

**National Earthquake Hazards Reduction Program (NEHRP)
Advisory Committee on Earthquake Hazards Reduction (ACEHR)**

National Institute of Standards and Technology

Boulder, Colorado

November 7-8, 2018

Meeting Summary

Meeting Attendance

Advisory Committee Members

Glenn Rix, Vice Chair	Geosyntec Consultants, Inc
Greg Deierlein	Stanford University
John Gillengerten	Consulting Structural Engineer
James Goltz	CA Emergency Management Agency
Nathan Gould	ABS Consulting
Ryan Kersting	Buehler & Buehler Structural Engineers, Inc.
Lisa Grant Ludwig	University of California, Irvine
Peter May	University of Washington, Seattle
Lori Peek	University of Colorado, Boulder
David Simpson	IRIS Consortium
Gregory Beroza*	Stanford University; Ex-officio member of ACEHR as Chair of the U.S. Geological Survey (USGS) Scientific Earthquake Studies Advisory Committee (SESAC)

Invited Speakers

Susan Dowty	International Code Council
Valeria Dueñas*	Department of Commerce Ethics Law Division

NEHRP Interagency Coordinating Committee Member-Agency Representatives and NIST Support

Howard Harary	NIST Engineering Laboratory (EL) Director
Luciana Astiz	NSF Program Director, Division of Earth Sciences
Tina Faecke	NIST/EL/MSSD, NEHRP Program and Management Analyst and ACEHR Designated Federal Officer
John Harris	NIST/EL/MSSD NEHRP Deputy Director
Katherine Johnson	NIST/EL/MSSD AAAS Fellow
William Leith	USGS, Senior Science Advisor for Earthquake and Geologic Hazards
Mike Mahoney	DHS/FEMA, Senior Geophysicist
Steven McCabe	NIST/EL/MSSD, NEHRP Director
Mike Mahoney	DHS/ FEMA, Senior Geophysicist
Joy Pauschke	NSF Program Director, Division of Civil, Mechanical and Manufacturing Innovation Program
Steve Potts*	NIST/EL/MSSD, NWIRP Program and Management Analyst

Registered Guest

Linda Rowan	External Affairs Director for UNAVCO
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* Participated via teleconference

Summary of Discussions

I. Opening Remarks

Howard Harary started the meeting at 8:30 AM MST. He welcomed everyone and thanked members for coming out to the Boulder campus. Harary announced that Tina Faecke will be the Designated Federal Officer, although he will continue to preside over the meeting. He gave an update on the status of the committee. As of this meeting, there are 11 active ACEHR members. The new chair of the Scientific Earthquake Studies Advisory Committee (SESAC), Dr. Gregory Beroza, will serve as an ex-officio member of ACEHR. Laurie Johnson's term as Chairperson ended on October 25, 2018, after completing her second three-year consecutive term. Glenn Rix ran this meeting as Vice Chairperson. Craig Davis, Robert Herrmann and Ronald Lynn completed their second three-year consecutive term in 2018, and NIST is working to appoint new members. In 2019, Jim Goltz, Peter May, and Nathan Gould will complete their second three-year consecutive term. Also, in 2019, four members - Glenn Rix, Ryan Kersting, David Simpson, and Gregory Deierlein will complete their first three-year term.

Harary provided an overview of the meeting agenda and thanked the committee for their comments on the March 2018 report. Faecke then discussed meeting logistics, and each of the members introduced themselves. Rix defined the meeting goals as receiving updated briefings on agency programs, providing clarification, if needed, to recommendations in the September 2017 biennial ACEHR report, discussing priorities for the 2019 ACEHR biennial report and to begin structuring the 2019 report.

II. Ethics Briefing

Valeria Dueñas from the Department of Commerce Ethics Law Division gave a briefing on ethics and rules for Special Government Employees.

III. Agency Updates

USGS Earthquake Program – Bill Leith

Leith provided an update on the Global Seismographic Network Program:

(<https://nehrp.gov/pdf/Leith%20for%20ACEHR%20Nov18.pdf>). Highlights of the presentation included:

- An update on the Global Seismographic Network;
- New products in the USGS Earthquake Hazards Program; and
- Questions the USGS is considering about seismic safety of tall buildings.

Peek referenced the phenomenon sometimes referred to as the “brain drain” of USGS scientific staff and asked Leith if anything was being done to address it. Leith replied that for every two scientists that retire, USGS can hire one replacement. USGS is working to educate Congressional Appropriations staff on the value of USGS products. Grant-Ludwig asked about the external research grant program. Leith responded that funding has been stable at about \$4M per year, but that doesn't address inflation costs. SESAC has recommended that research be maintained.

Kersting referenced mitigation in the Bay area and added that it was important for the ACEHR to understand where the money is coming from and how it is being spent so we can re-create it as a tool in other jurisdictions. He said the earthquake community is doing well with the development of codes and standards but need to focus more on mitigation.

Kersting asked Leith to expand on his statement that it is hard to quantify what NEHRP is doing. Leith responded that in anticipation of the reauthorization of NEHRP, a member of Congress asked the Congressional Research Service (CRS) to do a paper on NEHRP (<https://fas.org/sgp/crs/misc/R43141.pdf>). Leith was referencing one of their findings – that it is hard to quantify the benefits of NEHRP. Harary reminded the committee there was a presentation at the 2017 Earthquake Engineering Research Institute (EERI) annual meeting in Portland about the impacts of NEHRP that could inform some of their discussions. http://2017am.eeri-events.org/images/files_presentations/Wednesday/NEHRP_at_40/NEHRP_40_CombinedPresentation_030617_final.pdf.

Kersting asked how much has been spent on mitigation, compared to the need? Leith responded that the FEMA P-366 report: “Estimated Annualized Earthquake Losses for the United States” (https://www.fema.gov/media-library-data/1497362829336-7831a863fd9c5490379b28409d541efe/FEMAP-366_2017.pdf) estimates earthquake losses at \$6B/year. He said there are many examples where mitigation has paid off, but the problem is capturing them all.

USGS Scientific Earthquake Studies Advisory Committee (SESAC) – Gregory Beroza

Beroza introduced himself to the committee. He is a professor of geophysics at Stanford University with a focus on earthquake seismology. He is Director of the Southern California Earthquake Center (SCEC), Co-Director of a program at Stanford University on induced seismicity and has been Chair of the Advanced National Seismic System Steering Committee (ANSS) for the last five years. He is the incoming Chair of the Scientific Earthquake Studies Advisory Committee (SESAC).

Two main topics have occupied SESAC and the ANSS steering committee recently. One is the rollout of the Earthquake Early Warning (EEW) systems. The second is the continuing challenges brought about by the level funding of the USGS programs. SESAC believes there’s a large and growing mis-match between expectations of the USGS Earthquake Hazards Program, its funding levels, and what those allow the USGS to do. This has been evidenced most strongly in the forced defunding of the regional seismic networks. A broader concern is for the core scientific and engineering capability of the USGS. Beroza emphasized that quantifying the benefits of investments in terms of avoided losses is a hard thing to do, but very worthwhile. The public relies on USGS to provide authoritative, unbiased information. The USGS needs resources, including hardware/software people to provide this information. SESAC made that case to the USGS Director in their annual letter this year. SESAC is also concerned that the move of the Menlo Park USGS office to the NASA Ames Research Center will cause some people to retire rather than move. This may accelerate the “brain drain” that was discussed earlier in the meeting.

SESAC has come out in favor of aftershock forecasting to fill the information void that can exist in the aftermath of an earthquake. SESAC investigated the benefits of earthquake monitoring in Alaska and suggested that in the current budget climate it would be unwise to redirect resources to Alaska given the risks elsewhere in the country. SESAC is urging USGS to update hazard maps for Hawaii and Alaska – there’s significant new information in Alaska and the Hawaii hazard maps have not been updated for 20 years. SESAC is also suggesting USGS evaluate how the one-year maps are being used, and their utility. They require resources to implement but are useful in quantifying the risks from induced seismicity. Finally, Beroza is asking SESAC to evaluate the overall earthquake readiness at the USGS upcoming SESAC meeting.

Questions

Deierlein stated that operational earthquake forecasting seems like an intriguing technology and asked for a brief discussion of what it can do and some of the obstacles it faces. Beroza said rather than issuing an intermittent earthquake forecast in the aftermath of a magnitude 5 earthquake near a big fault, based on the 1/20 chance that it will lead to another earthquake in a few days, but instead to do it continuously. They use information about earthquake clustering in space and time, the fault system, and the size of earthquakes that different faults are capable of, to issue a continuous forecast of earthquake probability. It could be updated daily, hourly, or by event.

Peek asked if the hazard maps for Hawaii would be updated, and whether the closure of the observatory because of the Kīlauea volcano had any impact on the observatory. Beroza said the hazard map for Hawaii is 20 years old. Relative to the rest of the nation, it is out of date and SESAC thought it would be helpful to use what they've learned about earthquakes in the last couple of decades to update those maps. Leith added that monitoring will not be impacted. The observatory building was damaged by ground deformation and is not occupiable. All USGS personnel are displaced to a temporary location in Hilo. USGS gathered a lot of ground motion data so an updated map is achievable.

Simpson asked Beroza to elaborate on the specific concerns SESAC has regarding USGS readiness to respond to earthquakes. Beroza said there are fewer people at USGS to deploy instruments to map fault ruptures after an earthquake, and fewer instruments. The technology for measuring seismic events has evolved tremendously, so there is a lot of opportunity to collect data during aftershock sequences.

NSF Earthquake Program

A. Engineering Directorate – Joy Pauschke

Presentation: <https://nehrrp.gov/pdf/NEHRP%20ACEHR%20Nov%202018%20NSF.pdf>

Pauschke described NSF's structure as an independent federal agency created by Congress with seven directorates. The Geosciences and Engineering Directorates provide primary support for NEHRP. NSF supports fundamental research on social and economic sciences, earthquake mitigation and recovery, and integration of research and education. She described research awards related to NEHRP Strategic Goal A – "Improve Understanding of Earthquake Processes and Impacts."

Pauschke also described the National Hazards Engineering Research Infrastructure (NHERI) five-year Science Plan, and the NHERI Computational Modeling and Simulation Center (SimCenter) research tools. Lori Peek will be the Principal Investigator for the recent Engineering Directorate award for Coordinated Social Science, Engineering, and Interdisciplinary Extreme Events Reconnaissance Research (CONVERGE). It is a NHERI resource designed to:

- Foster deep integrations across the geotechnical, engineering and social science communities,
- Coordinate with local state governments in large scale responses;
- Identify and map interdisciplinary researchers;
- Develop training modules for ethically grounded research, and to democratize researchers; and
- Partner with RAPID, DesignSafe and with the University of Texas, Austin to build interdisciplinary models to replicate studies.

Peek described the CONVERGE award and stated that one of the main thrusts described in the NHERI Science Plan was to have a deep integration across the Engineering and Social Science community.

Pauschke continued with a description of the NHERI DesignSafe Reconnaissance Portal (<https://www.designsafe-ci.org/recon-portal/>) and the Slack Channel (<https://designsafe-ci.slack.com/>). She finished with additional descriptions of NSF awards and workshops.

B. Geosciences Directorate – Luciana Astiz

Presentation: <https://nehrrp.gov/pdf/NEHRP%20ACEHR%20Nov%202018%20NSF.pdf>

Astiz described the awards for the Geosciences Directorate. She gave brief descriptions of:

- The Seismological Facility for the Advancement of Geoscience (SAGE)
- The Geodetic Facility for the Advancement of Geoscience (GAGE)

She explained that the NSF Earth Sciences Division funds SCEC. These are five-year awards, currently in their third year. She described the most recent awards related to earthquakes. Pauschke finished the presentation with a description of how NSF is supporting the development of the Nation's Human Resource Base in Earthquake Safety Fields (NEHRP Strategic Goal C, Objective 14).

Questions

Simpson appreciated the detail and breadth of the NSF presentations. He referenced the SAGE/GAGE/IRIS/UNAVCO facilities which would only be five-year awards. Simpson observed that in his experience the development and decision process for awards of this type can take up to three years of the five-year award period of performance, leaving little time in the award period before the next renewal process starts. Speeding up the decision process or extending the award duration would provide more time for these sites to operate prior to commencement of the renewal process, which would be beneficial to the sites.

He then asked what the opportunities are for coordinated programs between USGS/NSF on subduction zone science.

Astiz explained that NSF will try to minimize that impact in the future. She added that NSF has awarded research community networks (RCN's) in modelling subduction zones, and in defining the big science questions related to them. Leith added that at the lower levels of the USGS, collaboration is going well, particularly through the GeoPRISMS program (<http://geoprisms.org/>). He reminded the committee that in 2018 Interior proposed a 20% reduction, but the congress did not agree. Coordinating at the lower levels is the only option, and USGS has been moving money to expand work in subduction zones at current budget levels.

On March 26, 2018, ACEHR sent a letter to Dr. Walter Copan, NIST Director and Interagency Coordinating Committee Chair, suggesting NSF engage the research community in a cross disciplinary workshop that sets future earthquake related priorities. Pauschke referenced recent cross disciplinary workshops on coastlines and people (CoPe) organized by the NSF funded University Cooperation for Atmospheric Research (UCAR): <https://coastlinesandpeople.org/>. There were four workshops in the fall organized through UCAR, the outcomes and papers are all listed on the site, including an opportunity to

think about subduction zone science. Pauschke recommended they participate in this initiative as a resource for the community.

Deierlein suggested that one way to expand funding for earthquake research is to encourage proposals with a strong computational element which could tap additional funding resources. Pauschke agreed and referenced the Computational and Data-Enabled Science and Engineering program (https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=504813). Pauschke's organization, the Division of Civil, Mechanical & Manufacturing Innovation, participates in that program which can receive proposals from the hazards community.

FEMA Earthquake Program – Mike Mahoney

Presentation: https://nehrrp.gov/pdf/FEMA%20update%20for%20ACEHR%20revised_7Nov2018.pdf

Mahoney presented:

- FEMA's priorities under NEHRP;
- FEMA's Earthquake Program budget - fairly constant at \$8.5M. Picked up \$0.2M in fiscal year (FY) 2019;
- Possible future program activity changes, per a meeting with Brock Long. Long asked for briefing on the earthquake program. He was on the Central United States Earthquake Consortium (CUSEC) Board from Alabama. He wanted more work on:
 - o Lifelines infrastructure with emphasis on resiliency;
 - o Building codes;
 - o Expanding earthquake insurance coverage;
 - o Disaster Relief Appropriations Act (DRAA);
 - o Better coordination and support of FEMA responses; and
 - o Earthquake Program outreach.

Mahoney also provided brief descriptions of state assistance, mitigation grants, and project updates.

NIST Earthquake Program – Steve McCabe

Presentation:

<https://nehrrp.gov/pdf/NIST%20EG%20Presentation%20for%20November%202018%20ACEHR%20Mtg%2011072018%20Final.pdf>

McCabe presented:

- An overview of the Earthquake Engineering Group program elements;
- An update on the Immediate Occupancy Report; performance-based seismic engineering methodologies, task order on seismic analysis of nonstructural components and systems, and cost-estimating relationships between federal building profiles and seismic retrofit costs;
- Accomplishments supporting NEHRP;
- Planned deliverables/milestones for FY2019; and
- NIST responses to ACEHR recommendations for NIST research.

NEHRP Overview – Steve McCabe

Presentation:

<https://nehrp.gov/pdf/NIST%20EG%20Presentation%20for%20November%202018%20ACEHR%20Mtg%2011072018%20Final.pdf>

McCabe provided updates on:

- ACEHR membership;
- NEHRP budget and leadership;
- NEHRP reporting;
- Executive Order 13717; and
- NIST Responses to Recommendations on the State of NEHRP.

Questions

In reference to a comment that the term “Secretariat” may be limiting and too bureaucratic, Harary suggested we refer to it as NEHRP from now on. There was a question on whether there was an Interagency Coordinating Committee meeting planned? McCabe said we’ve scheduled several meetings in the past but if one agency principal cancels their participation, the meeting doesn’t occur. NIST is considering a multi-tiered approach to setting up future meetings.

Kersting opened a discussion on the problem with code-based performance. Some of the issues mentioned include:

- The public desires a higher level of performance;
- Performance now is based primarily on collapse prevention;
- Buildings designed with pre-1980 building codes are not likely to be inhabitable immediately after a code-level earthquake; and
- The building code assumes that a structure is intended to withstand one design-level earthquake before being considered disposable.

Deierlein stated he’s been involved with the Applied Technology Council (ATC) project on tall buildings for the city of San Francisco. He elaborated that the study looked at 70 tall buildings of the “Pre-Northridge” (pre-1990) variety. Retrofitting would be very expensive, so they look toward inspection and repair for post-incident functional recovery. He suggested going forward, NEHRP may want to look at lower performing existing buildings and consider how to recover, and for newer stock - what to upgrade to. McCabe said New Zealanders are designing for repairability.

IV. Building Codes Briefing - Susan Dowty

Presentation: <https://nehrp.gov/pdf/Building%20Codes%20Briefing%20Nov%202018.pdf>

Dowty noted the discussions today have referenced the articles that have been coming out regarding seismic hazards and building performance. The International Code Council is watching very closely and has formed a seismic coalition to develop a joint article in response to some of the concerns. It will explain what the intent of the code is and give a historical perspective.

Dowty explained that the International Code Council is in the process of developing their 2021 codes. They reflect latest trends, and there is a pre-standard for retrofit projects that are not already addressed in the codes, like building over a garage, or on hillside structures.

She acknowledged that people are becoming aware of the limitations of what the codes provide and are demanding more, but nobody wants to pay for it. The International Code Council would like to see changes through the code development process, but they can also occur through guidelines, code amendments, appendix provisions, and legislation. As an example of the latter, she described two bills moving through the California legislature:

- CA AB 2681, which requires the Office of Emergency Services to develop a statewide inventory of potentially vulnerable buildings by Jan. 1, 2023; and
- CA AB 1857, which requires the California Building Standards Commission to consider a new standard to minimize structural building damage from earthquakes.

She noted the two bills were vetoed but are likely to come back in January.

Questions

Gould said many organizations are extending their code renewal cycles up to 6 years. Others don't adopt because of bureaucratic issues or training, etc. He asked if the International Code Council was considering expanding the timeframe for updates. Dowty said the International Code Council is advocating changes every three years because of the need to keep up-to-date with changes in building construction and technology. The International Code Council understands the difficulties in training and gearing up for a new code, but there is no discussion of extending the code cycle.

Deierlein asked Dowty for her perspective on whether we should have a national code. Dowty replied that existing buildings should be addressed at local levels, but new buildings could be addressed using a national approach. She added that appendices are a great tool for local jurisdictions, because some appendices are right for some jurisdictions but not others. Mahoney cited the code standards for tsunamis as an example. They started out as a voluntary appendix (Appendix M) and stayed there for several cycles, which served as the basis for getting them into Chapter 6 of ASCE. Mahoney added that making a code change is not simple – there are a lot of checks and balances. It is a two-step process:

- 1) The code action hearing – where the change is introduced and is voted on by a committee, which recommends approval/disapproval, and
- 2) That recommendation then goes through the public comment process. If there is no objection, it goes into the code. If there is public comment, it is considered at the Public Comment Hearings and voted on. For more information on International Code Council's Code Development Process, refer to their [Council Policy 28](#).

Dowty added the most controversial code change for 2021 is for tall wood buildings with cross laminated lumber. Tall is defined as 270 ft. and 18 stories. The fire services and the concrete/masonry industries have concerns. It has passed, but there is an effort to have it defeated through the online voting process.

The committee agreed that as new ACEHR members come on to the committee, it would be useful to have an education session on P-58-5 (Expected Performance of Code Compliant Buildings). Mahoney agreed to organize a presentation.

V. Planning for the September ACEHR Report

Rix noted the ACEHR report is due September 30, 2019, so the committee needs to start thinking about the major themes by looking at the September 11, 2017 report. May said it's an educational document, and some readers aren't specialists. It's important to talk about nature of risk, the history of NEHRP and where the program is now. The committee should also recognize that Congressional staffers won't read a lot of reports, but they will read the CRS document. He suggested there be some discussion not just about key programs to undertake but what the key message is. Some ideas submitted by committee members include:

- Insurance for tall commercial and condominium buildings;
- Financial recovery plans (not insurance);
- Description of the lifecycle of a successful program (how do we get to the level that we're pushing something important, or decide that we've been successful and it's time to push something else?); and
- Agency responses (have one session at the Spring meeting for the committee to review those responses).

Rix suggested we have a session at the spring meeting where the committee formally reviews the agency responses. May suggested one of the challenges is to advance NEHRP and recommended a discussion about strategic visions for the program. This could be part of a broader resilience effort. Kersting said one of the things we are supposed to be writing about is how well the program is working. The program has four main goals:

- 1) Improve the understanding of earthquakes and their effects (we're doing well but would like to be open minded about who the audience is);
- 2) Improve earthquake hazard risk assessment methods and their use (doing well);
- 3) Improve techniques for reducing vulnerabilities to earthquakes; and
- 4) Develop effective policies and practices for earthquake loss reduction and accelerate their implementation.

Kersting said that while we have great tools for practice, we're falling short on policies. We need to be focused on policies that leverage the tools that are being used to mitigate risks. If we're not going to talk about it, it will take a long time for the locals to do it on their own. Peek asked if there is a major policy gap. Kersting replied that we should start with defining our performance objectives, for example whether life safety is the goal for future earthquakes in the U.S. The risks posed by so many existing building types and building occupancies is something we need to be more forceful about. We can't wait for locals to do it on their own. NEHRP is supposed to be a coordinated federal effort.

Harary referenced a four-step program maturity model and added that most programs rarely get to the fourth step. The four steps are:

- 1) Awareness – of what other agencies are doing. We have great knowledge about that, and great sharing of information;
- 2) Coordination – not stepping on each other's toes, clear swim lanes – even if there are some rough edges;

3) Collaboration – we have collaboration between NSF and USGS and between NIST and FEMA. There may be room for three-way and four-way collaboration. It’s harder to make this happen, but there’s good value when it’s accomplished; and

4) Integration – planning, budgeting and executing together to solve a specific problem that a single organization can’t solve by themselves.

Harary said the intention for NEHRP was to get people working together. It’s very difficult when the four agencies have different budgets, different committees, and different OMB examiners who don’t talk to each other. NEHRP, he said, is pretty good at steps one through three, and asked if there are some opportunities on step four where we’re all working together.

Deierlein said that on coordination – the biggest thing at USGS is EEW. He said it’s a big chunk of money and asked what NSF and FEMA are doing to leverage that? Earthquake simulation is another area coming out of the SCEC. How can we help the agencies in areas where there could be more integration? Leith responded that it might be helpful for all of us to document where we do work together. An example is the two-pager product which describes the work of FEMA, NSF, and USGS in support of SCEC. NSF is funding machine learning that’s being used to process seismograms. There is lots of synergy going on at a level where you won’t see it.

Pauschke added that technologies like new materials, 3-D printing or additive manufacturing can change how we design structures. She suggested we bring some people to the table that can help with the next breakthroughs with natural hazards mitigation. Mahoney said that very few of us have the entire view of the program. He thinks it’s better off than we think it is. Outreach is happening, for example, through ShakeOut (<https://earthquake.usgs.gov/learn/topics/shakingsimulations/shakeout/>). In terms of other disasters, we have many examples of where homes built to new building codes performed very well. For example, where Hurricane Michael came ashore, homes elevated above flood heights and anchored to resist wind loads all survived, and people were able to remain in their homes. The issue for most hazards is existing buildings.

Day Two

I. Public Comment Period

Rix introduced Linda Rowan, External Affairs Director for UNAVCO. Rowan registered prior to the meeting and provided an update on UNAVCO, a non-profit University-governed consortium which facilitates geoscience research and education using geodetic tools (<https://www.unavco.org/>). She proposed three ways in which geodesy can help with earthquake risk reduction:

- Geodetic infrastructure exists which can be used to gather data;
- Geodetic data can help improve earthquake early warnings for magnitudes 7 or larger, and can measure ionospheric effects of tsunami’s which could help track tsunami movement; and
- Responses of engineered structures to earthquakes can be measured using geodetic tools.

II. Breakout Sessions

Rix proposed two breakout sessions and said he would use the feedback in the biennial report to assess how far NEHRP has come, what the impacts are, where NEHRP has done well, and areas of focus for the future. The feedback from the group breakout sessions is summarized in the below table.

	Seismic Hazards	Engineering/Construction	Social Sciences
Areas of Historical Expertise	Knowledge of seismic hazard	Knowledge of geotechnical systems Building code has been progressively refined for seismic safety	Contributions of social sciences to understanding human behavior in disaster
	Technology to provide real-time seismic information	Getting knowledge into practice (e.g. yellow books that came out of the Applied Technology Council)	Risk policy and communications
	Seismic hazard mapping	Performance-based design for retrofit of buildings	
	Earthquake science – all the physical processes associated with earthquakes	Seismic protective systems and seismic design	
	Seismic Hazards	Engineering/ Construction	Social Sciences
Lessons Learned from the 1989 Loma Prieta and 1994 Northridge Earthquakes	We didn't know about damage due to liquefaction, or that damage could occur off fault lines	We didn't do too bad in terms of number of fatalities and tagging	People didn't know how to respond to infrastructure failures
	Thought we knew about shaking intensity but didn't know about near-field effects	There were a number of surprises: steel moment frames in Northridge hospital functionality; impacts of side amplification, performance of pre-cast concrete, risk of existing structures, near fault effects	Disadvantaged populations suffered disproportionately
		Building code was focused on life safety. There were no loss estimation capabilities	Policies had focused mostly on new buildings
		Unreinforced masonry buildings largely destroyed, surprising number of bridge and steel moment frame failures	Did not anticipate the level of problems with insurance and funding for recovery
	Post-earthquake inspections were chaotic, soft story residential buildings didn't do well	Very little information readily available after these events	

	Seismic Hazards	Engineering/ Construction	Social Sciences
Areas of Need for the Future	Advanced technology development for seismic hazard characterization	Advanced technology development for new and existing structures, and infrastructure	Public policy and policy implementation
		Improving capabilities and technologies for achieving resilience	Public communication and effective communication with stakeholders
			Integration of seismic objectives into a resilient strategy
			Understanding and communicating consequences of earthquakes
			Implementing change within public policy

III. ACEHR Membership Recommendations

Rix led a discussion of people who might be good ACEHR committee candidates.

IV. Spring Meeting Planning

Suggestions for invited speakers included:

- John van de Lindt, Co-Director of the Center for Risk-Based Community Resilience Planning;
- John Heintz or someone from FEMA to speak on P-58-5;
- Chris Poland, former chair of ACEHR and NIST Community Resilience Fellow; and
- Lucy Jones and her current activities on policy recommendations and policy implementation.

V. Report Planning

The committee discussed report substance and formats that have been useful in the past to plan for their September 2019 report. Rix will develop an outline for the report prior to the Spring meeting, will refine it at the meeting, and will ask members for the areas they are interested in working on. He will then develop assignments for the report so there can be pre-work before the Fall meeting.

VI. Adjournment

Harary thanked the committee members and speakers for their contributions to an excellent meeting. The meeting adjourned at 2:15 p.m. MST.