Building Information Modeling

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Building Information Modeling (BIM) is the process of generating and managing building data during its life cycle[1]. Typically it uses three-dimensional, real-time, dynamic building modeling software to increase productivity in building design and construction.[2] The process produces the Building Information Model (also abbreviated BIM), which encompasses building geometry, spatial relationships, geographic information, and quantities and properties of building components.

Contents

Origins of BIM

Georgia Institute of Technology coined the term [3]. This theory is based on a view that the term **Building Information Model** is basically the same as **Building Product Model**, which Professor Eastman has used extensively in his book [4] and papers since the late 1970s. ('Product model' means 'data model' or 'information model' in engineering.)

Architect and Autodesk building industry strategist Phil Bernstein FAIA first used the actual term "building information modeling" and nicknamed it "BIM." Jerry Laiserin then helped popularize and standardize it [5] as a common name for the digital representation of the building process as then offered primarily by Bentley Systems, Autodesk and Graphisoft to facilitate exchange and interoperability of information in digital format. According to him[6] and others[7], the first implementation of BIM was under the **Virtual Building** concept by Graphisoft's ArchiCAD, in its debut in 1987.

Definition

Building information modeling covers geometry, spatial relationships, light analysis, geographic information, quantities and properties of building components (for example manufacturers' details). BIM can be used to

demonstrate the entire building life cycle, including the processes of construction and facility operation. Quantities and shared properties of materials can be extracted easily. Scopes of work can be isolated and defined. Systems, assemblies and sequences can be shown in a relative scale with the entire facility or group of facilities.

BIM can be seen as a companion to PLM as in the Product Development domain, since it goes beyond geometry and addresses issues such as Cost Management, Project Management and provides a way to work concurrent on most aspects of building life cycle processes.

BIM goes far beyond switching to a new software. It requires changes to the definition of traditional architectural phases and more data sharing than most architects and engineers are used to.

BIM is able to achieve such improvements by modeling representations of the actual parts and pieces being used to build a building. This is a substantial shift from the traditional computer aided drafting method of drawing with vector file-based lines that combine to represent objects.

The interoperability requirements of construction documents include the drawings, procurement details, environmental conditions, submittal processes and other specifications for building quality. It is anticipated by proponents that BIM can be utilized to bridge the information loss associated with handing a project from design team, to construction team and to building owner/operator, by allowing each group to add to and reference back to all information they acquire during their period of contribution to the BIM model. For example, a building owner may find evidence of a leak in his building. Rather than exploring the physical building, he may turn to his BIM and see that a water valve is located in the suspect location. He could also have in the model the specific valve size, manufacturer, part number, and any other information ever researched in the past, pending adequate computing power. Such problem was initially address by Leite et al. when developing a vulnerability representation of facility contents and threats for supporting the identification of vulnerabilities in building emergencies[8]

There have been attempts at creating a BIM for older, pre-existing facilities. They generally reference key metrics such as the Facility Condition Index, or FCI. The validity of these models will need to be monitored over time, because trying to model a building constructed in, say 1927, requires numerous assumptions about design standards, building codes, construction methods, materials, etc., and therefore is far more complex than building a BIM at time of initial design.

The American Institute of Architects has further defined BIM as "a model-based technology linked with a database of project information"[1], and this reflects the general reliance on database technology as the foundation. In the future, structured text documents such as specifications may be able to be searched and linked to regional, national, and international standards.

Modeling Guidelines

Modeling guidelines play a major role in effective information delivery from one system or user to another. Typical modeling guidelines define either a specific exchange file format or the file format handling capabilities of the recipient. Modeling guidelines also regulate the information content of the model.[9][10]

BIM in the UK

In the UK, CPIC (http://www.cpic.org.uk/en/) , responsible for providing best practice guidance on construction production information and formed by representatives of the major UK industry institutions, has proposed a

definition of Building Information Modelling (http://www.cpic.org.uk/en/current-projects/building-information-modelling.cfm) for adoption throughout the UK construction industry and has invited all UK industry parties to discuss it in order to ensure an agreed starting point. The proliferation of interpretations of the term currently hampers the adoption of a working method that will drastically improve the construction industry and the quality and sustainability of the deliveries from the design and construction team to clients.

BIM in the USA

Contractors

The Associated General Contractors and contracting firms also have developed a variety of working definition of BIM that describe it generally as "an object-oriented building development tool that utilizes 5-D modeling concepts, information technology and software interoperability to design, construct and operate a building project, as well as communicate its details."[*citation needed*]

Although the concept of BIM and relevant processes are being explored by contractors, architects and developers alike, the term itself is under debate[11], and it is yet to be seen whether it will win over alternatives, which include:

- Virtual Building Environment (VBE)
- Virtual Building
- Integrated Practice
- Virtual Design and Construction (VDC)

BIM is often associated with IFCs (Industry Foundation Classes) and aecXML, which are data structures for representing information used in BIM. IFCs is developed by buildingSMART (International Alliance for Interoperability). Other data structures are proprietary, and many have been developed by CAD firms that are now incorporating BIM into their software. One of the earliest examples of a nationally approved BIM standard is the AISC (American Institute of Steel Construction)-approved CIS/2 standard, a non proprietary standard with its roots in the UK.

Proponents claim that BIM offers:

1. Improved visualization
2. Improved productivity due to easy retrieval of information
3. Increased coordination of construction documents
4. Embedding and linking of vital information such as vendors for specific materials, location of details and quantities required for estimation and tendering
5. Increased speed of delivery
6. Reduced costs

In August 2004 the US National Institute of Standards and Technology (NIST) issued a report entitled "Cost Analysis of Inadequate Interoperability in the U.S. Capital Facilities Industry" (NIST GCR 04-867 (PDF) (http://www.bfrl.nist.gov/oae/publications/gcrs/04867.pdf) , which came to the conclusion that, as a conservative estimate, $15.8 billion is lost annually by the U.S. capital facilities industry resulting from inadequate interoperability due to "the highly fragmented nature of the industry, the industry’s continued paperbased business practices, a lack of standardization, and inconsistent technology adoption among stakeholders".

BIM in France

In France, several bodies are pushing for a more integrated adoption of BIM standards, in order to improve software interoperability and cooperation among actors of the building industry. Examples are the FFB (Fédération française du bâtiment) (http://www.ffbatiment.fr) , or the French arm of buildingSMART International (http://www.iai-tech.org/) who are supporting IFCs.

On the other hand, software editing companies such as Vizelia (http://www.vizelia.com) were early adopters of IFCs and can now benefit from the full potential of BIM in the Green Building fast-emerging business.

Additional Resources

BOOKS

BIG BIM little bim
Published October 2007
Written by Finith Jernigan, AIA
ISBN 978-0-9795699-0-6

Building Information Modeling: Planning and Managing Construction Projects with 4D CAD and Simulations
Published April 2008
Written by Willem Kymmell
ISBN 978-0-07-149453-3

BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers
Published March 2008
Written by Chuck Eastman, Paul Teicholz, Rafael Sacks, and Kathleen Liston
ISBN 978-0-470-18528-5

Interoperable Methodologies and Techniques in CAD. Chapter 4.
Written by Semiha Kiziltas, Fernanda Leite[12], Burcu Akinci[13], Robert Lipman[14]
In: CAD and GIS Integration
Published December 2009
Edited by Hassan Karimi, Burcu Akinci
ISBN 978-1-4200-6805-4

Green BIM: Successful Sustainable Design with Building Information Modeling
Published April 2008
Written by Eddy Krygiel, Brad Nies; foreword by Steve McDowell, FAIA, BNIM
ISBN 978-0-470-23960-5

BIM and Construction Management: Proven Tools, Methods and Workflows
Published May 2009
Written by Brad Hardin; foreword by Eddy Krygiel
ISBN 978-0-470-40235-1

Handbook of Research on Building Information Modeling and Construction Informatics: Concepts and Technologies
Published December 2009
Written by Jason Underwood, Umit Isikdag; foreword by Dana K. Smith
ISBN 978-1-60566-928-1

RESEARCH REPORTS

McGraw-Hill Construction SmartMarket Report on BIM.
Published December 2008
Written by Stephen A Jones
Research with hundreds of current BIM users on implementation and ROI. Includes 4-page special section "Introduction to BIM".
Free download: http://construction.ecnext.com/coms2/summary_0249-296182_ITM_analytics

VIDEOS

Thoughts on BIM by John Stebbins, CEO, Digital Vision Automation http://www.digitalvis.com/bim/

Anticipated future potential

BIM is a relatively new technology in an industry typically slow to adopt change. Yet many early adopters are confident that BIM will grow to play an even more crucial role in building documentation.

BIM provides the potential for a virtual information model to be handed from Design Team (architects, surveyors, consulting engineers, and others) to Contractor and Subcontractors and then to the Owner, each adding their own additional discipline-specific knowledge and tracking of changes to the single model. The result greatly reduces the information loss that occurs when a new team takes "ownership" of the project as well as in delivering extensive information to owners of complex structures. It also prevents errors made by design team members as well as the construction team (Contractors and Subcontractors) by allowing the use of conflict detection where the computer actually informs team members about parts of the building in conflict or clashing, and through detailed computer visualization of each part in relation to the total building. As computers and software become more capable of handling more building information, this will become even more pronounced than it is in current design and construction projects. This error reduction is a great part of cost savings realized by all members of a project. Reduction in time required to complete construction directly contributes to the cost savings numbers as well. It's important to realize that this decrease can only be accomplished if the models are sufficiently developed in the Design Development phase.

The Industry Foundation Classes (IFC/ifcXML) are an open specification for Building Information Modeling and are used to share and exchange BIM in a neutral format among various software applications. Green Building XML (gbXML) is an emerging schema, a subset of the Building Information Modeling efforts, focused on green building design and operation. gbXML is used as input in several energy simulation engines. But with the development of modern computer technology, a large number of building energy simulation tools are available on the market. When choosing which simulation tool to use in a project, the user must consider the tool's accuracy and reliability, considering the building information they have at hand, which will serve as input for the tool. Yezioro, Dong and Leite [15] developed an artificial intelligence approach towards assessing building performance simulation results and found that more detailed simulation tools have the best simulation performance in terms of heating and cooling electricity consumption within 3% of mean absolute error.

Theometrics is a New York-based company that aids in the implementation of BIM through onsite laser-measurement that can navigate users from any point on a BIM model to exact field locations. Their method specializes in feeding measurements to and from the model during the design and construction phases, enabling automated measurement and the creation of 2D or 3D drawings in the field, in real time.

See also

- Architecture

- Architectural engineering
- Construction management
- Design computing
- Integrated Project Delivery
- Virtual Design and Construction

References

1. ^ Lee, G., Sacks, R., and Eastman, C. M. (2006). Specifying parametric building object behavior (BOB) for a building information modeling system. Automation in Construction, 15(6), 758-776.
2. ^ Holness, Gordon V.R. "Building Information Modeling Gaining Momentum." ASHRAE Journal. Pp 28-40. June 2008.
3. ^ Yessios, C.I. Are We Forgetting Design? AECbytes Viewpoint #10 2004, http://www.aecbytes.com/viewpoint /2004/issue_10.html
4. ^ Eastman, C.M., Building Product Models: Computer Environments Supporting Design and Construction. 1999, Boca Raton, FL: CRC Press
5. ^ Laiserin's explanation of why 'BIM' should be an industry standard-term (http://www.laiserin.com/features/issue15 /feature01.php)
6. ^ Graphisoft on BIM (http://www.laiserin.com/features/issue19/feature01.php)
7. ^ Building Information Modeling Two Years Later –Huge Potential, Some Success and Several Limitations (http://www.laiserin.com/features/bim/newforma_bim.pdf)
8. ^ Leite, F.; Akinci, B.; Garrett, J.; Akin, O. (2009) Representation of Facility Contents and Threats for Supporting Identification of Vulnerabilities in Building Emergencies. In: Proceedings of the 2009 ASCE Computing in Civil Engineering Conference, Austin, TX.
9. ^ GSA BIM site (http://www.gsa.gov/Portal/gsa/ep/channelView.do?pageTypeId=17109&channelPage=/ep/channel /gsaOverview.jsp&channelId=-24291)
10. ^ Senate Properties modeling guidelines (http://www.senaatti.fi/document.asp?siteID=2&docID=588)
11. ^ Discussion (http://www.aecbytes.com/newsletter/2004/issue_5.html) of the BIM acronym
12. ^ http://www.caee.utexas.edu/prof/leite/
13. ^ http://www.ce.cmu.edu/people/faculty/akinci.html
14. ^ http://www2.bfrl.nist.gov/profiles/profiles.asp?lastname=lipman
15. ^ Yezioro, A.; Dong, B.; Leite, F. (2008) An Applied Artificial Intelligence Approach towards Assessing Building Performance Simulation Tools. In: Energy and Buildings, Volume 40, Issue 4, p. 612-620

External links

- AECbytes: Analysis, Research, and Reviews of AEC Technology (http://www.aecbytes.com/)
- What is BIM? (http://bim.arch.gatech.edu/?id=402) - by Professor Charles M. Eastman, Director of AEC Integration Lab at Georgia Tech.
- Managing BIM Technology in the Building Industry (http://www.aecbytes.com/viewpoint /2008/issue_35.html) - AECbytes Viewpoint #35: February 12, 2008
- buildingSMART (http://www.buildingsmart.com/) (International Alliance for Interoperability)
- CIS/2 (http://cic.nist.gov/vrml/cis2.html) - CIS/2 is the file exchange format that facilitates BIM for structural steel
- GSA National BIM Program (http://www.gsa.gov/bim) - National 3D-4D BIM Program by the U.S. GSA (General Services Administration)
- Open source BIM server (http://www.bimserver.org/)
- BIM object library (http://www.smartbim.com) - 1000's of high-quality BIM objects
- News and articles on building information modeling (http://www.reedconstructiondata.com/bim/news/) from Reed Construction Data's SmartBIM Community
- BIM Library (http://www.arcat.com/bim/bim_objects.shtml) - BIM files for building products
- Virtual Builders Network (http://virtualbuilders.net) - An online community of people pushing the limits of

BIM.
- Virirtual Design and Construction Wiki (http://vdcwiki.com) - A VDC Wiki.

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