MCEER RESEARCH TASK STATEMENT

Thrust Area: 3  
Budget:  
Yr 9 Assigned  
Project Number: 9.3.4

Task Title: Comprehensive Community Recovery Modeling

Investigator/Stephanie Chang
Institution: University of British Columbia

*indicates task leader

Statement of Project Goals: (Conceptually describe what the work is intended to accomplish, in 100 words or less. Do not provide detailed description here.)

This project aims to develop a decision-support tool for urban disaster recovery. The core effort focuses on developing a simulation model of disaster recovery. In Year 8, work is continuing on a “second generation” recovery model. The objectives in Year 9 are to (1) establish the credibility of the refined model by conducting an L.A./Northridge test, and (2) use the model to explore policy implications for building community resilience against extreme event disasters generally. The Year 9 tasks would involve completion of the computer code, testing and validation of the model, and system exploration of policy implications.

Problem Description and Research Approach of Proposed Work for Year 9: (Detailed description of research to be conducted and methodology to be used.)

Efforts in previous years have resulted in the development of a prototype or “first generation” comprehensive model of community recovery. In contrast to loss estimation models, the recovery model places much greater emphasis on the timepaths by which a community recovers from disaster. It seeks to capture how economic disruption losses accumulate over time, result from interactions within the neighborhood and community, and are influenced by response and recovery decisions (see figure 1). Such a model of the urban disaster recovery process can provide a means for informing and evaluating public decisions that can facilitate recovery.

The Recovery Model was initially conceptualized as a tool to support specific decision-making and planning, particularly for in the post-disaster context. Based on feedback from the end user as well as academic community, I now see it as being more appropriate and powerful as a tool for education, policy support, and strategic thinking about how to build more resilient communities. In this context, the paramount objectives going forward are to establish the technical credibility of the refined model and to demonstrate its applicability for exploring policy implications for building community resilience against disasters.

By the end of Year 8, I will have completed the conceptual redesign for the "second generation" model, together with specifications for the L.A./Northridge test and associated data collection for implementing the model. Note that in the "second generation" model, I plan to make tight linkages to the L.A. lifeline loss/resilience model; i.e., using outputs of that model as a direct input into the recovery model.
Year 9 tasks would involve completing the computer programming, testing and validating the model, and initiating exploration of policy implications. Policy exploration will be conducted in several steps. First, a selected series of mitigation and recovery strategies will be designed for policy simulation. Second, summary indicators of recovery and community resilience will be designed based on the multi-dimensional outputs of the model. Third, a series of simulation contexts will be designed to represent different community types, particularly with respect to socio-economic vulnerability. Fourth, a systematic framework will be set up for the simulations. This framework will be similar to that used in the first-generation prototype modeling in the sensitivity analysis exercise, except that it will be conditioned by the strategies, indicators, and contexts designed for the policy exploration. Finally, the framework will be implemented to systematically explore how different mitigation and recovery strategies affect long-term loss, recovery, and community resilience. From this perspective, an interesting question is whether
community social and economic characteristics matter more than specific aspects of the earthquake itself. A related question is whether some types of mitigation and recovery strategies appear more effective than others in the context of different types of communities. A third question is which types of strategies appear to be most effective generally for enhancing community resilience.

**Assessment of State-of-the-Art:** (Describe other relevant work being conducted within and outside of MCEER, and how this project is different.)

While a number of earthquake loss estimation models exist and are being developed, both within and outside of MCEER, none emphasize the dynamics of the recovery process. The simulation model being developed here is unique in its attempts to capture the full picture of community recovery – particularly in terms of interaction effects across space, time, and community sectors, and in its consideration of a broad range of pre- and post-disaster decision variables.

**Progress to date:** (If applicable, a short description of achievements in previous years. Clearly distinguish progress achieved in the past year, i.e., accomplishments from April 1, 2004, to March 31, 2005.)

A prototype simulation model has been developed and implemented in Matlab and tested through sensitivity analysis and validation exercises. End user feedback has been obtained through a focus group in Seattle and a practitioner survey. A number of publications have been produced, including an MCEER Technical Report, book chapter, and conference papers (see Contributions to MCEER Objectives form).

**Role of Proposed Task in Support of Strategic Plan:** (Describe how the effort will make a unique, useable contribution to the MCEER strategic plan.)

The proposed research will support MCEER’s strategic plan by contributing toward a decision-support system for disaster recovery. It develops a comprehensive model of community recovery, which quantifies the social and economic dimensions of community resilience. This model provides emergency managers and planners with a tool for exploring the complexities of how pre- and post-disaster decisions (e.g., implementing mutual aid agreements) influence community recovery and resilience.

**Task Integration:** (Describe how the work performed interfaces with other tasks and researchers funded by MCEER.)

This work provides a basis for implementing and testing community resilience measures being developed by other MCEER researchers, inc. K. Tierney and A. Rose. It can help determine inputs and calibration points for CGE modeling of indirect economic impacts by A. Rose. It will benefit from work on decision variables, loss reduction strategies, and their effectiveness that is being conducted by W. Petak and D. Alesch.
In addition, D. Alesch is submitting a multi-hazard proposal to MCEER for an interdisciplinary discussion of the disaster recovery process from a multi-hazard perspective. If the Alesch proposal is funded, the Recovery Model effort would contribute directly to these discussions.

**Possible Technical Challenges:**

Model calibration and validation remain challenges, since empirical data are sparse and complex to interpret for this purpose. Reducing the policy exploration to a manageable yet meaningful scope may be a challenge; for example, designing a limited but representative set of mitigation and recovery strategies for exploration.

<table>
<thead>
<tr>
<th>Anticipated Outcomes and deliverables: (Also indicate those of particular benefit to IAB members and other end users.)</th>
<th>Potential end-users beyond academic community: (IAB members and others.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second-generation community recovery model (software), implemented for L.A.</td>
<td>National, state, and local level government agencies concerned with disaster recovery</td>
</tr>
<tr>
<td>Policy simulations using this model.</td>
<td>Emergency managers and planners</td>
</tr>
<tr>
<td>Peer-reviewed journal article.</td>
<td>Utility agencies</td>
</tr>
<tr>
<td></td>
<td>Urban planners</td>
</tr>
</tbody>
</table>

**Educational outcomes and deliverables, and intended audience:**

Training of 2 graduate students.

In addition, the recovery model itself can serve as an educational tool for emergency managers, elected officials, and planners.

**Project Schedule and Expected Milestones for the Project:** (Milestones and estimated time of achievement; e.g., Fall, Spring, Summer.)

- **Fall 2005:** Complete programming and L.A. application.
- **Winter 2005:** Test and refine model. Design framework for policy exploration.
- **Spring 2006:** Conduct policy exploration.
- **Summer 2006:** Write reports/papers.

**Team Members:** (If known, provide names of team members associated with project including project leader, other faculty and their departments, undergraduate students, graduate students, postdoctoral students, industrial participants.)
S.E. Chang, Principal Investigator
2 graduate research assistants, to be determined

Plus coordination with MCEER researchers as noted above.

### Possible Direction of Work in Subsequent Years:

Interaction with potential end-users in 1~2 communities, potentially in a focus group setting. In contrast to previous end-user interaction, which focused on refining the model itself, the emphasis would turn to using the model to demonstrate recovery implications of mitigation and recovery strategies and to use it to help guide planning and policy decisions.

### Multi-Hazard Statement:

a) *(Conceptually describe in 200 words or less how some of the work you are conducting as part of your MCEER Year 9 research task can be exported/applied to other natural or man-made hazards including multi-hazard research.)*

The Recovery Model focuses on how communities respond to and recover from major disturbances in the built environment. It is thus directly applicable to many other hazard contexts. Some refinements would be needed to address technological or wilful disasters, as opposed to natural hazards.

b) *If you are seeking supplemental multi-hazard funding, describe the multi-hazard milestones that you plan to complete as part of your Year 9 research.*

Taking the perspective of long-term loss and recovery, an interesting question is whether community social and economic characteristics matter more than the nature of the extreme event itself. Also, what strategies for increasing earthquake resilience would most effectively enhance resilience to extreme events generally?

If granted supplemental multi-hazard funding, I will expand the scope of the Year 9 policy explorations to refer to a multi-hazard decision-making framework. Specifically, the initiating disruptions would reflect a range of hazard events, both natural and human-induced. Multi-hazard milestones would consist of expanding the scope of the milestones listed above:

<table>
<thead>
<tr>
<th>Year</th>
<th>Milestone Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 2005</td>
<td>Specify non-seismic hazard events and test their simulation in the model.</td>
</tr>
<tr>
<td>Winter 2005</td>
<td>Test and refine model. Expand policy exploration framework to incorporate multi-hazard perspective. Specifically address the questions identified above.</td>
</tr>
<tr>
<td>Spring 2006</td>
<td>Conduct policy exploration from multi-hazard perspective.</td>
</tr>
<tr>
<td>Summer 2006</td>
<td>Incorporate multi-hazard perspective in reports/papers.</td>
</tr>
</tbody>
</table>