CENG 6101 Project Management

Introduction to Building Information Modeling

(BIM)

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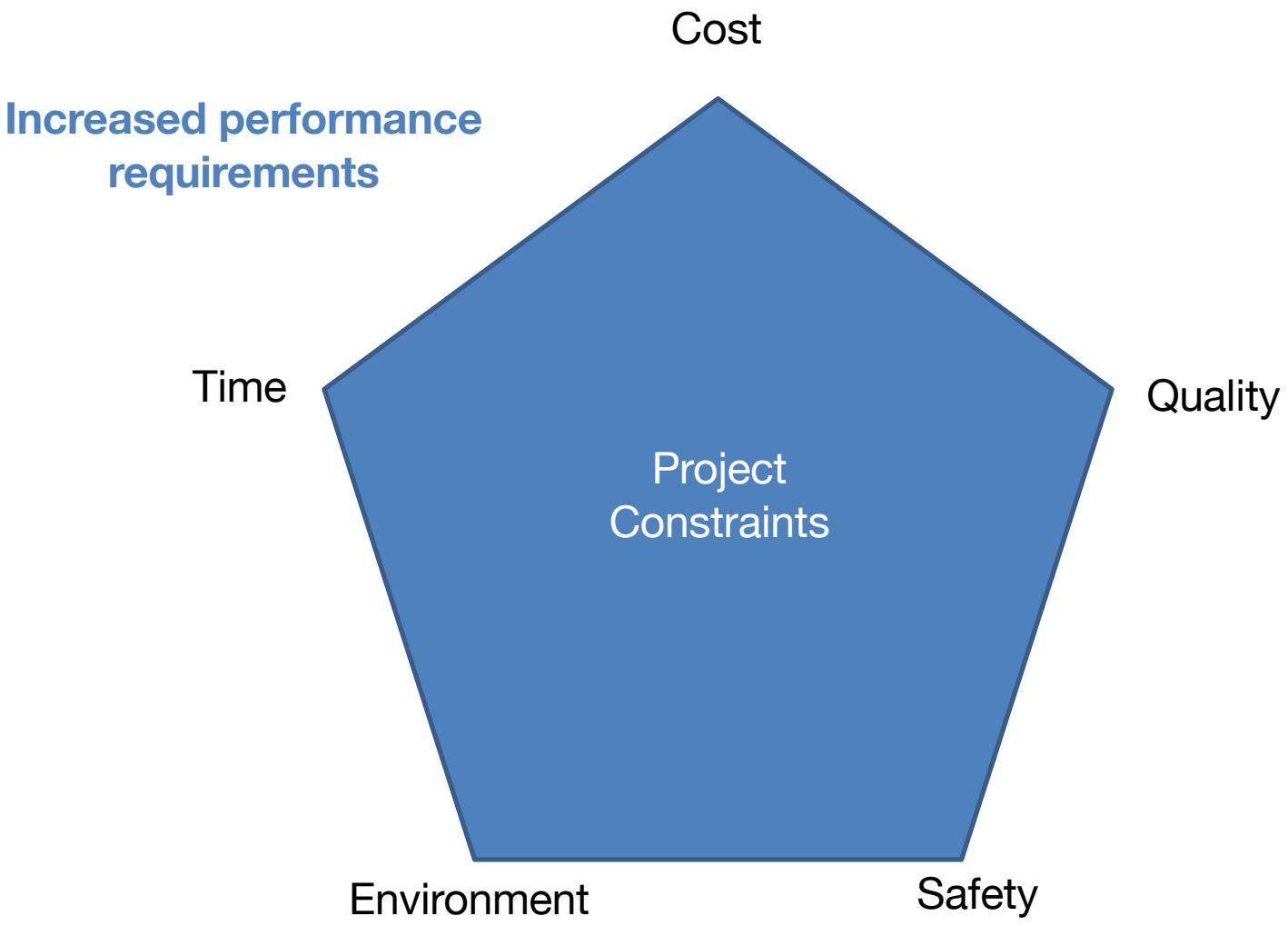
Why BIM?


Cost
Increased performance requirements
Time
Quality
Project Constraints
Environment
Safety

Why BIM?

Change Orders

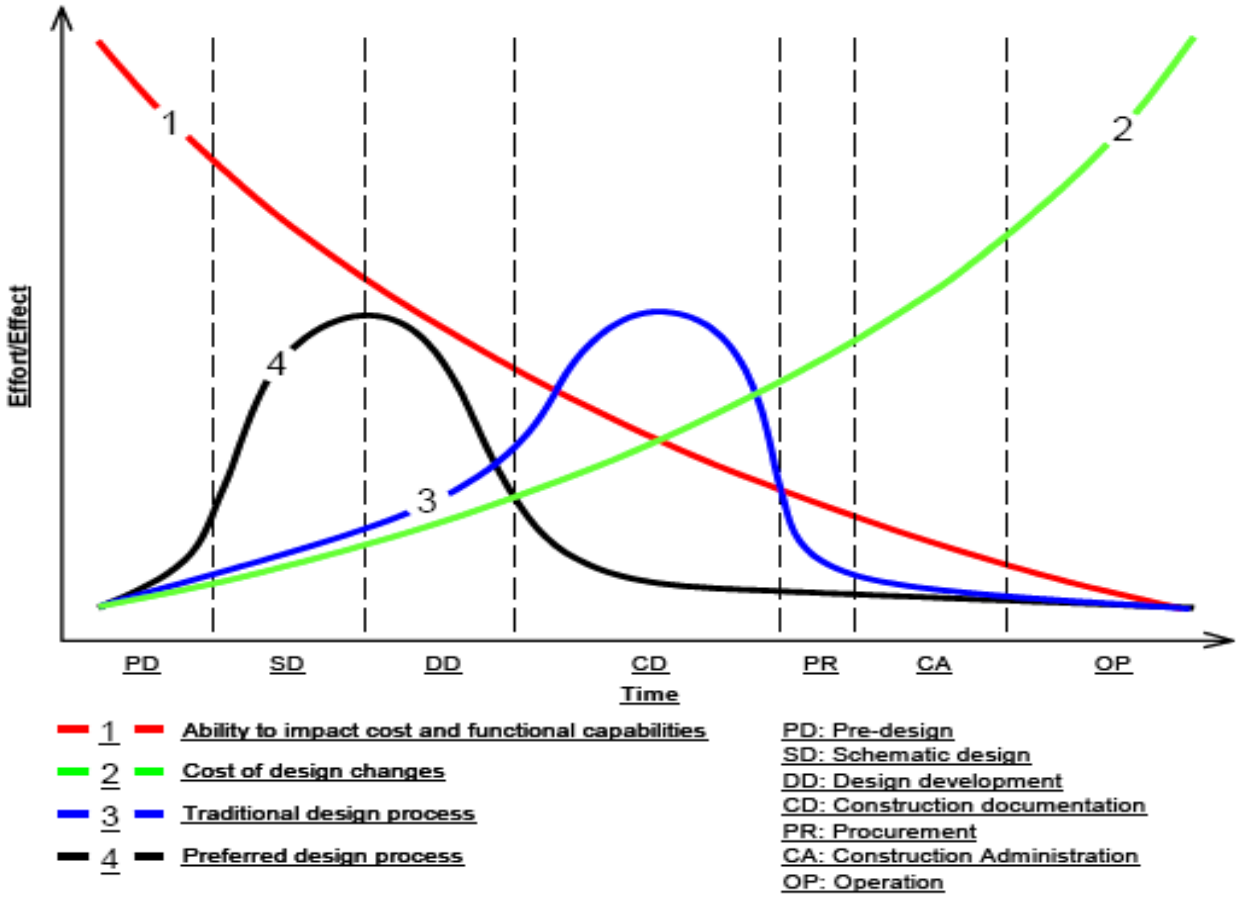
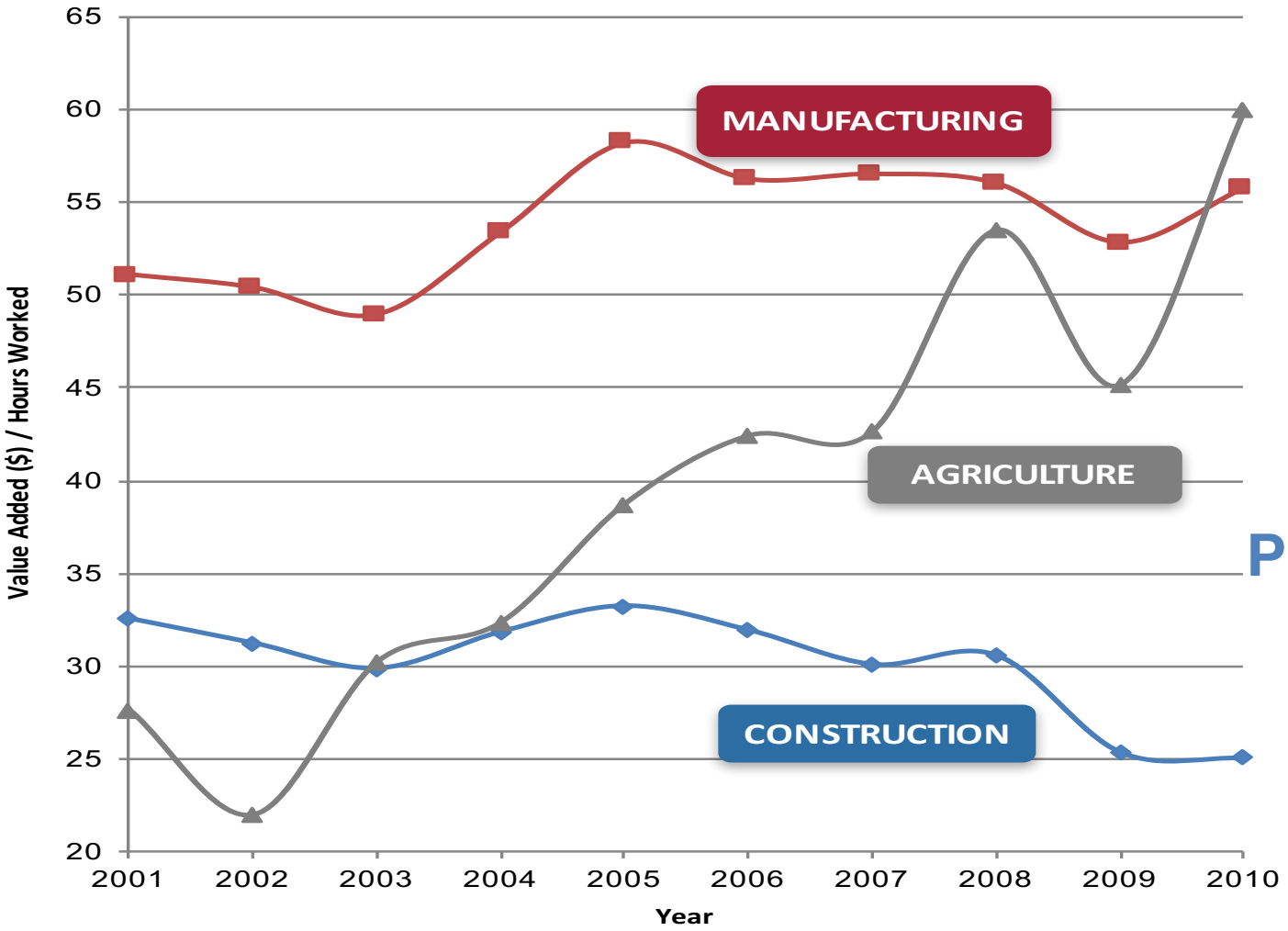


Figure 4: "Mcleany Curve" illustrating that effort and decision-making is shifted earlier in the design process in an Integrated Project Delivery (Construction Users Roundtable 2004).

Why BIM?



Poor Productivity

[Adapted from "Labour productivity ($2002 per hour worked), Alberta, by two-digit NAICS industry, 1997-2010," by Center for the Study of Living Standard (CSLS), 2012]

Why BIM?

2. In 2004 the Construction Industry Institute estimated that **57% of money spent on construction is non-value-added—which is WASTE.[2] With the U.S. construction market estimated at US$1.288 trillion for 2008, at 57% waste, over $600 billion per year is being wasted.**

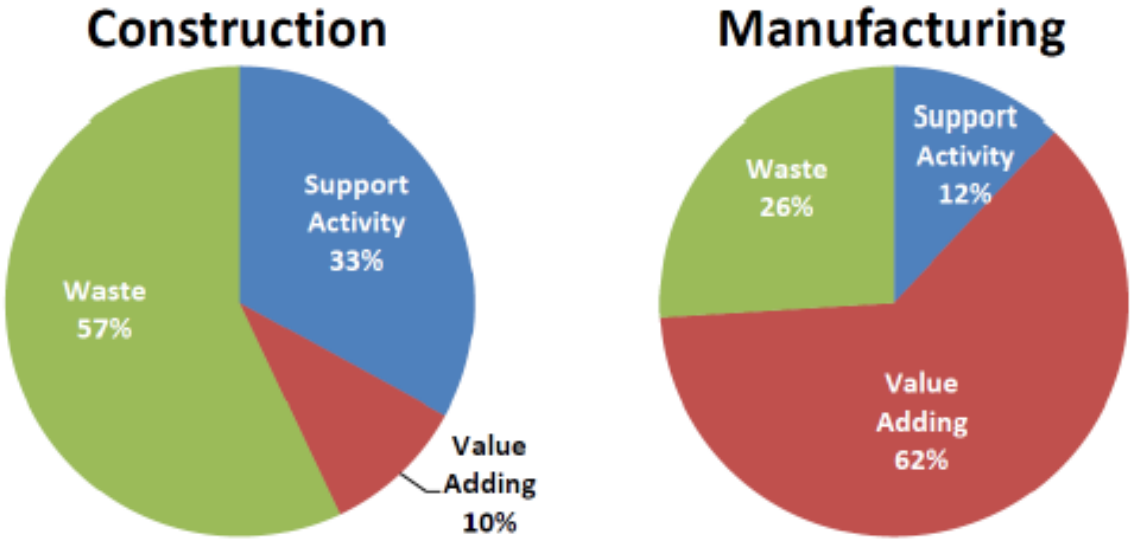


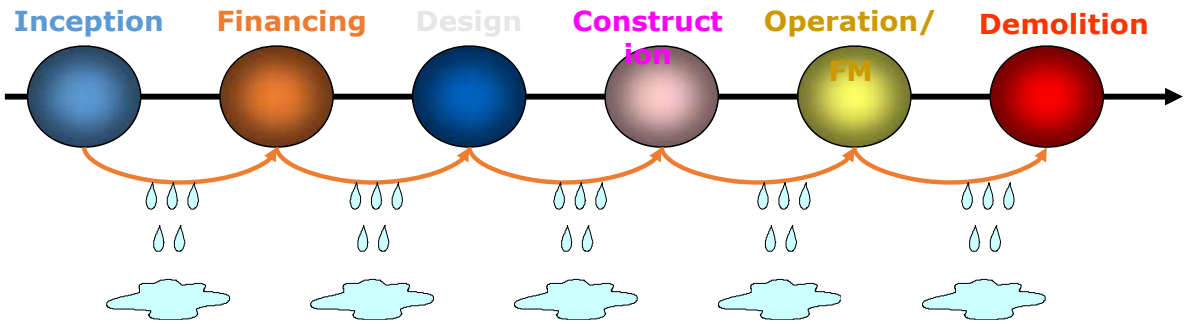
Figure 1: A large portion of the money spent in the construction industry is wasted, especially when compared to the manufacturing industry.

Wastage

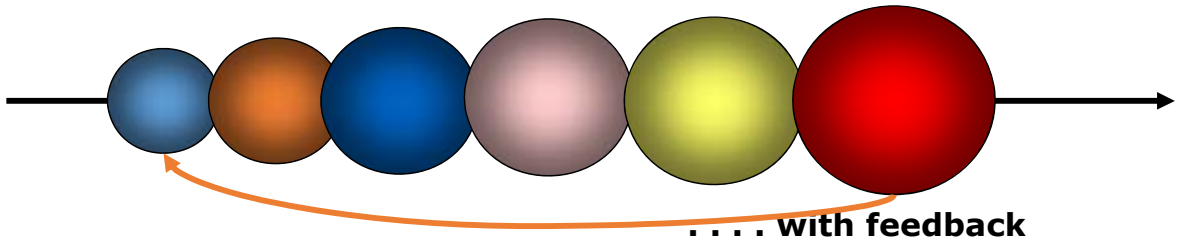
Why BIM?

Fragmentation

- Current model



- Model with interoperable solutions



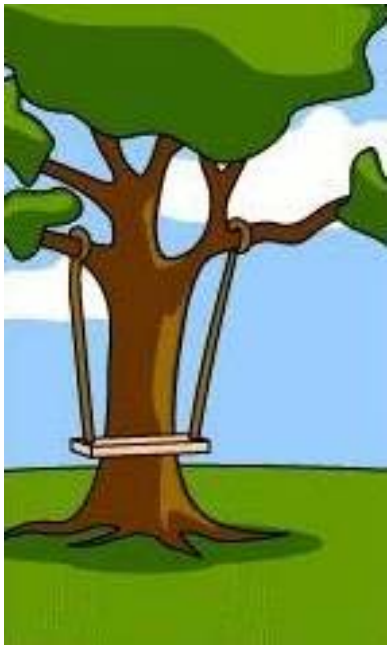
Flanagan (2007)

Why BIM?

Fragmentation

Why BIM?

Communication



What the client wanted

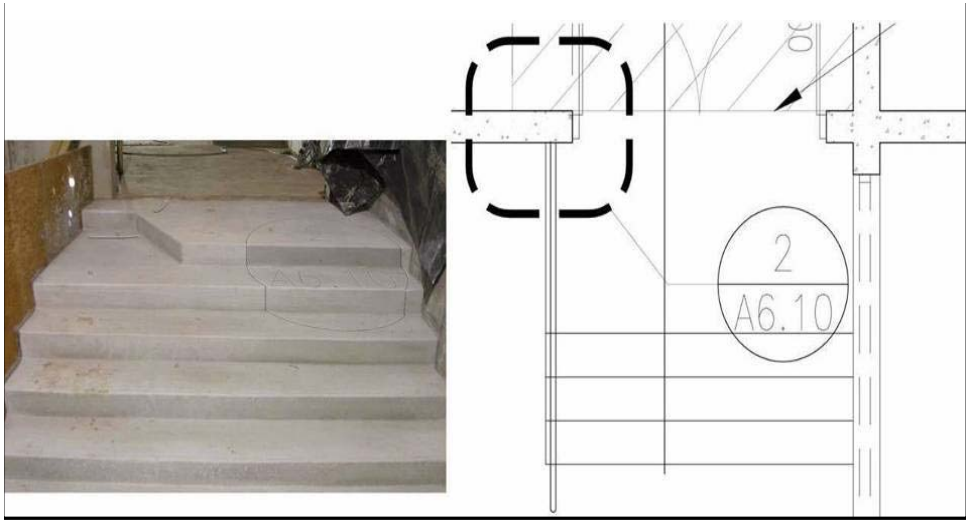
As the design team understood it

As the contractor build it

Why BIM?

Two different worlds of Designers and Builders

Communication

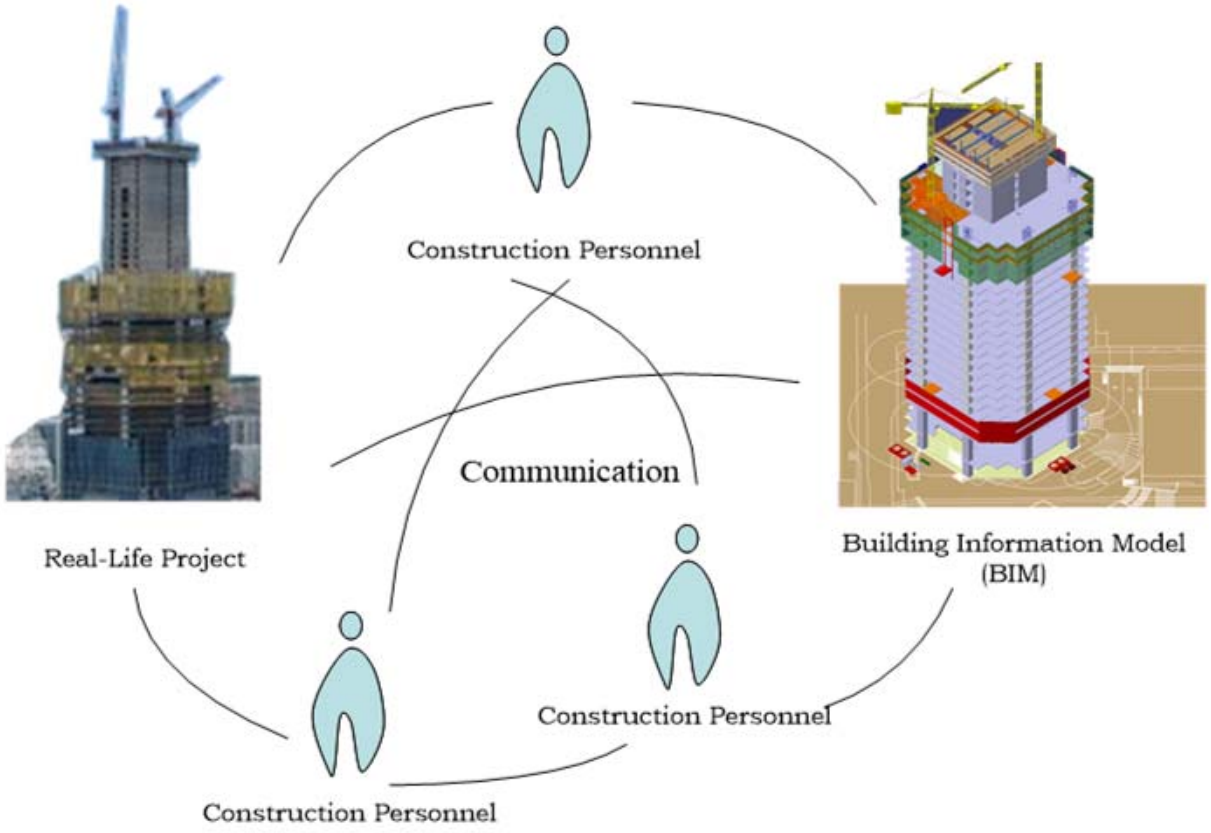


Why BIM?

No prototyping

Why BIM?

Building Information Modeling (BIM) or Building Information Model (BIM)

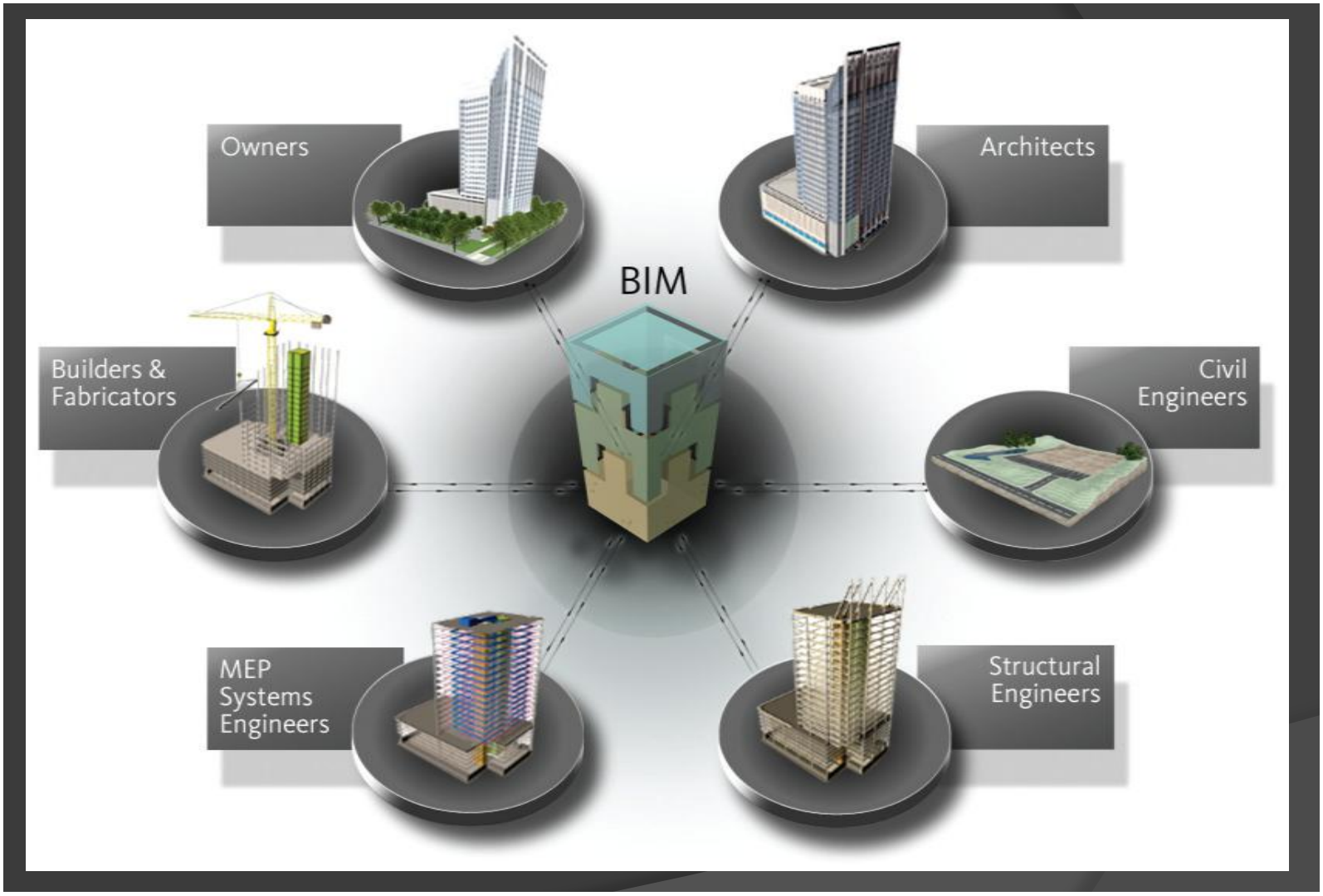


BIM Definition

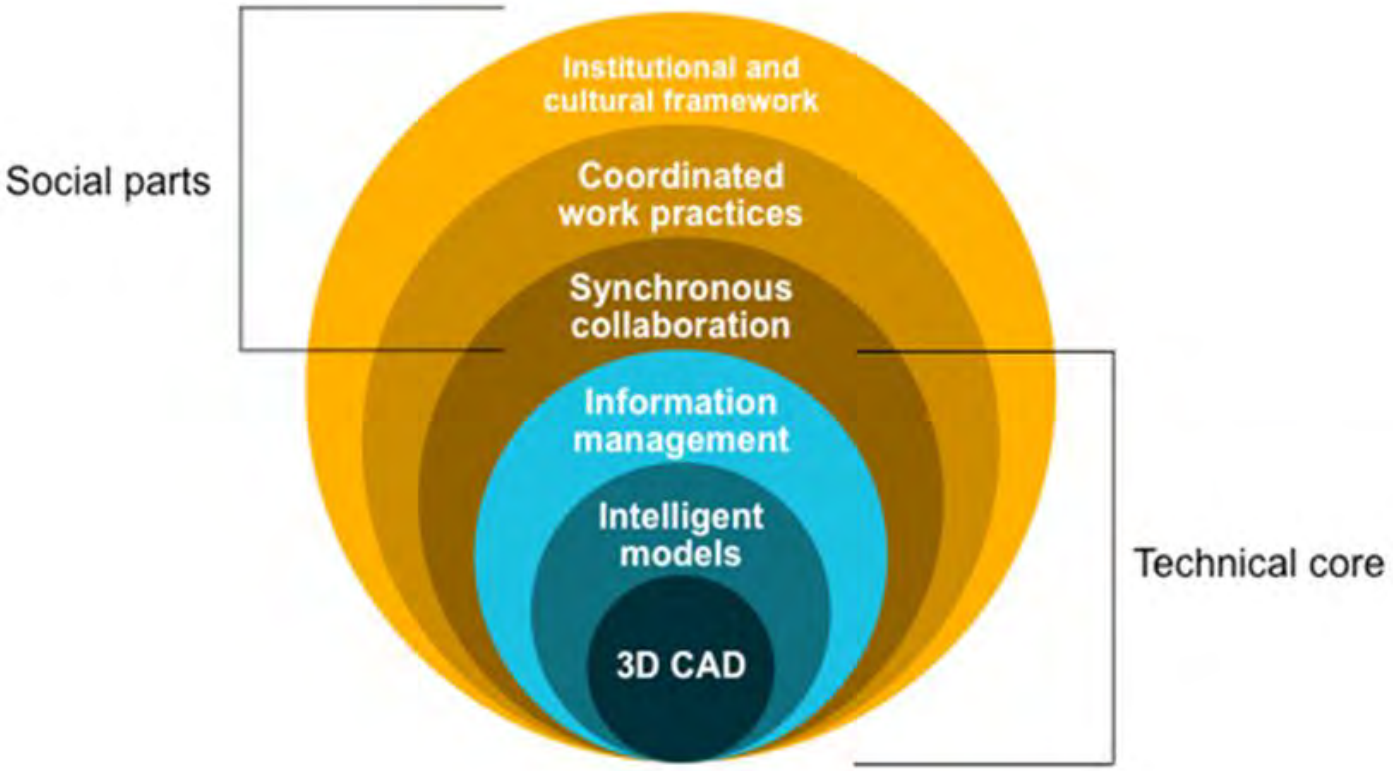
- BIM is defined as a digital representation of the building process to facilitate exchange and interoperability of information in digital format (Eastman, 1999).

- According to the U.S. National BIM Standard (2007), BIM is “a digital representation of physical and functional characteristics of a facility and a shared knowledge resource for information about a facility a reliable basis for decisions during its life-cycle.”

BIM Basics


Owners
Architects
BIM
Builders &
Fabricators
Civil
Engineers
MEP
Systems
Engineers
Structural
Engineers

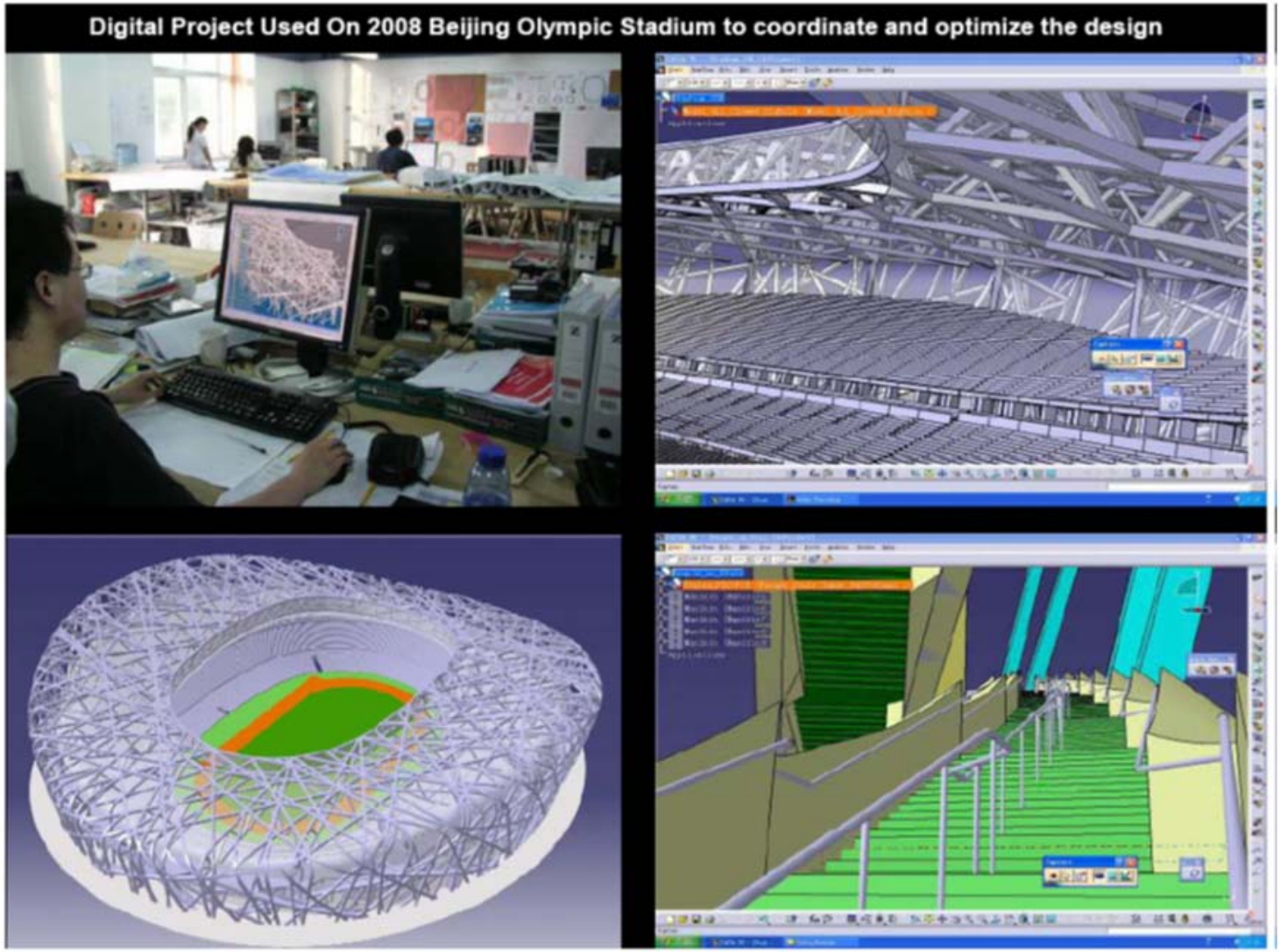
BIM Basics



BIM viewed as a sociotechnical system with a technological base and layers of social components

Image From:
Mondrup, T. F., Karlshøj, J., & Vestergaard, F. (2012). Communicate and collaborate by using building information modeling. Paper presented at CIB W078 2012 Conference, Beirut, Lebanon.

BIM Basics


Digital Project Used On 2008 Beijing Olympic Stadium to coordinate and optimize the design

BIM Basics

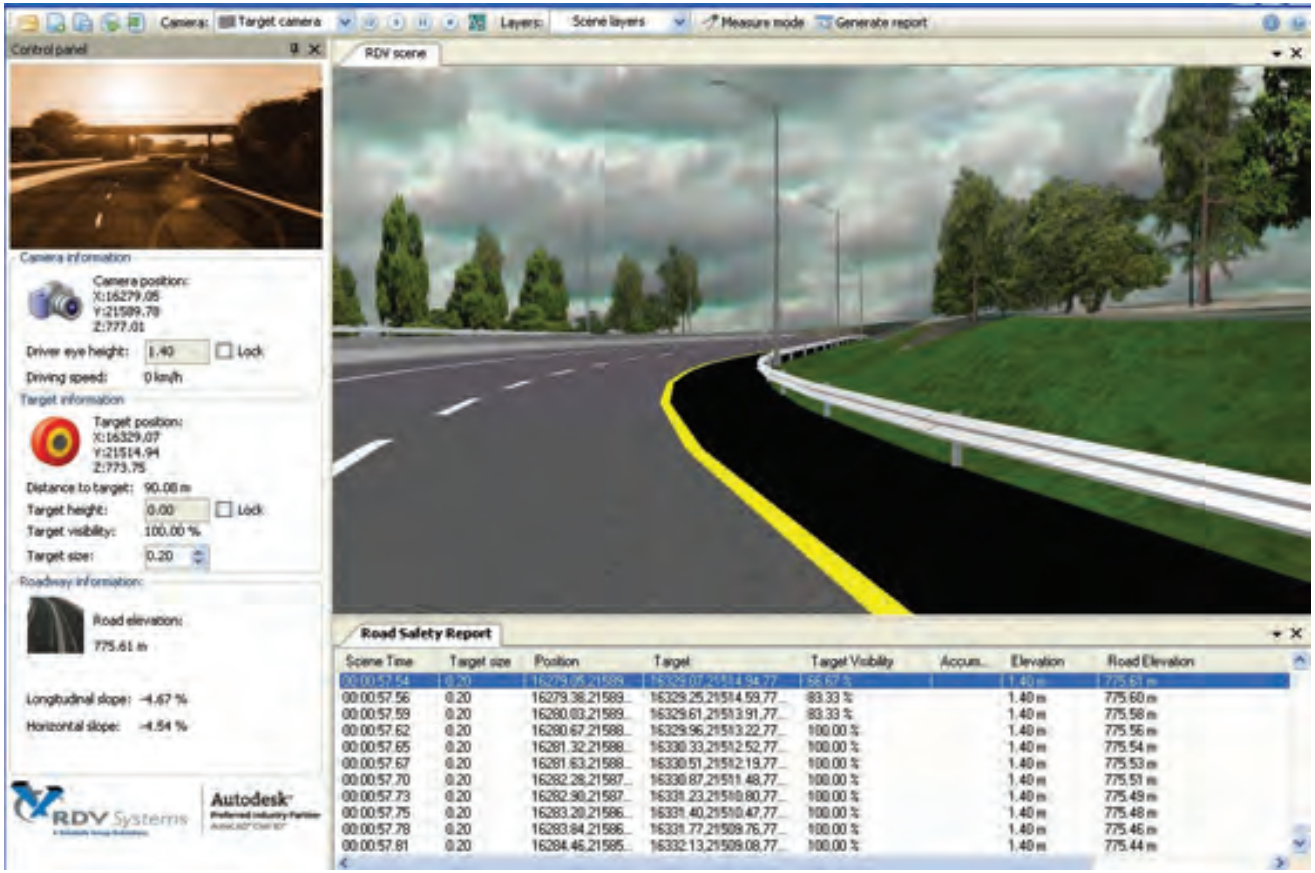
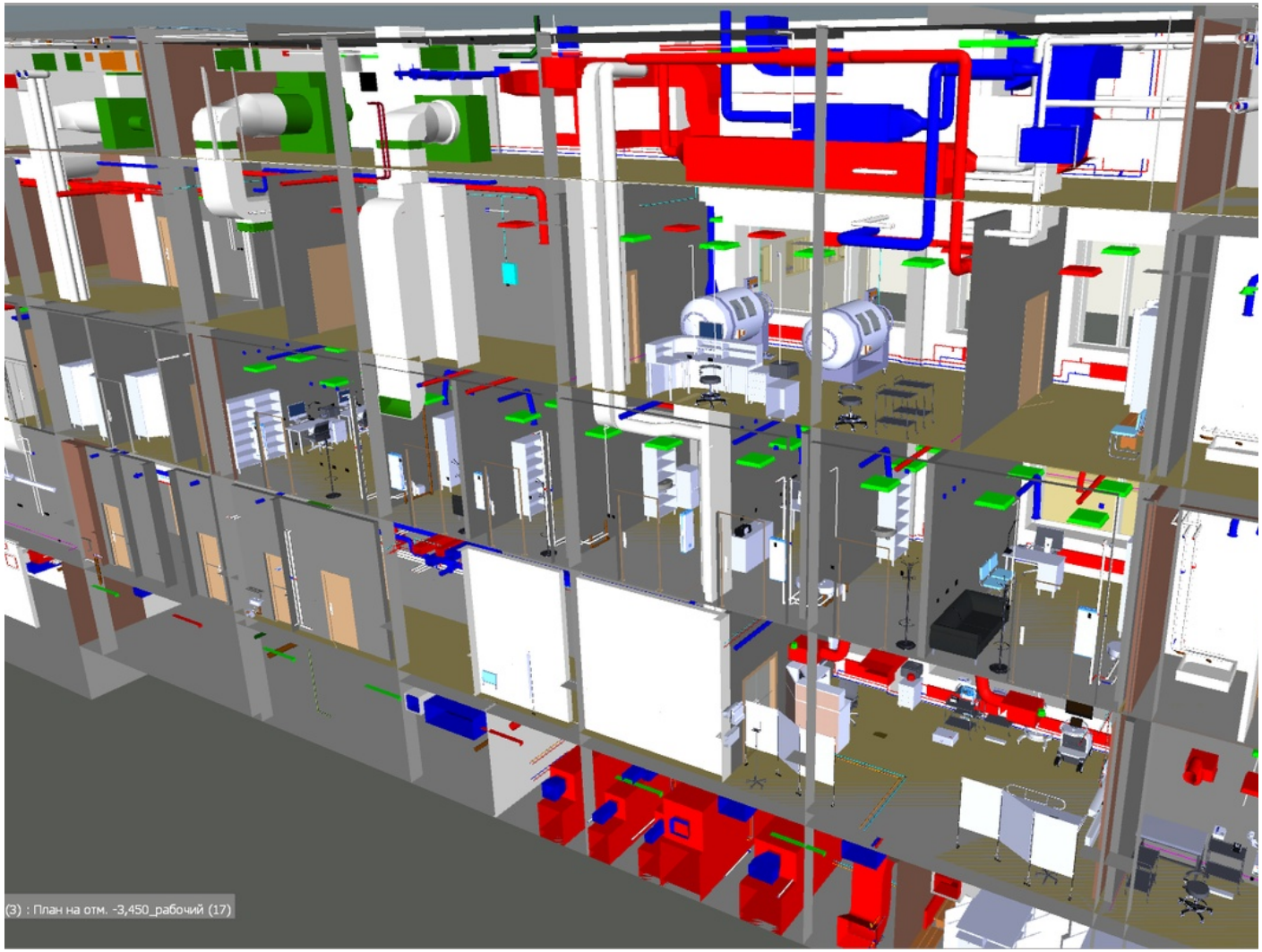


Figure 3: The Rapid Road Safety Analyzer from RDV Systems leverages the information model in AutoCAD Civil 3D, Autodesk's civil engineering software built for BIM, to identify whether the road geometry meets critical safety parameters.

BIM Basics



BIM systems model
Credit: WERFAU

BIM Basics

- Is it just for replacing the drawing board?
  - Is it simply another AutoCAD?

BIM Basics

- AutoCAD drawings only contain lines and arches, while BIM models contains information in each components.

- In a sense, design in a BIM environment is similar to playing Legos. You draw Lego pieces from a library, and form them into a BIM model.

- Three types of information contained in BIM:
  - (a) Geometric information includes size, volume, shape and spatial relationships,
  - (b) Semantic information information includes the type of individual construction component, specifications of material, construction schedule, and cost, and
  - (c) Topological information captures the dependencies of components.

BIM Usage Levels

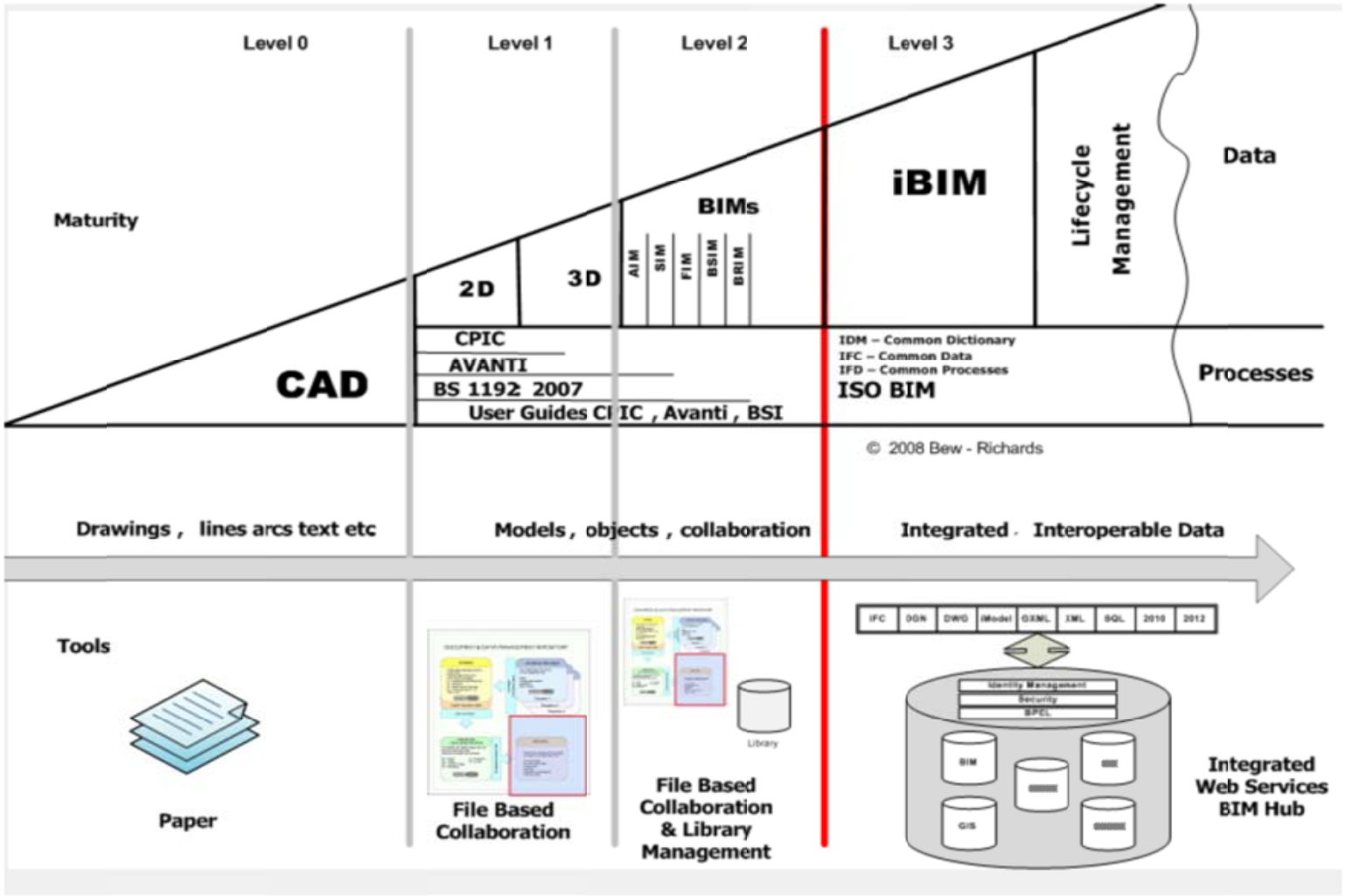


Figure 7: Maturity index illustrating the different levels of experience and approaches to BIM (BIM Industry Working Group of the BIS 2011)

BIM Usage Levels

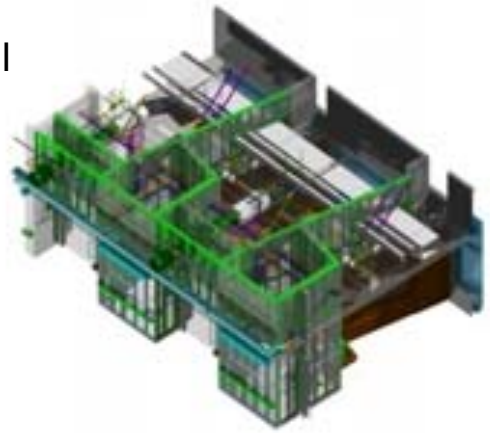
1. **Visualization**
2. **Coordination**
3. **Constructability**
4. **Fabrication & Installation**

Interior spaces and shell

High-level MEP

Fabrication-level MEP

Everything…(?)



Visualization

Permit Drawings

High-level coordination

Fabrication level MEP models, 4D Sequencing, 3D As-Built Models

BIM Estimates, multi-trade racking, Supply Chain Management

Source: DPR Construction: http://dpr-review.com/fall-winter-2010/story/the-four-levels-of-bim

BIM Trend

China	12th 5-year plan (2011-2015)
UK	April 2016, for all central government clients to require BIM to be used on their projects.
USA	Compulsory for Government Project funded after 2017
Singapore	Compulsory after 2015
Hong Kong	The Hong Kong Housing Authority requires BIM for all its new projects after 2014.
Norway	Encouragement instead of Mandatory. For example, all projects of the state client Statsbygg have used BIM since 2010.
Denmark	Danish state clients such as the Palaces & Properties Agency, the Danish University Property Agency and the Defense Construction Service require BIM to be used for their projects.
Finland	The state property services agency, Senate Properties, requires the use of BIM for its projects by 2007.
Netherlands	Since 2012 the Dutch Ministry of the Interior requires BIM for large building maintenance projects.
South Korea	Compulsory for all large size projects and for all public sector projects by 2016.
Germany	National BIM standard has been completed in 2014.

Note: Adapted from Zeiss (2013) and HKCIC (2014).

BIM Trend

- A Research and Markets study found that the international building information modeling (BIM) market will reach $11.7 billion by 2022, with a compound annual growth rate of 21.6% between 2016 and 2022.

- The research firm said it expects the Asia-Pacific region to experience the most growth in demand due to its rising construction activity and the push of BIM mandates.

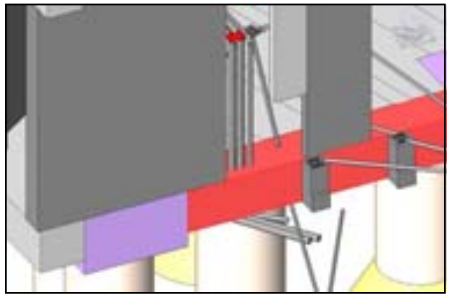
- BIM is growing in all areas of construction around the world, and adoption — especially in Asia — has been driven by emerging BIM mandates, a thriving real estate market and acknowledgment by contractors and other industry player of the benefits of BIM.

BIM Software

- A variety of commercial software packages such as ArchiCAD, the Dassault Systemes (DS), AutoCAD Revit Architecture, AutoDesk NavisWorks, can be put under the umbrella of BIM, although one should not simplistically equate BIM with them.

BIM Software: Building

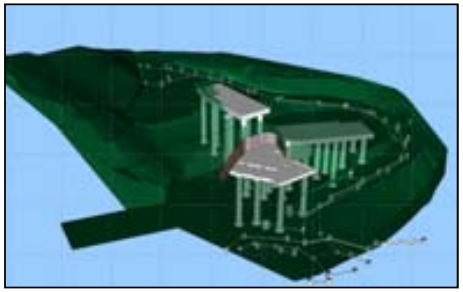
Revit (BIM Modeling)



Navisworks (Collision Check)

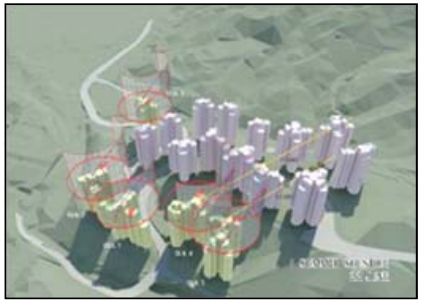
Navisworks (4D Simulation)

3D Max (Photo-realistic Rendering)

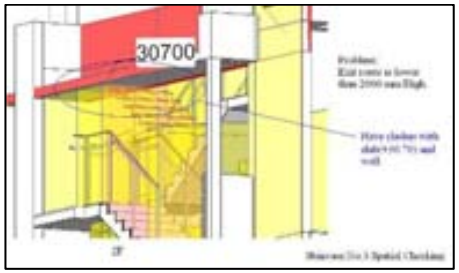


Civil 3D (CE/GE Design)

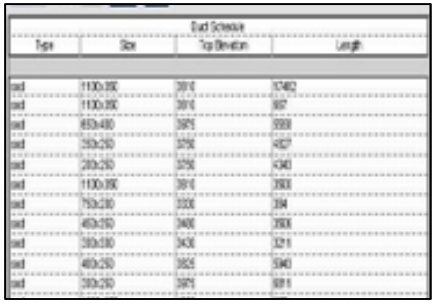
Viewers (Viewing / Markup)



Ecotect (Performance Analysis)



Solibri (Code Checking)

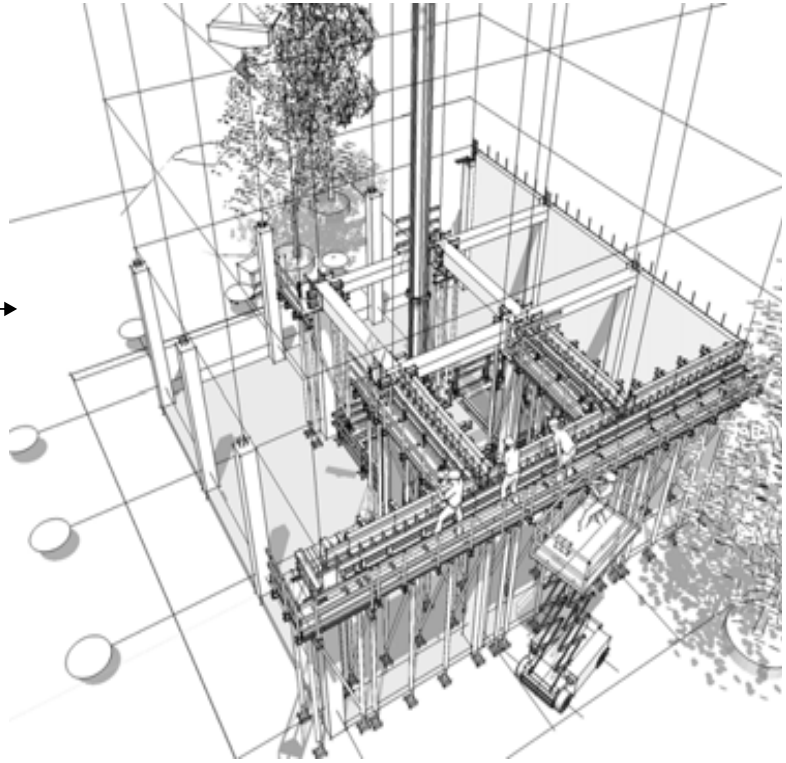


Cost X (Material Quantities)

BIM Benefits

- A. Fostering novel design

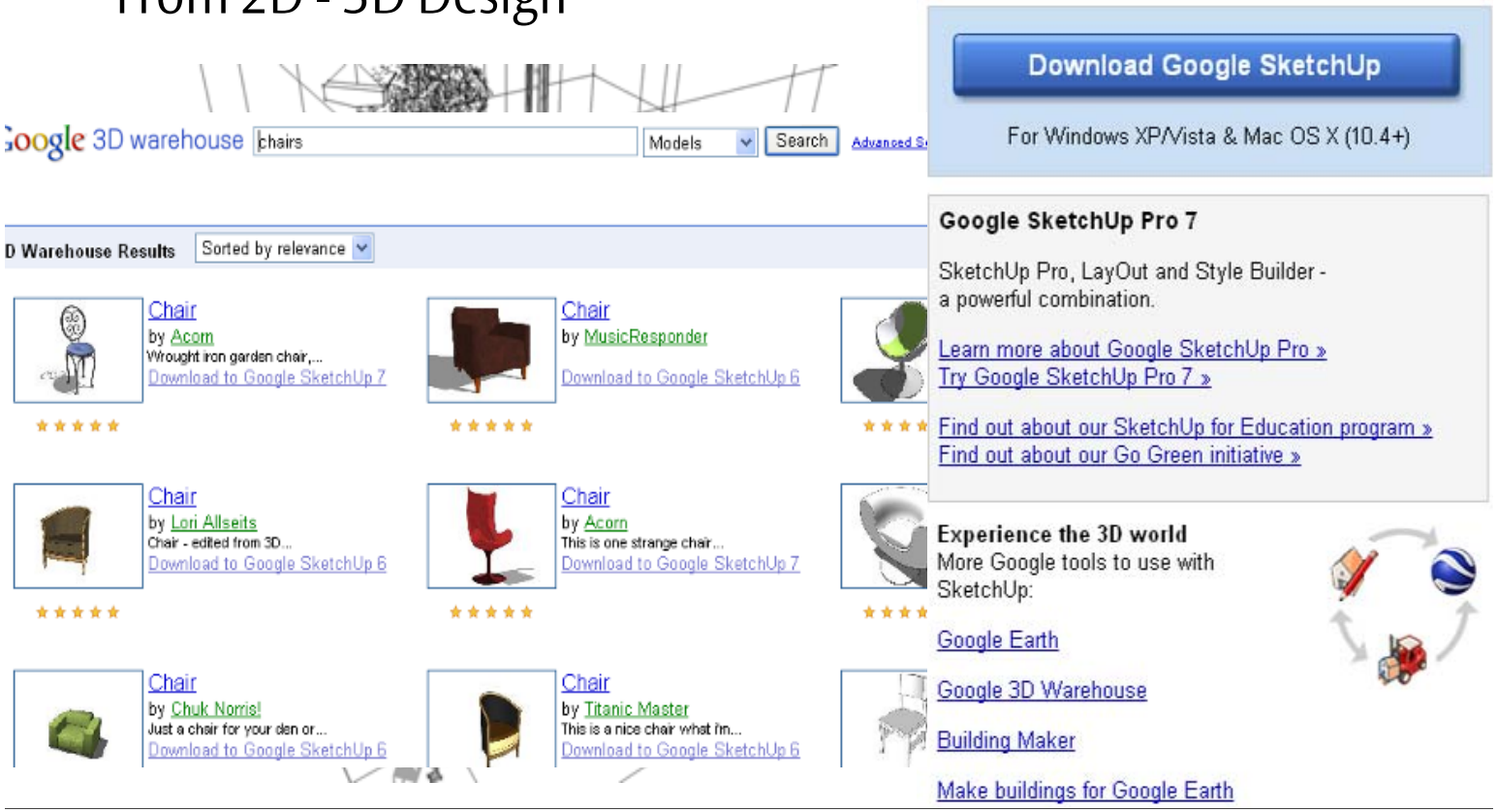
From 2D - 3D Design



BIM Benefits

- A. Fostering novel design

From 2D - 3D Design



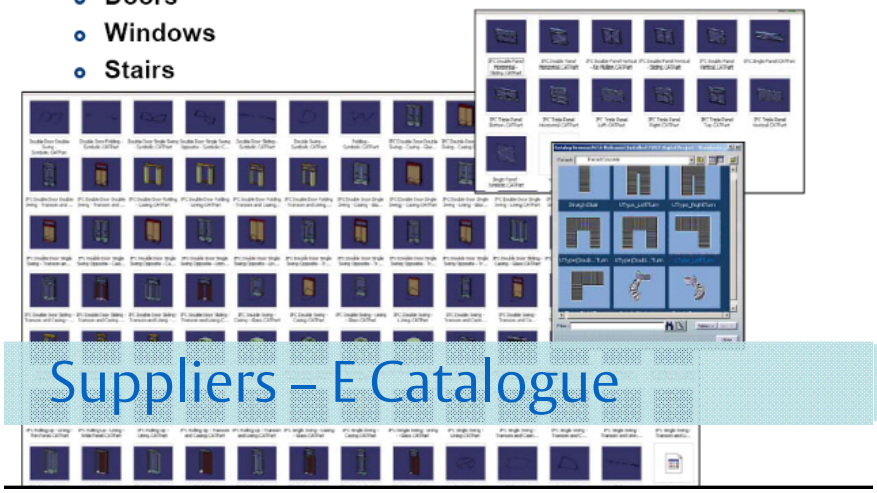
BIM Benefits

- A. Fostering novel design

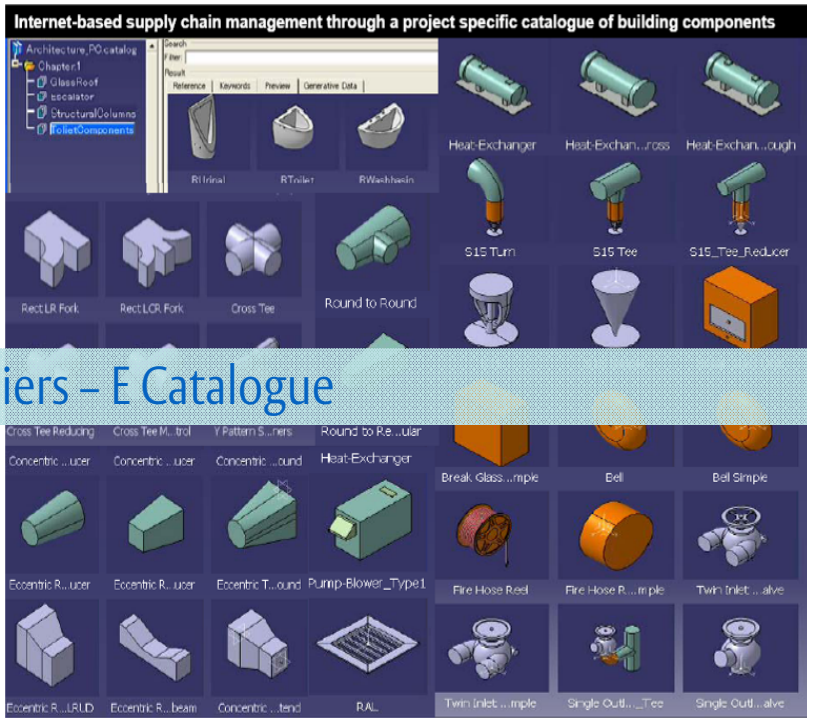
From 2D - 3D Design

Industry Foundation Classes (IFC) Compliant Parametric Components

- Doors
- Windows
- Stairs



Suppliers – E Catalogue



Suppliers – E Catalogue

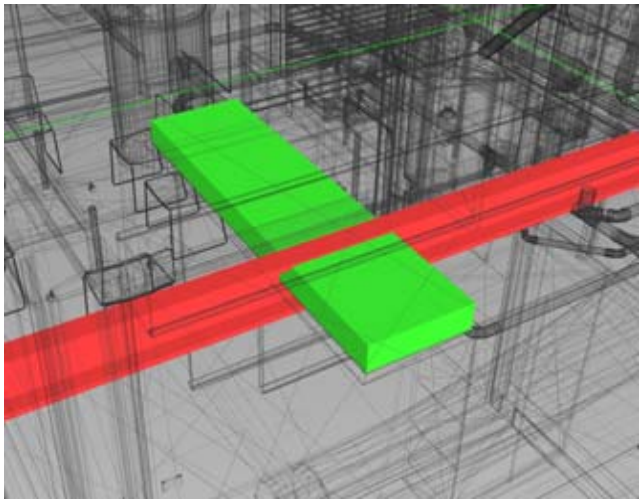
BIM Benefits

- A. Fostering novel design

- Design and Simulate: Lighting, Acoustics, Thermal, Visual, etc.

BIM Benefits

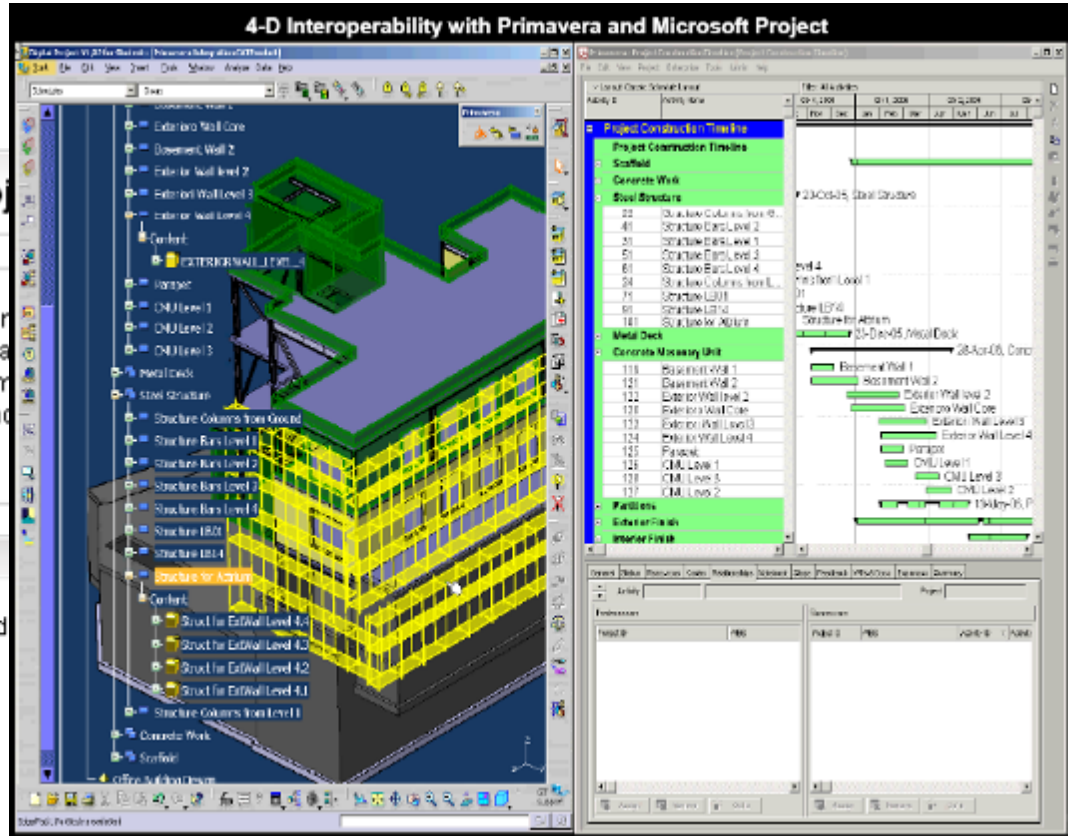
- B. Design error detection
- BIM-based designer errors detection has been and is still one of the most widely implementable functions that can bring direct, immediate benefits.
- Clash is a typical design error.
- There may be:
  - Hard clashes: two objects occupying the same space
  - Soft clashes: objects that demand certain spatial/geometric tolerance or buffers or buffers having objects within their buffer zone for access, insulation, maintenance or safety
  - Workflow clashes: clashes for work crews, equipment/materials fabrication, delivery clashes, and other project timeline issues.



BIM Benefits

- C. Construction site and project management

From 3D or nD



Oracle's Primavera P6 Enterprise Proj

Oracle's Primavera P6 Enterprise Project Portfolio Manager
executing projects, programs and portfolios. Oracle's Prima
comprising role-specific functionality to satisfy each team m
adapts to various levels of complexities within a project, and
your project team.

BENEFITS

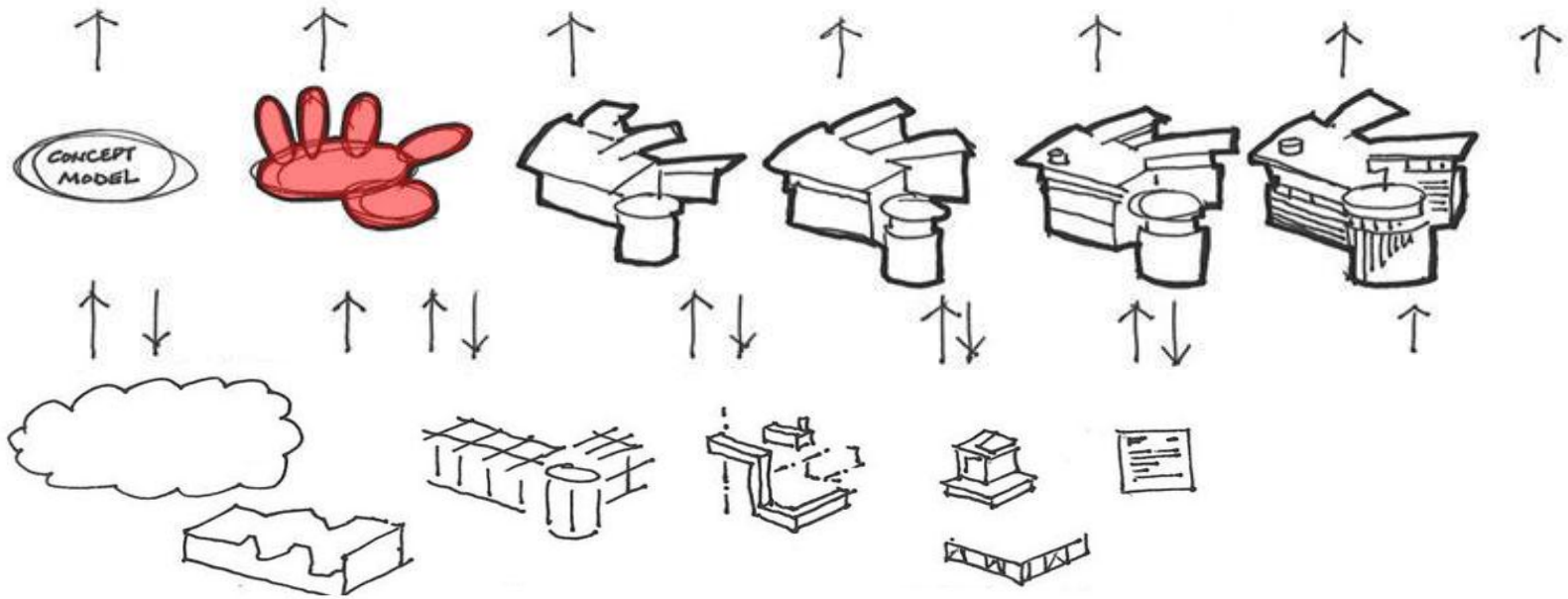
- Plan, schedule and control large-scale programs and ind
- Select the right strategic mix of projects
- Balance resource capacity
- Allocate best resources and track progress
- Monitor & visualize project performance vs. plan
- Foster team collaboration
- Integrate with financial management and human capital management systems

BIM Benefits

- C. Construction communication
- D. Construction plan rehearsal and optimization
- E. Detection of unsafe areas
- F. Project information and knowledge management
- G. Whole life cycle costing approach

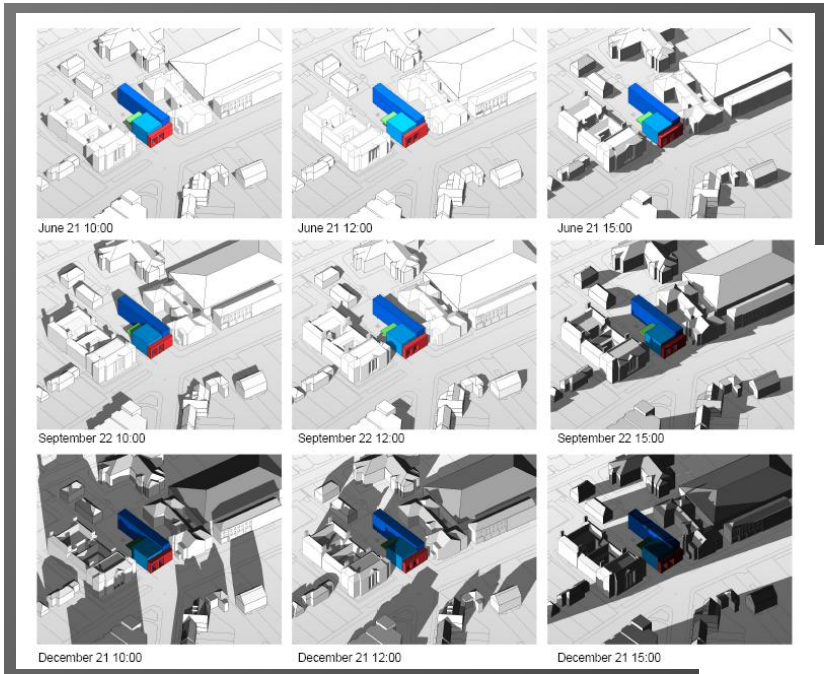
BIM Process

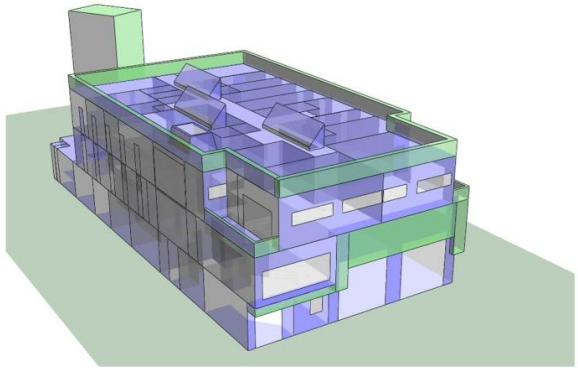
- Concept Phase

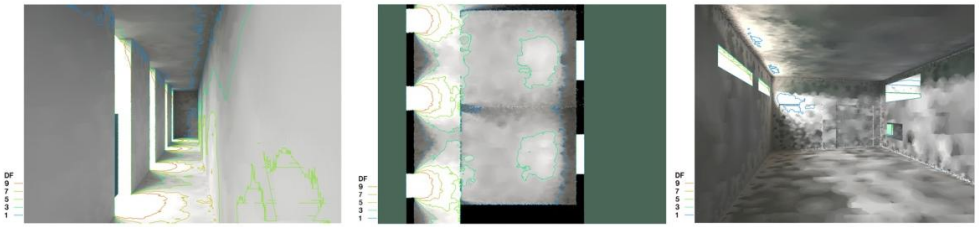


BIM Process

- Concept Phase: Environmental Assessment





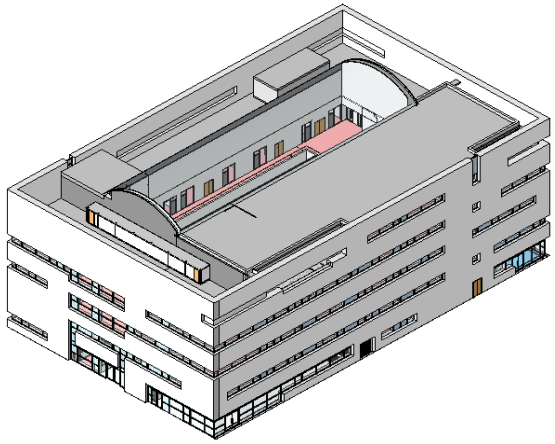


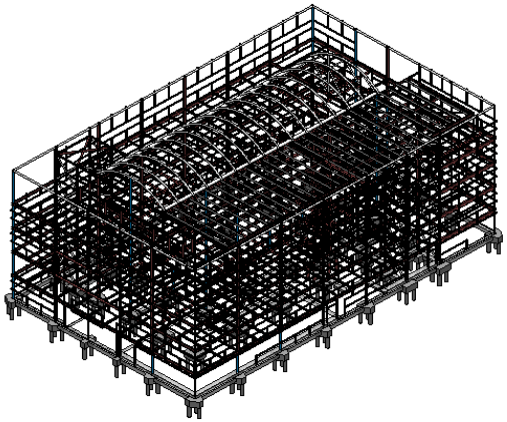
First floor corridor | 'Borrowed light' to Station Manager | Daylight to appliance bay

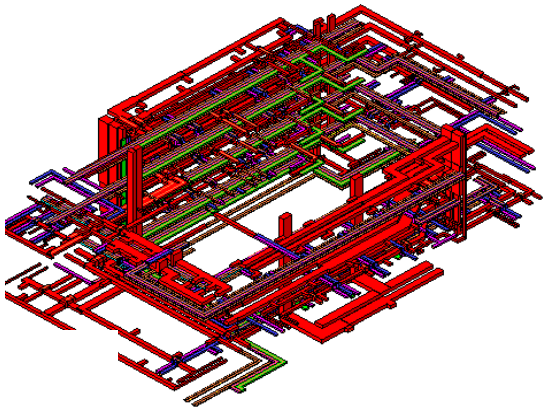
Early stage daylight studies

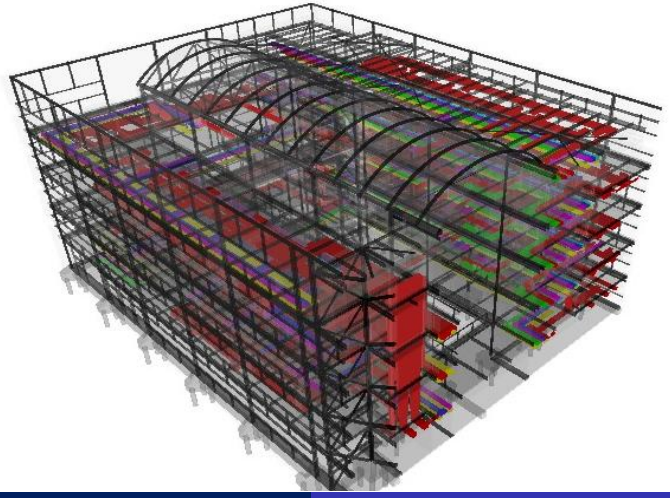
BIM Process

- Design Development: Design Integration



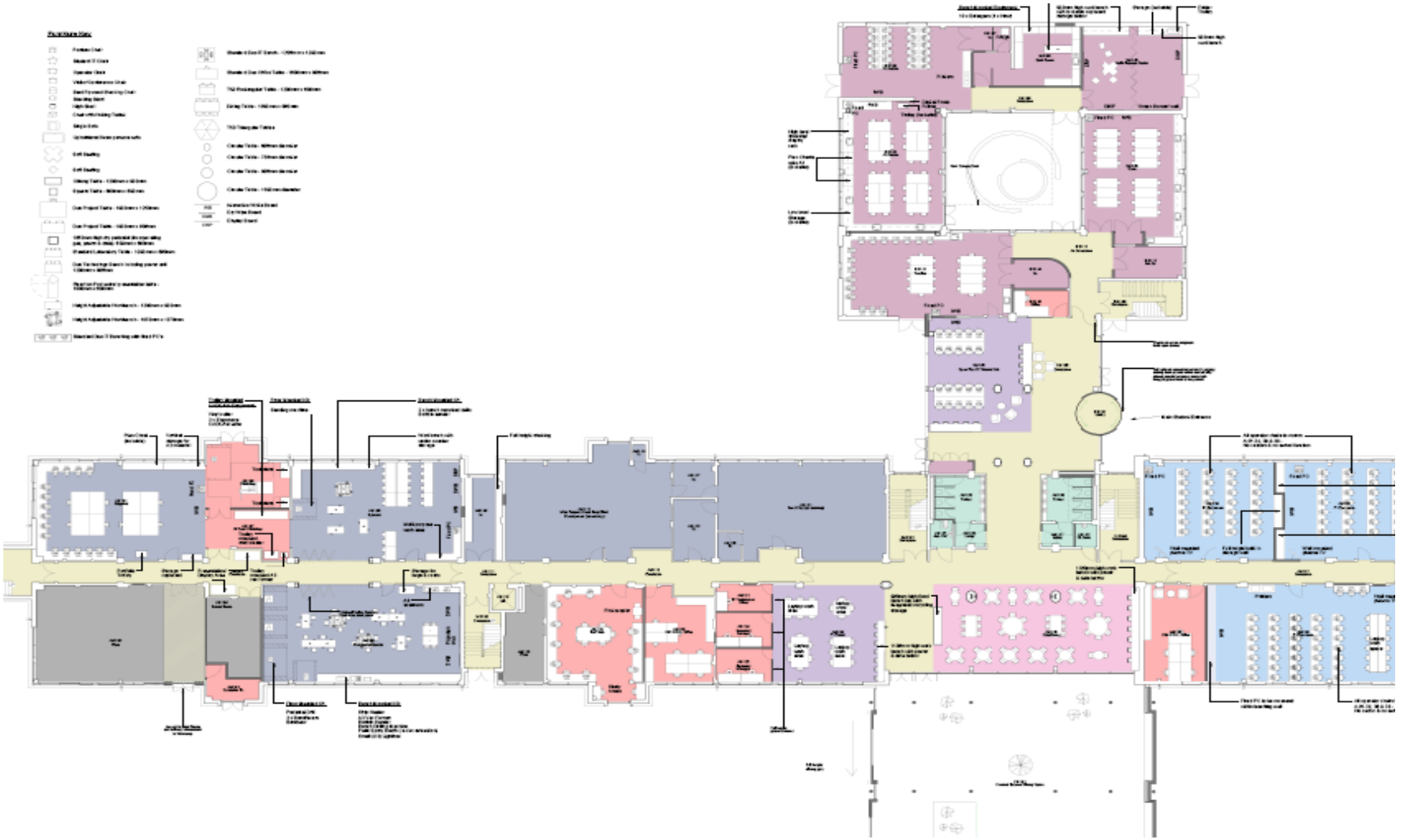






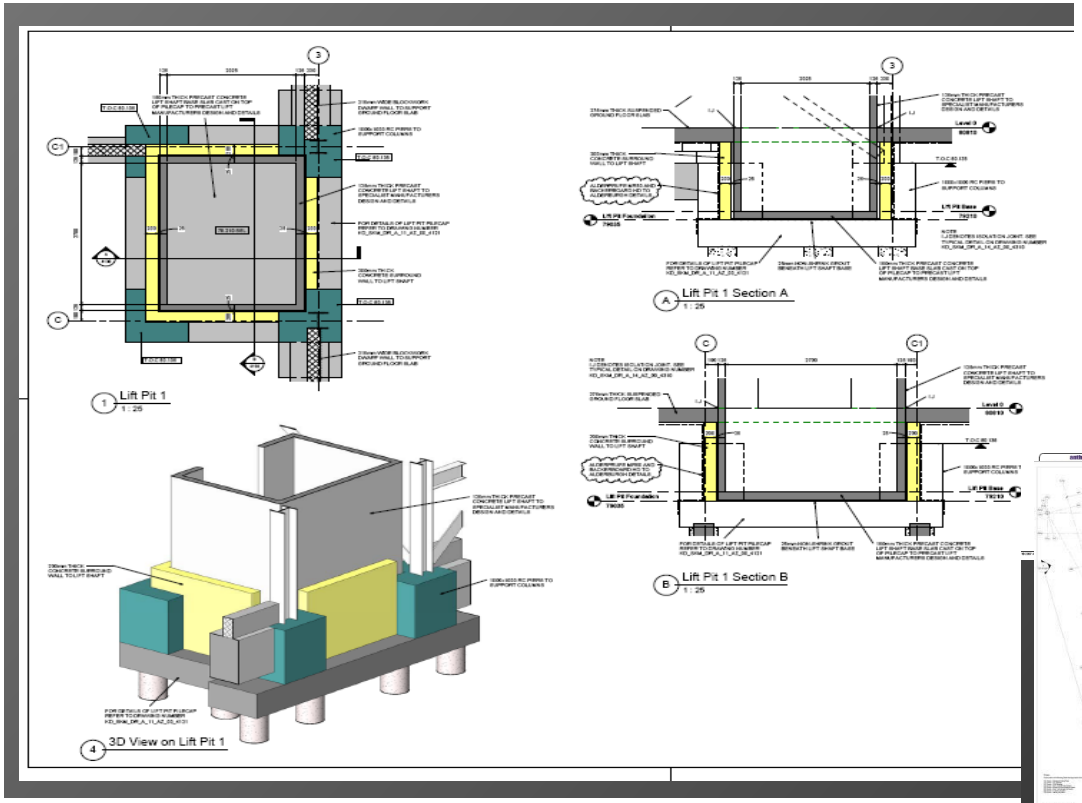
BIM Process

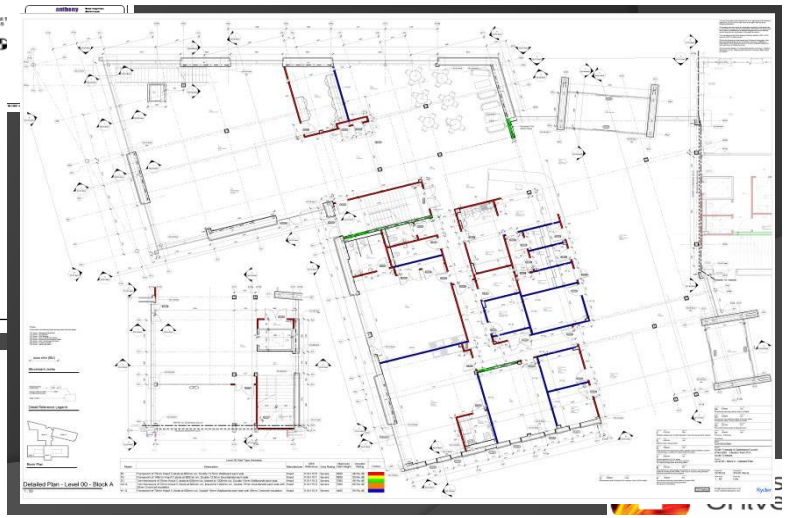
- Design Development: Floor Detailing



BIM Process

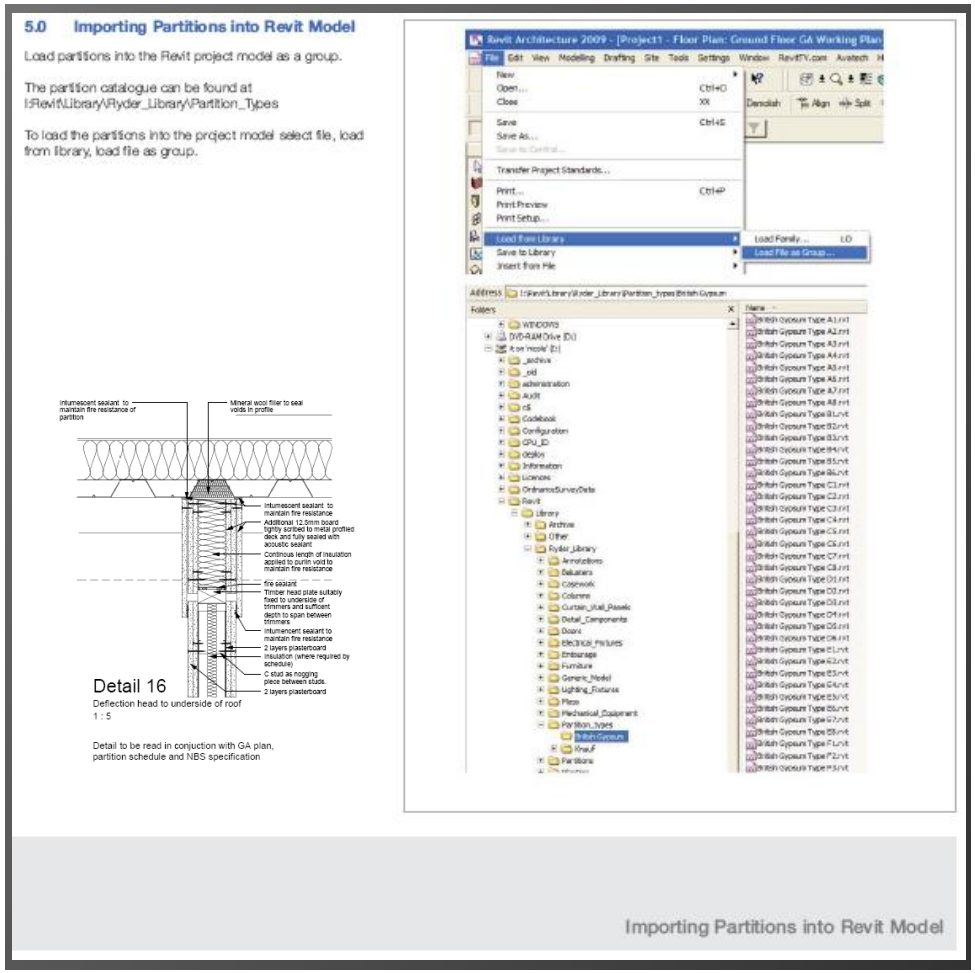
- Technical Design: Quantities, Components and Scheduling, Specification and Keynoting

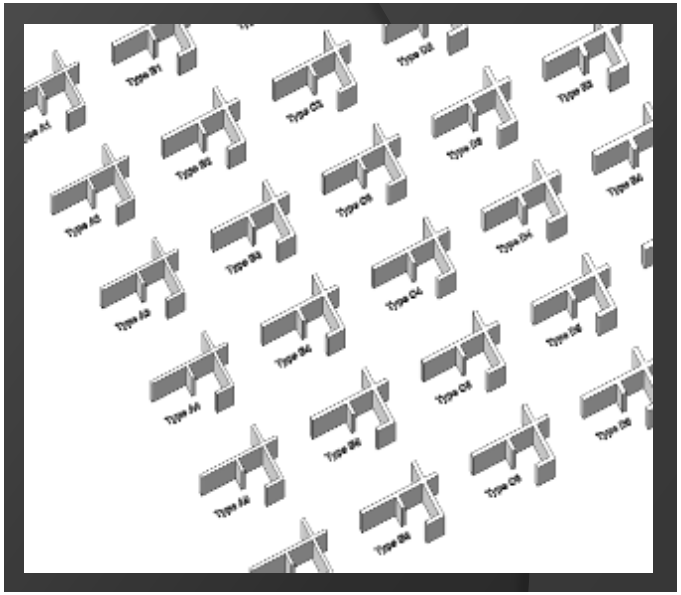


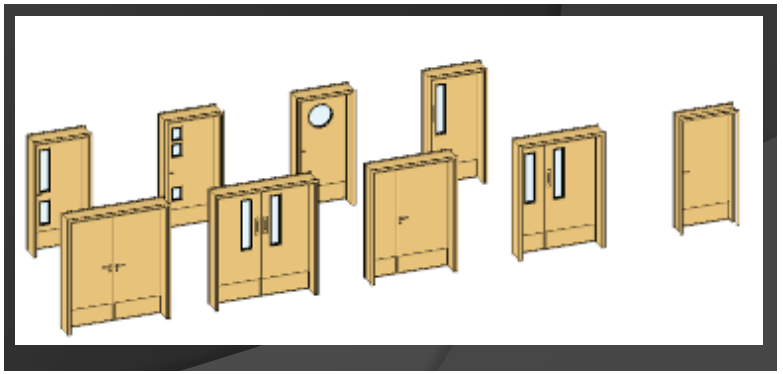


BIM Process

- Standardization: Such as Doors

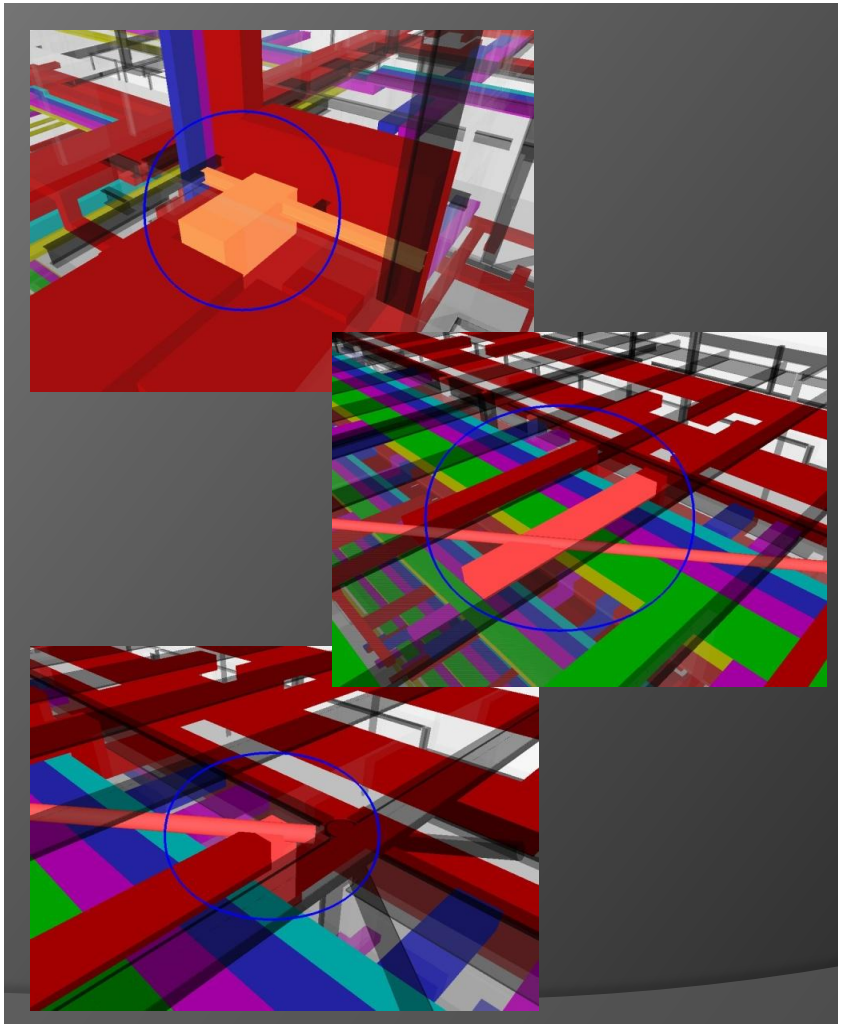


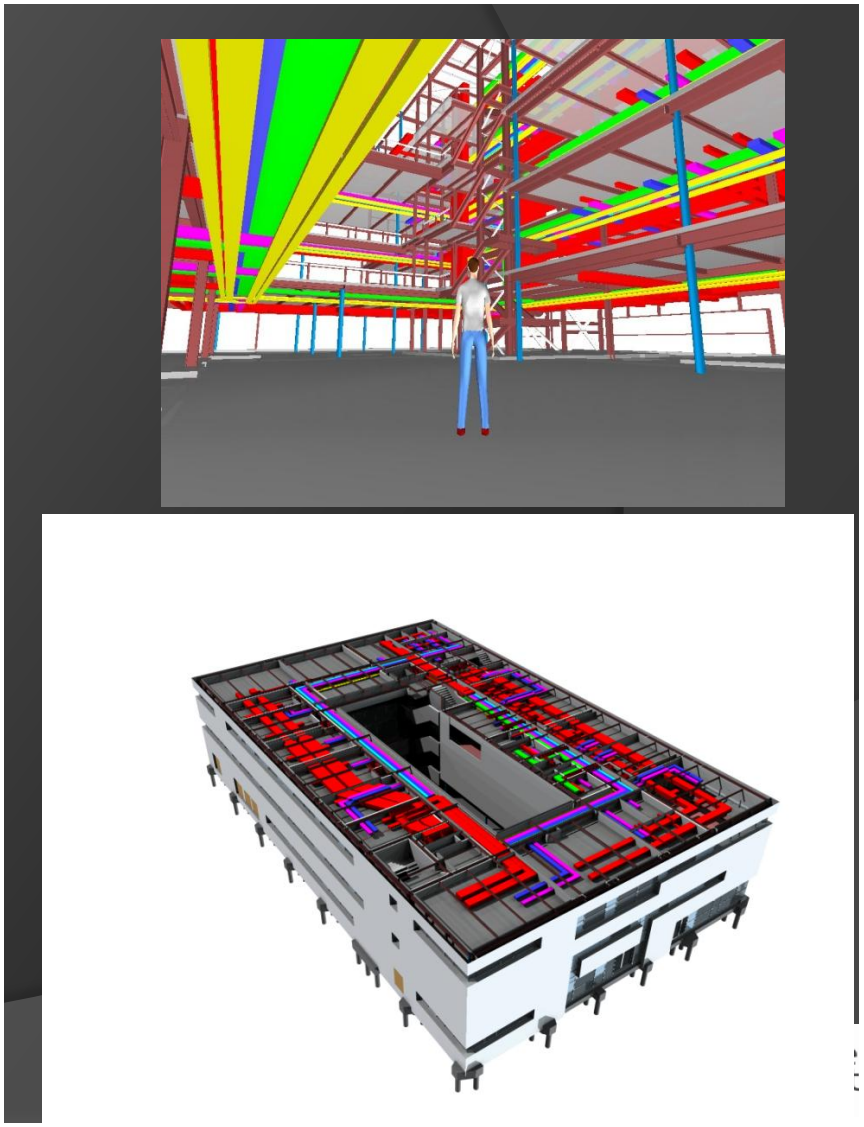




BIM Process

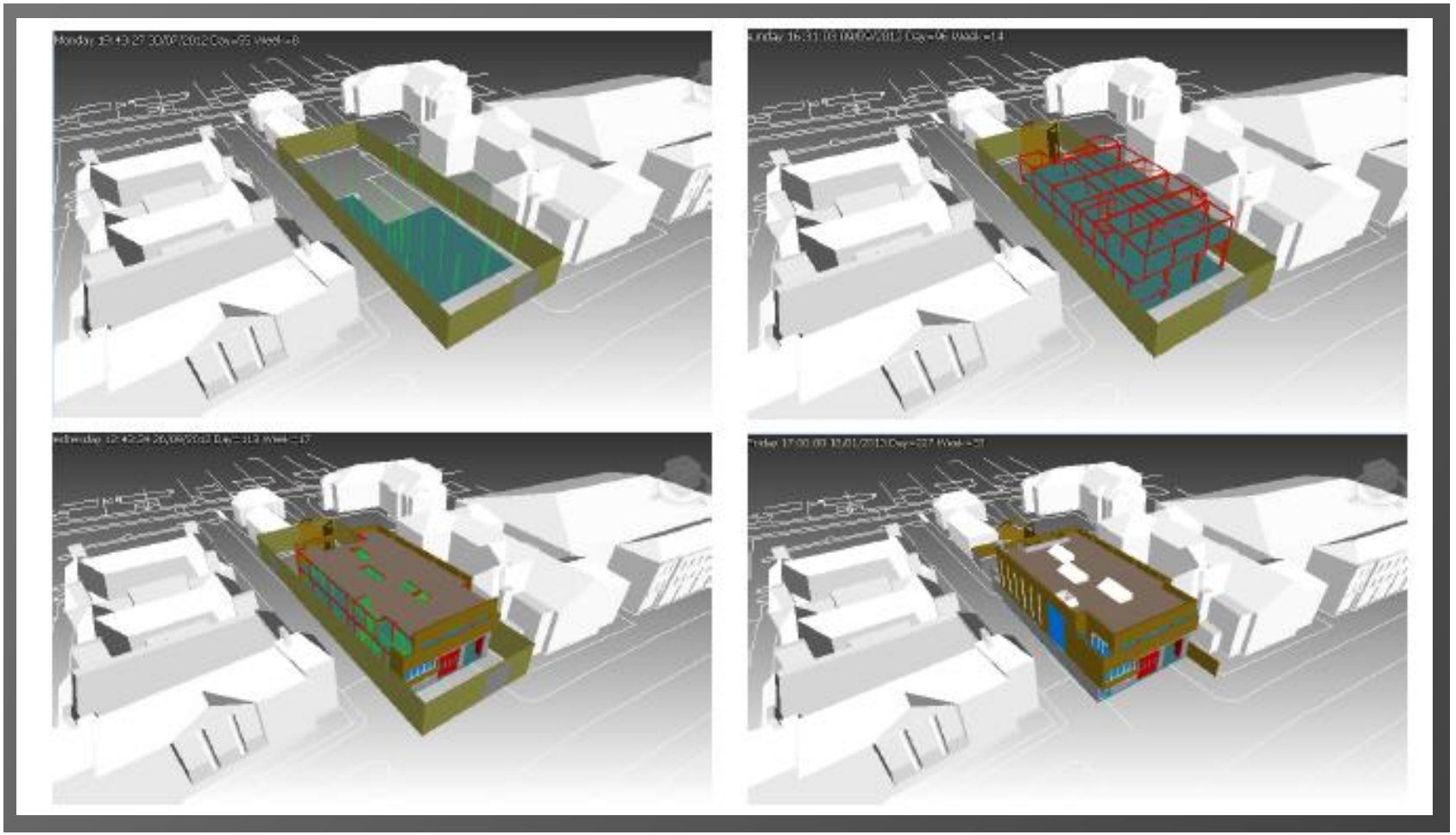
- Design Coordination





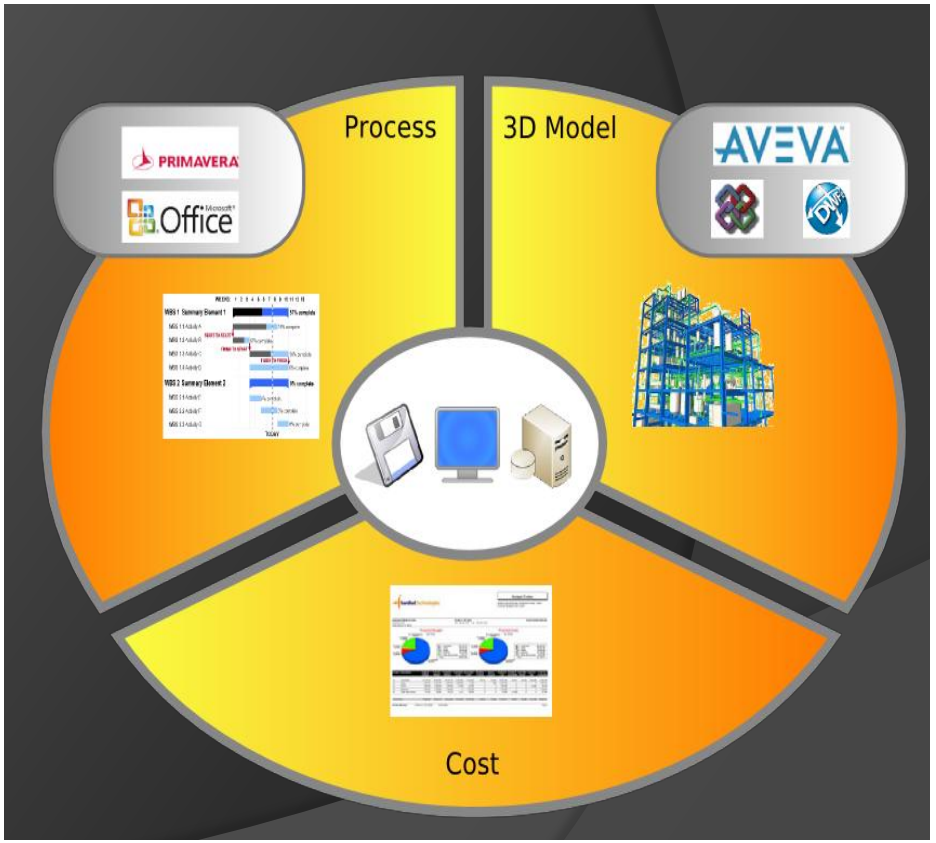
BIM Process

- 4D Planning: 3D + Time



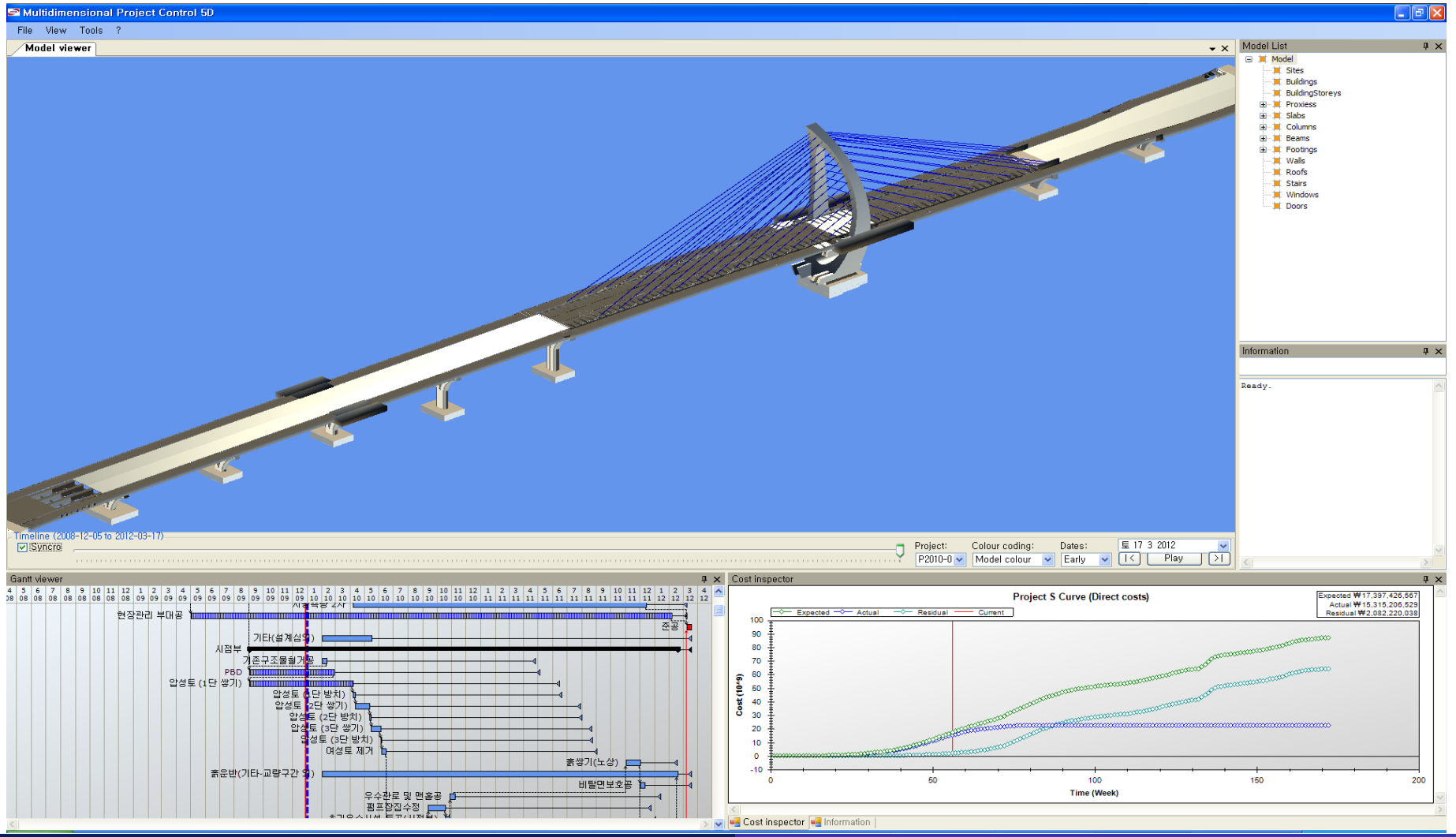
BIM Process

- 5D Planning: 3D + Time + Cost
  - Quantity takeoffs
  - Cost library linking
  - Review and analysis
  - Supply chain management



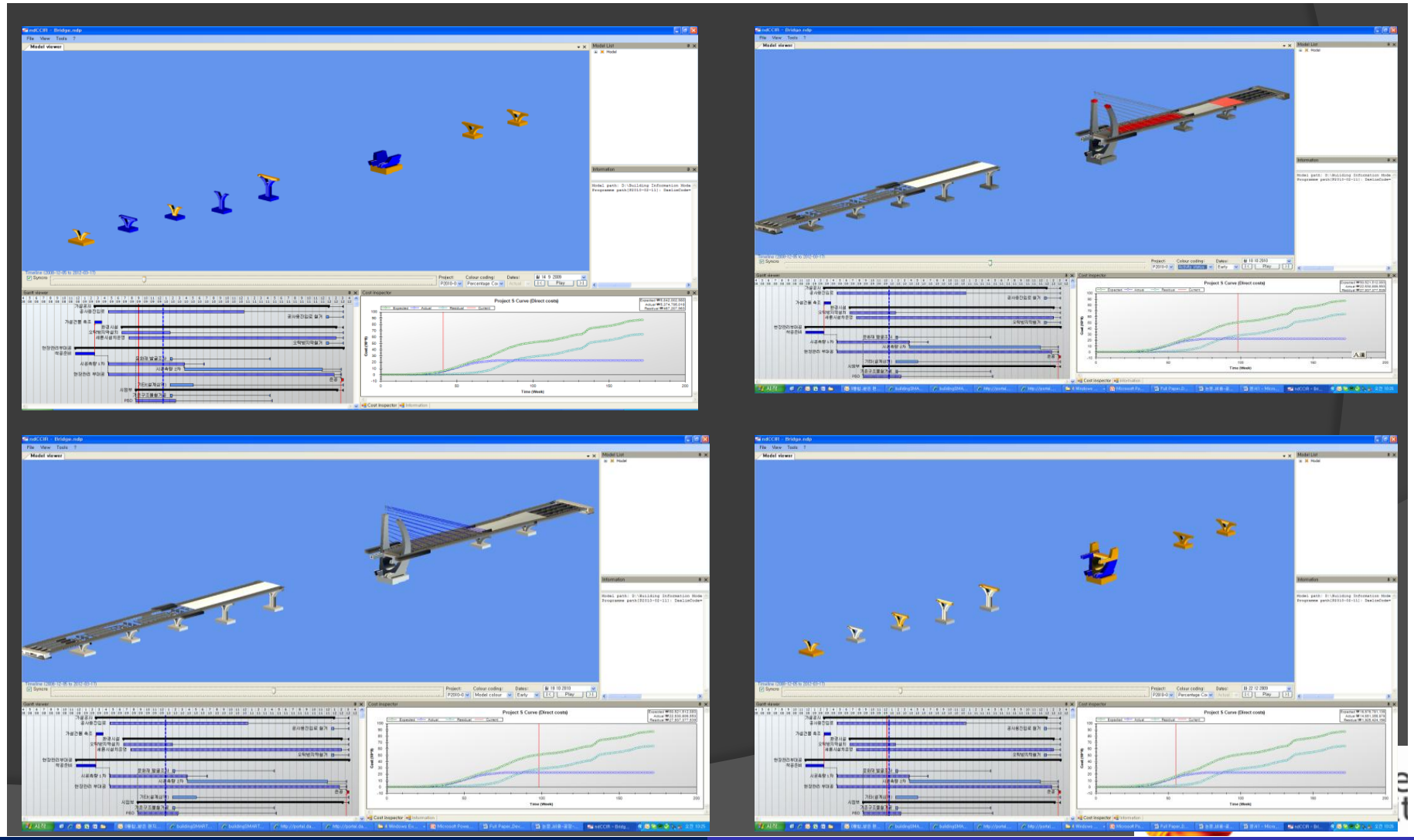
BIM Process

- 5D Planning: 3D + Time + Cost



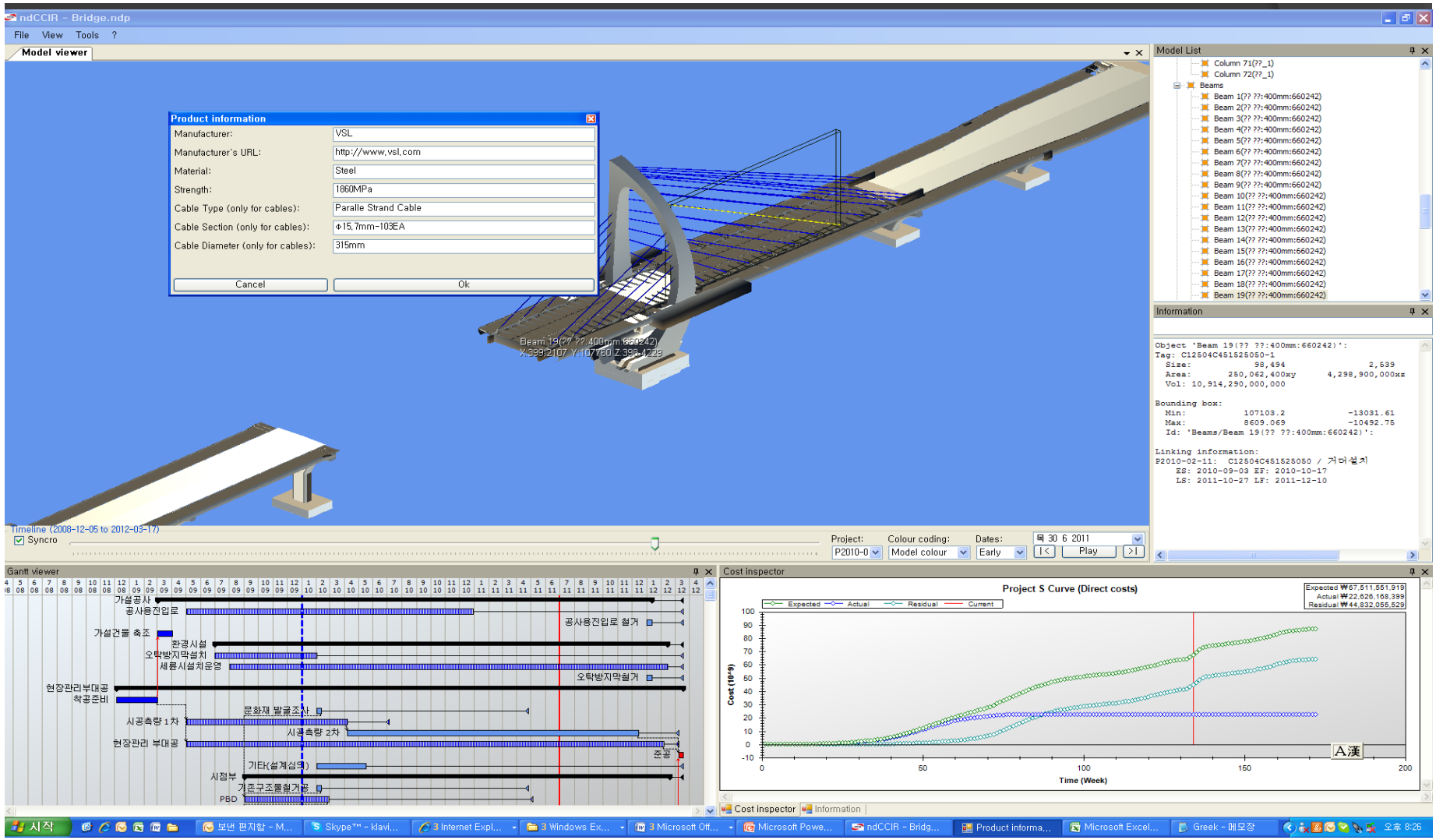
BIM Process

- 5D Planning: 3D + Time + Cost



BIM Process

- 5D Planning: 3D + Time + Cost



BIM Process

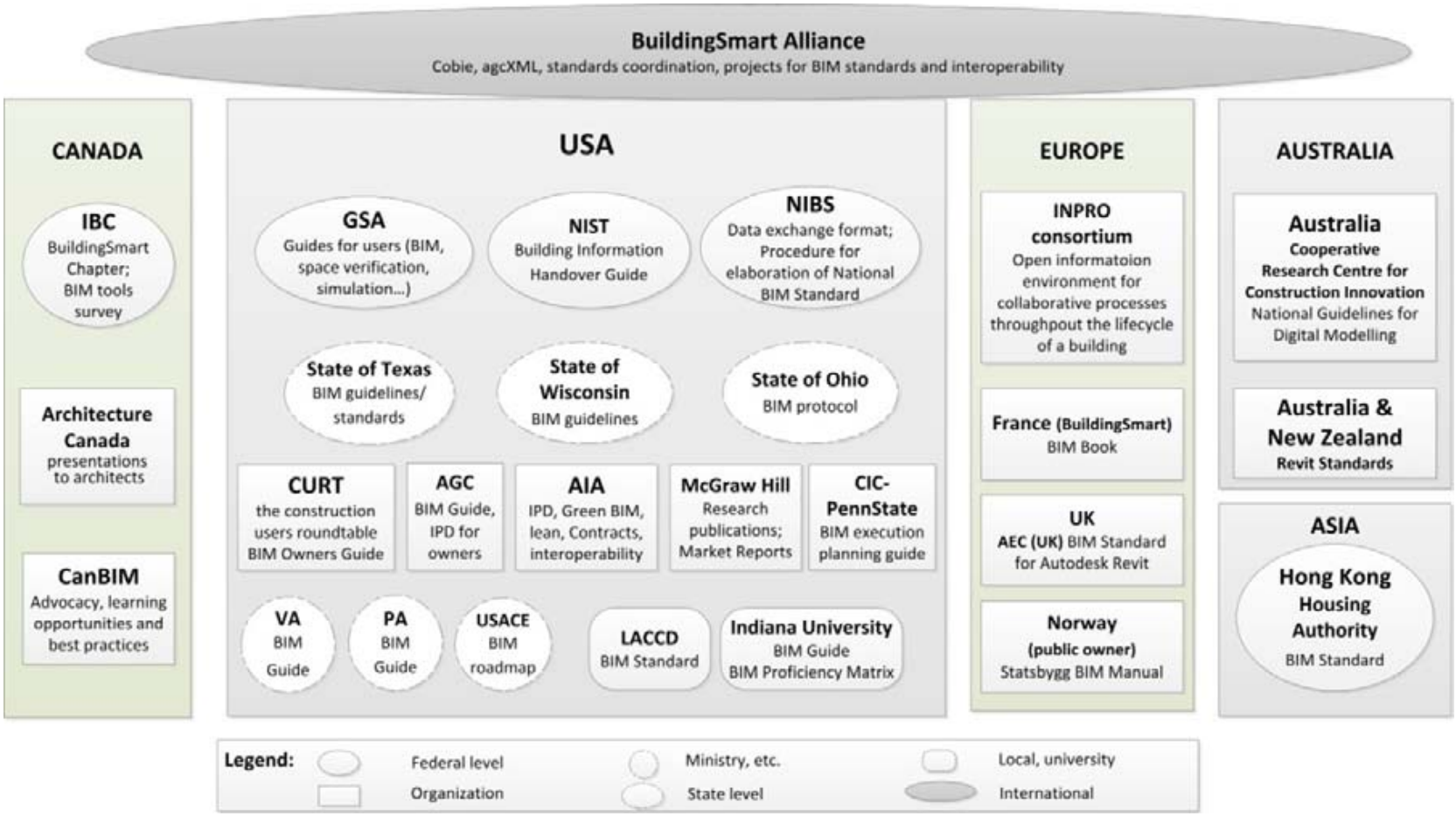
- 6D Planning: 3D + Time + Cost + Sustainability
  - Post Building Performance Monitoring
  - Technology Integration
  - Internet based energy management system
  - Reducing energy wastage and running cost

BIM Challenges

- Technical challenges
  - BIM is supposed to improve interoperability but existing BIM solutions present a new challenge; the lack of software compatibility makes it difficult to communicate between different BIM solutions, Industry Foundation Classes (IFC).
  - Design speed is another problem when using BIM in real-life projects. It takes a long time to create all the detailed 3D models of building, temporary work and plant, to the desired level of detail and accuracy (Huang et al., 2007).
- New costs
  - While bringing many benefits, BIM increases cost. Companies face the extra cost of learning BIM and unlearning their old approaches.
  - The cost–benefit relationship of BIM needs to be quantitatively measured (e.g. Gilligan and Kunz, 2007; Huang et al., 2007).

BIM Challenges

- Lack of legal framework
  - Standards: UK, USA, etc. have developed standards



BIM Challenges

- BIM and Project Delivery Method
  - Deep BIM implementation requires collaboration among parties, and Integrated Project Delivery Method is recommend often

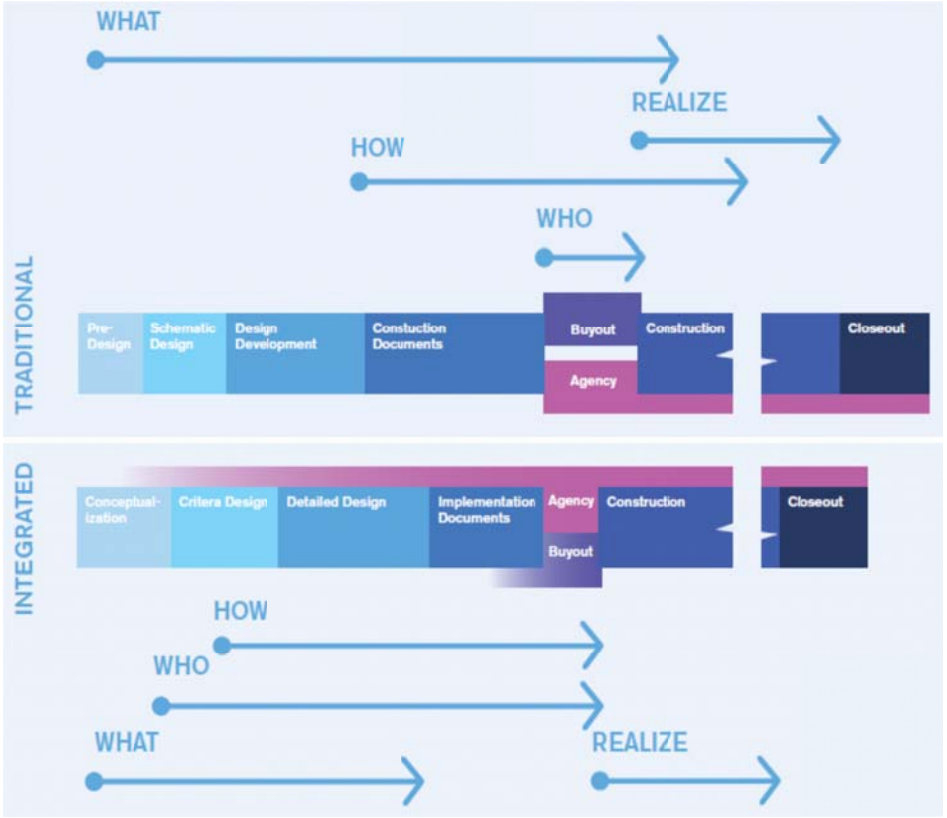


Figure 3: Differences between Integrated and Traditional Project Delivery (AIA California Council 2007)

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