INTEGRATING INFORMATION: BRIDGING THE GAP BETWEEN GEOGRAPHIC INFORMATION SYSTEMS AND BUILDING INFORMATION MODELING

Proposal to:

The Raymond A. Bowers Program for Excellence in Design and Construction of the Built Environment

Category I – Interdisciplinary Project Support 2008-2009

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INTRODUCTION:

Increasingly, graduates from *Landscape Architecture, Architectural Engineering, and Architecture* are challenged by the promise and demands of sustainable or 'green design'. And while guidelines are provided by the *Green Building Council*, *LEED*, and others, we recognize that thoughtful and successful sustainable design requires collaborative efforts that link the systems of buildings and built form to the living social and natural systems within which they are embedded. For decades, each of our disciplines have addressed this need; however, each have utilized independent computing platforms and/or programs to manage, analyze, model, and communicate quantitative information about embedded systems. Landscape architects, for example, first designed *Geographic Information Systems* so that their planning and site designs were embedded within layers of information about soil, vegetation, demographics, and transportation networks. Architects and architectural engineers rely increasingly on *Building Information Modeling* software for analogous tasks, but focused on rapid prototyping, analysis, and construction modeling. We are certain that the information within each of these 'systems' is compatible; however, it is not traditionally linked within a single relational database so that all of us can effectively integrate our ideas in a common platform. Attempts by CAD have been useful for collaborative drafting, however to truly integrate systems information, we must bridge the gap between *BIM* and *GIS*, thereby constructing a 3-D visual relational database.

This proposal therefore is a hybrid research and teaching proposal focused on the development of an experimental visual relational database linking building information with geospatial data for the Centre Region, specifically West Campus and portions of State College Borough. We chose this area to begin this process because:

1. High quality geospatial data is readily available;
2. The location allows us to enhance our data through field collection if necessary; and,
3. The location offers familiarity and transferability to all of our curricula.

We are proposing to use Bowers support to build the relational database this fall, publish the model via a universal platform such as Google Earth in December/January, and use the model as part of a collaborative methods/studio course in the spring semester.

SPECIFIC PROJECT TASKS:

The objectives for this collaborative project are:

1. **Develop a Core Geospatial Database within GIS. Each of the specific tasks below are largely related to data transfer, organization, and management. Most of the data needed has been organized by Murtha for the County.**
    a. **Develop a core topographic database of the State College Borough/West Campus Region.** Using local LIDAR (Light Detection and Ranging) data as a base we will construct a detailed topographic database for the State College borough. LIDAR data provides highly accurate and well categorized topographic and reflectance information, allowing

researchers to develop a detailed 3-D model of the earth's surface as well as the natural and cultural features above the surface. Figure 1 illustrates a categorized perspective image of a residential development with tree lined streets in the State College region.

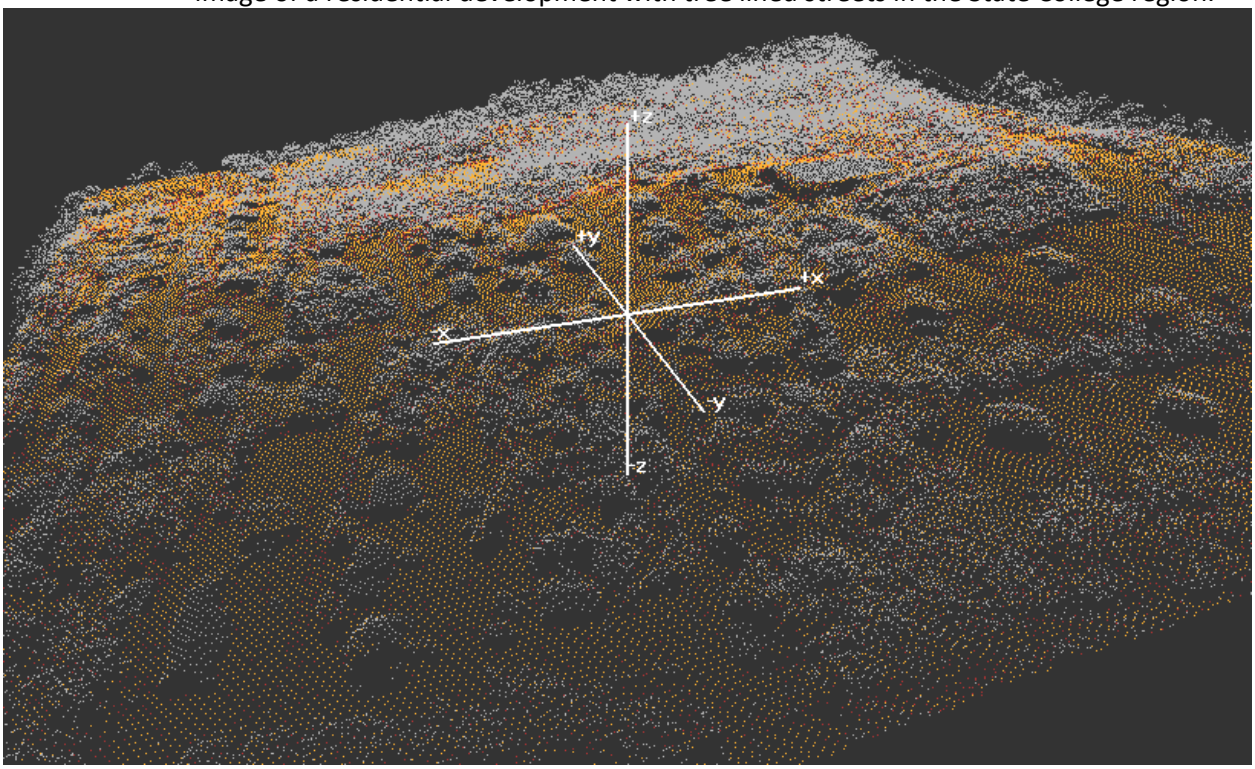


Figure 1. LIDAR image of State College Region (Murtha 2008).

b. **Develop a core set of ecological data for the State College Borough/West Campus Region.** This database will include core variables such as soil type (and DCNR soil analyses), Landcover, Vegetative Cover, etc.

c. **Develop a core set of local cultural systems data for State College Borough/West Campus.** This database will include transportation networks, parcels, zoning information, and building footprints.

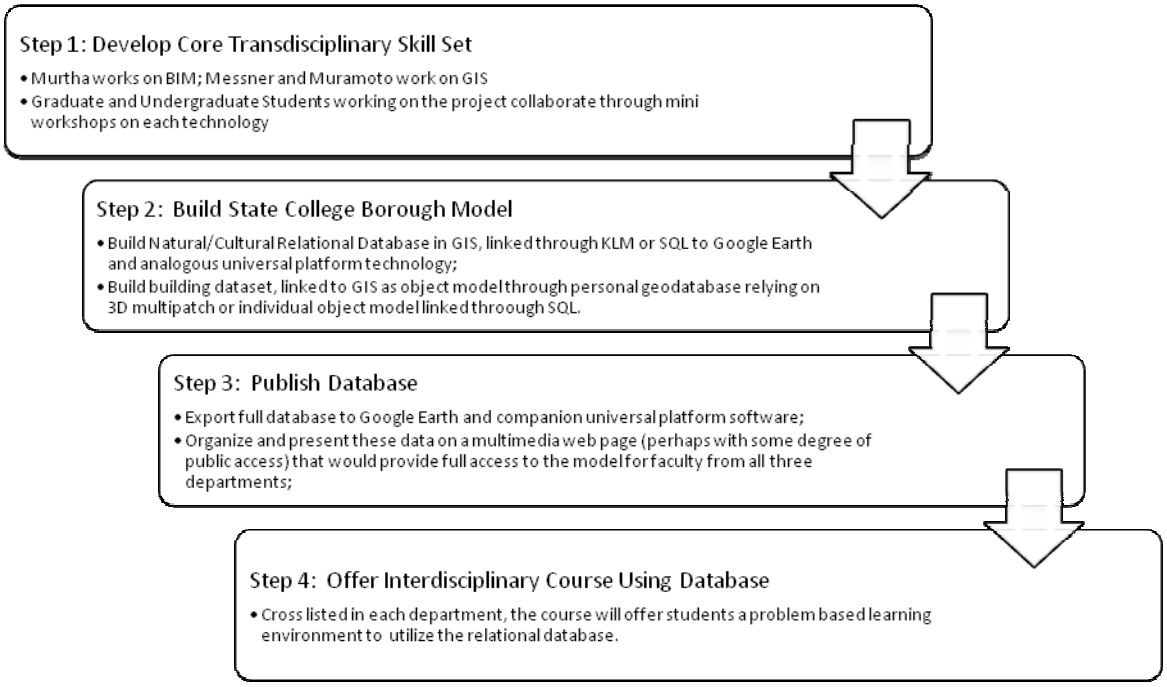
d. **Develop a core set of high resolution aerial photos within the database.** This simply involves mosaic-ing several recently acquired digital images from PASDA.

2. **Integrate these data with 3-D detailed building information.**
   a. **Develop individual models of the Borough/West Campus Buildings.** Primarily our efforts will target the borough area between Beaver Avenue and College Avenue from University to Corl Street and West Campus, including the newly sold OW Houts site. It is possible that we will expand this focus, time permitting.

3. **Publish these data as part of a partially public access database via the web.** Using a variety of universal program platforms, such as KLM in Google Earth, we will publish the data with the expectation that other faculty will utilize it as part of their studio and implementation courses.

4. **Utilize these data within a collaborative methods course or studio during the spring semester.** Depending on the complexity of the database, we will offer the use of this database within a design studio (cross-listed by each department) or within a technical methods course. We are purposefully leaving this open-ended in order to determine the complexity of the model as we construct it.

Stepwise Tasks:



Explanation of the project's strategy to help students better understand effective interdisciplinary collaboration.

Interdisciplinary collaboration is critical to this proposal. First and foremost our project emphasizes the development of a universal platform relying on independent skills derived from each discipline's information modeling applications. We have purposefully scheduled the project tasks so that faculty will first establish the interdisciplinary collaborative skill sets in the fall; and apply those skills in the spring course. For example, Murtha, a GIS specialist, will develop a core understanding of the information design and structure of *BIM*, guided by Messner. Messner and Muramoto, in turn will develop a core understanding of GIS during the fall semester, guided by Murtha. Graduate students and undergraduates participating in the fall build project will also develop these core skills. In the spring semester, these skills will then be transferred to students during the methods course or design studio. Basically, the faculty collaborators will use their research experience in the fall to develop an

introductory set of technology skills to transfer to students in the collaborative course in the spring. Murtha will organize the spring course relying on projected teaching assignments.

The collaborative course will be the proving ground for students to best understand interdisciplinary collaboration. First, it will allow students to gain familiarity with the software employed by the varying disciplines and to gain experience in how the project process shifts to integrate the design processes between the varying disciplines.

Project Schedule:

Activities for the proposed research/education proposal will primarily occur during the Fall Semester of 2008 and the Spring Semester of 2009. Murtha and Messner will begin working on the model building this summer, but the funding requested here specifically relates to the proposed activities included below.

Summer 2008 (June – August)

1. **Murtha and Messner organize and assess current database for Borough and West Campus;**
2. **For missing and incomplete data, we will request updated data.**

Fall 2008 (August – December 2008)

1. **Update ICon Lab and IEL with current versions of BIM and GIS software for universal platform access;**
2. **Murtha, Muramoto, and Messner develop core skills in transdisciplinary technologies;**
3. **Graduate and Undergraduate students begin compiling a GIS database for the target area of State College Borough; Students also acquire information to model all or a subset of buildings in the target area;**
4. **Murtha, Muramoto, and Messner prepare and submit NSF-CNH grant by November 18, 2008;**
5. **By December 1, complete model exported to universal platform such as Google Earth;**
6. **Model is tested and published to multi-media web page by January 10, 2009.**

Spring 2009 (January – May 2009)

1. **Transdiciplinary Course offered, guided by Murtha;**
2. **Database is used as part of problem based course;**
3. **Final Report prepared detailing the process and assessment of work accomplished.**

Deliverables:

The primary deliverable for this effort is a 3-D visual relational database of a portion of State College Borough and West Campus that links geospatial (environmental and cultural) data with building information models for minimally the area defined by University Drive, Beaver Avenue, College Avenue

and Corl Street in addition to West Campus. This database will be accessible via the web and offered in several universal computing platforms, including but not limited to Google Earth/KLM. This database will be valuable for future studio based design courses throughout the departments.

In addition to this primary deliverable, there are a series of added deliverables directly linked to the construction of the database, including:

1. A website housing the database and describing the process to construct it;
2. A spring course topically focused on applying the database to a real world design/engineering problem, e.g. the Borough's West End Redevelopment Zone/West Campus;
3. A white paper/monograph will be authored to document our process; and,
4. Peer-reviewed journal publications in our home disciplines and conference papers are critical to transfer the information derived from this project.

Outreach:

As a part of this project, we will work with the Borough of State College to obtain needed data files and to provide support for data visualization that they may be beneficial to their planning department. The project team has met with the Borough on three occasions to discuss this educational and research initiative, and they have expressed a deep interest in assisting with the development effort. This outreach and interaction with the Borough could provide many future side benefits to the departments regarding additional participation in courses and interest in providing data needed to provide valuable real world studio projects. This will also be valuable in future proposals to NSF for illustrating Broader Impacts of our research and educational initiatives.

Conclusions:

If we, as architects, planners, engineers, and scientists are to face the challenges of effective sustainable design, we must bridge the gap between the systems of buildings with the natural and cultural systems within which they are embedded. While the majority of this challenge will be overcome by interdisciplinary collaboration, part of the challenge is to bridge the information divide between *BIM* and *GIS.* Our proposed research will link the systems of built form, with the cultural a natural systems by constructing a universal platform 3-D visual relational database of West Campus and portions of State College Borough. We will publish these data for use by all of our departments at the end of the fall semester and test the usefulness of these data in an interdisciplinary course in the spring semester. Using our experience beginning this summer/fall we will expand our research to the broader watershed and region, with multi-year NSF support.