projects, activities and program
- Implement the evaluation and assessment activities within the EOT program and more broadly to those projects and activities it supports
- Follow up assessments with corrective actions consistent with the overall EOT program goals.

Building evaluation capacity will by necessity occur in conjunction with the creation and development of the EOT program. Evaluation capacity building focuses on educating participants and ensuring that they have the knowledge to support evaluation. It also stresses the development and maintenance of the organizational policies and infrastructure necessary to support sustained internal and external evaluation efforts (Compton et al., 2002; Frechtling, 1993; Frechtling et al., 1997; Witkin and Altschuld, 1995). An example of these evaluation efforts is the development of a database to track dissemination efforts and store evaluation data from all of the various NEES sites to be used in the annual report. In the first one to three years of EOT implementation, the focus of evaluation will be on building evaluation capacity and these activities will taper off as the other evaluation and assessment activities are implemented. Much of the evaluation capacity building activities will focus on educating participants, stakeholders and NEES and EOT staff in how to define, design, implement, and most importantly, maintain and sustain evaluation efforts for the duration of the project.

6. Achieving and Measuring NEES Goals and Objectives

Given the broad reach and multiple goals of the NEES EOT program, critical evaluation is essential to decision making, planning and ensuring that resources have been used effectively to achieve maximum impact. It is essential that from the beginning, the EOT program builds a culture of evaluation, assessment and corrective action so that all activities and projects include goals, evaluation and performance improvement as part of their design. The evaluation plan for the NEES EOT program and its activities includes three major components:

1) identification of constituent needs and priorities
2) performance metrics for the effectiveness of specific education, outreach, and training activities
3) assessment of learning using NEES infrastructure, remote delivery, and NEES data

Activities will have different milestones, for example three-year, six-year and ten-year evaluations to accompany the different phases of the educational plan. The plan will specify metrics for measurement of the success of activities and a system for using those metrics to evaluate and improve the program.

There are several different sets of metrics for assessing EOT program effectiveness. These include, to name a few, quality of activities, quantity of activities, diversity of participants, number of users, cost effectiveness, usefulness to constituent, and improved student learning, all measured against appropriate targets or goals set in advance for that metric. Specifically, each phase of an educational activity will have its corresponding evaluation and improvement component. The envisioned model includes identifying the early adopters who will implement proposed educational modules, assess their effectiveness and propose improvements. The experience from the early adopters would be used to make revisions and to implement the last phase of the NEES EOT Program, the institutionalization of the activities with an ongoing assessment and improvement process.

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Assessment of constituent needs bridges the capacity building and implementation phase. Through the many regional workshops, national meetings, and constituent-specific workshops held during the Consortium Development phase, broad understanding of constituent needs was established and is reflected in this plan (Wood and Reitherman, 2002; Nigbor, 2002). However, needs assessment is necessary to evaluate the effectiveness of the projects and activities of the organization. Targeted needs assessments may be necessary before specific activities are designed. Given that NEES operation is planned for a minimum of 10 years, baseline measures regarding needs are essential because these needs may change over time, in some cases becoming more sophisticated as the programs supported by EOT mature. Needs assessment is not a ‘one-time’ activity; it must be conducted throughout a program’s life. Initially, however, it is an integral step in identifying how best the EOT can design its services and programs to meet the needs of its constituents and stakeholders.

The second phase of the plan focuses on implementation of evaluation process and the institutionalization of this process around the EOT outcomes. Elements of this phase are:

- Evaluation of the effectiveness of specific education, outreach, and training activities
- Assessment of learning using NEES infrastructure, remote delivery, and NEES data

These areas of the EOT evaluation plan will be developed to meet both formative and summative needs of the program. Evaluation activities will be ongoing, and integrated into the NEES EOT planning and budget cycles.

6a. Phase I - Evaluation Capacity Building

In Year 1, the NEES EOT division will collaborate with the Consortium for Building Evaluation Capacity (CBEC) to establish a formal evaluation framework and model, set of evaluation questions for the overall program, structure for building and supporting the NEES EOT evaluation community and training for that community. CBEC (www.usu.edu/cbec/) is an NSF-supported project that helps NSF-funded STEM projects build their evaluation capacity. In conjunction with CBEC a NEES-EOT evaluation workshop will be planned and conducted so that the staff and critical stakeholders meet and outline the conceptual model and framework for the overall evaluation effort. At this meeting, the participants will refine and articulate the short and long-term outcomes for measuring the success and impact of the project’s mission, goals, programs and activities. They will also confirm the set of formal evaluation questions that will guide the evaluation processes, methods and data collection instruments. Stakeholders are critical participants in this workshop for it is important to the success of the evaluation program as well as the EOT that they participate in defining the evaluation questions most important to them, establishing the priorities for evaluation information and articulating measures of success from their standpoint.

The initial set of evaluation questions guiding the workshop and the resulting framework are:

- How effectively do the program’s strategies and activities support the mission and goals of NEES and the EOT program?
- What is the balance of program activities with respect to its communities, stakeholders, and audiences, and does this balance address these constituents’ needs?
- What is the quantity and quality of the program’s services and products, and how might they be improved?
- What differences have been made in earthquake engineering education and outreach, and student learning as a result of NEES and the EOT?
- How has the EOT program specifically contributed to earthquake hazard mitigation?
- What are the three most important things that must be done to ensure the program is fulfilling its vision?
- Where is better coordination between stakeholders needed to improve outcomes?

The workshop will be designed to build on the preliminary evaluation framework, set of goals and outcomes, and evaluation questions presented in this plan. Given the complexity of the NEES
concept it is necessary that the participants and stakeholders share in the development of a specific plan of action and set of implementation strategies. This step is crucial not only to establishing an evaluation framework that will result in active participation by the consortium members, but also to the development of a community of evaluators with the expertise necessary to assist in the evaluation of NEES and the activities it supports.

The goal of capacity building in evaluation is to build expertise in evaluation. Both ‘in-house’ and external evaluation expertise will be needed to assist the NEES EOT program. The workshop will be one way to initiate the development of that expertise. It will also be an excellent means for laying the groundwork for developing a program of evaluation services. This aspect of the plan will be described further in the discussion of Phase II activities.

6b. Bridge-Assessment of Constituent Needs

Assessment of the needs of the participants in NEES, NEES EOT programs and the NEES stakeholders will take place initially in the Capacity Building Workshop. During this workshop, an initial set of needs will be prioritized and compared to the needs that were identified during the consortium development workshops. This set of needs will be used to drive the development (and refinement) of the planned EOT activities and services. Once prioritized, these needs can also become the basis for the evaluation activities to be implemented at the program wide level and at the level of the individual projects undertaken by the consortium. As a service part of the organization, it is essential that the EOT staff know which needs activities address in order to examine their impact. Accurate needs assessment is also an important step when establishing priorities for the organization and the anticipated outcomes of its programs and services.

6c. Phase II- Evaluation Implementation

Phase II activities will begin in conjunction with capacity building activities, most specifically those activities that support the development of the evaluation infrastructure for the collection, data analysis and reporting out of evaluation results and information. In order to support an effective evaluation program, the EOT must have the appropriate databases, data collection tools and processes in place. Additionally, time must be spent on identifying effective means for motivating constituents to participate in evaluation activities, for while it is clear to the NEES EOT staff and program developers why evaluation is important with regards to the program, it may be less clear to participants further from the core functions of the program.

Evaluation in this phase focuses on outcomes that center around two areas:

1) Evaluation of the effectiveness of specific education, outreach, and training activities
2) Assessment of learning resulting from the use of NEES infrastructure, remote delivery, and NEES data

Evaluation activities will also depend upon the location of the education or outreach activity. As currently envisioned, NEES EOT activities may be one of three types: in-house (NEES EOT staff) designed and coordinated, activities developed by or coordinated by NEES Equipment Sites, and those that are offered in collaboration with an outside partner. Each type of project requires different evaluation plans, tools, processes, methods and data collection procedures as well as different metrics and participation models.

For example, EOT staff will evaluate those projects developed and coordinated in-house (e.g., outreach to practitioners, web presence, digital library, professional development workshop for faculty, newsletter, and underrepresented scholarship program). Formative evaluation activities will be undertaken to ensure effective design and implementation, and some of those measures will feed into the summative evaluation (evaluation designed to determine a project’s success at the end of the project). The summative evaluation will include other metrics. In contrast, those projects that are designed and conducted by the NEES Equipment Sites may need a different
evaluation strategy. In this situation, evaluation may be conducted by outside evaluators, or the evaluation metrics, methods, etc., may not be an exact match to the NEES EOT framework. Here, the individual EOT developer will need to identify a specific set of metrics that meets the needs of both organizations, and develop a mechanism for the Equipment Sites to easily provide them with the needed data. The NEES Equipment Site end-of-the-year report may be the most appropriate vehicle for collecting data regarding for example, number and type of visitors to the site, number of participants in educational programs, and so forth.

EOT program effectiveness will be evaluated using the following types of metrics measured against preset targets appropriate for each metric: the quality of programs, quantity of programs, number and diversity of users, cost effectiveness, usefulness to constituents, and improved student learning. Evaluation of student learning in the context of the NEES EOT program is extremely challenging and requires significant resources. Specific projects, particularly those involving new curriculum materials or in-depth professional development for teaching, that promise to have a large impact on student learning will be selected for in-depth study. To accomplish this type of evaluation, the participants must rely upon resources from NSF (or other outside funding sources) through its education and evaluation grants programs. Here, the project’s evaluation data will be used to supplement the program efforts by providing studies that are richly descriptive, focused on impact on learning (and teaching) and comparative in nature. These types of studies will require collaboration with K-12 schools, specific colleges and universities as well as collaborations with Schools of Education, Public Policy, or Public Health.
7. Beyond Ten Years: Sustaining EOT Programs

Sustainability refers to ensuring the health and continuation of the Education, Outreach, and Training program after the initial ten-year NEES funding period. Sustainability is not something that should be considered towards the end of the NSF funding period, but instead should be built into the design and ongoing maintenance of EOT activities. In other words, one of the goals for any longer term activity should be a plan for sustainability. Plans should include consideration of ongoing outreach and marketing, organization and management, volunteer and staff development, funding, dissemination, and evaluation. The capacity to develop and manage projects and secure funding sources that will lead to sustainability is a continual process of evaluating, refining, adjusting, and improving upon the initial efforts. NSF, NEESinc and the earthquake engineering community share responsibilities for sustaining a successful EOT program and its activities.

The NEES EOT program will need to prioritize activities, identify activity level outcomes and goals, and be consistent in monitoring/evaluating the implementation and results in order to achieve sustainability goals before the end of the ten-year funding window. To accomplish this sustainable objective, NEESinc and the NEES EOT program staff should:

- Be visible - market the program and its outcomes regularly to reinforce and build the stakeholder base and community reputation.
- Work continually to build and sustain relationships and partnerships
- Develop a program advisory committee that has broad contacts in business, philanthropic, and social service communities and includes local, informal, and influential community leaders
- Develop resources from diverse sources
- Identify which activities are priorities for long term implementation
- Draft and implement a sustainability plan
- Develop a funding plan with timelines, goals, tasks, strategies and actions
- Define how EOT activities will use partnerships to leverage resources
References


Southern California Earthquake Center – SCEC (2003), Communication, Education and Outreach (CEO) Program. URL: http://www.scec.org/ceo/.


Appendix I: Proposed Education, Outreach, and Training Activities

This table summarizes potential activities that could serve as elements of the proposed NEES Education, Outreach, and Training (EOT) program. For each activity a short summary of the activity is provided, along with the NEES EOT goals to which it contributes, the target audience, and potential measures for evaluation.

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<tr>
<th>Activity</th>
<th>NEES EOT Goals</th>
<th>Target Audience</th>
<th>Potential Measures</th>
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<td>Research Experiences:</td>
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<td>REU (NSF-supported Research Experience for Undergraduates Program):</td>
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<td>Program designed to foster research among undergraduate students. May</td>
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<td>occur at Equipment Site or at site of the funded research.</td>
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<td>Research Internship:</td>
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<td>NEES-developed program to provide university students, post-doctoral</td>
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<td>students, faculty, and industry members with research experience at</td>
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<td>NEES Equipment Sites and to expand the number of researchers using the</td>
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<td>International Student Research ²:</td>
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<td>Internationally-supported program to foster collaboration among</td>
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<td>the world-wide earthquake community</td>
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</table>

² The NEES EOT goals are discussed in Section 1c of the EOT Strategic Plan and are summarized here:
  Education: (E1) Promote and support the use of NEES facilities, tools, research and research results in undergraduate, graduate and K-12 education, (E2) Improve understanding and appreciation of earthquake engineering practice and research, and (E3) Improve the teaching and learning of earthquake engineering in undergraduate, graduate and K-12 education
  Outreach: (O1) Promote interaction of practitioners with researchers and transfer of results of NEES research into practice, (O2) Promote the NEES Collaboratory, (O3) Increase the pool of outstanding and diverse students, and (O4) Advance earthquake engineering research by partnering with other organizations to identify and promote community needs
  Training: (T1) Promote participation in the NEES Collaboratory.

³ Key to abbreviations of target audiences
  K-12 - K12 Undergraduate Students -UG
  K-12 Teachers -K12T Graduate Students -G
  High School Students -HS

⁴ Could be partnership with NSF-supported programs such as the Japan-US Summer research exchange
<table>
<thead>
<tr>
<th>Activity</th>
<th>NEES EOT Goals</th>
<th>Target Audience</th>
<th>Potential Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>RET (NSF-supported Research Experience for Teachers): Program designed to foster the transfer of the research experience to K-12 classrooms</td>
<td>E1 X E2 X E3 X O1 X O2 O3 O4 X T1 K12, K12T</td>
<td># RET sites and # of teachers participating</td>
<td># students participating, including demographic data # student accomplishments (papers, presentations, posters, etc.)</td>
</tr>
<tr>
<td>REHS*: NEES-developed program that along with the RET program, will help in linking research results with 9-12 classrooms</td>
<td>X X X</td>
<td>HS</td>
<td># students participating, including demographic data # student accomplishments (papers, presentations, posters, etc.)</td>
</tr>
<tr>
<td>Distributed Analysis of Research Data: This program has two goals: (1) provide classrooms with real world data and (2) use collective efforts to reduce large experimental results</td>
<td>X X X X</td>
<td>UG, G, F</td>
<td># students participating, including demographic data # student accomplishments (papers, presentations, posters, etc.) assessment of student learning</td>
</tr>
<tr>
<td>Curriculum Development/Training</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K-12 Modules and Materials: Products will incorporate experimentally obtained data and information technology resources into K-12 demonstration and teaching modules.</td>
<td>E1 X E2 X E3 X O1 X O2 O3 O4</td>
<td>K12</td>
<td># modules developed # modules adopted materials posted in NEES digital library assessment of student learning</td>
</tr>
<tr>
<td>Undergraduate Modules and Materials: Products will incorporate experimentally obtained data and information technology resources into undergraduate level demonstration and teaching modules.</td>
<td>X X X X</td>
<td>UG, F</td>
<td># modules developed # modules adopted # activities posted in NEES digital library assessment of student learning</td>
</tr>
<tr>
<td>Graduate Modules and Materials: Products will incorporate experimentally obtained data and information technology resources into graduate level demonstration and teaching modules.</td>
<td>X X X X</td>
<td>G, F</td>
<td># modules developed # modules adopted # activities posted in NEES digital library assessment of student learning</td>
</tr>
<tr>
<td>Professional Development Workshops for Teachers and Professors: Workshops will provide support for teachers and professors as they incorporate NEES modules and materials into curricula.</td>
<td>X X X X X</td>
<td>K12T, F</td>
<td># workshops # participants including demographic data assessment of student learning assessment of faculty learning</td>
</tr>
</tbody>
</table>

*REHS – Research Experience for High School Scholars. Summer program organized around NEES research: a high school scholar earthquake engineering recruitment course.
<table>
<thead>
<tr>
<th>Activity</th>
<th>NEES EOT Goals</th>
<th>Target Audience</th>
<th>Potential Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Target Audience-Catered Training</strong> (workshops &amp; online):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NEES-developed training targeted toward focused groups of the earthquake</td>
<td>X</td>
<td>K12, F, ER,</td>
<td># online training modules</td>
</tr>
<tr>
<td>engineering community in the use of the NEES facilities and tools.</td>
<td></td>
<td>R, P</td>
<td># workshops</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td># participants including demographic data</td>
</tr>
<tr>
<td></td>
<td>E1</td>
<td>E2</td>
<td>E3</td>
</tr>
<tr>
<td><strong>Community Development/Outreach</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conferences and Workshops Focused on E&amp;O:</td>
<td>X</td>
<td>K12, F, CD, ER</td>
<td></td>
</tr>
<tr>
<td>NEES developed activity to provide a forum to disseminate results and</td>
<td>X</td>
<td></td>
<td># workshops and conferences</td>
</tr>
<tr>
<td>best practices and to raise awareness of the NEES E&amp;O potential.</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>E1</td>
<td>E2</td>
<td>E3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td># workshop or conference assessment</td>
</tr>
<tr>
<td>Practitioner Seminars:</td>
<td></td>
<td>P</td>
<td></td>
</tr>
<tr>
<td>NEES developed seminar series to inform practitioners about NEES</td>
<td></td>
<td></td>
<td># seminars</td>
</tr>
<tr>
<td>activities and to gather feedback about needs in practice.</td>
<td></td>
<td></td>
<td># participants</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>documentation of seminar outcomes</td>
</tr>
<tr>
<td>Conferences and Workshops on Research Applications:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NEES developed activity to provide a forum to disseminate results and</td>
<td></td>
<td>R, P</td>
<td></td>
</tr>
<tr>
<td>raise awareness of the NEES research potential.</td>
<td></td>
<td></td>
<td># workshops and conference</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td># participants</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td># papers</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>workshop or conference assessment</td>
</tr>
<tr>
<td>Travel Funds for Students to Present NEES Research:</td>
<td></td>
<td>UG, G</td>
<td></td>
</tr>
<tr>
<td>Partial and full support for students to present at conferences</td>
<td></td>
<td></td>
<td># students participating, including demographic data</td>
</tr>
<tr>
<td>facilitates dissemination of results and awareness of NEES</td>
<td>X</td>
<td></td>
<td># student papers presented</td>
</tr>
<tr>
<td>program</td>
<td>E1</td>
<td>E2</td>
<td>E3</td>
</tr>
<tr>
<td>Database to Match NEES Researchers’ &amp; Curriculum Developers:</td>
<td></td>
<td>CD, ER, R</td>
<td></td>
</tr>
<tr>
<td>The intent of the database is to facilitate cooperation between two</td>
<td></td>
<td></td>
<td># combined research/education projects developed</td>
</tr>
<tr>
<td>different communities.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Museum Displays:</td>
<td></td>
<td>K12, GP</td>
<td></td>
</tr>
<tr>
<td>Museum displays will expose a broader community to NEES.</td>
<td>X</td>
<td></td>
<td># visitors, including demographics</td>
</tr>
<tr>
<td>Activity</td>
<td>NEES EOT Goals</td>
<td>Target Audience</td>
<td>Potential Measures</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
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<td>-----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Partnerships with Minority Organizations:</td>
<td></td>
<td>All</td>
<td># partnerships</td>
</tr>
<tr>
<td>Partnerships will connect NEES with a diverse group of researchers,</td>
<td></td>
<td></td>
<td># students participating, including demographic data</td>
</tr>
<tr>
<td>teachers and students; and minority organizations will gain access to</td>
<td></td>
<td></td>
<td># participant K12 pursuing STEM education</td>
</tr>
<tr>
<td>state-of-the-art facilities and new opportunities for members.</td>
<td>X X X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partnerships with providers of educational media:</td>
<td></td>
<td>All</td>
<td># programs/shows developed</td>
</tr>
<tr>
<td>Partnerships will provide the media with state-of-the-art programming</td>
<td></td>
<td></td>
<td># programs/shows adopted in grade schools</td>
</tr>
<tr>
<td>ideas and will help NEES in reaching the broader community.</td>
<td>X X X X X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partnership with NEERCs*:</td>
<td></td>
<td>UIG, G, K12,</td>
<td># developed activities</td>
</tr>
<tr>
<td>Partnerships will help in the development of combined activities</td>
<td></td>
<td>GP</td>
<td># students participating, including demographic data</td>
</tr>
<tr>
<td>while preventing duplication of resources.</td>
<td>X X X X X X X</td>
<td></td>
<td># practitioners participating</td>
</tr>
<tr>
<td>Partnerships with professional organizations:</td>
<td></td>
<td>R, P</td>
<td># developed activities</td>
</tr>
<tr>
<td>Partnerships will help NEES in outreach to engineering practitioners</td>
<td></td>
<td></td>
<td># participant practitioners</td>
</tr>
<tr>
<td>and the at-large community.</td>
<td>X X X X X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partnership with ASEE and ASCE education branch:</td>
<td></td>
<td>CD, ER, F</td>
<td># developed activities</td>
</tr>
<tr>
<td>These partnerships will enhance interaction with the engineering</td>
<td></td>
<td></td>
<td># sessions at conferences</td>
</tr>
<tr>
<td>education community.</td>
<td>X X X</td>
<td></td>
<td># papers, posters</td>
</tr>
<tr>
<td>Partnership with industry and major labs:</td>
<td></td>
<td>R, P</td>
<td># supported proposals</td>
</tr>
<tr>
<td>Partnerships will facilitate cooperative research and dissemination of</td>
<td></td>
<td></td>
<td># published papers</td>
</tr>
<tr>
<td>NEES research.</td>
<td>X X X X X</td>
<td></td>
<td># developed patents/products</td>
</tr>
<tr>
<td>Visualization Tools</td>
<td></td>
<td>K12</td>
<td># developed modules</td>
</tr>
<tr>
<td>K-12 visualization modules:</td>
<td></td>
<td></td>
<td># adopted modules</td>
</tr>
<tr>
<td>Visualization will enable K-12 students and the general public to</td>
<td>X X</td>
<td></td>
<td># participant students</td>
</tr>
<tr>
<td>interact with and better understand data generated from NEES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>experiments.</td>
<td></td>
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</tr>
</tbody>
</table>

* NEERC: NSF-supported Earthquake Research Center
<table>
<thead>
<tr>
<th>Activity</th>
<th>NEES EOT Goals</th>
<th>Target Audience</th>
<th>Potential Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>UG and Grad modules:</td>
<td></td>
<td></td>
<td># developed modules</td>
</tr>
<tr>
<td>Visualization will enable university students to interact with and better understand data generated from NEES experiments.</td>
<td>X X</td>
<td>UG, G, F, CD, ER</td>
<td># adopted modules</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td># participant students</td>
</tr>
<tr>
<td><strong>Information Resources</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EOT web presence:</td>
<td>X X X X X X</td>
<td>All</td>
<td># visitors (including demographics)</td>
</tr>
<tr>
<td>This web site will provide information about NEES, and gateways into NEES data, tools, and services.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital Libraries:</td>
<td>X X X X</td>
<td>All</td>
<td># of materials accessed quality of materials through peer review adopt digital libraries assessment matrices</td>
</tr>
<tr>
<td>In cooperation with existing digital libraries, a NEES digital library will provide a systematic way to catalog and dissemination NEES educational and outreach materials.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Newsletters &amp; public relations:</td>
<td>X X X X</td>
<td>All</td>
<td># of publications and audience</td>
</tr>
<tr>
<td>Outreach materials</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science Fair support:</td>
<td>X X X</td>
<td>K12</td>
<td># supported Science Fairs</td>
</tr>
<tr>
<td>NEES researchers and members answer questions and mentor science fair students and teachers.</td>
<td></td>
<td></td>
<td># participant students, including demographics</td>
</tr>
</tbody>
</table>
## Appendix II: Timeline for Proposed Activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Years 4-10</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Research Experiences</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Research Experiences for Undergraduates (REU)</td>
<td>Identify existing programs in NEES consortium; help publicize programs, recruit students, and match students with research projects and faculty</td>
<td>Write funding proposals to augment existing REUs; Coordinate publicity, recruiting, and matching for all NEES REUs</td>
<td>Continue coordination</td>
<td>Continue</td>
</tr>
<tr>
<td>Research internship</td>
<td>Identify any existing internship programs at Equipment Sites and help publicize</td>
<td>Develop criteria for NEES research internships, identify funding. Continue publicizing existing internships.</td>
<td>First NEES research internships.</td>
<td>Continue</td>
</tr>
<tr>
<td>International student research</td>
<td></td>
<td></td>
<td>Identify faculty collaborators; write funding proposals; begin recruitment of students</td>
<td>Continue—follow model for REU</td>
</tr>
<tr>
<td>Research Experiences for Teachers (RET)</td>
<td>Identify existing programs in NEES consortium; help publicize programs, recruit teachers, and match teachers with research projects and faculty</td>
<td>Write funding proposals to augment existing RETs; Coordinate publicity, recruiting, and matching for all NEES RETs</td>
<td>Continue coordination</td>
<td>Continue</td>
</tr>
<tr>
<td>Research Experiences for High School (REHS)</td>
<td></td>
<td></td>
<td>Identify faculty collaborators; write funding proposals; begin recruitment of students</td>
<td>Continue</td>
</tr>
<tr>
<td>Distributed analysis of research data</td>
<td></td>
<td></td>
<td>Identify research and faculty collaborators</td>
<td>Develop and test pilot distributed analysis activities</td>
</tr>
<tr>
<td><strong>Curriculum Development and Training</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>K-12 modules and materials</td>
<td>Create inventories of currently available modules; hold workshops to identify gaps and new topics</td>
<td>Identify researchers and curriculum developers Write funding proposals</td>
<td>Develop modules</td>
<td>Field test and distribute modules</td>
</tr>
<tr>
<td>Undergraduate modules and materials</td>
<td>Create inventories of currently available modules; hold workshops to identify gaps and new topics</td>
<td>Identify researchers and curriculum developers Write funding proposals</td>
<td>Develop modules</td>
<td>Field test and distribute modules</td>
</tr>
<tr>
<td>Graduate modules and materials</td>
<td>Create inventories of currently available modules; hold workshops to identify gaps and new topics</td>
<td>Identify researchers and curriculum developers</td>
<td>Develop modules</td>
<td>Field test and distribute modules</td>
</tr>
<tr>
<td>Activity</td>
<td>Year 1</td>
<td>Year 2</td>
<td>Year 3</td>
<td>Years 4-10</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Professional development workshops for teachers and professors</td>
<td></td>
<td></td>
<td></td>
<td>Begin professional development workshops</td>
</tr>
<tr>
<td><strong>Continuing Education &amp; Training</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Target-audience catered training (workshops &amp; online)</td>
<td>On-site training sessions (equipment and IT tools and services)</td>
<td>Continue on-site training Develop online materials</td>
<td>continue</td>
<td>continue</td>
</tr>
<tr>
<td><strong>Community Development/Outreach</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conferences/ workshops focused on E &amp; O</td>
<td>Plan EOT activities at NEES Annual Meeting; help coordinate E&amp;O activities of NEESR awardees</td>
<td>Continue Annual Meeting and NEESR awardee coordination; Plan K-12 teacher summer workshop, including funding;</td>
<td>Continue Annual Meeting and NEESR awardee coordination; Train K12 teachers in the summer workshop</td>
<td>Continue Annual Meeting and NEESR awardee coordination; Academic year: teachers teach content Summer: develop modules</td>
</tr>
<tr>
<td>Conferences/ workshops on technology transfer and research application</td>
<td></td>
<td>Workshop/activity to develop a plan for research utilization and technology transfer</td>
<td>First conference or workshop</td>
<td>continue</td>
</tr>
<tr>
<td>Student travel</td>
<td></td>
<td>Locate funding Establish collaboration with existing programs</td>
<td>First awards</td>
<td>continue</td>
</tr>
<tr>
<td>Database—match NEESR researchers and curriculum developers</td>
<td></td>
<td>Locate researchers, curriculum developers; plan database</td>
<td>Work on database</td>
<td>Database Ready for init public use</td>
</tr>
<tr>
<td>Practitioner seminar</td>
<td></td>
<td></td>
<td></td>
<td>First seminar</td>
</tr>
<tr>
<td>Partnerships w/ digital libraries</td>
<td>Identify and negotiate partnerships</td>
<td>continue</td>
<td>continue</td>
<td>continue</td>
</tr>
<tr>
<td>Partnerships w/ minority serving organizations</td>
<td>Identify and negotiate partnerships</td>
<td>continue</td>
<td>continue</td>
<td>continue</td>
</tr>
<tr>
<td>Partnerships w/ NEERCs</td>
<td>Identify and negotiate partnerships</td>
<td>continue</td>
<td>continue</td>
<td>continue</td>
</tr>
<tr>
<td>Partnerships w/ professional organizations</td>
<td>Identify and negotiate partnerships</td>
<td>Develop practitioner seminar</td>
<td>Announce Practitioner seminar</td>
<td>continue</td>
</tr>
<tr>
<td>Partnerships w/ education organizations (e.g. ASEE)</td>
<td>Identify and negotiate partnerships</td>
<td>continue</td>
<td>continue</td>
<td>continue</td>
</tr>
<tr>
<td>Partnerships w/ educational media</td>
<td>Identify and negotiate partnerships</td>
<td>continue</td>
<td>continue</td>
<td>continue</td>
</tr>
<tr>
<td>Partnerships w/ industry, labs</td>
<td>Identify and negotiate partnerships</td>
<td>continue</td>
<td>continue</td>
<td>continue</td>
</tr>
<tr>
<td>Activity</td>
<td>Year 1</td>
<td>Year 2</td>
<td>Year 3</td>
<td>Years 4-10</td>
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</tr>
<tr>
<td><strong>Visualization Tools</strong></td>
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</tr>
<tr>
<td>K-12 visualization modules</td>
<td></td>
<td></td>
<td>Identify high priority needs, existing modules, funding sources, and developers</td>
<td>Begin development</td>
</tr>
<tr>
<td>UG and G visualization modules</td>
<td></td>
<td>Identify high priority needs, existing modules, funding sources, and developers</td>
<td>Determine content for modules</td>
<td>Begin development</td>
</tr>
<tr>
<td><strong>Information Resources</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital library</td>
<td>Write specifications and negotiate partners for digital library.</td>
<td>Launch and promote The digital library</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EOT web presence</td>
<td>Establish web pages</td>
<td>Evaluate web pages and augment</td>
<td>continue</td>
<td>continue</td>
</tr>
<tr>
<td>Science fair support</td>
<td></td>
<td></td>
<td></td>
<td>Begin</td>
</tr>
<tr>
<td>Museum displays</td>
<td></td>
<td></td>
<td></td>
<td>Begin</td>
</tr>
<tr>
<td>Electronic research/educational journal</td>
<td>Establish the editorial board</td>
<td>Accept manuscripts</td>
<td>continue</td>
<td>continue</td>
</tr>
<tr>
<td>Outreach material</td>
<td>Develop brochures</td>
<td>Revise and expand outreach materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Newsletters (quarterly)</td>
<td>Initiate newsletter</td>
<td>Continue publishing newsletter</td>
<td>continue</td>
<td>continue</td>
</tr>
<tr>
<td><strong>Evaluation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacity building</td>
<td>Capacity Building Workshop to plan evaluation model and instruments, refine goals</td>
<td>Build databases for tracking evaluation data</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Needs assessments</td>
<td>Needs assessment for web presence and digital library</td>
<td>Needs assessment for design of other activities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual evaluation</td>
<td>Formative and summative evaluation of effectiveness of activities</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Student learning evaluation</td>
<td></td>
<td>Identify projects that impact student learning</td>
<td>Begin study if funded</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Identify partners and develop proposal for evaluation study</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Awards program</td>
<td>Identify funding and award criteria</td>
<td>Secure funding</td>
<td>Make first awards</td>
<td>continue</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Announce criteria for awards and solicit nominations</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix III: Potential Collaborators for NEES EOT

Organizations and programs with an emphasis on increasing participation of under-represented groups are identified with an (*).

Alliances for Graduate Education and the Professoriate Program (AGEP)*
www.ehr.nsf.gov/EHR/HRD/agep.asp

American Indian Science and Engineering Society (AISES)*
www.aises.org

American Society of Civil Engineers (ASCE)
www.asce.org

American Society of Engineering Education (ASEE)
www.asee.org

Applied Technology Council (ATC)
www.atcouncil.org

Center for Earthquake Research and Information (CERI)
www.ceri.memphis.edu

Consortium for Building Evaluation Capacity (CBEC)
www.usu.edu/cbec

Consortium of Universities for Research in Earthquake Engineering (CUREE)
www.curee.org

Digital Library for Earth Science Education (DLESE)
www.dlese.org

Earthquake Engineering Research Institute (EERI)
www.eeri.org

EarthScope
www.earthscope.org

Education, Outreach, and Training Partnership for Advanced Computational Infrastructure (EOT-PACI)
www.eot.org

Federal Emergency Management Agency (FEMA)
www.fema.gov

Gender in Science and Engineering Program (GSE)*
www.ehr.nsf.gov/hrd/pge.asp

Incorporated Research Institutions for Seismology (IRIS)
www.iris.edu

Louis Stokes Alliance for Minority Participation (LSAMP)*
www.ehr.nsf.gov/hrd/amp.asp

Math, Science, Engineering Achievement (MESA)*
www.mesa.ucop.edu

Mid-America Earthquake Center (MAE)
mae.ce.uiuc.edu

Multidisciplinary Center for Earthquake Engineering Research (MCEER)
mceer.buffalo.edu

Multimedia Educational Resource for Learning and Online Teaching (MERLOT)
www.merlot.org

National Action Council for Minorities in Engineering (NACME)*
www.nacme.org

National Earth Science Teachers Association (NSTA)
www.nsta.org

National Consortium for Graduate Degrees for Minorities in Engineering and Science, Inc. (GEM)*
wase.nd.edu/gem/gemwebapp/

National Engineering Education Delivery System (NEEDS)
www.needs.org/needs

National Geographic Society Education Foundation
www.nationalgeographic.com/education

Appendix III: Potential Collaborators
National Science Digital Library (NSDL)  
www.nsdl.org

National Society of Black Engineers (NSBE)*  
www.nsbe.org

National Center for Supercomputing Applications (NCSA)  
www.ncsa.uiuc.edu

Pacific Earthquake Engineering Research Center (PEER)  
peer.berkeley.edu

Presidential Awards for Excellence in Science, Mathematics and Engineering Mentoring (PAESMEM)*  
www.ehr.nsf.gov/EHR/HRD/paesmem.asp

Society for the Advancement of Chicanos and Native Americans in Science (SACNAS)*  
www.sacnas.org

Society of Hispanic Professional Engineers (SHPE)*  
www.shpe.org

Society of Women Engineers (SWE)*  
www.swe.org

Southern California Earthquake Center (SCEC)  
www.scec.org

Structural Engineers Associations (California, Washington, Illinois)  
www.seaint.org

The George and Marta Brown Foundation

Tribal Colleges and Universities Program (TCUP)*  
www.ehr.nsf.gov/hrd/tcup.asp

United States Geological Survey (USGS)  
www.usgs.gov

University of California, Irvine Center for Educational Partnerships  
sep.uci.edu

University Consortium of Instructional Shake Tables (UCIST)  
ucist.cive.wustl.edu

Women in Engineering Programs and Advocate Network (WEPAN)*  
www.wepan.org
Appendix IV: Sources of Potential Funding for Education, Outreach, and Training

National Science Foundation

Research Experiences for Undergraduates (REU)
- www.nsf.gov/home/crssprgm/reu/
This program supports active research participation by undergraduate students in any of the areas of research funded by the National Science Foundation. REU projects involve students in meaningful ways in ongoing research programs or in research projects specially designed for the purpose.

Research Experiences for Teachers (RET)
This program supports the active involvement of K-12 teachers and community college faculty in engineering research in order to bring knowledge of engineering and technological innovation into their classrooms.

Research in Undergraduate Institutions (RUI)
- www.ehr.nsf.gov/crssprgm/rui/start.shtm
This program activity supports research by faculty members of predominantly undergraduate institutions through the funding of (1) individual and collaborative research projects, (2) the purchase of shared-use research instrumentation, and (3) Research Opportunity Awards for work with NSF-supported investigators at other institutions.

Course, Curriculum & Laboratory Improvement (CCLI)
- www.ehr.nsf.gov/ehr/DUE/programs/ccli
This program seeks to improve the quality of science, technology, engineering, and mathematics (STEM) education for all students, based on educational research and empirical data concerning needs and opportunities in undergraduate education and effective ways to address them. The program targets activities affecting learning environments, course content, curricula, and educational practices, with the aim of improving learning contributing to the relevant knowledge base that will support future efforts to enhance STEM education.

National STEM Education Digital Library (NSDL)
- www.ehr.nsf.gov/ehr/DUE/programs/nsdl
This program aims to establish a national digital library that will constitute an online network of learning environments and resources for STEM education at all levels.

NEES Research – education component (NEESR)
A proposal submitted under this solicitation must utilize the equipment resources at one or more of the NEES Equipment Sites operated by the NEES Consortium, Inc., in the proposed research project.

Engineering Education Program (unsolicited proposals)
- www.eng.nsf.gov/eec
The Engineering Education program has the goal to increase the quantity and quality of U.S. citizens who earn BS degrees in engineering. Unsolicited proposals may be submitted with cutting edge new ideas for undergraduate engineering education improvements.

NSF Director’s Award for Distinguished Teaching Scholars (DTS)
- www.ehr.nsf.gov/ehr/DUE/programs/dts/
This award recognizes and rewards individuals who have contributed significantly to the scholarship of their discipline and to the education of students in STEM, and who exemplify the ability to integrate their research and educational activities. This award is the highest honor bestowed by NSF for excellence in both teaching and research in STEM fields, or in educational research related to these fields.
STEM Talent Expansion Program (STEP)
- www.ehr.nsf.gov/ehr/DUE/programs/step
This program seeks to increase the number of students receiving associate or baccalaureate degrees in established or emerging fields within STEM.

Teacher Professional Continuum (TPC)
- www.ehr.nsf.gov/ehr/DUE/programs/tpc
This program addresses critical issues and needs regarding the recruitment, preparation, induction, retention, and life-long development of STEM teachers for grades K-12. Its goals are to improve the quality and coherence of learning experiences for teachers across the continuum through research that informs teaching practice and the development of innovative resources for the professional development of K-12 STEM teachers.

Integrated Graduate Education and Research Traineeship (IGERT)
- www.nsf.gov/igert
The program’s goal is to enable the development of innovative graduate education activities that are research-based and that will produce scientists and engineers who are well prepared for a broad spectrum of career opportunities. IGERT integrates research and education with emphasis on experimentation to yield a variety of new models for a paradigm shift in graduate education.

Research on Learning and Education (ROLE)
- www.ehr.nsf.gov/rec/programs/research/
This program seeks to capitalize on important developments across a wide range of fields related to human learning and to STEM education. The ROLE Program aims to advance the knowledge base within and across the intersections of these multidisciplinary areas. It encourages projects that reconcile and integrate basic research and educational practice, and generate hypotheses from one disciplinary area that can be tested and refined in another.

Graduate Teaching Fellows in K-12 Education (GK-12)
- www.ehr.nsf.gov/dge/programs/gk12/
This program supports fellowships and associated training that enable graduate students and advanced undergraduates in STEM fields to serve in partnership with mentor teachers in K-12 schools as resources knowledgeable about both the content and applications of these disciplines.

Grants for the Department-Level Reform of Undergraduate Engineering Education
The program supports grants to enable departmental and larger units to reformulate, streamline, and update engineering degree programs, develop new curricula for emerging engineering disciplines, and meet the emerging workforce and educational needs of U.S. industry. Grants are available for both planning and implementation efforts.

Information Technology Experiences for Students and Teachers (ITEST)
ITEST is designed to increase the opportunities for students and teachers to learn about, experience, and use information technologies within the context of science, technology, engineering, and mathematics, including Information Technology courses. Supported projects are intended to provide opportunities for both school-age children and for teachers to build the skills and knowledge needed to advance their study, and to function and contribute in a technologically rich society.
NSF Programs on Diversity

Louis Stokes Alliance for Minority Participation (LSAMP)
- www.ehr.nsf.gov/ehr/hrd/amp.asp

The LSAMP program requires each awardee to establish meaningful partnerships among academic institutions, and encourages the inclusion of government agencies and laboratories, industry and professional organizations. Supported activities include, among others: student enrichment, such as collaborative learning, skill development, and mentoring; academic enrichment, such as curricular and instructional improvement; and direct student support, such as summer activities.

Alliances for Graduate Education and the Professoriate Program (AGEP)
- www.ehr.nsf.gov/EHR/HRD/agep.asp

This program seeks to significantly increase the number of American Indian/Alaskan Native (Native American), African American, Hispanic American, and Native Pacific Islander students receiving doctoral degrees in STEM fields customarily supported by NSF. The lack of role models and mentors in the professoriate constitutes a significant barrier to producing minority STEM doctoral graduates. NSF is particularly interested in increasing the number of minorities who will enter the professoriate in these disciplines.

Centers of Research Excellence in Science and Technology (CREST)
- www.ehr.nsf.gov/hrd/crest.asp

This program makes substantial resources available to upgrade the capabilities of the most research-productive minority-serving institutions. It develops outstanding centers through the integration of education and research. It serves to promote the production of new knowledge, to increase the research productivity of individual faculty, and to expand a diverse student presence in STEM disciplines. The program also enables CREST Centers to increase the effectiveness of related science and engineering activities within their research areas.

Historically Black Colleges and Universities-UP (HBCU-UP)
- www.ehr.nsf.gov/ehr/hrd/hbcu.asp

This program seeks to enhance the quality of undergraduate STEM education at Historically Black Colleges and Universities as a means to broaden participation in the Nation's STEM workforce.

Tribal Colleges and Universities Program (TCUP)
- www.ehr.nsf.gov/ehr/hrd/tcup.asp

This program provides awards to enhance the quality of STEM instructional and outreach programs, with an emphasis on the leveraged use of information technologies at Tribal Colleges and Universities, Alaskan Native-serving Institutions and Native Hawaiian-serving institutions.

Research on Gender in Science and Engineering (GSE)
- www.ehr.nsf.gov/ehr/hrd/pge.asp

This program seeks to broaden participation of girls and women by supporting research, dissemination of research, and integration of proven good practices in education that will lead to a larger and more diverse domestic science and engineering workforce. Typical projects will contribute to the knowledge base addressing gender-related differences; and how pedagogical approaches and teaching styles, curriculum, student services, and institutional culture contribute to causing or closing gender gaps that persist in certain fields.

The White House established the PAESMEM Program to recognize the importance of role models and mentors in the academic, professional, and personal development of students underrepresented in STEM fields. The program identifies outstanding mentors and mentoring programs that enhance the experiences of underrepresented students in the sciences, mathematics, and engineering. PAESMEM awardees have been exemplary in their demonstration of the idea that the Nation must fully develop its human resources in STEM disciplines through the support of increased access by, and inclusion of, diverse populations.

US Department of Education

Institute of Education Science - Education Research

Under this program title, the Institute of Education Sciences supports research to improve education at all levels. The intent of these grants is to provide national leadership in expanding fundamental knowledge and understanding of education from early childhood through postsecondary study.

Educational Resources Information Center
- www.ed.gov/programs/eric/index.html

The Educational Resources Information Center (ERIC) ERIC is a national information system providing educators, researchers, and the general public with access to education literature and resources. The ERIC database is the world's largest and most frequently used education database, composed of more than one million bibliographic records spanning 1966 to the present.

Regional Education Laboratories

Laboratories conduct applied research and development, provide technical assistance, develop multimedia educational materials and other products, and disseminate information in an effort to help others use knowledge from research and practice to improve education.

Private Foundations

Bill & Melinda Gates Foundation – Education Program
- www.gatesfoundation.org/Grants/default

The foundation funds scholarships and high school improvements in the United States in an effort to dramatically increase the high school and college graduation rates of the most disadvantaged students.

Lockheed Martin Corporation Philanthropy
- www.lockheedmartin.com/wms/findPage.do?dsp=fec&ci=13019&rsbcI=12908&fI=0&fi=0&sc=400

Philanthropic contributions are made primarily to programs of nationwide interest and programs in geographic areas of the corporation's operations. The total available annually for distribution is based on the previous year's sales and earnings, and related factors such as performance and business priorities. Area of interest include K-16 Math and Science Education
## Appendix V. List of Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Name</th>
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</thead>
<tbody>
<tr>
<td>AGEP</td>
<td>Alliances for Graduate Education and the Professoriate Program</td>
</tr>
<tr>
<td>AISES</td>
<td>American Indian Science and Engineering Society</td>
</tr>
<tr>
<td>ASCE</td>
<td>American Society of Civil Engineers</td>
</tr>
<tr>
<td>ASEE</td>
<td>American Society for Engineering Education</td>
</tr>
<tr>
<td>ATC</td>
<td>Applied Technology Council</td>
</tr>
<tr>
<td>BEST</td>
<td>Building Engineering and Science Talent</td>
</tr>
<tr>
<td>CBEC</td>
<td>Consortium for Building Evaluation Capacity</td>
</tr>
<tr>
<td>CERI</td>
<td>Center for Earthquake Research and Information</td>
</tr>
<tr>
<td>DLESE</td>
<td>Digital Library for Earth Systems Education</td>
</tr>
<tr>
<td>E&amp;O</td>
<td>Education and Outreach</td>
</tr>
<tr>
<td>E3</td>
<td>Electronic Encyclopedia of Earthquakes</td>
</tr>
<tr>
<td>EERI</td>
<td>Earthquake Engineering Research Institute</td>
</tr>
<tr>
<td>EOT</td>
<td>Education, Outreach, and Training</td>
</tr>
<tr>
<td>EOT-PACI</td>
<td>Education, Outreach, and Training Partnership for Advanced Computation Infrastructure</td>
</tr>
<tr>
<td>FEMA</td>
<td>Federal Emergency Management Agency</td>
</tr>
<tr>
<td>FTE</td>
<td>Full-time equivalent</td>
</tr>
<tr>
<td>GEM</td>
<td>National Consortium for Graduate Degrees for Minorities in Engineering and Science, Inc.</td>
</tr>
<tr>
<td>GSE</td>
<td>Gender in Science and Engineering Program</td>
</tr>
<tr>
<td>HBCU</td>
<td>Historically Black Universities and Colleges</td>
</tr>
<tr>
<td>IRIS</td>
<td>Incorporated Research Institutions for Seismology</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>LSAMP</td>
<td>Louis Stokes Alliance for Minority Participation and other AMP programs nationwide</td>
</tr>
<tr>
<td>MAE</td>
<td>Mid-America Earthquake Center</td>
</tr>
<tr>
<td>MERLOT</td>
<td>Multimedia Educational Resource for Learning Online</td>
</tr>
<tr>
<td>MESA</td>
<td>Math, Science, Engineering Achievement</td>
</tr>
<tr>
<td>NACME</td>
<td>National Action Council for Minorities in Engineering</td>
</tr>
<tr>
<td>NCMST</td>
<td>National Commission on Mathematics and Science Teaching for the 21st Century</td>
</tr>
<tr>
<td>NEEDS</td>
<td>National Engineering Education Delivery System</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>NEERC</td>
<td>National Earthquake Engineering Research Centers</td>
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<tr>
<td>NEES</td>
<td>George E. Brown, Jr. Network for Earthquake Engineering Simulation</td>
</tr>
<tr>
<td>NEESgrid</td>
<td>Software that comprises the IT component of the NEES Equipment Sites</td>
</tr>
<tr>
<td>NEESinc</td>
<td>NEES Consortium, Inc.</td>
</tr>
<tr>
<td>NEESII</td>
<td>NEES Cyberinfrastructure Center, IT staff and all software (including NEESgrid)</td>
</tr>
<tr>
<td>NEESR</td>
<td>NSF NEES Research program</td>
</tr>
<tr>
<td>NEHRP</td>
<td>National Earthquake Hazards Reduction Program</td>
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<tr>
<td>NISEE</td>
<td>National Information Service for Earthquake Engineering</td>
</tr>
<tr>
<td>NRC</td>
<td>National Research Council</td>
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<tr>
<td>NSBE</td>
<td>National Society of Black Engineers</td>
</tr>
<tr>
<td>NSDL</td>
<td>National Science, Technology, Engineering, and Mathematics Education Digital Library</td>
</tr>
<tr>
<td>NSF</td>
<td>National Science Foundation</td>
</tr>
<tr>
<td>NSTA</td>
<td>National Science Teachers Association</td>
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<tr>
<td>PAESMEM</td>
<td>Presidential Awards for Excellence in Science, Mathematics and Engineering Mentoring</td>
</tr>
<tr>
<td>RET</td>
<td>Research Experience for Teachers Program</td>
</tr>
<tr>
<td>REU</td>
<td>Research Experience for Undergraduates Program</td>
</tr>
<tr>
<td>SACNAS</td>
<td>Society for the Advancement of Chicanos and Native Americans in Science</td>
</tr>
<tr>
<td>SDSC</td>
<td>San Diego Supercomputer Center</td>
</tr>
<tr>
<td>SHPE</td>
<td>Society of Hispanic Professional Engineers</td>
</tr>
<tr>
<td>STEM</td>
<td>Science, Technology, Engineering and Math</td>
</tr>
<tr>
<td>SWE</td>
<td>Society of Women Engineers</td>
</tr>
<tr>
<td>TCUP</td>
<td>Tribal Colleges and Universities Program</td>
</tr>
<tr>
<td>UCIST</td>
<td>University Consortium on Instructional Shake Tables</td>
</tr>
<tr>
<td>USGS</td>
<td>United States Geological Survey</td>
</tr>
<tr>
<td>WEPAN</td>
<td>Women in Engineering Programs and Advocate Network</td>
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</tbody>
</table>
Appendix VI: Acknowledgments

The development of the NEES EOT Strategic Plan was supported by National Science Foundation Award CMS-0337808. The opinions, findings and recommendations expressed herein are those of the authors, and do not necessarily reflect the views of NSF. This support is gratefully acknowledged.

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