Research on Lean Management by BIM Technology in Shanghai Tower

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Agenda

Project Overview

Strategy Briefing

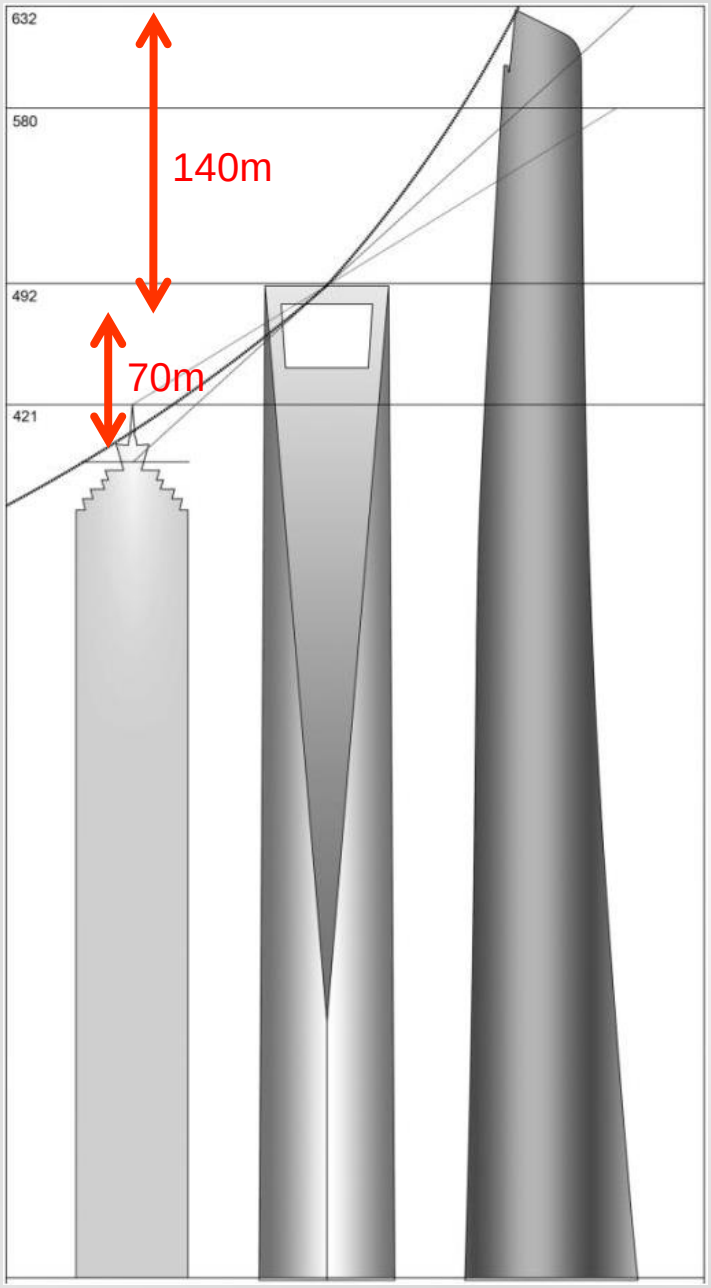
BIM Management Mode Selection by Owners

BIM Practice by Designers, Contractors and Supervisors

Reflections

Project Overview

- **Location**
  Z3 lot, Lujiazui Fanatical Center
- **Section / Floor**
  - 9 sections, underground:5 floors, Ground : 121 floors
- **Building Height**
  - 632m
- **Construction Area**
  - 570,000 ㎡ (0.16M underground, 0.41M ground)
- **Functional Orientation**
  - 24 hours opening International High Level office,
  - Super five-star hotel and ancillary facilities
  - Deluxe Shopping Mall
  - Tourism and Entertainment
  - Features Meeting Facilities

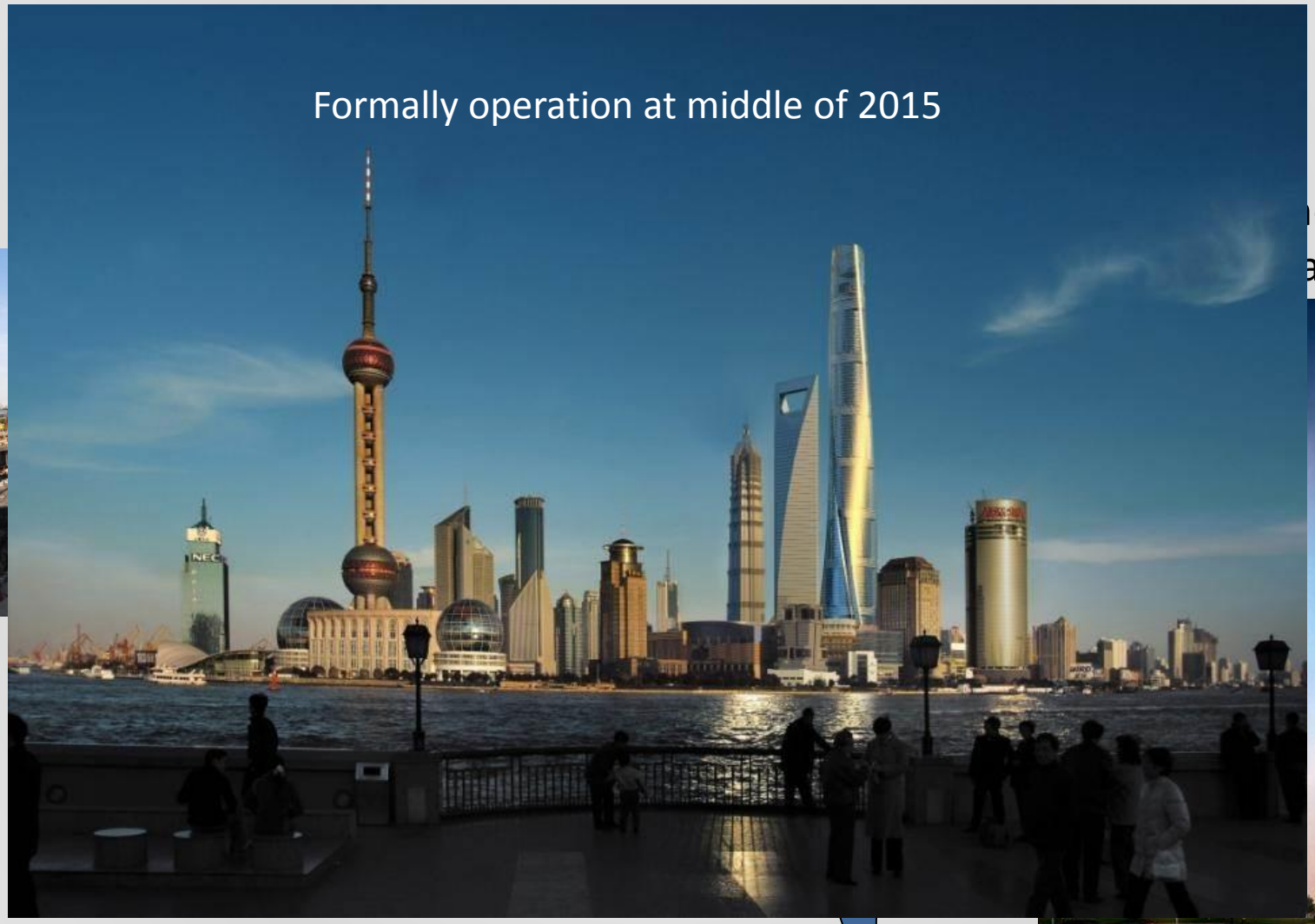


The height of Shanghai Tower is determined by full consideration of the other two skyscrapers in this area

Progress

Project

Formally operation at middle of 2015



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Vertical Community

High specification requirements

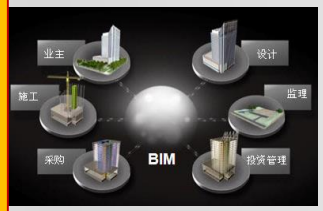
High specification standards

High Difficulty Issues

Green Community

U.S. GREEN BUILDING COUNCIL LEED USGBC

China Green Building: ★★★ LEED-CS2.0: Golden



BIM

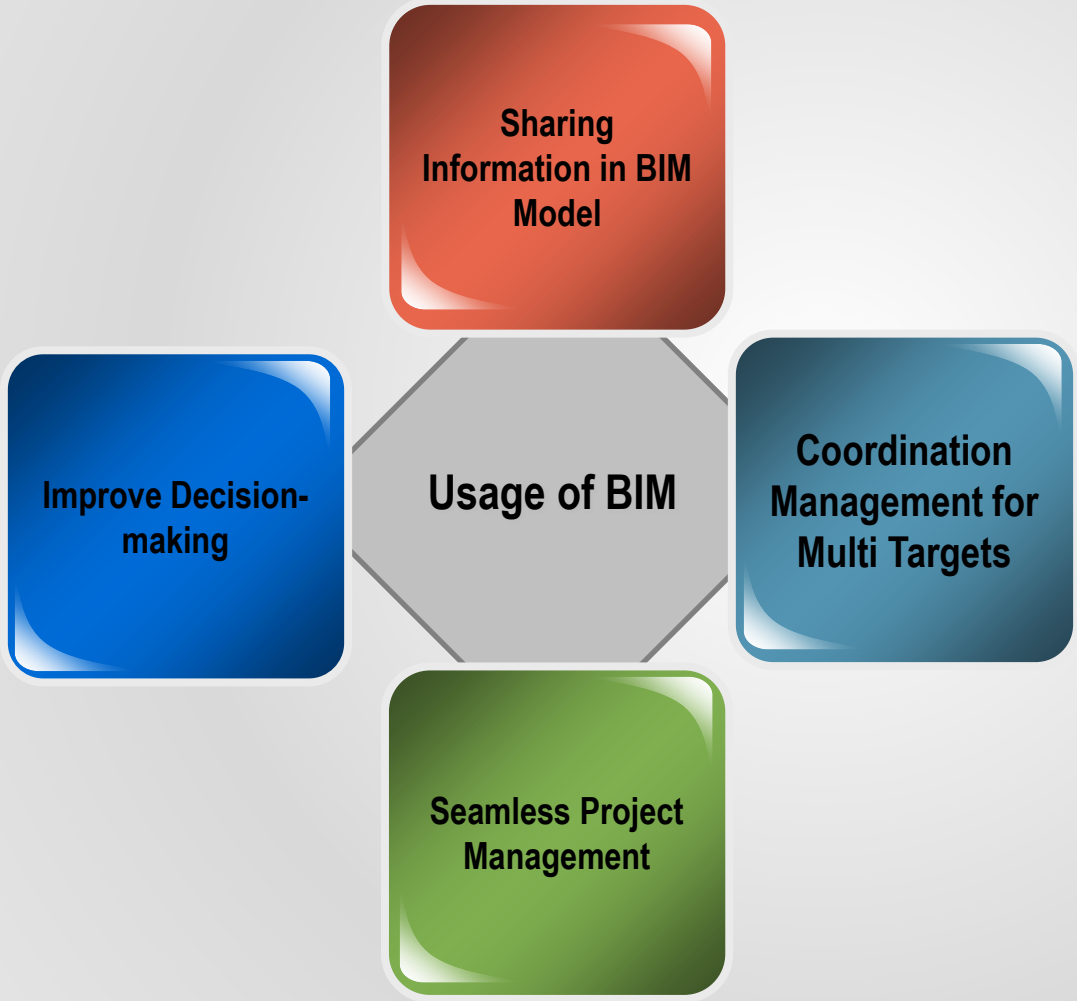
Humanistic Community

Strategy Briefing

Issues	Methodologies	Solutions
Too many sub contractors to coordinate	Setup the team by organization behavioristic	All stuff participation & Specification Responsibility & Coordination Efficiency & Execution
Hard to share the complex & huge information	Flexible operation system, using new tech: virtual construction, pre-fabrication, etc.	Design：BIM detailed design Construction：factory precast M&A：One-Stop service
Difficult to achieve cost control in such a big project	Blue Ocean Strategy: Value Innovation	Viable benefit allocation policy by BIM low risk and high chance win-win model
Difficult to achieve schedule control in such a long life-cycle project	Quantified Value Creation Comparative Analysis, Strategy selection Stratigic positioning	For Shanghai tower: Owner leading, contractors participating: Lean management by BIM

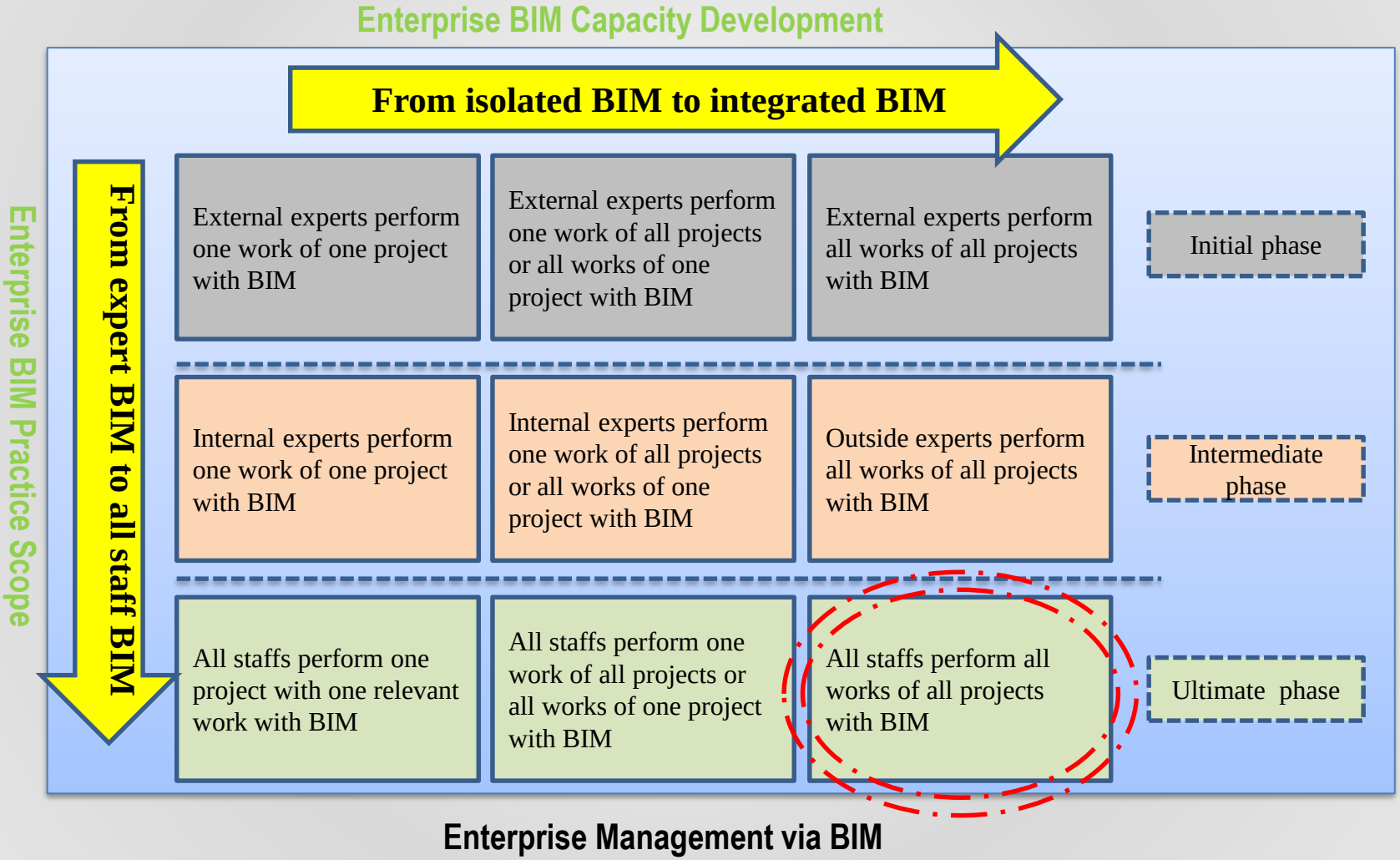
BIM Management Mode Selection by Owners

BIM features and usages



The bottleneck for the info technology adoption in building engineering is information sharing, and BIM is reliable solution for providing effective approaches of framing info sharing and management platform.

BIM Capacity Development



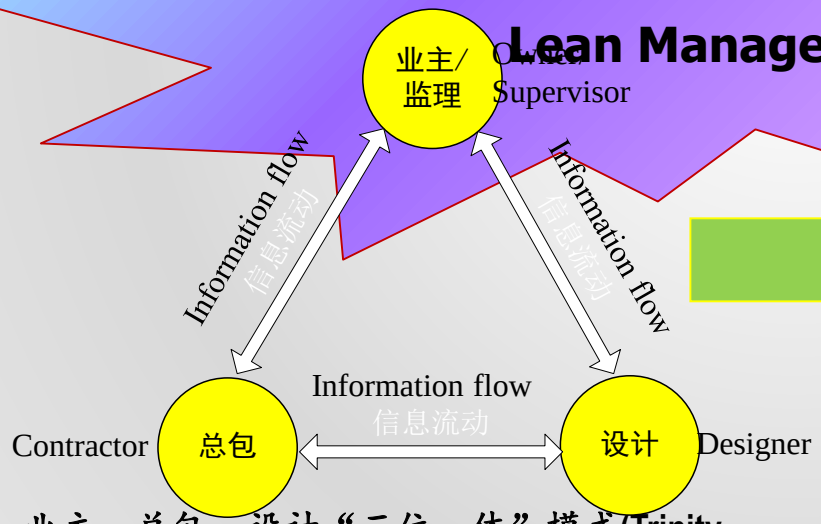
BIM Management Model: Options & analysis

Function & Effect / BIM Adoption Mode	Scope	Effect	Adoption Level
Driven by Design Firm	Design Phase		wide
Driven By Contractor			
Driven By			

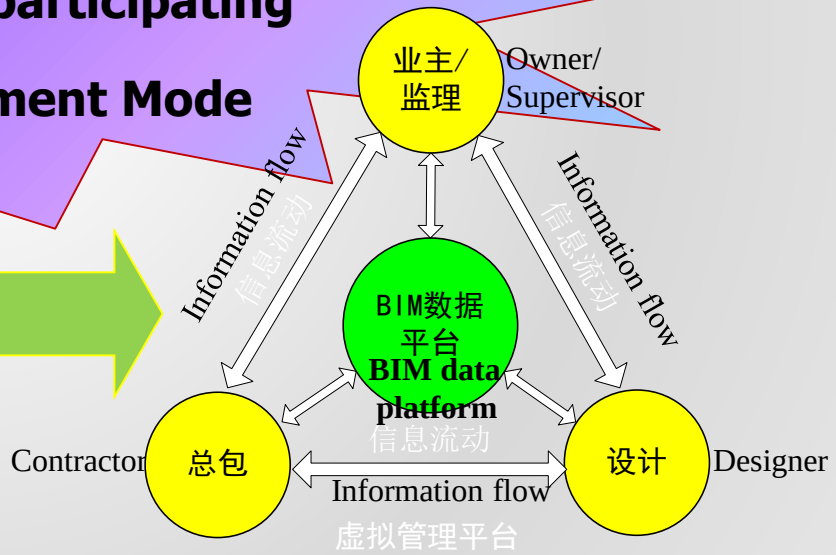
Owner Leading

All contractors participating

Lean Management Mode

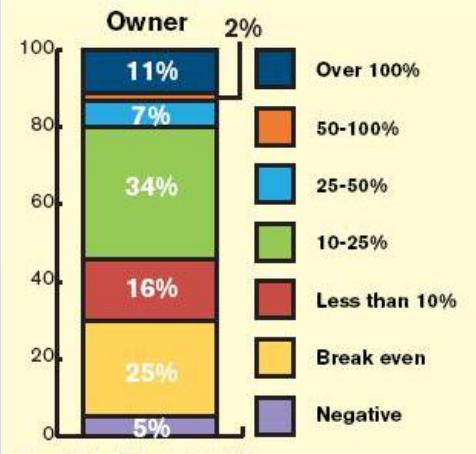


业主、总包、设计“三位一体”模式(Trinity Management Mode: Owner, General contract & Design)



基于BIM“三位一体”精细化管理模式 (Lean BIM-based Management Mode)

Opportunity of BIM Application



US owner BIM ROI
McGraw-Hill Construction, 2009

Stanford CIFE center summarized huge gains and effects by BIM application according to 32 projects in US:

1）Eliminates 40% of the extra-budgetary changes

2）Time of cost estimation reduced by 80%;

3）The contract price reduced by 10% (the average profit of the contractor in the past five years is between 2.8% -3.3% in China);

4）The duration of the project reduced by an average of 7%.

Total construction area of 2010 was 7 billion square meters, the finished area was 2.6 billion square meters, construction investment was 10 billion Yuan. However, each 10,000 square meters of residential construction generated 500-600 tones of construction waste and accounted for 25% of municipal waste, the amount of dust accounted for 22% of the city.

With BIM adoption, cost estimation time can be cut off by 80%, and 40% of the budget changes can be eliminated .

(China Construction Research Institute, 2012 statistics)

Principle and strategy

Three Principles of Lean Management:

- **All stuff participation & Specification**
- **Responsibility & Coordination**
- **Efficiency & Execution**

Shanghai Tower BIM Strategy Include:

What is the BIM Strategy Goal and how to Schedule it?

How to use BIM to increase ROI, accelerate growth?

How to Setup a qualified BIM Management Team?

How to Setup BIM Standard & Progress?

How to Manage & Coordinate all the designer contractor through contract terms

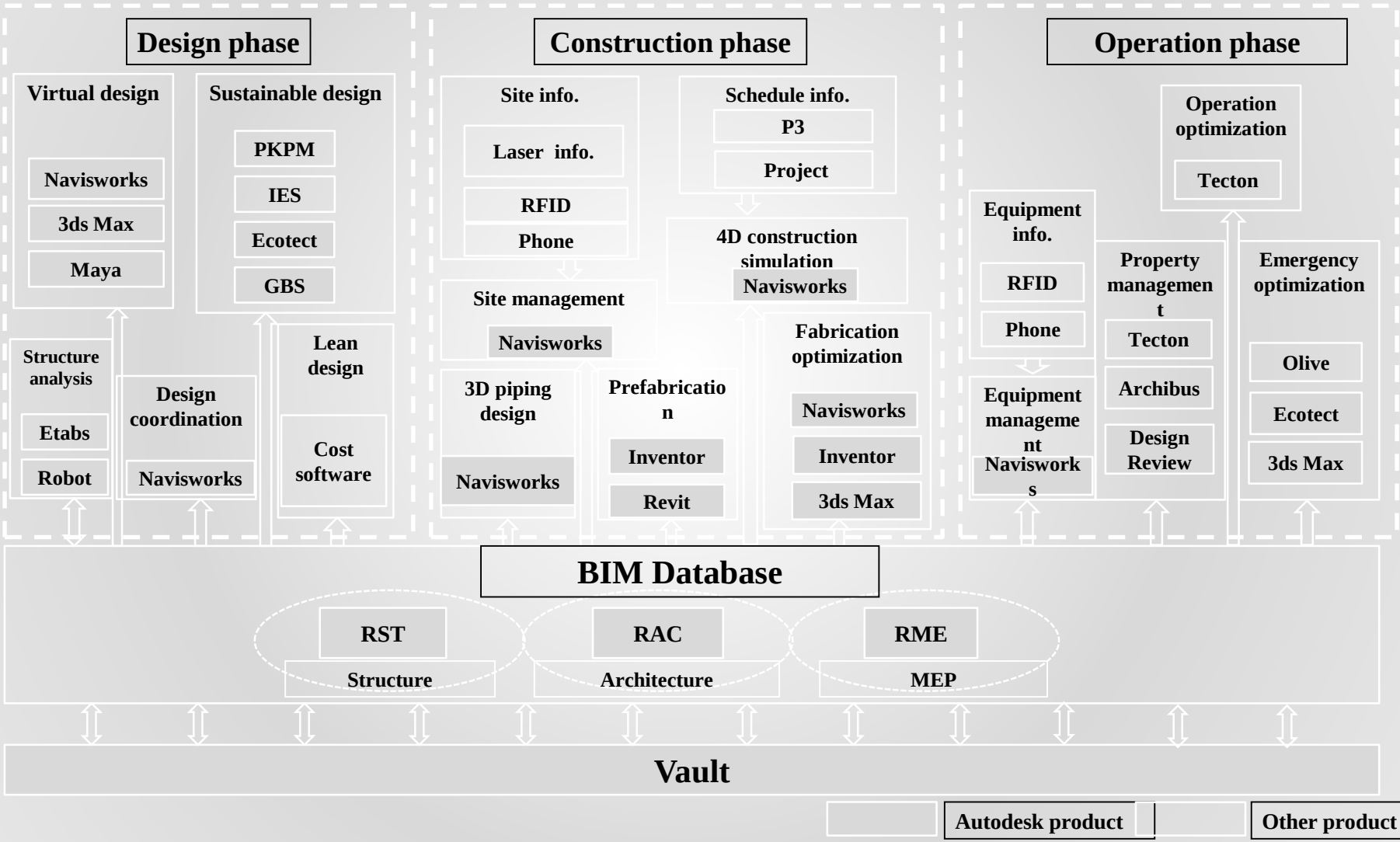
How to Examine BIM Adoption & Achievements?

Strategic Cooperation – Shanghai Tower & Autodesk

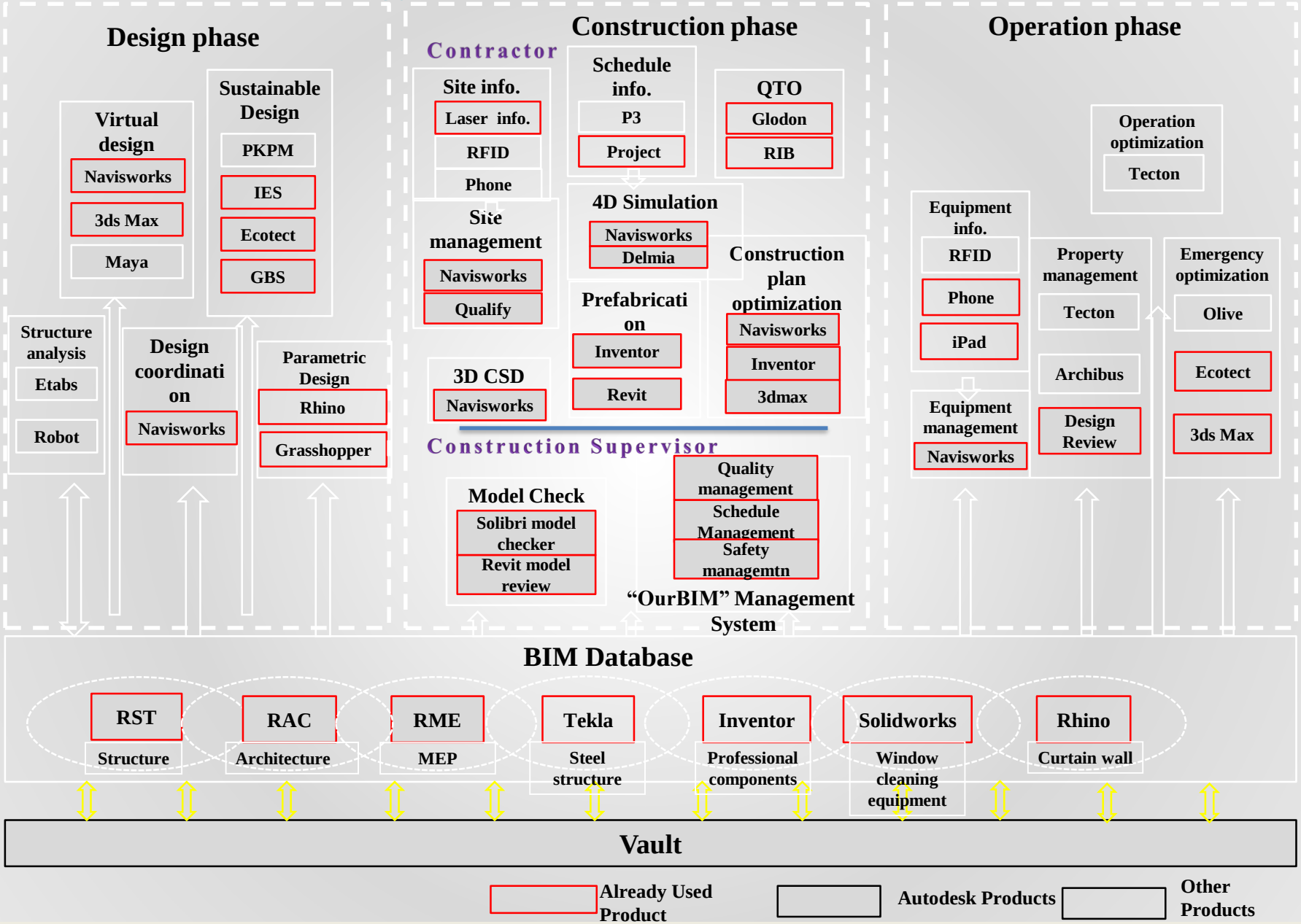
Shanghai Tower – Autodesk MOU Ceremony

2010.05.17

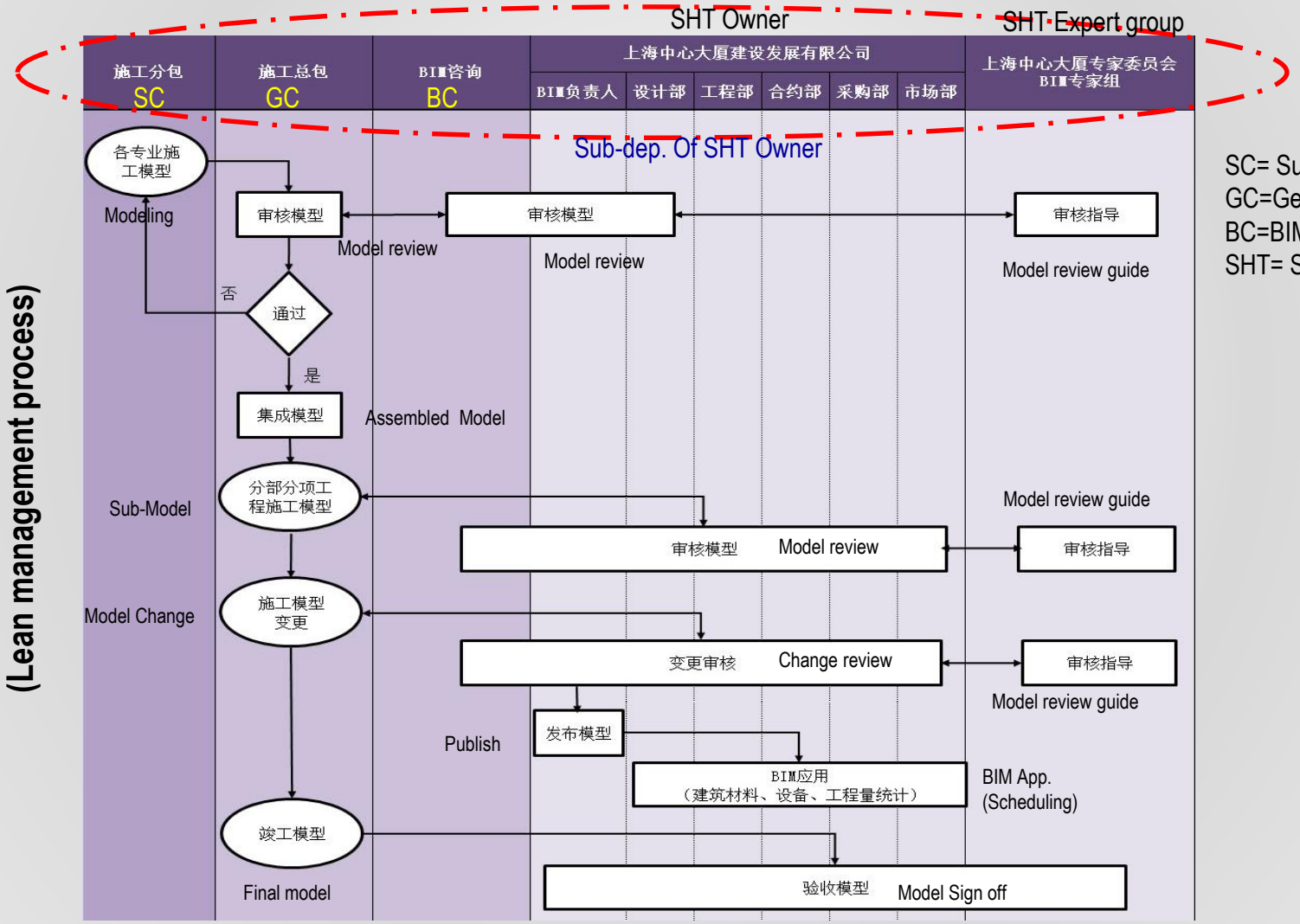
Software and technology framework in 2010



Software and technology framework in 2013

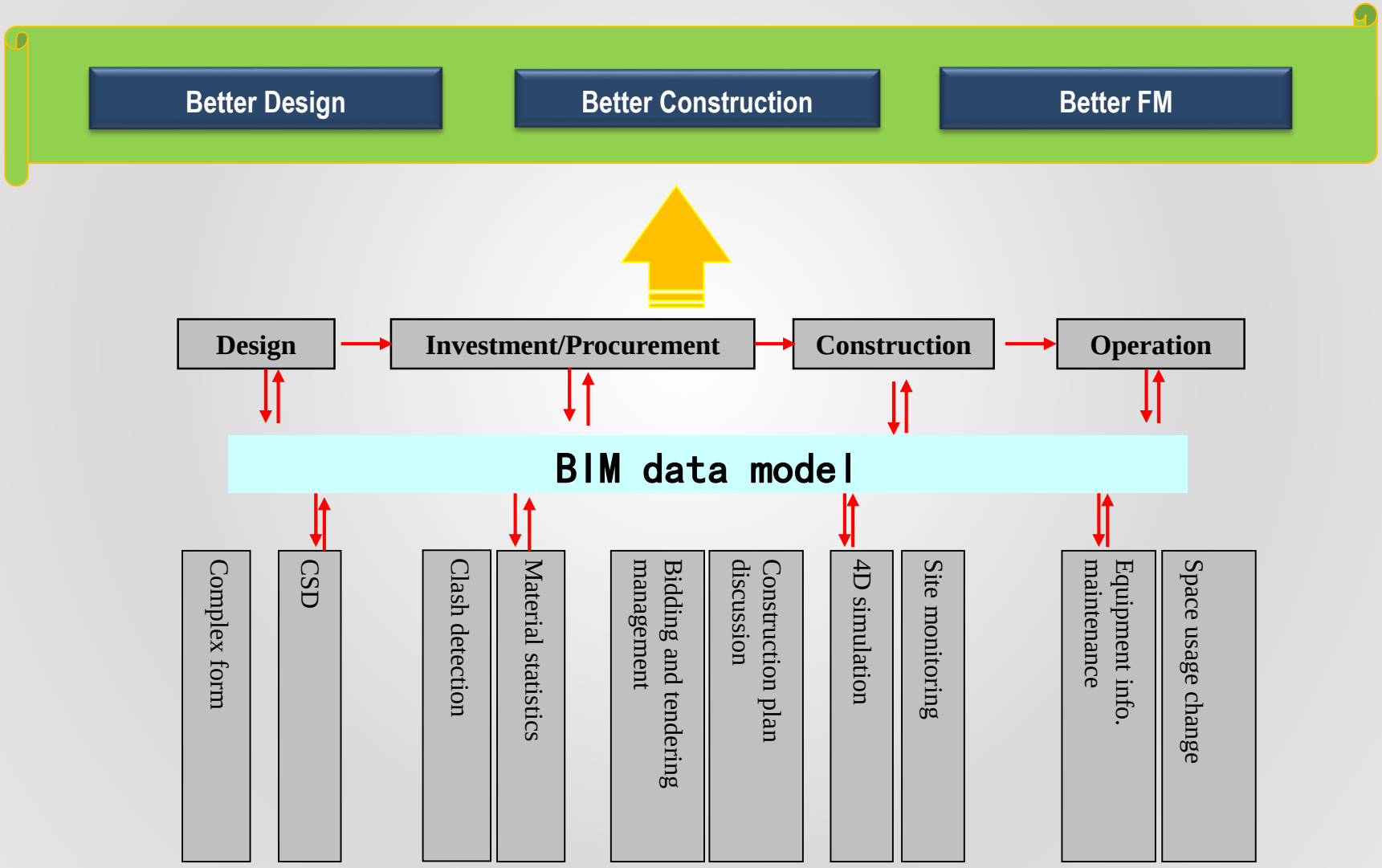


Lean management process

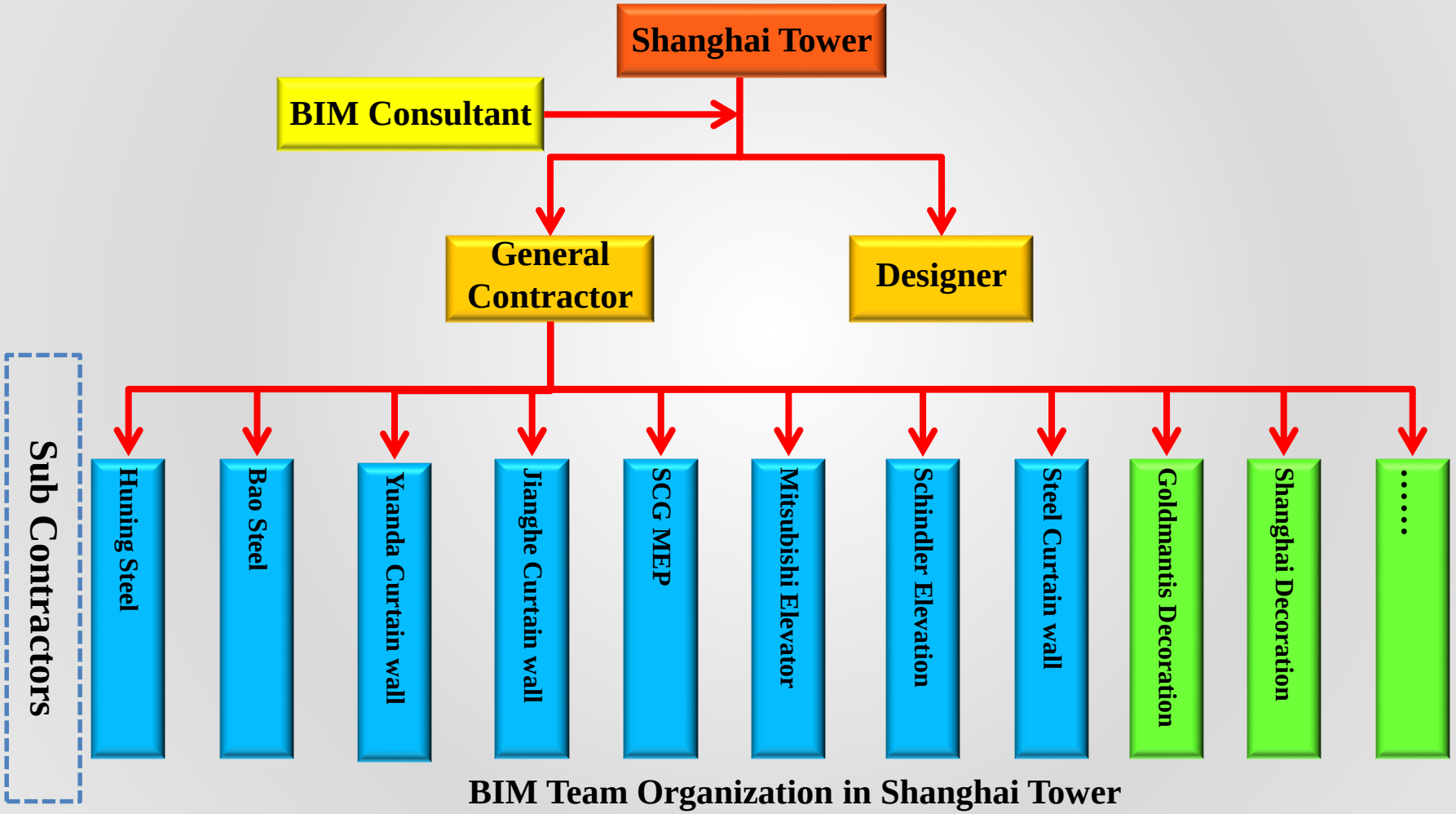


SC= Sub Contract
GC=General Contract
BC=BIM Consulting
SHT= Shanghai Tower

Goal with BIM



Organization framework



BIM Team Organization in Shanghai Tower

BIM Requirement in Tender Documentation

- BIM Requirement for Contractor
- BIM Requirement for Steel Subcontractor
- BIM Requirement for Elevator Subcontractor
- BIM Requirement for Curtain wall Subcontractor
- BIM Requirement for MEP Subcontractor
- BIM Requirement for Window-cleaning Equipment Subcontractor
- Etc.

机电分包工程建筑信息模型化（BIM）要求

分包商应负责在其服务
型，并按业主及总包商要求

1. 基本要求
   1) 分包商应负责在服务
      自身三维技术应用
   2) 分包商应建立完整
      开始BIM模型的创
      组织架构表和执行
   3) 分包商应指派专业
      工作会议，以保证
   4) 分包商应确保软硬
   5) 分包商在服务期内
      度相一致的BIM模
      型，同时向总包商
      的BIM模型集成到
   6) 分包商提供的BIM
      相关顾问公司的审
   7) 分包商应提供所有
      机文件的电子版。
   8) 在项目结束时，分
      BIM应用资料和相

2. BIM技术应用要求
   1) 通过BIM三维可视化
      题并及时处理。
   2) 根据施工进度及时更
      撞位置的检测报告，
   3) 基于BIM模型进行机
   4) 基于BIM模型及施工
      视频等文件，协调施

3. BIM模型要求
   1) BIM模型应能用于定义各方工作界面，满足上海中心项目对模型文件的划分要求。
   2) BIM模型文件应按项目要求合理命名。
   3) BIM模型应包含机电工程中必要的构件，满足上海中心项目对模型构件的建模范围和详细程度的要求，并与项目实际情况保持一致。
   4) BIM模型构件都应按专业附着不同的颜色，以便有效识别和区分。
   5) BIM模型中的构件应能存成独立的参数化族文件，便于管理和各参与方的重复应用。
   6) 分包商应按照总包要求的模型格式来提交满足要求的3D模型。经过挑选的模型将会被整合，分包商将会在后继工作中被要求维护此模型的BIM完整属性。
   7) BIM模型需合理组织和规划，确保能被各方应用。
   8) BIM模型的构件信息应能满足后期运营维护阶段的数据管理应用。可参考《机电分包BIM模型运维信息要求》。业主和总包有权要求分包商根据项目实际情况随时增加相关信息。

4. BIM数据的所有权和权利

   所有BIM模型以及所有其他项目过程中产生的数据都归属于业主所有。

   所有3D，4D和与BIM有关的信息均为保密信息。分包商在发布这些信息之前，应确保得到业主的同意和授权，并做好相关的数据传递/交接纪录。

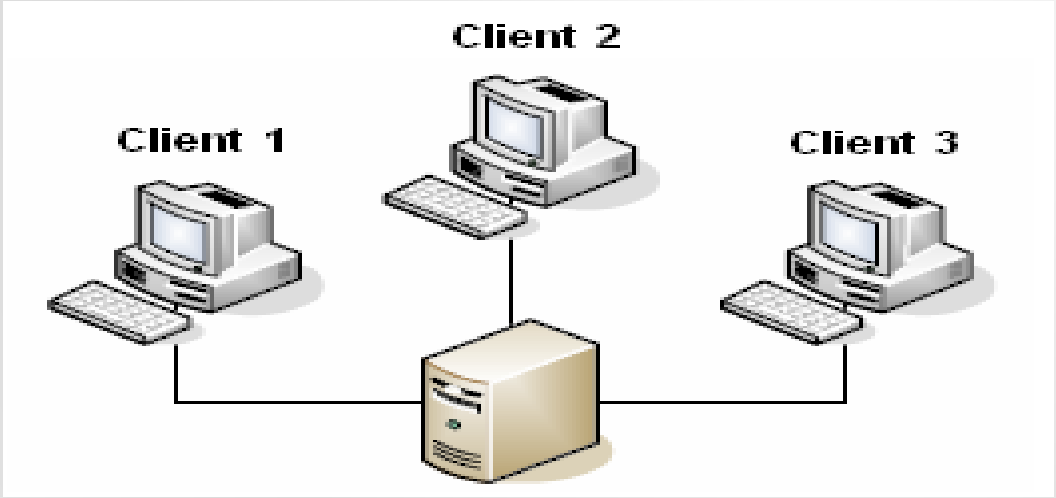
5. BIM工作计划

   分包商应提供BIM模型的创建、维护和应用计划，以及BIM人力资源计划，作为投标文件的组成部分。其中应至少包括以下几个时间节点的说明：

成果描述	完工时间
BIM组织架构表	合同签定后的10天内
BIM执行计划书	合同签定后的20天内
最初的BIM模型	合同签定后的60天内
施工深化图纸	与图纸一起递交BIM模型

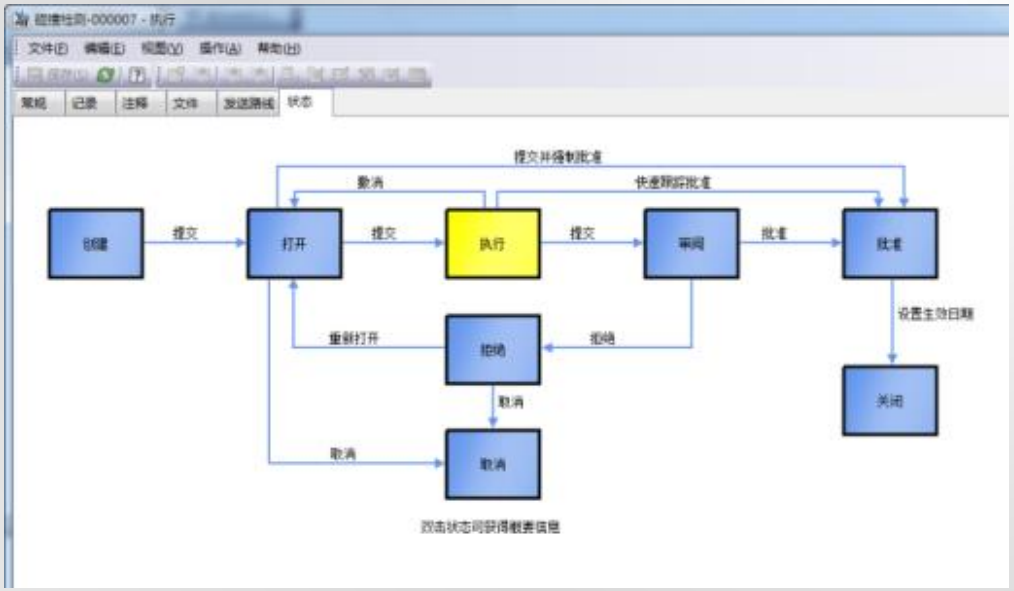
Data Management Platform

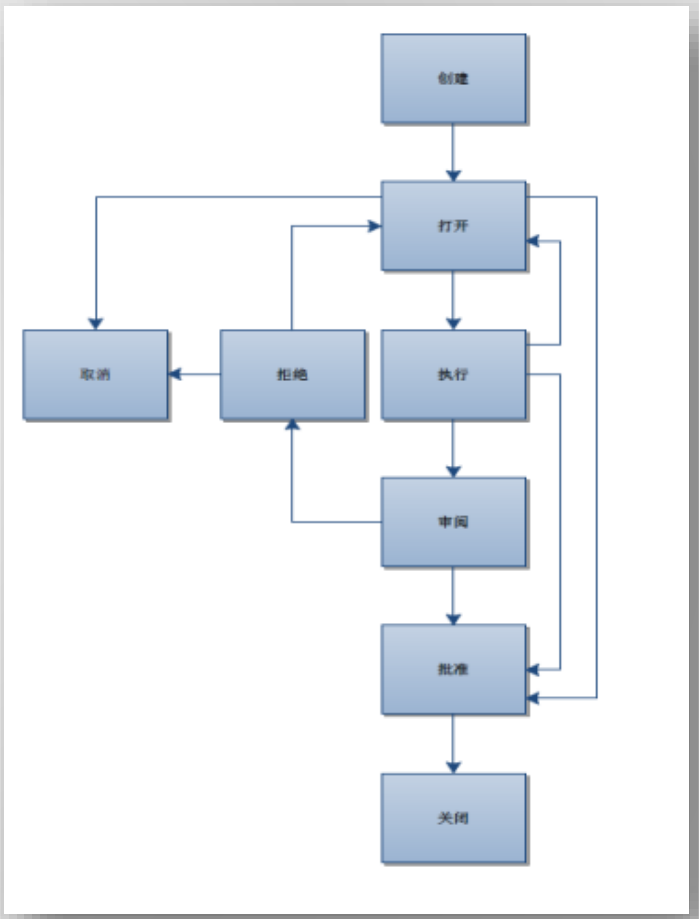
Autodesk Vault



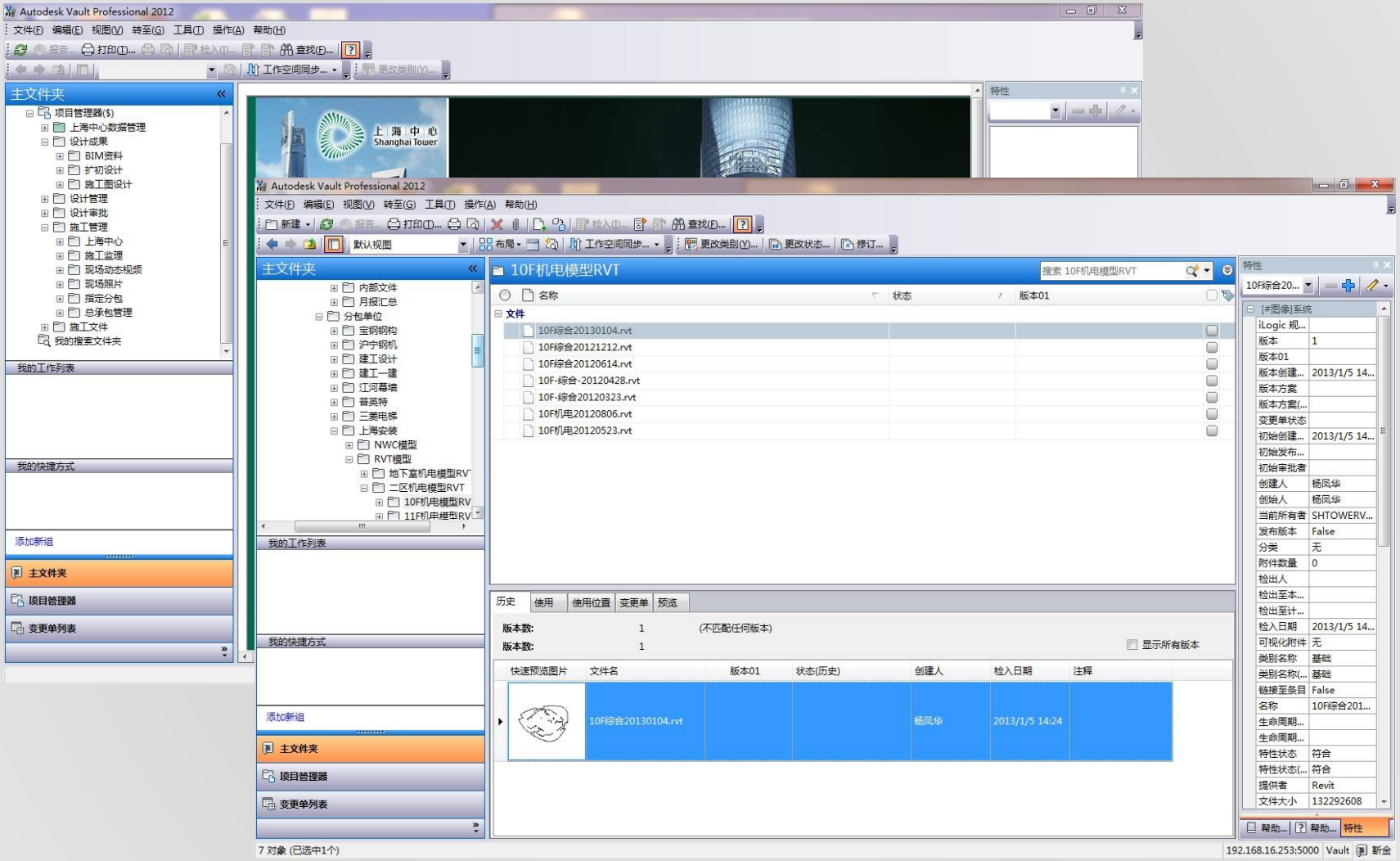
Set up Vault platform to ensure the Accuracy, Timeliness and Safety of data

- Data centralized management and distribution by Vault
- Through change order, auxiliary BIM for each process to ensure the process can proceed smoothly
- Record auditing information and data, for convenience of reviewing
- Remind users by email and working list





Data Management and Sharing by Vault



The data in Vault already surpassed 60G

BIM Standard

上海中心 B

第二版

上海中心

20

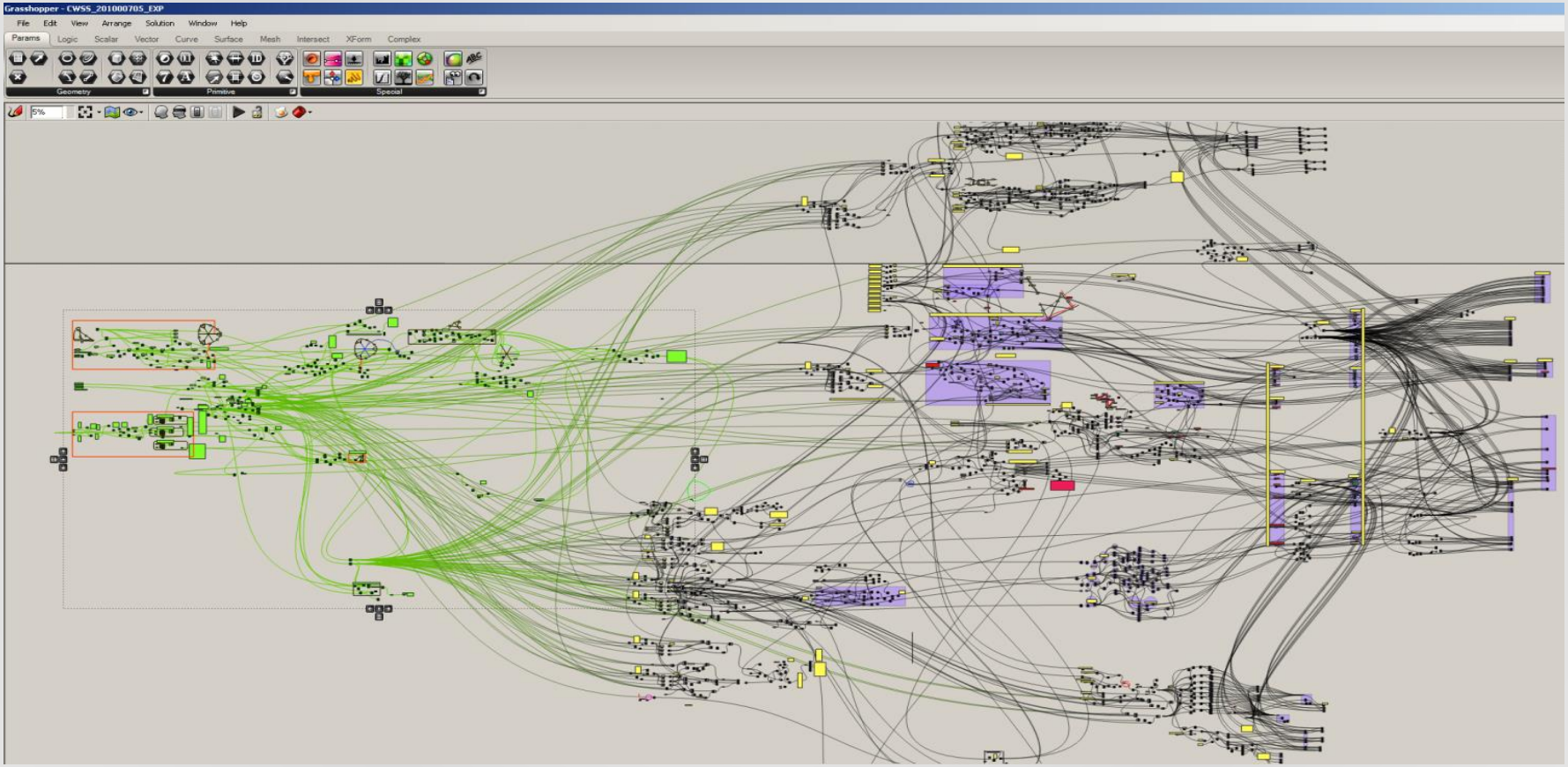
Design Phrase

Visual Design

1）**Improve by multi-discipline collaboration**

2）**Improve by visual design management**

Parametric Design



data input
parameters input
conditions input

formula drive
data drive
scripts drive

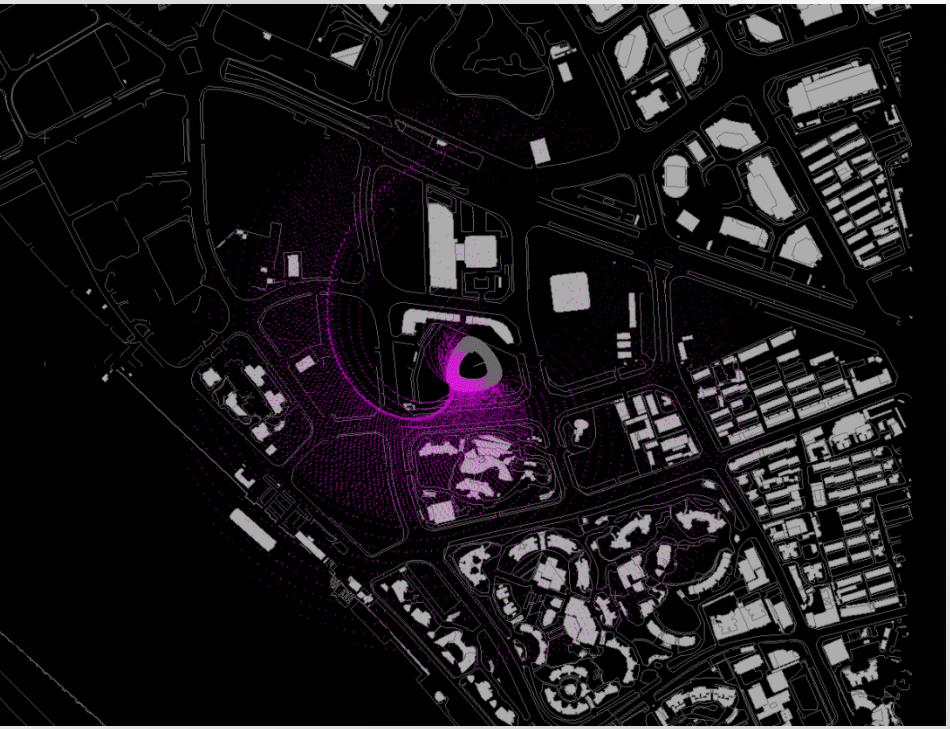
data output
model output

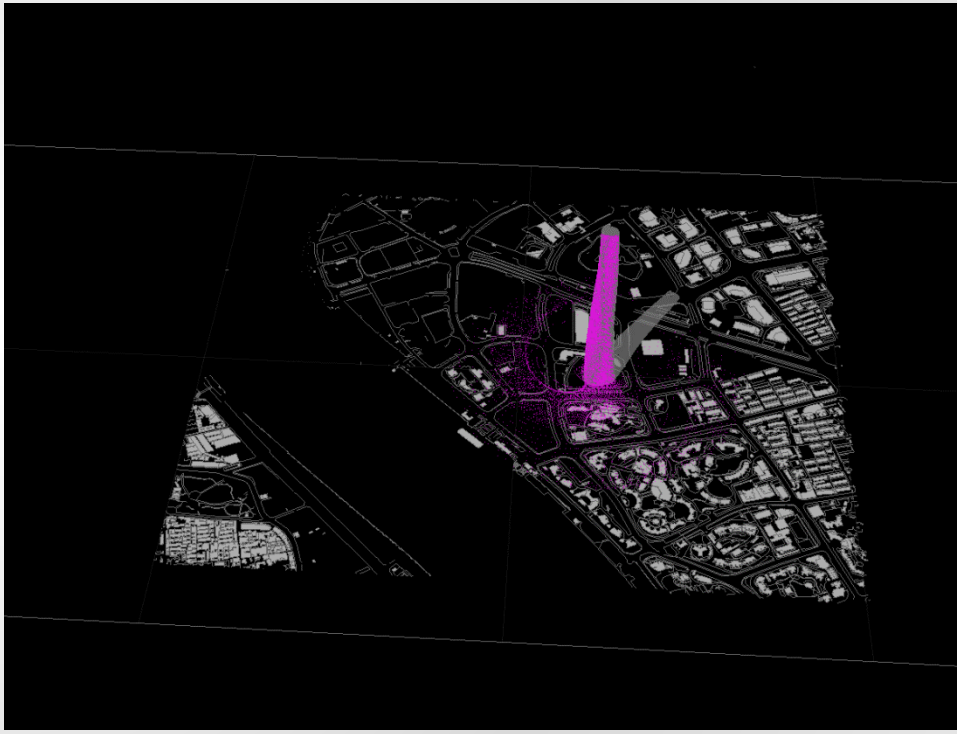
share
analyze
feedback

model final
system selection

return

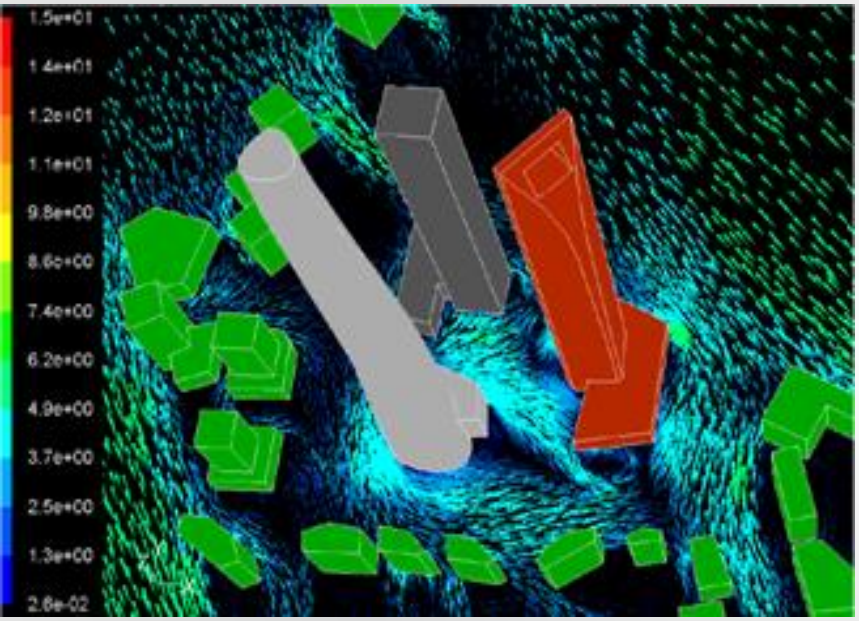
Sustainable Design



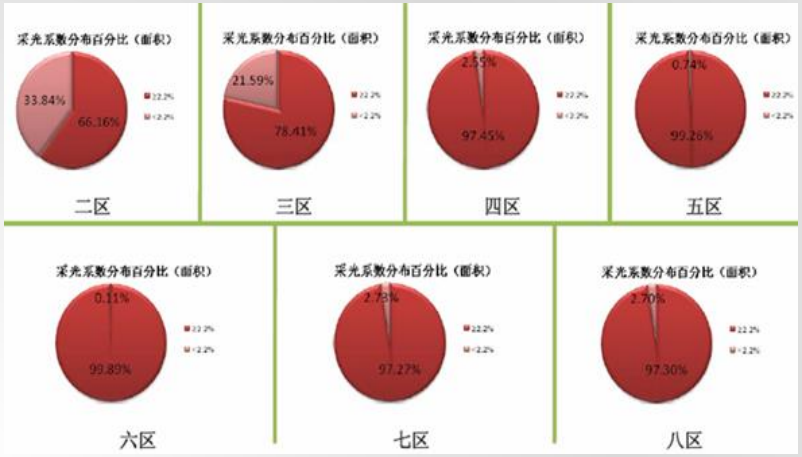


Light Pollution Analysis

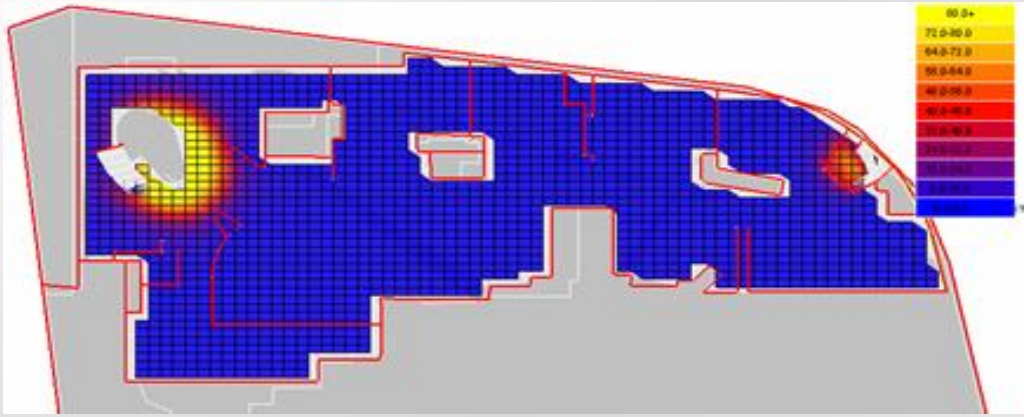
Sustainable Design



Building wind environment simulation



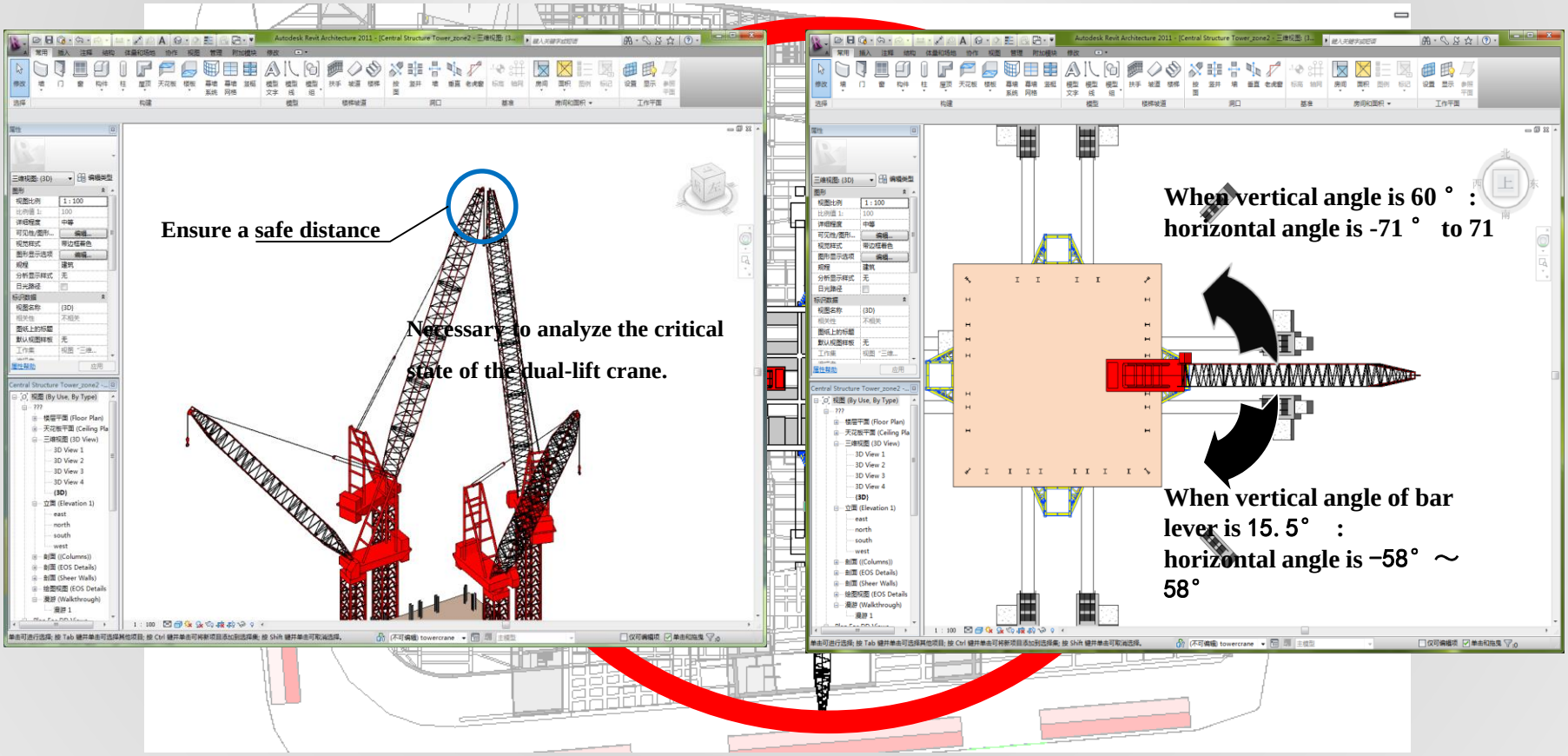
Indoor natural lighting simulation



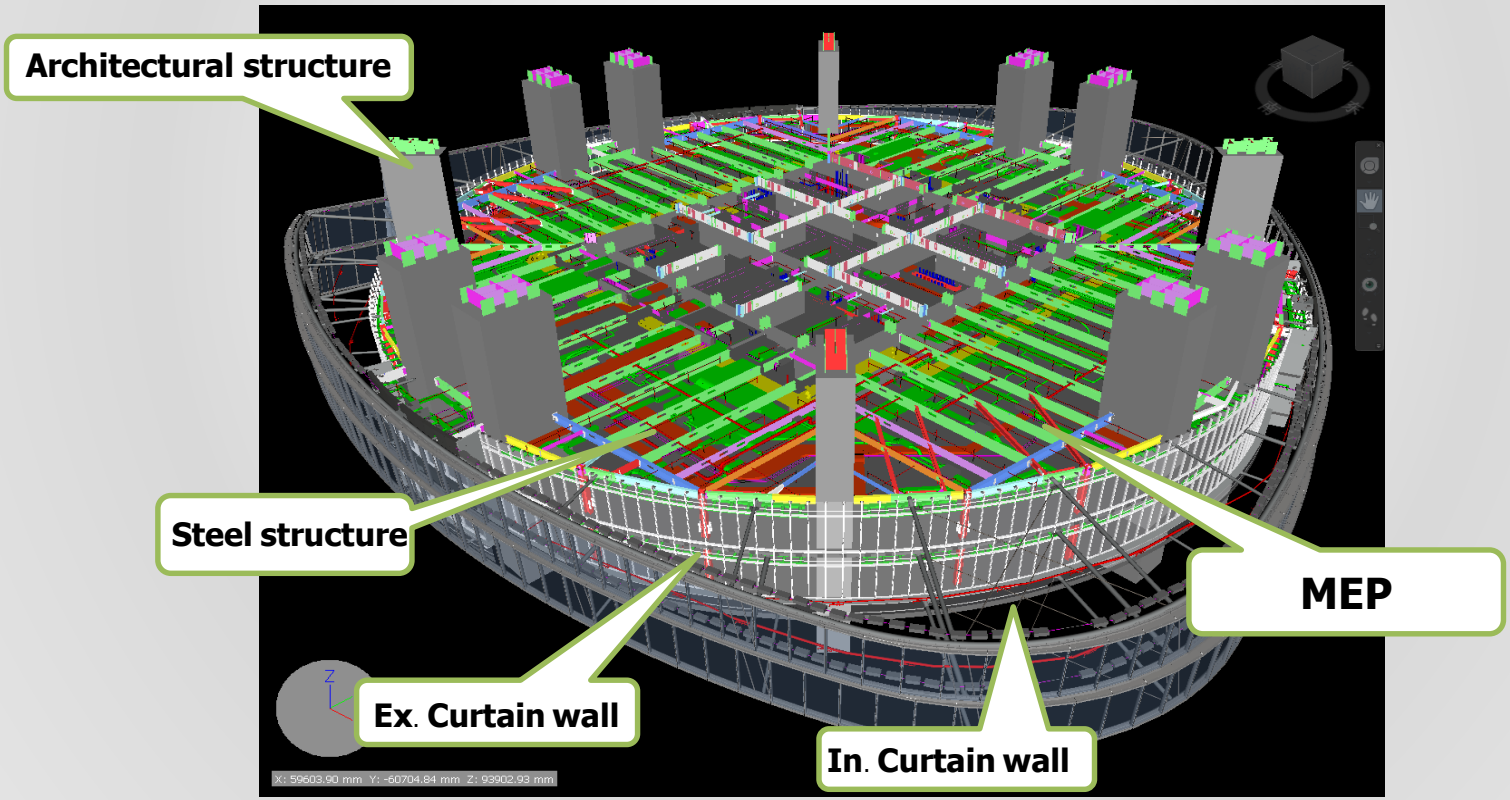
Underground natural lighting simulation

Construction phase

Improve construction management efficiency thru visualized simulation

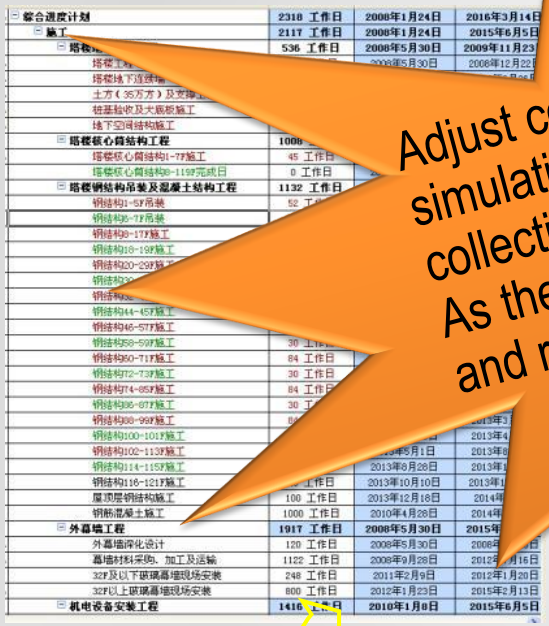


Improve construction efficiency via multi-discipline collaboration

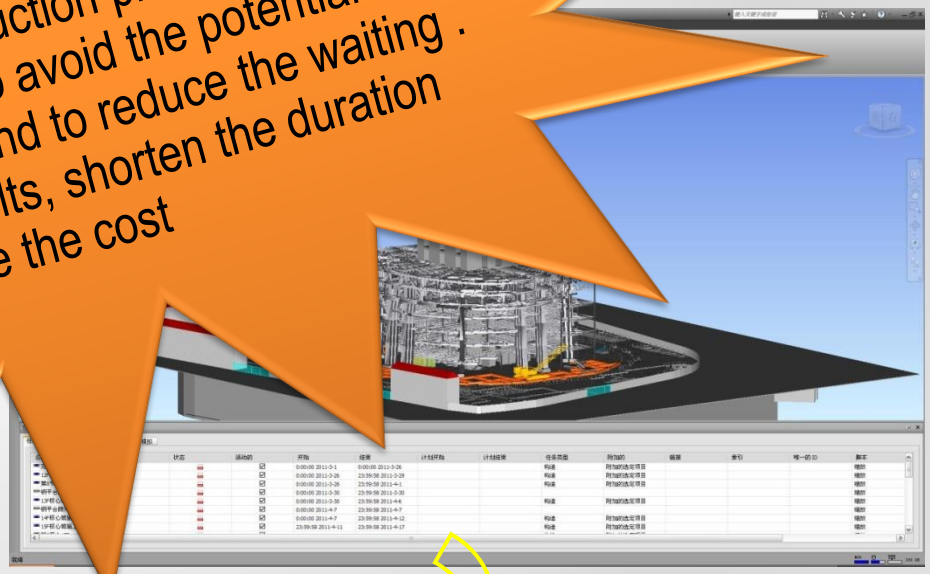


Shorten construction duration thru 4D-Simulation

Construction schedule



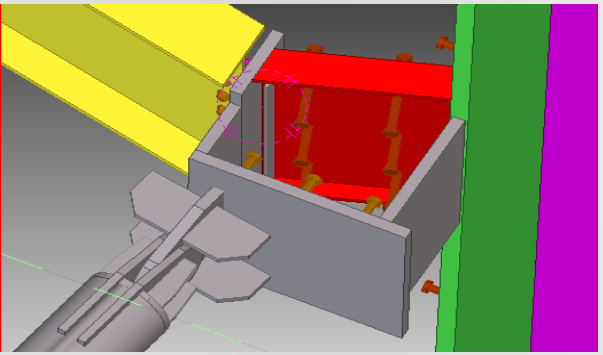
(model)

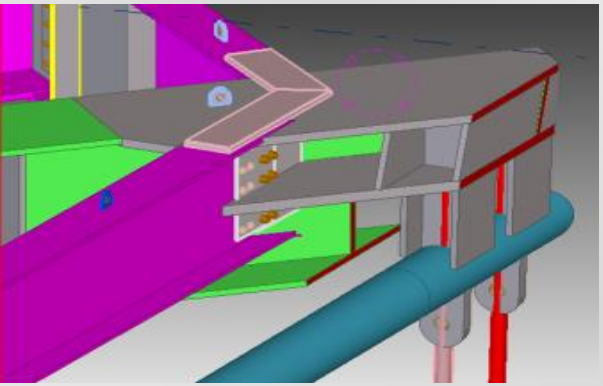


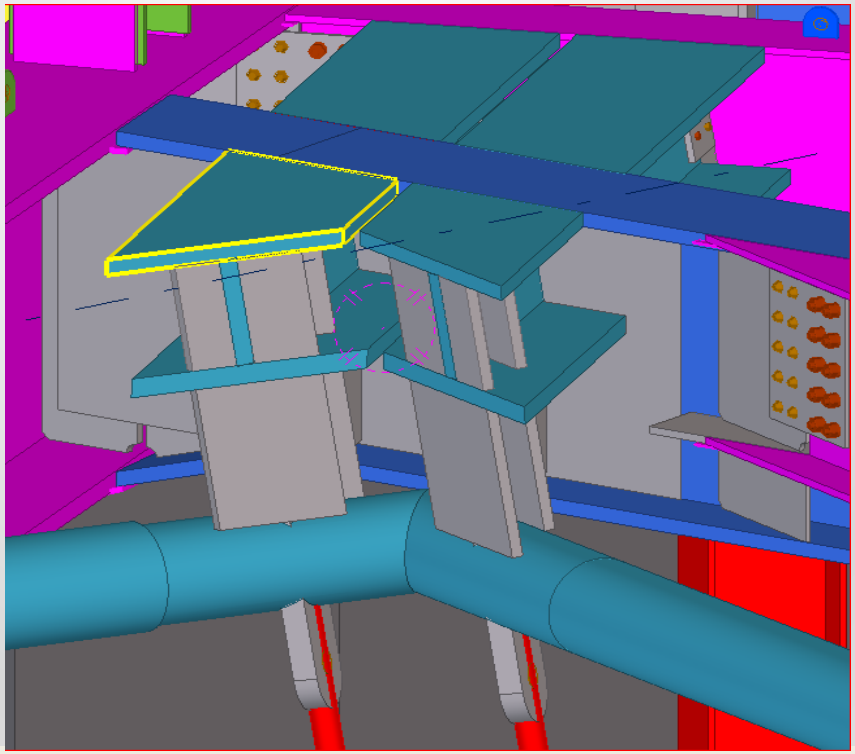
Adjust construction plan via simulation, to avoid the potential collection, and to reduce the waiting . As the results, shorten the duration and reduce the cost

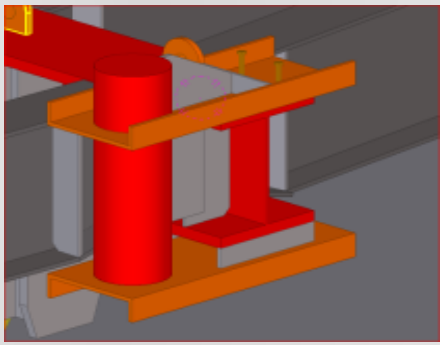
Shorten Construction Duration & Decrease Cost via BIM

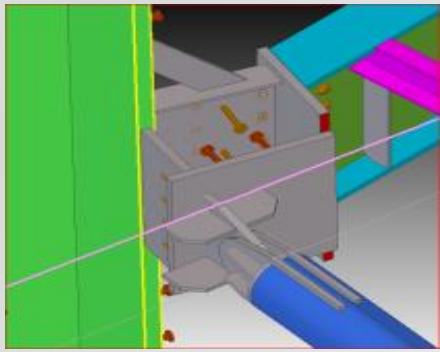
Improve the efficiency and reduce the cost in steel work thru pre-assemble simulation





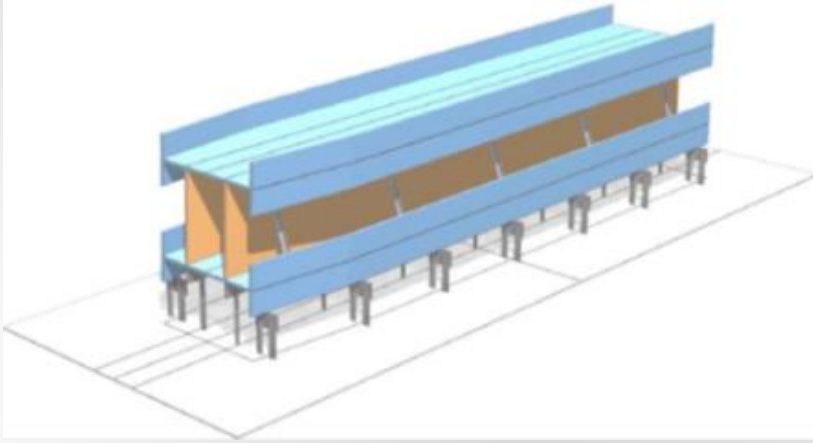


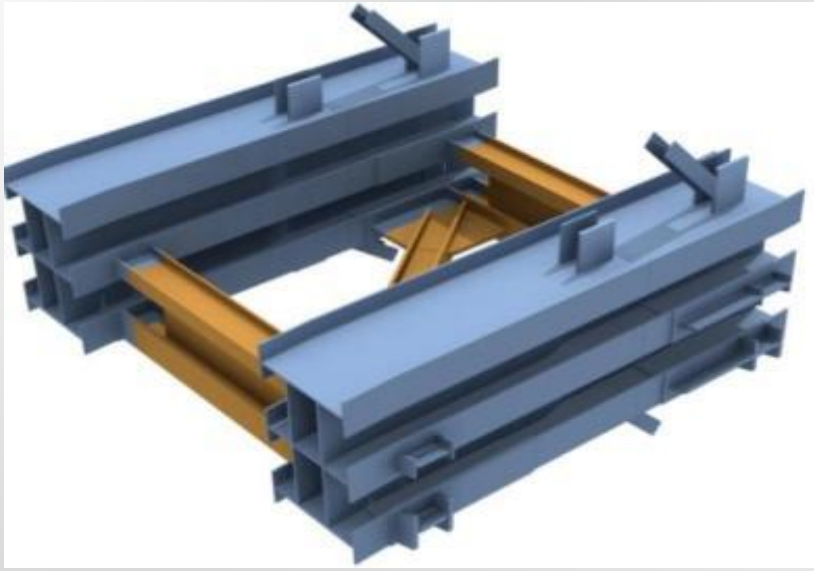




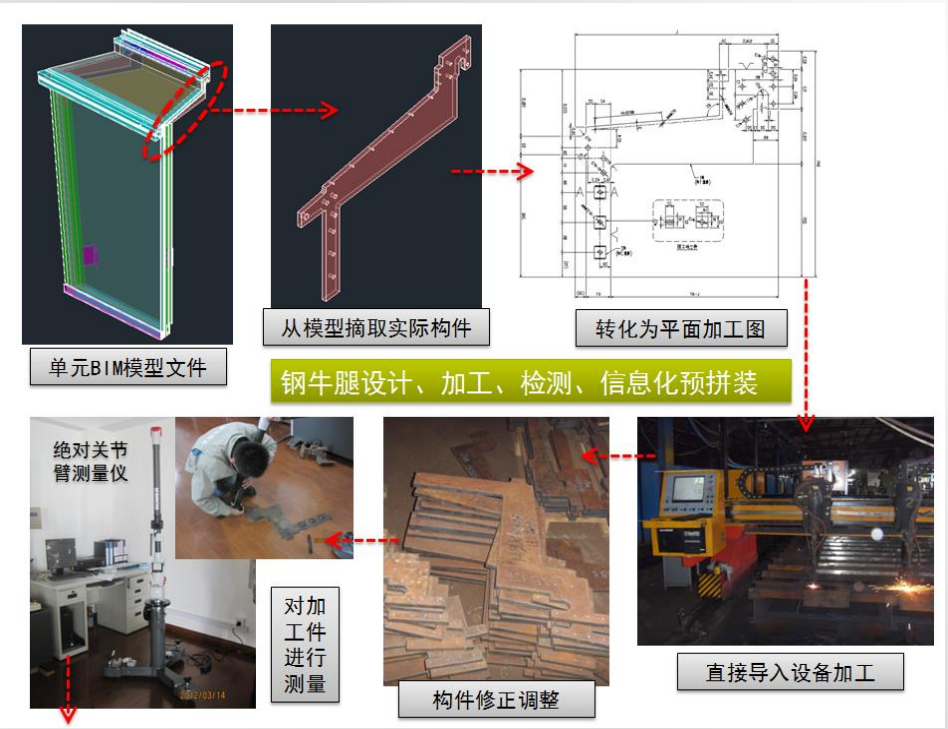
Lean fabrication and construction with BIM model

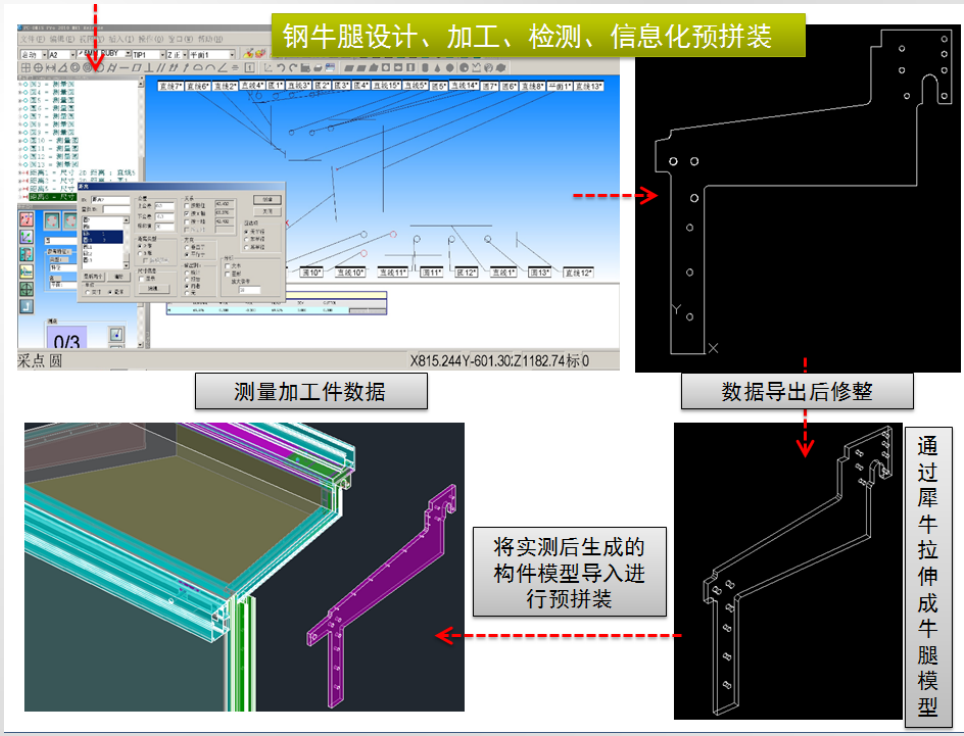
Improve the efficiency and reduce the cost in steel work thru pre-assemble simulation





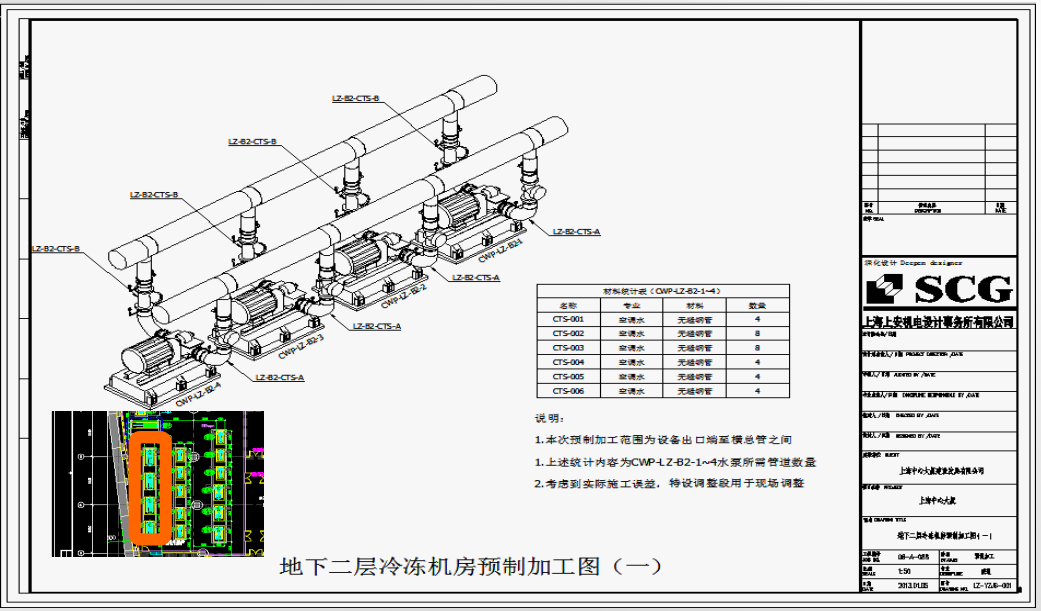
Curtain wall: Improve the efficiency of design and installation thru pre-fabrication & pre-assemble simulation

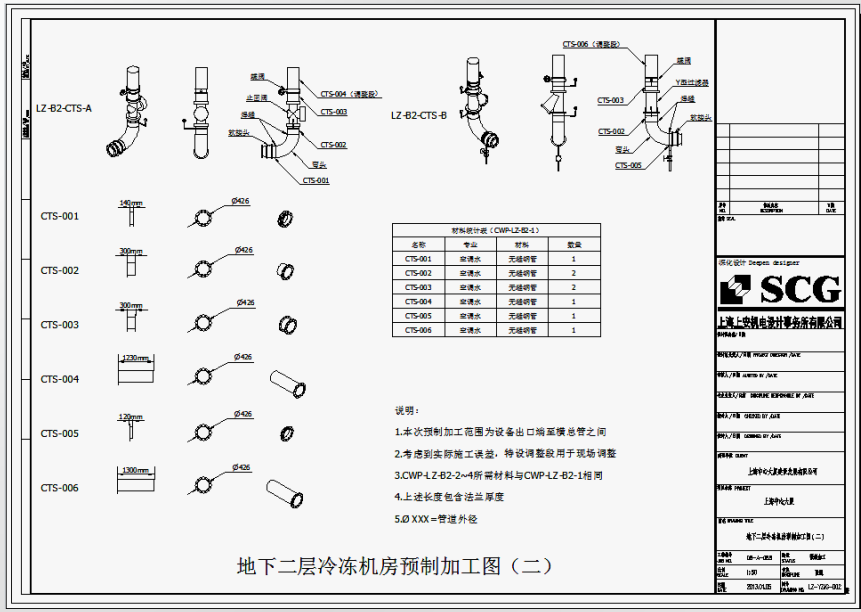




Lean fabrication and construction

MEP: Improve the efficiency and quality of design and prefabrication thru detailed design and pre- assemble simulation with BIM





Lean fabrication and construction

MEP: Improve the efficiency and quality of design and prefabrication thru detailed design and pre- assemble simulation)

Retrieve info via scanning code on ducts

物料信息	
物料编码	7#-4F-SA-1
物料类型	风管（预制加工）
物料描述	铁狮门加工测试物料 规格 长：1.5M 宽：0.7M 高0.4M 7号楼预制加工件 吊装
生产信息	
生产厂商	上海市安装公司-预制工厂
生产日期	2012年12月17日
生产编码	S201250004（2012年50周004号）
成品入库	2012年12月17日
成品出库	2012年12月28日
安装信息	
安装单位	上海市安装公司-第一分公司
到库日期	2012年12月28日
仓管员	林琪
领料安装日期	2013年1月7日
领料安装班组	风管班-1
内控检验日期	
内控检验	

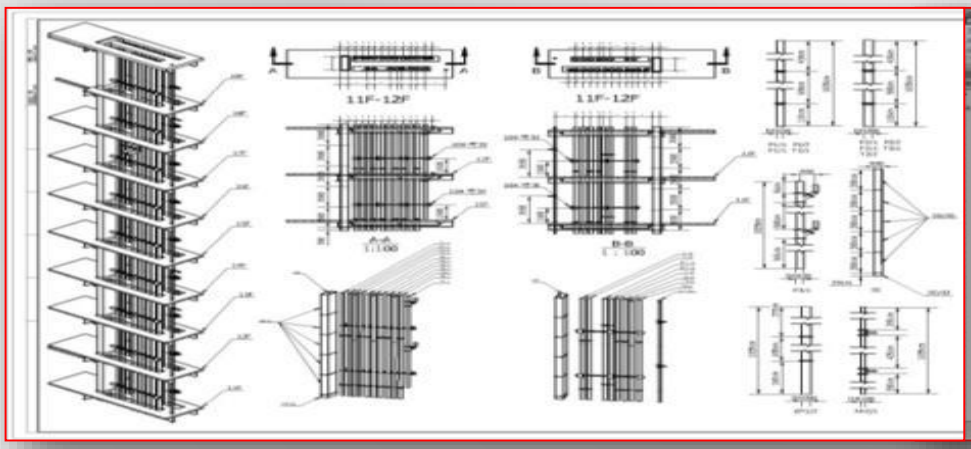
Retrieve electronic info from paper

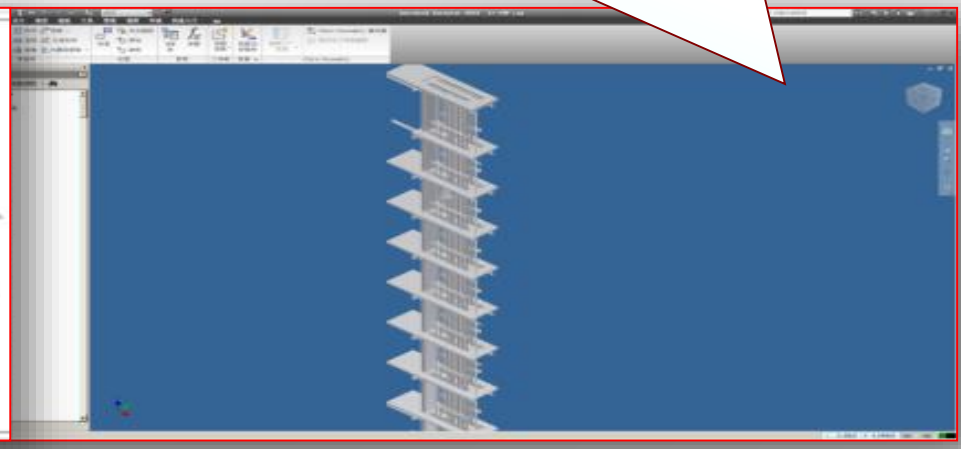
Retrieve info of location ,properties & parameters, including installer, installation time

Lean fabrication and construction

MEP: Improve the efficiency and quality of design and prefabrication thru detailed design and pre-assemble simulation

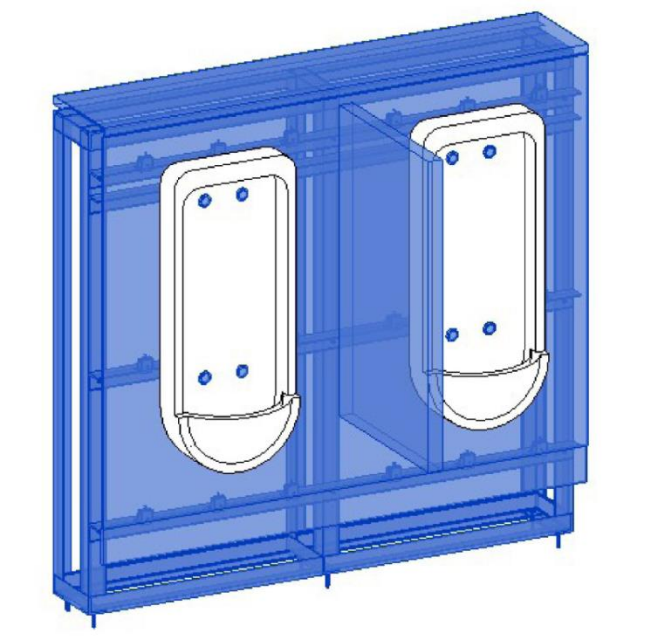
Benefits from Lan Prefabrication and construction plan：
1） 60% site work reduction
2） 90% reduction in hazard and poisonous work, ex. welding, glue, etc.)
3） 70% prefabrication of duct and pipe



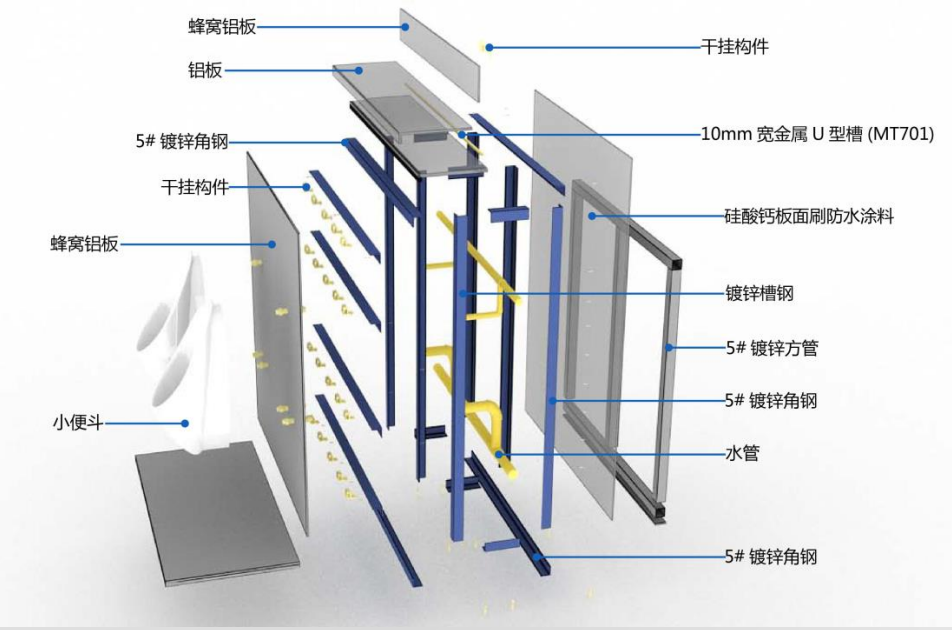


Lean fabrication and construction

BIM for Decoration : improve quality and efficiency and reduce site work thru BIM model based design



Urinal unit



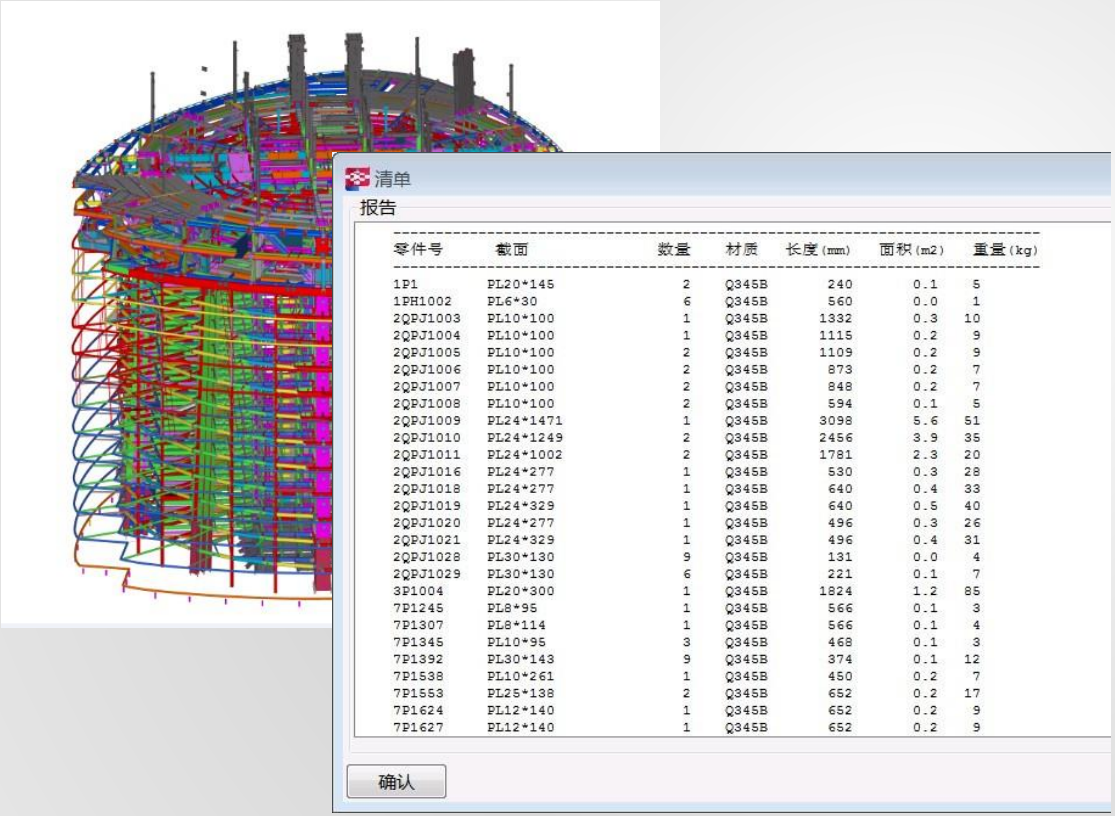
Displaced view of Urinal

BIM for Decoration : improve quality and efficiency and reduce site work thru BIM model based design

BIM Model vs. On-site Installation Results

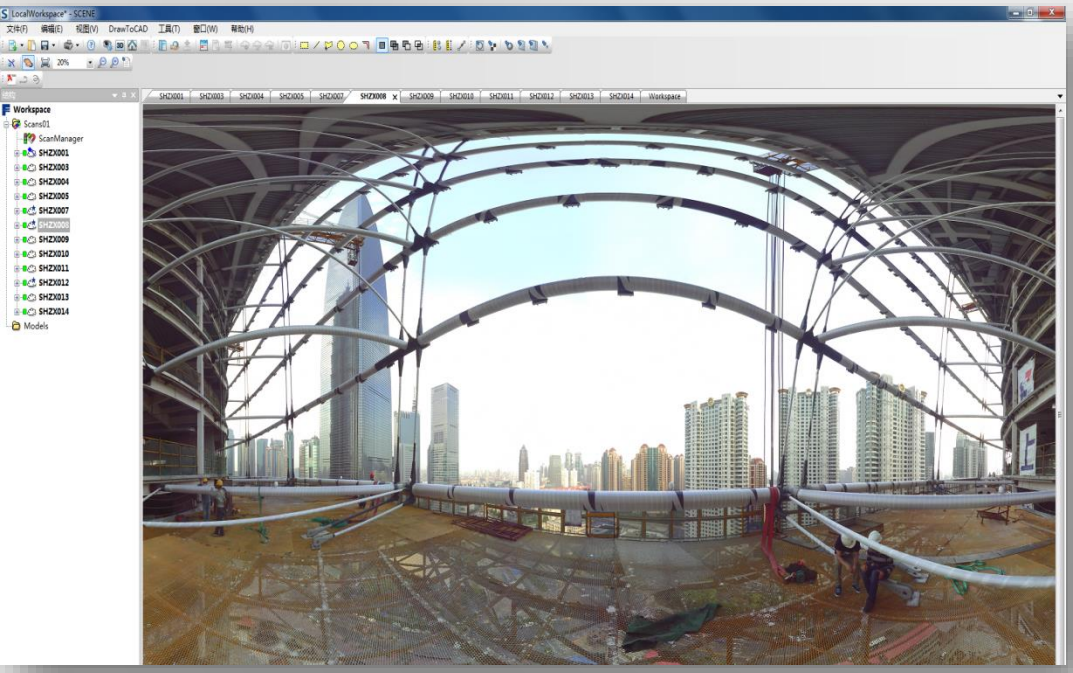
Quantity Take-off by BIM

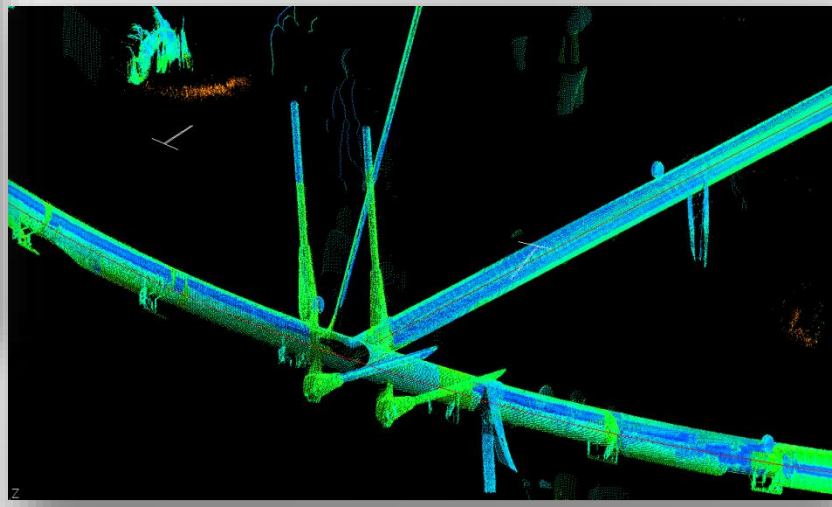
- Architecture, Steel, MEP, Curtain wall, Decoration



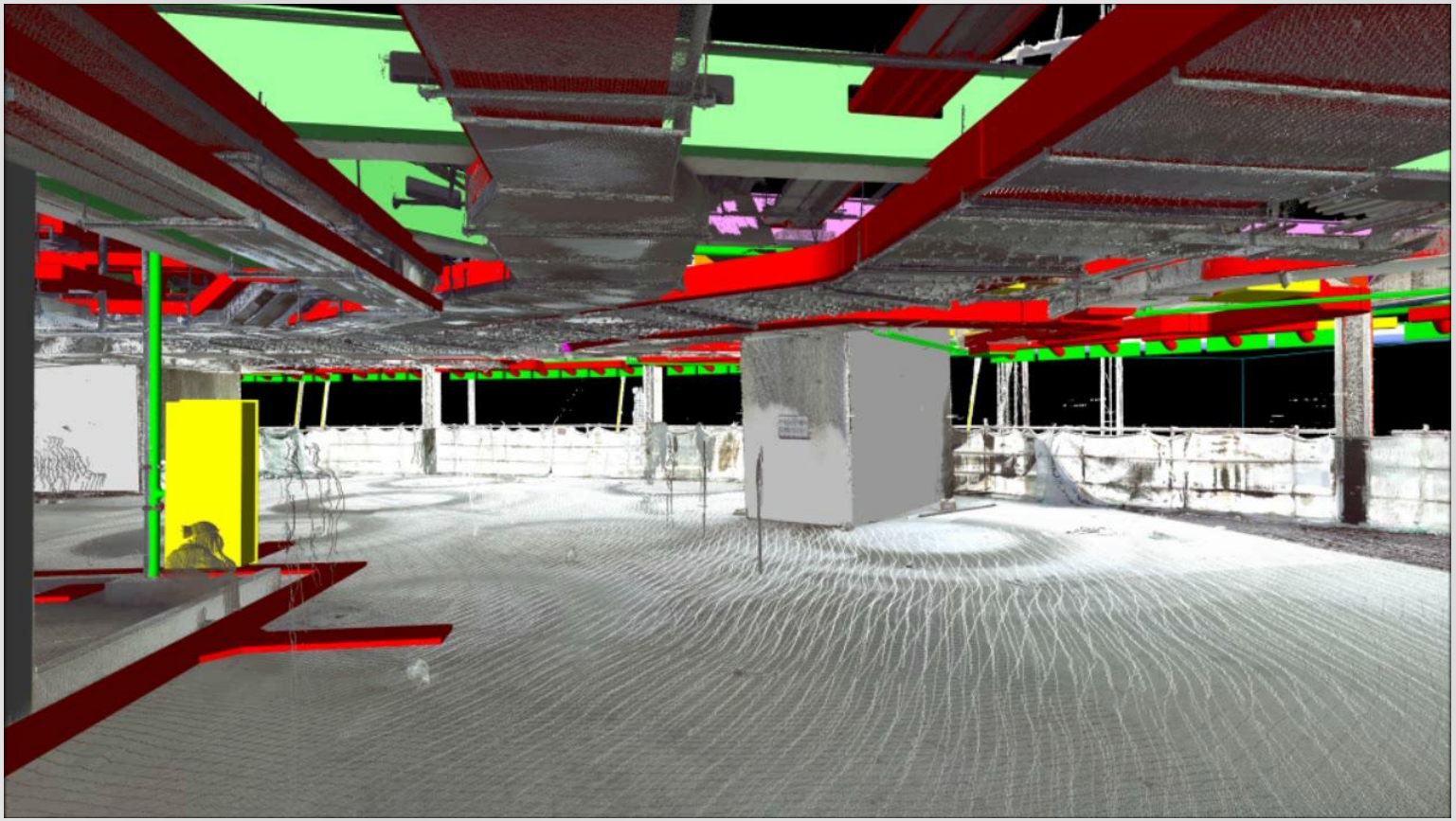
- Info. lost from design model to QTO model
- Lack of QTO info. in design model
- Modeling rule difference
- etc.

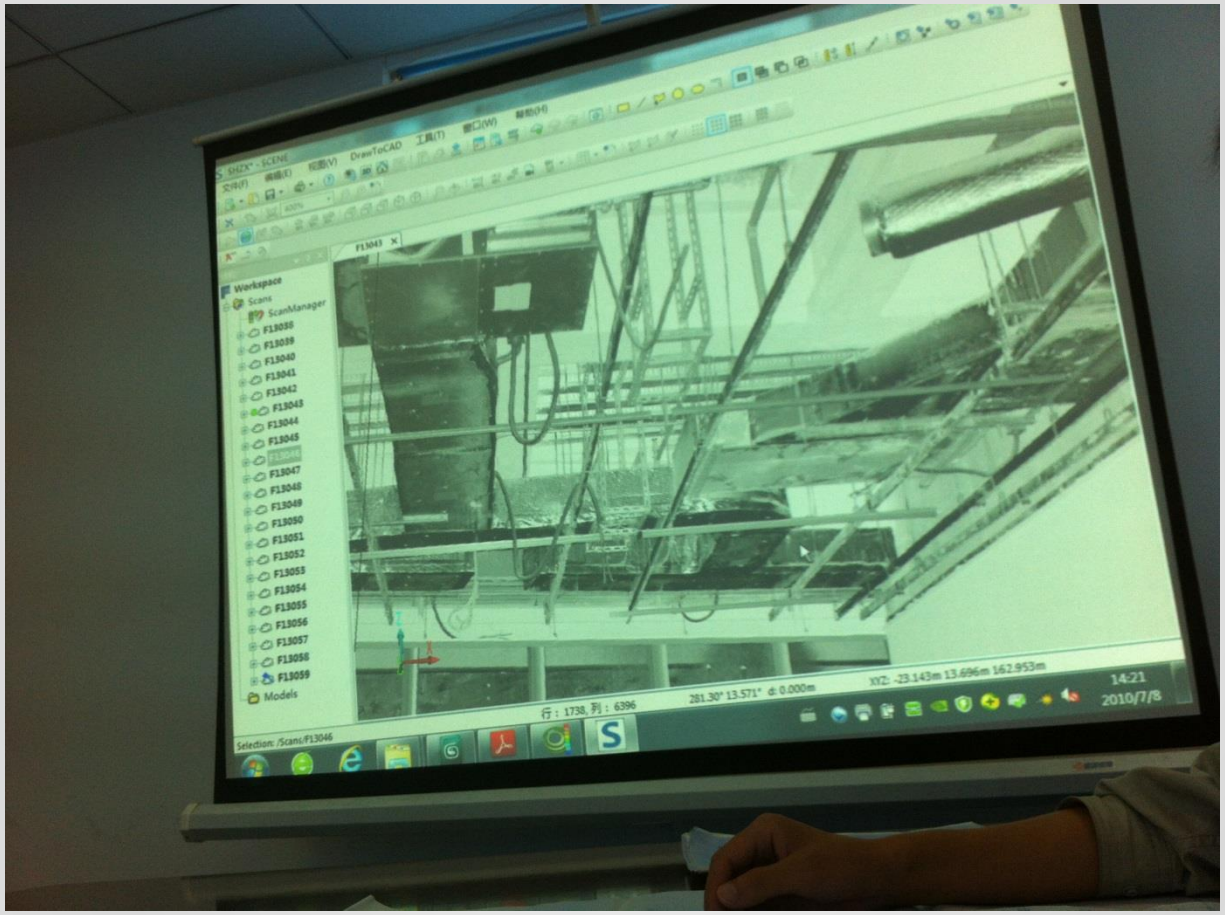
Site monitoring via 3D laser scanning and BIM





Site monitoring via 3D laser scanning and BIM




Workspace
Scans
ScanManager
F13038
F13039
F13040
F13041
F13042
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F13049
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Models
14:21
2010/7/8

Drawings to models

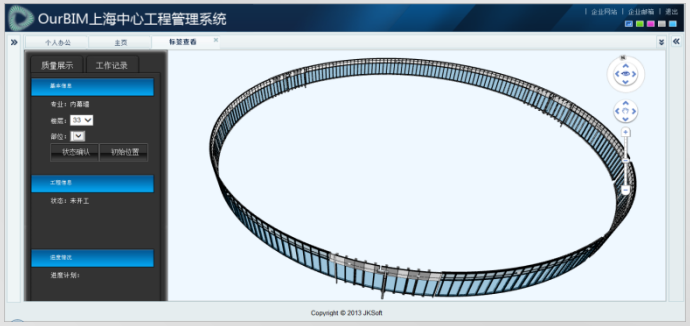
BIM Practice by Construction Supervisors

With BIM, supervision work extended to the design stage, construction preparation stage, construction stage and completion stage.

- Design stage – initial confirmation
- Construction preparation stage – intuitive understanding
- Construction stage – management of quality, schedule and safety
- Completion stage – model confirmation and information integration

OurBIM System

One platform
+
two sets of models
=
management function

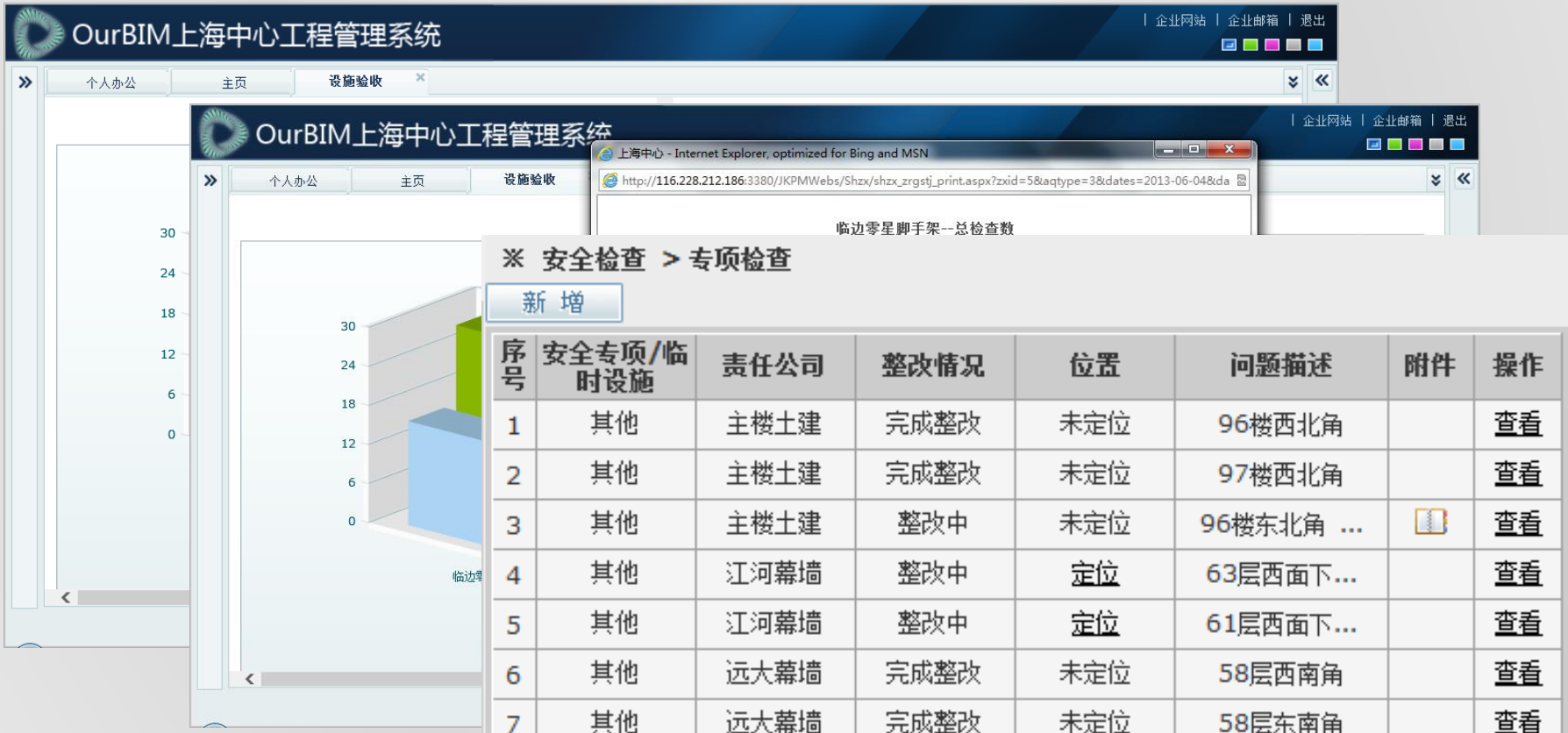


Schedule management: record

Quality management: label

标签对应问题详细信息

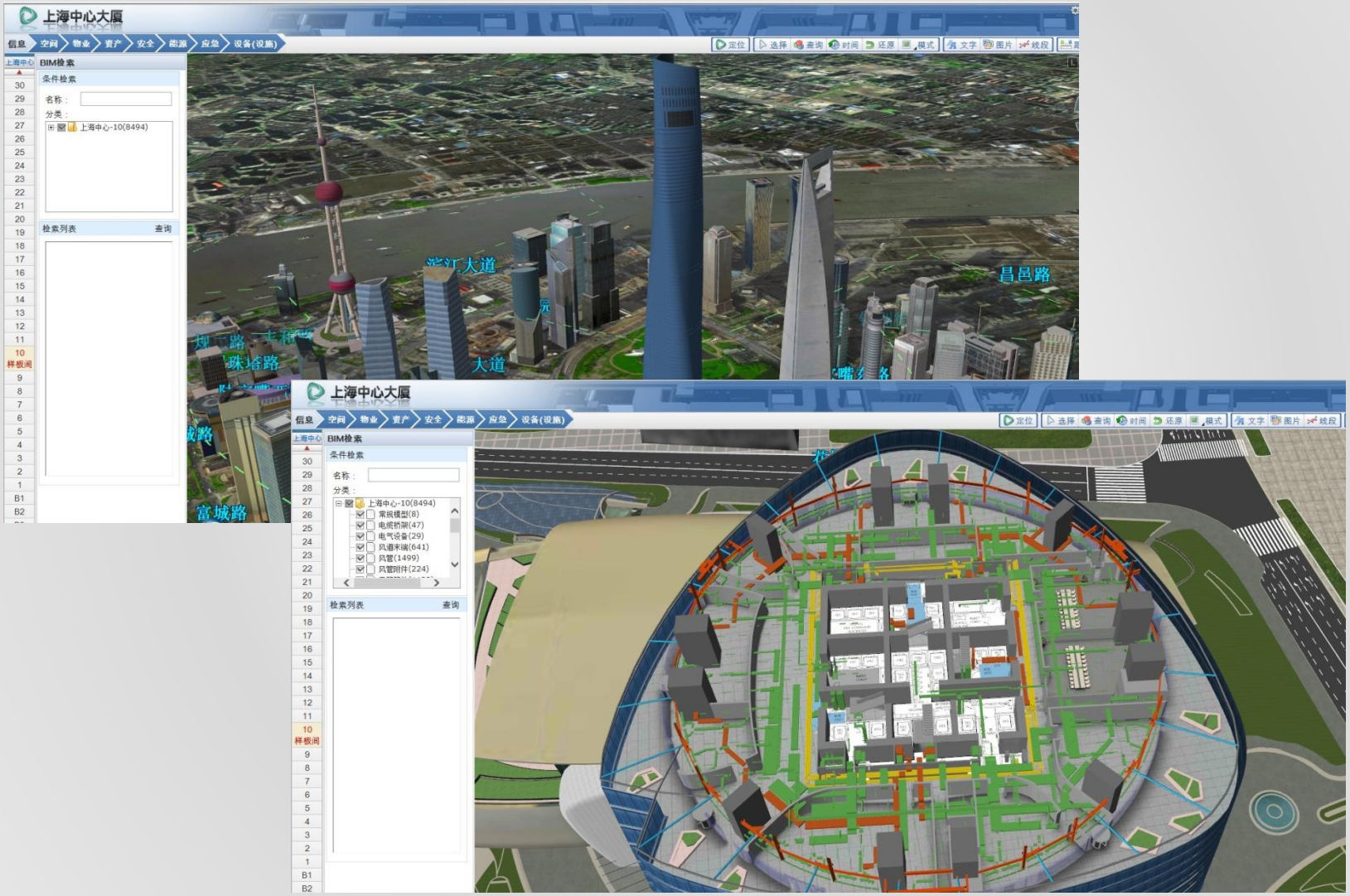
Safety management: analysis



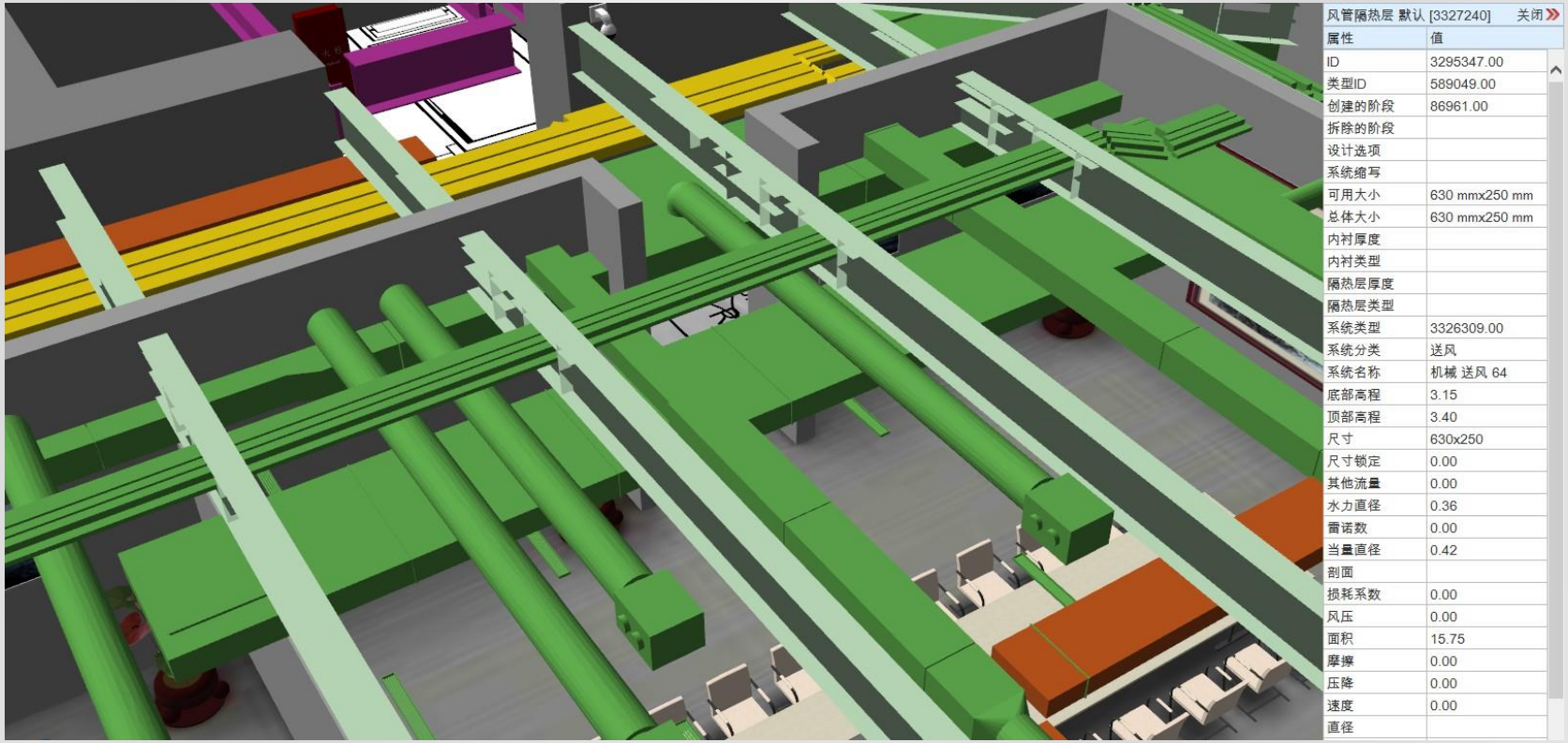
序号	安全专项/临时设施	责任公司	整改情况	位置	问题描述	附件	操作
1	其他	主楼土建	完成整改	未定位	96楼西北角		查看
2	其他	主楼土建	完成整改	未定位	97楼西北角		查看
3	其他	主楼土建	整改中	未定位	96楼东北角 ...		查看
4	其他	江河幕墙	整改中	定位	63层西面下...		查看
5	其他	江河幕墙	整改中	定位	61层西面下...		查看
6	其他	远大幕墙	完成整改	未定位	58层西南角		查看
7	其他	远大幕墙	完成整改	未定位	58层东南角		查看
8	其他	远大幕墙	整改中	定位	58层东北卡...		查看

STATISTICS FORM

Operation phase



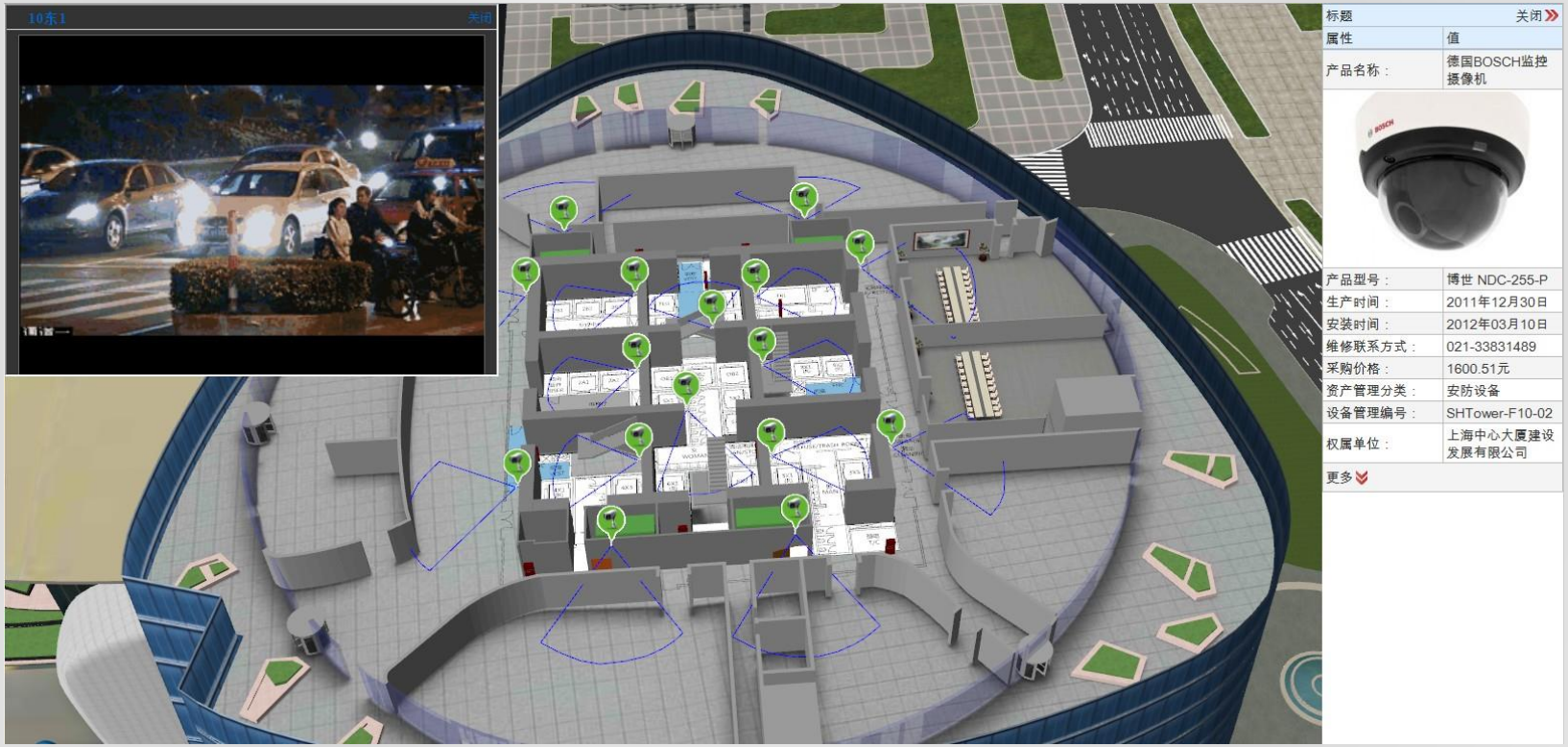
Asset management



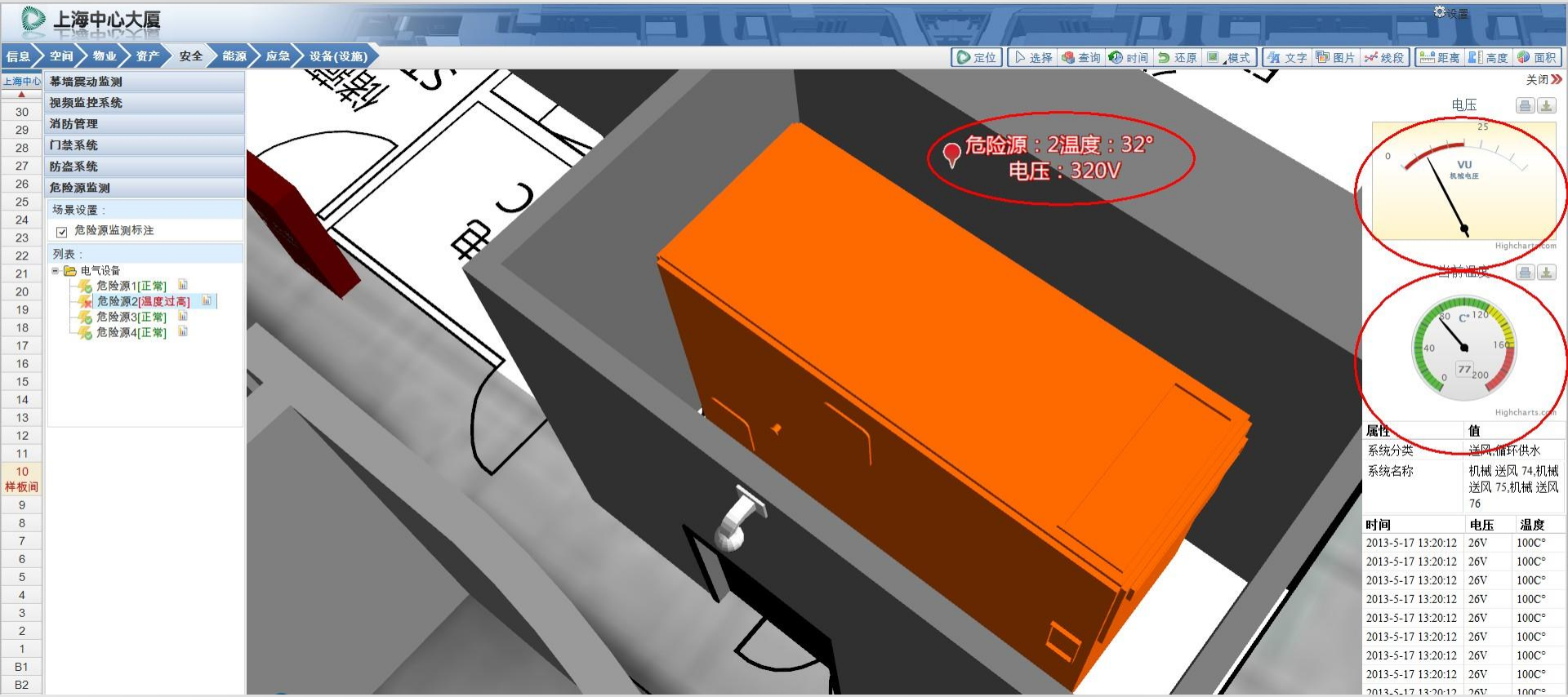
风管隔热层 默认 [3327240] 关闭

属性	值
ID	3295347.00
类型ID	589049.00
创建的阶段	86961.00
拆除的阶段	
设计选项	
系统缩写	
可用大小	630 mmx250 mm
总体大小	630 mmx250 mm
内衬厚度	
内衬类型	
隔热层厚度	
隔热层类型	
系统类型	3326309.00
系统分类	送风
系统名称	机械 送风 64
底部高程	3.15
顶部高程	3.40
尺寸	630x250
尺寸锁定	0.00
其他流量	0.00
水力直径	0.36
雷诺数	0.00
当量直径	0.42
剖面	
损耗系数	0.00
风压	0.00
面积	15.75
摩擦	0.00
压降	0.00
速度	0.00
直径	

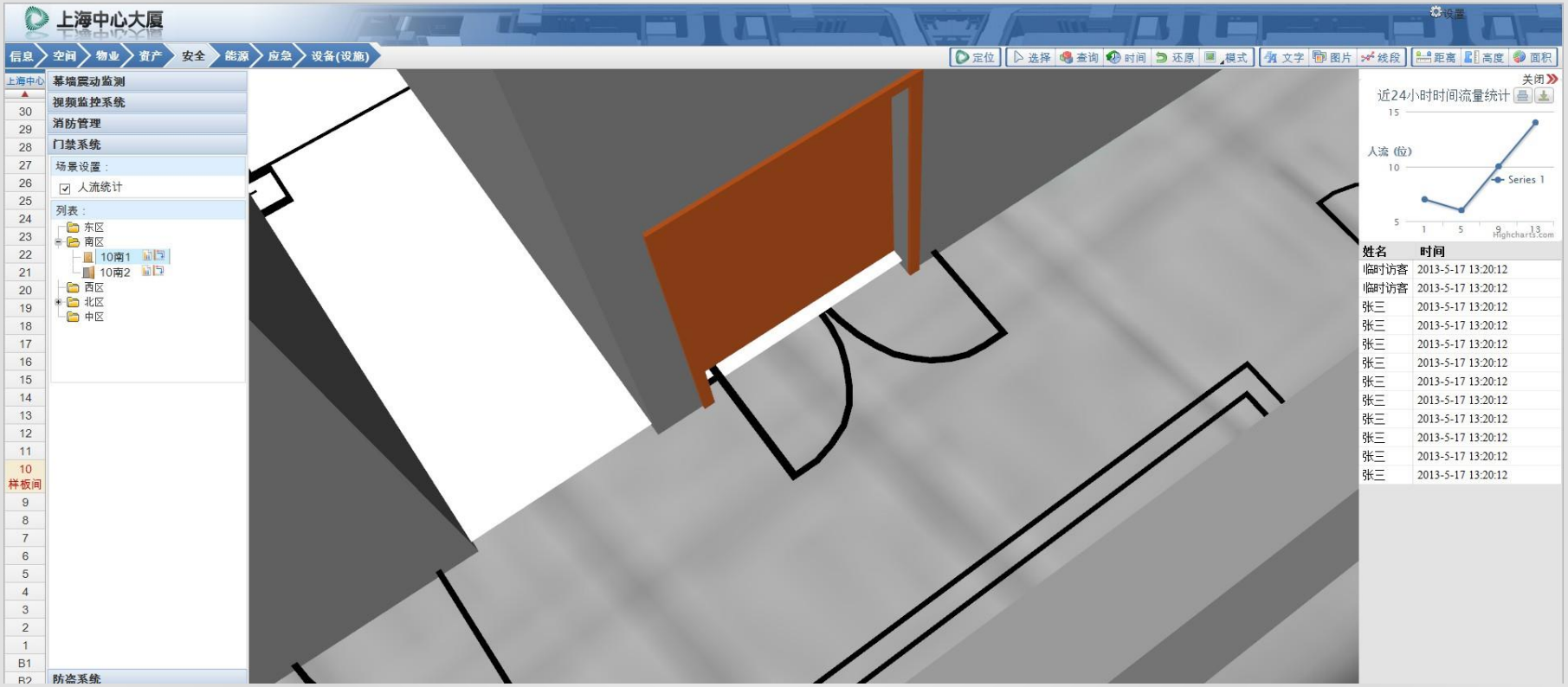
BAS monitoring



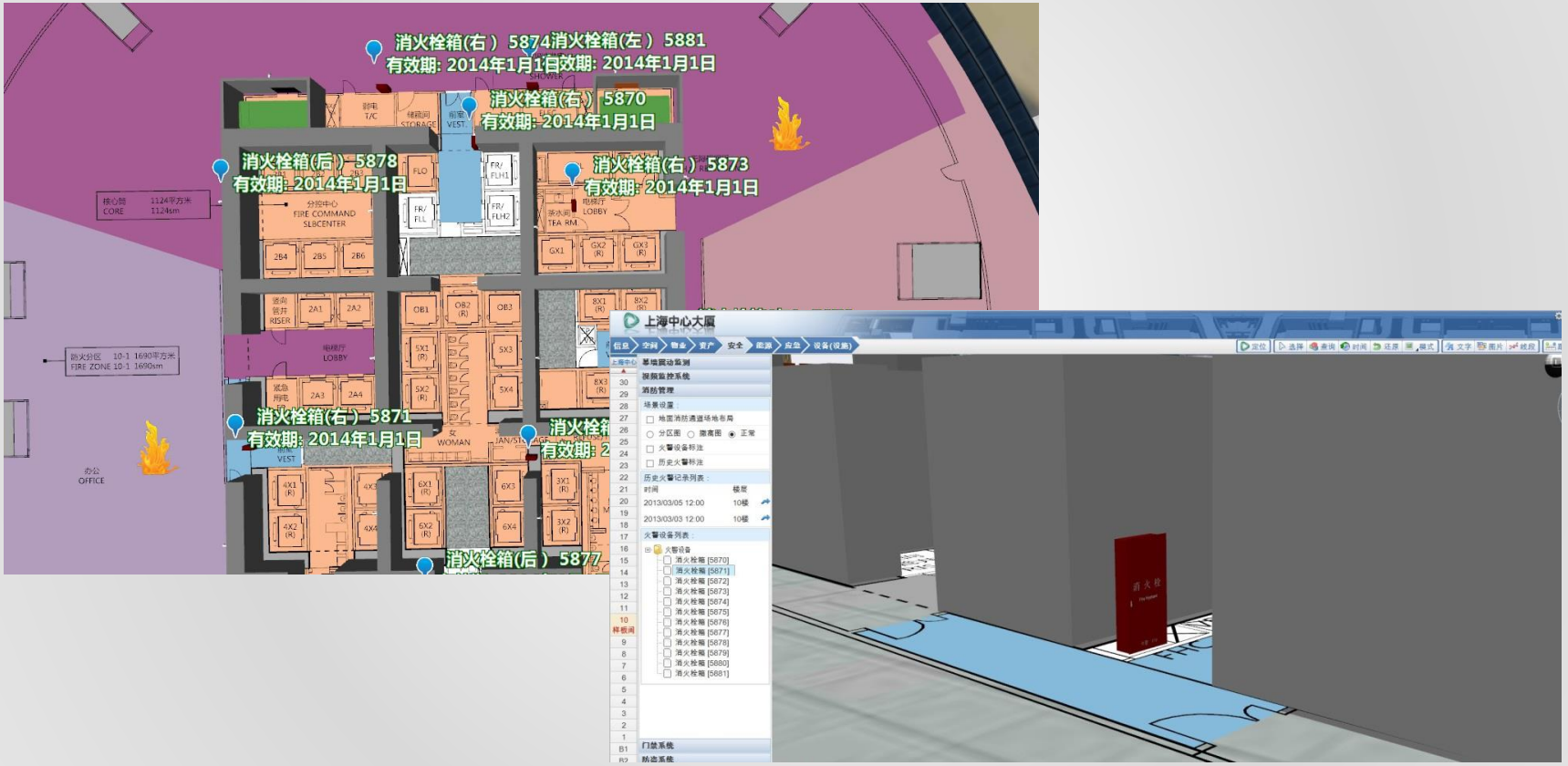
Hazard monitoring



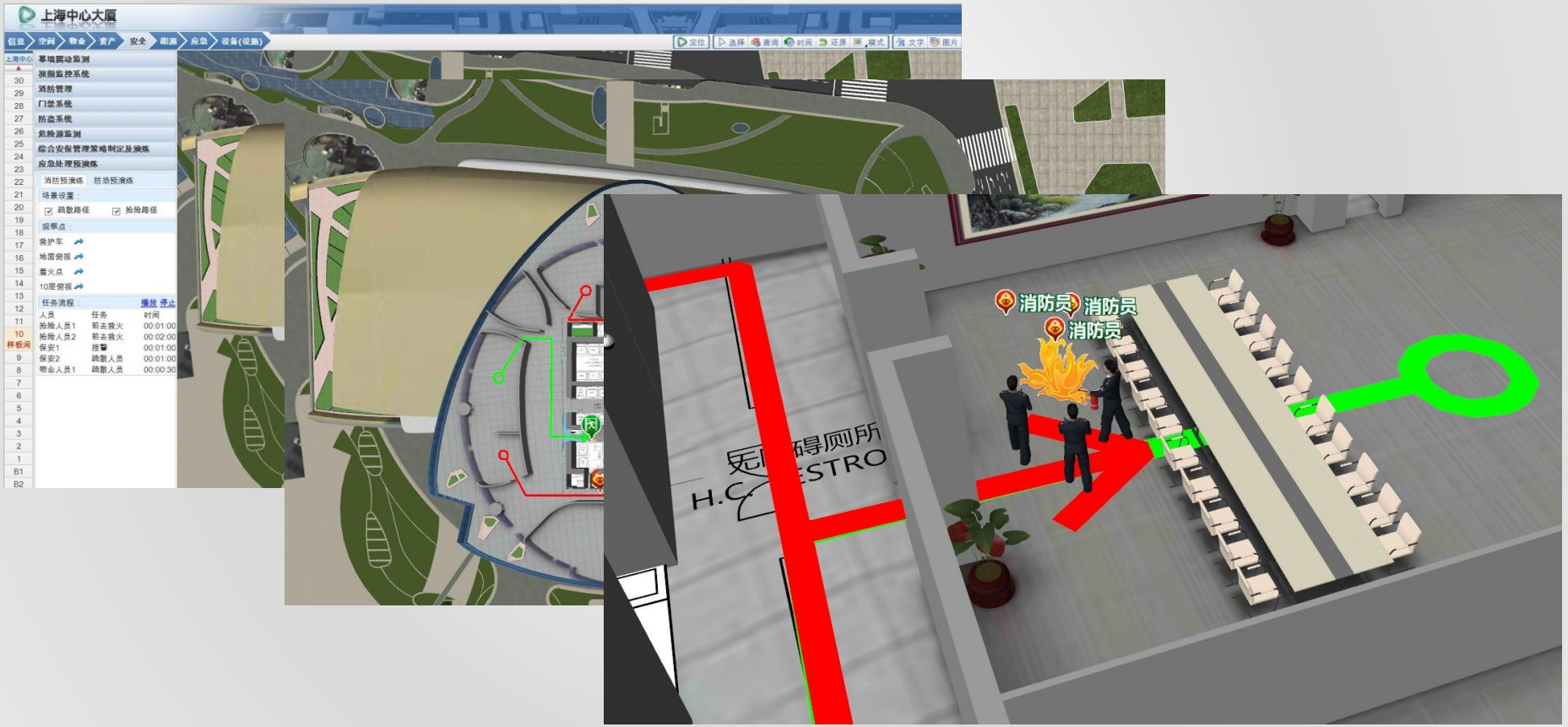
Access control and personnel management



Fire extinguishing system management



Disaster warning and emergency response



Economic Indicator of BIM

BIM economic indicators (reference)

ex.opening	unit cost of direct construction(CNY)
slab opening	2600
block opening	19800
block opening	5400
MEP opening	1600
total conflict	**8400**
total cost	**10, 000, 000**
average unit cost	**1190. 48**

BIM economic indicator estimation of SHT (by reference unit cost of conflict)

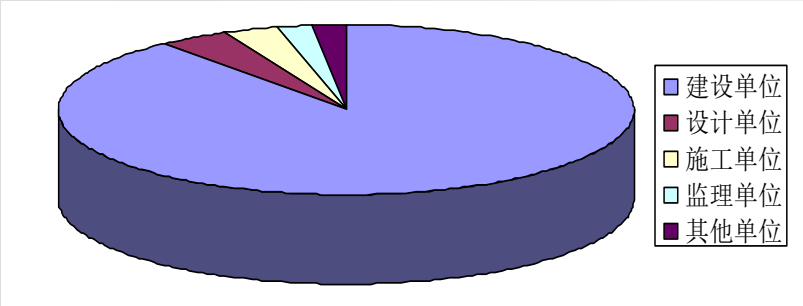
area	unit
9F model floor	4656.1m²
10F model floor	4648.4m²
total area of model floor	9304.5m²
total area of Shanghai tower	570000m²
total conflict of model floor	1013
reference average cost	**1190.48CNY**
total cost of model floor	**1,205,952.38CNY**
total economic indicator cost of SHT	**73,877,463.29CNY**

BIM economic indicator estimation result of Shanghai tower （Cost per changes ）

SHT Total	CNY 12 billion
Change rate	3%–5% in average
Fee subject to change	CNY 360 million)

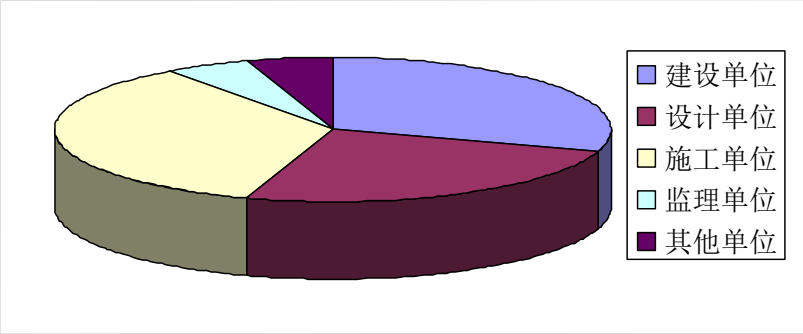
Shanghai Tower save at least CNY 100 million with BIM adoption

Viable Benefit Allocation



Owner
Design Institute
Construction companies
Audit companies
Other

Establish reasonable reward tactics



Owner
Design Institute
Construction companies
Audit companies
Other

Reward the companies with the saved cost subject to new tech adoption, and put the statement inside the contract.

Reflections

1. The mode is decided by enterprise development strategies

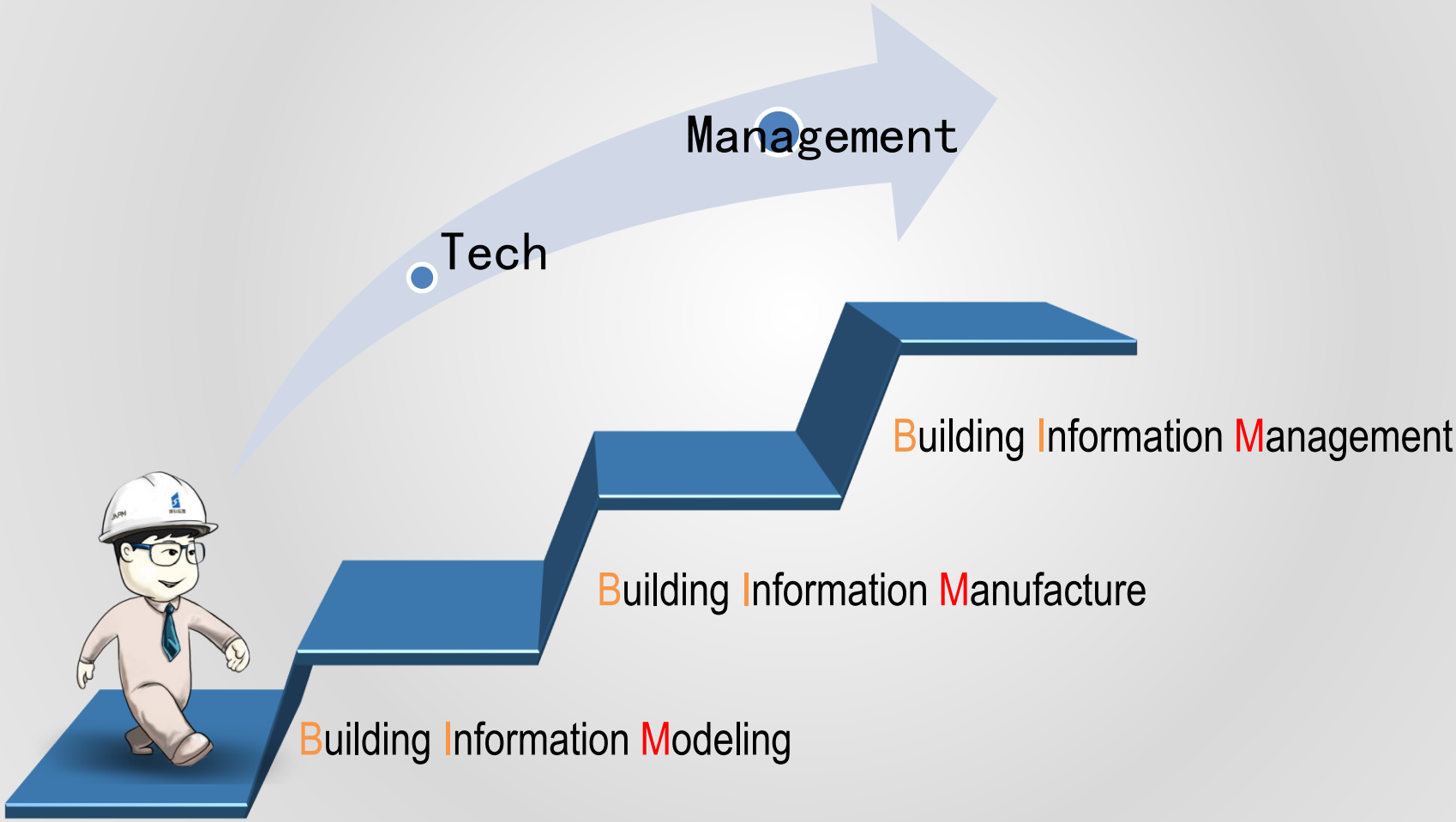
- **Involve** lean BIM-based mode gradually into the company's management activities
- Shanghai Tower set up a structure to involve all parties
- Invited BIM consultants to take (as much as) advantages of BIM

2. Need to setup national BIM Implementation and related standards

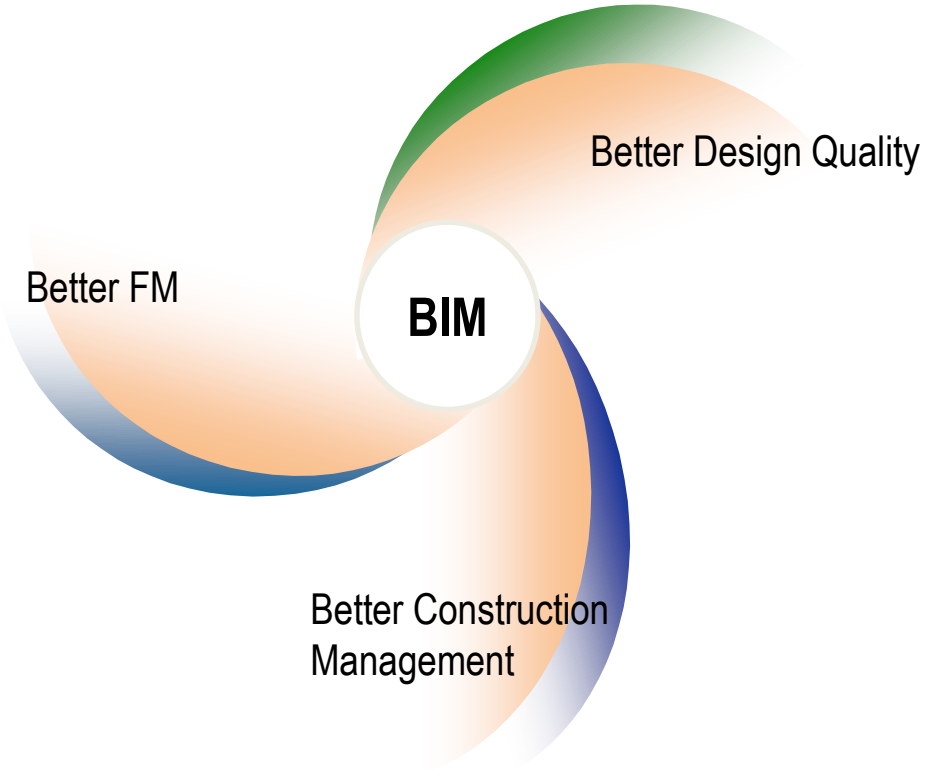
- The overall BIM adoption in China is at the very primary stage
- Lacking of national-wide standards
- Lacking of mechanism for BIM adoption
- Suggest government set up unified BIM standards and promote BIM into real practices

Reflections

Real BIM Management by BIM Tec- How?



Science and Technology empower the new economy




Thanks!
Suggestions & Advices