Earthquake Engineering Educational Activities Using the Center Approach

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Abstract: In 1986, the National Science Foundation established the National Center for Earthquake Engineering Research to carry out systems integrated studies in earthquake hazard mitigation that would yield results that could not be accomplished by using the individual investigators approach. The success of the national center over 10 years has resulted in an expansion of the center approach in earthquake engineering research. In 1997, the National Science Foundation awarded three earthquake engineering research centers. The National Center for Earthquake Engineering Research continued its efforts with a name change to the Multidisciplinary Center for Earthquake Engineering Research in 1998.

One of the most important efforts in pursuing the "center approach" is the organized earthquake engineering educational effort, which would be difficult to carry out with individual investigators. This paper summarizes the Center's programs of the past 14 years, including formal degree programs and other types of nontraditional efforts. Special emphasis will be given to organized efforts concerning the interface between research and educational activities that require a center approach for development and implementation.

Keywords: education, engineering, undergraduate education, instruction, public awareness

1. Introduction

Educational activities are broadly classified into three general types. The first is the formal degree program which includes exposure, awareness and some technical knowledge in earthquakes and earthquake engineering at the undergraduate degree level, graduate degree programs with concentration in earthquake engineering, and doctoral (and post-doctoral) level of research training. The second type is the professional advancement effort through certificate programs, short courses, seminars, workshops, conferences, through "personal contact" activities and through reading and/or viewing materials including technical reports, newsletters, books, computer software, films/videos and web-based information systems. The third type is the pre-college and general public awareness educational activity For an earthquake engineering research center, its educational activities may be developed by targeting the first or more of these three types of audiences.

An engineering research center typically devotes a majority of its resources and efforts to research and undergraduate and graduate students training (first type of audience). This aspect of research-education interface does not necessarily require an organized center approach. However, the K-12 students, the general public and in particular the transfer of knowledge to the professional engineering community can be effectively carried out in an organized fashion through the center approach.

Effective transfer of knowledge is influenced by many external variables which affect the eventual application of research findings. Experts in this area of communication agree that one of the most effective vehicles for knowledge utilization is through social interaction [1], involving researchers and users from many different disciplines to maximize exchange of information on respective needs, potential applications and their limitations. The principal assumptions are that the greater the systematic organization and coordination between information user and researcher, the more likely the knowledge will be used. Further, the greater the number and variety of end user communities, the more likely the user is to be innovative and to use new ideas.

Because the Multidisciplinary Center for Earthquake Engineering Research (MCEER) serves a wide range of end users with varying needs and educational and professional backgrounds, it is imperative that the educational efforts of the Center build on the collective strengths of its researchers, packaging knowledge in various ways to optimally

educate these individuals. MCEER's systems approach to research and education thus provides an ideal platform to develop and carry out its education activities.

2. Some Current Undertakings And Achievements

2.1 K-12 Education

The National Center for Earthquake Engineering Research (NCEER) began its K-12 activities in 1988, with a series of workshops and seminars to raise the awareness of teachers and administrators about earthquake hazard and the risk posed to a school population by a damaging earthquake. Basic concepts of earth science and engineering were presented, accompanied by information on emergency response and social counseling procedures. The seminars were also augmented by Center-developed support materials and reference resources [2]. This outreach will be expanded in 2000, through the creation of an annual summer Teachers Institute, which will add to the normal seminar content by exposing them to earthquake research and thus stimulating ideas for creative educational approaches. It is well documented that teachers, like other professionals, benefit from continuing education and that exposure to research enhances appreciation of the scientific method [3].

An important aspect of K-12 Educational activities is the inclusion of underrepresented minorities. A critical objective of the National Science Foundation (NSF) is to stimulate interest among these precollege students in Science, Mathematics, Engineering and Technology (SMET). MCEER embraces this objective and endeavors to encourage this interest among individuals who do not traditionally enter these fields. This is carried out through outreach to such groups as BEAM (Buffalo-area Engineering Activities for Minorities), American Society of Civil Engineers Future Cities Program, the Girl Scouts and Boy Scouts of America, Urban League, and others.

2.2 Undergraduate Activities

Undergraduates have always been a part of the MCEER educational process. Because most MCEER researchers are also teaching faculty, they integrate many of their findings and approaches into traditional undergraduate and graduate studies. Students are then exposed to state-of-the-art knowledge and research developments through such course offerings as structures, mechanics, and others.

To further enhance student exposure to MCEER research, the Center has entered a collaborative enterprise with its sister Earthquake Engineering Research Centers (EERCs), the Mid-America Earthquake Center (MAE) and the Pacific Earthquake Engineering Research Center (PEER), to organize the Tricenter Research Experiences for Undergraduates (REU) program. The program invites undergraduate students from U.S. universities to engage in EERC faculty-supervised research activities. The multi-year program will conclude annually with an REU symposium, which will require all participating students to make presentations on their research and will offer lectures on issues key to developing engineers – ethics and communications.

2.3 Masters of Engineering Program in Earthquake Engineering

In 1998, encouraged and partially supported by MCEER, the Department of Civil, Structural and Environmental Engineering at the University of Buffalo developed a Master's of Engineering Program in Earthquake Engineering. The intent of this specialized degree is to provide post-graduate training for students wishing to improve their knowledge base in earthquake engineering. It is a design and practice-oriented program suitable for students planning to pursue a professional career in consulting, industry or government service. In addition to traditional courses in structural dynamics, plastic analysis and design, concrete and steel structures and construction estimating, a seminar on social and economic aspects of earthquake engineering is part of the curriculum. This seminar, offered for the first time in Spring 2000, featured speakers from many different disciplines and professions, many of whom were electronically linked to the class from remote sites. The aim of the seminar is to present earthquake mitigation issues in a problem-focused context, as opposed to one constrained by a single discipline.

2.4 Virtual Laboratory Tools for Earthquake Engineering Experiments

A separately funded MCEER education project at Notre Dame University was identified to develop learning tools to be used in the Masters of Engineering courses in structural dynamics. A suite of Virtual Laboratory earthquake engineering experiments were developed using Java to provide an interactive means of instruction on structural performance under seismic conditions. Two modules were developed, consistent with MCEER's emphasis on

advanced technologies, to enact simulations under varying conditions. The first module, "Structural Control using Tuned Mass Dampers (TMD) and Hybrid Mass Dampers (HMD)," considers a single-degree-of-freedom building model subjected to various historical earthquake records. The second module, "Base Isolation," considers a two-degree-of-freedom building model with base isolation, which can be animated by various historical isolation earthquake records. The modules allow users to change system parameters and design TMD, HMD, and base isolators for structural response modification. Both modules were mounted on the Notre Dame web site, and hotlinked to MCEER's web site (http://mceer.buffalo.edu) to provide wide access to the modules.

Each module is accompanied by technical background information in English and Japanese for the user, as well as suggested exercises and references. They are intended to provide students with a greater understanding and appreciation of simulation techniques. This is especially useful for students at institutions without sophisticated experimental facilities.

2.5 Student Leadership Council

As part of its charge from the NSF, MCEER has established a formal EERC Student Leadership Council (SLC). Because MCEER is a multi-institutional organization, SLC subcouncils are established at MCEER-affiliated institutions. SLC participants receive MCEER support to participate in Center research.

The SLC is designed to increase interaction between EERC-funded faculty and associated students, enhancing student exposure to research and the center approach. It is also intended to encourage networking with students at other EERC–affiliate institutions and to improve needed skills in communication and other areas. Increased interactions between SLC students and members of MCEER's industry partnership program will provide both students and practitioners with another valuable learning opportunity.

2.6 Professional and Continuing Education

Throughout its lifetime, NCEER/MCEER has had constant interaction with engineering professionals. It became apparent that as new technologies were developed for use in seismic design and construction, there was an increasing need for professionals to become better informed about the technologies and their potential for application [4].

In 1996, NCEER launched a formal short course program for practicing engineers, called PACE (Professional and Continuing Education). The initial three courses focused on passive energy dissipation systems and their use in the design of building for seismic and wind retrofit. The course was supplemented by an MCEER monograph [5] on the same subject, which presented technical information in a fashion that would be easily understood by the professional non-expert. The monograph continues to be in high demand and is an excellent educational tool.

The second topic to be featured in the PACE program was a pilot course on the seismic retrofitting of highway bridges, which was based on research and a resulting manual [6] produced under the Center's Federal Highway Administration contract. Because this information was immediately relevant to state transportation engineers, it was a valued learning experience.

In NCEER's transition to MCEER, the Center has continued its momentum to develop new courses which can help practicing engineers stay abreast of new design and code developments. More specific, corporate-driven courses are likely to be offered as MCEER's industrial partnership program grows. A major direction is the application of advanced technologies in performance-based engineering.

2.7 Public Education Activities

MCEER education and outreach to the public-at-large serves as a foundation to many of the program's other activities. Only 1 in 10 Americans is attentive to science and technology policy issues [7]. Therefore, in communicating information about seismic hazards, risk and mitigation approaches, it must be carefully formulated. Messages need to be represented clearly and credibly, presented in many formats to appeal to different learning styles, and easily accessible [8]. The audiences may include average homeowners, public officials, concerned citizens, and students – all with a different need to know. To reach them, MCEER's efforts in this area have used many vehicles to convey information – popular press, television, museum exhibits, public briefings, web-based information and fact sheets.

2.8 MCEER Web Site and Information Service

Perhaps our most dynamic mechanism for conveying timely information and reference assistance is the MCEER web site. Developed and maintained by the MCEER Information Service, the web site is a key repository of many of MCEER's activities and products. Technical reports may be partially viewed and ordered, and the Center's two newsletters are mounted there. In addition, many links and references, "frequently-asked-questions," and educational exercises make it a comprehensive source of information. It is a highly visited site, with nearly 300 outside visitors each day. It is now undergoing additional enhancements to make it even more accessible – particularly to users in the disabled community.

Beyond its management of the web site, the Information Service has a national and international reputation for excellence in key earthquake reference acquisitions and in thorough reference assistance. The searchable Quakeline® database of earthquake-related publications is the only one its kind, featuring fugitive reference citations on earthquake engineering and related subjects that might not be otherwise catalogued or archived.

Because of their expertise, the Information Service was selected by the National Science Foundation to lead an effort to unify the information provision activities of many other natural disaster organizations. The program, called EqIP (Earthquake Information Providers group), seeks to improve access to useful earthquake information and reduce redundancies through a global web site, EqNet. EqNet functions as sort of a clearinghouse - a gateway to the numerous other organizational web sites which exist. EqIP's US-based members include federal agencies, universities, not for profit agencies, and private research organizations.

3. New Challenges

Among the new emphases MCEER plans to pursue in the coming years is the increased utilization of advanced communications technologies for information sharing and exchange. It is our goal to be able to link MCEER-affiliated institutions into one network that will allow both researchers and students access to teaching and research going on throughout the consortium. Students involved in disaster studies need increased exposure to knowledge of other disciplines that address earthquake problems. Remote learning capabilities, when used responsibly and effectively, can help make this type of holistic learning experience a reality.

As a cooperative effort, MCEER is working with the Mid-America Center and the Pacific Earthquake Engineering Center to develop graduate school modules in earthquake-related studies. Each center will build on their own respective technical expertise to formulate six- to eight-week stand-alone modules that can then be exchanged with other institutions. As more modules are developed it is hoped that a complete program will be developed that might serve as a template for a national earthquake-engineering curriculum, which would be made widely available. The first modules are to be completed in 2000.

4. Discussions and Conclusions

MCEER's vision is to help establish earthquake resilient communities by emphasizing the application of advanced and emerging technologies in pre-earthquake mitigation and post-event response and restoration. From the viewpoint of research, NCEER/MCEER has been pioneering its multidisciplinary team approach for the past 10 years with steady progress. Cross-disciplinary fertilization and cooperation has not been popular in the past, and is viewed as an important development by many research-intensive academic institutions. MCEER has clearly established itself as a successful pioneer in multidisciplinary research by researchers from a consortium of universities.

Developing a dedicated education program such as the master of engineering in earthquake engineering in a university by a research center has major challenges. First of all, earthquake engineering is considered as a component among all civil engineering activities. Second, the curricula is the collective wisdom of the faculty members of the department, third, only a fraction of civil engineering faculty are interested in earthquake engineering and are affiliated with the research center. Lastly but not the least, cross department cooperation to develop a multi-disciplinary team effort in educational activities is a very difficult task due to stirring disciplinary views of the faculty and typical university budget allocation scheme heavily based on student credit hours generated by the faculty members. In addition, there is the traditional difficulty of individual faculty performance assessment in a multidisciplinary team. Our limited experiences suggest that it is relatively easier to develop multidisciplinary team efforts among various institutions than to formulate teams within one institution. The latter can happen only when the right faculty members and department chairs and deans see things within the same wavelength at the right time. To pursue a degree program in earthquake engineering by a research center is clearly not for every university.

Those that are not developing a degree program in earthquake engineering can concentrate on earthquake engineering research and train graduate students through traditional means.

For working professionals the center approach has the advantage of packaging and offering a variety of subjects of interest to a wide spectrum of audiences through dedicated efforts in preparing course materials and in marketing and offering the short courses. Since the audiences are mature professionals knowing what they need, new communication technologies in distance learning should be seriously explored for some such offerings.

Like professional education, K-12 and general public outreach activities require special expertise and dedicated staff. This again is most suitable for a center to organize rather than by individual academic department or individual research investigators. A knowledgeable public is the most important element in developing earthquake resilient communities. However, the success of this educational process is difficult to measure and will take a long time, beyond the funding period of a research center. Thus, the sponsoring agencies must be agreeable to using the resources to establish information services within the center and to pursue such education outreach activities for the long term benefit of earthquake hazard mitigation.

This research-driven center approach can at the same time provide more robust and responsive educational programs to a variety of audiences because of its collective technical strength of the participating researchers and the systematically-integrated approach.

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