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DEVELOPMENT OF THE EDUCATION, OUTREACH AND TRAINING PROGRAM FOR THE NEES COLLABORATORY

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SUMMARY

The United States National Science Foundation has funded a project to develop an education, outreach and training (EOT) strategic plan for the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES). When NEES becomes fully operational on October 1, 2004, it will be a state-of the-art earthquake engineering experimental research facility consisting of 15 geographically distributed laboratories networked together and supported by advanced information technology (IT) infrastructure. NEES capabilities such as tele-presence, a curated data repository and advanced IT 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 paper describes the development and framework of the NEES EOT strategic plan, and some of the challenges associated with EOT programs for a distributed facility. In the plan, emphasis is being placed on addressing the needs of the diverse earthquake-engineering constituency and the unique features of the NEES collaboratory.

INTRODUCTION

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 (see Figure 1). This National Science Foundation (NSF)-funded major research equipment facility is built and operated to advance earthquake engineering research and education through collaborative and integrated experimentation, theory, data archiving, and model-based simulation. The entire NEES initiative is based on the concept of a collaboratory, essentially a "… 'center without walls,' in which the nation's researchers can perform their research without regard to geographical location (Wulf [1])." The four components of a collaboratory are distributed research facilities, shared instruments, a community data system and an open community contribution system. The IT component of the collaboratory uses the newest and fastest communications technologies to network the NEES equipment sites together and maintains a curated repository for all researchers to archive experimental data. The types of data that may be archived include videos, drawings, photographs, graphics, reports and simulations as well as digital data captured from instruments.

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When the system becomes operational in October 2004, the NEES IT will link earthquake researchers across the U.S. with leading-edge computing resources and research equipment, allowing collaborative teams (including remote participants) to plan, perform, and publish their experiments. The goal of NEES is to accelerate progress in earthquake engineering research and education while improving the seismic design and performance of civil and mechanical infrastructure systems through the integration of people, ideas, and tools in a collaboratory environment (NEES Consortium [2]). The NEES Collaboratory is administered and managed by a single community-based and community-led consortium known as the NEES Consortium Inc. (see also NEES Consortium [3]). This not-for-profit corporation is responsible for overseeing the management, operations, maintenance, and scheduling of the NEES shared-use facilities. NEES research projects that will utilize the infrastructure managed by the Consortium are selected by NSF on a competitive, peer-reviewed basis.

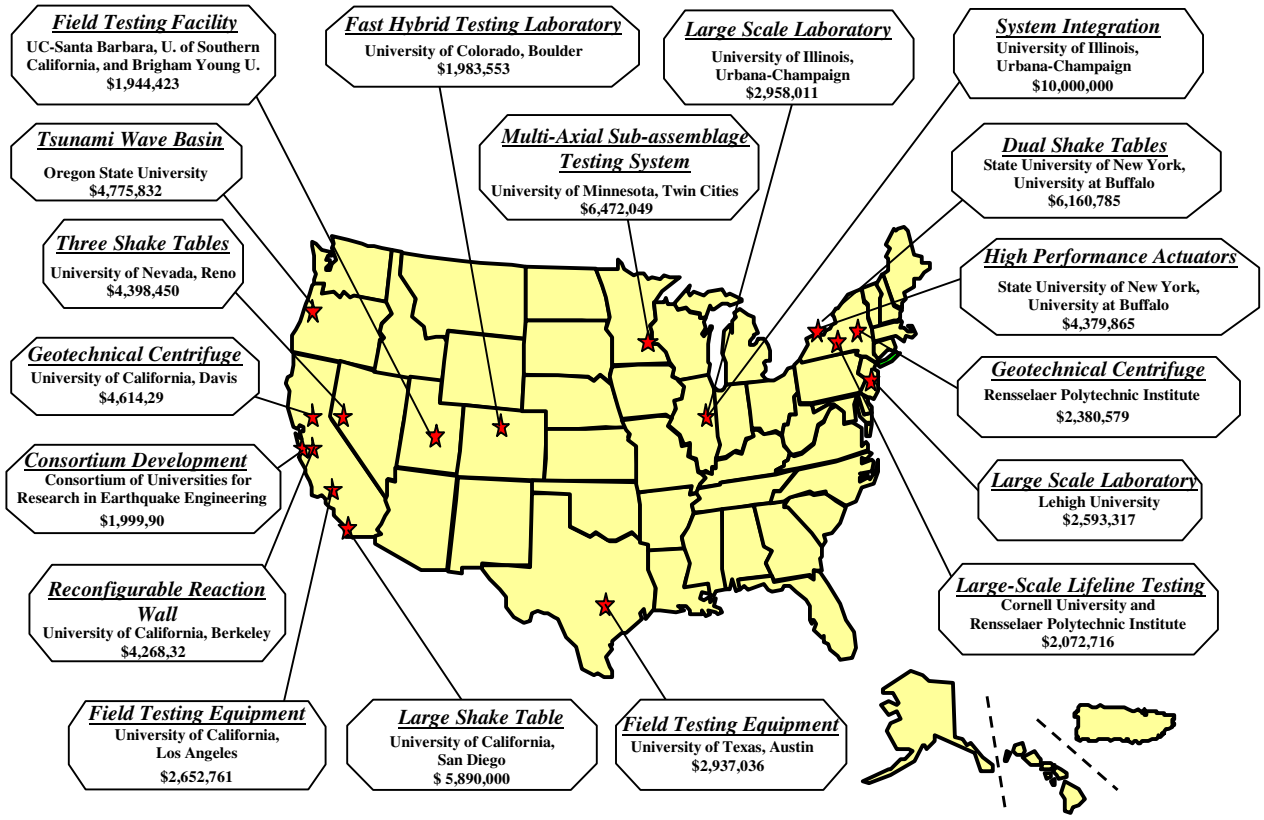

Figure 1: Geographical distribution of NEES Equipment Sites and other original NEES awards.

The NEES Collaboratory will provide new tools that have the potential to deepen the understanding of earthquake engineering concepts by modeling and simulating large-scale systems. NEES will give the earthquake engineering community unprecedented access to state-of-the-art laboratories, simulation programs, and data repositories. This will provide 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. The teleobservation capabilities and the curated repository of NEES will 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 more quickly incorporate new findings into practice. The unique features of NEES will provide an unparalleled opportunity to significantly change the way we teach and disseminate engineering concepts. NEES, therefore, provides an opportunity to study how students can best learn using remote teaching and remote experimentation.

However, the unique nature of the NEES collaboratory presents not only opportunities but also challenges that need to be addressed to maximize the return of the NEES investment.

The challenges and opportunities of the research components have been addressed by a number of regional workshops (Wood [4]), research workshops (NEES Consortium [5], [6]), NEES National Meetings (NEES Consortium [7], [8]), and by the Earthquake Engineering Research Institute (EERI [9]) and the National Research Council (NRC [10]). These reports focus mainly on the research challenges of NEES, but the EERI report also addresses some of the education and outreach needs and challenges that the earthquake engineering community will face in the near to medium-term future. The EERI report presents several initiatives to address and engage different communities (i.e., K-12, undergraduate, graduate and the public in general) in the need for improving earthquake engineering education, research and practice. Based on the information from regional workshops, reports and in the evaluation of education and outreach plans from other similar initiatives (e.g., IRIS [11], Earthscope [12], UCAR [13], DLESE [14], MCEER [15], ASCE [16], SCEC [17]), this paper discusses the need for the NEES Educational, Outreach and Training Strategic Plan, its constituents, goals, needs, challenges, proposed activities and measures of success.

NEES EDUCATION OUTREACH AND TRAINING STRATEGIC PLAN

The need for a NEES Education, Outreach, and Training (EOT) Strategic Plan was recognized through the work of the authors and others participating in the NEES Consortium Development Project (Wood [4]). In response to this need NSF funded a project (NEES Consortium [18]) to create the framework for the development, implementation and assessment of the NEES Educational, Outreach and Training program. The EOT strategic plan will serve as a bridge between the NSF, the NEES Collaboratory, and the Earthquake Engineering Community to ensure an innovative and effective education, outreach and training program. The strategic plan will establish the framework to be used by educators, researchers and organizations, such as NEES Consortium Inc., as they develop uses and applications of NEES to meet the educational needs and technological challenges of future K-12, graduate and undergraduate students, practitioners and interested public.

By incorporating ideas from engineering education literature, engineering education coalition successes, educational outcomes specified by ABET, national K-12 curriculum standards, existing education, outreach, and training programs, as well as input from educational developers and users at all levels, the proposed educational plan will reflect the priorities and needs of students, educators, researchers, practitioners, and the earthquake engineering community. More importantly, the EOT Strategic Plan will provide a focus that researchers can use in the submission of Small Group and Grand-Challenge proposals under the NSF NEESR Program, as these proposals must demonstrate that the principal investigators will develop educational and outreach programs and a plan for the dissemination and transfer of findings to the earthquake engineering community (NSF [19]).

The proposed goals for the NEES EOT Strategic Plan, as summarized in Table 1, are divided into three categories: Education, Outreach and Training. The goals are designed to be broad enough to meet the needs of all constituencies, and to focus on the unique contributions that NEES can make. In other words, NEES will make efforts to not duplicate education and outreach activities that exist at other centers such as the three national earthquake centers. On the other hand, if NEES IT capabilities and facilities can augment an existing program, NEES will establish a partnership with an organization and build on the existing program. The goals also aim to engage the entire community in shaping and growing the EOT program through assessing and promoting community needs.

Table 1: Proposed Goals for the NEES EOT Strategic Plan

Education	**E1**	**Promote and support the use of NEES facilities, tools, research and research results in undergraduate, graduate and K-12 education** through development of an active NEES Educational Community.
	E2	**Improve understanding and appreciation of earthquake engineering practice and research** by developing and disseminating NEES-related instructional materials and analysis tools
	E3	**Improve the teaching and learning of earthquake engineering in undergraduate, graduate and K-12 education** by providing professional development in the use of the NEES Collaboratory for educational and outreach activities
Outreach	**O1**	**Promote interaction of practitioners with researchers and transfer of results of NEES research into practice** through an active NEES Professional Community
	O2	**Promote the NEES Collaboratory** by disseminating information about NEES laboratory facilities, tools, research activities and research results
	O3	**Increase the pool of outstanding and diverse students** interested in earthquake engineering and supporting disciplines by taking advantage of the NEES Collaboratory
	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
Training	**T1**	**Promote participation in the NEES collaboratory** by providing training in the use of NEES laboratories and telepresence, collaboration, data archiving, analysis, visualization, and simulation tools

STRUCTURE OF NEES EDUCATION, OUTREACH AND TRAINING PLAN

Constituents

A diverse set of programs is needed to serve the broad group of users of the NEES collaboratory. The identified set of constituents for the NEES EOT program includes:

1. precollege education (both teachers and students)
2. undergraduate education (both faculty and students)
3. graduate education (both faculty and students)
4. researchers and remote users of the NEES collaboratory
5. practitioners and decision makers
6. laboratory managers and technicians responsible for supporting NEES experimentation
7. the public-at-large

There is a need to attract more students into science, mathematics, engineering, and technology (SMET) careers, and a need to provide engaging materials to help students better understand SMET 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" [20], "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 SMET concepts. For the precollege community, NEES educational materials may include classroom activities and lesson plans, videos, computer simulations, or data sets. Programs might include visitations to equipment sites, national student competitions, or remote interactions with NEES researchers. Professional development of teachers is key to integrating NEES materials into precollege education. One of the goals of the National Commission [20] 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. Teacher development may be accomplished by partnering with organizations such as the Mid-America Earthquake Center and the Center for Earthquake Research and Information that are already running summer institutes for teachers. In addition, 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 SMET concepts in the classroom. Through partnerships with organizations such as the Digital Library for Earth Systems Education (DLESE), NEES can ensure that instructional materials are readily available to teachers and students.

Educational modules that use NEES experimental results and data to demonstrate earthquake engineering concepts such as soil-structure interaction or ductility will be helpful to both undergraduate and graduate education. Programs that involve undergraduate students in NEES research could be instrumental in encouraging students to pursue higher degrees. Examples include summer Research Experiences for Undergraduates (REU), or a class or individual students could perform "mini-analyses" of data to support the ongoing research (a somewhat similar approach to SETI@home - SETI [21]).

Researchers, practitioners, and remote users of NEES could benefit from training on how to use the experimental facilities and the IT tools. It is envisioned that training will be delivered as both short courses and web-based training and instructional modules. A visiting scholars program would enable researchers and students to spend time at equipment sites and to establish relationships with NEES researchers for longer-term research collaboration. Results of research will be disseminated to researcher and practitioners through professional meetings, focussed seminars and publications. Partnerships with agencies such as the United State Geological Survey and the Federal Emergency Management Agency, and professional organizations such as the Applied Technology Council, the Earthquake Engineering Research Institute and the American Society of Civil Engineering, to name just a few, will ensure a strong dissemination program.

The K-12 community and the public at large would benefit from exhibits at museums and science centers (e.g., Hennet [22], Benthien [23]), targeted web-based resources (e.g., DLESE [14] and SCEC [17]), and high-impact media and entertainment such as films produced by the Discovery Channel, the Learning Channel, and the Public Broadcasting Service (e.g. DragonFlyTV [24]).

Staffing and Contributors

The NEES Consortium EOT Department will be staffed by three full-time professionals: an EOT Manager, an Education and Outreach (E&O) Specialist and a Training Specialist (NEES Consortium [25]). The EOT Manager will report to the Executive Director 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, 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 Site and IT training courses, arranging for appropriate training staff and the development and maintenance of training materials.

The Consortium Staff will be assisted by the NEES Consortium Education Outreach and Training (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 (NEES Consortium [26]). The composition of the EOT Committee includes educators, practitioners, and E&O directors from a variety of earthquake engineering and earth science organizations.

While the oversight of the EOT program resides at NEES headquarters, each of the 15 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 NEES headquarters and the equipment sites, researchers on NEESR grants will be developing educational materials and modules, and outreach activities (NSF [19]). Because of the nature of the NEESR proposal review and funding process, the associated education elements can be developed completely independently of NEES EOT programs, however, the goal is to provide some assistance and coordination from NEES headquarters so that these programs complement and build on EOT strategic goals.

DEVELOPMENT OF PLAN

To account for the diversity of the constituency, the geographic distribution of the different equipment sites, and the innovative information technology and tele-presence that form the basis of the NEES collaboratory, the development of the EOT Strategic Plan needs to incorporate a wide range of expertise, interests and resources. The development of the plan has drawn expertise from education, outreach and training programs of existing organizations (e.g., IRIS [11], Earthscope [12], UCAR [13], DLESE [14], MCEER [15], ASCE [16], SCEC [17]), the NEES research plans developed by the National Research Council and the Earthquake Engineering Research Institute (EERI [9] and NRC [10]), engineering education literature (e.g. NSF [27], [28]) and information collected from 25+ workshops run by the NEES Consortium Development team (e.g., Wood [4]; Andrews [29]; Reitherman [30], Anagnos [31]). The constituency was also polled through three targeted workshops (e.g., K-12 education, undergraduate and graduate education, and practitioners) and during the NEES National meeting to critique and augment the elements of the plan. The goal of these workshops and the national meeting has been to consult with experts on the early findings regarding needs, priorities and gaps and to involve them in the discussion of the draft educational and assessment plans. Therefore, the strategic plan development team is engaging the broad community to provide additional input on the resulting draft plan through presentations and web-based discussions. The resulting final report, the ten-year plan for NEES Education, Outreach, and Training, will be published as a written report and posted on the NEES Consortium web site (www.nees.org) for wide distribution.

A preliminary framework of priorities, proposed programs, phases of implementation, proposed categories of metrics and assessment are being drafted using the information collected in each workshop. Participants critique the preliminary framework and use it at as a starting point for discussion and development of a more mature plan. As each EOT activity and program is proposed, participants must first identify which of the eight EOT program goals it fulfills and what the outcomes of the activity would be. Next, with these outcomes in mind, the program is sketched out including metrics to measure the outcomes. The necessary resources, along with potential collaborators and funders, are identified. Table 2 summarizes a preliminary list of proposed program and activities. One theme that has emerged from the workshops is that education, outreach, and training activities should be focused on NEES' unique facilities and capabilities and should wherever possible build on existing programs. The project team is identifying existing programs that have excellent potential for partnerships and expansion with the aim of avoiding duplication.

Table 2: Proposed NEES EOT Programs

Program	Goals Supported by Program								Target Audience	Funding	Outcomes/Measurable
	E 1	E 2	E 3	O 1	O 2	O 3	O 4	T 1			
Research Experiences											
NSF Research Experiences for Undergraduates	X					X		X	UG	NSF	# REU sites and # students participating # students participating, including demographic data # graduate students in Earthquake Eng.
NSF Research Experiences for Teachers	X		X		X	X		X	K12, K12T	NSF	# RET sites and # of teachers participating # students that teachers will reach # underrepresented students reached # participant students pursuing SMET careers
Research Internship	X					X		X	UG, G	NSF, NEES Inc.	# students, including demographic data major accomplishments
International student research[3]	X					X		X	UG, G	NSF, Other	# students, including demographic data major accomplishments
REHS[4]	X					X			HS	NSF Human Resource Develop-ment Programs, Dept. of Education	# students participating, including demographic data. Student accomplishments (papers, presentations, posters, etc.), pursuit of graduate education, etc.
Distributed analysis of research data	X	X			X	X			UG, G	NEESR projects	# published papers
New researcher internship					X			X	R	NEESR projects	# new researchers participating in NEES projects. Researcher post-award activity.
Curriculum Development											
K-12 modules and materials	X		X			X			K12	NSF, Dept. of Education, Foundations	# modules developed # modules adopted materials posted in NEES digital library
Undergraduate modules and materials	X		X			X			UG, F	NSF, Dept. of Education, Foundations	# modules developed # modules adopted # participant students pursuing SMET careers # activities posted in NEES digital library

[3] Could be partnership with NSF-supported programs such as the Japan-US Summer research exchange

[4] REHS = Research Experience for High School Scholars. Summer program organized around NEES research: a high school scholars earthquake engineering recruitment course.

Program	Goals Supported by Program								Target Audience	Funding	Outcomes/Measurable
	E 1	E 2	E 3	O 1	O 2	O 3	O 4	T 1			
											assessment of learning
Grad. modules and materials	X		X			X			G, F	NSF	# modules developed # modules adopted # activities posted in NEES digital library assessment of learning
Practice seminar	X			X					P	Industry, Professional orgs	documented online workshops
Target audience catered training (workshop & on-line)		X		X					K12, F, ER,	NSF, NEES	# online training modules # workshops # participants workshop and training assessment
Community Development/Outreach											
Conferences and workshops focused on E & O	X		X		X		X		K12, F, CD, ER	NSF, Dept. of Education, Foundations	# workshops and conferences # participants # papers workshop or conference assessment
Conferences and workshops on research application				X	X		X		R, P	NSF, NEES	# workshops and conference, # participants # papers workshop or conference assessment
Travel funds for students to present research						X	X		UG, G	NSF, NEES	# students participating, including demographic data # student papers presented
Database to match NEESR researchers & curriculum developers	X		X				X		CD, ER, R	Not needed – NEES supported program	# combined research/education projects developed
Partnership with Digital libraries	X		X		X	X			K12, F, GP	NSF, NEES	# developed partnerships Adopt digital libraries assessment matrices
Partnerships w/ minority organizations					X	X	X		ALL	NSF, NEES, Dept. of Education	# partnerships # students participating, including demographic data # participant K12 pursuing SMET education

Program	Goals Supported by Program								Target Audience	Funding	Outcomes/Measurable
	E 1	E 2	E 3	O 1	O 2	O 3	O 4	T 1			
Partnership with educational media			X			X	X		K12, UG, G	NSF, Dept. of Education	# programs/shows developed # programs/shows adopted in grade schools
Partnership with ERCs		X					X		K12, GP		# developed activities # students participating, including demographic data
Partnership with prof. orgs (w/ international)				X	X	X	X		K12, P	NSF Int., ASCE	# developed activities # participant practitioners
Partnership with ASEE	X		X				X		F	NSF, Dept. of Education	# sessions # papers, posters
Partnership with industry and major labs				X	X	X	X		P	NSF, DOE, FEMA	# supported proposals # published papers # developed patents/products
Visualization Tools											
K-12 modules			X						K12	NSF, Dept. of Education	# developed modules # adopted modules # participant students
UG and Grad modules			X						UG, G, F, CD, ER	NSF, Dept. of Education	# developed modules # adopted modules # participant students
Information Resource											
Science Fair support		X				X			K12	NEES	# supported Science Fairs # participant students
Museum Displays		X				X			K12, GP	NSF, Dept. of Education, NEES	# visitors (K-12, UG, G, All)
EOT web presence		X	X					X	K12, GP, UG, G	NEES	# visitors (K-12, UG, G, All)
Newsletters & public relations	X	X		X			X		P, ER, All	NEES	# of publications and audience

Key to abbreviations of target audiences

K-12 -K12
K-12 Teachers -K12T
High School Students -HS
Undergraduate Student -UG
Graduate Student -G
University Faculty -F
Researchers -R
Curriculum Developer -CD
Education Research -ER
Practitioners -P
General Public -GP
Community -C
All Audiences -All

Because of the newness, complexity and scope of the EOT program, it will take several years for the program to grow to a complete program. While in any year NEES EOT staff will develop and implement a variety of projects and activities, the staff will need to focus their efforts on particular areas based on resources and constituent needs. In the first year the focus will be on training, both for Equipment Sites and Information Technology. In the second year the focus will move toward coordination with funded education-elements of NEESR proposals and development of proposals for stand-alone EOT projects. In year three, staff will focus efforts on including practitioners in EOT activities, as the results of NEESR research become available. At year five, there will be an evaluation of progress to date and planning for the next five years. It is anticipated that any activity within the EOT program will have three phases: planning (or start-up), implementation, and institutionalization. The planning phase will consist of putting a program activity into place with specific planning targets such as number of activities, number of educational modules, number of users, etc. The implementation phase will consist of working closely with a subset of selected institutions, Equipment Site representatives and practitioners to assess activities for educational/outreach effectiveness, increased motivation, improved critical thinking, transportability, and other identified benchmarks. The institutionalization phase will include the adoption by the targeted community of the proposed activities. This phase will ensure that the educational programs are well established so that they change the way that users learn and gather information.

Examples of Proposed Programs

As indicated in Table 2, a number of programs have been proposed, to meet the needs of each of the constituents. This section describes examples of some of these programs in more detail based on input from strategic planning workshops. It should be stressed that these are proposed programs to be incorporated into the strategic plan. However the implementation of any program ultimately depends upon the availability of resources and the perceived need and interest by the earthquake engineering community.

Digital Library: At several of the strategic planning workshops, university professors have identified a desire to have a web-based library where they can archive and search educational materials to support earthquake-engineering education. A program to serve this need is proposed as follows. The NEES curated repository would set aside storage space to store and archive educational materials and data sets. NEES would establish a partnership with DLESE and with the Electronic Encyclopedia of Earthquakes (E^3) to build on the existing dissemination portals. For example, NEES would be defined as a collection within DLESE and within E^3, so that visitors to the DLESE or E^3 web site could easily find all educational materials stored in the NEES repository.

The Electronic Encyclopedia of Earthquakes, which "includes more than 500 topics described using text, images, animations and curricular links" (Benthien, [23]), would help users navigate to NEES content. For example, consider a ground failure module in the NEES curated data repository: It has an in-class and field trip option, the intended student level is lower level undergraduate (13-14) as well as upper level undergraduate (15-16), and disciplinary nature of the class could either be engineering or earth science. These user-relevant descriptors (metadata) are part of the E^3 system and would help either the student or the instructor go directly to this NEES content. A user familiar with NEES might always access this material directly from the NEES web site, but the portal service provided by E^3 and DLESE would be useful to some significant percentage of the users. E^3 also could be the resource for background material on and definitions of terms such as liquefaction, lateral spreading, subsidence, total stress, and effective stress. The relationship between NEES and E^3 would be synergistic, because as modules and materials were contributed to the NEES repository, E^3 would "ingest" the content and augment its "Curricular Connections" that are associated with its encyclopedia entries. The Curricular Connections feature of E^3, based on DLESE standards, provides a ready-made layer of annotation or navigation to any content developed and stored within NEES.

Note that the disciplines encompassed within E^3 include but are not limited to engineering. Physics, earth science, and mathematics are the other basic E^3 disciplinary categories. Thus, the potential curricular usage of NEES-generated earthquake engineering data and other materials is not limited to classes that have the word "engineering" in their title. More widespread will be usage by a high school or college-level physics instructor, assignment of NEES data sets for a mathematics class homework assignment, or exploration of the engineering aspects of an earthquake topic, such as the ground failures example in this scenario, by a student in a geology class. To our knowledge there are few undergraduate course in the US devoted to earthquake engineering, and the number of regularly offered graduate-level full-semester courses devoted to earthquake engineering in the country is less than 100. The multi-disciplinary nature of E^3 will thus facilitate use of NEES resources by those who are not currently studying in the earthquake engineering field.

An advantage of collaborating with DLESE and E^3 is searchable access through an existing, nationally recognized system that has a developed infrastructure for contribution and marketing. Currently DLESE is providing training at national and regional teachers meetings to develop "ambassadors" who can effectively represent DLESE to other teachers in their districts. Another advantage is that E^3 has an established system for peer review and quality control, and it ties to DLESE standard definitions and on-line tutorial information. In addition, both DLESE and E^3 maintain user statistics that will support assessment activities. The NEES/DLESE/E^3 digital library program would fulfill NEES EOT goals E1 and E2 in the education area and goal O2 in the outreach area (see Table 1). Table 3 summarizes the outcomes and measures of success for this program. The resources to implement the digital library include storage space on the San Diego Supercomputer (where the NEES curated data repository resides), and funding to archive submitted materials in such a way that they can be readily integrated into the E^3 system (which E^3 terms "ingestion.") Data fields must be supplied to document the origin of the resource and permission to use it, type of file, person to contact for further information, and suitable grade/discipline applications, for content to be ingested into E^3. Thus, while E^3 is an NSF-funded digital library collection that can be of benefit to NEES, some effort needs to be expended on the side of NEES so that contributions are provided in usable form, rather than as large amounts of data "thrown into the hopper" without considering E^3 requirements.

Table 3: Evaluation of NEES/DLESE/E^3 Digital Library Program

Outcome	Measures of Success
Development of centralized resources for engineering education	Number of contributions and users; Satisfaction of users
Increased use of NEES-developed educational materials	Number of users accessing materials
Promotion of an active NEES educational community	Number of contributions to digital library
Increased awareness of NEES as an important earthquake engineering resource	Number of users accessing materials

Teacher Professional Development Workshop: The successful implementation of NEES-developed activities and tools in K-12 classrooms will depend not only on meeting curriculum needs but also on the competence and understanding by teachers of the use of the new tools. To provide the needed expertise and tools, the NEES Consortium could establish a workshop for K-12 Teacher Professional Development. This workshop would be phased-in over two years.

In the first year, the workshop would present a 2-week residential (immersion) content and pedagogy training summer course for a total of 80 training hours. Twenty middle school and high school teachers from around the country would address the content level that is appropriate for the development of interest in math and science (and where girl/minority students typically lose interest in math and/or science). The workshop would include a 1-day follow-up session in the fall, and a 1-day follow-up session in the spring. For the second year workshop, a new group of teachers would be invited to participate and the most enthusiastic/productive teachers from the first year would be invited back to serve as mentors for the next cohort. The alumni will also write classroom lessons that would be field tested in their classrooms during the next school year. Workshop participants would organize "mini-workshops" for their fellow teachers to help in forming the network for wide implementation of the NEES Educational Programs.

This Teacher Professional Development Workshop would address several of the Education (E2 and E3) and Outreach Goals (O2, O3 and O4) of the NEES EOT Strategic Plan (see Table 1). To ensure diversity in the selection of participants and represented schools, the workshop organizers would rank schools by using the percent of students on free-lunch and by recruiting teachers with the help of organizations such as NESTA, NSTA, JETS, MESA, SWE, AGU, ASEE, among other organizations.

Teachers attending the workshop would be given pre-and post- assessments using existing assessment tools. After the workshop, workshop organizers would measure the number of classes and students who use the materials that result from the workshop. Participants would also be asked to evaluate the how students' achievement is affected by the modules that result from the workshops. Table 4 summarizes the outcomes and measures of success for the proposed workshop.

Table 4: Evaluation of Teacher Professional Development Workshop

Outcome	Measures of Success
Implementation of NEES education and teaching modulus for 6-12 education	Number of contributions and users; Satisfaction of users
Increased use of NEES-developed educational materials	Number of teachers and students using NEES-developed teaching modules; Satisfaction of teachers and students
Promotion of an active NEES educational community	Number of implemented educational modules Number of involved K-12 teachers
Increased awareness of math and science as career paths for high school students	Long-term monitoring of student and their career choices; Increased numbers students choosing SMET careers

EVALUATION AND ASSESSMENT

The assessment plan for NEES education, outreach, and training activities and programs includes three major components:

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

Programs will have different milestones, for example two-year, five-year and ten-year evaluation to accompany the different phases of the educational plan. The plan will specify metrics for measurement of the success of programs and a system for using those metrics to evaluate and improve the program.

There are many metrics for assessing EOT program effectiveness. These include quality of programs, quantity of programs, number of users, cost effectiveness, usefulness to constituent, and improved student learning, to name a few. Specifically, each phase of an educational program will have its corresponding assessment component. The envisioned model could include identifying the early adopters that will implement proposed modules and will assess their effectiveness. The experience from the early adopters would be used to implement the last phase of the NEES Educational Program, the institutionalization of the developed activities.

CONCLUSIONS

A strategic plan for education, outreach and training will be in place when the NEES Collaboratory commences operation on October 1, 2004. The plan will exploit the innovative nature of the laboratories, the telepresence and the advanced IT capabilities of the system. Proposed programs will focus on the unique features of NEES, and make use of partnerships to augment existing programs operated by other earthquake centers and professional organizations. Assessment is a key element of the strategic plan, and is being built into the design of each program.

While the unique features of NEES will provide an unparalleled opportunity to significantly change the way we teach and disseminate engineering concepts, they also provide a unique set of challenges. Due to the distributed nature of the research facilities, EOT programs will be initiated and operated at 15 different facilities, requiring superior coordination. Since NSF, not the NEES Consortium, will be selecting NEES research projects on a peer-reviewed competitive basis, a number of educational projects will be funded that must be folded into the ongoing EOT program. An active program to work with researchers before proposals are submitted will help to ensure that these funded projects are focused on NEES EOT goals. A complete and ongoing training program for both equipment sites and the IT infrastructure and tools is needed to support users of the NEES facilities. 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 programs. Thus most programs will need to be funded from stand-alone proposals to funding agencies.

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