Specification and Work Plan for
Version 2 of the Masonry Unit Database

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Background

The Masonry Unit Database or MUD is a data model and allied applications that provide the design and construction community with industry-standard models for masonry units. The motivation and background research for the MUD was completed at Georgia Tech during Phase II of the Building Information Modeling for Masonry Initiative (BIM-M). In Phase III of the initiative, Cad Technology Center (CTC) was selected as the commercialization partner for the MUD. Russell Gentry at Georgia Tech provided technical oversight of the project; his participation in the project was supported by a grant from the Charles Pankow Foundation. Jeff Elder of Interstate Brick was the project manager for BIM-M. As of this writing, CTC has substantially completed their work for Version 1 of the MUD (V1 MUD), which was released on 30 June 2017.

The primary components of MUD V1 include: (1) a relational database schema, adapted from Georgia Tech and implemented by CTC, to store masonry unit information, (2) masonry unit input web pages, which act as a back-end for entering masonry units into the MUD, (3) user-facing web pages that provide access to the MUD, including the browsing of masonry units and the downloading of BIM and CAD files[1], (4) a Revit application that generates masonry units from parameters stored in the MUD and that allow for direct import of masonry units into Revit as families and (5) a set of generic masonry units, from the concrete masonry, structural clay masonry and veneer clay masonry families, populated into the database. The elements of the MUD and their relationships are shown in Figure 1.
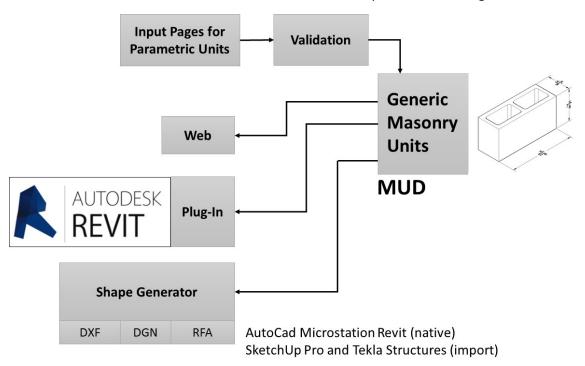

Figure 1 - Elements and Organization of the Masonry Unit Database.

Version 1 of the MUD includes a selection of masonry units from the concrete masonry, structural clay masonry and veneer clay masonry industries. These elements represent the largest industry segments in

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[1] The MUD web pages can be found at www.muddb.org

the masonry industry. More than 100 unique units have been identified for inclusion in MUD Version 1. Figure 2 depicts the 8 inch concrete masonry units (CMU) units slated for inclusion in the MUD.
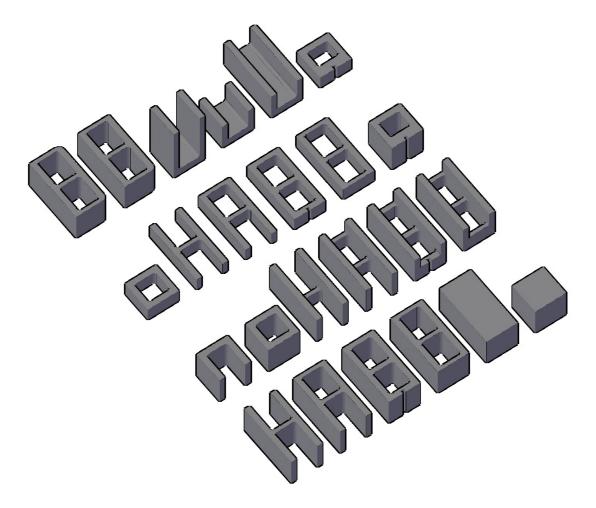

Figure 2 - *8 inch concrete masonry units identified by NCMA for inclusion in the MUD.*

The web portal for the MUD has been developed to facilitate user access to the database; the portal groups masonry units by material type and size (see Figure 3). The organization of masonry units within the web portal are show in Figure 4. In future versions, adhered veneers, cast and natural stone, tile and thin brick will be added to the MUD.
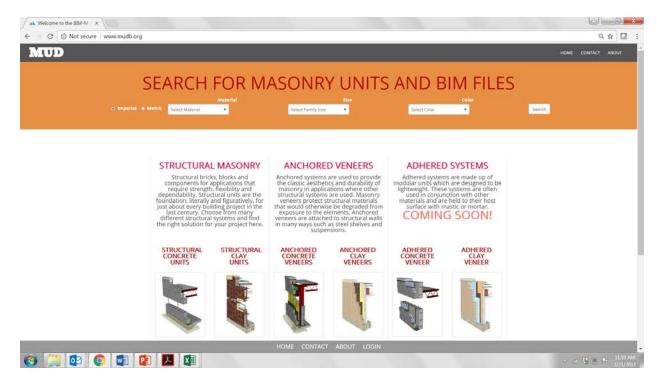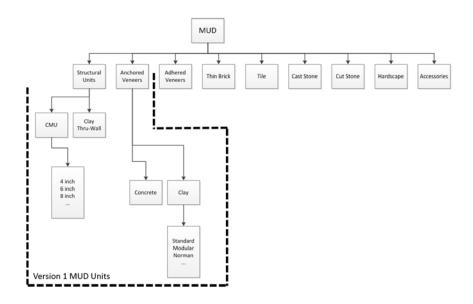
Figure 3 - MUD web portal home page.

Figure 4 - Organization of Masonry Units in the MUD.

Masonry units stored in the MUD can be parametric or custom. Parametric units have relatively regular geometry, and are generated from a set of shape parameters, which are stored in the geometry table in the database. The AISC database of steel shapes contains only parametric shapes, for example. Custom masonry units contain geometric features that are unique, and difficult to represent parametrically.

These units are explicitly modeled in CAD and BIM applications, and then stored in the database for download. Version 1 of the MUD contains parametric units only. Version 2 of the MUD will be extended to include custom units.

Masonry units stored in the MUD can be generic or specific. Generic units are industry standard units that are sold by more than one manufacturer. They do not carry a SKU (stock keeping unit or order code). Specific units are made by a manufacturer. They represent a masonry unit that can be purchased. In general, multiple specific units will map to a single generic unit. Version 1 of the MUD contains generic units only. It is anticipated that Version 3 of the MUD will contain specific units.

The masonry units can be accessed through the MUD web portal (Figure 3). In addition, a Revit plug-in has been developed to allow for direct access to the MUD through Revit (Figure 5). The plug-in generates the units parametrically and embeds them in the Revit model as Revit Families. The Revit plug-in accesses the MUD database stored on CTC servers, ensuring that the most current version of the data is embedded into Revit.
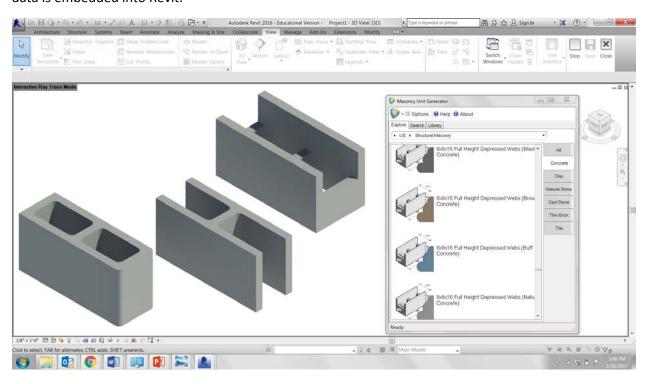

Figure 5 - *Access to the MUD using the Revit Plug-In.*

This document outlines the specification and work plan for the next version of the MUD (MUD V2) to improve the functionality of the MUD, to add additional units to the MUD, and to prepare for the long-term development and maintenance of the MUD by the masonry industry once the BIM-M Initiative sunsets. A number of the proposed additions to the MUD were anticipated in the original MUD RFP and industry response letter (authored by Prof. Gentry and released by BIM-M in 30 January 2016 and 15 February 2016 respectively). Additional modifications have been proposed by industry stakeholders as part of our outreach, through developer's workshops and at the most recent BIM-M Symposium, held May 4-5 2017 in Addison, Illinois.

This document does not propose a fixed schedule or fee structure for the implementation of MUD V2. It is anticipated that the cost and schedule for the next version of the MUD will be negotiated by BIM-M and CTC.

Version 2 Revisions and Updates

This section of the document discusses briefly the additions that are anticipated in Version 2 of the MUD. These come from discussions with BIM-M stakeholders, from Jeff Elder (MUD project manager for BIM-M), and from conversations with Wyatt Crane of CTC.

1.   Feedback from BIM-M Stakeholders

The MUD is being released on a limited basis on 30 June 2017, to meet the commitment that we made to our stakeholders at the May BIM-M Symposium. The MUD has not undergone significant user testing and it is inevitable that MUD usage will uncover some bugs and inconsistencies. In addition, there are a number of concrete masonry units that need to be added to the MUD – as part of Version 1. We therefore anticipate that users will identify problems with the MUD and that we will need to triage bug reports and prioritize request for bug fixes and upgrades, based on user feedback. At this time we have not identified the person or persons who will receive feedback from MUD usage. Prof. Gentry recommends that "contact" emails from the MUD web pages and the Revit plug-in go to a team, including Jeff Elder, Wyatt Crane, and Prof. Gentry. These will be assigned one of three priorities: (1) V2 bug fix required, (2) V2 upgrade based on cost/schedule impacts, and (3) future functionality.

We recommend a formal review by a small group of colleagues, including NCMA and WSCPA, members of the TMS BIM Committee, Integrus Architects and industry software collaborators.

2.   Implement Custom Units

In MUD V1 all masonry units are generic and parametric. By "generic", we mean that the units are not associated with a given manufacturer, but rather represent the geometry and material properties available from a number of manufacturers. By "parametric" we mean that the geometry of the units is simple enough to be generated from a table of the unit's geometric parameters (width, height, length, core dimensions etc.). The AISC database of hot-rolled steel shapes is parametric, for example.

We recognize that many masonry units contain complex geometry that cannot be represented by simple parameters. These units will need to be modeled independently in the native software environments (Revit, AutoCad, SketchUp . . .) and stored in the database as binary files for retrieval. We refer to these as "custom" masonry units to differentiate them from parametric units. Note that custom masonry units may still be generic, meaning that the units are available from more than one supplier. Figure 6 shows examples of custom masonry units.

In MUD V2 we will extend the data schema and populate the database with a number of custom masonry units – primarily from the manufactured stone and dimensioned granite stone masonry industries. We will also need to produce a small specification for the modeling of custom units, so that all of the custom units contained in the MUD are consistent and will interact properly with other parametric and custom units in the database. So, for example, all units need to be drawn with the same layer/level nomenclature, in the same coordinate system, and with consistent insertion points.
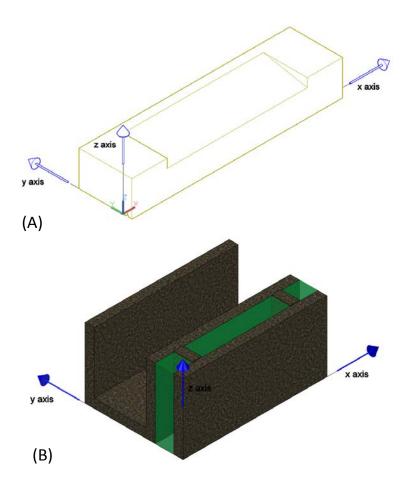
Figure 6 - Examples of Custom Masonry Units: (A) Cast stone lug sill and (B) CMU with integral insulation.

3. Parametric Units with Variable Parameters

One potential addition to the MUD is the ability to include parametric units with one or more parameters identified as variable. So, for example, if a cast-stone lintel has a given cross-section but is available in any length from 2 to 8 feet, that single parameter (length) can be identified as variable in the database. Though such flexibility could be very powerful, it also could be quite complex to implement. To limit the complexity, we propose to restrict masonry units to 3 variable parameters. We could then add a parameter table for VP1, VP2 and VP3 giving the range over which these three parameters could vary, and perhaps the increment of this variation. This feature could also prove useful for materials that are of rather simple geometry but are made to size (variable length, width and height).

We feel that this is a low priority update to the MUD. Therefore BIM-M and CTC should discuss the impact of the variable parametric unit on MUD V2 cost and schedule, to determine whether to move forward with this functionality.

4. MUD Export to CadBlox and Tradesmen's

Prior feedback from stakeholders has identified the need for the MUD to be available as an export that can be attached by other software. This export requires that the database be version controlled and be

exported in a negotiated format. In MUD V2 we will work with primary stakeholders Tradesmen's and CadBlox to determine whether and how such an export will take place.

5.   MUD Expert to Excel Exhibit

In the original RFP, it was suggested the so-called Excel Exhibit could be used as a means of populating the database. In MUD V1 this proved to be difficult, as it was not feasible to validate the set of parameters imported from the spreadsheet. Instead, an input interface has been developed to validate the input, field by field, as the units are input. Nevertheless, the Excel format for the database is quite useful for review and validation of the information in the database. If possible, we would like to include an Excel export in MUD V2.

6.   Updates to Unit Input Methods and Preview

The current masonry unit input module is not intuitive and it is difficult to validate whether geometry input into the database creates a valid masonry unit. At the current time, the Revit plug-in must be executed on the data and the subsequent unit dimensioned to check whether it the unit is correct. In MUD V2, a preview application will be developed to work with the input module. The input module will also be updated so that masonry units in the database can be copied and updated.

The input module will also need to be updated to work with custom masonry units. As part of this revision, we also need to standardize the process by which a masonry unit is reviewed and validated for inclusion in the MUD. We also need to standardize the production of the thumbnail images (currently axonometric views of the units, encoded as PNG files, 300 pixels in X and Y, with overall dimensions noted).

7.   Updates to Revit Plug-In

We anticipate minor updates to the Revit Plug-In in MUD V2. For example, a better functioning installation routine for the plug-in is needed. In addition, the plug-in may need to be updated for use with custom masonry units.

8.   Addition of Masonry Units from the Manufactured Stone and Architectural Granite Industries

We have commitments from the manufactured stone industry (through NCMA) and the dimensioned granite stone industry for Version 2 of the MUD. The International Masonry Institute (IMI) will support the addition of tile into the MUD. Part of our work will be to enter a range of these units into the MUD – and more importantly, to extend the schema as necessary to support these unit types. At this point the MUD has been envisioned to represent units with a reproducible and exact geometry. Both of these new masonry types include units with variable geometry. Some manufactured stone comes in various sizes to support random or coursed ashlar masonry. It is not yet clear how we will represent such units geometrically in the MUD. We need to meet with the stakeholders in these industries to better understand their needs.

9.   Masonry Naming Convention

BIM-M has had as a goal the development of standard, human-readable names for masonry units. This is specific concern in the concrete masonry, veneer clay masonry and structural clay masonry segments – as these three segments encompass more than one-half of the masonry units sold in North America. Unit names input into the database so far follow general industry practice, but have not been "approved" through a standard practice. As part of MUD V2, we propose a small working group to

review the names of units in the database and to update them as needed to fit industry best practices. This task must be completed before the MUD gains widespread use. We propose the following working group for this purpose:

- Jeff Elder, Interstate Brick
- Kurt Siggard, Concrete Masonry Association of California and Nevada
- Tom Cuneio, CadBlox
- Nick Lang, NCMA
- Scott Conwell, IMI
- Russell Gentry, Georgia Tech, ex officio

This need not be a time consuming activity. Rather we propose a one-time meeting of the working group (electronically) with a ballot process that quickly selects names for units that are input into the database, based on the naming conventions developed as part of the initial meeting.

10. Colors and Textures

Colors and textures of masonry units has only been partially implemented in MUD V1. The proposed schema for the MUD included the potential to store bitmapped images of real masonry surfaces, so that colors and textures could be mapped onto the masonry units when they were viewed and downloaded. One of the difficulties of this approach is that it is platform dependent, that is, AutoCad, Revit and other applications handle colors and textures differently. We need to clarify why and how we are displaying colors and textures in the MUD. This should be resolved as part of MUD V2, in preparation for the potential to host manufacturer-specific units in the MUD in Version 3.

Summary

MUD V1 has been released as of this writing. We anticipate that there will be errors identified and improvements needed as the first version of the software and database are used. The additional features discussed in this report and proposed for V2 will also need to be considered as cost and schedule are determined.   At the most recent BIM-M Executive Board meeting, the board expressed an interest in moving ahead with MUD V2 through a negotiation with CTC – and not through a formal RFP process open to multiple bidders. It is anticipated that Prof. Gentry and Georgia Tech will continue to act as technical consultants on the development of the MUD.

Acknowledgements