Objective

• Present the engineering perspective on interdisciplinary research in disaster vulnerability
Outline

- State of science
- Research opportunities
- Limitations
State of the Science

- Fundamental paradigm shift

Life Safety → Performance Levels

- New definitions of vulnerability
  - **Vulnerability** = non-performance levels
  - Example: immediate occupancy performance level implies that structure should have only cosmetic damage and will have all lifeline functionality available to it
  - This definition requires a systems approach to vulnerability definition!
State of the Science

- Advanced vulnerability assessment methods – relate to performance levels—PBEE - earthquake primarily
  - Building structural system
  - Non-structural components
  - Contents
  - Lifeline systems
    - Transportation
    - Water/sewer
    - Power
    - Communications
    - Gas

Primary current focus

Performance models in their infancy
Research Opportunities

- Bring performance modeling for other hazards in line with earthquake performance definitions

- Multi-hazard performance evaluations - this should be within the context of the digital city concept
  - E.g. hurricane wind force, storm surge and flood levels
  - E.g. earthquake and tsunami plus technological hazards – earthquake of March 11, 2011 in Tohoku, Japan

- Define performance levels within the context of social and economic requirements for functionality and resiliency

- Building and other structure specific models – need for better understanding of structural response such as the behavior of materials when subjected to extreme loads
Research Opportunities

- Study and develop methods for evaluating and modeling
  - Interaction/dependence between
    - Structure – vulnerability correlation of similar structures
    - Lifeline systems
    - Social components
    - Economic components
- Time-dependent modeling - consideration of aging and deterioration in performance assessment as well as population and infrastructure growth
- Consider life-cycle issues and sustainability – reusable/new materials that are also hazard resistant
Research Opportunities – cont’d

- Need for technologies that connect vulnerability models with regional risk assessment – high data, high computation
- Need for multi-scale models that go across the structural, social and economic components – these are typically data intensive, and computationally very intensive

Data and other information collection:
- Single structure instrumentation for
  - Performance assessment – pre- and post event evaluation
  - Design development
  - Instrumentation that integrates structural performance, energy consumption and environmental conditions
- Regional data collection
  - Inventory compilation for all hazards
  - Develop technologies for automated inventory compilation
  - Technologies for continuous updating – such as direct link to building permitting process and visualization tools (e.g. google earth, remote sensing, video cameras, etc.)
  - Post-event regional damage evaluation methods – using remote sensing
Research Opportunities – cont’d

• Develop new materials and systems for
  o New structures
  o Retrofit purposes
  o Rapid reconstruction

• Special designs for evacuations & temporary housing
  o Address individual hazards – hurricane, tornado, floods, tsunamis
  o Identify common themes
  o Include the following in evacuation strategies
    ▶ Multicultural social environments
    ▶ Economic conditions – government and individual – correlate to social status

• Relationship between vulnerability and resiliency of a region

• Need for demonstration projects – similar to the southern California earthquake scenario – for other hazards and for multiple hazards

Include social and economic implications in the design of these materials
Constraints

- Very limited funding
- Limited communication between the fields – engineering, social and economic sciences
- Lack of appreciation of the cross-disciplinary issues by all the fields