



CBIM
PhD BIM School

Building Information Modelling: A concise introduction

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Technion IIT

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BIM: A Concise Introduction

Learning Goal

To be able to answer these questions:

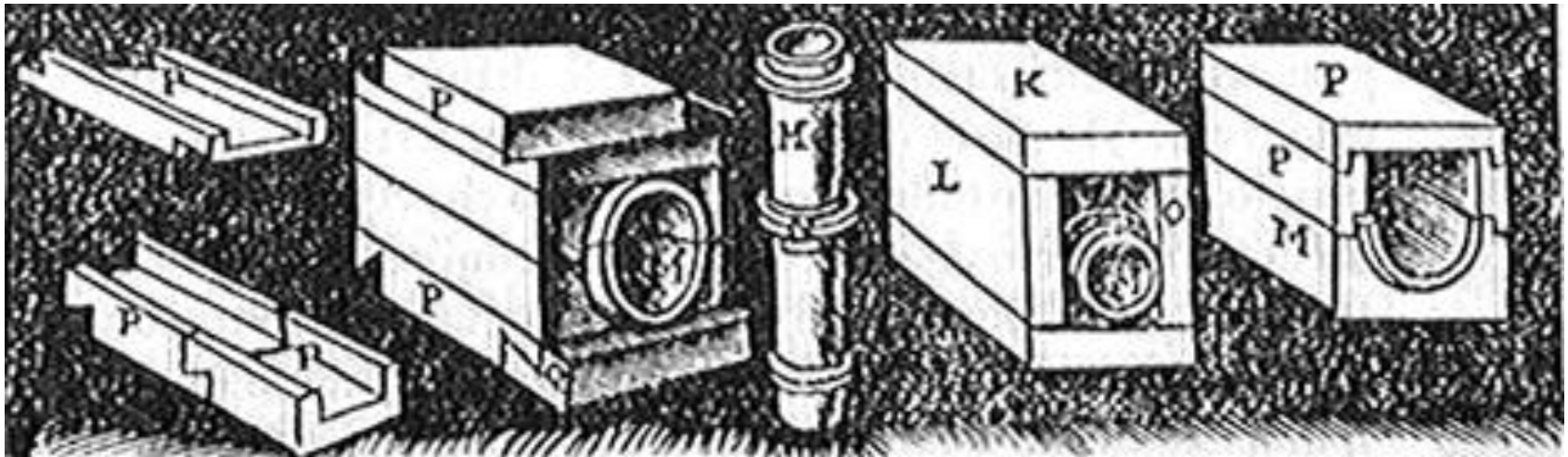
- How has building design and construction communication developed through history?
- What is building information modeling?
- What are BIM technologies and processes?
- What are BIM environments, platforms and tools?
- Why is digital prototyping so significant?

Communicating Information using Engineering Graphics

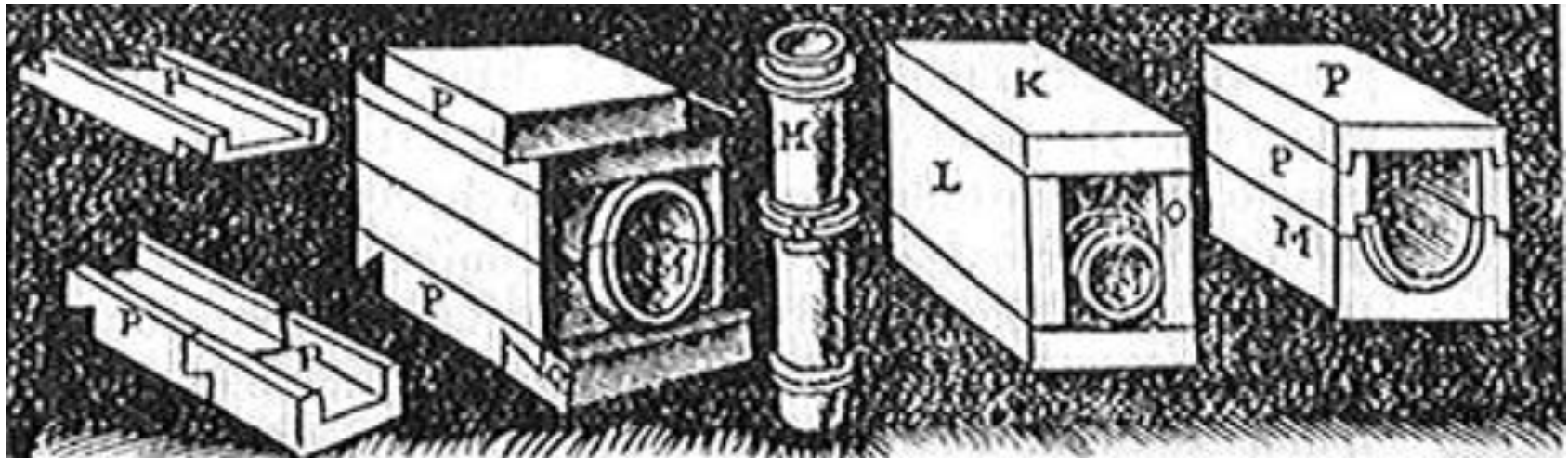
- Roman era - the birth of "civil engineering".
- Master Builders of the Middle Ages
- Development of technical drafting
- Computer-aided drafting (CAD)
- Building Product Modeling
- BIM

Communicating Information using Engineering Graphics

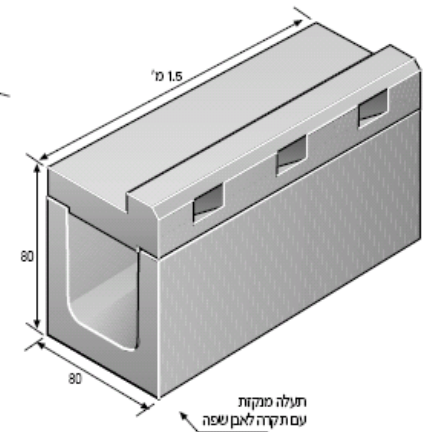
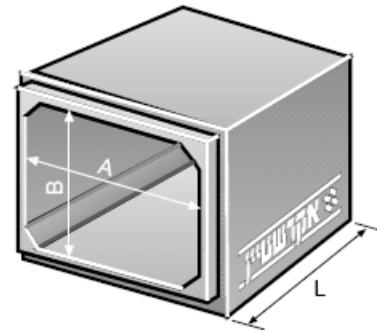
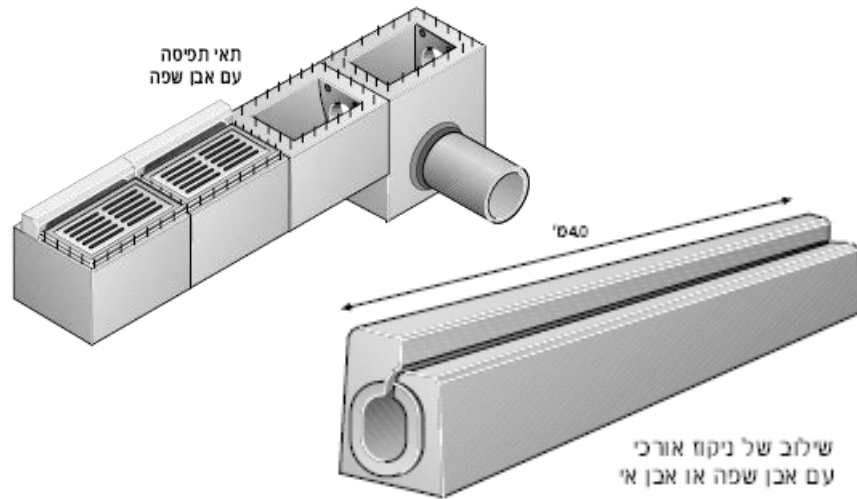
Ancient Roman construction
- the birth of "civil engineering"



Cesare Cesariano del De Architectura (Como, 1521), Different types of piping. Weterobius



Cesare Cesariano del De Architectura (Como, 1521), Different types of piping. Weterobius



Ackerstein Products Catalog, 2006

Communicating Information using Engineering Graphics

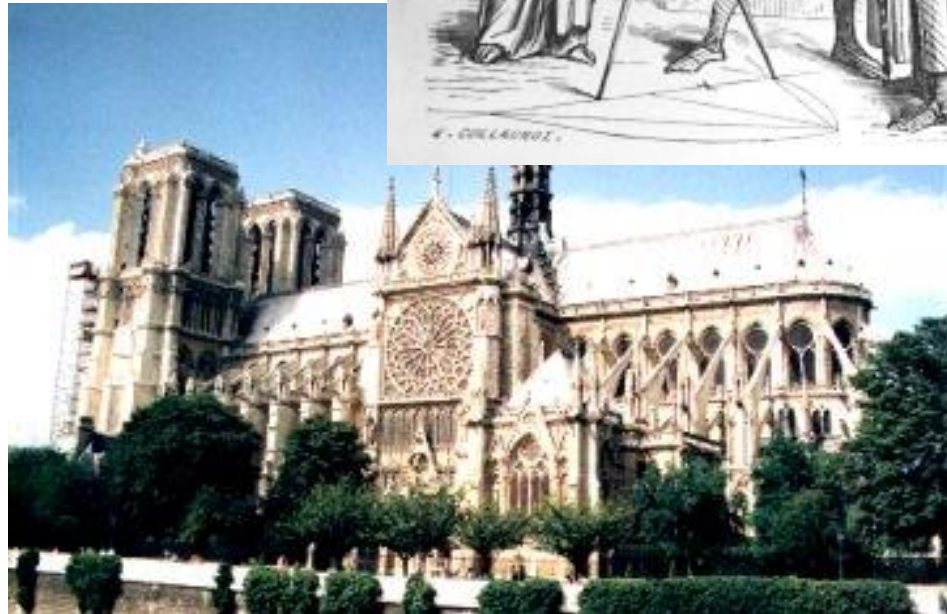
The Age of the Master Builders

No paper drawings as we know them, but verbal instructions on site, sometimes using diagrams drawn on a special floor surface



Strasbourg cathedral

Built between 1163 - 1176. The tower height was 142 m – it was the world's tallest building from 1645 to 1847.



Notre Dame Cathedral in Paris

Communicating Information using Engineering Graphics

Development of technical drafting

- During the Renaissance (cultural revival in Europe, 14th-16th centuries), architects began to specialize in design and stopped working in construction.
- Multiplicity of materials and methods of construction led to specialization in the trades
- Education of the architect became more theoretical and less practical.
- Two key inventions allowed communication between planners and executors: what were they?

De re aedificatoria (English: *On the Art of Building*)

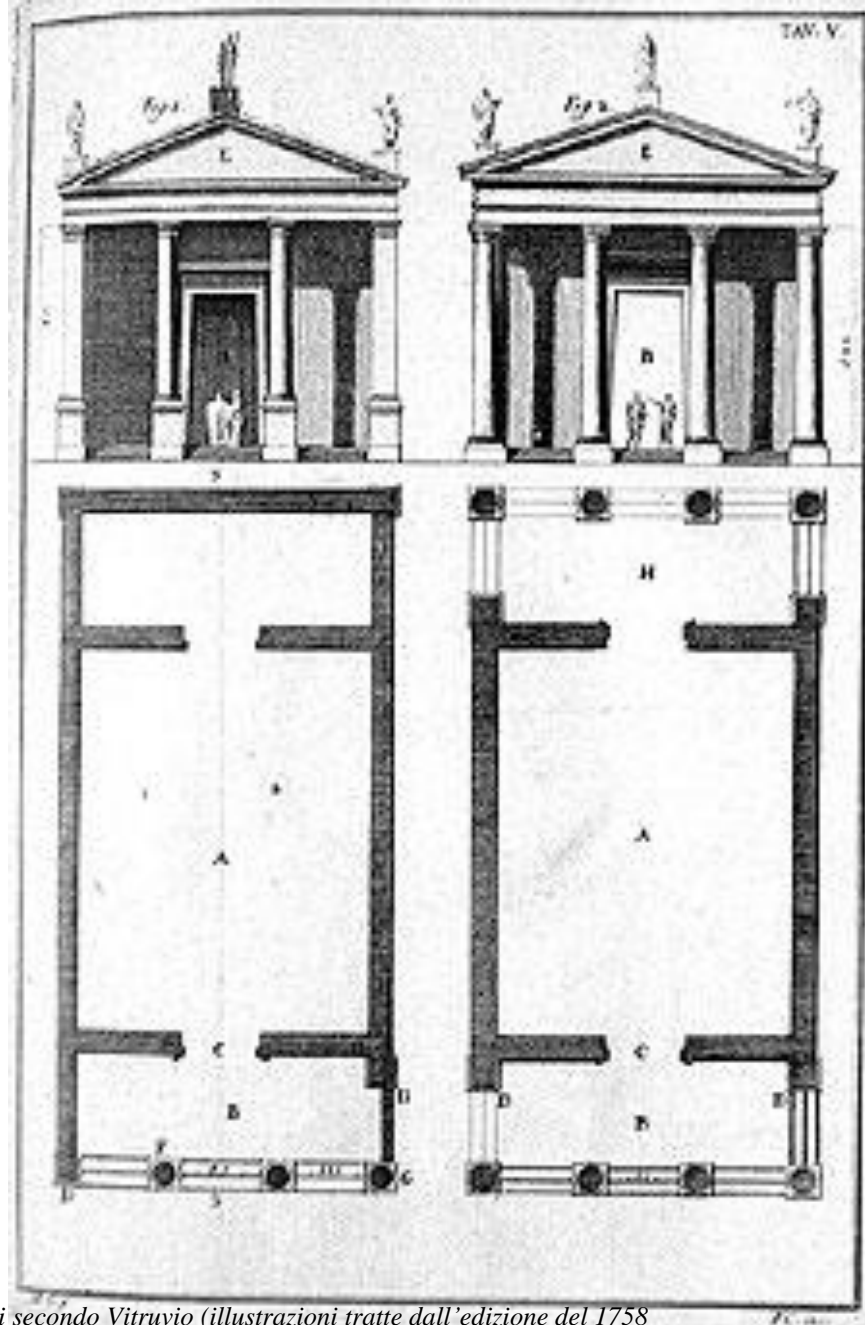
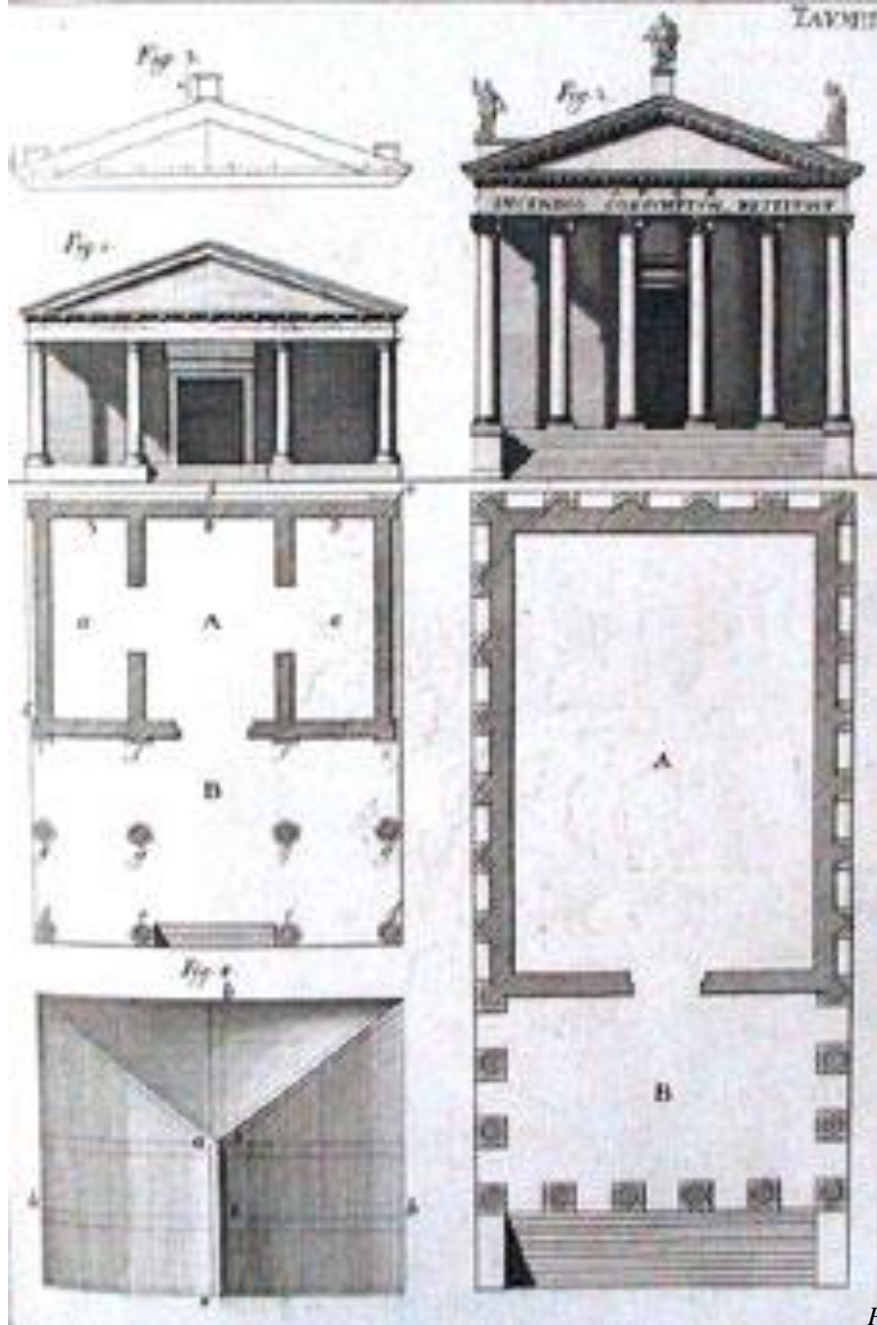
[Leon Battista Alberti](#) 1443 - 1452

Communicating Information using Engineering Graphics

In the 1760s, the Frenchman Gaspard Monge developed a precise standardised method of describing three dimensional objects in two dimensions, called **descriptive geometry**.

The method was deemed so powerful that it was kept in secrecy for many years, and Monge published the details only in 1799 (Monge 1799).

Monge, G., (1799). Géométrie descriptive: Leçons donnees aux Ecoles Normales, l'an 3 de la Republique. Paris, Baudouin, Imprimeur du Corps législatif et de l'Institut national.



Piante di templi secondo Vitruvio (illustrazioni tratte dall'edizione del 1758 del De Architectura, conservata nella Biblioteca comunale di Formia)

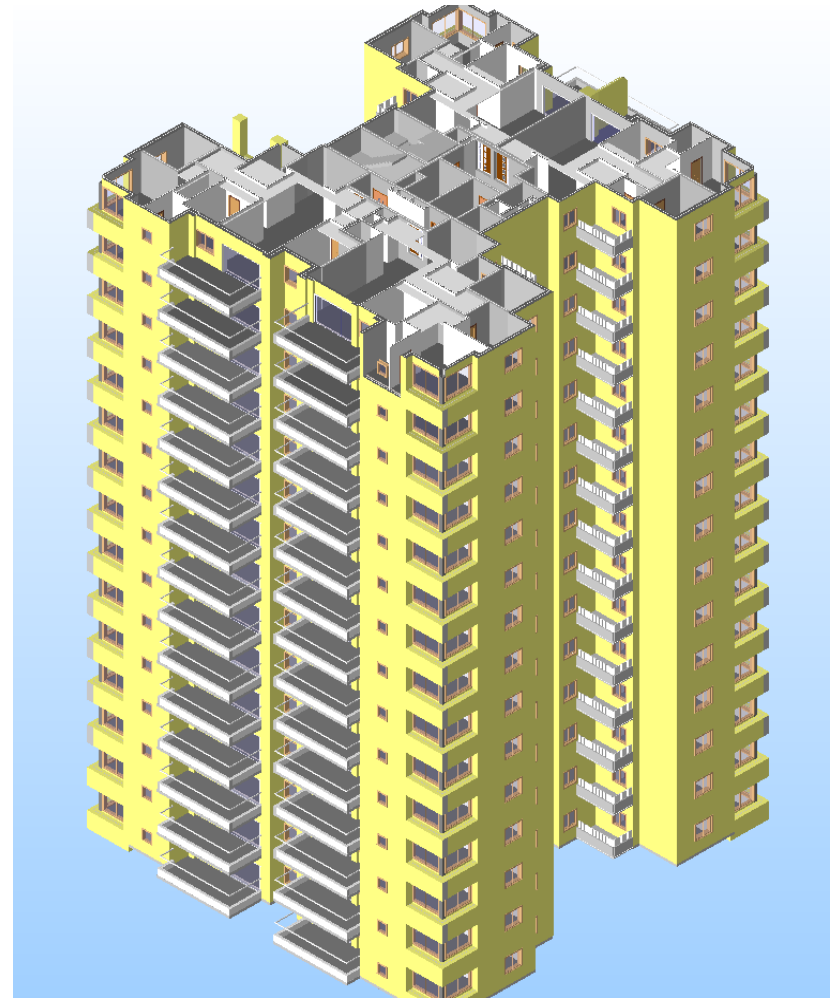
Communicating Information using Engineering Graphics

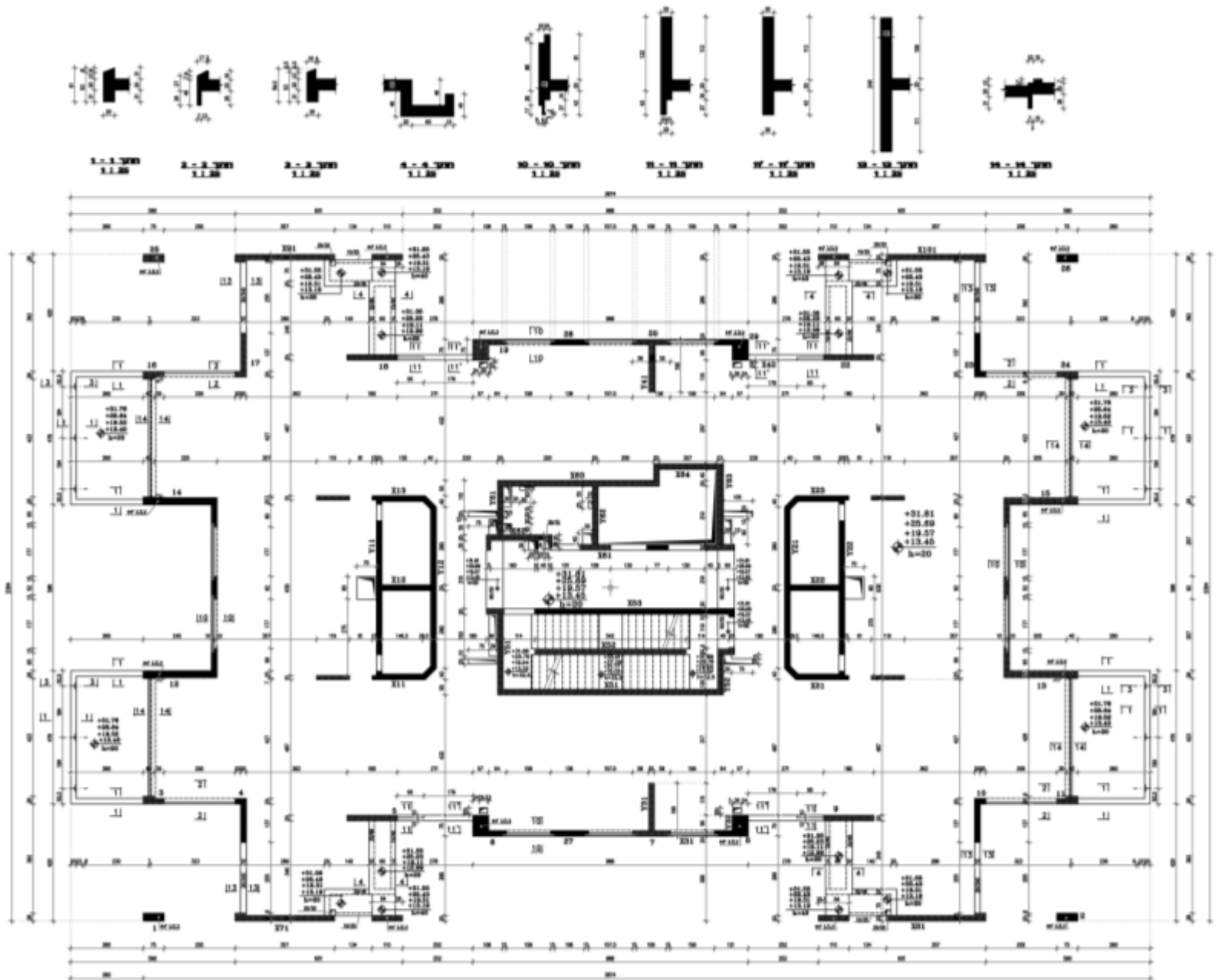
- Perspective views



Communicating Information using Engineering Graphics

- Perspective views
- **Parallel projection**
 - Orthographic projections
 - Multiple views
 - Axonometric projection
 - Tilted projections



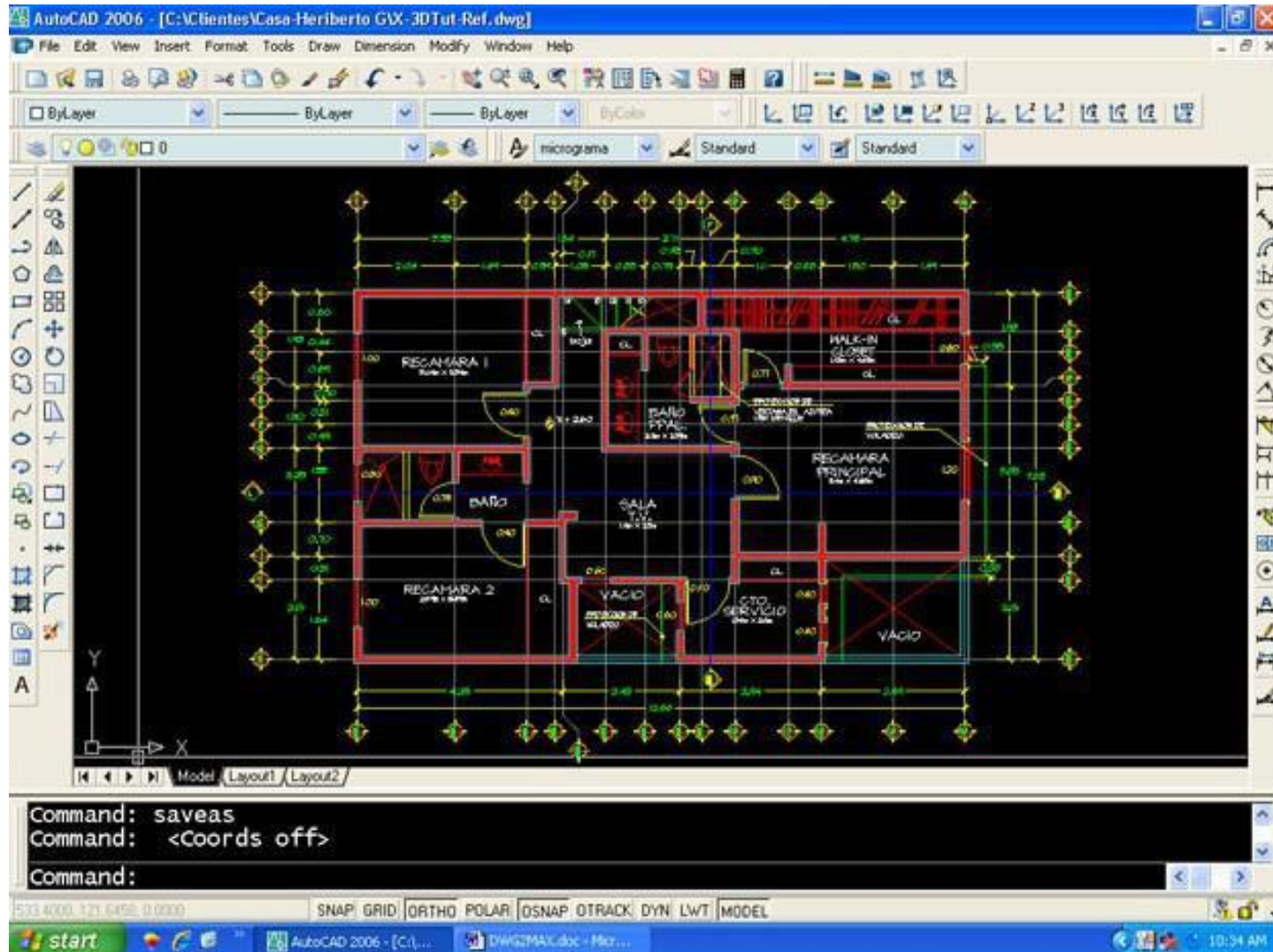


Communicating Information using Engineering Graphics

Use of Graphics in Engineering

- **Visualization:** The ability to create a conceptual view of non-existent objects in the reader's mind.
- **Communication:** Ability to pass a product concept from one person to another unambiguously.
- **Documentation:** Conservation of information over time.

CAD



Building Information Modeling

=

BIM

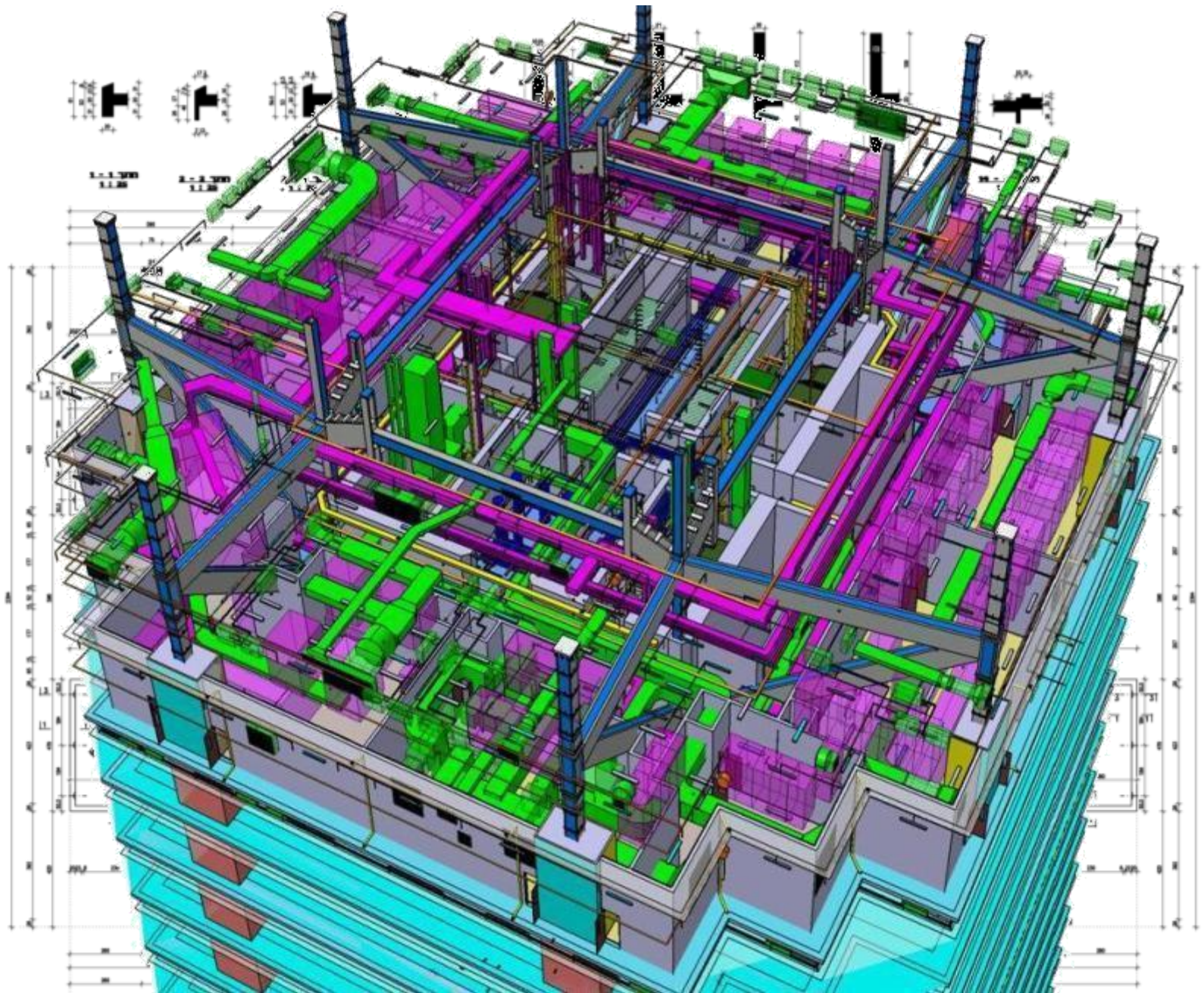
What is Building Information Modeling?

- A **Building Model** is a digital representation of a building, its function, design, construction and later its operation. A building model replaces building drawings.
- Unlike computerized drawings, building models are readable by computer software.
- **Building Information Modeling** is the process of creating a building model. The term also describes the software and technologies for compiling and processing building model.
- **REVIT** is an example of building information modeling software.

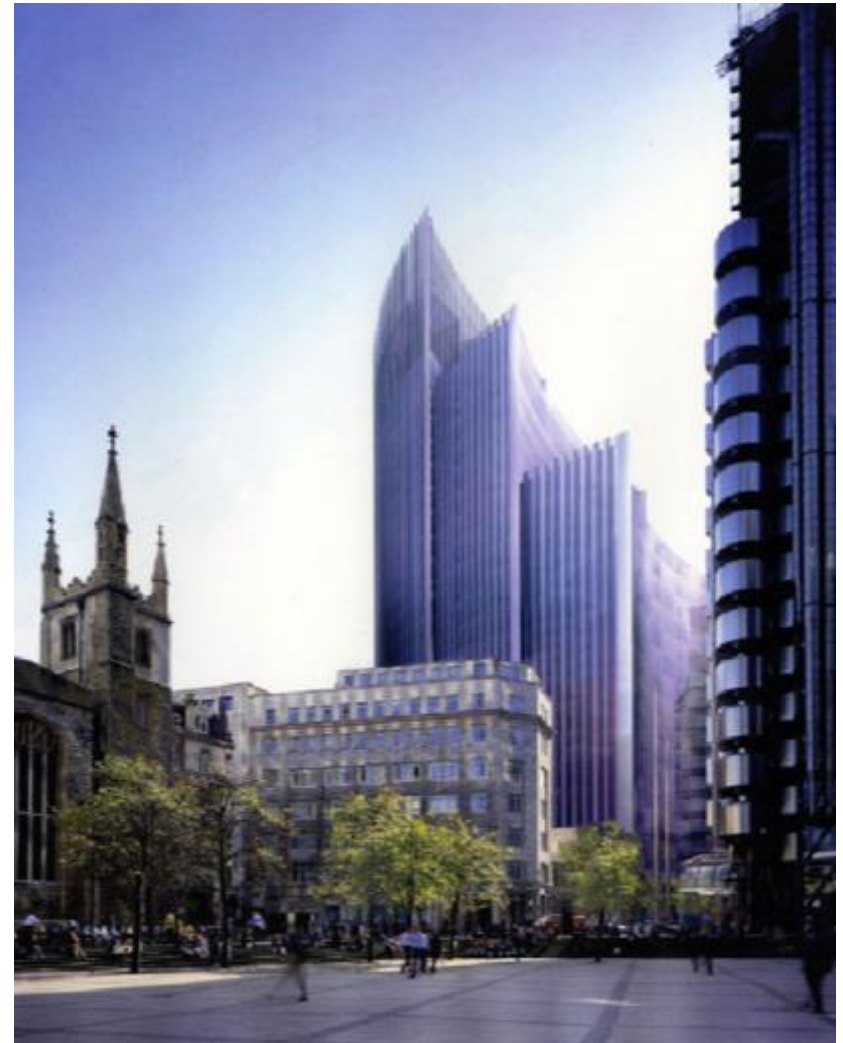
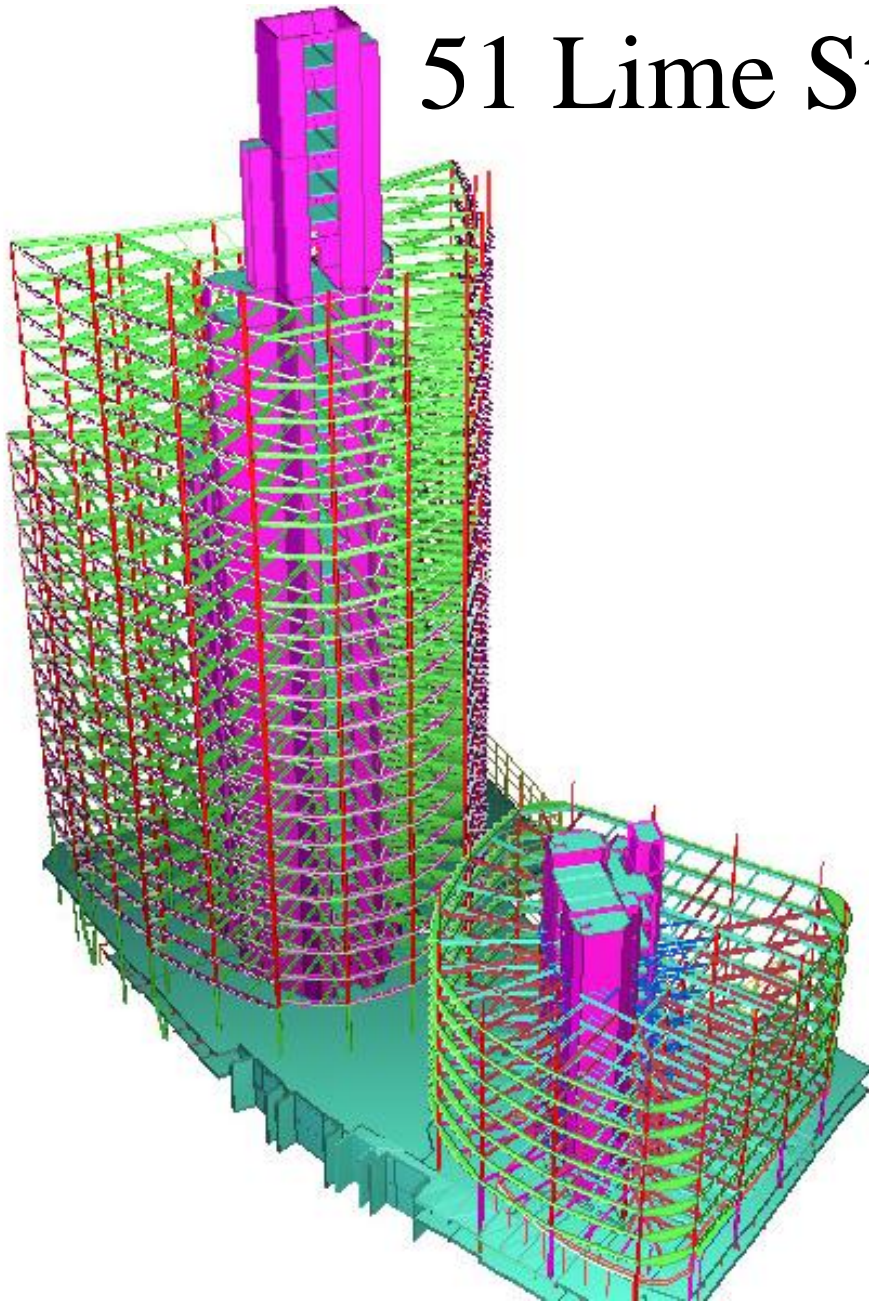
First concepts

Eastman, C., (1975) “Building Description System”, AIA Journal
The Use of Computers Instead of Drawings

“Designing would consist of interactively defining elements... It should be possible, then, to derive sections, plans, isometrics or perspectives from the same description of elements... Any change of arrangement would have to be made only once for all future drawings to be updated. All drawings derived from the same arrangement of elements would automatically be consistent... any type of quantitative analysis could be coupled directly to the description. All data preparation for analyses could be automated. Reports for cost estimating or material quantities could be easily generated... Thus BDS will act as design coordinator and analyzer, providing a single integrated database for visual and quantitative analyses, for testing spatial conflicts and for drafting. ... Later, one can conceive of a BDS supporting automated building code checking in city hall or the architect’s office. Contractors of large projects may find this representation advantageous for scheduling and materials ordering.”



51 Lime Street (Willis Building)



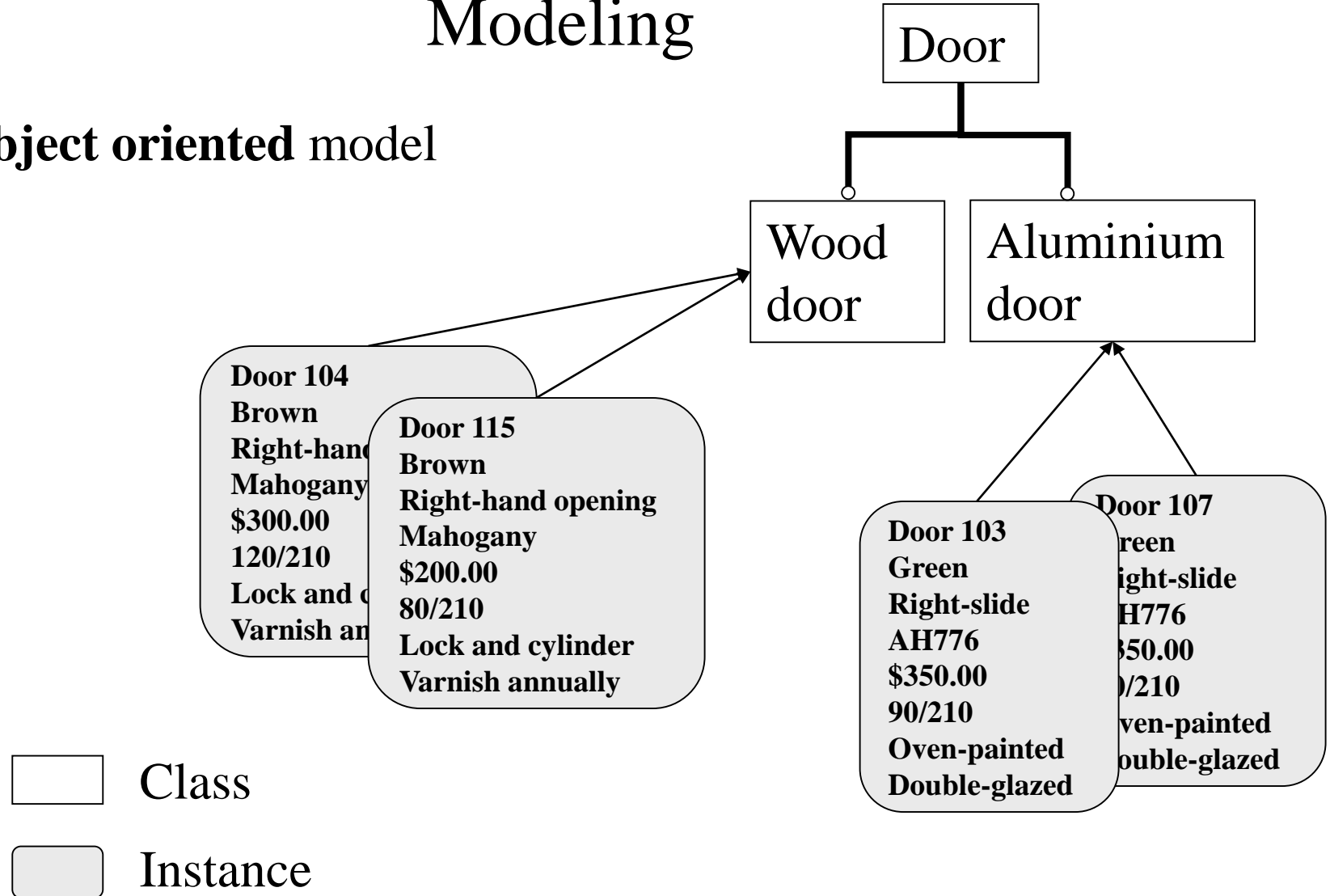
Common Principles in Building Information Modeling

- **Object oriented** model
- **Solid** model
- **Parametric** model
- **Single data model**
- **Digital prototyping**
- Supports **collaborative engineering**

Common Principles in Building Information Modeling

Modeling

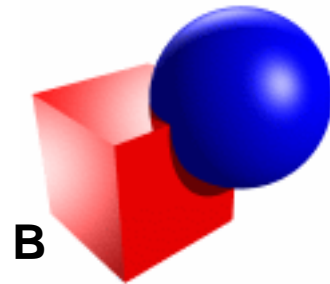
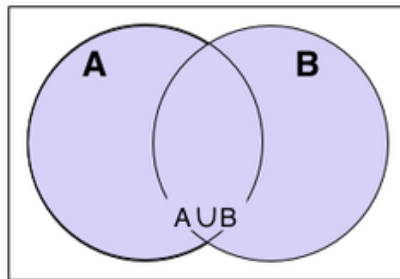
- **Object oriented model**



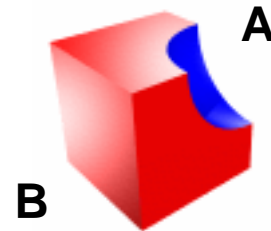
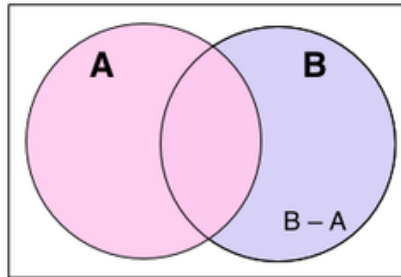
Common Principles in Building Information Modeling

- **Solid** model

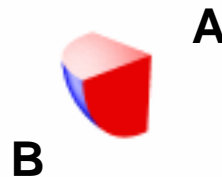
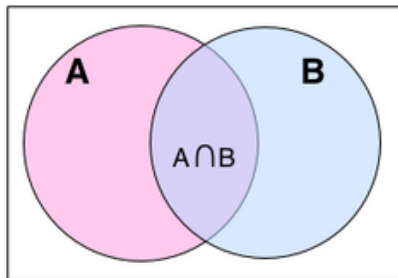
Constructive Solid Geometry (CSG)



Union $A \cup B$



Subtraction $B - A$



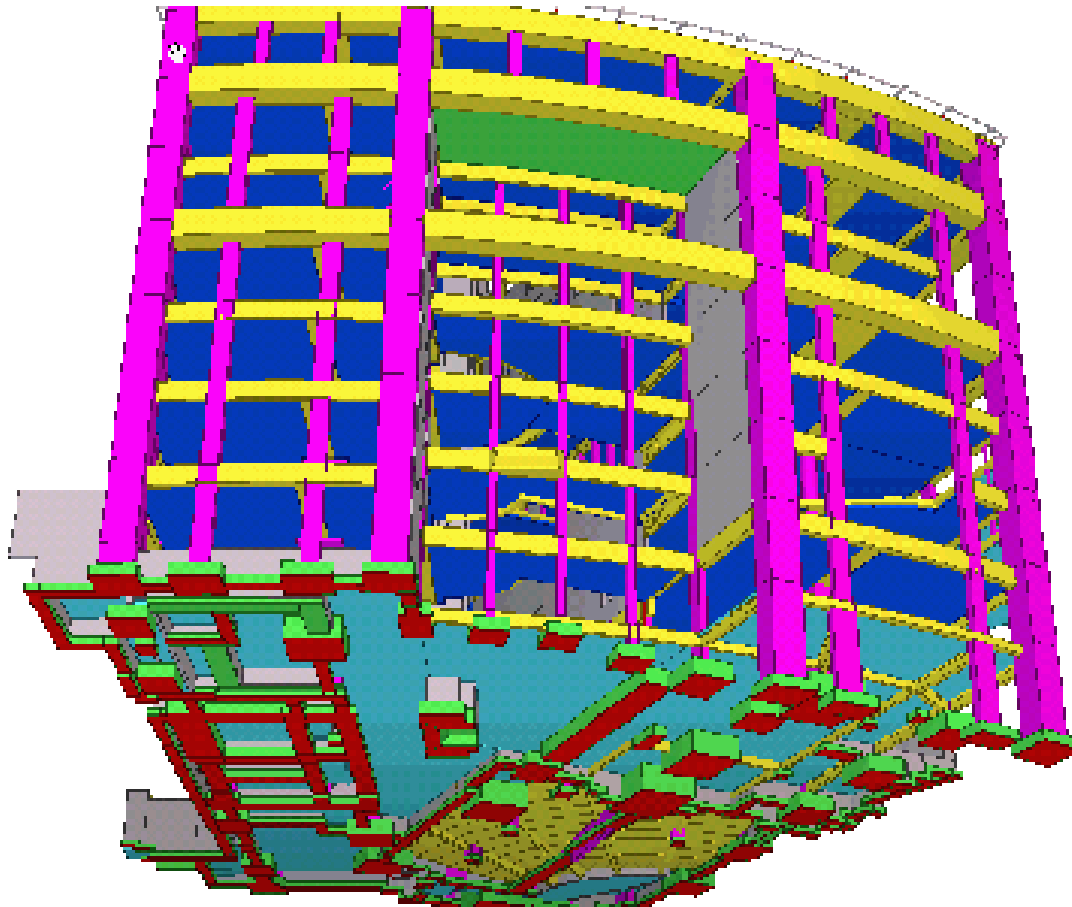
Intersection $A \cap B$

Common Principles in Building Information Modeling

Modeling

- **Solid** model

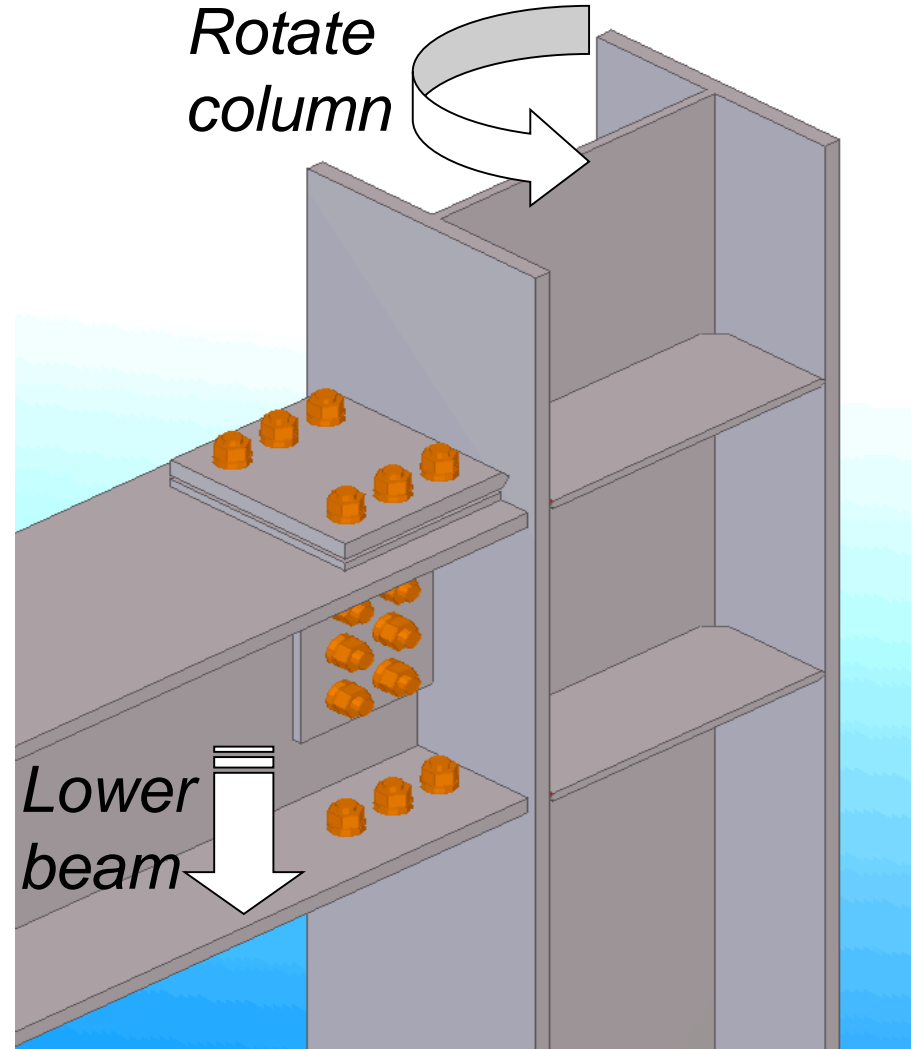
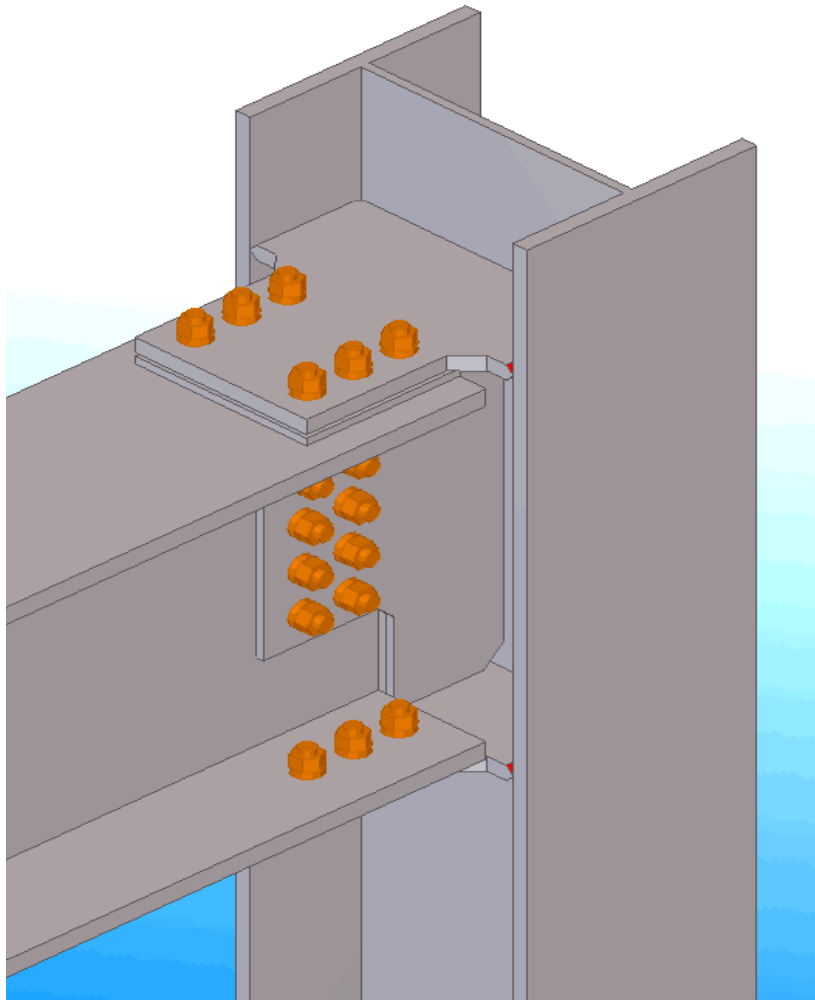
Constructive Solid Geometry (CSG)



Common Principles in Building Information

Modeling

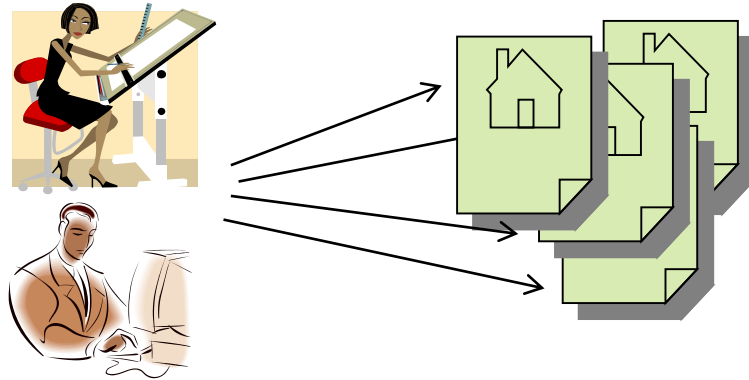
- **Parametric model**



Common Principles in Building Information Modeling

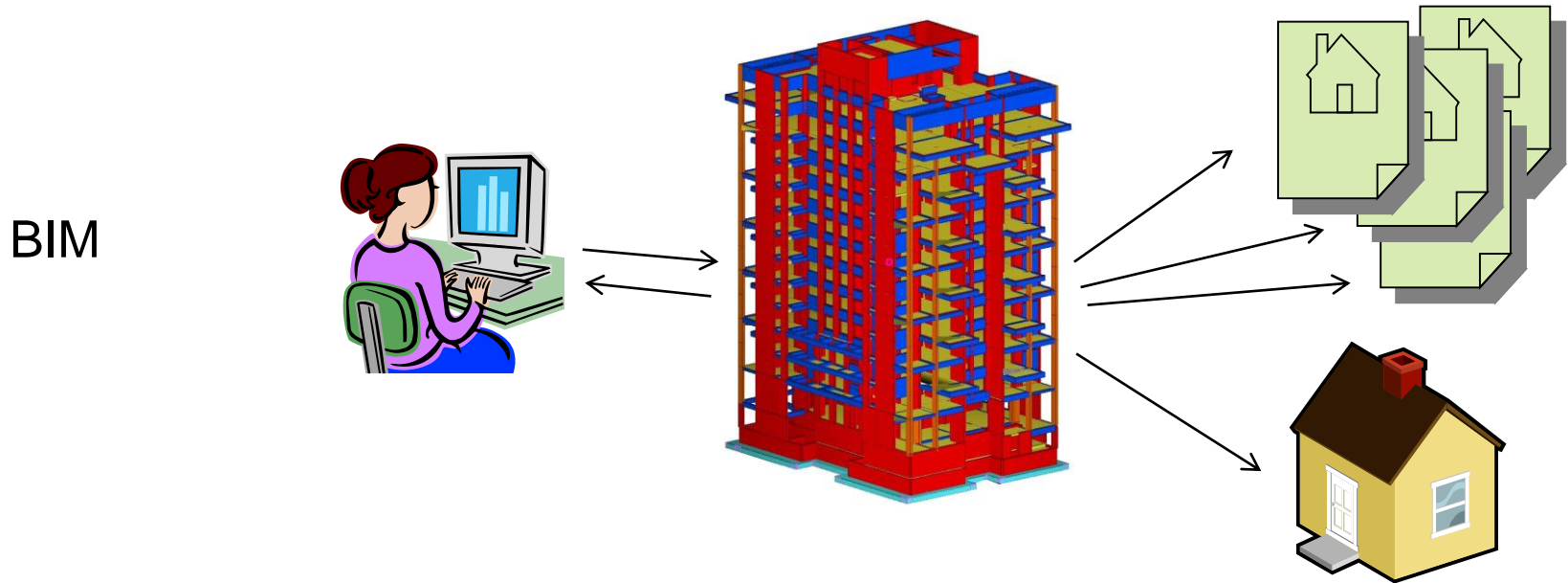
- **Single data model**

Manual drawing or CAD



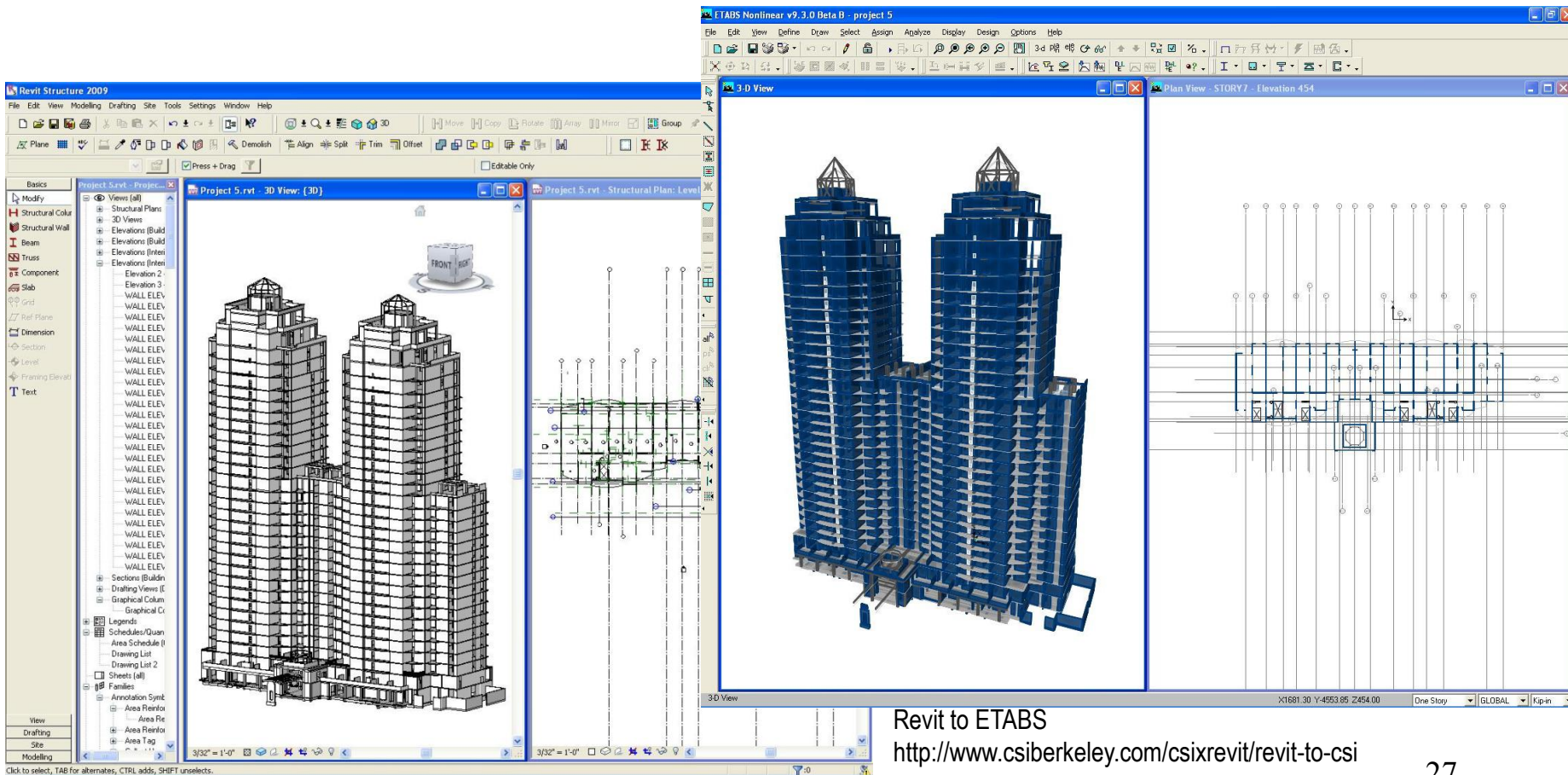
Common Principles in Building Information Modeling

- **Single data model**



Common Principles in Building Information Modeling

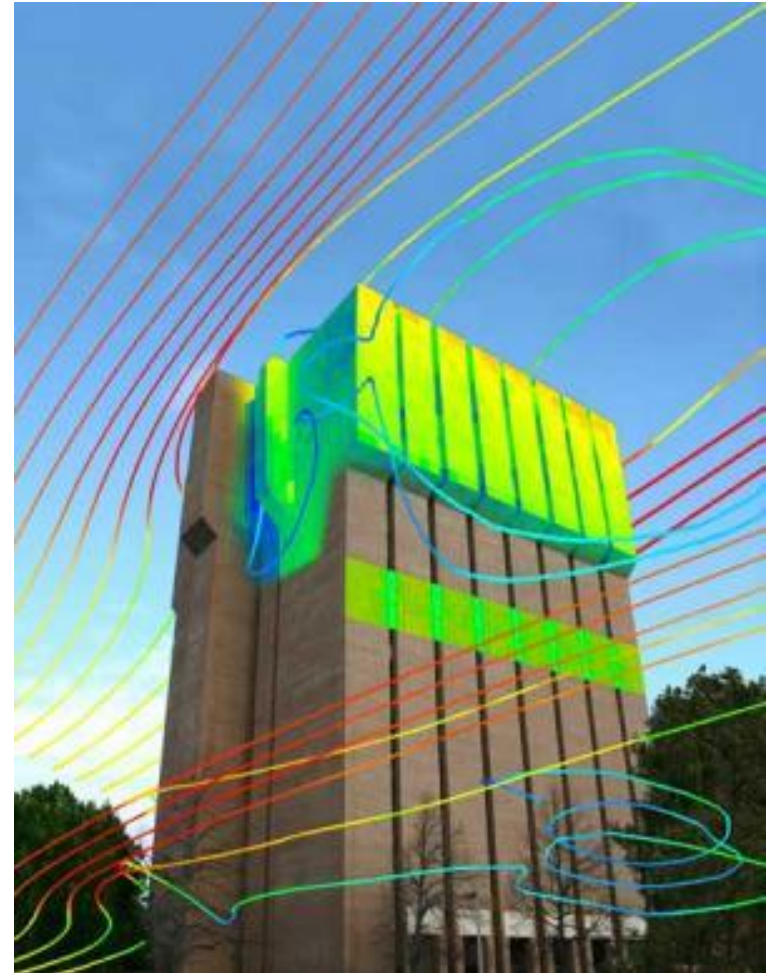
- **Digital prototyping – virtual design and construction (VDC)**
 - Structural static and dynamic analyses



Common Principles in Building Information Modeling

Modeling

- **Digital prototyping – virtual design and construction (VDC)**
 - Functional simulations (heating and cooling, lighting, energy, acoustics, circulation)
 - Quantity take-off and cost estimates at different levels of detail
 - Digital first-run studies (construction process – VDC)



Common Principles in Building Information Modeling

- Supports collaborative engineering

IFC entities and property values of each view

(a) Architectural view

(b) Mechanical system view

(c) Structural view

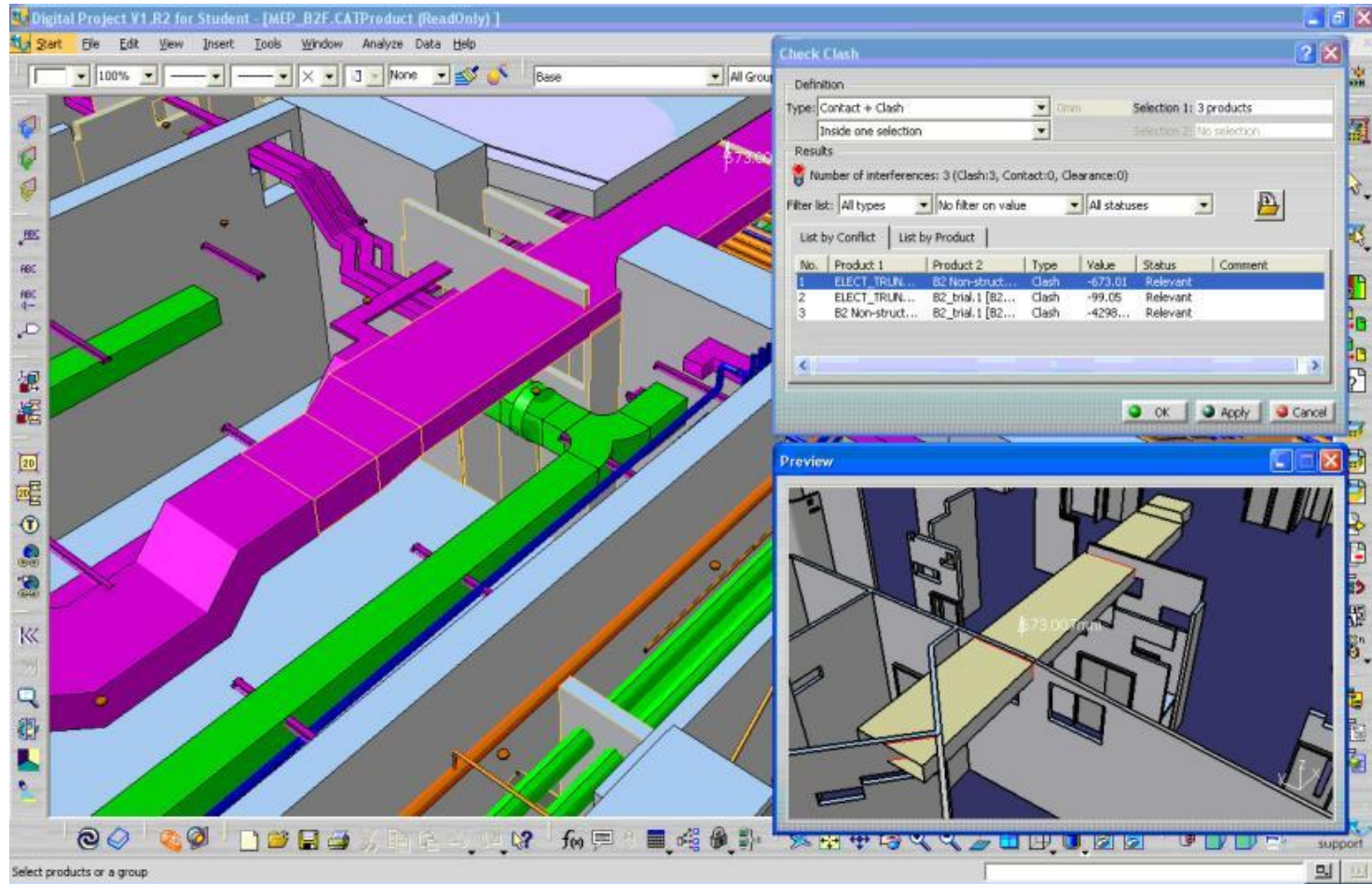
Common Principles in Building Information Modeling

- Supports **collaborative engineering**



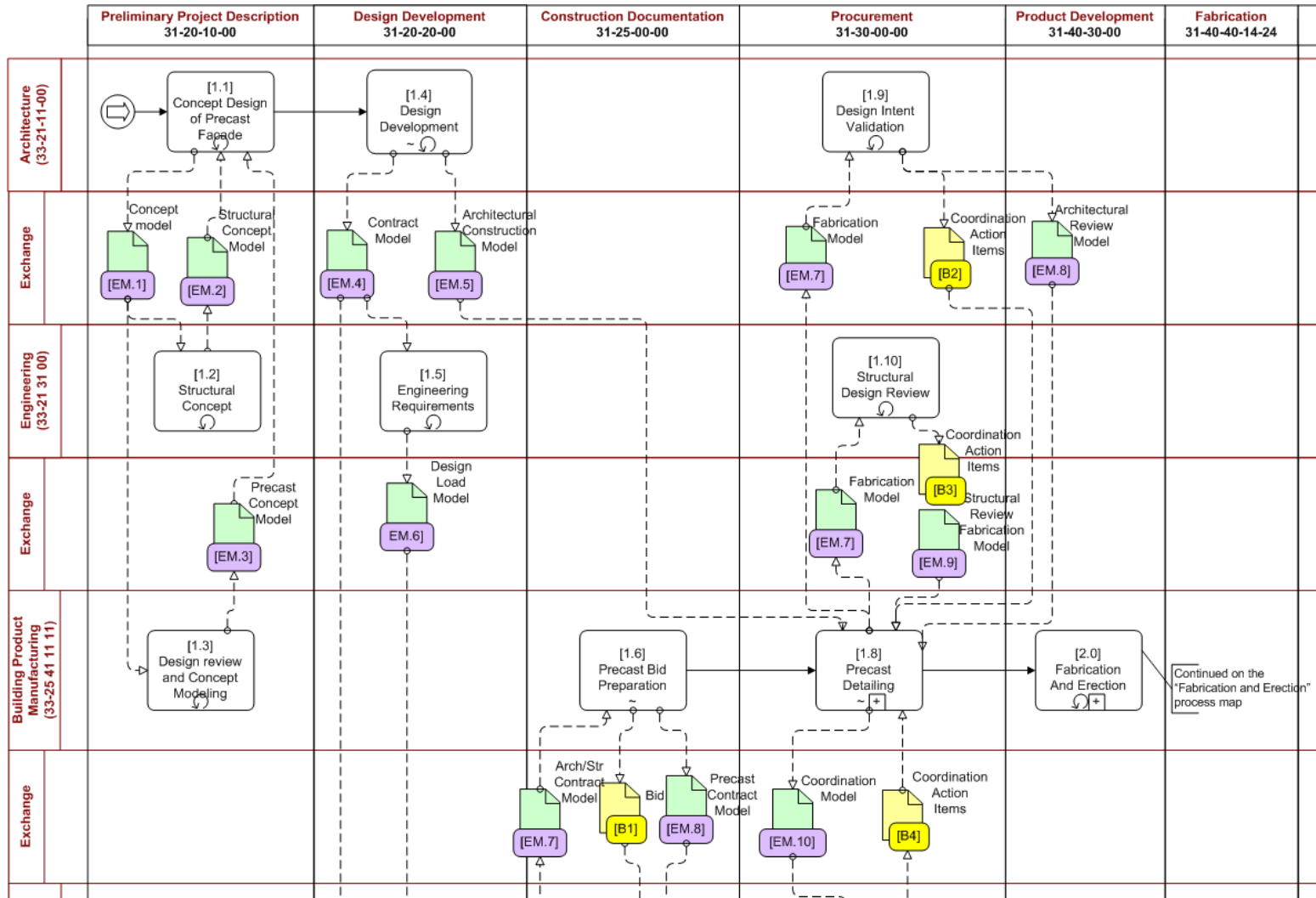
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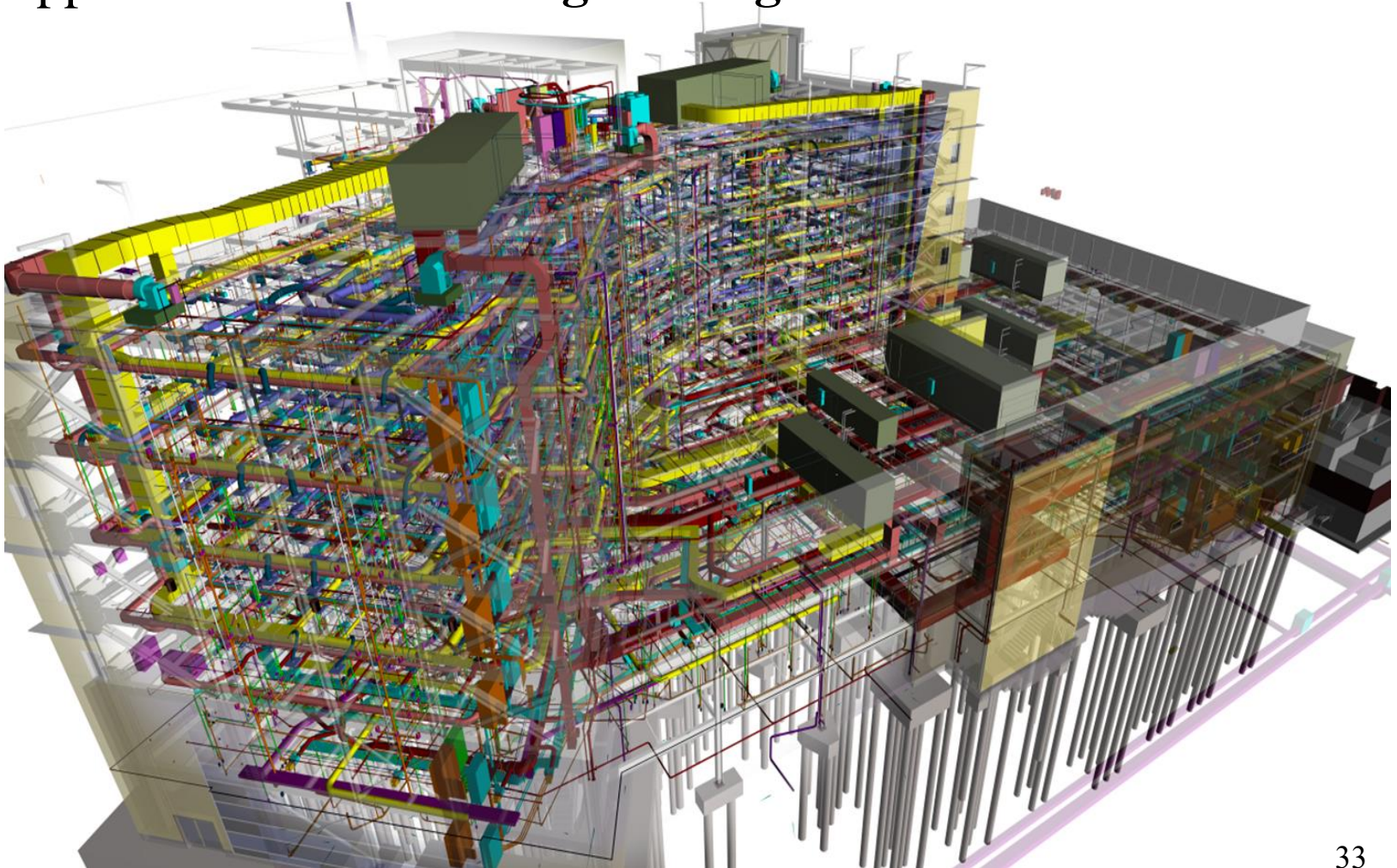
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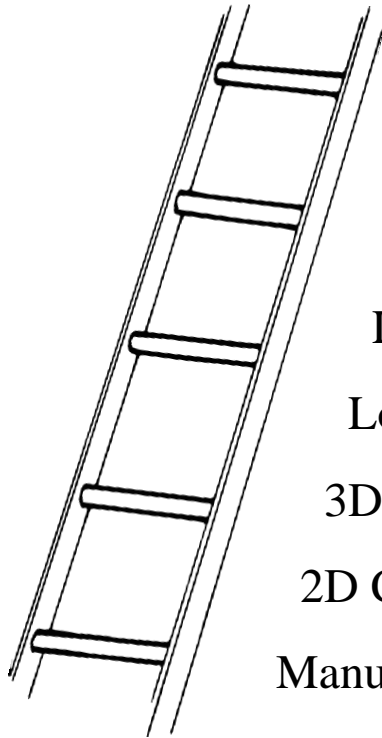
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BIM Processes

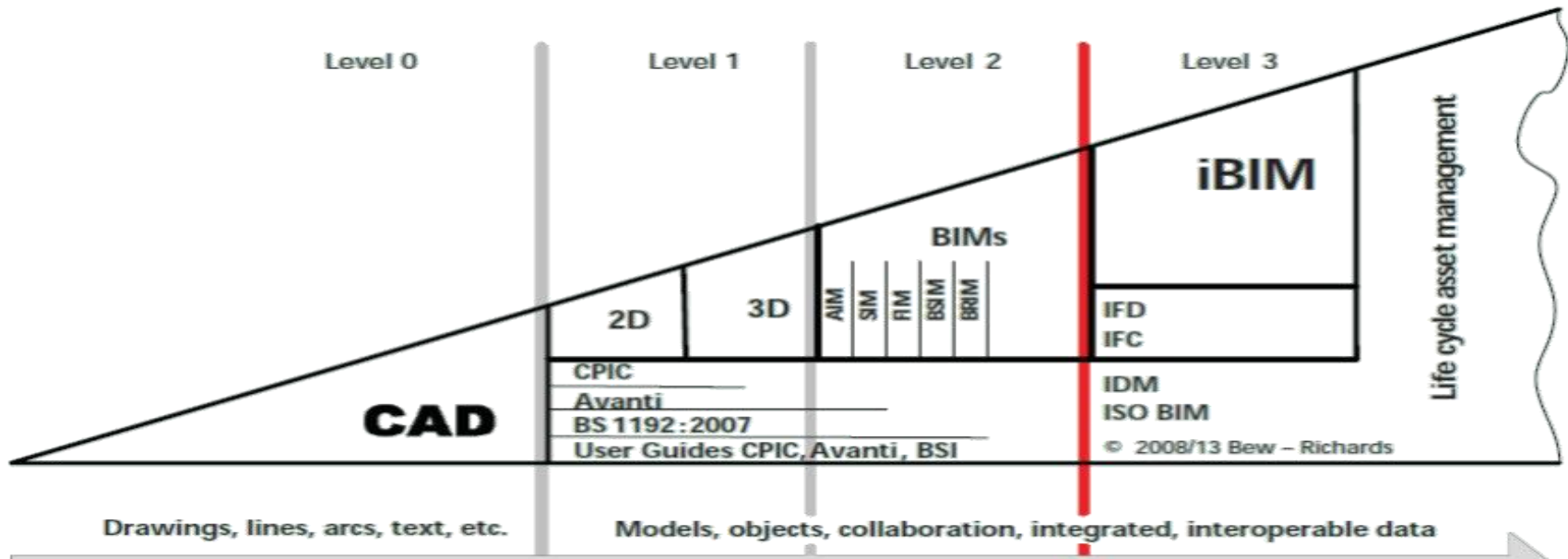
The BIM Ladder



- Collaborative BIM with a cloud model
- Collaborative BIM with an integrated model
- Multi-disciplinary BIM with coordinated models
- Lonely BIM with simulations
- Lonely BIM for producing drawings
- 3D CAD
- 2D CAD
- Manual drafting

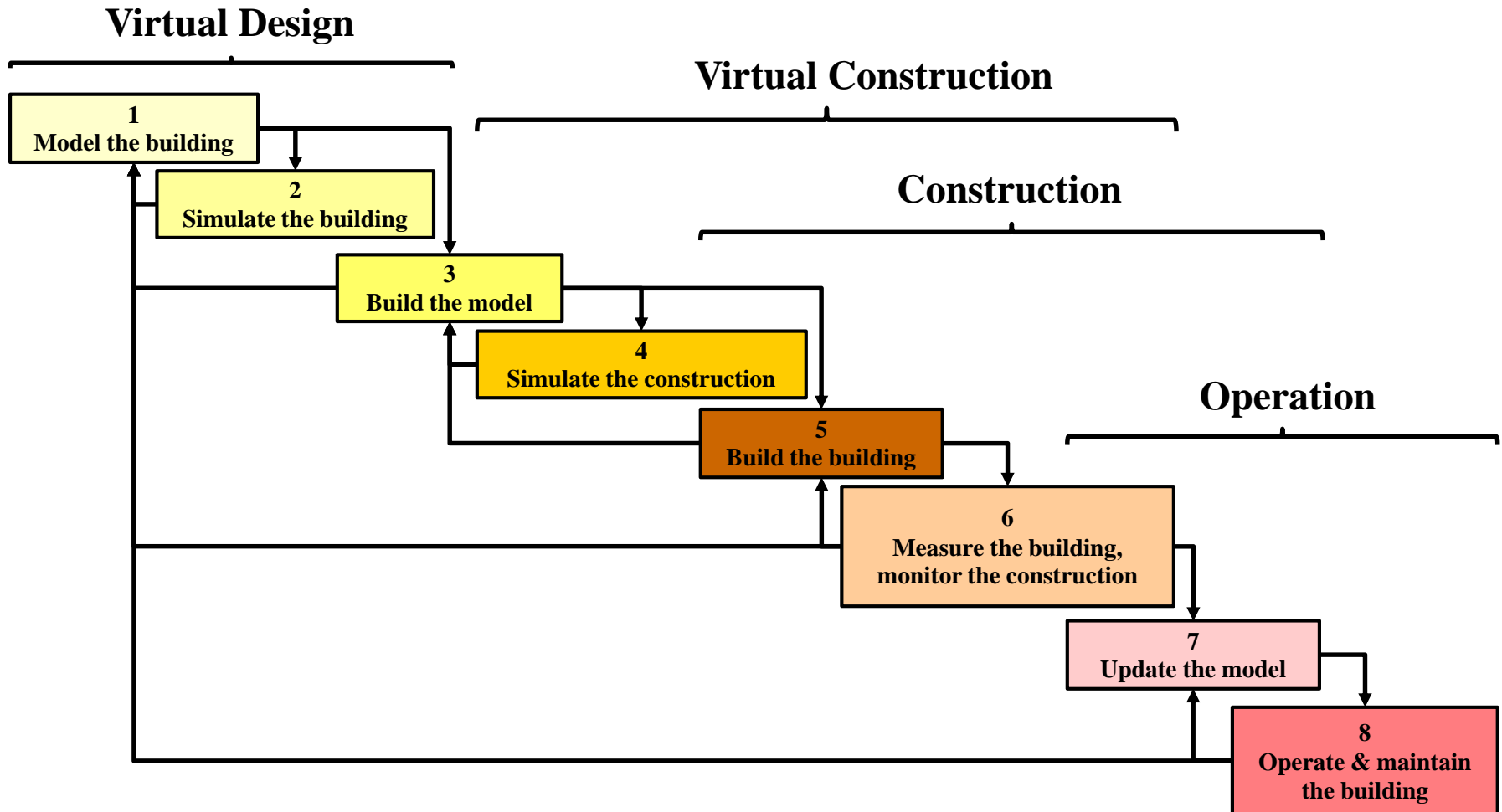
Gurevich, U., Sacks, R. and Shrestha, P., (2017). '[Mapping the Impact of BIM Adoption Efforts on Occupant Value](#)', Building Research and Information, Vol. 49, No. 6, pp. 610-630.

BIM Maturity Levels

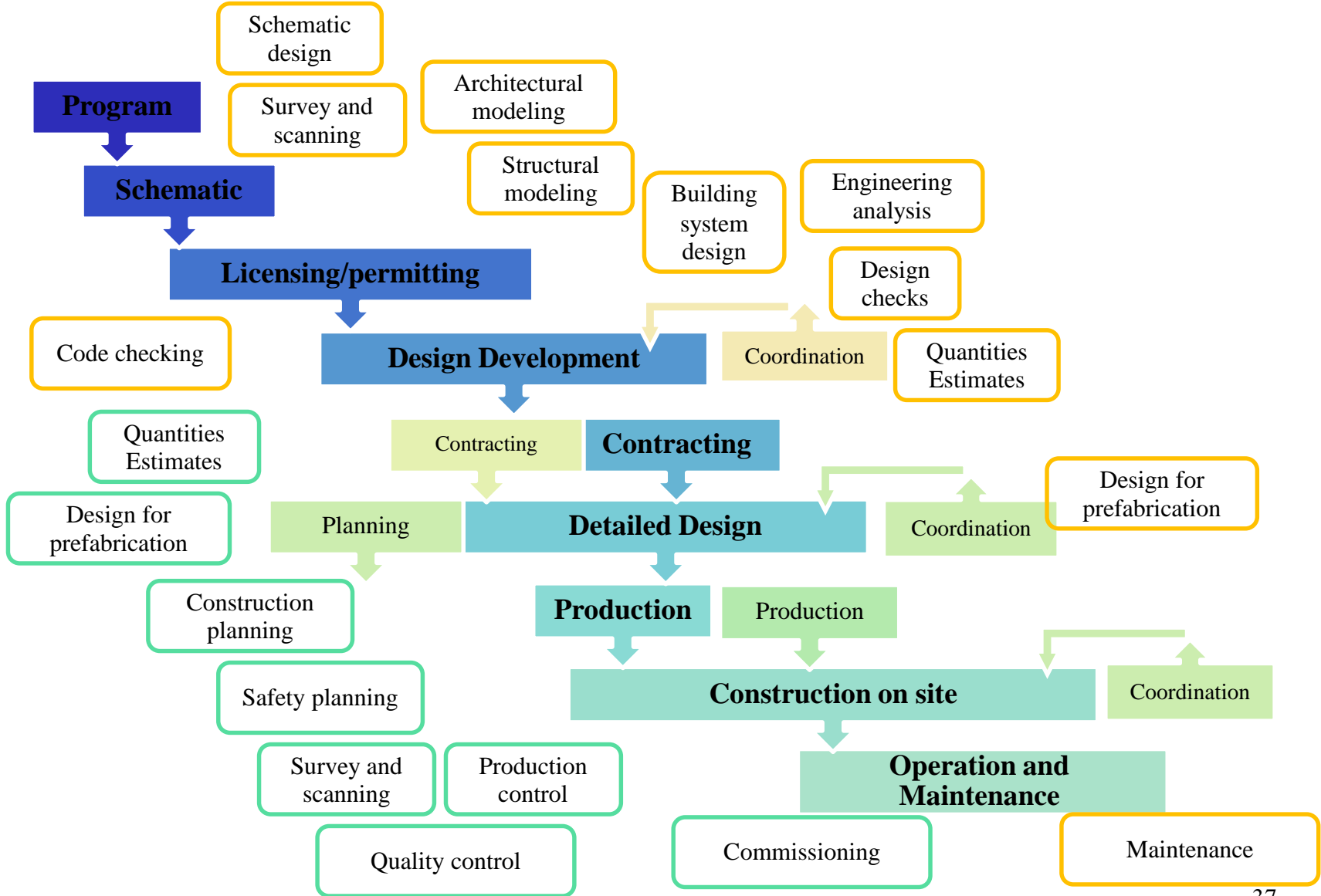


BIM Process

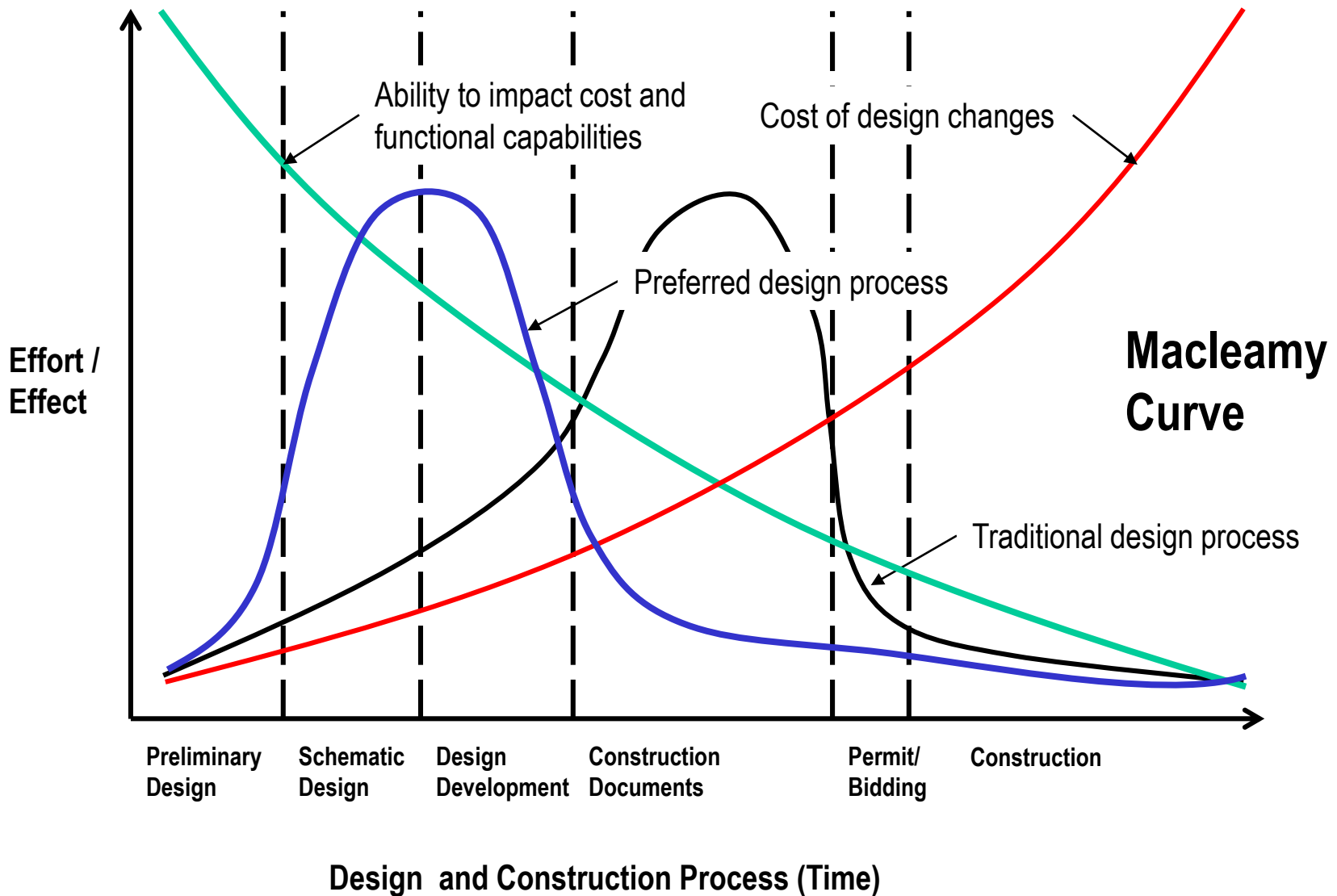
Virtual Design, Virtual Construction and Digital Twin



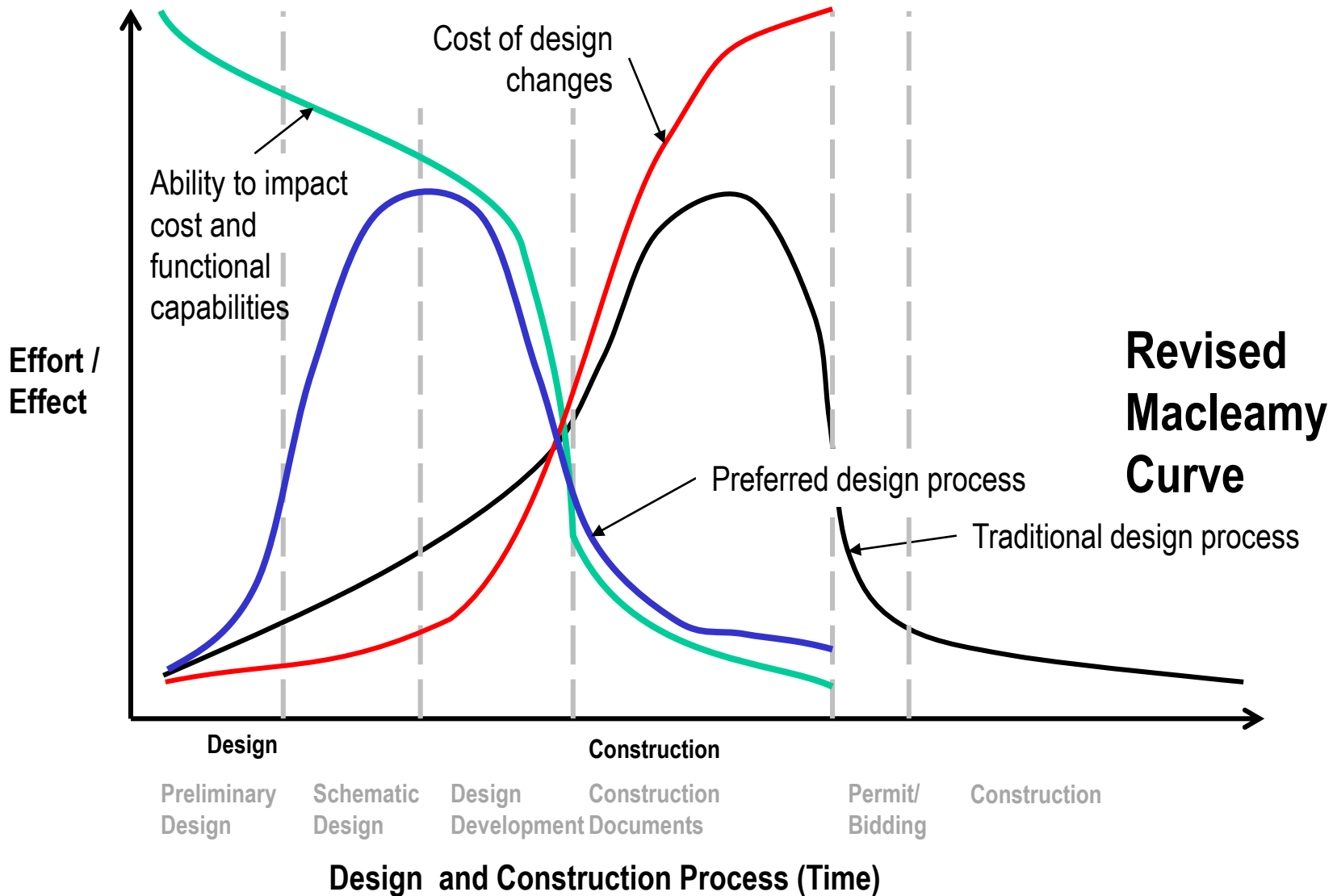
BIM through a typical project



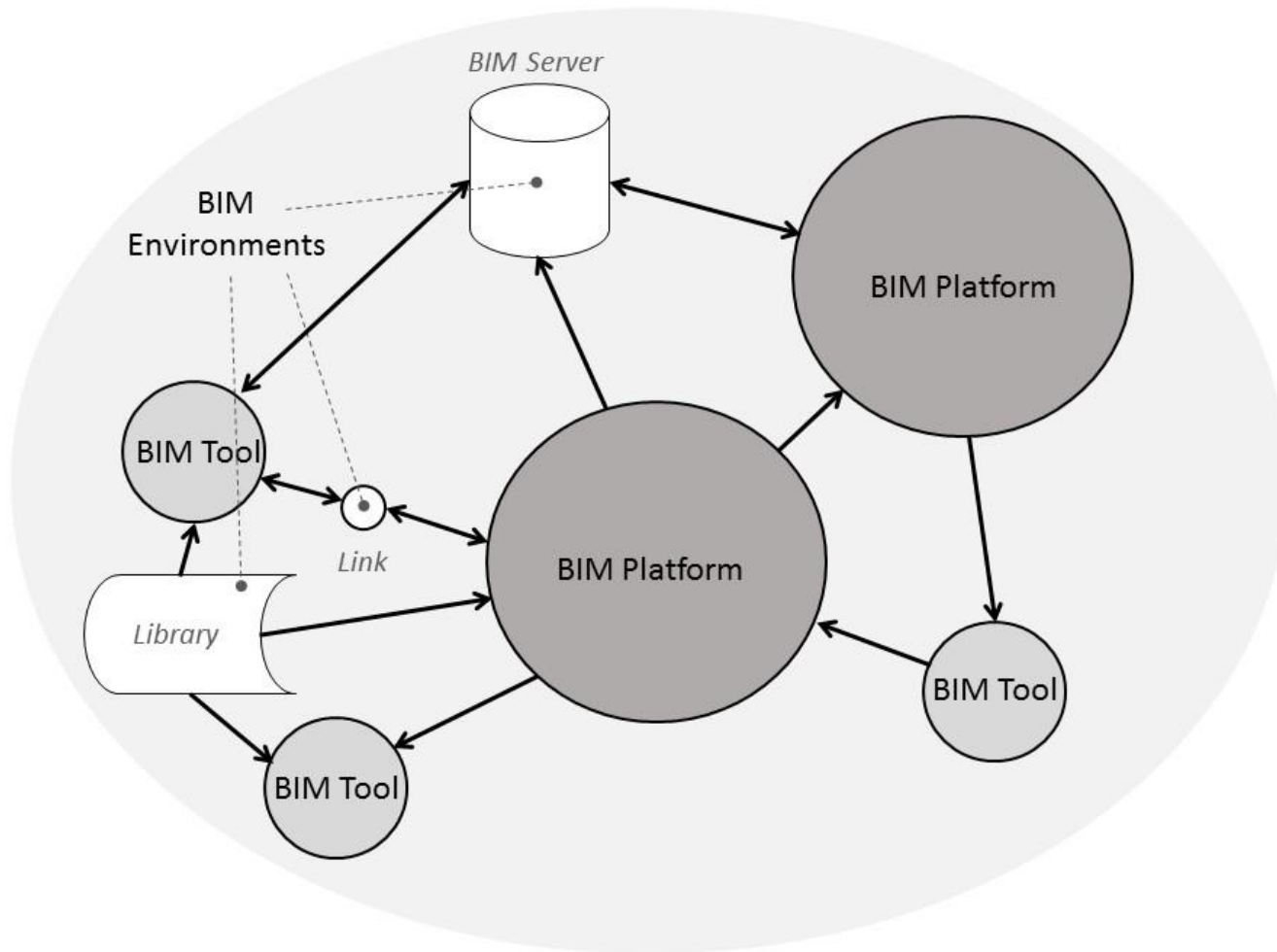
Implications for practice



Implications for practice



BIM environments, platforms and tools



BIM environments, platforms and tools

BIM platform

- A core BIM information generator with functions to maintain the integrity of a model based on the parametric and object-based modeling capability. It provides a primary data model that hosts the information from various BIM applications.
- Generally known object-based parametric BIM applications such as Revit, ArchiCAD, Tekla Structures, Vectorworks, Bentley AECOSim, and Digital Project fall into this category.
- Most BIM platforms internally incorporate tool functionality such as rendering, drawing production, and clash detection. Most platforms provide different sets of interfaces, libraries, and functions for different domains and trades.

BIM environments, platforms and tools

BIM environment

- A set of BIM platforms that are interfaced to support multiple information and process pipelines that encompass the various BIM tools, platforms, servers, libraries and workflows within the project workflows of an organization.

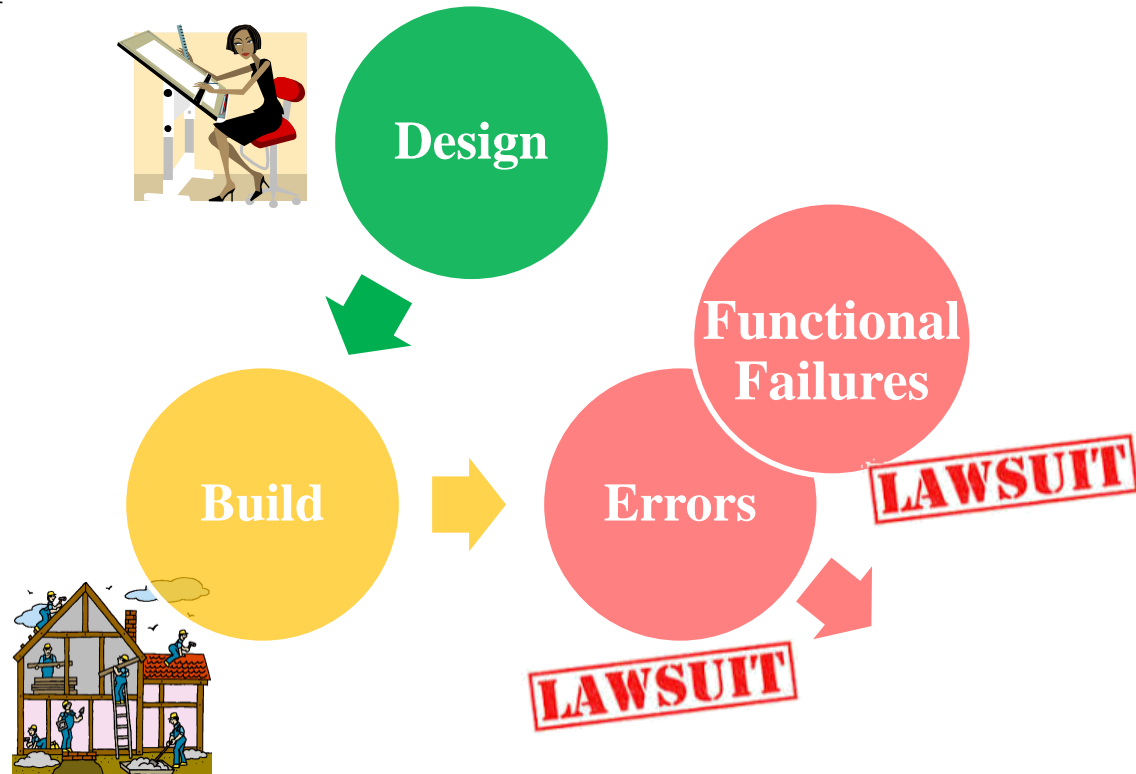
BIM environments, platforms and tools

BIM tool

- A BIM information sender, receiver, and processor used within a BIM process in association with BIM platforms.
- Example BIM tools include applications such as specification generation tools, cost estimation tools, scheduling tools, and Excel-based engineering tools that do not include geometric definitions and are all text-based. AutoCAD for drawing production or other AutoCAD-based applications can be also regarded as BIM tools as far as they are used in the context of a BIM process.
- Other examples include tools for model quality checking, rendering, navigation, visualization, facility management, early design generation, project management, and various types of engineering and simulation.

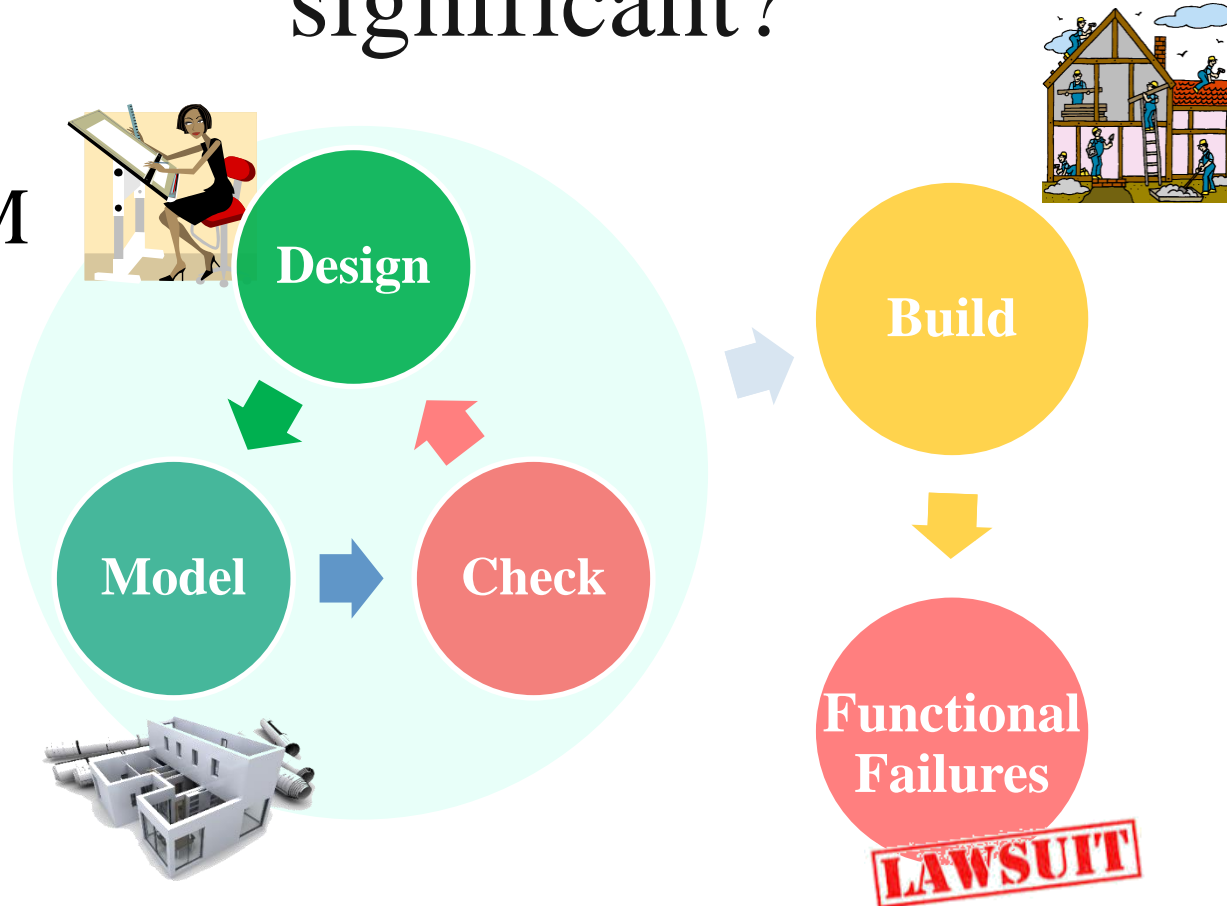
Why is digital prototyping so significant?

Pre-BIM



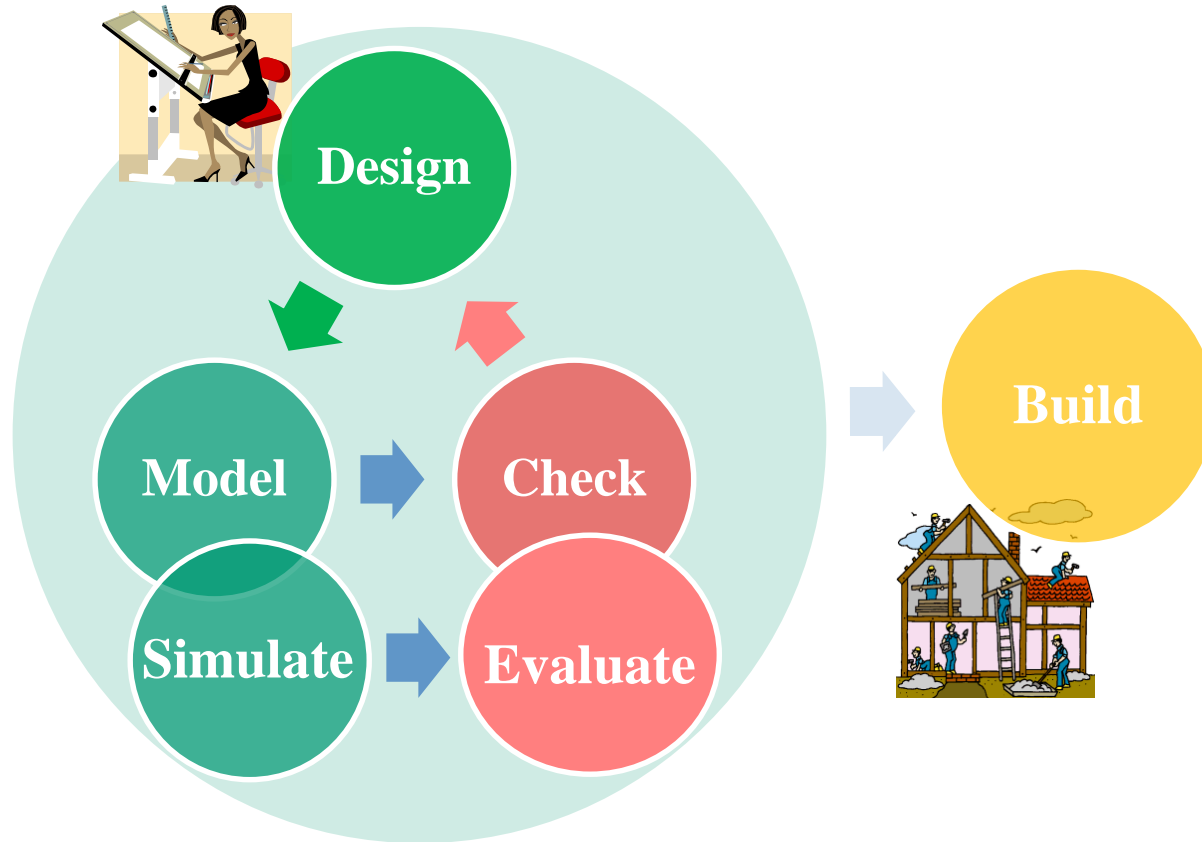
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Basic BIM

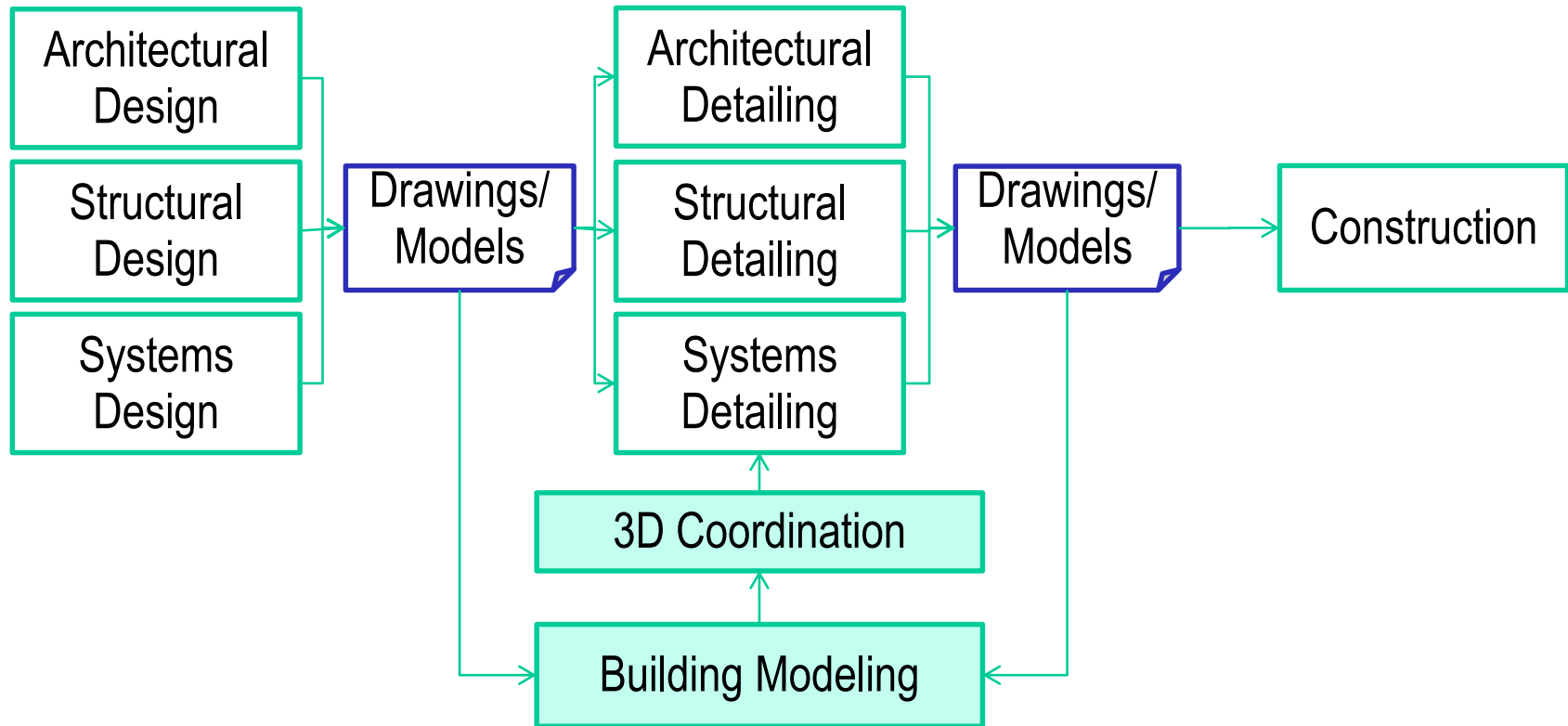


Why is digital prototyping so significant?

BIM

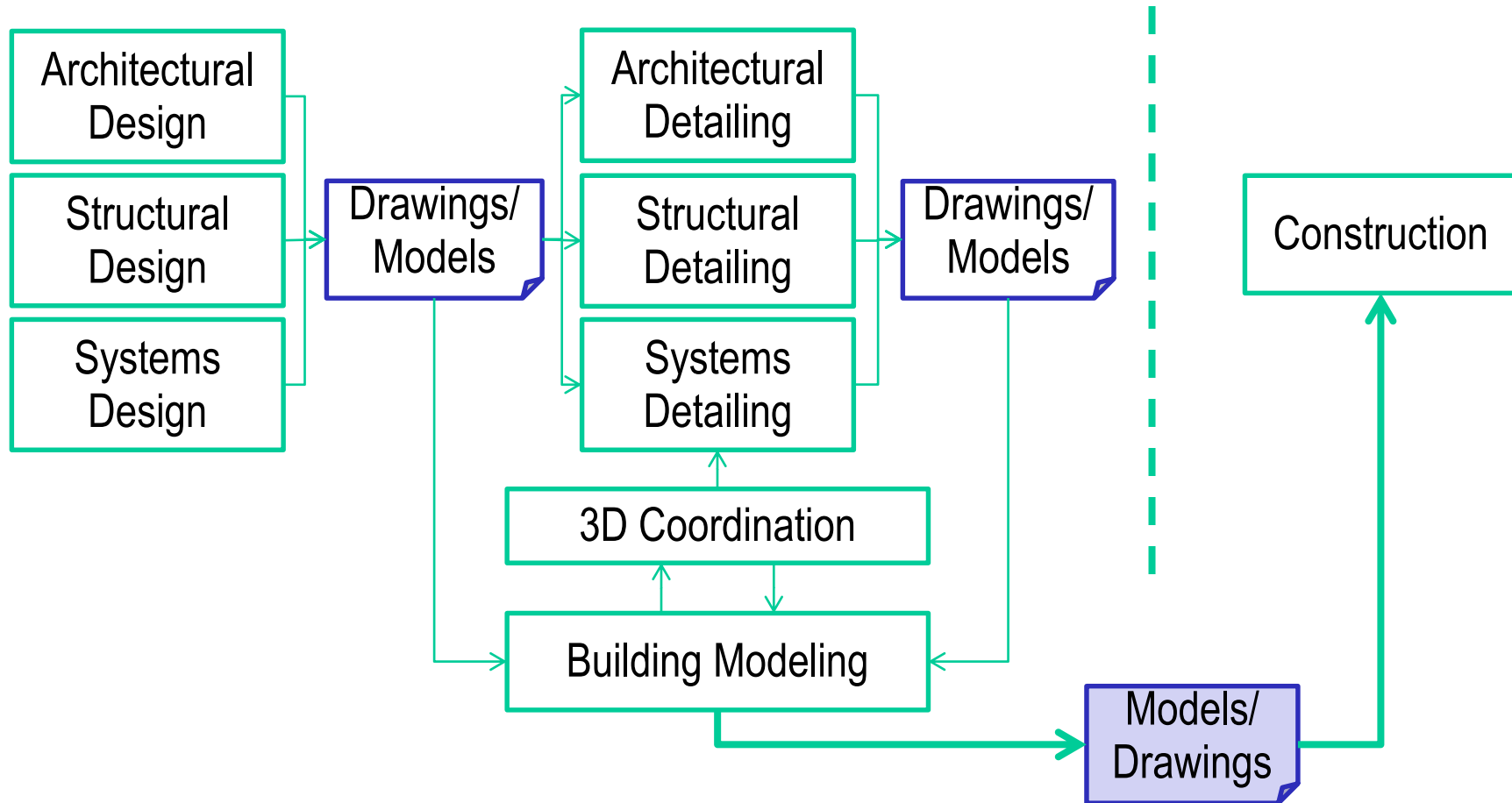


BIM Information Flow

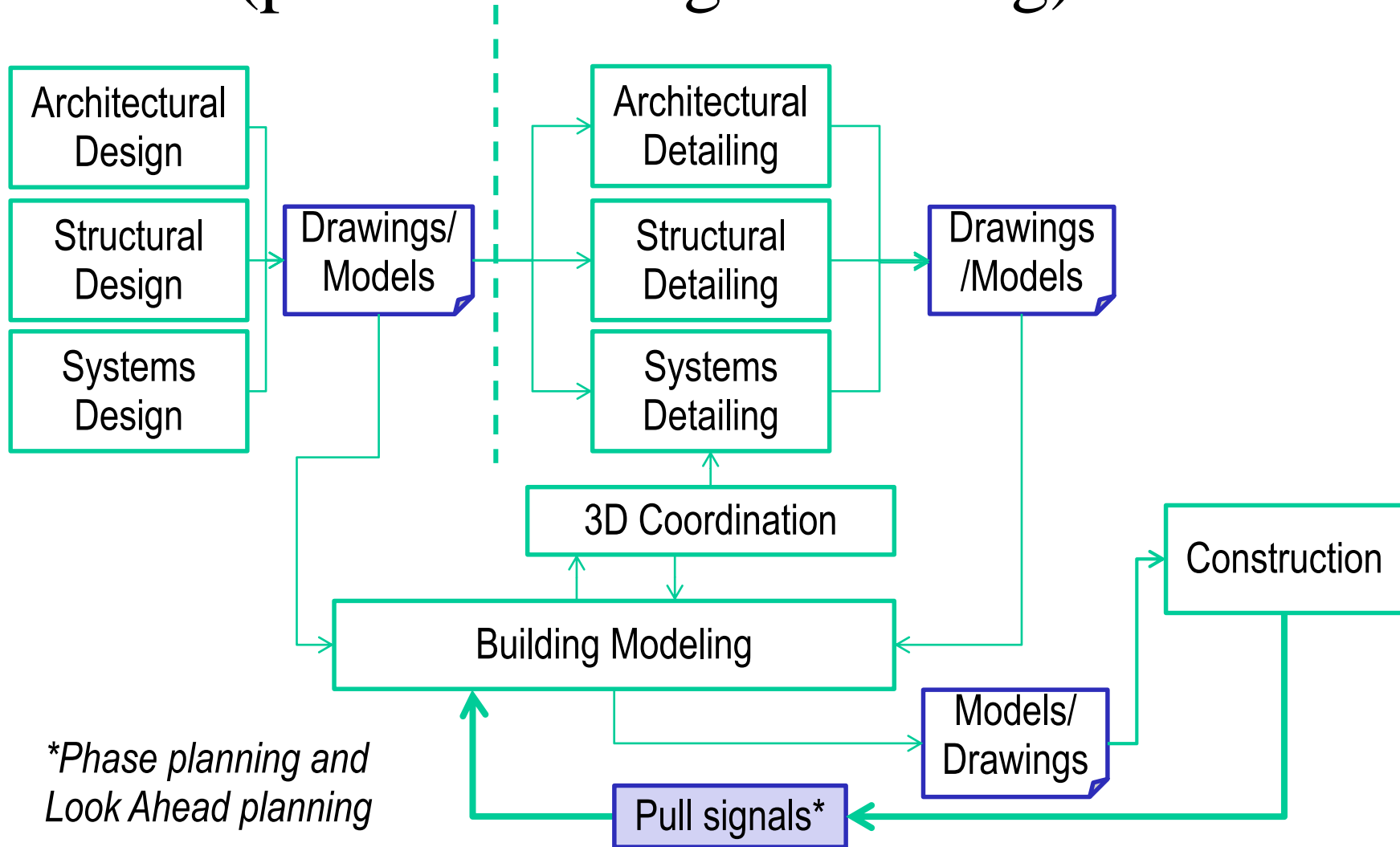


VDC Information Flow

VDC = Virtual Design and Construction



Lean (pull) VDC Information Flow (pull flow design detailing)



BIM: A Concise Introduction

Learning Goal

To be able to answer these questions:

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Sacks, R., Eastman, C. M., Lee, G., and Teicholz, P. (2018). *BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors and Facility Managers*. John Wiley and Sons, Hoboken, NJ. (Chapters 1-3)

Kolarevic, B., (2005). *Architecture in the Digital Age: Design and Manufacturing*, Routledge, Oxford.