The Resilient and Sustainable Infrastructure (RSI) Cluster Core Programs at the National Science Foundation (NSF)

Directorate for Engineering

Division of Civil, Mechanical and Manufacturing Innovation (CMMI)

Webinar

January 7, 2015

Question & Answer Session
at
End of Webinar

Submit questions during webinar to:

kwebster@nsf.gov

(This email is only valid during this webinar)

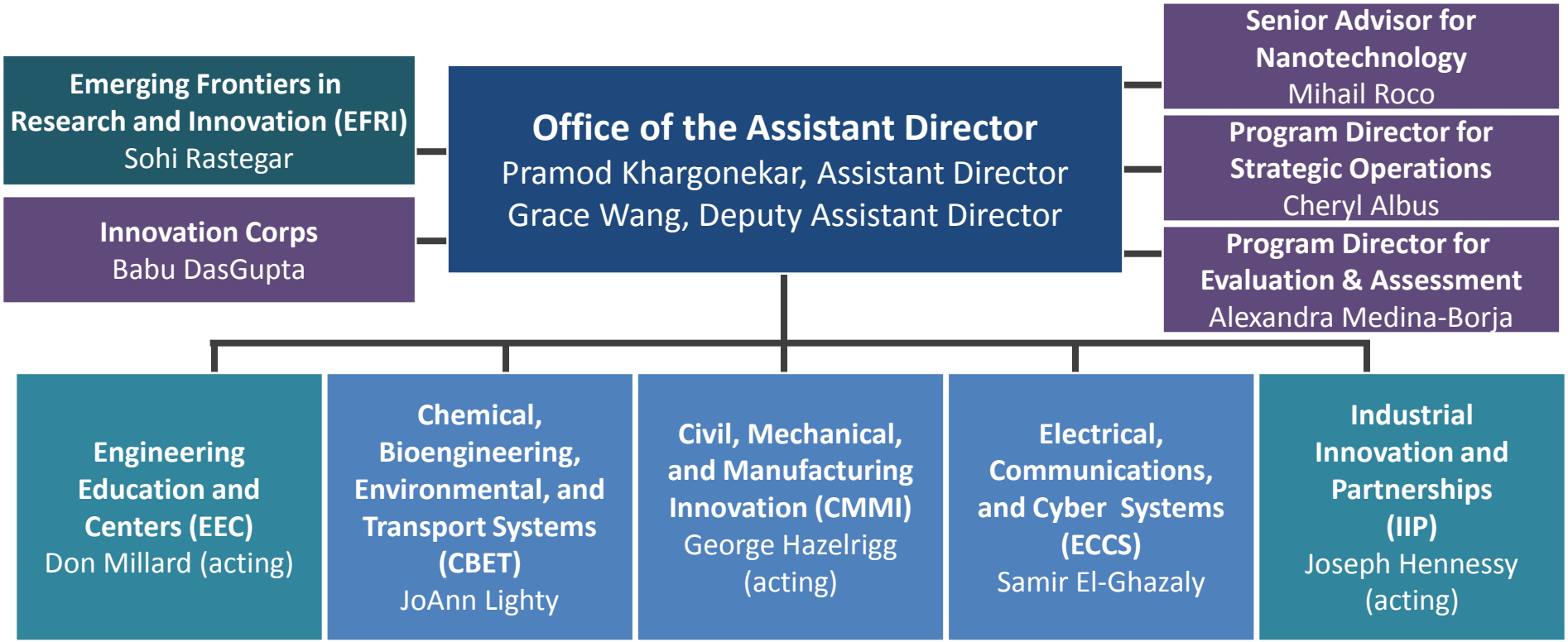
Webinar Agenda
RSI Cluster Programs and Presenters

1. Overview - *Richard Fragaszy*
2. Revised RSI Programs (revised Program Descriptions)
   - Civil Infrastructure Systems (CIS) - *Elise Miller-Hooks*
   - Infrastructure Management and Extreme Events (IMEE) - *Dennis Wenger*
3. New RSI Programs
   - Structural and Architectural Engineering (SAE) - *Kishor Mehta*
   - Geotechnical Engineering and Materials (GEM) - *Richard Fragaszy*
   - Engineering for Natural Hazards (ENH) - *Joy Pauschke*
4. Cross-Directorate Program Solicitation related to RSI Cluster
   - NSF 15-531, Critical Resilient Interdependent Infrastructure Systems and Processes (CRISP) - *Elise Miller-Hooks*
5. Questions and Answers – all
   - Send questions during webinar to kwebster@nsf.gov

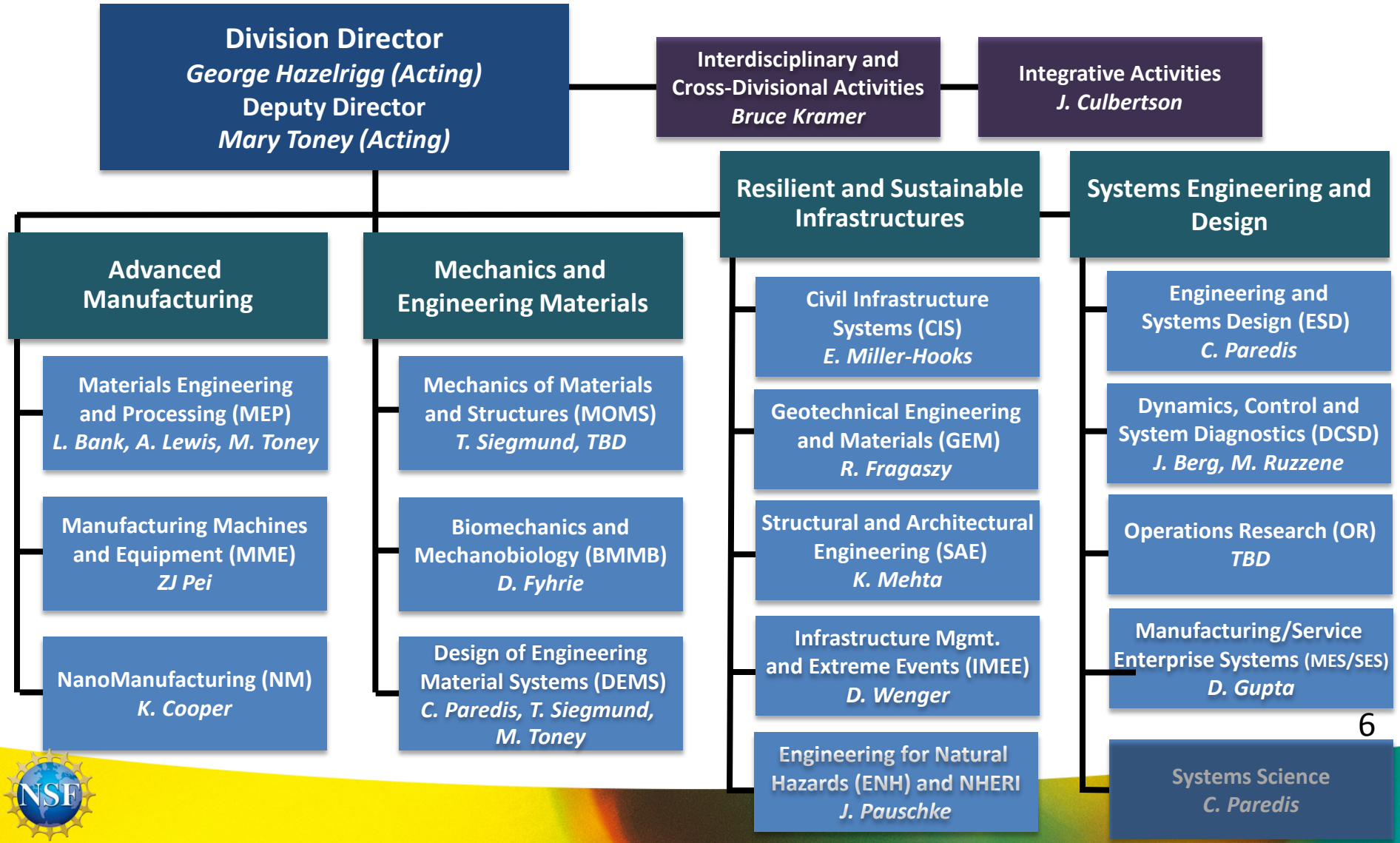
Overview

Richard Fragaszy

NSF Directorate for Engineering (ENG)



Division of Civil, Mechanical and Manufacturing Innovation (CMMI)



Proposal Submission Due Dates

Proposal Due Date: Full proposal window end date, 5:00 pm proposer's local time (see NSF 15-1, Grant Proposal Guide (GPG), Chapter I.F)

"Unless otherwise specified in a program solicitation that has an identified deadline date, proposals must be received by 5 p.m. submitter's local time on the established deadline date."

- 2015 Full Proposal Windows
  - February 1, 2015 - February 17, 2015
  - September 1, 2015 - September 15, 2015

- Proposer's local time submission FastLane timestamp
  - Submit proposal by window end date (e.g., February 17, 2015)**, 4:59 pm** proposer's local time to ensure submission by 5:00 pm proposer's local time
  - Any submission past the 5:00 pm deadline is considered late (even one second past the deadline); proposal will be returned without review

Proposal Submission per NSF 15-1, Grant Proposal Guide

Submit proposal following NSF 15-1, Grant Proposal Guide, Proposal Preparation Instructions, Chapter II. Several significant changes from NSF 14-1 to NSF 15-1 (see NSF 15-1 for ALL changes):

- **Chapter II.C.2.d, Project Description**…must now contain, as a separate section within the narrative, **a section labeled "Broader Impacts of the Proposed Work".**

- **Chapter II.C.2.d(iii), Results from Prior NSF Support**…listing of publications resulting from an NSF award must provide **complete bibliographic citation** for each publication in either the Results from Prior NSF Support section or in the References Cited section of the proposal.

- **Chapter II.C.2.g, Budget and Budget Justification**…for the proposing organization must be no more than three pages. For proposals that contain a subaward(s), **each subaward must include a separate budget justification of no more than three pages.**

Revised RSI Programs

Elise Miller-Hooks

Dennis Wenger

Civil Infrastructure Systems (CIS)

Program Description PD 15-1631

http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=13352

Program Director: Elise Miller-Hooks

elisemh@nsf.gov

703-292-2162

Unsolicited Proposal Due Dates

- February 1, 2015 - February 17, 2015
- September 1, 2015 - September 15, 2015

CIS: Scope

- Fundamental and innovative research necessary for
  - designing, constructing, managing, maintaining, operating & protecting efficient, resilient and sustainable CIS
- Recognizes role CIS play in societal functioning
- Focus on civil infrastructure as a system
  - intra-/inter-physical, information and behavioral dependencies of spatially-distributed components
- Foci:
  - transportation systems
  - construction engineering
  - infrastructure systems and infrastructure management
- Ordinary and disrupted operating environments

CIS: Scope

- Does NOT support research with a primary contribution pertaining to:
  - individual infrastructure components
  - materials
  - sensor technology
  - extreme event modeling
  - climate modeling
  - human factors
  - structural engineering
  - geotechnical engineering
  - environmental sciences
  - hydrologic engineering

CIS: Future Direction

Whether contributions are:

1. methodological (e.g. systems engineering, network optimization, risk analysis, control theory, integration,…)
2. computational (e.g. algorithm design)
3. theoretical/scientific
4. mathematical
5. creation of new knowledge/insights (e.g. through exploiting technological advancements, studying complex systems,…)

***main goal** is to support research with promise of:*

- long-lasting, cascading impact on research field
- potential to benefit society

Infrastructure Management and Extreme Events (IMEE)

Program Description PD 15-1638

http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=13353

Program Director: Dennis Wenger
dwenger@nsf.gov
703-292-8606

Unsolicited Proposal Due Dates

- February 1, 2015 - February 17, 2015
- September 1, 2015 - September 15, 2015

IMEE: Scope

- The IMEE program supports, basic, fundamental, multidisciplinary research on the impact of hazards and extreme events upon civil infrastructure and society.
- The focus is upon research on the mitigation of, preparedness for, response to, and recovery from multi-hazard disasters.
- 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.
- Community and societal resilience and sustainability are important topics with the research portfolio.

IMEE: Examples of Research Topics in the Four Core Areas of the Disaster Cycle

Mitigation

- The analysis of structural and non-structural mitigation effectiveness.
- Processes and frameworks for local capacity building for resilience and disaster risk reduction.
- Social and physical vulnerability analysis associated with disaster risk reduction.

Preparedness

- Research on warnings and risk communication
- Evacuation and protective action measures
- Multi-hazard emergency planning
- The effectiveness of pre-disaster planning and integrated community level planning mechanisms.

IMEE: Additional Examples of Research Topics in the Four Core Areas of the Disaster Cycle

Response

- Infrastructure interdependencies and cascading disasters.
- Innovation and improvisation in emergency management and among first responders.
- The use of new communication technology and social media in emergency management and response.

Recovery

- Linking disaster recovery to the mitigation of future disasters.
- Resilience metrics and models.
- Resilience of interdependent infrastructure processes and systems.
- Social factors related to economic recovery and resilience.

IMEE: Research Areas Not Supported

- IMEE does not support research on the normal, day-to-day operation of traditional infrastructure systems, and this research should be submitted to the Civil Infrastructure Systems (CIS) program
- IMEE does not support basic research on non-hazard or disaster related structural engineering and geotechnical engineering, and this research should be submitted to the Structural and Architectural Engineering (SAE) and Geotechnical Engineering and Materials (GEM) programs.
- IMEE does not support hazard and disaster research that is mechanistic and embedded in traditional engineering disciplinary frameworks, and this research should be submitted to the Engineering for Natural Hazards (ENH) program.

IMEE: Future Directions and Emphases

- IMEE has adopted the federal government's definition of infrastructure and examines both traditional gray infrastructure and emergent infrastructures as emergency preparedness and response, banking and finance, public health as processes and systems.
- Increasing emphases must be placed on research on mitigation and sustainable disaster recovery and resilience. In particular, IMEE is strongly interested in funding research on strengthening the theoretical foundation for multidisciplinary research on recovery.
- Research on social media and social networks and how they can be integrated into emergency management is needed.
- Transformative research in the areas of warning, risk communication, and evacuation is needed.

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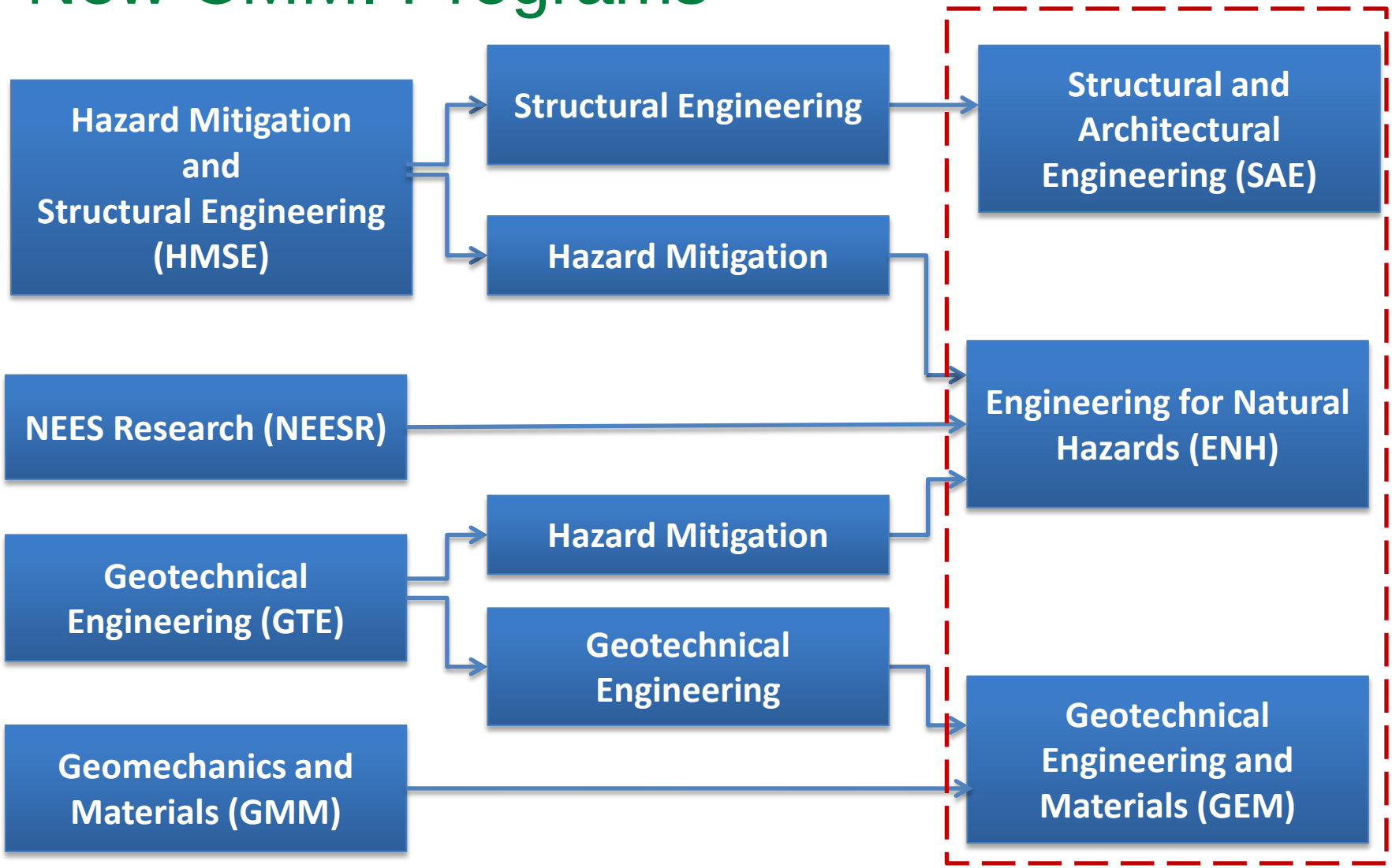
New RSI Programs

Kishor Mehta

Richard Fragaszy

Joy Pauschke

New CMMI Programs



Structural and Architectural Engineering (SAE)

Program Description PD 15-1637

http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=13358

Program Director: Kishor Mehta

kimehta@nsf.gov

703-292-7081

Unsolicited Proposal Due Dates

- February 1, 2015 - February 17, 2015
- September 1, 2015 - September 15, 2015

SAE: Goal and Scope

- **Goal** - Sustainable Structures that can be Occupied and/or Operated During Their Life

- **Scope :** Fundamental Research to Advance Knowledge and Innovation
  - Buildings (foundation-structure-envelope-nonstructural system)
  - Other Structures (towers, tanks, signs, bridges, etc.)
  - Design, Construction, Operation, Maintenance, Repair, End-of-Life Disposal

Photo Credit: *Texas Tech University*

SAE: Research Topics

- Structures that Over Their Life-Cycle are:
  - Cost-Effective
  - Efficient Use of Resources
  - Sustainable and Resilient Materials (renewable, fatigue, corrosion)
  - Serviceability for Deflection, Vibration
  - Physics Based Computational Simulation
  - Structural Health Monitoring with Focus on Decision Making

The SAE program encourages knowledge dissemination and technology transfer activities that can lead to broader societal benefit and implementation for structures.

SAE: Research Topics

- Research encouraged to include integration of:
  - Material Science
  - Mechanics of Materials
  - Dynamic Systems and Control
  - Reliability
  - Architecture
  - Economics
  - Human Factors

  Sustainable Structures That can be Occupied and/or Operated During Their Life

SAE: Research Topics not Supported

- Sensor Technology and Data Collection
- Structural Engineering for Natural Hazards (submit to ENH program)
- Blast Loads
- Fire Effects on Buildings

SAE: Examples of Sources for Research Topics

- Federal R& D Agenda for Net Zero Energy, High-Performance Green Buildings, Final Report. September 30, 2008. As approved by the NSTC Committee on Technology.
  http://www.whitehouse.gov/files/documents/ostp/NSTC%20Reports/Federal%20RD%20Agenda%20for%20Net%20Zero%20Energy%20High%20Performance%20Green%20Buildings%20Oct2008.pdf

- Ochsendorf, J. Challenges and Opportunities for Low-Carbon Buildings. The Bridge, NAE: Spring 2012
  http://www.nae.edu/Publications/Bridge/57865/58544.aspx

Geotechnical Engineering and Materials (GEM)

Program Description PD 15-1636

http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=13351

Program Director: Richard Fragaszy

rfragasz@nsf.gov

703-292-7011

Unsolicited Proposal Due Dates

- February 1, 2015 - February 17, 2015
- September 1, 2015 - September 15, 2015

GEM: SCOPE

- The GEM program supports basic research in soil and rock mechanics and dynamics, Geotechnical Engineering and geomaterials, all in support of physical civil infrastructure systems. It also supports work on geothermal energy and geothermal heat pump systems, as they relate to soil/rock mechanics.
- Research specifically related to earthquake, tsunami and landslide hazards should be directed to the Engineering for Natural Hazards Program; however, fundamental research on geomaterial behavior is appropriate for the GEM Program.
- Geotechnical Engineering research supported by this Program includes shallow and deep foundations, earth structures, underground construction, tunneling, subsurface characterization, geoenvironmental engineering, and geotechnical engineering aspects of coastal engineering.
- Research is supported on the fundamental behavior of soil and rock, including improvement of material properties by mechanical, electrical, hydraulic, thermal, chemical, and biological processes.
- The focus of the program is on sustainable geosystems. Life-cycle analyses that include consideration of environmental effects are encouraged.
- The Program does not support research directly related to natural resource exploration or recovery. Proposals on these topics will be returned without review.

GEM: Examples of Research Topics

- Fundamental studies of soil behavior, including laboratory testing, constitutive and numerical model development. Element-scale studies of liquefaction behavior are appropriate for the GEM Program.

- Laboratory-scale and centrifuge modeling, as well as field testing of geosystems, unrelated to hazards. For example, research related to design/construction/performance of building excavations or underground construction. Development of rapid/more efficient underground excavation techniques.

- Life-cycle analyses of alternative methods of geo-construction, comparing financial, energy, GHG emission, and environmental considerations.

- Biological enhancement of soil properties, such as microbial-induced calcite precipitation (MICP).

- Bio-inspired geotechnics for foundations, reinforcement, self-boring tools, etc.

GEM: Examples of Sources for Research Topics

- National Research Council, Geological and Geotechnical Engineering in the New Millennium: Opportunities for Research and Technical Innovation. Washington, DC: The National Academies Press, 2006, http://www.nap.edu/openbook.php?record_id=11558

- National Research Council, Underground Engineering for Sustainable Urban Development. Washington, DC: The National Academies Press, 2013, http://www.nap.edu/catalog/14670/underground-engineering-for-sustainable-urban-development

- DeJong, J.T., Soga, K.S., Kavazanjian, E., Burns, S., van Paassen, L., Al Qabany, A., Aydilek, A., Bang, S.S., Burbank, M., Caslake, L., Chen, C.Y., Cheng, X., Chu, J., Ciurli, S., Fauriel, S., Filet, A.E., Hamdan, N., Hata, T., Inagaki, Y., Jefferis, S., Kuo, M., Laloui, L., Larrahondo, J., Manning, D.A.C., Martinez, B., Montoya, B.M., Nelson, D.C., Palomino, A., Renforth, P., Santamarina, J.C., Seagren, E.A., Tanyu, B., Tsesarsky, M., Weaver, T. (2013). Biogeochemical Processes and Geotechnical Applications: Progress, Opportunities, and Challenges. *Geotechnique*. 63 (4), 287-301

GEM: Future Directions

- Bio-Geo Engineering and Bio-Inspired Geotechnics
  - This is the highest priority area for the GEM Program
  - Proposals directly related to hazards such as field studies of liquefaction mitigation should be submitted to the Engineering for Natural Hazards Program
  - Proposals which do not include the appropriate biological and/or geological sciences expertise are unlikely to be successful

- Geotechnical Engineering aspects of renewable energy
  - Geothermal heat pump systems
  - Foundations for wind turbines, tidal turbines
  - Geothermal steam and electricity production
  - Note: CBET's program Energy for Sustainability does not include wind or geothermal energy

- Beyond the Observational Method
  - Utilization of real-time sensed data to revise design during construction

- Non-Intrusive Site characterization
  - Geophysical methods of site characterization, especially the development of automated input of subsurface characteristics directly into design codes

Engineering for Natural Hazards (ENH)

Program Description PD 15-7396

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

Program Directors:
Joy Pauschke, (jpauschk@nsf.gov)
Richard Fragaszy, (rfragasz@nsf.gov)
Kishor Mehta, (kimehta@nsf.gov)

Unsolicited Proposal Due Dates

- February 1, 2015 - February 17, 2015
- September 1, 2015 - September 15, 2015

Dear Colleague Letter

http://www.nsf.gov/pubs/2015/nsf15028/nsf15028.jsp

ENH: Goals and Scope

- **Goals** - support research that
  - Prevents natural hazards from becoming disasters
  - Considers mitigation of constructed civil infrastructure for single and multiple natural hazards
  - Broadens consideration of natural hazards independently to enable consideration of the multi-hazard environment within which the constructed civil infrastructure exists
  - Requires larger collaborative, multidisciplinary research teams to address multiple hazards
- **Scope**
  - Natural hazards – earthquakes, windstorms (e.g., tornadoes and hurricanes), tsunamis, landslides, and other natural hazards that impact constructed civil infrastructure
  - Constructed civil infrastructure
    - Holistic soil-foundation-structure-envelope-nonstructural building **system**, including façade and roofing
    - Geostructures
    - Underground facilities such as tunnels
    - Other structures
- **Scope not supported by ENH (return without review)**
  - Hazards such as blast loading and fire effects
  - Development of sensor technologies
  - Long-term structural and field site monitoring

ENH: 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 and technology transfer activities that can lead to broader societal benefit and implementation for natural hazard mitigation for civil infrastructure.

ENH: Examples of Sources for Research Topics

- National Research Council, *Grand Challenges in Earthquake Engineering Research: A Community Workshop Report*. Washington, DC: The National Academies Press, 2011, http://books.nap.edu/catalog.php?record_id=13167.

- NIST GCR 14-973-13, *Measurement Science R&D Roadmap for Windstorm and Coastal Inundation Impact Reduction*. (This roadmap developmental effort was supported in part by NSF, through award CMMI-1235689, to obtain community input on related long-term fundamental research challenges in windstorm and coastal inundation impact reduction), http://www.nist.gov/customcf/get_pdf.cfm?pub_id=915541

New Cross-Directorate Program Solicitation related to RSI Cluster

Elise Miller-Hooks

Critical Resilient Interdependent Infrastructure Systems and Processes (CRISP)

Solicitation NSF 15-531

http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=50518

Program Directors:

Elise Miller-Hooks, elisemh@nsf.gov
Bruce Hamilton, bhamilto@nsf.gov
Robert O'Connor, roconnor@nsf.gov
Rajiv Ramnath, rramnath@nsf.gov
Sudipta Sarangi, ssarangi@nsf.gov
Gurdip Singh, gsingh@nsf.gov
Dennis Wenger, dwenger@nsf.gov

Full Proposal Due Date

- March 20, 2015

CRISP: Background

- Anticipated Funding Amount: $20 million
  - *Type 1 Awards*: Projects will be of 3 years in duration with a maximum total budget of $500,000
  - *Type 2 Awards*: Projects will be of 3-4 years in duration with a total budget ranging from $1 million - $2.5 million
- Involves 3 Directorates: ENG, CISE, SBE
- Requirement:
  - at least one PI or co-PI who is an ***engineer***
  - at least one PI or co-PI who is a ***computer, information or computational scientist***
  - at least one who PI or co-PI who is a ***social, economic or behavioral scientist***

CRISP: Critical Infrastructures

- Critical infrastructures mainstay of national economy, security and health, e.g.:
  - **Energy** - production and distribution of natural gas, coal, refined oil products, and electricity
  - **Transportation** - mobility to people and goods through combinations of air, rail, road, water-borne modes
  - **Telecommunications** – landline/mobile telephony, GPS signaling, internet/intranets, with data management/computing services
  - **Water** - sourcing, storage, processing and distribution of water, and recovery, processing, reuse and disposal of waste water
- Perspective evolving from
  - collections of discrete physical and human components **to** ecosystem of interconnected/interdependent physical, cyber & human components
- Infrastructures broadly as processes delivering services

CRISP: Interdependent Critical Infrastructure Systems (ICIs)

- Infrastructures are generally conceived here:
  - networks of systems and processes
  - function collaboratively and synergistically
  - produce & distribute a continuous flow of essential goods & services
  - interdependent and connected
- Example of interdependencies

  Electric power system depends on fuel delivery to power generating stations through transportation services

  →Production of fuel needs electrical power

  →Fuels needed for transportation

CRISP: Prevailing Goals

1. Create new approaches/engineering solutions for design/operation of infrastructures as processes/services
2. Enhance understanding/design of interdependent critical infrastructure systems (ICIs) and processes that provide essential goods and services despite disruptions/failures from any cause
   - natural, technological, organizational, regulatory, cyberspace or malicious
3. Create knowledge for innovation in ICIs to safely, securely, and effectively expand range of goods and services they enable
4. Improve effectiveness, efficiency, dependability with which they deliver existing goods and services

CRISP Research Objectives

1. Create new knowledge, approaches, engineering solutions to:
   - increase resilience, performance, readiness in ICIs
2. Create theoretical frameworks/multidisciplinary models of ICIs, processes and services:
   - capable of analytical prediction of complex behaviors
   - in response to system and policy changes
3. Develop frameworks to understand interdependencies created by interactions between:
   - physical, cyber, social, behavioral and economic ICI elements
4. Understand organizational, social, psychological, legal, economic obstacles to:
   - improving ICIs, identifying strategies for overcoming obstacles

Predecessor RIPS: Awards Made

More info on RIPS current awards
http://www.nsf.gov/news/news_summ.jsp?cntn_id=132852

RIPS Type I

(1) The Interdependent Criticality of Built, Social, and Information Infrastructures in Community Resilience: A New Framework and Participatory Process – *Lead: University of Colorado Boulder*

(2) Human Geography Motifs to Evaluate Infrastructure Resilience – *Lead: University of Maryland*

(3) A Meta-Network Systems Framework for Resilient Analysis and Design of Modern Interdependent Critical Infrastructures – *Lead: New York University*

RIPS: Awards Made

RIPS Type II

(1) Quantifying Disaster Resilience of Critical Infrastructure-based Societal Systems with Emergent Behavior and Dynamic Interdependencies – *Lead: University of Maryland*

(2) Towards Resilient Computational Models of Electricity – *Gas ICI – Lead: MIT*

(3) Strategic Analysis and Design of Robust and Resilient Interdependent Power and Communication Networks – *Lead: Washington State University*

(4) Vulnerability Assessment and Resilient Design – *Lead: University of Florida*

(5) Resilience Simulation for Water, Power and Road Networks – *Lead: Arizona State University*

(6) Participatory Modeling of Complex Urban Infrastructure Systems – *Lead: Georgia Tech*

(7) Water and Electricity Infrastructure in the Southeast (WEIS) Approaches to Resilient and Interdependent Systems under Climate Change – *Lead: Carnegie Mellon University*

Questions and Answers

Richard Fragaszy
Kishor Mehta
Elise Miller-Hooks
Joy Pauschke
Dennis Wenger

During Webinar, please email questions to kwebster@nsf.gov

After Webinar, please email questions to Program Officer of relevant program