National Science Foundation (NSF)

Update of NSF's Role in the National Earthquake Hazards Reduction Program (NEHRP) Advisory Committee on Earthquake Hazards Reduction (ACEHR)

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NIST Headquarters, Gaithersburg, MD

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Outline

- About NSF
- NSF Directorate for Engineering (ENG) in NEHRP
- NSF Directorate for Geosciences (GEO) in NEHRP
- Examples of NSF Multidisciplinary Programs addressing hazards

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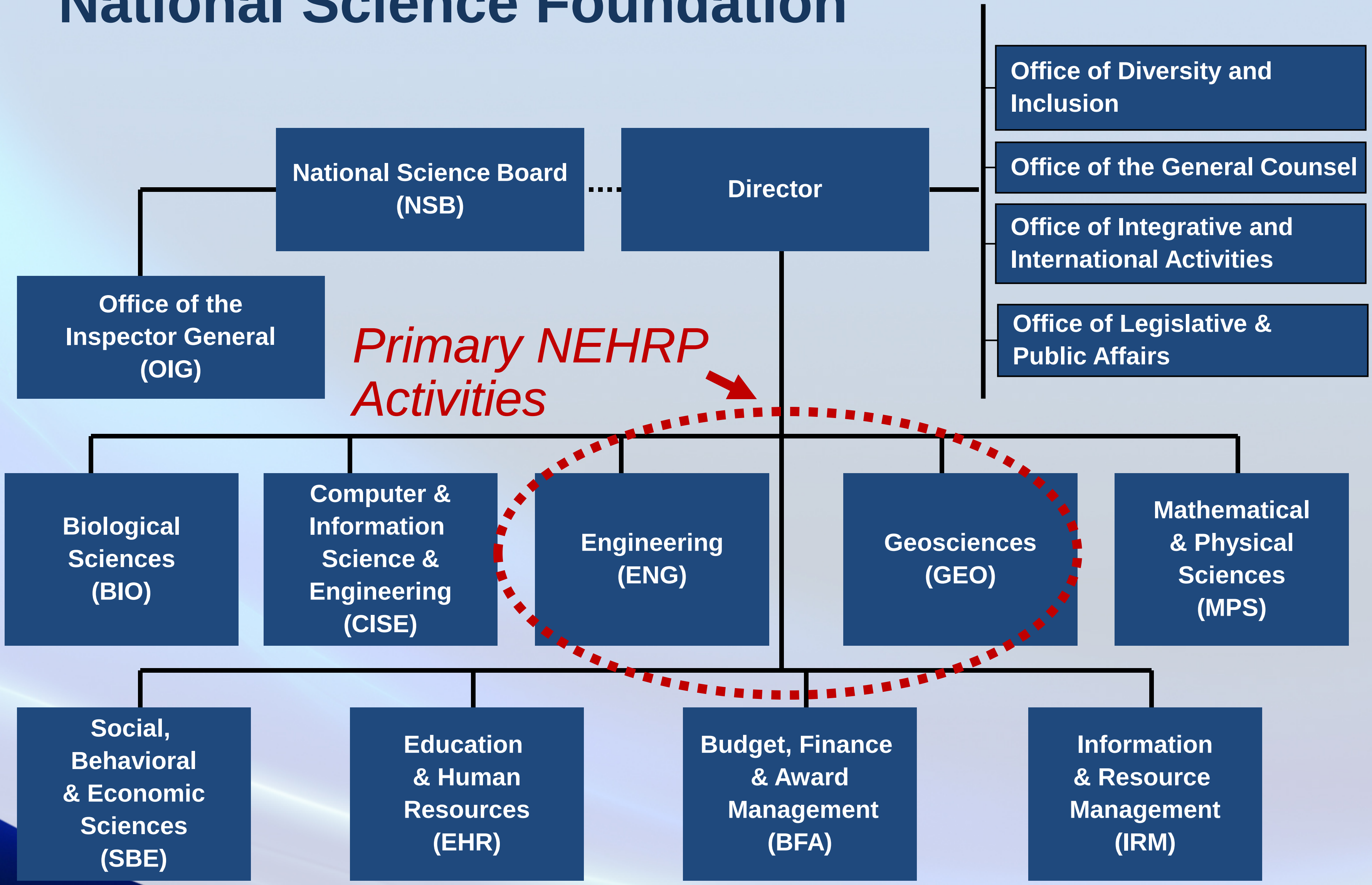


National Science Foundation FY 2016 Budget Request

http://www.nsf.gov/about/budget/fy2016/pdf/fy2016budget.pdf

FY 2016 BUDGET REQUEST

NSF Budget by Appropriation (dollars in millions)					
	FY 2014 Actual	FY 2015 Estimate	FY 2016 Request	Change Over FY 2015 Estimate	
				Amount	Percent
Research and Related Activities	$5,775.32	$5,933.65	$6,186.30	$252.66	4.3%
Education and Human Resources	$832.02	$866.00	$962.57	$96.57	11.2%
Major Research Equipment and Facilities Construction	$200.00	$200.76	$200.31	-$0.45	-0.2%
Agency Operations and Award Management	$305.95	$325.00	$354.84	$29.84	9.2%
National Science Board	$4.25	$4.37	$4.37	-	-
Office of Inspector General	$13.84	$14.43	$15.16	$0.73	5.1%
TOTAL	**$7,131.39**	**$7,344.21**	**$7,723.55**	**$379.34**	**5.2%**

Totals may not add due to rounding.

FY 2016 Cross-Foundation Investments includes “Risk and Resilience”
Risk and Resilience will include PREEVENTS and CRISP (see later slides)

NSF NEHRP Expenditures			
Directorate	(Dollars in Millions)		
	FY 2014 Actual	FY 2015 Estimate	FY 2016 Request
ENG	$30.00	$40.20	$42.20
GEO	$12.00	$12.00	$12.00
Total	$42.00*	$52.20	$54.20

*Does not include for FY 2014 per the NSF FY 2016 Budget Request: Carryover from FY 2014 into FY 2015 – approximately $8.47 million for awards to be made in FY 2015 under program solicitation NSF 14-557, Decision Frameworks for Multi-Hazard Resilient and Sustainable Buildings (RSB). NEHRP expenditures for FY 2015 will be reflected in the FY 2015 Actuals.

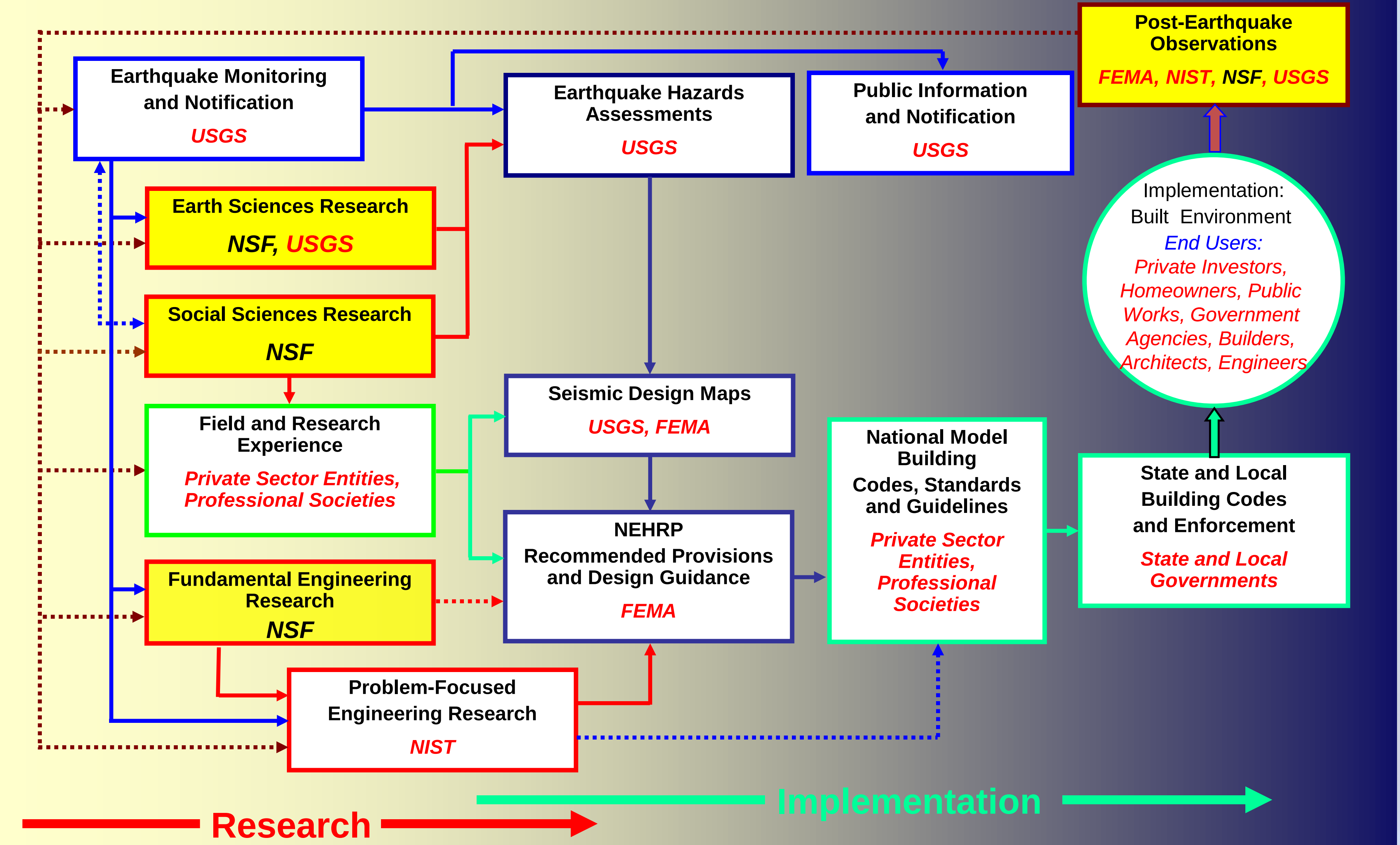
NSF Role in NEHRP

- Supports basic earthquake research - earth sciences, earthquake engineering, and social, behavioral and economic sciences - through programs that support solicited and unsolicited proposals
- Includes support for
  - Basic research in earth sciences, earthquake engineering, and earthquake mitigation, preparedness, response and recovery
  - Research and information centers
  - Research infrastructure/facilities
  - Integration of research with education (e.g., REU students)
- Involves disciplinary and multidisciplinary research from areas such as
  - Computer and information science and engineering
  - Earth sciences
  - Architecture/architectural engineering
  - Engineering (e.g., civil: structural, geotechnical, coastal; mechanical)
  - Social, behavioral, and economic sciences
  - Urban planning and geography

NEHRP Success Stories - *Seismic Waves*

NSF-supported Research (examples)

http://www.nehrp.gov/library/success.htm



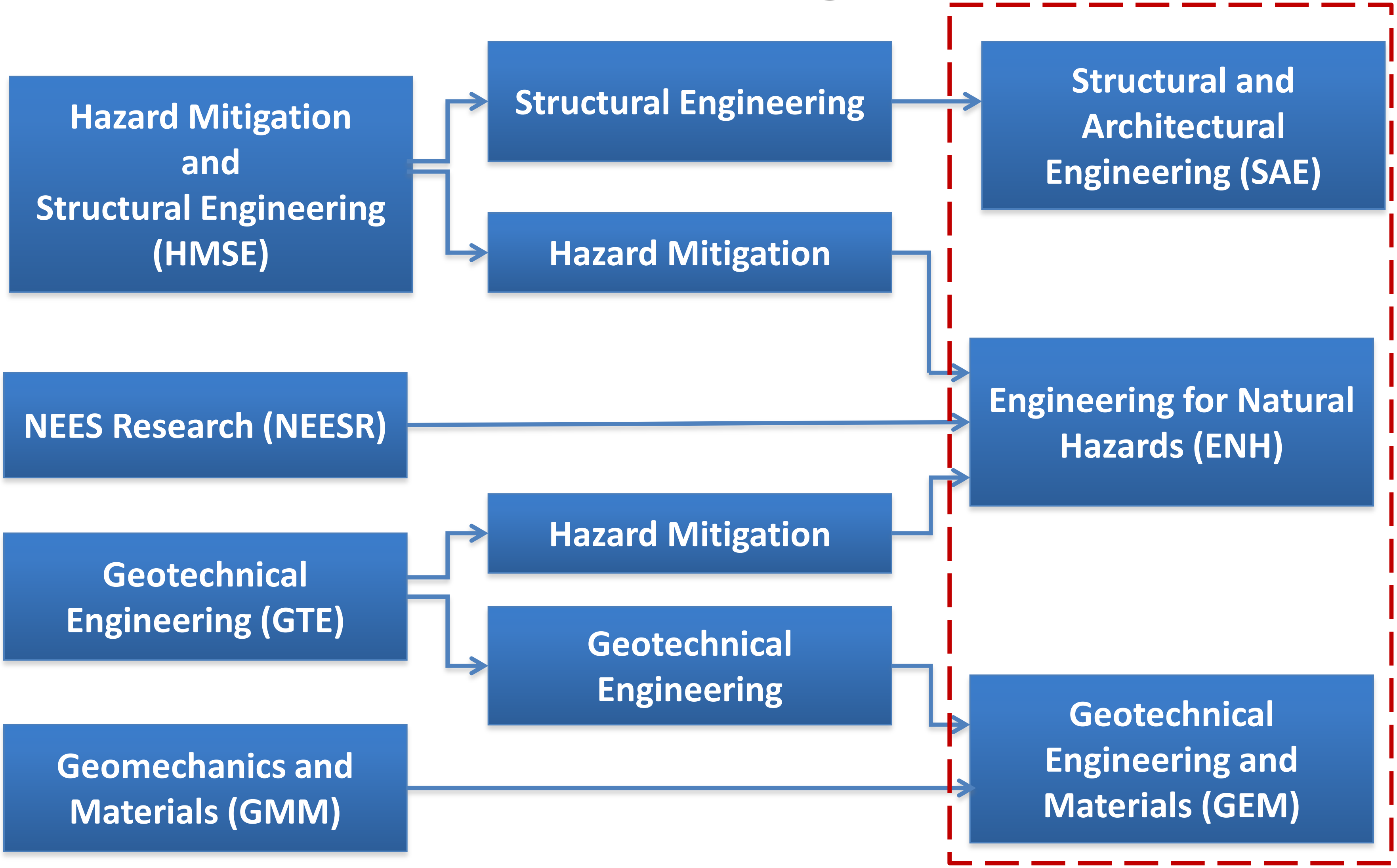
NEHRP Impact on the Built Environment

Directorate for Engineering (ENG)

FY 2015 ENG Programs Supporting NEHRP in the Division of Civil, Mechanical and Manufacturing Innovation (CMMI)

- Engineering for Natural Hazards (ENH) – new for Spring 2015
  - Research awards, including RAPID awards
- Infrastructure Management and Extreme Events (IMEE)
  - Research awards, including RAPID awards
  - Support for Natural Hazards Center at University of Colorado, Boulder
- Natural Hazards Engineering Research Infrastructure (NHERI) – new in FY 2015 (NSF 14-605)
  - $62 million over five years, support starting in FY 2015
  - Earthquake and wind engineering research, education, and community outreach resources
  - Four components
    - Network Coordination Office
    - Cyberinfrastructure
    - Computational Modeling and Simulation Center
    - Experimental Facilities, including a RAPID facility – up to 7

New CMMI Research Programs in FY 2015



Former CMMI Programs through September 2014 submission window

New CMMI Programs as of February 2015 submission window

Engineering for Natural Hazards Program

PD 15-7396 (ENG/CMMI)

http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505177&org=NSF

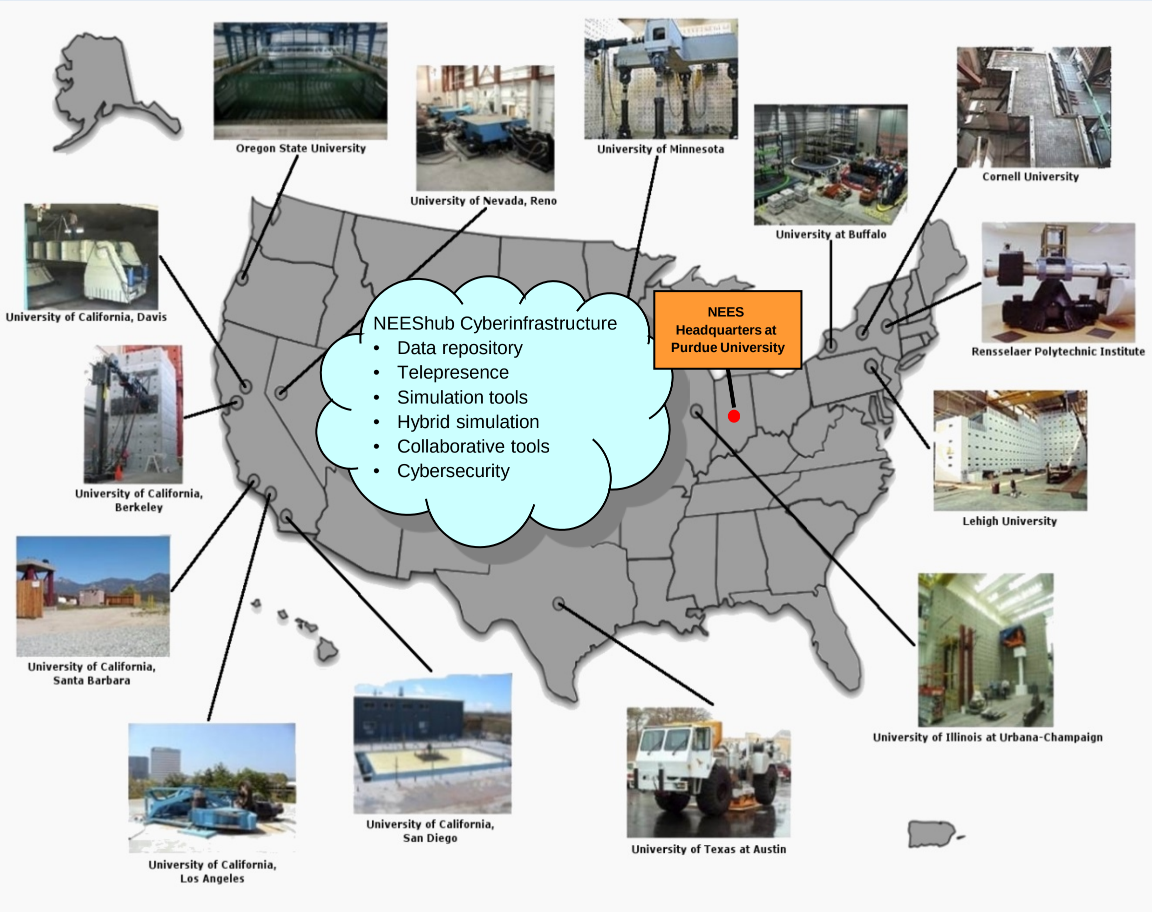
GOALS

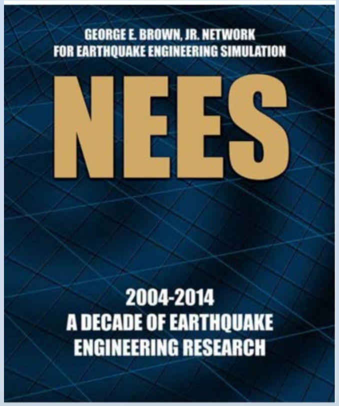
- Prevent natural hazards (e.g., earthquakes, windstorms, tsunamis, landslides) from becoming disasters, and
- Broaden consideration of natural hazards independently to the consideration of the multi-hazard environment within which the constructed civil infrastructure exists.

RESEARCH AREAS

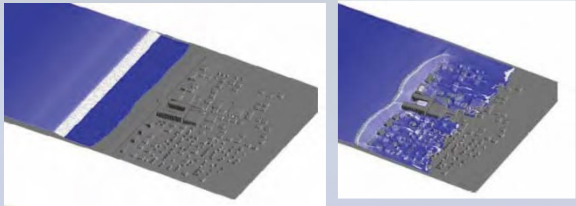
- Advances in system-level design concepts for new and existing sustainable civil infrastructure to achieve desired lifetime system-level performance under single or multi-hazard loadings;
- Advances in geotechnical engineering for design and construction of natural hazard-resistant foundations and geostructures, liquefaction mitigation, soil-foundation-structure interaction, levee and earth dam stability, and landslide, mudflow and debris flow analysis and mitigation, with a focus on field or system performance;
- Applications of decision theory for design concepts for civil infrastructure to achieve desired lifetime system-level performance for both multi-hazard resilience and sustainability; and
- Advances in computational modeling and simulation that integrate theory, computation, experimentation, and data, as appropriate, to advance natural hazard mitigation for civil infrastructure.

The ENH program encourages knowledge dissemination & technology transfer activities that lead to broader societal benefit & implementation for natural hazard mitigation for civil infrastructure





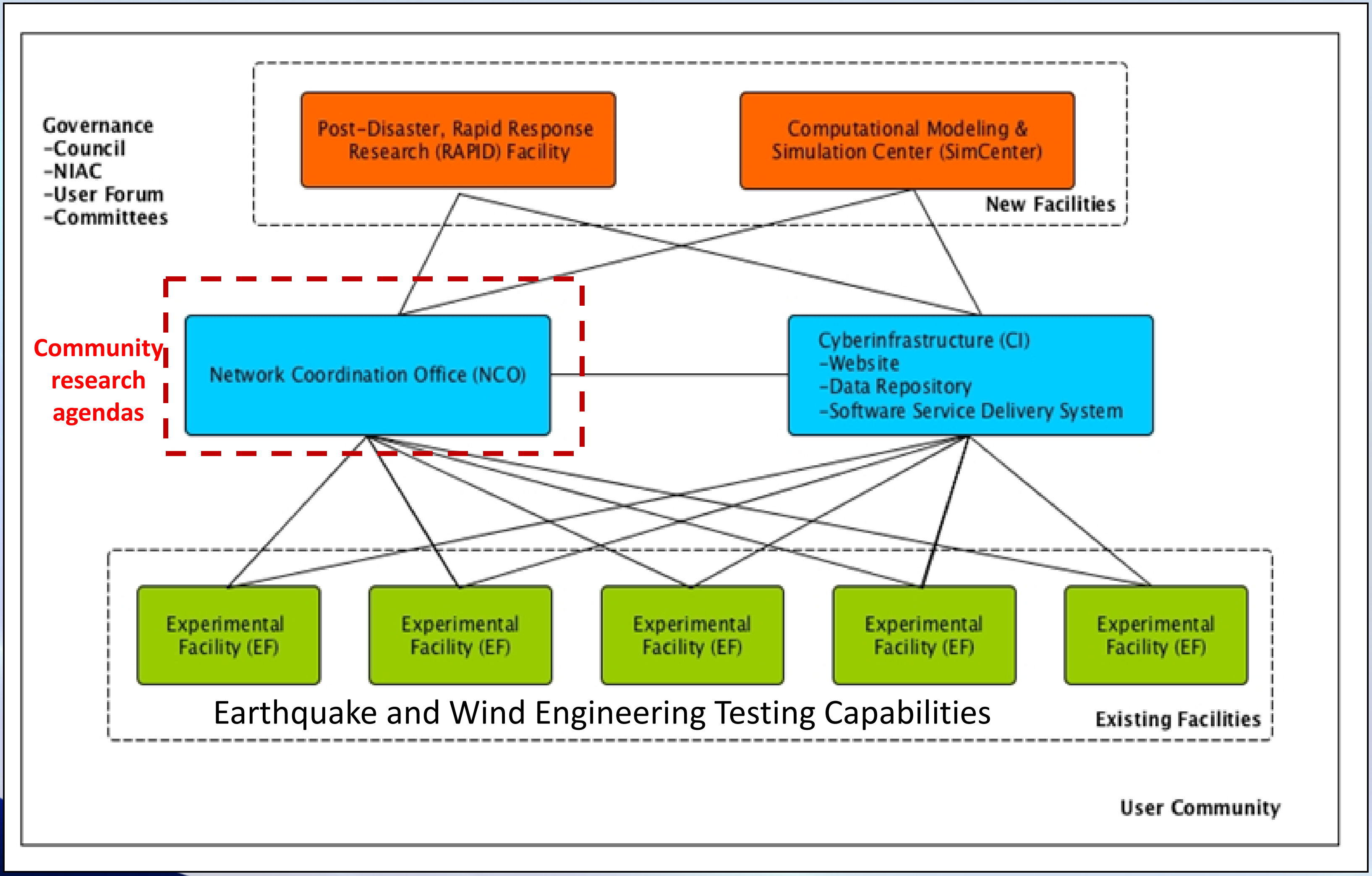
http://nees.org/retrospective



NEES 2005 - 2014

Snapshots from a numerical model of a tsunami flooding a coastal town. The top plot shows the approaching tsunami, where the white face of the wave indicates breaking. The lower plot shows the wave inundating the town, and interacting with the infrastructure. NSF Awards 0619083 and 1215454 (Reference: http://nees.org/site/images/pdf/NEES2004-2014.pdf)

Natural Hazards Engineering Research Infrastructure Notional Diagram per NSF 14-605



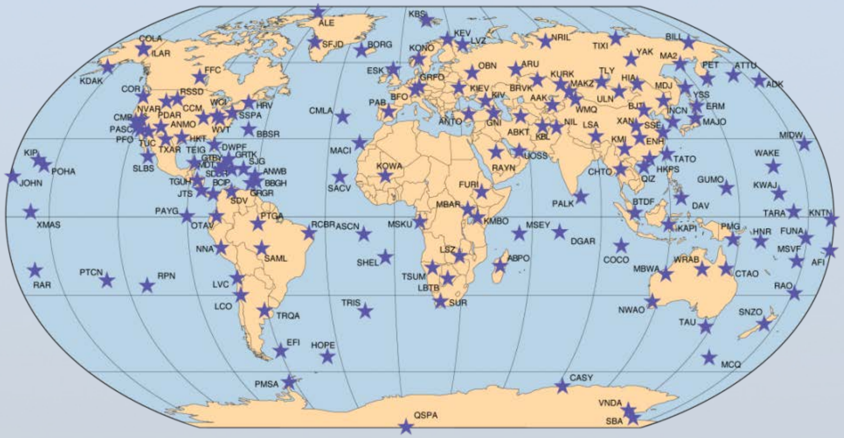
Vision for NHERI (NSF 14-605)

- Understand, model, and predict the lifecycle performance of civil infrastructure, from component to holistic system levels, under different natural hazard events (earthquakes and windstorms);
- Reduce the reliance on physical testing for modeling the performance of civil infrastructure under natural hazard events through advanced computational modeling and simulation capabilities;
- Build the basic science knowledge and computational modeling and simulation capabilities to evaluate multi-hazard resilient and sustainable civil infrastructure and communities;
- Translate research into innovative mitigation strategies and technologies to reduce the impact of natural hazards on existing and new sustainable civil infrastructure and communities; and
- Integrate research, education, and outreach to train a broad and inclusive STEM workforce to conduct and translate research into an innovation ecosystem for multi-hazard resilient and sustainable civil infrastructure and communities.

Directorate for Geosciences (GEO)

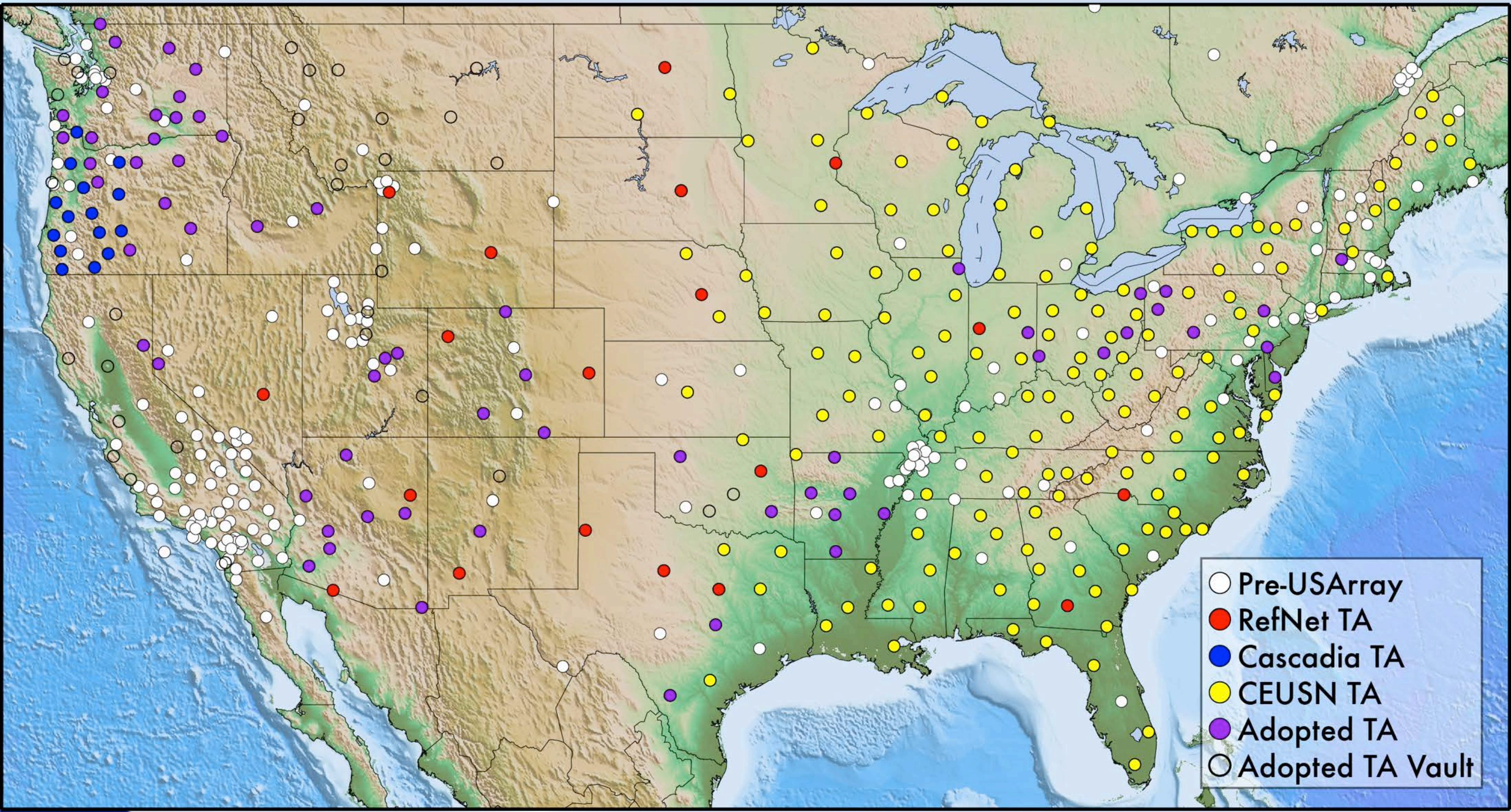
SAGE Seismic Facility

- SAGE: Seismological Facilities for the Advancement of Geoscience and EarthScope



- Operations planned FY14-18
  - Annual budget ~$25M
- NEHRP links
  - Primary: Global Seismographic Network (GSN)
    - External review underway, report due within a month
  - Contributing: Transportable Array
    - Data key in understanding seismicity related to fracking
    - Conversion of selected stations to long-term operations
  - Contributing: Data management
    - ACEHR notes this is key resource for community

Long-term legacy from Transportable Array



~221 long-term broadband stations prior to TA

260 TA stations added to the long-term network

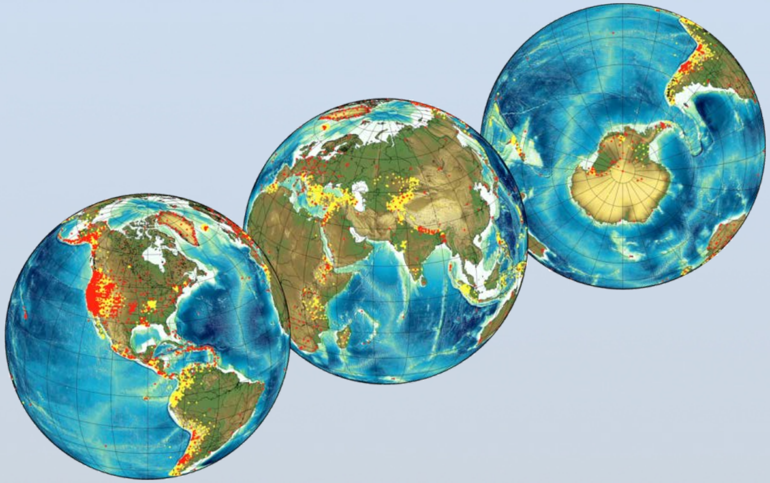
Courtesy IRIS

CEUSN: Central & Eastern US Seismic Network

- Joint effort of NSF, USGS, other partners
- Goal
  - Convert to long-term ~160 TA seismic stations
  - Enhance research and monitoring in central & eastern United States, including monitoring of critical facilities
- Estimated costs
  - 5-yr conversion: $12M
  - Annual O&M: $1.6M
- Status
  - All stations collecting data, all data publicly available
  - Cumulative funding: $8.2M NSF, $200k USGS
  - Plan through FY15: $9.3M NSF, $600k USGS

GAGE: Geodetic Facilities

- GAGE: Geodesy Advancing Geosciences and EarthScope
- Integration of prior geodetic facilities & EarthScope/PBO
- Operations planned FY14-18
  - Annual budget ~$12.5M (NSF/NASA)
- Primary NEHRP link:
  - GAGE-provided GPS data now incorporated into USGS National Seismic Hazard Maps
- Real-time, high-rate GPS being assessed for use in Earthquake Early Warning systems



Additional GEO Activities

- Continued joint support (w/USGS) for Southern California Earthquake Center (SCEC)

  (~$2.7-3.0M NSF/year) www.scec.org
- Fundamental research via Geophysics, Tectonics, EarthScope, GeoPRISMS, Geomorphology & Land-Use Dynamics, and other core EAR programs
- Planned FY16 new start: PREEVENTS
  - Prediction of and Resilience against Extreme Events

PREEVENTS

- Program w/multidisciplinary portfolio to improve
  - Fundamental understanding of processes underlying geohazards & extreme events
  - Models of geohazards, extreme events, and their impacts
  - Enhance societal preparedness & resilience
- Focused on natural hazards
- GEO-centered, with potential for links
- $23.5M in FY16 request
- Part of NSF's Risk & Resilience activity

PREEVENTS: Timeline

Year	Major items
FY15	Dear Colleague Letter to announce program and plans
FY16	Accepting first proposals under DCL
FY17	First solicitation for full program, including Nucleus
FY19	Second solicitation for full program
FY20	Program evaluation

Science Across Virtual Institutes (SAVI)

An NSF International Collaboration Funding Mechanism

- SAVI/Collaborative Research: Pacific Rim Earthquake Engineering Mitigation Protective Technologies International Virtual Environment (NSF awards CMMI-1446424 and CMMI-1446353) – links researchers in Chile, Japan, New Zealand and U.S. to accelerate research on seismic protective systems
- SAVI: Virtual International Institute for Seismic Performance Assessment of Structural Wall Systems (NSF award CMMI-1446423) – links researchers in Chile, Japan, New Zealand and U.S. for seismic performance assessment of structural wall systems
- Virtual Institute for the Study of Earthquake Systems (FY 2012 supplement to NSF award EAR-1033462, Southern California Earthquake Center) – links SCEC researchers with researchers in Japan at the Earthquake Research Institute, Tokyo University, and the Disaster Prevention Research Institute, Kyoto University, http://www.scec.org/vises/

Examples of NSF Multidisciplinary Research Programs Addressing Hazards

- NSF ENG/CMMI

  Infrastructure Management and Extreme Events (PD 15-1638)

  "…supports fundamental, multidisciplinary research on the impact of hazards and extreme events upon civil infrastructure and society. The program is focused upon research on the mitigation of, preparedness for, response to, and recovery from multi-hazard disasters. Community and societal resilience and sustainability are important topics within the research portfolio of IMEE. The program is deeply multidisciplinary and attempts to integrate multiple issues from civil, mechanical, transportation, and system engineering, sociology, psychology, economics, geography, political science, urban planning, epidemiology, natural and physical science, and computer science.
- NSF GEO, CISE, ENG, MPS, and SBE Directorates and OIIA (anticipated $20 million)

  NSF 14-581, Interdisciplinary Research in Hazards and Disasters (Hazards SEES)

  Hazards SEES…seeks to: (1) advance understanding of the fundamental processes associated with specific natural hazards and technological hazards linked to natural phenomena, and their interactions; (2) better understand the causes, interdependences, impacts, and cumulative effects of these hazards on individuals, the natural and built environment, and society as a whole; and (3) improve capabilities for forecasting or predicting hazards, mitigating their effects, and enhancing the capacity to respond to and recover from resultant disasters. The overarching goal of Hazards SEES is to catalyze well-integrated interdisciplinary research efforts in hazards-related science and engineering in order to reduce the impact of hazards, enhance the safety of society, and contribute to sustainability.
- NSF CISE, ENG, and SBE Directorates (anticipated $20 million)

  NSF 15-531 Critical Resilient Interdependent Infrastructure Systems and Processes (CRISP)

  The goals of the…CRISP solicitation "are to: (1) foster an interdisciplinary research community of engineers, computer and computational scientists and social and behavioral scientists, that creates new approaches and engineering solutions for the design and operation of infrastructures as processes and services; (2) enhance the understanding and design of interdependent critical infrastructure systems (ICIs) and processes that provide essential goods and services despite disruptions and failures from any cause, natural, technological, or malicious; (3) create the knowledge for innovation in ICIs so that they safely, securely, and effectively expand the range of goods and services they enable; and (4) improve the effectiveness and efficiency with which they deliver existing goods and services.

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NSF, Directorate for Engineering, Division of Civil, Mechanical and Manufacturing Innovation, Resilient and Sustainable Infrastructures Cluster Programs
http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=13545&org=CMMI&from=home

NSF, Directorate for Geosciences, Division of Earth Sciences
http://www.nsf.gov/div/index.jsp?div=ear

Science Nation (video): Engineering Innovative Seismic Retrofits that Don't Break the Bank
http://www.nsf.gov/news/special_reports/science_nation/reinforcedbuildings.jsp