MCEER RESEARCH TASK STATEMENT

Thrust Area: Networking            Budget: Yr 9 Assigned
                                Project Number: 9.5.3

Task Title: Implementation of Web-based GIS Geotechnical Data for Critical Infrastructures at MCEER Facilities.

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Institution: T.D. O’Rourke, Cornell University
*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 is a networking subtask for Task “Development of Web-based GIS Geotechnical Data for Critical Infrastructures”. The purpose of this task is to implement at MCEER a shared computational tool of geospatial databases and information using an Internet Map Server application. This will include porting the existing IMS application for acute care facilities that is currently maintained at Cornell University to the facilities at MCEER in Buffalo, New York.

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

MCEER researchers at Cornell University currently use Manifold GIS to implement Internet Map Server technology. Based on the success of the MCEER research, other MCEER researchers (ImageCat), and partner organizations (EERI) have begun using the same technology. Besides being a fully functional GIS in the classical sense, Manifold GIS offered MCEER researchers a number of other attractive benefits:

1. Of primary importance was the integration of an Internet Map Server within the Desktop GIS software, making development easier. Therefore, all GIS tasks developed within the desktop software was immediately available to the IMS.

2. Additionally, Manifold GIS has integrated the structured query language (SQL) within the GIS software, and also embeds spatial operators within SQL. Therefore, powerful GIS functions were easily developed by leveraging SQL and the spatial constructs.

3. Manifold GIS utilizes an enterprise server strategy that will allow for the development of multi-user system. Although not necessary for year 7 work, the enterprise server strategy will be important for year 8 activities when additional collaboration among researchers is envisioned.

4. Manifold GIS is fully integrated within the Microsoft software strategy, and allows integration with other third part Microsoft products.
5. Finally, Manifold GIS uses a Microsoft pricing strategy, allowing users to purchase the software for under $250. In addition, Manifold offers a liberal educational pricing system that will enable an unlimited number of collaborators at different universities to use the developed application.

These benefits will allow MCEER researchers to rapidly implement the entire Internet map server application (IMS) for acute care facilities (currently maintained at Cornell University) at the MCEER location in Buffalo, New York. The IMS application is further defined in the Progress to Date section of this proposal.

To accomplish this task, MCEER researchers at Cornell University will coordinate with IT staff at SUNY Buffalo in preparation of a site visit for implementation. The purpose of the site visit is to better understand the MCEER network environment and its potential to run the IMS applications. Based on the information gathered, we intend to make recommendations to the IT staff that increase the likelihood of a successful implementation. Upon conclusion of the preliminary discussions with IT staff, the Principal Investigator will perform the following activities at the MCEER facilities in Buffalo:

1. Install Manifold GIS software.
2. Install geocoding engine for nationwide address matching
3. Create the appropriate directory structure on the MCEER server.
4. Configure MCEER server for use with Microsoft IIS and .asp.
5. Load GIS data, borehole data, site plans, and imagery on the MCEER server.
6. Configure .asp pages to work within the MCEER server architecture, including modifications to existing code, set up of linkages to third party web servers, and implementation of scripts to automatically update dynamic data.
7. Configure data permissions to allow read and execute privileges for anonymous Internet users.
8. Perform acceptance testing of the application within the MCEER network environment.

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

This product is an alternative to existing procedures as it allows MCEER to directly store the information on acute care facilities on their own site. Currently the data is installed on an experimental server at Cornell University. This server will most likely become unavailable within the next year or two. Installing the application and data at MCEER will provide MCEER with greater autonomy in distributing the information to educators and researchers world-wide.

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.)

The entire Year 7 and Year 8 tasks were complete and are currently maintained on the
Cornell University experimental server. It is our intention to migrate the entire application over to the MCEER servers.

Progress to date has involved collecting geotechnical information at OSHPD for over 150 hospital sites. Hardcopy records at OSHPD were copied and information was manually entered into spreadsheets for storage. A database design of structural and geotechnical information was created, and spreadsheet data was imported into the databases. Geographical locations described in the hardcopy materials (latitude and longitude values, street addresses) were geocoded to create map information of acute care facilities. In addition, geographic information related to landslides, liquefaction potential, roads, political boundaries, and other databases were downloaded from numerous sources, and integrated into a GIS. Integration of the data often required coordinate re-projection, merging of adjacent files, and general topological correction of data. Upon completion of the data integration, basic maps and queries were developed within GIS software.

The GIS application was then integrated into an Internet based GIS. Initially, two different software platforms were used to create identical systems, and then compared. Researchers found that the ease of use within Manifold allowed for more rapid development. Therefore, additional features were added to the IMS site to expand the query and display capabilities.

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

This work supports the strategic plan by providing an Internet-oriented geotechnical database, useful for assessing liquefaction potential, liquefaction-induced ground deformation, seismic site response, landslide activity, water levels, soil strata, liquefiable layers, etc. The database provides valuable overarching information for both the Lifelines and Hospital Thrusts. Moreover, the GIS developed for the acute care facilities will provide the basis for evaluating individual sites as well as the regional hospital systems and its interactions with transportation, water supply, and electric power systems.

Finally, this project will support the overall overarching task of integration of lifeline systems.

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

The results of the survey and other aspects of the study will be of interest to PIs doing structural research in Thrust 2, in addition to those PIs doing research in Thrust 3, Response.

Possible Technical Challenges:

Because we have already implemented this application at Cornell University, we anticipate very few technical challenges. However, the primary technical challenges for this project relate to the current computer architecture at MCEER. The application must be run in a Microsoft environment with Microsoft Internet Information Services (IIS). Further, the server must support Active Server Pages (.asp). Also, Manifold must be loaded on a properly configured machine with sufficient random access memory (1 GB minimum), and processing power (2.4
Ghz. Minimum). Also, while most technical challenges can be overcome by applying massive amounts of manpower to the project, we intend to coordinate our efforts with the MCEER IT staff to ensure an easier transition of the application.

### Anticipated Outcomes and deliverables:

(Also indicate those of particular benefit to IAB members and other end users.)

A working IMS application for MCEER that includes acute care facility application to perform the following activities:

- Statistical assessment of geotechnical issues at hospital sites to support decisions regarding MCEER geotechnical research.
- Comprehensive geotechnical GIS database that is accessible through the Internet to multiple users.
- Overarching capability to query and analyze geotechnical data throughout the Los Angeles region.

### Potential end-users beyond academic community:

(IAB members and others.)

Geotechnical engineers, structural engineers, building officials, hospital regulators (including OSHPD), and hospital community (including owners, administrators, and facilities managers). Lifeline managers and engineers for water supply, transportation and electric power systems.

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

- Web-based geotechnical database accessible by multiple users. The intended audience here includes lifeline agencies, government, planners, engineers, and universities.

- Repository for geographic data to support research, undergraduate and graduate courses, to be maintained by MCEER for long term viability. The application will allow student researcher access to the GIS data, operations, and analyses from their dormitories or other remote locations via the Internet.

### Project Schedule and Expected Milestones for the Project:

(Milestones and estimated time of achievement; e.g., Fall, Spring, Summer.)

**Fall 05** – Prepare data sets to minimize difficulties in transferring the application to MCEER in Buffalo. Coordinate site and system requirements with MCEER IT staff.

**Winter/Spring 06** – Site visit to MCEER in Buffalo to install software, application, and
ancillary data. The installation will include acceptance testing, and any necessary modifications to the application. Installation of remote access software to allow modification to application by MCEER researchers at Cornell University.

**Summer 06** – Continued maintenance to insure proper functioning of the system.

**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.)*

AJ Lembo, Cornell University  
TD O’Rourke, Cornell University

**Possible Direction of Work in Subsequent Years:**
This work will allow MCEER to become the primary data holder for the IMS applications, data, and research results. Future applications can then be installed at MCEER, turning the website into a state-of-the-art IMS application.

**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.)*

While the site we developed was for acute care facilities, the many integrative technologies used in the application are easily adaptable for multi-hazard research. In fact, this current application was itself transformed into a multi-hazard application, focused on the Niigata earthquake and Indian Ocean Tsunami. Therefore, the technology that we install at MCEER will be capable of adaptation to other multi-hazard research.

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.*