



Title:

Step towards Informatization: Restrictive Factors and Strategies of BIM Technique’s Popularization in China’s AEC Field and Its Adoption in Professional Practice

Authors:

Wang Luli, wangluli@biad.com.cn, Beijing Institute of Architectural Design
 Zhang Linyi, zhanglinyi@biad.com.cn, Beijing Institute of Architectural Design
 Zhang Hao, zhanghao1@biad.com.cn, Beijing Institute of Architectural Design

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Introduction:

BIM, building information model, integrates all kinds of building information into a 3D model for the whole lifecycle of buildings. It is one of the important technical bases to realize the standardization, informatization and industrialization of AEC industry, which will effectively improves work efficiency, saves resources, reduces costs and achieves sustainable development.

Origination of "Positive BIM Technology":

The informatization development of China’s construction industry is still at the primary stage. Its BIM implementation level (the proportion of projects applying BIM in the total project volume) in 2014 is far less than that in the United States in 2012. Less than 10% firms reach very high BIM implementation level (greater than 60%).

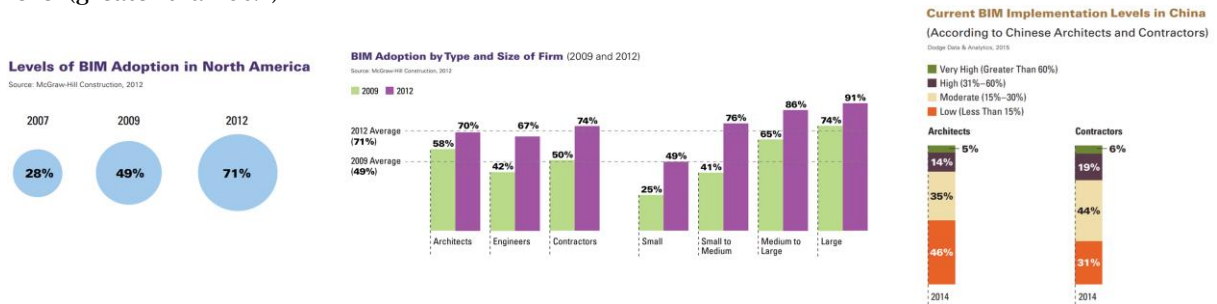


Fig. 1: BIM adoption data in North America and China. (a) Levels of BIM Adoption in North America, (b) BIM Adoption by Type and Size of Firm in North America, (c) BIM Implementation levels in China.

During the past 15 years in China, a large number of projects’ BIM models were made according to the construction documents drawn by AutoCAD, which has a specific name, “BIM Model Translation”. Actually, the way of “BIM Model Translation” does not take the advantages of BIM technology at all. Meanwhile, in the analysis of BIM application status in China’s construction industry released by Glodon Company Limited (a digital building platform service provider in China) in 2020, the way for construction firms to get BIM models shows that nearly 80% of firms need to build BIM models by themselves, and only 8.87% models are provided by clients or design firms. The low rate of BIM implement level in design firms is a gigantic waste from the perspective of the project’s whole lifecycle.

Only by introducing BIM technology in the design phase can we realize the smooth data delivery in the whole industrial chain and the informatization of the AEC industry.

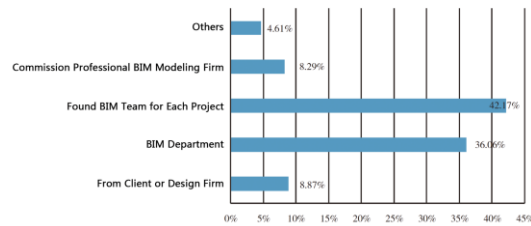


Fig. 2: Different ways to get BIM models for construction firms in China.

BIM software is the carrier of BIM Technology. Taking Revit, the most popular BIM software, as an example, its popularization in design firms of China remains at a very low level. By interviewing hundreds of professional engineers in the design firms, three main restrictive factors are summarized.

First, complex software operations and detailed pre-setting result low efficiency in the beginning of each project. Before building the 3D model, many preliminary settings are required, such as the elevation of each floor, the size of columns, the type and thickness of walls, etc. For design teams who are used to no more than 20 AutoCAD commands, the BIM way is far less efficient in the early stage of work. So it is difficult for them to choose Revit, or any other BIM software from their own initiatives.

Second, relying on the outsource BIM modeling firms brings high communication cost. Only a small number of design teams in China are very skillful at Revit. For most projects that need a BIM model, it's common for the design team to hire an outsource BIM modeling firm to do the 3D work, while the design team still work on 2D by AutoCAD. The most valuable part of BIM — coordination among data, geometry and the design team — is missing in this workflow. To make things worse, many BIM firms' employees, without architecture background, can't meet the requirements of the design team. Thus, huge communication cost happens, and it brings the intuitive feeling of "BIM Technology reduces work efficiency" to the design team, which greatly hinders BIM's popularization.

Last but not least, high initial investment but unclear tangible benefits. Revit model operation require high performance computers as well as skilled engineers. A design team needs at least a dozen or even dozens of computers and professional software training. However, those high investment cost couldn't bring direct and obvious tangible benefits immediately to the design firms. While market activities are driven by economic profits, the short-sighted urge for "quick money" is actually the top restrictive factor of BIM's popularization. From this point of view, the fast pace of construction project schedule in China is the deep reason behind.

Through the analysis of the above three constraints, the fundamental reason for the difficulty of BIM technology promotion and popularization is that the design team does not really participate in BIM design, but relies too much on the BIM firm. It brings negative results such as "BIM Model Translation" phenomenon, increases communication costs and subcontracting costs, and decreases profits. These negative results prevent more designers from BIM Technology. It's a vicious circle.

However, with the development of technology, AutoCAD mode's limitation will become more and more obvious. Its low efficiency of information delivery is the main issue. Another issue is its unfriendly access to IoT and other high-tech applications. On the contrary, BIM's application on the whole process of project will become a trend. To achieve the goal of the AEC industry's informatization, it's urgent to complete BIM Technology popularization among design teams.

Different from the "BIM Model Translation", "Positive BIM Technology" is specially proposed. It aims BIM Technology popularization from the design phase, and targets informatization of the AEC industry. Positive BIM Technology requires the design team to actively participate in BIM collaborative design, which is significantly important as the design work is the beginning of a project. It is the smooth information delivery among design team, client, construction team and other product or service suppliers that help the whole AEC industry complete its informatization. As BIM's role is

greatly enlarged in the project lifecycle process, “Positive BIM Technology” also has huge potential to connect with the IT industry. Thus, a full preparation for Industry 4.0 can be made.

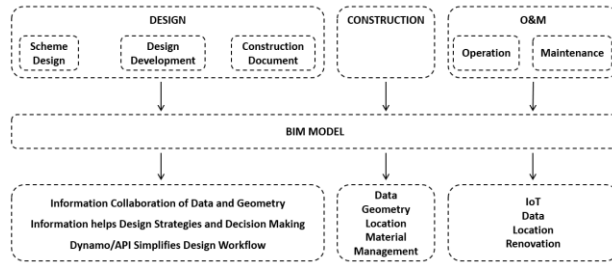


Fig. 3: BIM model adoption during the project lifecycle.

Step towards Informatization:

Positive BIM technology popularization strategies

To introduce Positive BIM Technology and complete BIM Technology popularization among design teams, we must focus on the following five aspects.

First, the design firms need to have positive incentives for the promotion and popularization of positive BIM. For example, provide high performance computer and software operation tutorials, reward those projects by positive BIM design, etc. The investment of design firms builds the foundation of Positive BIM Technology popularization.

Second, the design team need to evolve from the traditional AutoCAD work mode to the BIM work mode: think in the way of 3D construction instead of 2D drawing, adapt to the new mode of real-time 3D collaboration and document management, and adjust project schedule in design phase. Moreover, make full use of data by building simulation tools, most of which have friendly access to BIM software. The evolution of design teams is the key strategy of Positive BIM Technology Popularization.

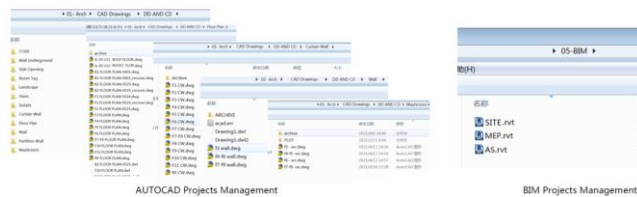


Fig. 4: Comparison of document management between AutoCAD and BIM: (a) AutoCAD Document Management for Architecture, and (b) BIM Document Management for Architecture, Structure and MEP.

The group of images below shows the comparison of design schedule for the same scale project (150000 m² office building) in AutoCAD era and BIM era. The left one is the recommended schedule in AutoCAD era with national wide projects experience, while the right one is a professional practice project design schedule adopted Positive BIM Technology since scheme design phase by a design team with almost zero BIM experience. For the BIM project schedule, the phases of scheme design and design development are longer than that of the traditional AutoCAD project. But from the larger scheme of things, the whole design schedule of BIM project is actually one month shorter.

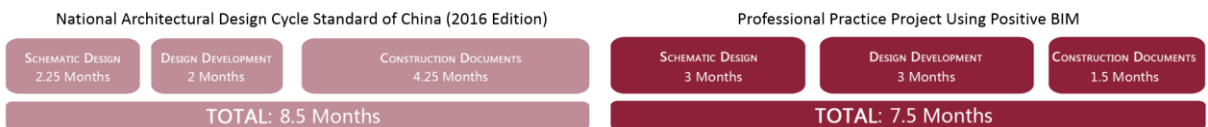


Fig. 5: Comparison between the national architectural design cycle standard of office buildings with the scale of 15000 m² and the actual cycle of positive BIM design projects in the same scale.

As mentioned above, this project is an active attempt of Positive BIM Technology application by a design team with almost zero BIM experience. By forcing themselves using Revit instead of AutoCAD, the design team provided exciting evidence that Positive BIM Technology is magnificently powerful in design phase, in terms of thinking, workflow, collaboration, and project management.



Fig. 6: The project adopted Positive BIM Technology by a team with almost 0 BIM experience.

Third, use BIM model since scheme design phase, and increase the influence of BIM by compelling delivering BIM model among different collaborators. BIM model can be developed along the project lifecycle, and different LOD (Level of Detail) matches different phase. The smooth delivery of BIM model among different teams eliminates the various document formats, reduces the cost of communication, and simplifies the workflow. By positively using it since scheme design phase, the design team will be more familiar and confident in BIM implement; by compelling delivering BIM model among different collaborators, BIM environment is created gradually in the AEC industry.

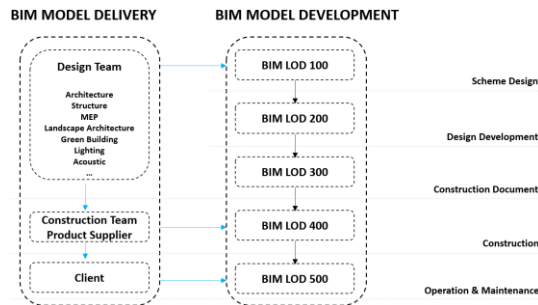


Fig. 7: BIM model delivery and BIM model development during the project lifecycle.

Forth, make better use of the outsource BIM team to power up the work efficiency. As the data and geometry are closely coordinated in the BIM model, those inefficient and repetitive work in AutoCAD mode can be simplified, even eliminated. With the help of developers from BIM team, the collaboration between data and geometry can maximize value of the information model by coding with python, Dynamo, C#, etc.

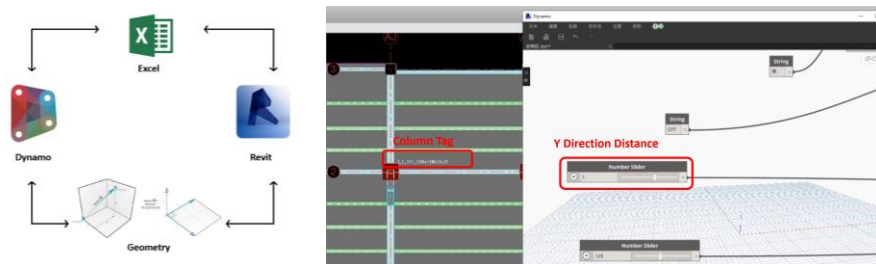


Fig. 8: Revit and algorithm: (a) Revit and coding environment for data and geometry collaboration, and (b) Dynamo script to control all the column tags' position.

Finally, with accumulation of BIM project experience and the improvement of working methods, BIM templates library for different design phases, as well as the components library, can be built for future usage.

Professional Practice of Positive BIM Technology Adoption in Different Design Phases

BIM technology can be applied through the whole process of project, from the schematic design phase to construction documents phase. Each phase has its own key points on BIM adoption.

The perfect timing for Positive BIM Technology interaction is from schematic design phase. It's the real-time collaboration of the data and the 3D volume, reasonable site plan based on building simulation analysis, colored floor plans using specific strategy, and the scheme-related data tables that power the work efficiency most in this stage.

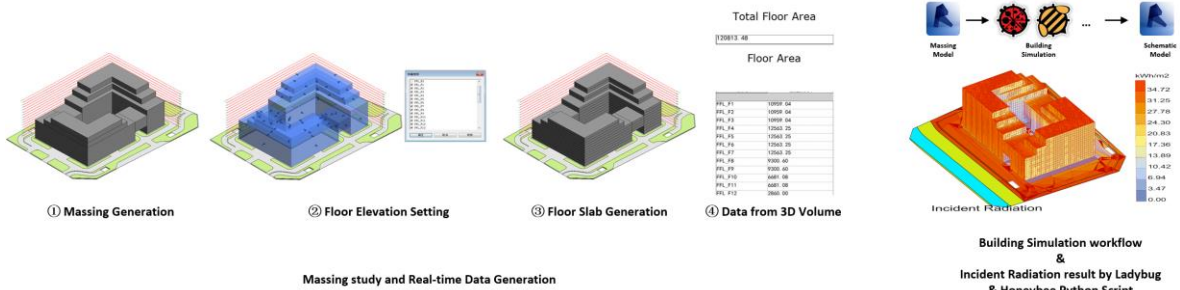


Fig. 9: Massing study with real-time data generation, and building simulation in scheme design phase.

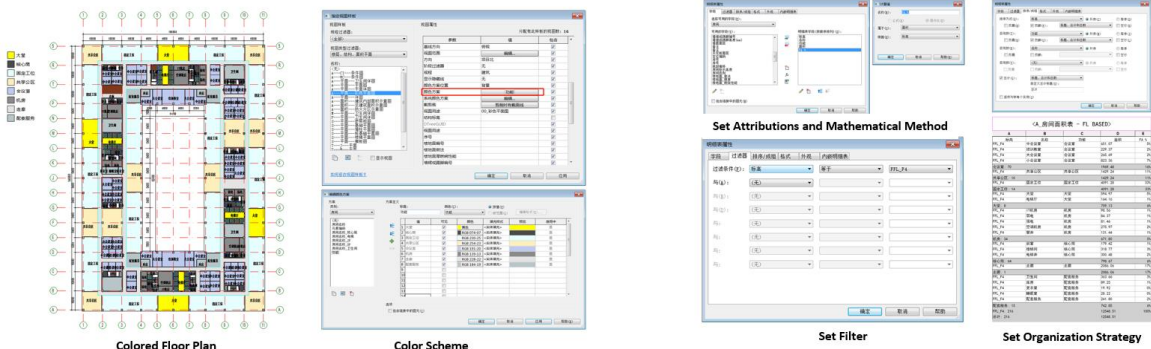


Fig. 10: Efficient Revit functions for scheme design: (a) Colored floor plan generation and color strategy setting, and (b) Editable filter, data organization strategy, and mathematical analysis of area schedules.

The most efficient timing for BIM Technology application is design development phase. During this stage, easy understanding and quick coordination of the project between architects, structure engineers and MEP engineers can be realized by taking BIM Technology. Communication cost is minimized since all the components exist in 3D model. System collision or other problems can be exposed in the beginning, and it avoids the possibility of project's fundamentally changes in construction document phase. Moreover, with the help of algorithm, building code analysis, which needs lot of time and possible omissions in the AutoCAD era, can be down automatically. The image below shows the automatic Egress circulation generation tagged with Ped-sim data of distance and time by coding in Dynamo.

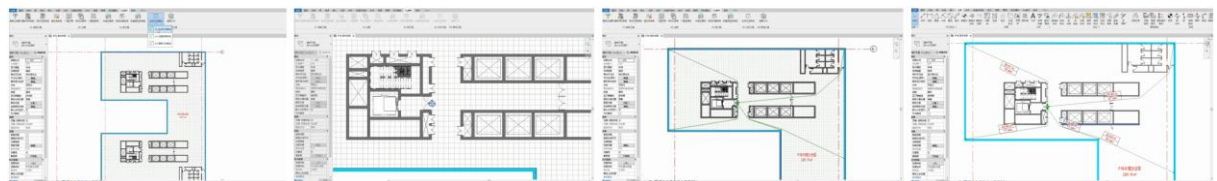


Fig. 11: Automatic egress circulation generation by Dynamo: (a) Choose the egress circulation generation function, (b) Locate the exit, (c) Egress circulation automatically generated, and (d) Tag the distance and time needed for escape.

Significantly profits can be obtained in the construction document phase only with the Positive BIM Technology adopted in the design development phase. In the construction document phase, most design issues are already solved, the design floor plans are relatively stable, and the BIM model keeps developing, from LOD 200 to LOD 300. This process is much shorter than that in the AutoCAD era. The advantage of this working environment is magnified by its script friendly feature. The images below show two algorithm application in Revit. The left one is the result of automatic dimension annotations (blue color) by Dynamo + Python, and right one is the algorithm process of automatic viewsheets creation from views by Excel + C#.

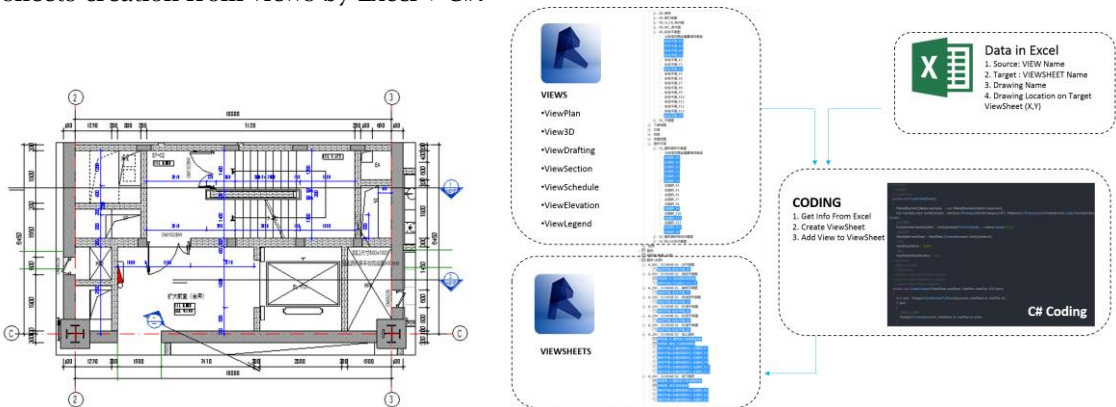


Fig. 12: Revit algorithm applications in construction document phase: (a) Detail drawing of staircase with automatic annotation generation, and (b) Revit Viewsheets created from Views with coding.

Additionally, the BIM cloud platform is an efficient tool for quick discussions on design details in this stage.

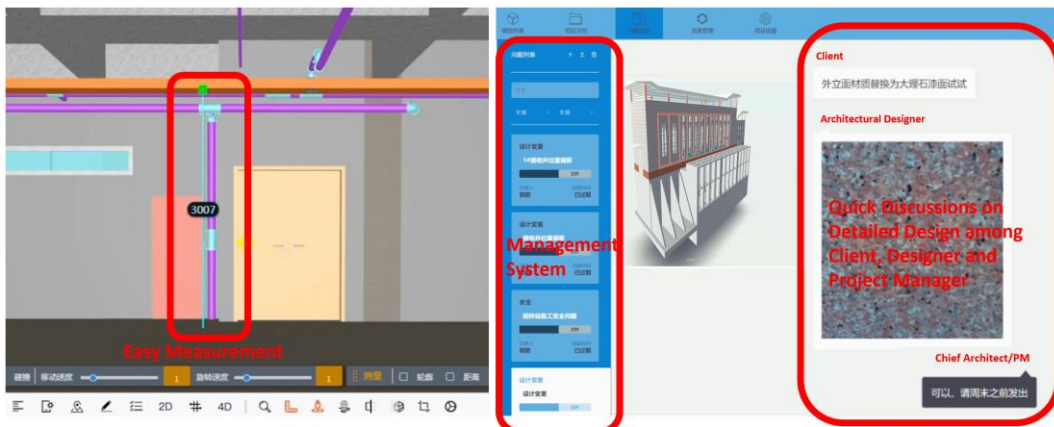


Fig. 13: BIM cloud platform: (a) Easy measurement, and (b) Convenient communication among the client, designer and project manager.

Conclusion:

BIM technology has strong advantages during project’s whole process, and it greatly improves the work efficiency in the AEC industry. But its popularization in China is greatly limited, especially in design companies. To change this situation, great efforts should be made by different members in the whole industry. The design teams, at a leading position in this process, must take a positive part in BIM Technology adoption, and contribute to its popularization. Positive BIM Technology mainly aims at the design phase, from schematic design to construction document phase. With its adoption, the progress toward AEC industry informatization will be accelerated. What’s even more exciting, Positive BIM

Technology could also provide opportunities for the connection with the IT industry, and make a fully preparation for Industry 4.0.

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