

## Social Involvement to Empower a Better BIM Content Library

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### ABSTRACT

A BIM content library organizes Building Object Models (BOMs) in a structured way for easy access, exploration, management, search and visualization. It could be a comprehensive library to cover everything in the construction industry or a corporate website that just hosts models of one single manufacturer's products. This paper proposed an approach of using social involvement to improve the performance of BIM content libraries. Four major problems of existing libraries were discussed. They are the lack of content, difficulty of assessing model quality, no commercial data, and no support to customized libraries. Proposed social involvement approaches include user upload, BOM marketplace, social rating/comment/vote, manufacturer-specific database, cloud storage, and social tags. This paper presents a framework of using social involvement, and a prototype application is required as the future work for the purpose of validation.

### INTRODUCTION

The Architecture, Engineering, Construction and Facility Management (AEC/FM) industry has been seeing the boom of the application of Building Information Modeling (BIM) since the new century. A survey conducted by McGraw-Hill Construction (Jones and Bernstein 2012) indicates that the industry-wide adoption of BIM in 2012 is 71% in North America, compared to 28% in 2007. A Building Object Model (BOM) is the digital model of a building component. As the carrier of those geometric and analytical data, BOMs are data-rich and play an essential role in supporting BIM applications.

There are two types of BOMs – generic BOMs and manufacture-specific BOMs. BOMs incorporated in BIM authoring tools, such as Autodesk Revit, Graphisoft ArchiCAD, and Bentley AECOSim Building Designer, are typically generic BOMs which combine fixed and parametric geometry. Those generic BOMs represent the consensus of the industry about typical building component types (Eastman *et al.* 2011), for example, a single door has only one door leaf and a 900x2100 single door has a fixed height of 2100 mm and a fixed width of 900 mm

(other dimensions could be customized in an instance). A common point for all generic BOMs is that they do not include much manufacture-specific information. Still using the door in Revit as an example, it incorporates some identity data such as *Manufacturer, Model, Description, URL, Cost, and OmniClass Code*, as well as limited analytical data such as *Heat Transfer Coefficient, Solar Heat Gain Coefficient, Thermal Resistance*, etc. However, those parameters are optional in Revit and it is designer's responsibility to populate them for two possible reasons: to support a particular engineering analysis such as the assessment of energy use when key parameters of selected products are known, or, to specify the final constructed or purchased products and serve as a guide for constructing or selecting the physical object in reality. For a given building product, all physical parameters are fixed and commercial parameters may not be fixed but can be determined (Fisher and Struik 1974), for example, the price or stock status at a certain moment. A manufacturer-specific BOM is the digital model of a particular building product and embeds as much physical and commercial information as possible.

Manufacturer-specific BOMs are normally organized by BIM content libraries. BIM authoring tools take a lot of efforts to improve their generic BOMs to offer a great flexibility to designers and do not include manufacturer-specific BOMs because there are too many manufacturer-specific BOMs to be included. Based on the data published by Reed Construction Data, as of December 18, 2013, there are 12,265 building product manufacturers in its database, and each manufacturer produces several to several hundred building products. A BIM content library refers a system that organizes a set of BOMs in a structured approach to provide easy access, exploration, management, search, and visualization of models. BIM content libraries provide designers with a large number available design options, mainly manufacturer-specific BOMs and some generic BOMs. If BOMs in a library are authored and maintained by their manufacturers, they have the most accurate and up-to-date information. Maintaining a manufacturer-specific BOM also support the reuse of product information. Designers of different projects using the same building product can use the same BOM instead of respectively creating a generic object in BIM authoring tools then specifying its properties based on the product catalog.

## PROBLEM STATEMENT

**Lack of content.** The first challenge a BIM content library has to face is the number of BOMs. A good quantity of available models is the cornerstone to support the usefulness of a BIM content library. Some libraries aim to cover everything in the AEC/FM industry with multiple BIM formats, for example, BIM Stop and National BIM Library have a comprehensive collection of object models for all popular BIM authoring tools. Some libraries are also comprehensive in terms of their coverage but only focus on one specific format, for example, Revit City is a library that only provides Revit models. Manufacturer-maintained libraries normally target on specific domains, for example, Andersen Windows and Doors have BIM models of most of their products, which are mainly windows and doors, available on their website. It is important a BIM content library should have a reasonable number of models in covered areas, otherwise its usefulness is limited.

After investigating major BIM content libraries, it was found that there is a lack of enough content in most libraries. Table 1 lists most popular libraries currently available and it was found that only Trimble 3D Warehouse (formerly Google 3D Warehouse) has more than 100 thousand models and other libraries usually have few thousands to tens of thousands models. However, when taking a closer look at Trimble 3D Warehouse, one can find that most models are not for building design and construction but are furniture, vehicles, household items, etc. As such, there is a lack of model content in each category, compared to the huge number of manufactures.

**Table 1. Existing BIM Content Libraries**

Libraries	Number of Categories	Number of Models	User Upload	Social Rating
Autodesk Seek	24	14,379	Yes	No
Revit City	285	14,625	Yes	Yes
BIMStore	32	≈3,000	Yes	Yes
Arcat	16	≈7,000	Yes	No
BIMobject	36	2826	Yes	No
Trimble 3D Warehouse	N/A	≈103,000	Yes	No
Smart BIM Library	24	≈77,000	Yes	No
National BIM Library	174	≈5,000	No	No
BIM Stop	48	≈2,800	Yes	Yes
Sweets BIM Collection	90	≈6,000	Yes	No

**Not easy to assess the quality of BOMs.** It may be easy to assess the quality of an object before downloading in other types of content libraries, for example, people can listen to a section of a song, view a picture or a part of a video clip, or read some pages of a document to make sure it fits their needs. However, this is not the case for BOMs. A designer normally assess the suitability of a model first by reading its descriptions and then have to download it and import it into a desired BIM application to test its quality. This is due to the complicated specifications and behaviors embedded in models. For example, a window in Revit has to be hosted in a wall but this kind of behavior will not be verified by just looking at the screenshot of a 3D model and reading its specifications.

Some BOM libraries allow users to rate models (see Table 1 for examples). Social rating is a good approach to give an overall evaluation of the quality of a model. However, a simple rating is not enough to provide a good reference in the full spectrum of a model. For example, a BOM may receive a high rating from some architects because of its elaborated structure but it actually lacks values of some key parameters. An energy analyst may be disappointed after downloading this model based on its high rating and then finding that it is useless in energy study.

**No commercial data.** After investigating all popular BIM content libraries, it was found that the only commercial-related information incorporated in existing BOMs is

the name of their manufacturers. There is a lack of integration between a product's commercial data and its digital model. The main reason is that most commercial data are dynamic and could be changed at any time throughout the life cycle of a product. For example, the price of a particular door may be different between the time of design and the time of procurement. Another example is that a type of window may be in stock when a cost engineer quotes the price but out of stock by the time the contractor wants to place an order.

**Not customized libraries.** There are mainly four types of navigation systems to browse BOMs in popular BIM content libraries. As summarized in Table 2, the first type of navigation is by standard classification systems such as CSI MasterFormat<sup>TM</sup> or OmniClass<sup>TM</sup> (ICBO 1997). The second one is by object systems in a particular software application such as Revit. The third one is by manufacturers. The last one is by user tags or keywords. User tag is the only way one can find a model in Trimble 3D Warehouse by tag/keyword search because it has too many models. However, this search-only method is not efficient in quickly finding a desired model.

Due to the fast adoption of BIM, more and more BIM users, especially designers, have a need to organize BOMs in their own way. First, their favorite BOMs may be from several online libraries, and they have to download them separately and store them in their personal workstations according to a hierarchical folder structure. This needs a lot of efforts and people may get lost in finding a particular model if the folder structure is not well organized. Second, organizing BOM content in a local computer does not support on-demand access if a user works at multiple locations. The industry needs a BIM content library that supports personalized organization of a user's favorite models.

**Table 2. Navigation Methods**

<b>Libraries</b>	<b>Standard Classification</b>	<b>Software Application</b>	<b>Manufacturer</b>	<b>User Tag</b>
Autodesk Seek		√		
Revit City	√	√		
BIMStore		√	√	
Arcat	√		√	
BIMobject			√	
Trimble 3D Warehouse				√
Smart BIM Library		√	√	
National BIM Library		√	√	
BIM Stop		√	√	
Sweets BIM Collection	√		√	

## SCOPE

This paper discusses potential improvement of BIM content libraries that can be achieved by employing social involvement. The concept of social web has been changing the ecology of Internet since Facebook and Youtube, but the construction

industry has not seen much integration of social involvement with BIM content libraries. Most popular BOM libraries are still traditional file organizers which are moved to online spaces compared to the old days when designers manage their 2D symbols and blocks for CAD applications. There may be many other aspects where BIM content libraries could be improved by different approaches, for example what properties a BOM should have or the interoperability of a BOM for different BIM applications. However, they are out of the scope of this paper.

## **SOCIAL INVOLVEMENT**

A social web is an ecosystem of participation, where value is generated from the aggregation of many individual user contributions (Zhang 2009). Tim O'Reilly (2007), who described well the architecture of social web systems, indicates that the primary driver of value is user participation. This section discusses how social involvement will potentially solve the issues mentioned earlier.

**User upload/contribution.** The first user involvement for a BIM content library is making it possible for a user to share BOMs with the community. It can be concluded from Table 1 that most popular libraries encourage user contribution by uploading models, either created by users or their collections. Libraries without upload function are normally proprietary libraries such as manufacturer-maintained libraries that only host product models of selected manufacturers. User upload is the most direct and effective way to quickly populate content for most public libraries, otherwise the number of available models in each category will be very limited because it is hard for the management team of a comprehensive library to post enough resources. There should be a good mechanism to ensure that the content uploaded by users go to the right category, especially there are hundreds sub categories when using MasterFormat or OmniClass as an organizing structure.

**BOM marketplace.** Table 1 also points out that user upload is not the sovereign remedy for the lack of content, because, even by supporting user upload, there are still not many models in some libraries. It partially reflects that managing BOM libraries is a relatively young market and all libraries need time to grow up. However, people should also ponder over a better approach in this market. After investigating the success of Apple App Store and its followers such as Android Market and Windows Marketplace, the conclusion is that a key reason that Apple iPhone beat the once-leader Nokia cellphones is the Apple App Store. It provides with iPhone users with tons of applications that meet a huge variety of needs either for work or for entertainment. The Apple App Store launched in July 2008 and by July 2009 it has more than 65,000 apps (Muchmore 2011). The number of apps is quickly growing and by June 2013 it has about 900,000 apps and this platform built many successful businesses. There is no doubt that Nokia is very strong in developing cellphone applications but, as a single company, it has no way to compete with a group of thousands developers/companies. The fundamental reason that people are willing to develop apps for Apple App Store is that it provides them an opportunity to make money by selling their apps.

This idea can be extended to a BOM marketplace, because any app store is actually a library of programs. After interviewing many designers, authors found that they all created many models during their work but they did not share them in public libraries because they will not get any rewards. In this case, our industry wastes a lot of efforts in creating a same model in many times. An ideal scenario is that one model is created and shared by an author and many other users collectively enrich this model during the long run for reuse. A BIM content library would attract many models if it employed the concept of BOM marketplace and people can sell their work. Of course, there are many associated issues to be carefully addressed, for example the copyright of a BOM.

**Social ratings, votes, and comments.** The most common social involvement methods in social websites are ratings, votes, and comments. Table 1 shows that not many BIM content libraries employ the approach of social rating and only very few of them allow user comments. It has been mentioned that the quality of a model is not easy to be assessed and, when user upload is allowed and the marketplace is established, it is more difficult to spot errors and mistakes in user contributed models due to the large amount.

Social rating has been adopted by few BIM content libraries but it is not able to fully reflect the details embedded in a model. Comments are more powerful in terms of discussing the features and behaviors of a model. A BOM library should incorporate a mini-forum for each model where users can post their comments and reply other comments. In this case, any mistakes and errors could be quickly caught by a user and announced in the comments. A well-organized library should also allow user to vote on the comments by two buttons – “Agree” and “Disagree”. A comment is more believable with more votes of “Agree”. In this case, if a model received a comment saying it has a particular defect and this comment is agreed by many users, then it may save another user’s time in downloading and testing it, if this defect indeed matters a lot for this user’s needs. This is called collective intelligence. Ideally, the library incorporates a function to inform the author of a model when this model receive comments, especially those indicating defects, so that the author may update the model with improvements. The drawback of social commenting is that comments are written in natural language and not structured, so that it is not easy to mine the semantics of those comments. Instead of using natural language processing approach, ontologies could be an innovative method to regulate and structure the comments (Zhang and Xing 2013).

Social ratings can also be applied to library users and be combined with social comments and votes to better indicate the overall quality of a model by its rating. In a mature virtual community, the opinion from an experienced member (or an expert) is more important and should be valued more than that of an unknown member. A library should foster a virtual community of expert users by calculating the ratings on users based on the quality of their comments and votes. Ratings, comments and votes of a model from a confirmed expert user deserve a higher weight than that of general users. This approach will make the ratings of models more accurate and reasonable.

**Manufacturer's access.** Most models in BIM content libraries are manufacturer-specific models, as such an easy access to maintain their models is of key importance for those manufacturers. User upload is a kind of access for manufacturers but it is not enough. For models of commercial products, the key point is the up-to-date information, including the physical model and commercial data. Each manufacturer should be able to create an account in the library and, with a specially designed interface, it is able to easily upload latest models in a batch and maintain commercial data through a database.

Model-related commercial data include price, warranty terms, stock status, shipping cost, UPC code, consumable parts, etc. Most of that information is dynamic and hard to be integrated into digital models. A solution proposed by this research is to have manufacturers update the commercial data of their models in a database and link those data to the actual model. In this way, designers can get the latest commercial data any time they browse models. Ideally, if a library's database is associated with a manufacturer's ERP system through a proper API, then updating information will be automatic. A simple add-on in BIM authoring applications will be able to check information update in real time after a BOM is selected and imported, by linking the BOM in a building model and the BOM in a library.

**Customized libraries.** Customized libraries could be realized by cloud storage and social tags. All library users, for example, designers or design firms, can have an account where they can organize models that they often use or they like in a location called favorite models. This concept is similar to cloud storage – the whole library is a public cloud where multiple customized personal clouds and corporate clouds share models without creating multiple copies. Models in customized libraries may or may not be shared in the public cloud, i.e. models uploaded by a user may only be linked to his/her favorite models but not to the public library. Social tags are also useful in labeling models with customized keywords to quickly search for desired models.

## CONCLUSION AND FUTURE WORK

This paper proposed an approach of using social involvement to improve the performance of BIM content libraries. Four major problems of existing libraries were discussed. They are the lack of content, difficulty of assessing model quality, no commercial data, and no support to customized libraries. Beside the function of user upload which is a method that is already employed by many libraries, the concept of BOM marketplace is a new way to attract more BOM content. Social ratings, comments, and votes about a model will be able to harvest collective intelligence to effectively detect any mistakes and errors in the model. Also, the ratings and votes on user comments will be able to foster a virtual community of model experts whose comments and ratings deserve more weight to quickly but more accurately assess the quality of models. A specially designed access for manufacturers allows dynamic update of physical and commercial data of models. Ideally this update could be automatic if the library database is linked with manufacturer's ERP system. Finally, cloud storage will help a BOM library establish customized libraries in both personal and corporate levels. Social tags can also support the concept of customized libraries.

The social involvement approaches proposed in this paper should be prototyped and examined to prove its validity. The research team will create a BIM content library supported by social involvement in a prototype application and then validate this framework by both qualitative and quantitative studies. Social involvement approaches are subject to adjustment based on the validation result.

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