Resilient Interdependent Infrastructure Processes and Systems (RIPS)

NSF 14-524

Elise Miller-Hooks

Program Director, Civil Infrastructure Systems

elisemh@nsf.gov

November 2014

Infrastructures

- Critical infrastructures mainstay of national economy, security and health
  - **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 and mobile telephony, GPS signaling, internet and intranets, and associated data management and computing services
  - **Water** - sourcing, storage, processing and distribution of water, and recovery, processing, reuse and disposal of waste water
- Infrastructures are generally conceived here:
  - networks of systems and processes
  - function collaboratively and synergistically
  - produce and distribute a continuous flow of essential goods and services

Infrastructures are Interdependent

- Interdependent Critical Infrastructure Systems (ICIs)
  - 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

Interdisciplinary

- Interdisciplinary paradigm integrating:
  - Cyber-physical
  - Engineering
  - Social, behavioral and economic (SBE) sciences

General Program Goals

(1) Foster interdisciplinary research community to discover new knowledge for design and operation of infrastructures as processes and services

(2) Enhance understanding of ICI design and processes that provide essential goods and services despite disruptions/failures from various causes:

- Natural
- Technological
- Organizational
- Regulatory
- Cyberspace
- Malicious

(3) Create knowledge for innovation in ICIs to advance society with new goods and services

Specific Program Objectives

(1) Create theoretical frameworks and multidisciplinary computational models of interdependent infrastructure systems, processes and services
- Analytical prediction of complex behaviors
- Response to system and policy changes

(2) Synthesize approaches to increase resilience, interoperations, performance and readiness

(3) Understand organizational, social, psychological, legal, political and economic obstacles to
- improving ICIs
- identifying strategies for overcoming those obstacles

Computer Science Perspective

- Rapid adoption and pervasiveness of
  - Computing
  - Communications
  - Information communications technologies
- New capabilities of
  - Awareness
  - Autonomy
  - Interoperability
  - Cooperation
  - Control

Computer Science Perspective

- ICIs composed of deeply interconnected cyber-physical-social systems promise
  - significantly improved service resiliency against all hazards
- Connections with cyberspace also open ICIs to new classes of threats and vulnerabilities

Award Types

- Type I Awards
  - 1-2 years with $300k max
  - Theory, modeling, metrics projects to create knowledge/methods to conceptualize and study interdependent infrastructure as processes and services
- Type II Awards
  - 3 years with $1-2.5M max
  - As above + conduct major new interdisciplinary, interdependent infrastructure research

Total of $17M awarded

Awards Made

- 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*

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*

Directorates Involved

- Engineering (ENG)
- Computer and Information Science and Engineering (CISE)
- Social, Behavioral and Economic Sciences (SBE)

Thank you

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