SimCenter
Center for Computational Modeling and Simulation

# Simulation and Data Needs to Support Disaster Recovery Planning

**Greg Deierlein**
*SimCenter Co-Director*
*Stanford University*

NSF award: CMMI 1612843

# Acknowledgments

**Planning Committee:** Adam Zsarnoczay (chair), Greg Deierlein, Ann-Margaret Esnard, Tracy Kijewski-Correa, Laura Lowes, Frank McKenna, Matt Schoettler

**Advisers:** Laurie Johnson, Scott Miles, Paolo Gardoni, Henry Burton

**SimCenter Staff:** Corinna Fong, Grace Kang

**Session Moderators:** Jack Baker, Rachel Davidson, Tim Cockerill

**Recorders:** Bingyu, Caroline, Ioanna, Maryia, Omar, Pablo, Preetish

**Financial Support:** *National Science Foundation*

# Workshop Goals

- **Identify approaches and tools to evaluate the impact of natural hazards** and inform strategies to manage risks through mitigation and planning for disaster recovery
- **Collect and prioritize questions and concerns** about mitigating the devastating effects of earthquakes, storms and other extreme events that can be evaluated through scenario studies that can be facilitated using advanced simulations
- **Identify and prioritize the needs for improved models and supporting data** that can be integrated into computational workflows for advanced simulation of natural disaster impacts
- **Brainstorm strategies** to facilitate development and migration of simulation technologies into research and practice on disaster risk management and recovery through multi-disciplinary testbeds and other mechanisms.

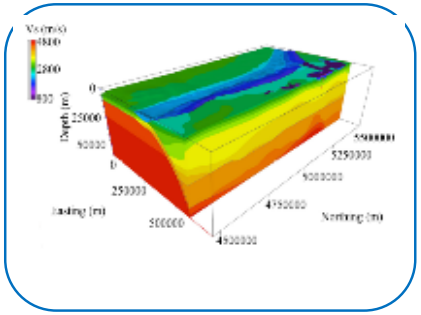
SimCenter NHERI
Center for Computational Modeling and Simulation

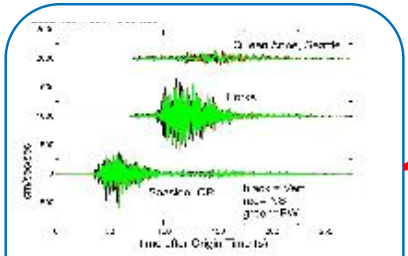
Simulation of Earthquake Events

Generate Site-Specific Ground Motions

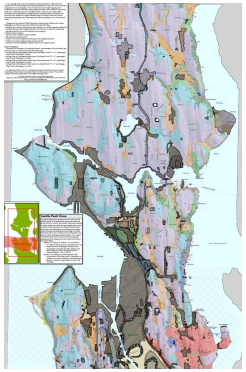
Simulate Structural Response

Estimate Loss and Assess Regional Risk

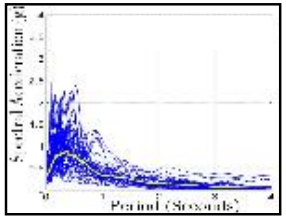




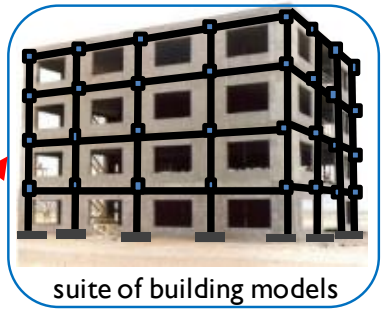
rock motions at various locations within the region



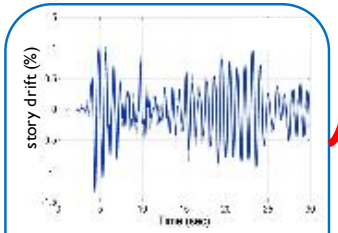
site-specific soil conditions



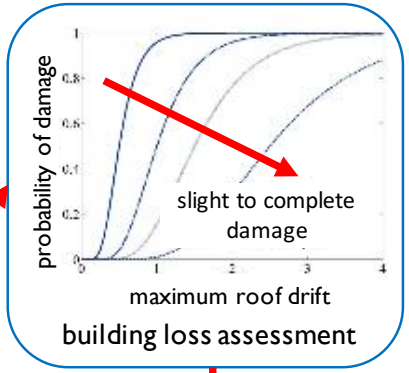
site-specific ground motions representing site hazard



suite of building models



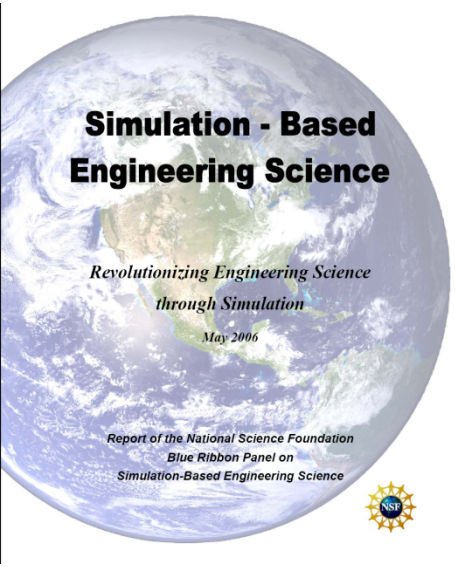

building response




building loss assessment

Earth Scientists  Str/Geo Engineers  Loss & System Modelers  Social Scientists

# Simulation-Based Engineering & Science




**Modeling and simulation will expand our ability to cope with problems that have been too complex for traditional methods.** Such problems, for example, are those involving multiple scales of length and time, multiple physical processes, and unknown levels of uncertainties.

**"Digital City":** The concepts and methods of SBES promise to revolutionize the practice of urban planning, transportation, structural and environmental engineering, and municipal and environmental management.

**The Tyranny of Scales:** Formidable obstacles remain in linking highly disparate length and time scales and in bringing together the disciplines involved in researching simulation methods. Fundamental discoveries will be needed to surmount these obstacles.

# Simulation-Based Engineering & Science

NATURAL HAZARDS ENGINEERING RESEARCH INFRASTRUCTURE

**FIVE-YEAR SCIENCE PLAN**

MULTI-HAZARD RESEARCH TO MAKE A MORE RESILIENT WORLD

SECOND EDITION
JANUARY 2020

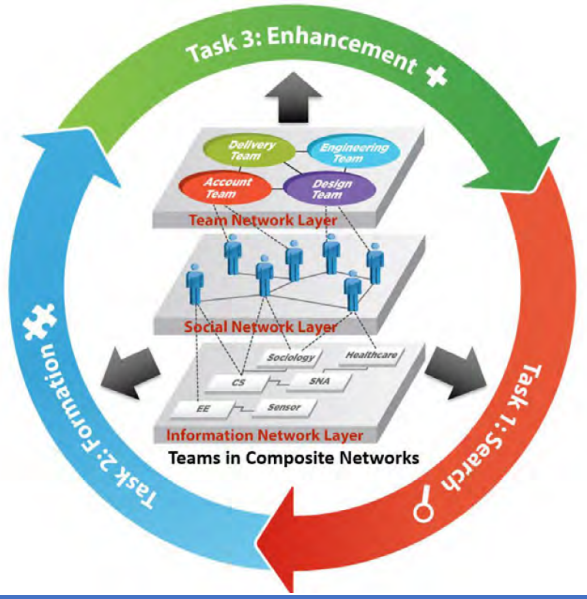
NSF | NHERI Natural Hazards Engineering Research Infrastructure

## Three Grand Challenges

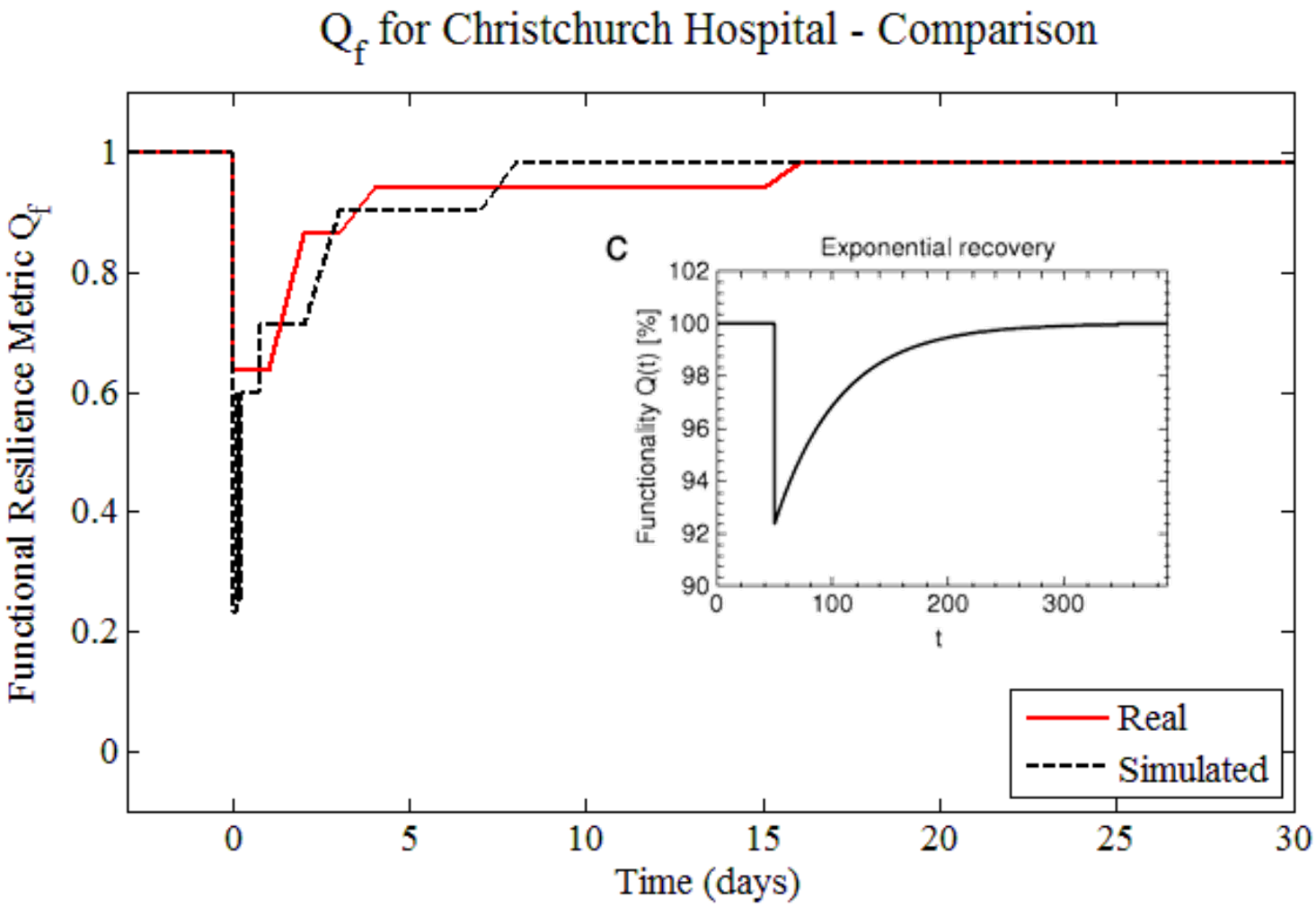
1. Identify and quantify the characteristics of earthquake, windstorm, and associated hazards—including tsunamis, storm surge, and waves—that are damaging to civil infrastructure and disruptive to communities.

2. Assess the physical vulnerability of civil infrastructure and the social vulnerability of populations in communities exposed to earthquakes, windstorms, and associated hazards.

3. Create the technologies and engineering tools to design, construct, retrofit, and operate a multi-hazard resilient and sustainable infrastructure for the nation.



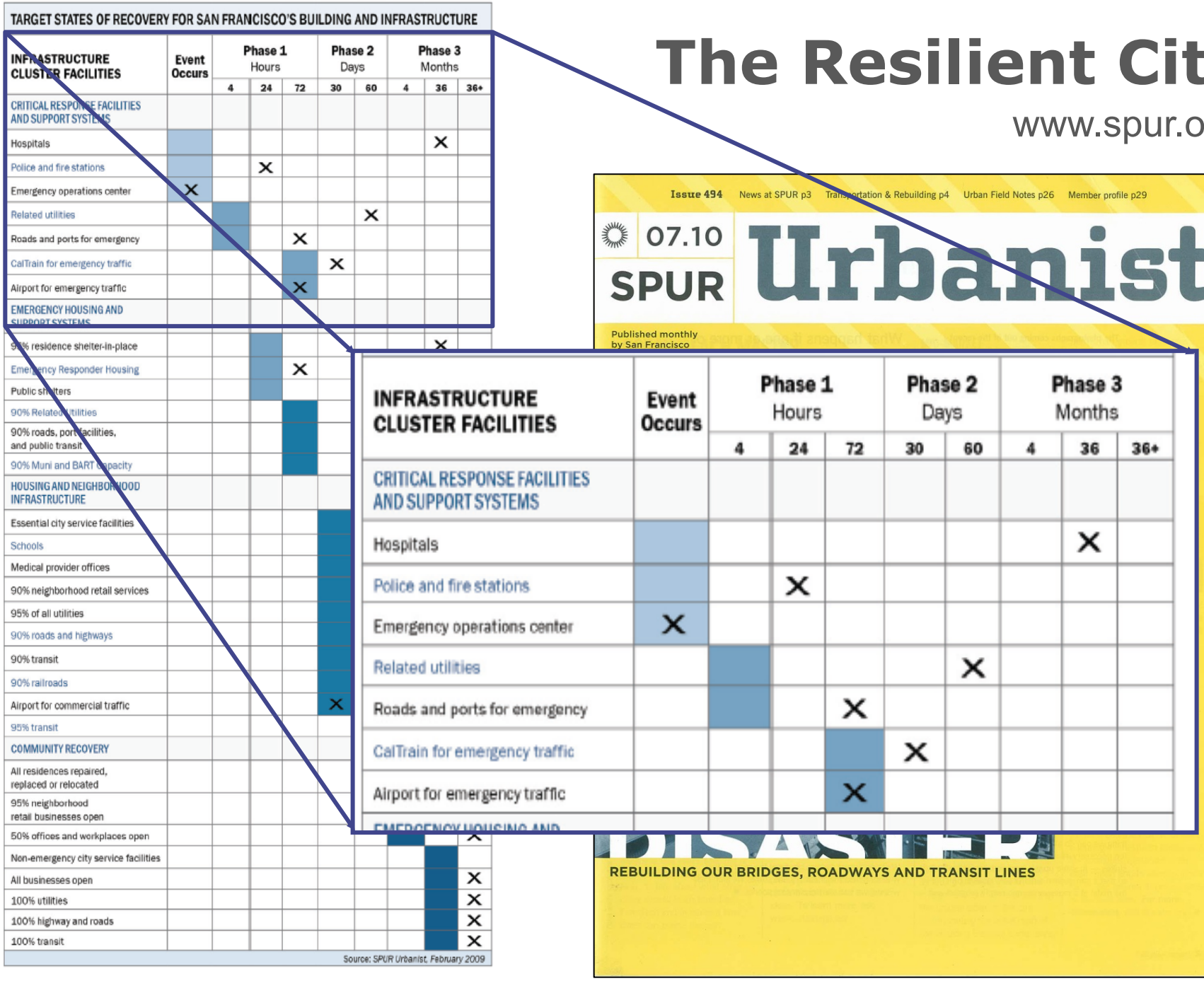
# Resilience to Natural Disasters




J. Mitrani-Reiser

# The Resilient City

www.spur.org



TARGET STATES OF RECOVERY FOR SAN FRANCISCO'S BUILDING AND INFRASTRUCTURE

| INFRASTRUCTURE CLUSTER FACILITIES | Event Occurs | Phase 1 Hours | | | Phase 2 Days | | Phase 3 Months | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 4 | 24 | 72 | 30 | 60 | 4 | 36 | 36+ |
| CRITICAL RESPONSE FACILITIES AND SUPPORT SYSTEMS | | | | | | | | | |
| Hospitals | | | | | | | | X | |
| Police and fire stations | | | X | | | | | | |
| Emergency operations center | X | | | | | | | | |
| Related utilities | | | | | | X | | | |
| Roads and ports for emergency | | | | X | | | | | |
| CalTrain for emergency traffic | | | | | X | | | | |
| Airport for emergency traffic | | | | X | | | | | |
| EMERGENCY HOUSING AND SUPPORT SYSTEMS | | | | | | | | | |
| 95% residence shelter-in-place | | | | | | | | X | |
| Emergency Responder Housing | | | | X | | | | | |
| Public shelters | | | | | | | | | |
| 90% Related utilities | | | | | | | | | |
| 90% roads, port facilities, and public transit | | | | | | | | | |
| 90% Muni and BART capacity | | | | | | | | | |
| HOUSING AND NEIGHBORHOOD INFRASTRUCTURE | | | | | | | | | |
| Essential city service facilities | | | | | | | | | |
| Schools | | | | | | | | | |
| Medical provider offices | | | | | | | | | |
| 90% neighborhood retail services | | | | | | | | | |
| 95% of all utilities | | | | | | | | | |
| 90% roads and highways | | | | | | | | | |
| 90% transit | | | | | | | | | |
| 90% railroads | | | | | | | | | |
| Airport for commercial traffic | | | | | X | | | | |
| 95% transit | | | | | | | | | |
| COMMUNITY RECOVERY | | | | | | | | | |
| All residences repaired, replaced or relocated | | | | | | | | | |
| 95% neighborhood retail businesses open | | | | | | | | | |
| 50% offices and workplaces open | | | | | | | | | X |
| Non-emergency city service facilities | | | | | | | | | |
| All businesses open | | | | | | | | | X |
| 100% utilities | | | | | | | | | X |
| 100% highway and roads | | | | | | | | | X |
| 100% transit | | | | | | | | | X |

Source: SPUR Urbanist, February 2009

Issue 494 News at SPUR p3 Transportation & Rebuilding p4 Urban Field Notes p26 Member profile p29

07.10

SPUR

Urbanist

Published monthly by San Francisco

DISASTER

REBUILDING OUR BRIDGES, ROADWAYS AND TRANSIT LINES

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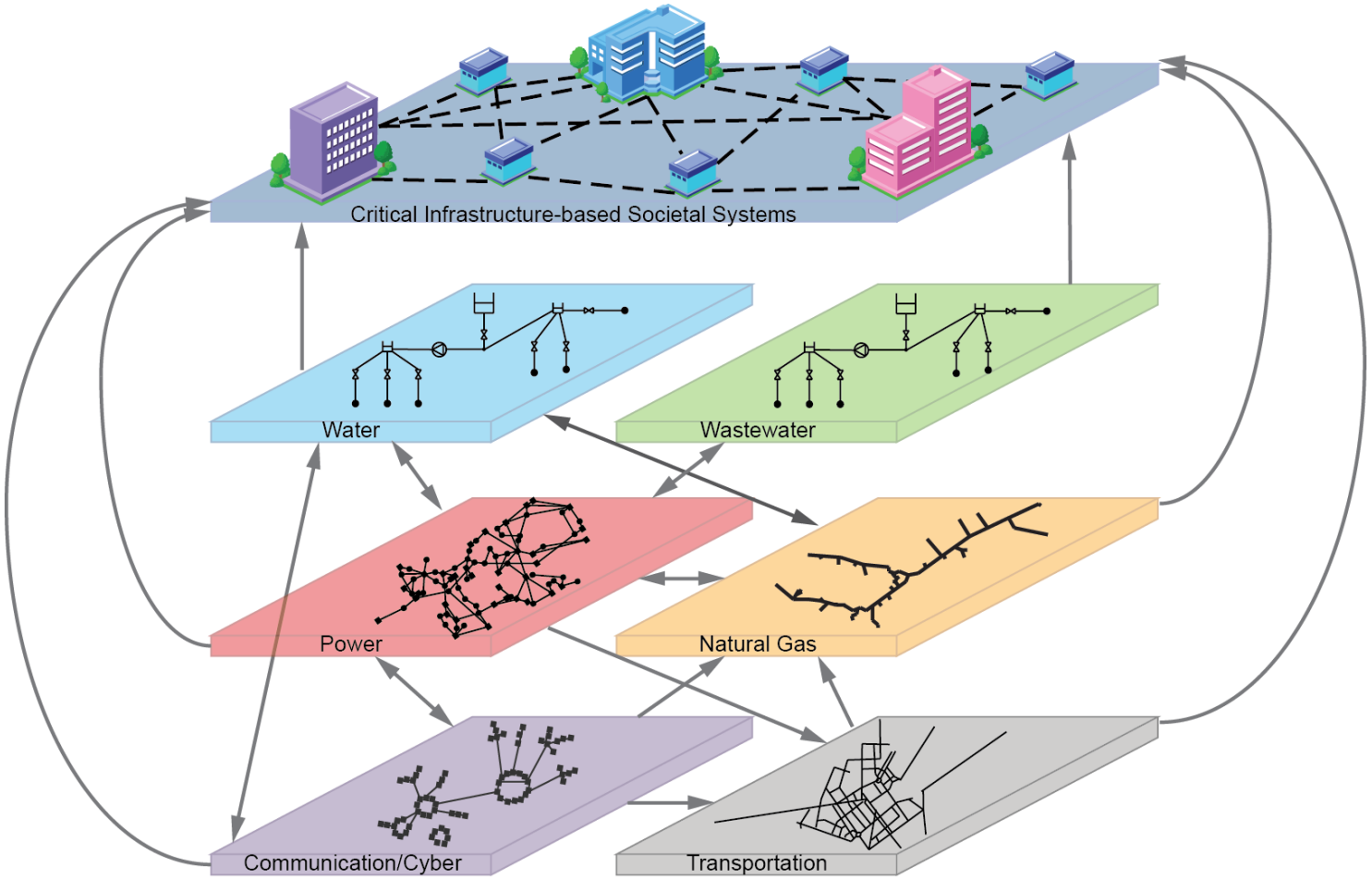
| Airport for emergency traffic | | | | X | | | | | |
| EMERGENCY HOUSING AND | | | | | | | | | |

# Interdependent Infrastructure



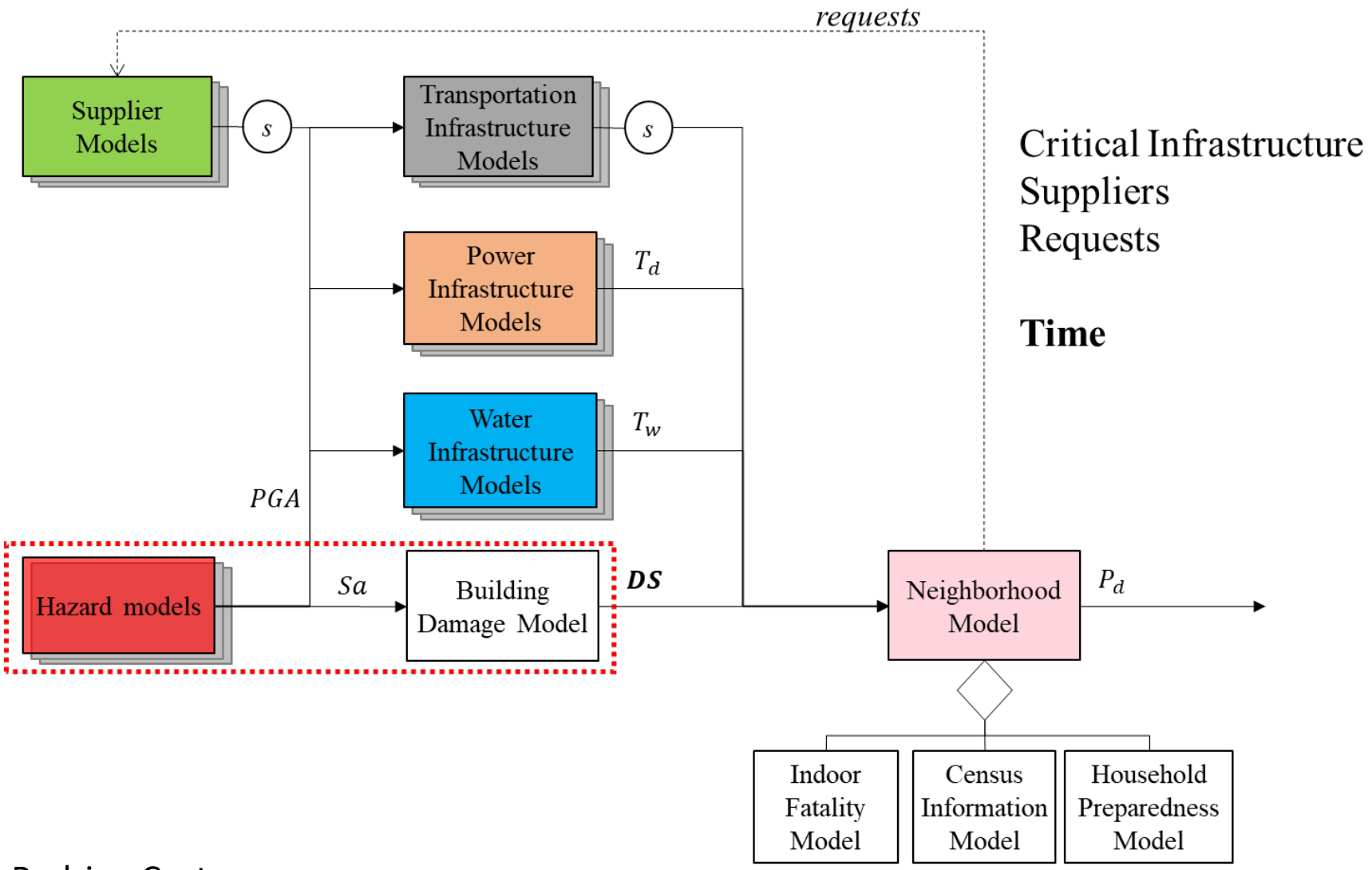

J. Mitrani-Reiser

# Interdependent Societal Systems

**Healthcare Delivery New Zealand**

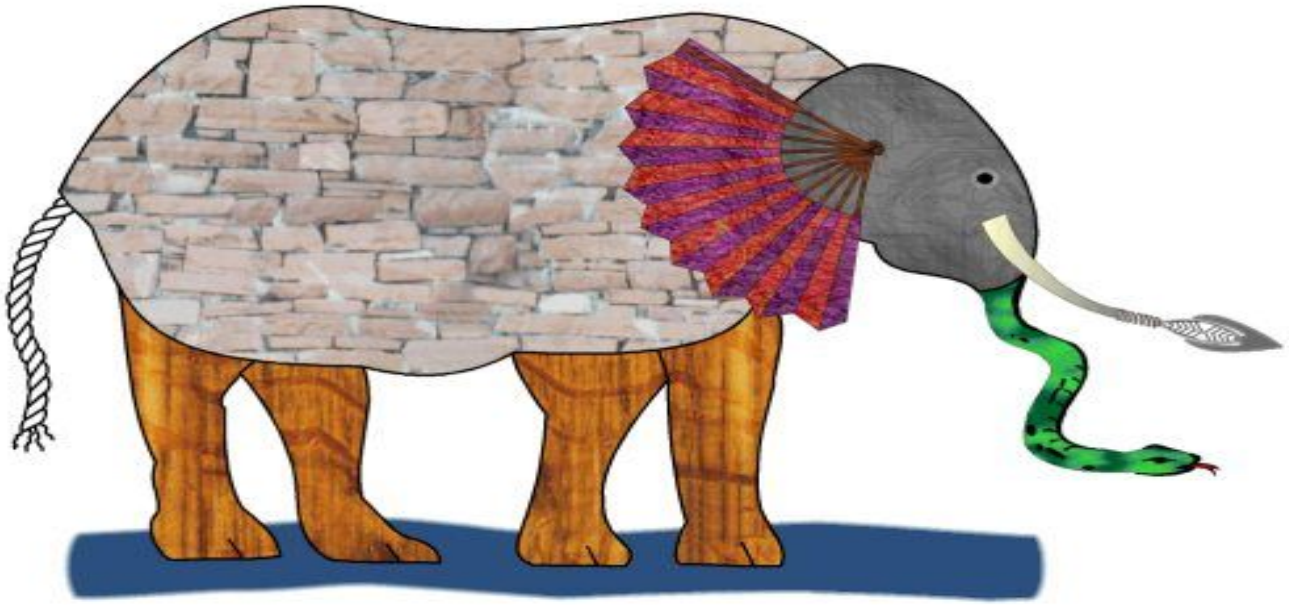
J. Mitrani-Reiser

# Computational Models



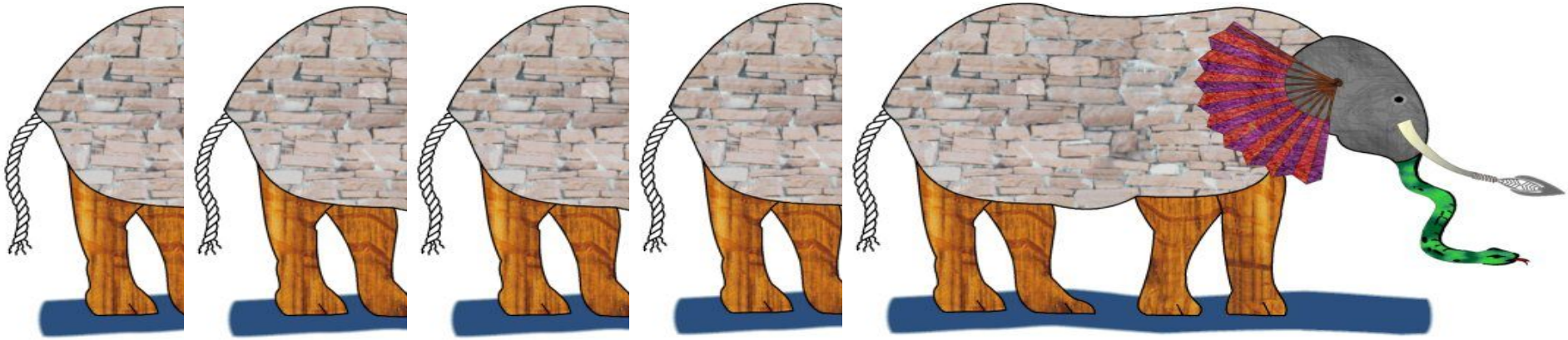

Rodrigo Costa

# Different Perceptions



**Simulation and Data Needs to Support Disaster Recovery Planning**

# Different Realities & Perceptions



**Natural** **Built** **Social** **Economic** **Institutional**

**Earthquake** **Tsunami** **Tornado** **Hurricane** **Atmospheric River**

**Natural Science** **Engineering** **Social Science** **Public Policy** **Urban Planning**

# Agenda

## Thursday - January 30

9:00 am **Welcome, SimCenter Overview, and Workshop Goals**

### Session I
### Regional Simulations

9:30 am **Application Frameworks for Regional Simulation**
*Gregory Deierlein, Paolo Gardoni*

10:15 am **Breakout sessions**
*simulation tools, attributes, gaps and capabilities*

11:45 am Short break

12:00 pm **Discuss observations**

12:30 pm Lunch

### Session II
### Connecting Across Expertise

1:30 pm **Issues in Disaster Simulation for Recovery Planning**
*Laurie Johnson*

2:00 pm **Breakout sessions**
*Collect questions to be addressed by simulations*

3:00 pm Short break

3:15 pm **Discuss observations**

3:45 pm **Breakout sessions**
*Prioritize development opportunities*

4:45 pm **Discuss observations**

5:15 pm Workshop adjourns, informal reception

6:00 pm Closure for the day

## Friday - January 31

9:00 am **Brief recap of day 1**

### Session III
### Data Sources

9:30 am **Data needs and sources**
*Tracy Kijewski-Correa, Charles Vardeman*

10:00 am **Breakout sessions**
*Identify uses, needs and sources data*

11:30 am Short break

11:45 am **Discuss observations**

12:15 pm Lunch, group picture

### Session IV
### Interdisciplinary Engagement

1:15 pm **Engagement through benchmarking testbeds**
*Scott Miles, Paolo Gardoni, Rachel Davidson,* Youngjun Choe

2:00 pm **Breakout sessions**
*Develop strategies for sharing and vetting of methods*

3:30 pm Short break

3:45 pm **Discuss observations**

4:15 pm **General discussion, closing remarks**

4:30 pm Workshop adjourns

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*simu*

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1:30 pm **Issue**
*Lauri*

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*Colle*

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*Laurie Johnson, Rodrigo Costa*

**Data needs and sources**
*Tracy Kijewski-Correa, Charles Vardeman*

**Engagement through benchmarking testbeds**
*Scott Miles, Paolo Gardoni, Rachel Davidson,* Youngjun Choe

# Our Request

Participate

Stay Engaged

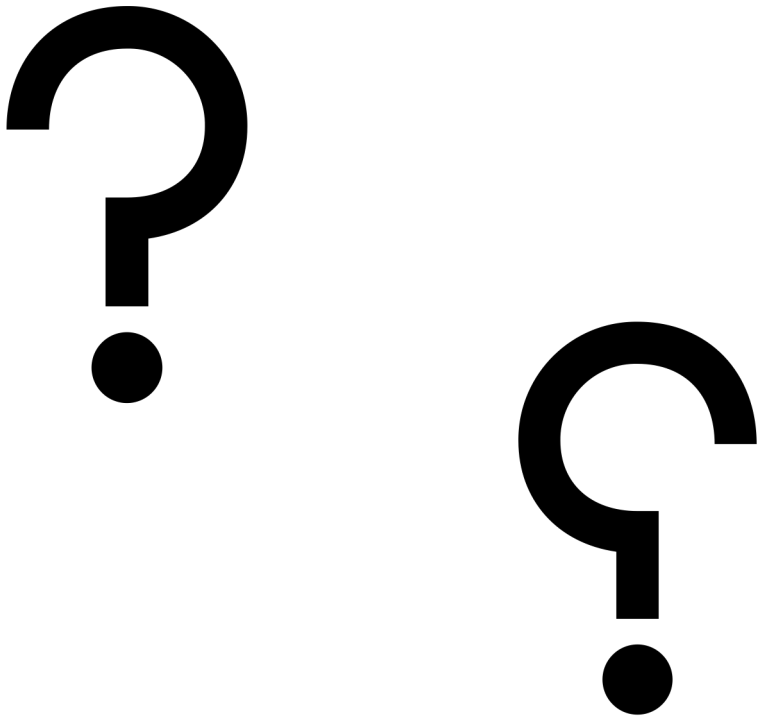
Put Away Devices

Listen

Practice Empathy

Mind Your Moderator

Meet Someone New

Learn & Enjoy

# Questions