

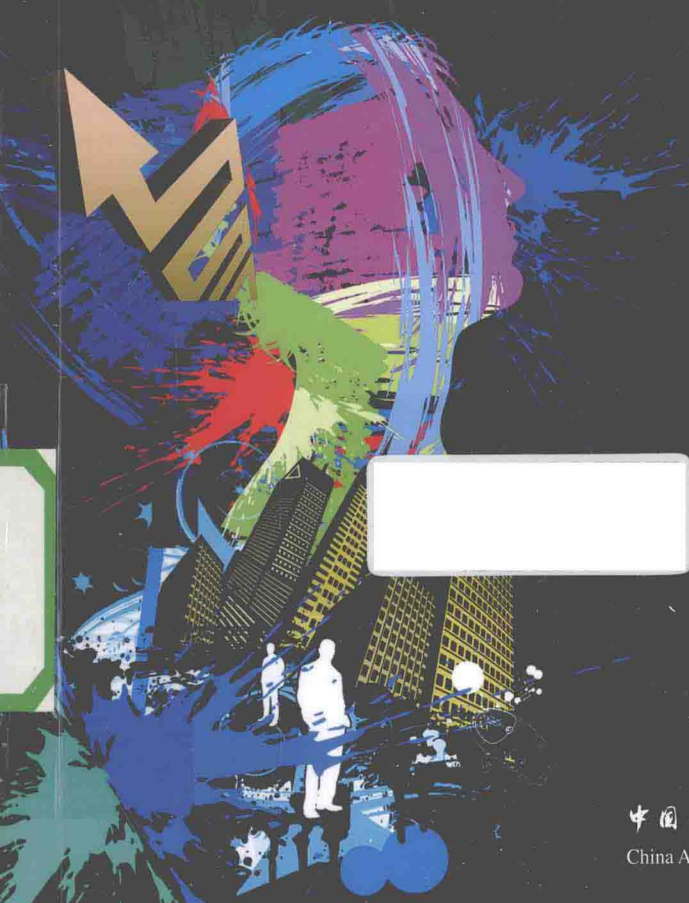
BIM Technology:
The Second Revolution
in Architectural Design

BIM 技术

第二次建筑设计革命

主编 欧阳东

Editor-in-Chief Ouyang Dong



中国建筑工业出版社

China Architecture & Building Press

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本书是作者近几年在BIM技术应用推广方面的实践和感悟, 作者将逐渐形成的具有本土特点的BIM技术解决方案融入书中, 其中有方法、案例, 也有实践、经验; 有问题、思考, 也有破解、建议。全书共7章, 分别对BIM技术的现状、趋势、优势、标准、软件、问题等的分析和总结, 对我国建筑设计行业各企业实施BIM技术是很好的指导与借鉴。全书图文并茂, 突出要点, 实操性强, 中英文对照, 有较强的指导性、参考性、实用性和权威性。

本书既可供政府部门、建设单位、设计单位、施工单位、监理公司、物业公司、软件厂商、系统集成商等单位的负责人、设计师、技术人员等学习参考, 也可作为大中专学校相关专业的教学参考书。

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欧阳东，1982年毕业于重庆建筑工程学院自动化专业，工学学士，2009年毕业于厦门大学，EMBA高级经济管理硕士；2005年取得国家一级电气注册工程师职称。曾任综合所所长、机电院院长、运营中心主任等职务，现任集团院长助理、集团总法律顾问；社会兼职：《智能建筑电气技术》杂志副社长；“中国智能建筑信息网”理事长。

Mr. Ouyang Dong obtained his Bachelor's degree in Automation from Chongqing Institute of Architecture and Civil Engineering in 1982 and an Executive MBA (EMBA) in Senior Business Administration and Management from Xiamen University in 2009, and became a National First Class Registered Electrical Engineer in 2005. He was previously Director of the Comprehensive Department, President of the Electrical and Mechanical Institute, Director of the Operation Center of China Architecture Design & Research Group (CAG), and is currently Assistant to the CAG President and the Group General Legal Counsel. His appointments include Deputy Director of the publication *Intelligent Building Electrical Technology* and President of the China Intelligent Building Information website.

作为工种负责人，参与了几十项大中型项目的设计工作，并取得了“北京梅地亚中心”等多个设计项目的国家级、省部级优秀设计奖。作为项目负责人，参与了多项企业级、部级和国家级科研项目，并取得了《建筑机电设备开放式通信协议研究》等多个科研项目的住房和城乡建设部华夏建设科学技术奖二、三等奖，主编了《医疗建筑电气设计规范》（中英文）；作为第一专利人，发明了“智能型灯光面板”获得三项专利。作为主编或副主编完成了《建筑机电节能设计手册》等十几本著作的编著工作，并均已正式出版；独著《建筑机电节能设计探讨》、《设计企业管理研究》等十几篇技术论文和管理论文。主持过多次全国性行业会议，多次在行业会议上宣讲了“建筑机电节能设计研究”、“管理创新——企业发展之精髓”、“BIM技术——第二次建筑设计革命”。

作为院（集团）院长助理兼设计运营中心主任，组织完善、调整、建立了一套“新的设计组织架构体系——项目经理和设计研究室主任的强矩阵管理架构”，取得非常好的经营业绩，各项经营指标连续四年均创历史新高。作为负责人组织BIM技术应用和推广工作，并取得了BIM最佳企业应用奖和五个BIM项目最佳设计奖。曾获得院（集团）管理创新特殊贡献奖、“十一五”科技创新奖、科研管理奖。

As principal of his profession, Mr. Ouyang has participated in designing dozens of large and medium-sized projects, and several of his design projects, such as Media Center Hotel Beijing have earned national and provincial excellent design awards. As project principal, he has been involved in several corporate, ministerial and national scientific research projects. Mr. Ouyang's multiple scientific research projects like *Open Communication Protocol Study of Building Mechanical and Electrical Equipment* were awarded second and third prizes in the China Construction Science and Technology Awards from the Ministry of Housing and Urban-Rural Development of the People's Republic of China and he also edited *Code for the Electrical Design of Medical Buildings* (Chinese and English versions). In addition, Mr. Ouyang holds three patents, including one for intelligent lighting panels. As chief or associate editor, he has completed the compilation of a dozen works that have all been published, like *Building Mechanical and Electrical Efficiency Design Manual*, and a dozen of academic papers in technology and management, such as *Discussion on Building Mechanical and Electrical Efficiency Design and Study on Design Enterprise Management*. Moreover, he has chaired national industry conferences numerous times and presented papers on *Study on Building Mechanical and Electrical Efficiency Design, Management Innovation: the Essence of Corporate Development*, and *BIM Technology: The Second Revolution in Architectural Design*.

As Assistant President of CAG and Director of Design Operation Center, Mr. Ouyang has conducted, adjusted and established a set called *New Design Organizational Structure System: Strong Matrix Management Structure for Project Managers and Design & Research Office Directors*, and yielded outstanding business results with all business indicators hitting the record highs for four consecutive years. As principal, he has implemented the application and promotion of BIM technology, and was awarded the Best Enterprise with BIM Application and five Awards of the Best Design for BIM Projects. He was also awarded the CAG Special Services Award to Management Innovation, and 11th Five-Year Technology Innovation Award and Scientific Research Management Award.

序

Foreword

信息技术日新月异的发展，有力地推进了各个行业的技术水平、管理能力的提升。在建筑设计行业，建筑设计不仅是一种艺术创作，更是一个涉及多个专业领域、综合性很强的系统工程，它包含的大量信息需要强有力的技术手段去采集、分类、分析、检索和传输；而建筑信息模型BIM（Building Information Modeling）技术作为数字建筑技术中出现的新概念、新理念和新技术，将为建筑设计的进步提供强有力的技术支撑。

2010年1月27日，在清华大学举办的“BIM对中国建筑业未来影响及中国BIM标准的研究制定”专家讨论会上，我们提出的第一个讨论话题是“BIM对未来中国建筑行业将引发的是技术革命还是产业革命”。记得与会专家对BIM是否可以成为产业革命还将信将疑，今天我们高兴的看到，该书作者已经从产业实际发展的角度，提出了“BIM技术是第二次建筑设计革命”，这将引发建筑设计行业从技术手段到商业模式等各层面上的颠覆性变革。

作为我国建筑设计行业的领跑者，中国建筑设计研究院也是BIM技术的先行先试先用者。作者结合近几年在BIM技术应用推广方面的实践和感悟，将逐渐形成的具有本土特点的BIM技术解决方案融入书中，其中有方法、案例，也有实践、经验；有问题、思考，

The development of information technologies vigorously promotes the technology level and ascends management ability in a wide range of industries. In architectural design industry, design is not only a kind of artistic creation, but also a very strong comprehensive system engineering related to multiple professional areas, which contains lots of information needing strong technical method to collect, classify, analysis, retrieve and transmit. BIM (Building Information Modeling) technology, as a new concept, new idea and new technology in digital building technology, provides strong technical support to the progress of architecture design.

On January 27, 2010, in an expert discussion conference held in Tsinghua University which named “The impact of BIM on future Chinese construction industry and BIM standards formulation”, we put forward the first topic “Whether a technology revolution or industrial revolution for future Chinese architectural industry that will be triggered by BIM?”. I remember experts were skeptical about BIM at that time, however, today we are happy to see that, the author has put forward “BIM technology is the second architecture design revolution” from the perspective of actual development, which will trigger an disruptive change from technology to the business model and so on various levels in architectural design industry.

As a leader of Chinese architectural design industry, CAG is also a forerunner of BIM technology. Considering the BIM application experience and comprehension in recent years, the author composites a localized characteristic of BIM technology solutions into the book, including methods, case studies, also the practice and experience; besides, there are problems, thinking, cracking, and advice. Especially the analysis and summary of BIM's

也有破解、建议。特别是书中对BIM技术的现状、趋势、优势、标准、软件、问题等的分析和总结，对我国建筑设计行业各企业实施BIM技术是很好的指导与借鉴。

BIM技术的推广和普及，不仅需要政府的积极引导，也需要更多像本书作者这样的实践者与热心人，愿意将其实践经验与社会各界分享。这体现了一个科技工作者的社会责任。在此，我向他们表示致敬！

中国工业化与信息化融合的道路刚刚起步，任重而道远。希望本书的出版对指导建筑设计企业实施基于BIM技术的信息化战略起到积极作用，促进BIM技术在建筑设计行业的广泛理解与深入应用，推动中国工程建设行业在我国绿色城镇化的快速、健康发展中朝阳永铸。

current situation, trend, advantage, standards, software, or problem, for the architectural design industry are good guides and references for the implementation of BIM technology in our Chinese enterprise

The promotion and popularization of BIM technology, not only needs the government's active guide, but also need more practitioners and enthusiasts, like author willingly to share practical experience to the society, which presents social responsibility of a scientific and technical workers. Here, I pay my respect to them!

The path to the fusion of industrialization and information has just started, and a long way to go. I Hope that the publication of the book could play a positive role to guide the architectural design enterprises to carry out the information strategy based on BIM technology, promoting the broad understanding and in-depth application of BIM technology in architectural design industry, motivating rapid and healthy development of Chinese construction industry in China's green urbanization.



中国工程院院士

2013-7-1

Sun Jianguang

Academician of the Chinese Academy of Engineering

JUL 1, 2013

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| <p>形势 Trend</p> | <p>党的十八大胜利召开，回顾“十一五”（2006-2011）时期取得的辉煌业绩，国民生产总值（GDP）从26.6万亿元增加到51.9万亿元，跃升到世界第二位，年增速9.3%；科技投入5年累计8729亿元，年增速超过18%；提出了科技驱动创新和生态节能环保，并明确提出了实现“工业化、信息化、城镇化”。因此，科技创新和节能环保将是中国建筑业永恒主题。</p> <p>With its successful assembly, the CPC' s 18th National Congress recalled the brilliant achievements obtained during the “11th Five-Year Plan” (2006 – 2011), in which China's GDP had an annual growth rate of 9.3%, an increase from 26.6 trillion Yuan to 51.9 trillion Yuan and the economy ranked second in the world, and investment in science and technology amounted to 872.9 billion Yuan in five years, with an annual growth rate of more than 18%. Meanwhile, science and technology-driven by innovation and eco-energy environment were proposed, and it was made clear to achieve industrialization, informationization and urbanization. Therefore, technological innovation, energy saving and environmental protection will be ongoing themes pursued by China's construction industry.</p> |
| <p>目的 Goal</p> | <p>贯彻执行国家技术经济和节能政策，在中国建筑行业推广BIM新技术，促进行业科技进步。BIM技术的全面应用将显著提高工程项目设计、施工、运营全生命周期的质量及效率，降低成本，提升集成化程度，并产生巨大的经济和社会效益，也是实现项目精细化管理、企业集约化经营的有效途径。</p> <p>To implement the national technological economy and energy-saving policy, promote new technologies including BIM technology in China' s construction industry, and advance industrial scientific and technological progress. The full application of BIM technology will significantly improve the quality and efficiency of project design, construction and full operation life cycle, reduce costs, enhance the degree of integration and generate immense economic and social benefits, and also, serve as an effective means to realize the project' s detailed management and intensive corporate management.</p> |

(续表)

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| <p>主题 Theme</p> | <p>在中国建筑设计行业第一个提出“BIM技术——第二次建筑设计革命”，必将引发建筑设计行业从技术手段到商业模式等所有层面上颠覆性变化；同时明确指出“通过改变建筑设计模式，可以提高企业竞争力”，BIM已经不是设计企业发展的可选项，而是必选项，设计企业投资BIM是投资企业未来的最佳途径之一。这场建筑设计革命将不受个人好恶和思维习惯的束缚而向前推进，谁愈先采用，谁愈早受益。</p> <p>The first introduction of “BIM Technology: The Second Revolution in Architectural Design” in China’s architecture industry will inevitably trigger a fundamental change at all levels, from technological means to business modes throughout the industry, but this will also enhance corporate competitiveness through changing architecture design modes, and so BIM is no longer an option in the development of design enterprises, but a must. Therefore, investing in BIM is one of the optimal paths for investing in an enterprise’s future. This architectural design revolution will, regardless of personal tastes and thinking habits, will move everything forward. Whoever adopts it earlier will benefit sooner.</p> |
| <p>需求 Needs</p> | <ol style="list-style-type: none">1. 经济发展的需求（GDP、生产力、可持续健康发展等）；2. 技术进步的需求（手段、流程、质量、效率等）；3. 核心竞争力需求（人才、品牌、战略等）；4. 行业发展的需求（科技研发、节约投资等）；5. 城市发展的需求（城镇化、数字城市等）；6. 社会进步的需求（节能环保、社会责任等）。 <ol style="list-style-type: none">1. Economic development needs (GDP, productivity, sustainable and healthy development, etc.);2. Technological progress needs (means, processes, quality and efficiency, etc.);3. Core competitiveness needs (human resources, brand and strategy, etc.);4. Industrial development needs (research and development and investment savings, etc.);5. Urban development needs (urbanization and digital city, etc.);6. Social progress needs (energy saving and environmental protection, social responsibility, etc.). |

(续表)

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| <p>变革 Revolution</p> | <ol style="list-style-type: none">1. 传统思维的变革 (习惯意识, 传统想法等);2. 技术手段的变革 (科技创新、科研转化生产力、软件技术变革等);3. 商业模式的变革 (开拓新的经营模式及市场、传统工作模式等);4. 城镇化建设变革 (政府审批、管理运营的统筹、应急预案等);5. 产业信息的变革 (全生命周期、信息的全过程传递和综合使用等);6. 建筑产业的变革 (信息化水平、工业化水平等)。 <ol style="list-style-type: none">1. Revolutionizing traditional thinking (habitual awareness and traditional ideas, etc.);2. Revolutionizing technical means (scientific and technological innovation, scientific research converted to productivity and changes in software technology, etc.);3. Revolutionizing business modes (to develop new business modes, markets and traditional operation modes, etc.);4. Revolutionizing urbanization (government approval, planning of operation management and contingency plans, etc.);5. Revolutionizing industrial information (full life cycle, entire process of delivery and integrated use of information, etc.);6. Revolutionizing the construction industry (informationization level and industrialization level, etc.). |
| <p>内容 Content</p> | <ol style="list-style-type: none">1. BIM技术的现状和未来发展趋势 (含中国三届BIM设计大赛);2. BIM技术应用的优势和劣势比较;3. BIM技术标准的现状和编制规划;4. BIM技术在企业应用方面的推广 (含BIM设计培训和协同设计);5. BIM技术在设计项目方面的推广 (含BIM设计项目流程);6. BIM技术设计应用软件汇总;7. BIM技术应用遇到的问题 and 政府影响。 <ol style="list-style-type: none">1. Current Status and Future Trend of BIM Technology (including the three contests of "Innovation Cup" for BIM Design);2. Comparison of Application of the Advantages and Disadvantages of BIM Technology;3. Current Status and Compiling Planning of BIM Technology Standards;4. BIM Promotion in Enterprise Application (including BIM design training and collaborative design);5. BIM Promotion in Design Projects (including BIM design project process);6. Summary of BIM Technology in Design Application Software;7. Problems in BIM Technology Implementing and the Role of Government. |

(续表)

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| <p>对象 Object</p> | <p>政府部门、建设单位、设计单位、施工单位、监理公司、物业公司、软件厂商、系统集成商等单位的负责人、设计师、技术人员等。 Directors, designers and technicians of Governments, project owners design units, construction enterprise, supervision companies, property companies, software vendors and system integrators.</p> |
| <p>特点 Features</p> | <p>图文并茂，突出要点，实操性强，中英文对照（中英文不一致时以中文为准），有较强的指导性、参考性、实用性和权威性。 Combination of words and photographs, highlighting key points, powerful practical functionality, Chinese and English versions (In case of discrepancy between Chinese and English, the Chinese text shall prevail) , strong guidance, reference, practical and authoritative values</p> |
| <p>不足 Inadequacies</p> | <p>由于大家均是利用业余时间、短时间编写，又采用了大量的国内、外的BIM资料，翻译的经验也不足，有不妥或不准确之处，请大家批评指正。 Incongruity and inaccuracy are unavoidable due to the limited compilation time as this was done during spare time, as well as abundant domestic and foreign BIM data and insufficient translation experience. Constructive feedback is welcome.</p> |



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国务院政府特殊津贴专家

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本书重点摘要

Summary

1 BIM技术的现状和发展趋势

Current Status and Future Trend of BIM Technology

1.1 BIM技术总论

Overview of BIM Technology

建筑行业全生命周期（设计、施工、运营）的BIM技术革命

The BIM Revolution in the Full Lifecycle of the Construction Industry (Design, Construction and Operation)

BIM技术建筑行业（设计、施工、运营）技术的8个特点

Eight Features of BIM Technology in the Technology of the Construction Industry (Design, Construction and Operation)

BIM技术建筑行业（设计、施工、运营）技术的8个特点
Eight Features of BIM Technology in the Technology of the Construction Industry
(Design, Construction and Operation)

| | | | |
|---|---|--|---|
| 1 | 可视化 Visualization | 可视化 Visualization | 可视化 Visualization |
| 2 | 参数驱动 Parameter driven | 专业综合 Professional integration | 信息与分类标准 Information and classification standard |
| 3 | 关联修改 Correlation modification | 施工过程模拟 Construction process simulation | 物资编码与管理 Material coding and management |
| 4 | 任务划分与管理 Task partitioning and management | 施工工艺模拟 Construction process simulation | 远程与移动平台工作 Remote and mobile platform work |
| 5 | 性能分析 Performance analysis | 施工信息管理 Construction information management | 基于BIM信息的设备管理 BIM information-based device management |
| 6 | 协同设计 Collaborative design | 基于BIM信息成本管理 BIM information-based cost management | 基于BIM信息的租赁管理 BIM information-based lease management |

(续表)

| | | | |
|---|--|--|---|
| 7 | 三维设计交付 3D design delivery | 物资编码与管理 Material coding and management | 基于BIM信息的安全管理 BIM information-based security management |
| 8 | 远程与移动平台工作 Remote and mobile platform work | 远程与移动平台工作 Remote and mobile platform work | 基于BIM信息的自控系统 BIM information-based auto-control system |

BIM技术能解决各方的主要关注点

Major focuses which can be settled by using BIM technology

| 序号 SN | 各方名称 Name | BIM技术能解决各方的主要关注点 Major focuses which can be settled by using BIM technology | | | | |
|----------|---------------------------|--|----------------------|-------------------------|------------------------------|------------------------------------|
| | | 关注点1 Focus 1 | 关注点2 Focus 2 | 关注点3 Focus 3 | 关注点4 Focus 4 | 关注点5 Focus 5 |
| 1 | 政府方 Government | 工程质量 Engineering quality | 成本控制 Cost control | 工作效率 Work efficiency | 行业标准 Industry standard | 技术进步 Technological improvement |
| 2 | 建设方 Project Owner | | | | 工程进度 Project progress | 风险控制 Risk control |
| 3 | 设计方 Project Designer | | | | 设计收入 Design revenue | 业务范围 Business scope |
| 4 | 施工方 Project Contractor | | | | 工程进度 Project progress | 修改返工 Modification and reworking |
| 5 | 运营方 Project Operator | | | | 信息传递 Information transfer | 维护便捷 Convenient maintenance |

1.2 BIM技术的应用现状

Current Application of BIM Technology

- 美国使用BIM技术的现状
- 欧洲使用BIM技术的现状
- 亚洲使用BIM技术的现状
- 中国使用BIM技术的现状

BIM in the US
BIM in Europe
BIM in Asia
BIM in China

附表 Annexed tables

中国勘察设计协会主办《第一届“创新杯”BIM设计大赛（2010）》

The 1st “Innovation Cup” for BIM Design (2010) sponsored by China Exploration & Design Association

中国勘察设计协会主办《第二届“创新杯”BIM设计大赛（2011）》

The 2nd “Innovation Cup” for BIM Design (2011) sponsored by China Exploration & Design Association

中国勘察设计协会主办《第三届“创新杯”BIM设计大赛（2012）》

The 3rd “Innovation Cup” for BIM Design (2012) sponsored by China Exploration & Design Association

1.3 BIM技术的主要特点

Major Features of BIM Technology

- 特点之一：可视化设计
- 特点之二：参数化设计
- 特点之三：关联修改
- 特点之四：任务划分与管理
- 特点之五：性能分析
- 特点之六：协同设计
- 特点之七：三维设计交付
- 特点之八：远程与移动平台工作

Feature 1: Visualization design

Feature 2: Parametric design

Feature 3: Correlation modification

Feature 4: Task partitioning and management

Feature 5: Performance analysis

Feature 6: Collaborative design

Feature 7: 3D design delivery

Feature 8: Remote and mobile platform work

1.4 BIM技术未来的发展趋势

Future Trends of BIM Technology

- 趋势之一：国家发展目标与BIM未来技术发展相一致
- 趋势之二：未来BIM的发展整体架构图
- 趋势之三：BIM技术促进了决策流程和成本控制的优化
- 趋势之四：BIM技术应用的高价值体现
- 趋势之五：5D技术对项目成本、周期、质量的影响力
- 趋势之六：云计算对建筑产业发展的影响
- 趋势之七：BIM技术对智能建筑及数字城市的技术支撑
- 趋势之八：绿色可持续及装配式建筑设计

Trend 1: Consistency of national development goals and future BIM technical development

Trend 2: Overall framework of future BIM development

Trend 3: BIM technology optimizes decision-making flow and cost control

Trend 4: High value of BIM application

Trend 5: Influence of 5D technology on project cost, cycle and quality

Trend 6: Influence of cloud computing on the development of the construction industry

Trend 7: Technical support of BIM technology in smart buildings and digital cities

Trend 8: Green sustainability and fabricated architectural design

2 BIM技术应用的优势和劣势比较

Comparison of Application of the Advantages and Disadvantages of BIM Technology

2.1 二维设计与BIM设计软件的十四个比较

14 Top Differences Between 2D Design Software and BIM Design Utilities

- **对比之一：**设计信息在整个设计过程中的传递关系

Difference 01: Delivery of design information between each stage and discipline in project

对比结果：二维设计软件的信息在不同工程阶段及不同专业间的传递有损失；而三维BIM设计软件可实现信息更有效传递！

Conclusion: Information is easily lost when delivering information in 2D design software, between different stages and different disciplines, but 3D BIM software can deliver the information more efficiently!

• **对比之二：**设计工作量、设计过程的重心变化关系

Difference 02: Change of focus in terms of design workload and design process

对比结果：为保证设计质量，二维设计软件设计人员的大量时间花在协调和对图上，后期修改工作量大；而三维BIM设计软件设计工作量前移，重点在方案比选和技术优化，一旦模型关联关系建立修改便利！

Conclusion: To assure the design quality, the 2D designers spend much time in coordinating and comparing drawing, and will suffer heavy work load if any change in drawing after; however, the 3D BIM software can put the word in advance, and focus on the scheme choice and technology optimization. When the model is setup, it is easy to make change.

• **对比之三：**计算与绘图的融合修改关系

Difference 03: Integration of calculation and drafting

对比结果：二维设计软件的专业计算基本与绘图脱节；而三维BIM设计软件将计算与绘图融合，做到一处修改，处处更新。

Conclusion: Calculation and drafting are separated by 2D design software. They can be combined by BIM design software, enabling updates in real time.

• **对比之四：**二维图标与真实产品构件库的关系

Difference 04: Relationship between 2D symbols and real products

对比结果：二维设计软件CAD图块仅表达外形，相关数据缺失；而三维BIM设计软件可提供“数形合一”的构件族库！

Conclusion: AutoCAD 2D blocks created by 2D design software include only geometry without any technical data. With BIM design software, product databases with real products can contain both geometry and technical data.

• **对比之五：**设备数据与工作状态模拟的关系

Difference 05: Relationship between equipment data and project progress simulations

对比结果：二维设计软件无法进行设备工作状态模拟；而三维BIM设计软件通过设备构件族信息，可准确模拟设备的工作状态！

Conclusion: Project progress simulations are not supported by 2D design software, but they can be supported by BIM design software. This is made possible by product databases that contain complete technical data on real, commercially available products.