Journal of Civil Engineering and Environmental Technology
Print ISSN: 2349-8404; Online ISSN: 2349-879X; Volume 2, Number 8; April-June, 2015 pp. 681-685

http://www.krishisanskriti.org/jceet.html

A Review of Building Information Modelling Techniques

Ankush Thakur[1], Hari Krishan Pandit[2], Ashish Tiwari[3] and Anil Dhiman[4]

[1]PG student, Jaypee University of Information & Technology Wakhnaghat
[2,3]PG Student Jaypee University of Information & Technology Wakhnaghat
[4]Jaypee University of Information & Technology Wakhnaghat
E-mail: [1]ankush.thakur2509@gmail.com, [2]hari.pandit2050@gmail.com,
[3]tiwariashish841@gmail.com, [4]anil.juit@gmail.com

Abstract—*Recent evolution of building information modeling (BIM) and its encouraged use of virtual design and construction (VDC) in the architecture, engineering, and construction (AEC) industry are fundamentally changing the process by which buildings are designed and constructed. In today's century engineer and architect must be able to deal with a rapid pace of technological changes, a highly interconnected world, and complex problems that require multidisciplinary solutions. This paper focuses about the BIM, its applications, how it enhance the career and its impact on the various Fields*

1. INTRODUCTION

Building information modelling is a powerful tool that uses three-dimensional (3D) intelligent parametric models to design, review, simulate, and coordinate building projects. BIM offers the ability to explore and plan every aspect of construction, especially before excavating ground for the construction firms. The owner can benefit by receiving an accurately built model at handover and by extracting material and equipment data and using it to manage and monitor the building.

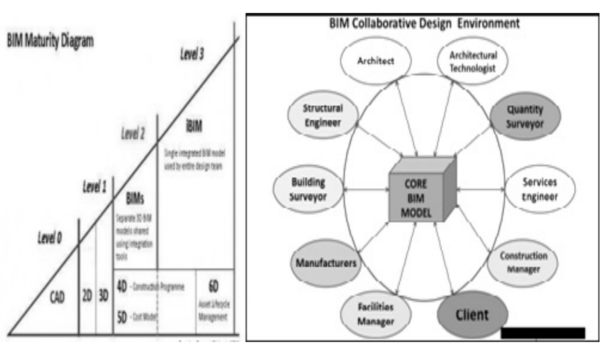


Fig. 1: BIM Collaborative Design Environment

Many construction firms adopted BIM, and top firms know that BIM offers significant benefits. There are some strong evidences suggesting that BIM is a powerful tool for the construction industry and that it will become an even greater force in the design, construction, and operation phases throughout the life cycle of a constructed facility.

2. APPLICATIONS OF BUILDING INFORMATION MODELING

Some of the main applications of BIM are as follows.

- **Detailed Analysis and Design**: BIM is the perfect tool to provide collaboration which is required in detailed analysis and design processes.
- **Documentation:** BIM provides the documentation that includes set of drawings incorporating appropriate data regarding each step of construction process and all details required to make a comprehensive estimate and ultimately execute the project.
- **Fabrication:** It is easy to generate shop drawings for various building systems using BIM.
- **Construction 4D/5D:** 4D and 5D designs are easy using BIM, 4^{th} dimension being as time and 5^{th} dimension the cost.
- **Operation and Maintenance:** BIM can bridge the information loss associated with handling a project for design team, to construction team and to building owner/operator, by allowing each group to add to and reference back all information they acquire during the period of their contribution to BIM model.
- **Renovation:** BIM enhances information exchange, cost estimation accuracy, reduction of time, preventing over ordering, reduce period of disuse in renovation projects.
- **Visualization:** 3D rendering can be easily generated for a building easily.

Many major innovations in the BIM market are yet to be seen that will have major impacts upon the AV professionals. Here are few examples

- **3D Design**: 3D visualization allows costumer to see historic prevention and site context with respect to the new project. They also allow for 3D coordination to reduce RFIs, errors and omissions.
- **4D Design:** 4D modeling is the integration of a 3D (BIM) model with a construction schedule in order to visualize the sequence of construction. For example, 4D BIM

notifies that one cannot schedule installation of tie-lines until after the delayed cable trays have been installed.

- **5D Design:** Automated quantity take-offs (QTO) and cost estimating, including the relationship between quantities, cost and location are included.
- **6D Design:** It refers to the intelligent linking of 3D CAD component or assemblies with all aspects of project life cycle management information such as conceptual energy analysis, detailed energy analysis and sustainable element tracking.

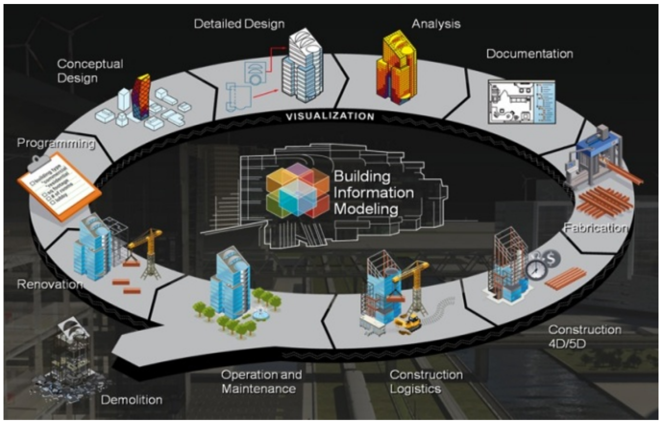


Fig. 2: Applications of BIM

3. CAREER ENHANCEMENT BY BIM

The advancement of skills, knowledge, and expertise to succeed in a particular profession are the true definition of career enhancement. Skills and expertise can be thought of as competence and knowledge about particular systems, techniques, or managerial aspects of a profession. For example, an architect might demonstrate particular knowledge about special building enclosure systems, a structural engineer might be known for expertise on tunnel structures, and a fabricator might have developed expertise in minimizing the waste of raw materials when forming ductwork. These all are professional skills, which can be enhanced in some way by BIM. BIM facilitate specific technical knowledge and convey that knowledge using specific tools and a managerial understanding of what to deliver, to whom it should be delivered, and at what point in the project it should be delivered. BIM is truly a skill, and mastery of that skill certainly qualifies as expertise. BIM skills are catalysts of professional development, which enhance the quality of the built environment, and enrich one's own professional experience.

4. BIM: CAREER AND AEC INDUSTRY

BIM creates a revolution in AEC industry and the way we design, develop, and build projects. BIM is not only affecting the design and construction processes and information sharing and flow; BIM is also affecting the people in the organizations. It enables better understanding and control of design and construction processes, better coordination and collaboration, and better outcomes, which ultimately contributes to the careers of many professionals in the industry. McGraw Hill Construction (2012a) Survey found that in 2012, 71% of architects, engineers, contractors, and owners have become engaged with BIM on their projects—a 75% growth surge over 5 years. The same survey reported that contractors (74%) surpassed architects (70%) to lead adoption by firm in 2012 (Fig. 3). Engineers experienced the greatest increase from 42% in 2009 to 67% in 2012. Mechanical engineers lead their peers with 83% reporting engagement with BIM, followed by electrical engineers at 77%. The survey also found that architects have implemented BIM heavily largely because of the length of time they have been involved with BIM. Implementation of BIM by engineers and contractors is rather slow. However, the surge in BIM adoption by the min recent years indicates the dramatic changes in implementation of BIM in the near future.

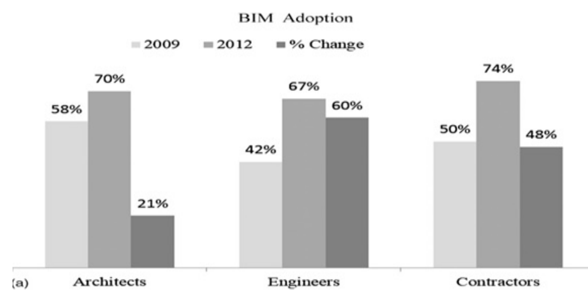
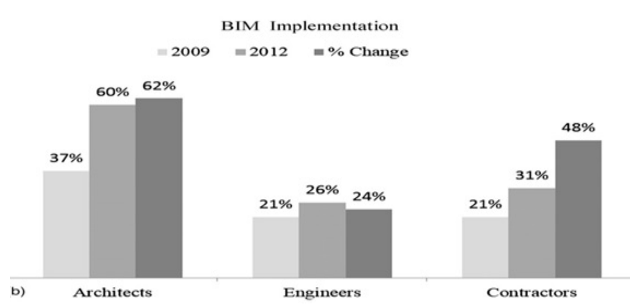


Fig. 3: BIM Adoption (Source McGraw Hill Const., 2012a)

The National BIM Survey (NBS) 2012 identified key disciplines in AEC industry that use BIM. This survey finds that architects are heavy users of BIM (37%), followed by architectural technologists (21%), quantity surveyors (5%), structural engineers (4%), building surveyors (3%), civil engineers (3%), and contractors (3%). The survey also identified a small number of users in disciplines such as CAD, landscape architecture, interior design, manufacturing, facility management, and property development. In case of infrastructure projects A/E firms are the heavy users of BIM technologies and processes and it is expected that 78% ill use it on more than 25% of their projects by 2013 (McGraw Hill Construction) utilizing BIM are provided.



Source :McGraw Hill Const., 2012a

Fig. 4: BIM implementation by key players in AEC industry

4.1 Architects: Architects are responsible for designing, managing, and supervising projects using 2D and 3D CAD and paper-based review, analysis, and process of work product delivery , which are in many cases sources of errors, and discrepancies that can jeopardize the architect's career. BIM embraces the collaborative modelling as an effective way of communicating the architect's design intent.. Also, architects are taking advantage of BIM's visualization capabilities to engage clients more deeply in finding solutions and a better understanding of the final outcome that they desire.

4.2 Engineers: Structural and civil engineers are responsible for design of structure elements, highway, bridges, and other infrastructure. Structural design tools based on BIM help engineers optimize their structural design and compare and contrast various approaches to sustainable designs with associated lifecycle costing, and when a concept is approved, it provides the foundation for field operations and construction sequencing.

4.3 Contractors: The ability for the contractors to impart their years, if not decades, of construction knowledge into the design process was not previously possible because many designers never knew which contractor would be selected to do the construction. And even if they did, there was really no interface in the design process in which contractors could plug in. BIM changes this process and its collaborative visual/analytical tools generate new kinds of documents for daily use at the site by making outcomes far more predictable and with a reduction in errors and increasing margins. BIM gives component-based construction models that enable the virtual construction, sequencing, and operation of infrastructures, part of the planning and design phase.

4.4 Fabricators: With the help of BIM models, fabricators resemble much more prior to final installation. Large-scale structural element is now prefabricated with cost, safety, quality, and timeliness benefitting from data rich BIM models.

4.5 Software engineers: As BIM is rapidly adapted in industries, more dedicated software and tools will be required for different types of construction. Software engineers have to understand characteristics of construction projects and different segments of construction industry. Then they need direct input from the firms engaged in different segments and design to develop better and most efficient BIM tools to meet the need of industry.

5. IMPACTS OF BIM

5.1 BIM Impact on AEC Industry: Since the BIM has been the most fundamental change in AEC industry in the past few decades as it has affected most of the traditional roles in the industry. BIM can affect construction professionals such as designers, estimators, schedulers, project engineers, project managers, and superintendents in their career enhancements.

5.2 BIM Impact on the Designer: A responsibility of a designer for designing a facility that meets the owner's needs from a functionality perspective, as well as aesthetics and cost. It allows the designer to communicate design intent to the owner better than previously. 3D visualization of the spaces provides a better way to understand the space that is much more effective than showing the owner a plan in 2D. It also allows the designer to receive quick feedback on the design options from the perspective of cost and to ensure that what is being designed meets the original program. BIM allows a designer to incorporate the constructability input earlier into the design documents so that an easily utilizable document by the construction personnel and the construction team is created.

5.3 BIM Impact on Estimators: On a typical construction project, estimators are responsible for providing cost feedback to the project and then buying out the project to ensure that all scopes are bought out and the project can be built in the allocated time. BIM has clearly affected estimators because of the fact that many mundane activities that used to be performed by estimators, such as quantity take-off, can now be automated using BIM This allows project estimators to provide rapid cost feedback and participate in the early design process to provide cost information for various set-based design scenarios. BIM tools is also creating an opportunity for estimators to take on a meaningful role in the design process

5.4 BIM Impact on Schedulers: Schedulers typically are responsible for the development of the project schedule and assisting the management of the project through developing look-ahead plans and managing the weekly production schedules. They are also responsible for communicating the impact of changes and the progress of the project. BIM allows the schedulers to better communicate the sequence and logistics by connecting BIM with a critical path method (CPM) or weekly work plan. BIM also allows schedulers to verify quantities from the model and understand flow of work and impact of time– space conflicts and congestion on the project, which produces a much higher and scientifically based schedule than a gut feeling produces.

Model Data usage for Predictive Analysis of Building Performance: This has 3 aspects:

- Most of the BIM software products have engineering analysis tools such as finite-element analysis and energy analyses built in and most can export relevant pre-processed data for import to external third-party analysis tools. Varying degrees of human effort are required to adapt the exported data to the forms needed by the analysis tools, and different degrees of rework are required to change the analysis models whenever the building model is changed. Instead of this, the procedures are more productive, quicker and less error prone than compilation of the analysis models from scratch.
- Construction cost estimation and automated life cycle with links to online sources of cost data.

- Evaluation of conformance to program/client value and code compliance checking using rule processing. A recent comprehensive review Eastman et al. 2009 shows that while this functionality is still limited in scope, its development is beyond the proof of concept stage.

6. LIMITATIONS OF BIM

Professional should also be aware that there are number of considerations and limitations of BIM that must be taken into account besides all of the benefits mentioned above. Some are listed below.

6.1 Cost of software and hardware: Since BIM modelling can be done by using different structural and architectural software either 2D or 3D. Current trend shows that cost of BIM software packages are more expensive. With the introduction of BIM software, the requirement on hardware has increased significantly which is also expensive.

6.2 Transition from drafting to modelling: This task requires a high level skilled design drafter who has an understanding of the project and the material used; it is also an increased level of responsibility on the designer. The cost associated with training and maintaining a skilled design modeller is higher than a draftsman with no knowledge of the trade**.**

6.3 Compatibility between Software Platforms: The biggest issue with early adapter of BIM is issue of inter-product compatibility. Due to relatively new nature of the market, every software manufacturer is doing something with its software. Thus it creates difficulty for the project if different team members own different software products.

6.4 Cost of Training: With new software, there is a great demand to train staff quickly so that investment can be justified. Thus the cost required to train staff is high.

7. ANTICIPATED FUTURE POTENTIAL

BIM is a significantly new technology in an industry typically slow to adopt change. Yet many of the early adopters are confident that BIM will grow to play much more crucial role in building designing and documentation. Proponents claim that BIM offers improve productivity, visualization due to easy giving of information, increased coordination of construction documents, linking of vital information such as vendors for specific materials quantities and location of details required for estimation and tendering, increased speed of delivery and reduced costs.

BIM also include most of the data required for performance analyses of building energy. In BIM the building properties can be used to automatically create the input file for building energy simulation and save a large amount of time and effort. Moreover, automation of this process reduces mismatches and errors in the building energy simulation process. India is an emerging market with an expanding construction market and huge potential for large scale residential and commercial development owing to population and economic growth. There are many qualified, trained and experienced BIM professionals who are implementing this technology in Indian construction projects and also assisting teams in the USA, Australia, UK, Middle East, Singapore and North Africa to design and deliver construction projects using BIM. In spite of this, and India's vibrant building sector, BIM usage was only reported by 22% of survey respondent

8. CONCLUSION

Building information modelling has changed the way of thinking of professionals about how technology can be applied to building design, construction, and management. BIM has affected all key professionals and the way of analysis in industry and there is a high demand for BIM skilled personnel. Many schools have started offering BIM courses and programs to prepare BIM-ready young engineers. The study found that BIM is helping construction professionals in better estimation, performance, communication, visualization, estimation, operation, and maintenance—which contribute lots to their knowledge, skill, and expertise, ultimately enhancing their professional careers. The study also conclude that BIM has created new career paths for young professionals. Positions such as BIM engineer/BIM manager did not exist a few years ago, but now they are key positions in many AEC companies. Many non-traditional companies have also started using BIM. This will open up new opportunities for young engineers. This trend in BIM-based career paths will continue to emerge, adding more jobs in AEC and related industries, thereby enhancing urgent professionals' career paths significantly

REFERENCES

[1] Becerik-Gerber, B., Gerber, D. J., and Ku, K. (2011). "The pace of technological innovation in architecture, engineering, and construction education: Integrating recent trends into the curricula." J. Inf. Tech. Constr., 16, 411–431.

[2] Buchal, R. O. (2001). "Incorporating solid modelling and team-based design into freshman engineering graphics." Eng.Des. Graphics J., 65(1), 19–29. Eastman, C., Teicholz, P., Sacks, R., and Liston, K. (2011).

[3] BIM handbook: A guide to building information modelling for owners, managers, architects, engineers, contractors, and fabricators, 2nd Ed., Wiley, Hoboken, NJ

[4] Gier, D. (2008). "What impact does using building information modelling have on teaching estimating to construction management students

[5] Goedert, J., Cho, Y., Subramaniam, M., and Guo, H. (2011). "Teaching construction project management with BIM support: Experience and lessons learned." Autom. Construct. 20(1), 76–87.

[6] Kaner, I., Sacks, R., Kassian, W., and Quitt, T. (2008). "The pace of technological innovation in architecture, engineering, and construction education: Integrating recent trends into the curricula." J. Inf. Tech. Constr., 13, 303–323.
[7] Khanzode, A. (2006). "An integrated, virtual design and construction and lean (IVL) method for coordination of mechanical, electrical and plumbing systems." Ph.D. thesis, Stanford Univ., Stanford, CA. - 129
[8] Azhar, S. (2011). "Building information modelling (BIM): Trends, benefits, risks, and challenges for the AEC industry." Leadersh. Manage. Eng., 11(3), 241–252.