Center for Earthquake Research and Information (CERI)

http://www.memphis.edu/ceri/

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Leadership

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Mission

CERI, established in 1977 as the Tennessee Earthquake Information Center, is a Tennessee Board of Regents Center of Excellence at the University of Memphis devoted to understanding the causes and consequences of earthquakes and the structure and evolution of the continental lithosphere. CERI addresses these needs through cutting-edge research, comprehensive graduate student education, operation of state-of-the-art seismic and GPS networks, and dissemination of technical and practical information to the private and public sectors.

Membership/Affiliate Criteria

CERI operates as an autonomous educational and research unit within the University of Memphis. The criterion for membership is primarily based on source of support for CERI faculty, staff, and graduate students (i.e., whether personnel are on CERI budgets). There are no formal criteria for defining a CERI affiliate.

BUDGET INFORMATION

Please see attached spreadsheet. The Center's budget was balanced in FY'17 through contributions of $220K by the College of Arts and Sciences.

PERFORMANCE NARRATIVE

Primary Goals and Purpose of CERI and Support Systems Offered to Member Faculty

CERI is a Tennessee Center of Excellence created to perform state-of-art scientific research into the nature of earthquakes in continental interiors, monitor earthquakes within the central and southeastern United States, and to serve the public and educational institutions of the State of Tennessee in providing accurate information on earthquake effects and hazards. CERI faculty members administer the Geophysics Concentration for the MS and PhD Earth Science graduate program at the University of Memphis and the interdisciplinary program in Engineering Seismology with the Civil Engineering Department.

CERI is an entity of the State of Tennessee that is reauthorized every 4 to 8 years by the legislature and governor. This occurred in the most recent legislative session (2015-2016) when CERI was reauthorized under State Sunset Laws to June 30, 2022 (SB 1510 and HB 1608).

CERI has additional direct ties to the State through the West Tennessee Seismic Safety Commission (WTSSC). The WTSSC has been tasked to initiate, with the assistance of state, federal, and local government agencies, a comprehensive program to prepare the state for responding to a major earthquake. The WTSSC is a twelve (12) member board appointed as follows: two (2) members chosen by the Speaker of the House of Representatives, two (2) members chosen by the Speaker of the Senate and eight (8) members appointed by the governor. The WTSSC represent the following professional areas: architecture, fire protection, public utilities, engineering, geology or seismology, local government, insurance, business, emergency health services, nonprofit emergency assistance, local education and emergency management. The WTSSC was created through the Tennessee Code Annotated, Title 58, Section 4. CERI (created by Tennessee Code Annotated, Section 49-8-602) is authorized and directed to provide any information or services requested by the commission to achieve its goals. Gary Patterson, Director for Education and Outreach at CERI, is the Executive Director for the WTSSC.

Thus, through State of Tennessee mandates, CERI addresses a wide range of scientific and public outreach activities in addition to University academic matters.

A primary function of CERI is maintaining a large seismic network in the central and southeastern United States to monitor earthquakes. CERI technical staff operate and maintain over 144 seismic stations in 10 states in the region from Arkansas to Virginia. This seismic network is part of the Advanced National Seismic System (ANSS) through our partner, the U.S. Geological Survey. CERI personnel analyze earthquakes that occur within CERI's area of influence to determine and distribute earthquake locations and magnitudes. The raw waveform data and data products are then sent to national data centers in Seattle (Incorporated Research Institutions in Seismology – IRIS) and to the U.S. Geological Survey in Golden, Colorado, and become available to the public through USGS, IRIS, and CERI websites. Much research at CERI concerns earthquake hazards within the central and southeastern U.S. region and is helped by data collected by the seismic network. ***Goals of the network include continual upgrade of hardware***

and software facilities to more efficiently and accurately determine the parameters of earthquakes within the region.

CERI's research mission into the causes and effects of earthquakes is greatly enhanced by participation in graduate programs in Earth Sciences and Civil Engineering. In Fall 2015 the CERI faculty was given full responsibility for administering the Geophysics Concentration for the MS and PhD in Earth Sciences. At the same time, CERI and the Civil Engineering Department started an interdisciplinary program in Engineering Seismology that has resulted in cross listing many CERI and Civil graduate courses. ***Goals for the Earth Sciences Geophysics Concentration include high quality graduate student training resulting in refereed student publications and exceeding TBR yearly graduation quotas for PhD (3) and MS (5) degrees. Goals for the Engineering Seismology program include increasing funding levels for interdisciplinary external research and contributing to Engineering MS and PhD graduate numbers. CERI leadership and faculty have been steadily building the graduate program over the past 11 years with the eventual goal that the concentration in geophysics will become a nationally ranked geophysics graduate program.***

CERI offers the faculty the full spectrum of support systems needed for success in research and education. Faculty and research staff members are provided office and lab space for their research, support staff for IT systems, liberal start-up funds for computers and other equipment, and administrative support for submitting grants and contracts to external sponsors as well as for day-to-day contract administration. Governance of all academic matters is done democratically and faculty and research staff input is required for decisions concerning graduate student admissions. In addition, the Graduate Coordinator and Director for Administration and Finance facilitate all needed activities for proper functioning of the graduate programs. ***A major goal of CERI is to provide a high-quality learning environment for the graduate students including good office space and laboratory facilities***.

Activity Targets, Outcome Objectives, and Metrics Associated with Achieving Progress

Activity Targets:

- Maintain seismic, GPS, and IT networks
- Administer the Geophysics Concentration for MS and PhD degrees in Earth Sciences
- Develop the Engineering Seismology Interdisciplinary Program between CERI and Civil Engineering
- Acquire External Research Support including support of Graduate Students
- Maintain vigorous Education and Outreach Program

Objectives:

- Upgrade Seismic Networks
- Upgrade IT Research Network
- Attain/exceed TBR graduation rate for PhD degree using CERI graduates
- Attain/exceed TBR graduation rate for the MS degree using CERI graduates
- Attain at least 2 refereed publications per year for faculty members. Increase student refereed publications.
- Increase external support of graduate students
- Balance the Center budget

Evidence of Progress Made during 2016-2017 Towards Goals/Objectives/Targets

Activity Targets:

- Maintain seismic and GPS networks: This is a principal task for network personnel and has been ongoing. A staff of 7 is organized and routinely given tasks by the Director for IT and Seismic Networks. A large number of technical improvements have been made to the seismic networks. These include:
    - All metadata now are in SIS, a national repository.
    - Continued migration away from Solaris and Microsoft operating systems toward linux (Ubuntu) with redundancies incorporated into replacement servers (mostly SuperMicro 1u servers).
    - Replaced aging dbb radios with Ubiquiti bullets.
    - Completed review and reprocessing of earthquake events from years1995-2000. Began review of 2015, the first year for AQMS, the new data collection software system.
    - Brought "High-Peak" communication node online
    - Replaced all obsolete and maintenance-heavy Panda II analog systems in the Eastern Tennessee network with either Reftek's or where digital telemetry paths don't exist, with NM standardized ISIS4 hardware.
    - Replaced sensors on the I40 Bridge over the Mississippi with episensors. All 96 structure channels are now Episensor with Kinemetrics Granites. Working with USGS Menlo Park to improve communications from the bridge to Autozone Headquarters in downtown Memphis and a new communications bridge to the UofM Law school Gigabit network allowing for near real-time archiving of the data.
    - Modified communications at Star Mountain remote node to remove a repeater; it now transmits directly to Memphis via public internet.
    - Built new a node computer prototype that includes a PC with PCI slot for legacy analog and moves all other processes to a fanless PC.

- Upgrade IT Research Network: 15 new iMacs were installed in the CERI MacLab and the entire network was upgraded to OS Sierra. The upgrade was accomplished through funds given by the College of Arts and Sciences and through University TAF funds.

- Attain/exceed TBR graduation rate for the PhD in Earth Sciences: Three PhD students graduated between September 2016 and August 2017 (Dhar, Kutliroff, and Mousavi) which allowed the Center to attain the previously used TBR minimum quota for PhD of 3 students per year.

- Attain/exceed TBR graduation rate for the MS in Earth Sciences: Of the three PhD students who graduated between September 2016 and August 2017 from Center programs, Dhar also was awarded an MS degree. The other two PhD students had already earned a UofM MS degree in previous years. This is certainly less than the nominal number of 5 students of year but we expect most future PhD students will also pick up their MS degrees on the way to their doctorate. Because of the Center's ongoing budget problem, Center faculty is currently debating whether to admit students who only desire a terminal masters degree. This is related to the challenge discussed below where we have found it necessary to reduce the number of graduate admissions over the past two years.

- The Engineering Seismology program is being maintained between CERI and the Civil Engineering Department. Primary evidence for program success is the cross listing of 9 CERI graduate courses in Civil Engineering. CERI supports a tenure-track faculty member who has a joint appointment between CERI and Civil Engineering (Taborda). The program has resulted in closer ties between CERI and Civil primarily through graduate students from both programs taking courses in the other. This has also resulted in joint research projects, such as the I-40 bridge seismic instrument upgrade.

- Increase external support including graduate student support: 26 proposals for external grants and contracts were submitted by Center faculty and staff between September 2016 and August 2017. 24 projects were on-going or newly awarded during the same time interval. Student GRA support on external grants and contracts was (6, 6, 9) for (Fall'16, Spring'17, Summer'17), respectively, compared to (9, 5, 6) for (Fall'15, Spring'16, Summer'16), respectively. Having the HUD grant raised Center research income to FY'14/FY'13 levels and was a welcome increase over FY'15 that was a 7 year low. However, the Center Faculty and Research Staff were not able to raise the number of student GRA stipends in FY'16 compared to earlier years. Even so, GRAs from external research programs comprised a larger percentage of graduate support since we reduced our student population by allowing fewer annual admissions.

- Maintain vigorous Education and Outreach Program:
  CERI's Education and Outreach (E&O) Program continued its mission in 2016-2017 to transfer technical and non-technical earthquake information to public and private sector groups in the Central and Eastern US, especially in the Greater Memphis Area. Over its 38-year history, CERI has grown to become an annual destination for dozens of area schools, non-governmental organizations, and professional groups seeking earthquake information. Non-technical information transfer at CERI includes activities for K-12 teachers and students, public service announcements, public meetings for earthquake safety, and museum display development. CERI E&O's frequent technical interaction with state and local governments has naturally led to development of multidisciplinary applied research projects that address gaps in community preparedness, such as school structural safety evaluations.

  The ongoing effort by staff to interact with local school systems to disseminate earthquake information has continued with great success. Ranging from teacher conferences to individual classroom visits CERI E&O has provided information vital to the educational needs of the local and regional student population and the teachers who educate them. These students in turn disseminate this information to their families and others they come in contact with. This information also stays with the students later in their lives and provides a baseline of information on the seismic history of the region when they reach adulthood.

  The use of the CERI web page in conjunction with Facebook and Twitter to provide notices and information on local seismic events has helped to address our goal of educating the public about earthquake hazards. CERI social media resources are routinely used and promoted by local media.

  As discussed in the introduction to this document, CERI partnered in 2006 with the University of Memphis Government Relations and the Governor's Office to create the West TN Seismic Safety Commission to prepare Tennesseans for the next damaging

earthquake. CERI E&O provides organizational framework for the WTSSC and the University of Memphis serves as fiduciary agent. Activities funded to date through the WTSSC are primarily focused on earthquake preparedness, but WTSSC has also funded several applied research projects at the University and sponsored many research meetings. At its last official meeting, the commission voted to empower its Executive Director to organize a structural earthquake vulnerability assessment for all West TN schools over the next 5 years and approved $50,000 FY 2016. WTSSC funds have also been used as leverage by CERI E&O to justify larger applied research grants. The most significant of these applied research projects is the $3.2 million 2016 HUD Hazards Mapping, Assessment and Education Grant, which provides over $500,000 in UofM student funding and over $700,000 in faculty/staff salary recovery through 2022.

The "Partners in Preparedness" Program was created by CERI E&O through the University of Memphis Foundation in 2004 to support disaster preparedness and community service through private sector donations. Although donations have fallen off significantly since 2015 ($1000 in 2016-17), the program has generated over $230,000 since inception. Private sector support serves as leverage for the E&O Program and provides funding flexibility that is critical to successfully implementing public disaster preparedness meetings and projects.

One of CERI E&O's most substantive awareness efforts in 2017 was production and distribution of radio and TV public service announcements, narrated by Senator Lamar Alexander (https://www.youtube.com/watch?v=2MTf-2lZpIo&feature=youtu.be), to promote earthquake safety through participation in the Great Central US Shakeout (shakeout.org/centralus). PSA distribution was directed by University of Memphis Marketing Department and resulted in over 2500 "spots" on regional radio and TV. The television PSA carried direct branding for the University of Memphis and was seen, or heard, by millions of Central US citizens. Over 395,000 Tennesseans registered for the 2017 Shakeout and over 2.6 million registered across the nation.

CERI E&O's critical interaction with government was more apparent in 2016-17 than most years. Three examples support this observation: CERI E&O reached a comprehensive data sharing agreement with the US Army Corps of Engineers Command Staff and will assist them in scenario development for future earthquake exercises; by official request of the TN Comptroller's office, CERI E&O clarified the area over which earthquake drills are required in TN, and; CERI E&O complied with requests from the Federal Office of Government Accountability to organize a response from local and state government on the structural safety of federally owned buildings in Shelby County.

Public and private sector interest in earthquakes is largely driven by the occurrence of significant local and global earthquakes, which occur three to ten times per year. Given this constraint, it is difficult to develop traditional performance benchmarks that measure E&O progress from year to year. The benchmarks below were developed at the request of the CERI Director to inform long term strategic planning at CERI.

2016-17 Performance Benchmarks for CERI E&O

1. Number of disaster preparedness outreach activities in 2017.

K-12 student presentations and teacher workshops:	**31**
Professional and Civic Group presentations:	**22**

Official Military and Emergency Management and Planning:	**12**

2. 2016 Viewership of CERI-sponsored museum displays:

Memphis Museum	**236,000**
Reelfoot Lake Visitors Center	**800,000**

3. Number of jurisdictions and agencies requesting materials in 2017 **35**

4. Number Tennesseans registered for the Great Central US Shakeout (shakeout.org/CentralUS) **396,000**
   Central US residents registered for the 2017 Shakeout **2.8 million**

5. Web Page and Social Media

Memphis.edu/ceri, Page views in 2017	**~624,000**
CERI Facebook friends and "followers"	**1,900**

- Attain at least 2 refereed publications per faculty member. Increase student refereed publications: Appendix 1 contains a list of refereed publications published by CERI faculty, staff, and students, and Appendix 2 presentations giving at national conferences for 2016-2017. Appendix 1 shows that 10 faculty and staff were authors or co-authors on 19 publications. Only 2 faculty members had one or less publication. More importantly for building a nationally ranked graduate program, 12 out of 19 publications (63%) had graduate students as first authors. Last year this number was 11 out of 28 (39%) publications showing a relative increase. The 58 presentations given at national scientific meetings show that 17 of the presentations were authored or co-authored by students. Generally, refereed publications have been averaging about 20 publications per year before 2015. Our scientific output has remained constant in response to internal budget cuts.

Identification of Special Achievements and/or Challenges During the Prior Year

Achievements:

- *Monitoring Earthquakes in the Central United States:* CERI, partnered with the US Geological Survey, is the regional center for the central United States in the Advanced National Seismic System. CERI faculty and staff actively monitor the New Madrid and Eastern Tennessee Seismic Zones and maintain a large seismic recording network of ~140 seismic stations in 10 states. CERI responds to significant regional earthquake events by fielding aftershock studies using temporary seismic stations and provides the public, media, and other scientific organizations data and earthquake information. . CERI processed and posted 503 earthquakes during the 2016-2017 academic year (9/1/16-8/31/17) to the National Catalog (https://earthquake.usgs.gov/data/comcat/) and to our local catalog (http://www.memphis.edu/ceri/seismic/catalog.php).
- *CERI Education and Outreach Program:* CERI E&O programs directly reach over 2000 K-12 students from Shelby County each year through site visits and in-school presentations. Many more students are influenced through CERI workshops for teachers who use provided materials in their classrooms. In addition, several public service announcements for earthquake awareness have been co-produced with the Tennessee Emergency Management Agency each year since 2006 and shown throughout the central

U.S. CERI E&O staff have also helped in the installation of museum displays at the Pink Palace museum in Memphis and the New Madrid museum in New Madrid, MO.

- *HUD National Disaster Resilience Competition (https://www.hudexchange.info/programs/cdbg-dr/resilient-recovery/):* CERI partnered with the Tennessee Department of Economic Development in submitting a $228M grant to this national competition. The grant was ultimately funded for $44M. Funds will benefit municipalities in western Tennessee as well as providing $3.5M in project funds for investigators in several academic departments at the University of Memphis.
- *IRIS Community Wavefields Experiment*
  CERI faculty and graduate students participated in a national seismological community seismic experiment designed to record induced seismicity in northern Oklahoma in June 2016. The experiment was sponsored by the Incorporated Research Institutions in Seismology (IRIS) of which the University of Memphis is a member. The experiment resulted in the collection of a high-quality data set that has led to a successful NSF project being awarded to the Center and will be featured in at least two PhD projects.
- *Jesuit Seismological Association (JSA) Award Winner*
  Center faculty member Christine Powell was awarded the JSA award by the Eastern Section of the Seismological Society of America in October 2016 for her work concerning intraplate seismic zones of North America.

Challenges:

The Center's continuing challenge is budgetary. After experiencing significant cuts made by the University at the end of FY2014, the Director instituted severe restrictions on use of CERI general funds for student and faculty travel, seminar visitors, and other academic or research activities. At the beginning of FY16 we had to cut one technical position, there was a retirement of one staff member at the end of 2016 and a tenured full professor is currently retiring at the end of the year (2017). Some of the more severe budget restrictions have been alleviated by generous gifts from a small number of CERI boosters. For example, the Director has been able to support student travel to professional meetings from the CERI Foundation account.

Plans for the Upcoming Academic Year Including Goals and Expected Achievements

CERI is currently pursuing the writing of a new strategic plan. All Center personnel (faculty, staff, and graduate students) met at the Meeman Biological Research Station for the day on October 27, 2017, to start dialog on the new strategic plan. Our last strategic plan was written in 2005 and applied to 2005-2008. We also underwent an external review in 2011 that was very helpful in resolving a long-standing administrative problem and gave direction to future faculty hires that have been mostly accomplished. University budget reorganization and resulting CERI budget reductions have taken much of our energy since 2015 and have, unfortunately, reduced our forward momentum with respect to growing the graduate program. Our strategic planning exercise should be good in helping to revitalize our existing programs and moving us forward. Writing of the strategic plan will be complete in Spring 2018 and will be forwarded to the administration for comment.

Our budget deficit has significantly decreased over time through the help and support of the Dean of the College of Arts and Sciences. However, the deficit is still a major factor affecting programs at the Center. Obtaining more or larger external grants to increase support of our graduate students, allowing for more faculty and staff salary release, and increasing the potential for Indirect Cost Return is an obvious strategy that the faculty and staff are actively pursuing. But in addition, there are a number of issues that should be discussed with the administration

concerning the role of interdisciplinary research centers at the University and how they might best contribute to the academic priorities of the University as a whole. It is likely that these discussions will take place in conjunction with our strategic planning during Spring 2018.

CERI Personnel 2016-2017

FACULTY

CHIU, Jer-Ming	Professor
CHOI, Eunseo	Assistant Professor
CRAMER, Chris H.	Research Professor
DAUB, Eric	Assistant Professor
LANGSTON, Charles	Professor, Director
POWELL, Christine	Professor/Graduate Coordinator
SMALLEY, Robert	Research Professor
TABORDA, Ricardo	Assistant Professor (joint with Civil Eng.)
WITHERS, Mitch	Associate Research Professor, Director IT and Seismic Networks

POST-DOCTORAL FACULTY

WU, Chunquan	Post-Doctoral Fellow

FACULTY EMERITUS

DORMAN, Jim	Director/Professor
JOHNSTON, Arch	Director/Professor

STAFF

BOLLWERK, Jim *	Seismic Network Engineer
BREWER, Steve *	Digital Seismic Systems Supervisor
BROADBENT, Tanya	Draftsman
DAVIS, James *	Local Tech Support Provider I
DEBULA, Robert	Local Technical Support Provider II
HORTON, Steve	Research Scientist
MARSHALL, Deshone	Local Technical Support Provider I
McGOLDRICK, Chris *	Research Equipment Tech II
MORAN**,** Nathan Research	Associate II – Physical Science
PARKER, John *	Research Assoc. Tech
PATTERSON, Gary	Director Education & Outreach
PAUL, John	Research Scientist
SMITH, Michelle	Assistant Director Adm. & Finance
STEINER, David *	Research Equipment Technician II
WITHERS, Holly *	Research Associate II

*seismic and gps networks staff

GRADUATE STUDENTS

AHAMED, Sabber	Graduate Research Assistant
AL NOMAN, Md. Nayeem	Graduate Research Assistant
ASLAM, Khurram	Graduate Research Assistant
AUSBROOKS, Scott	Graduate Research Assistant
AZIZZADEH, Shima	Graduate Research Assistant
BASU, Urbi	Graduate Research Assistant
BOLARINA, Oluwaseyi	Graduate Research Assistant
DHAR, Mahesh	Graduate Research Assistant
FADUGBA, Oluwaseun	Graduate Research Assistant
GENG, Yu	Graduate Research Assistant
GLOVER, Chloe	Graduate Research Assistant
HUDA, Md. Monsurul	Graduate Research Assistant
JAMBO, Eric	Graduate Research Assistant
KHOSHNEVIS, Naeem	Graduate Research Assistant
KUTLIROFF, Jerome	Graduate Research Assistant
LIU, Chunyu	Graduate Research Assistant
MEREDITH, John	Graduate Research Assistant
MATHENY, Peter	Graduate Research Assistant
MOUSAVI, S. Mostafa	Graduate Research Assistant
OGWENO, Luke Philip	Graduate Research Assistant
SAXENA, Arushi	Graduate Research Assistant
YANG, Yang	Graduate Research Assistant
ZHANG, Jia	Graduate Research Assistant
ZHANG, Yixin	Graduate Research Assistant