Research Objectives

The vision of the MCEER education program is to educate potential users through formal and nontraditional programs. Users include but are not limited to researchers, students, practicing professionals, public officials, organizational decision-makers and other beneficiaries of new discoveries and applications in earthquake studies. The objective is to increase awareness, improve safety and advance earthquake loss reduction activities in government, private industry, and the public at large.

In 1986, the National Science Foundation established the National Center for Earthquake Engineering Research (NCEER) 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 NCEER for 10 years has resulted in an expansion of the center approach in earthquake engineering research. In 1997, NSF awarded three earthquake engineering research centers. NCEER continued its efforts with a name change to MCEER 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 not only summarizes the NCEER/MCEER programs of the past 14 years, but also examines formal degree programs and other types of nontraditional efforts. In accordance with the nature of the effort, both successful and challenging efforts will be highlighted. Special emphasis will also be given to organized efforts that require a center approach for development and implementation. Among the activities to be highlighted in this paper are:

• K-12 efforts
• Undergraduate participation
• Master of Engineering program in earthquake engineering
• Professional and public education

Effective transfer of knowledge is influenced by many external variables which affect the eventual application of research findings. Experts in this
MCEER works with various organizations to enhance the impact of its educational activities. These partners include:

- Earthquake Information Providers Group (EqIP)
- Federal Emergency Management Agency (FEMA)
- IRIS (Institutions in Research in Seismology)
- Mid-America Earthquake Center (MAE)
- Pacific Earthquake Engineering Center (PEER)

area of communication agree that one of the most effective vehicles for knowledge utilization is through social interaction (Lagorio et al., 1991), 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 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 and educational outreach activities, which are highlighted in Table 1. Because of the importance of having a center-wide platform, a five-member committee on education-research interface was established and chaired by the Center’s director. The five members are Research Committee members from the Center’s core institutions: University at Buffalo, Cornell University, University of Delaware, University of Southern California and University of Nevada/Reno.

All educational activities are overseen by this committee and are coordinated by the Assistant Director for Education and Research Administration. Representatives from these institutions also play an advisory role in identifying future activities. As efforts to electronically link the affiliated institutions together continue, more educational activities common to the core universities are expected.

Achievements and New Undertakings

K-12 Education

The Center began its K-12 activities in 1988, with a series of workshops 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 necessary emergency response and social counseling procedures.

The end users of MCEER education and educational outreach activities span a wide range of audiences, beginning with K-12 students, teachers and parents, university students, and extending to government officials, public and private business executives, practicing professionals, and researchers advancing the state of existing knowledge. In summary, the public-at-large can be considered to be MCEER’s end user community.
A highlight of these activities was realized in 1997, when an earthquake education program to promote awareness and preparedness was held in Anchorage, Alaska. In spite of its high seismic hazards, no unilateral mitigation/response plan for schools existed within the district before this initiative.

A comprehensive listing of existing earthquake educational materials was initiated in 1989. The Bibliography of Earthquake Education Materials (Ross, 1989) has been widely distributed and has been revised several times. The latest revision of the document—which includes both paper and electronic reference material citations—will include an evaluative component. A panel of educators will assess materials for effectiveness and grade-appropriateness. When completed, the document will also be produced on CD-ROM to facilitate more expedient searching and retrieval.

Single-day seminars for teachers have also been held over the years, to expose them to basic concepts, available materials and resources, and potential instructional ideas. This effort 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 (Voss, 1999).

An important aspect of K-12 Educational activities is the inclusion of underrepresented minorities. A critical objective of NSF is to promote interest among precollege

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Table 1. MCEER’s Traditional Technology Transfer Activities

<table>
<thead>
<tr>
<th>Activity/Product</th>
<th>Focus</th>
<th>Target Audience</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
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<tr>
<td>Technical Reports</td>
<td>MCEER research topics</td>
<td>x</td>
</tr>
<tr>
<td>Newsletters</td>
<td>MCEER research updates, activities</td>
<td>x</td>
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<tr>
<td>Workshops</td>
<td>State-of-knowledge exchange</td>
<td>x</td>
</tr>
<tr>
<td>Conferences</td>
<td>Review, application of research</td>
<td>x</td>
</tr>
<tr>
<td>Seminars, Briefings</td>
<td>Current issues of technical interest</td>
<td>x</td>
</tr>
<tr>
<td>Short Courses</td>
<td>Professionally relevant research and applications</td>
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<tr>
<td>Computer Programs; Software</td>
<td>Design analysis, vulnerability assessments, ground motion data access</td>
<td>x</td>
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<tr>
<td>Public Awareness</td>
<td>Hazard and risk education</td>
<td>x</td>
</tr>
<tr>
<td>Educational Materials</td>
<td>Teaching tools from an earthquake perspective</td>
<td></td>
</tr>
<tr>
<td>Web-based Information</td>
<td>Timely information, links, references</td>
<td>x</td>
</tr>
</tbody>
</table>

1 Academia  2 Practice  3 Policy  4 Informed Lay Audience  5 General  6 Precollege  7 University Students
MCEER educational activities are natural extensions of its ongoing research activities. For example:

- The work the Center has done in the area of structural control provides an engaging focal topic for many groups from K-12 to practice, because of its innovative approach.
- People at many levels are interested in the application of pre-existing technologies, for example, in the area of defense, to the solution of earthquake engineering design problems.
- Relating earthquake problems from a multidisciplinary perspective stimulates interest in individuals beyond limited technical contexts.
- The Center’s studies in Emergency Response will lead to an educational effort to assist emergency responders in the effective use of decision support systems.
- Work on retrofit technologies for improved pipeline performance are of interest to the utility community.
- MCEER’s hospital project will be developing important guidelines on the performance of buildings and critical nonstructural components which will be very useful to hospital administrators.

...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), ASCE Future Cities Program, the Girl Scouts and Boy Scouts of America, Urban League, and others.

...While not a precollege project, a particular effort to involve minorities was carried out under the auspices of MCEER’s New York City-area Consortium for Earthquake-loss Mitigation (NYCEM) project. An element of the study required field validation of building inventory data being used in an earthquake loss estimation of New York City, under FEMA sponsorship. MCEER contributed funding to the activity to support the City University of New York (CUNY), a minority-serving institution, to allow CUNY students to carry out the needed field survey. This effort was successfully carried out under the guidance of Professor George Mylonakis of CUNY.

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.

Graduate Activities

Graduate education has traditionally been a prominent element of MCEER educational activities. Faculty members have supported numerous graduate students to assist in their MCEER-sponsored activities. Hundreds of students have matriculated with the help of MCEER faculty involvement and advisement, and have progressed to significant positions at universities, public agencies and private businesses. Many of their technical efforts have been documented in the NCEER/MCEER Technical Report Series.

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 course, offered for the first time in Spring 2000, featured speakers from many different disciplines and professions, many of whom were linked to the class remotely. More information on this course, developed by Professor Ernest Sternberg, as well as the degree program itself, may be found in Graduate Professional Education in Earthquake Engineering: An Integrated Approach in this report.

Virtual Laboratory Tools for Earthquake Engineering Experiments

Professor B.F. Spencer carried out a separately funded MCEER education project at Notre Dame University 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...
MCEER’s professional and continuing education program focuses on informing professionals about new technologies and their potential for application.

(HMD),” considers a single-degree-of-freedom building model subjected to various historical earthquake records. The module allows users to change system parameters and design TMD and HMD for structural response modification. A snapshot of this module can be seen in Figure 1.

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. Again, users may change system parameters and design base isolators to modify structural performance.

Both modules were mounted on the Notre Dame web site, and hotlinked to MCEER’s web site to provide wide access to the modules. They may be found at the following URL’s: http://www.nd.edu/~quake/java/animation.html, and http://www.nd.edu/~quake/java/isolation/animation.html. Each module is accompanied by technical background information 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. These activities may be expanded as MCEER’s research program in User Networks for Seismic Assessment and Retrofit of Critical Facilities becomes better developed. They may also provide insight into how such activities might be designed at a larger scale, such as through the new NSF initiative, Network for Earthquake Engineering Simulation.

Student Leadership Council

As part of its charge from the NSF EEC Division, MCEER has established its own EERC Student Leadership Council (SLC). Because MCEER is a multi-institutional organization, SLC subcouncils are established at institutions with greater numbers of MCEER students. The balance of students at remaining universities will be incorporated into an at-large chapter, allowing them equal access to the SLC activities.

The SLC is designed to increase interaction between EERC-funded faculty and associated students, enhancing student exposure to research and the concurrent process. 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 students and practitioners with a valuable interface.

Professional and Public Education

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.

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 buildings for seismic and wind retrofit.

The course was supplemented by an MCEER monograph (Constantinou et al., 1998) 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 course itself was well-received in areas where local engineers had a better appreciation for the potential of the technology. This became an important lesson to learn. While MCEER research had great potential for knowledge transfer, it needed to be carefully tailored to the needs, expectations, and educational background of the audience.

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 (FHWA, 1995) done under the Center’s Federal Highway Administration contract. Because this information was immediately relevant to state transportation engineers, it needed to be carefully tailored to the needs, expectations, and educational background of the audience.

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In NCEER’s transition to MCEER, course delivery has been slowed, but 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.

Public Education Activities

MCEER education and outreach to the public-at-large serves as a foundation to many of the program’s other activities. 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 (Nathe et al., 1999). 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, museum exhibits, public briefings and fact sheets.

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, countless links and references, “frequently-asked-questions,” and educational exercises make it a comprehensive source of information (see Figure 2). It is a highly visited site, with nearly 300 outside visitors each day. It is now undergoing additional
New Endeavors

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 its 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 that would be made widely available. The first modules are to be completed in 2000.

Conclusions

It has been satisfying to watch the Center’s educational program become more robust and responsive to the needs of information-seekers. This has only been possible due to the collective technical strength
contributed by its many researchers and the systematically-integrated approach which MCEER/NCEER has historically used for both research and education. The great challenge we face in trying to communicate rather abstract concepts of risk and mitigation cannot be handled effectively by a single investigator.

As MCEER research continues to bear fruit and the interaction between research and education increases, the educational outcomes for the public will be enriched. Education programs with an impact are essential for MCEER to achieve its vision of disaster resilient communities.

References


Nathe, Sarah, Gori, Paula, Greene, Marjorie, Lemersal, Elizabeth and Milet, Dennis, 1999, Public Education for Earthquake Hazards, Natural Hazards Observer, No. 2, November.

