

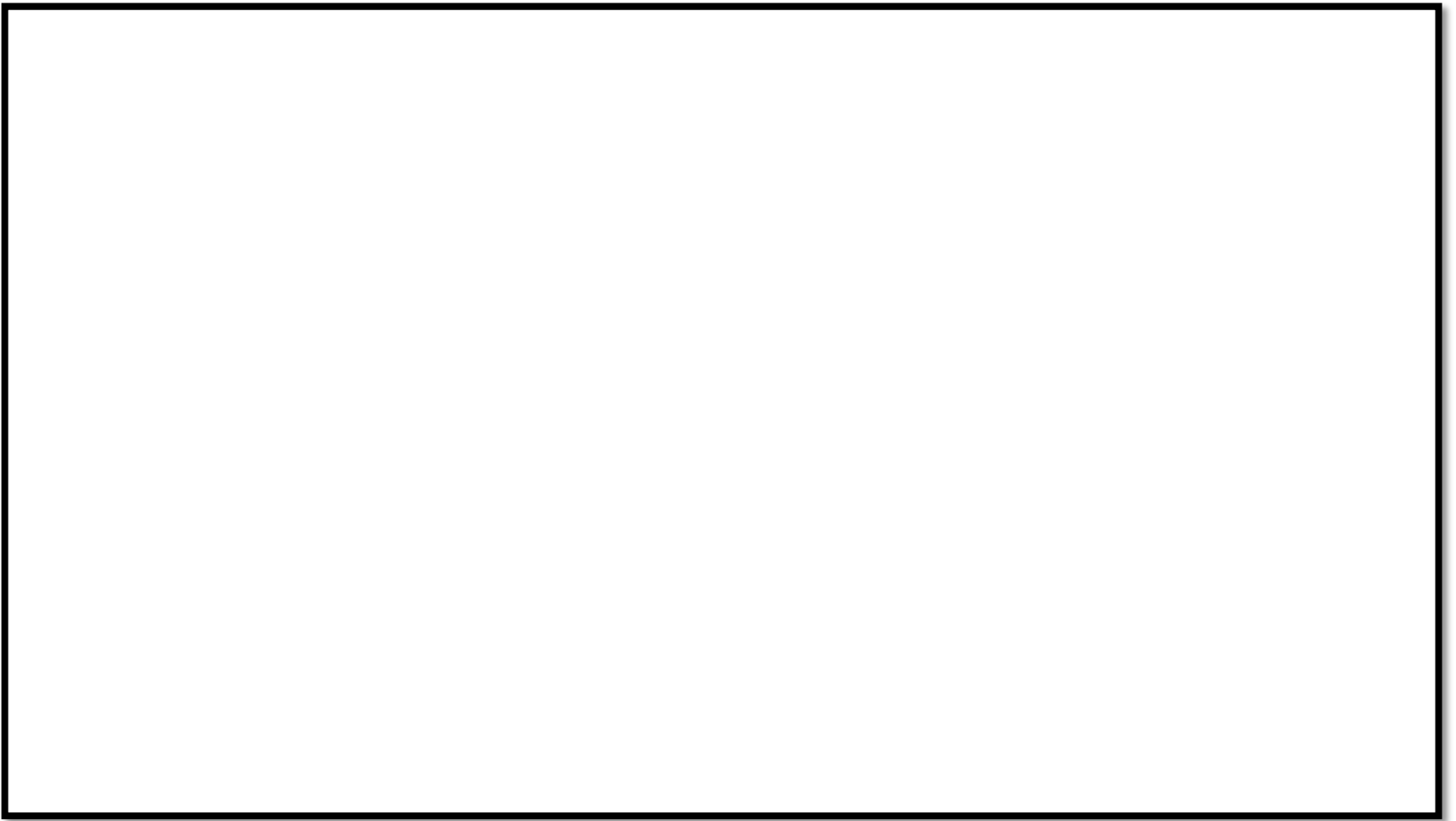
# Fundamentals of BIM

Vishal Singh

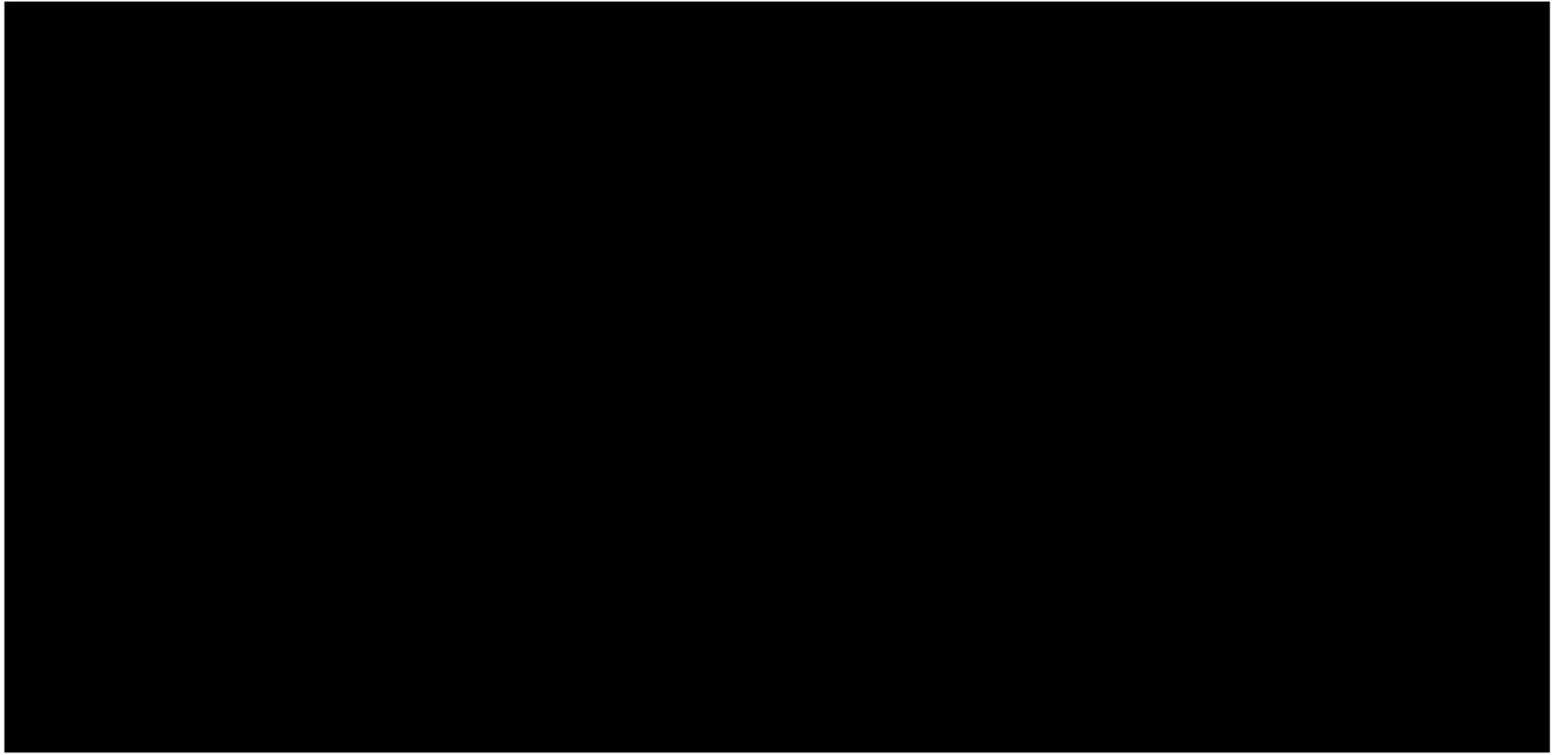
Aalto University, 11th March 2019

# What is this session about?

- Recap on benefits
- Basic introduction to applications and history
- Ask some basic questions
- Look at some simple examples



Source: <https://www.youtube.com/watch?v=iqvlYQAJCIQ>



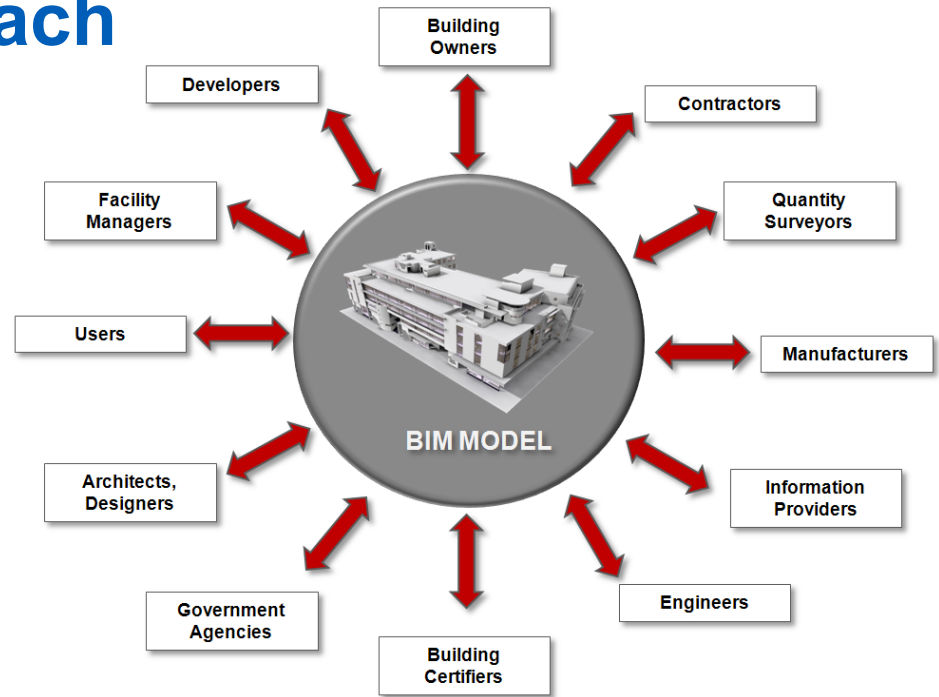
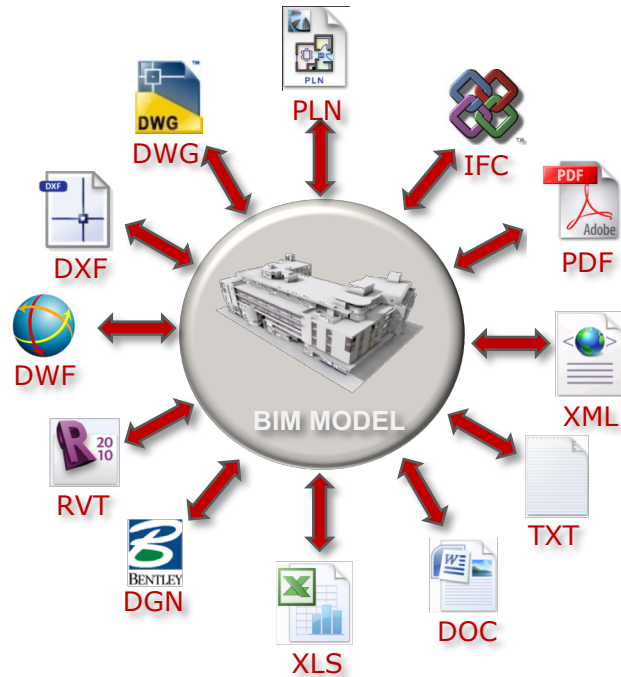
Source: <https://www.youtube.com/watch?v=C0WnjbsTT9Q>



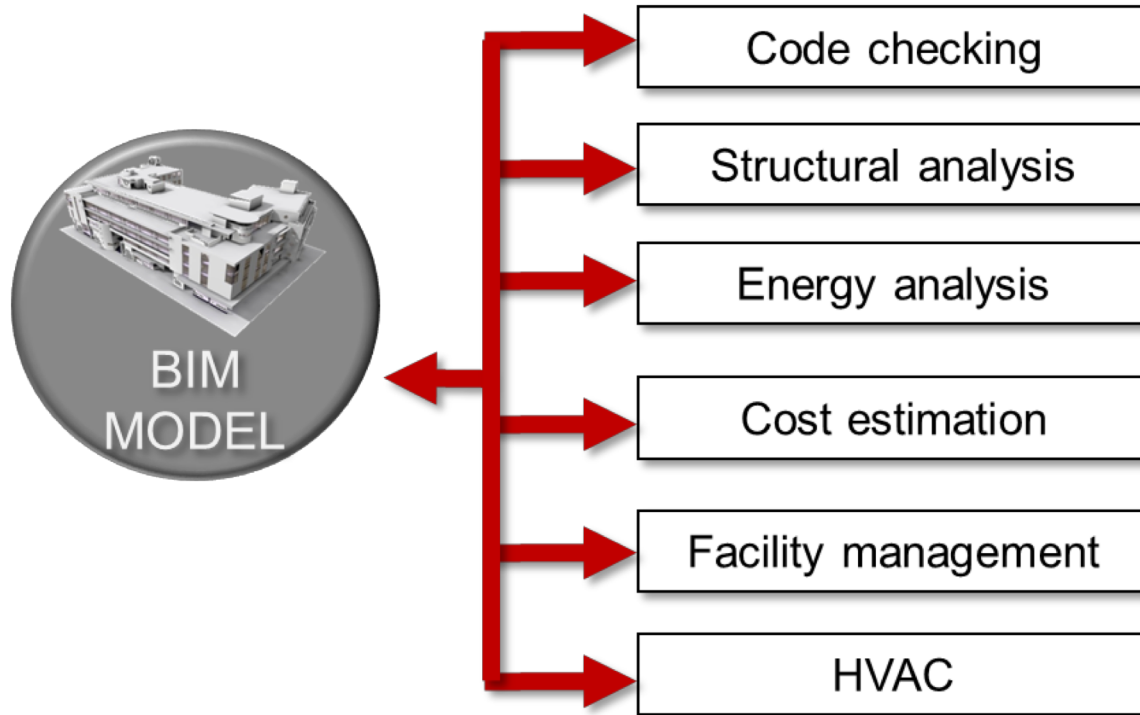
# Potential benefits of BIM

- Visualization
- Intelligent documentation
- Clash detection
- Performance analysis
  - Cost
  - Schedule
  - Energy...
- Project collaboration
- Lifecycle management
- ...

# BIM- integrated approach



# Analysis & simulations



Source: ArchiCAD tutorials , Graphisoft

# Clash Detection

## Type of clash

## Explanation

Hard clash

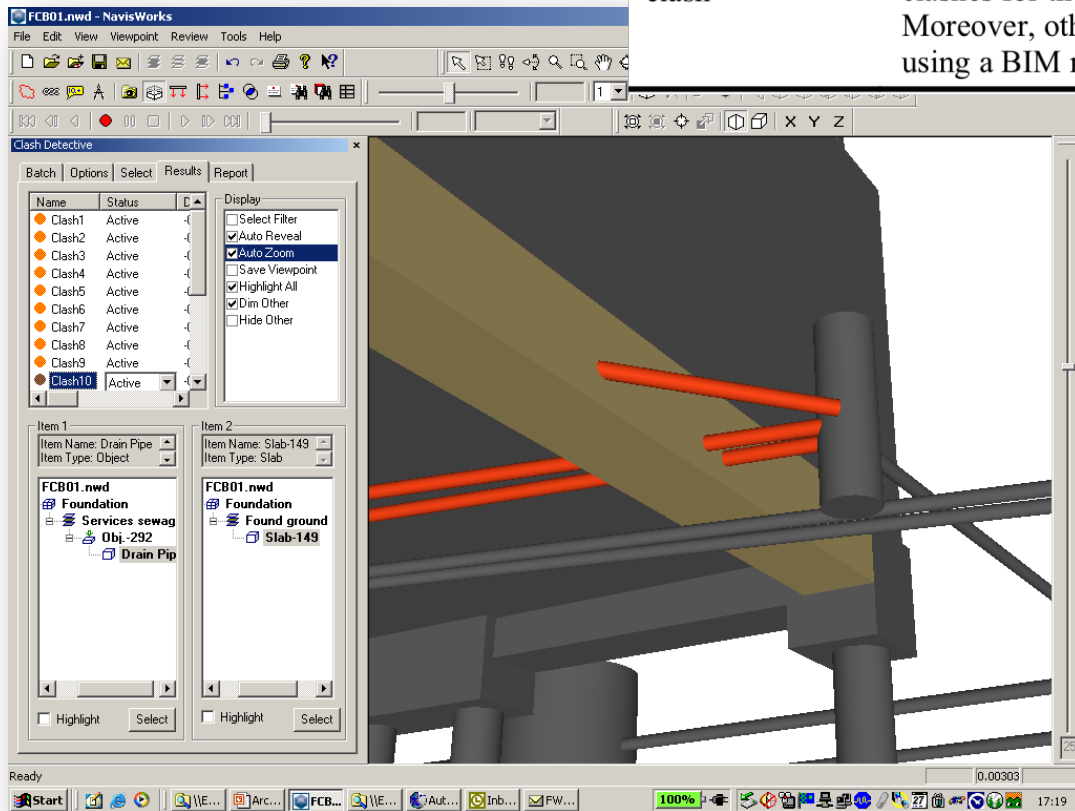
It occurs with two objects are taking up the same space; for instance, a beam which is going through a plumbing run is designed.

Soft  
clash/clearance  
clash

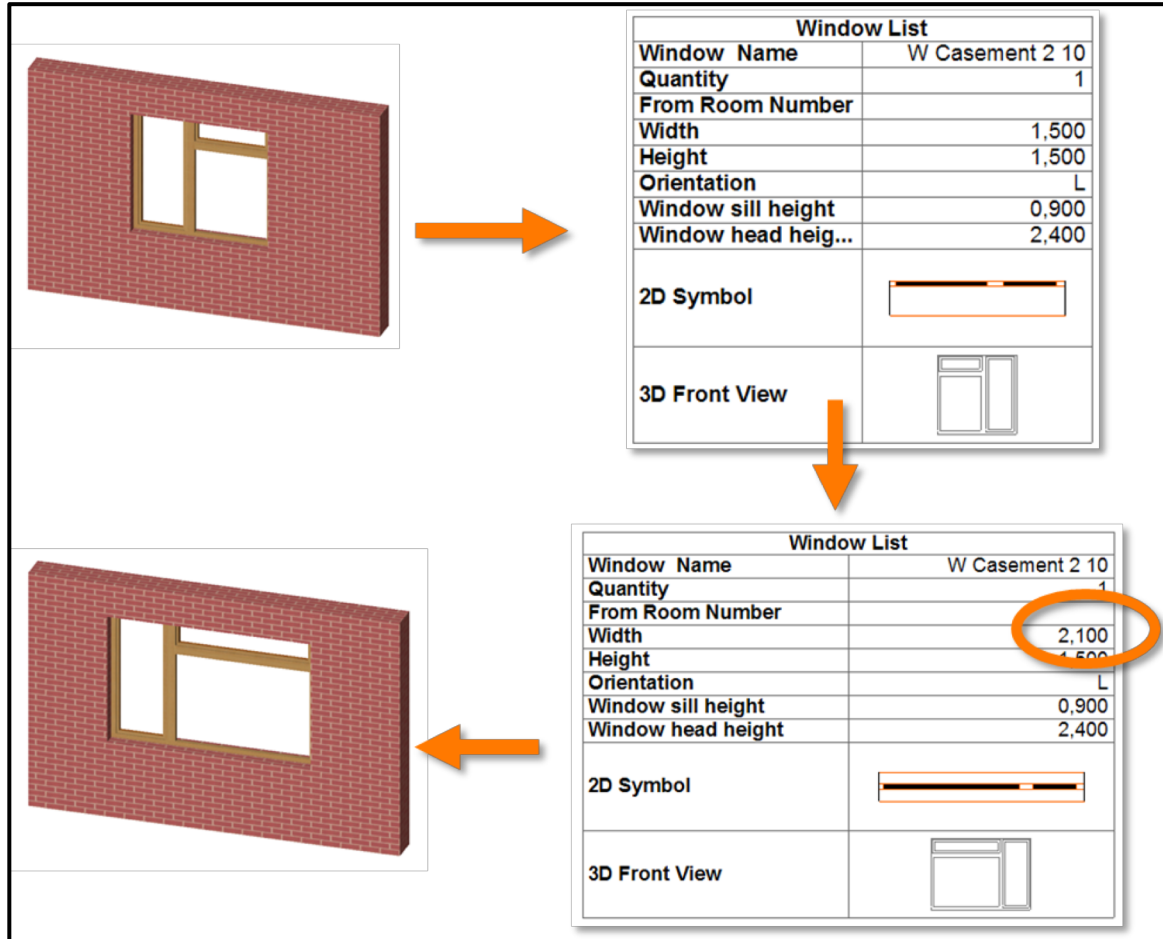
It indicates that the object needs more positive spatial/geometric tolerances, spaces and buffers within their buffer zone for better accessibility, insulation, maintenance and safety.

4D/workflow  
clash

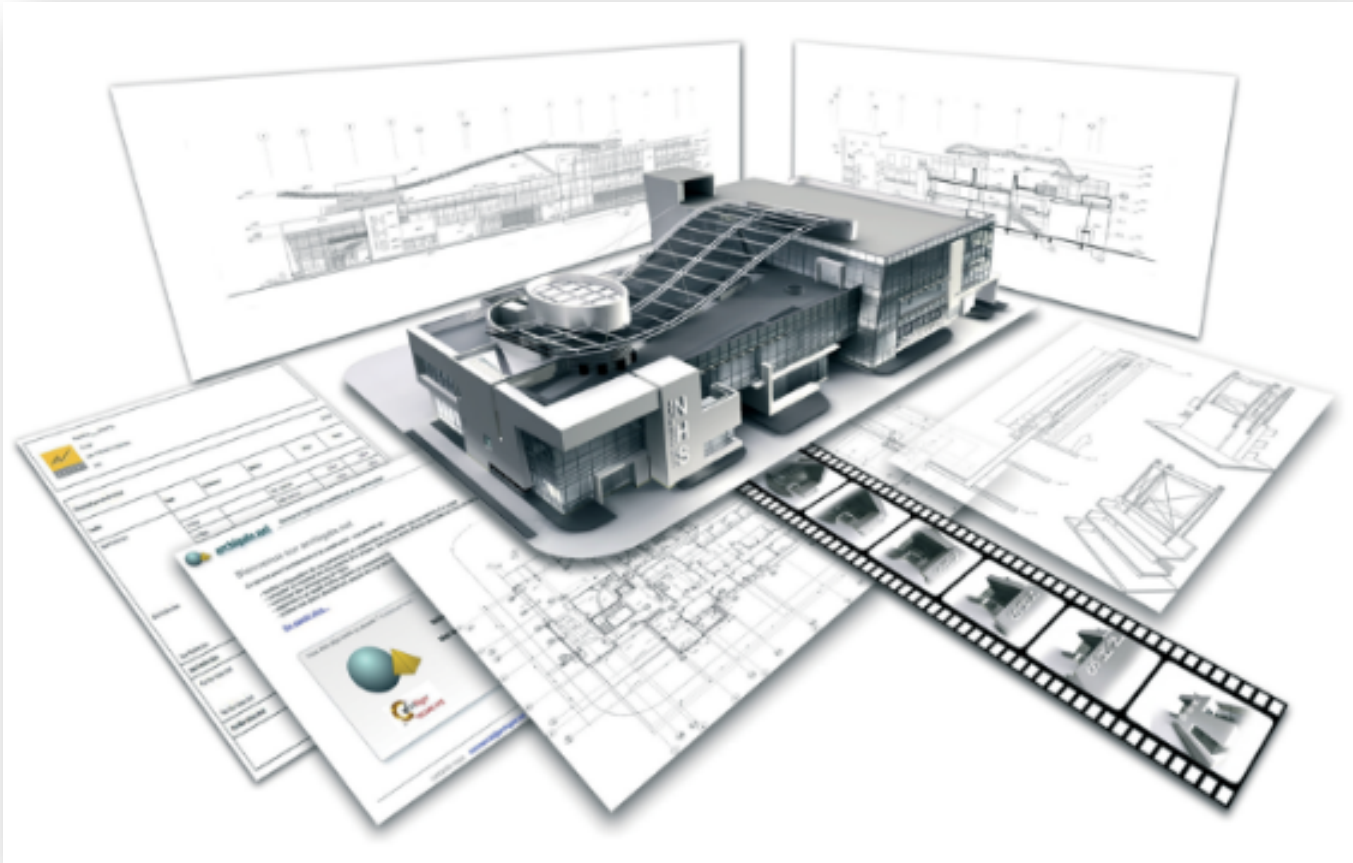
With 4D/Workflow clash detection method, you can determine scheduling clashes for the crews, equipment/materials fabrication and delivery clashes. Moreover, other project timeline issues can be examined and perceived using a BIM modelling project.



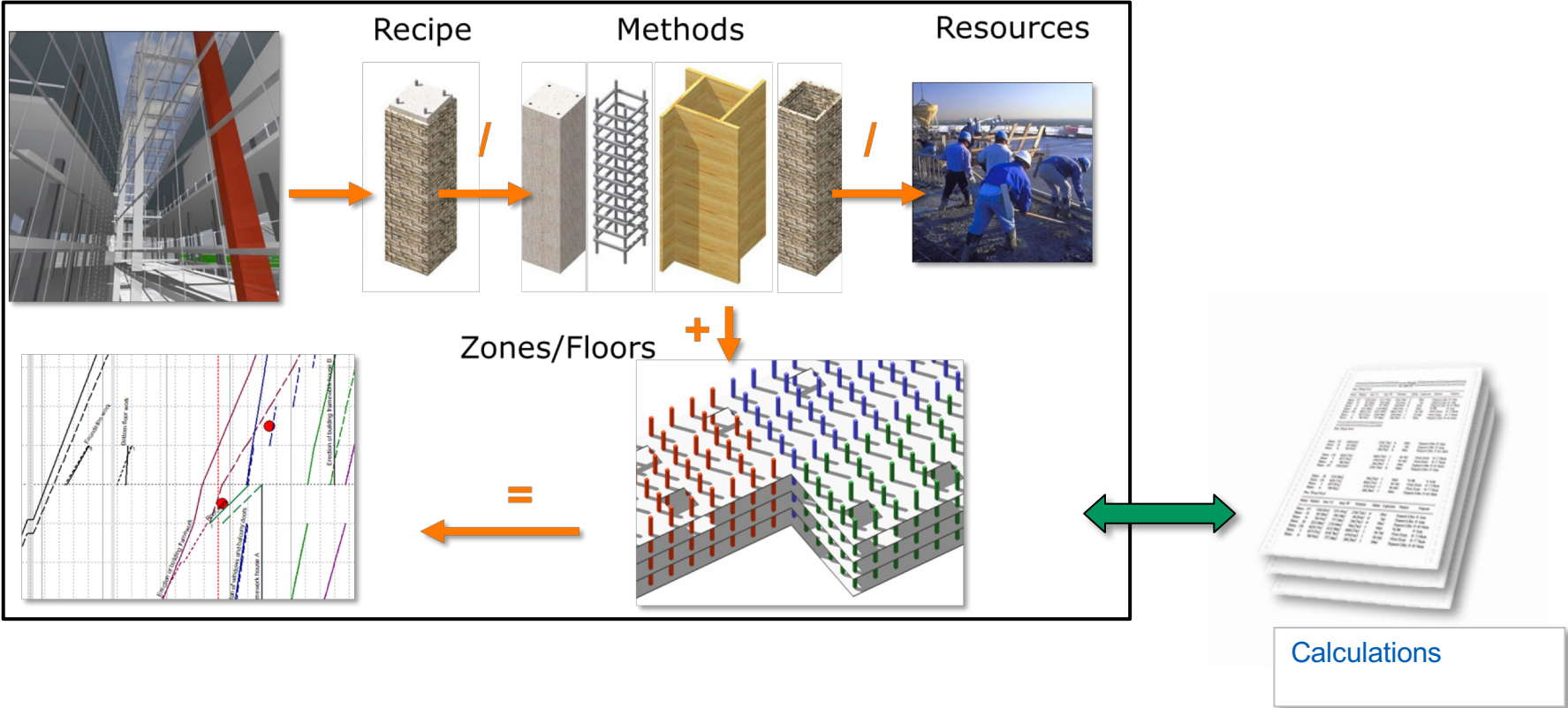
# Interactive Schedule

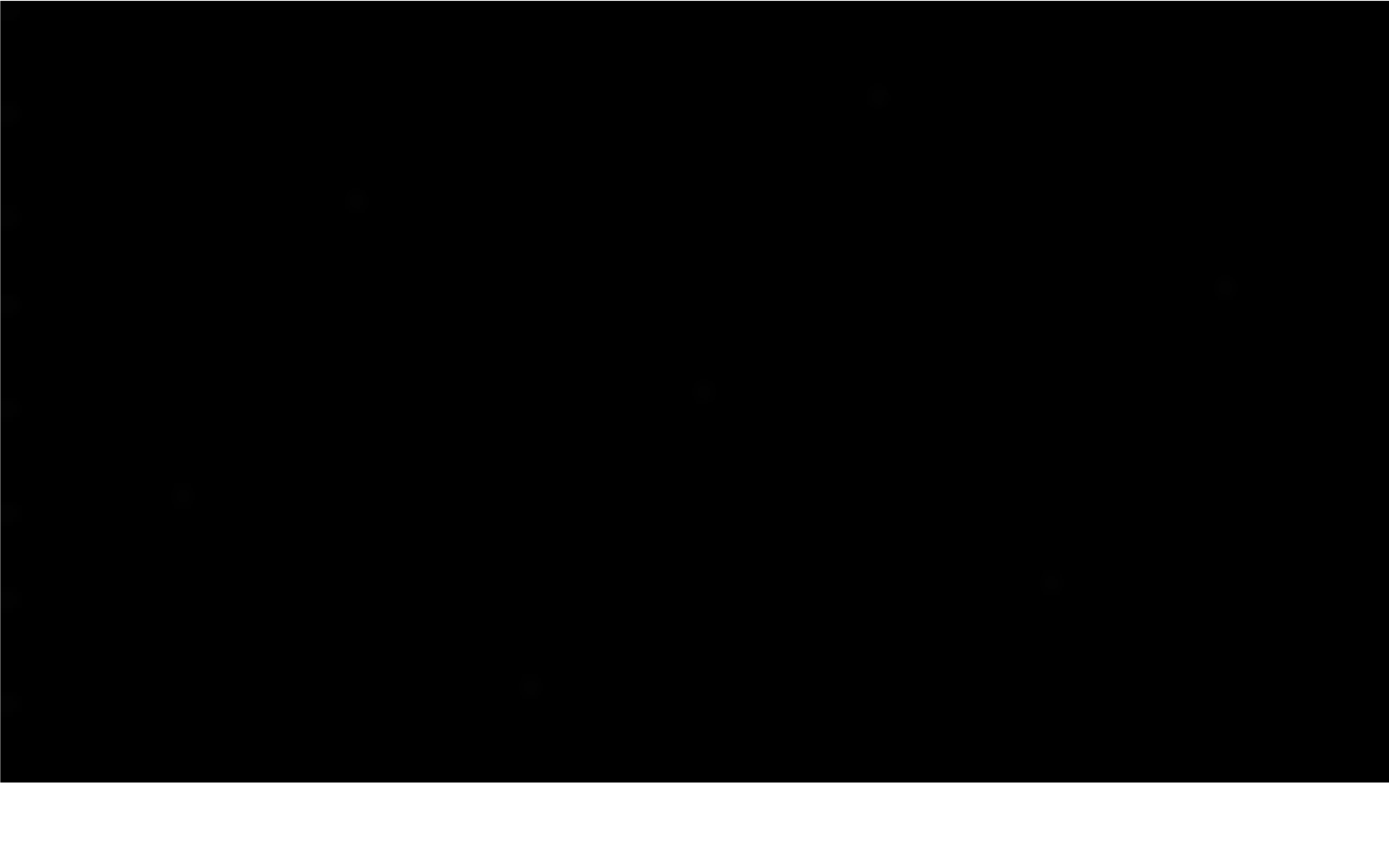


# Intelligent documentation



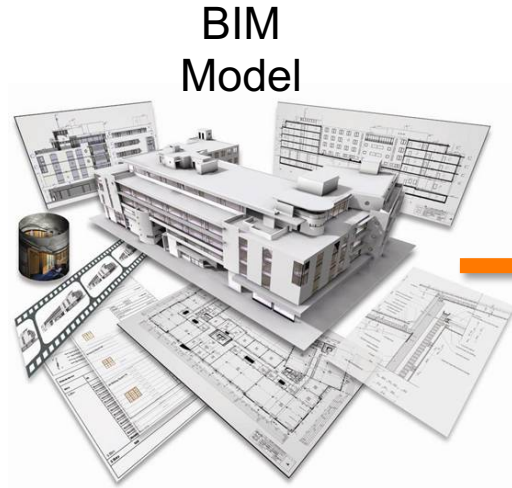
# 4D/5D- Approach: scheduling, estimation







# Fabrication



CNC Machine



Factory Made Building Elements

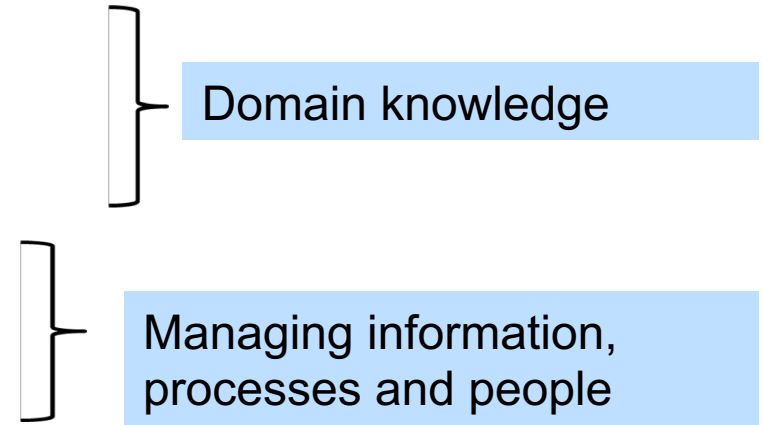


On-site construction

# BIM: topics you will be expected to be familiar with!

Paradigm shift... industry transformation

- Intelligent information management
- Object-based model
- Virtual prototyping
- Integration
- Collaboration
- New ways of working...IPD



# Geospatial reality to virtual to reality

## NYCT Tunnel Rehabilitation

- Terrestrial Laser Scan to 3D Model to Automated Tunnel Panel Manufacturing

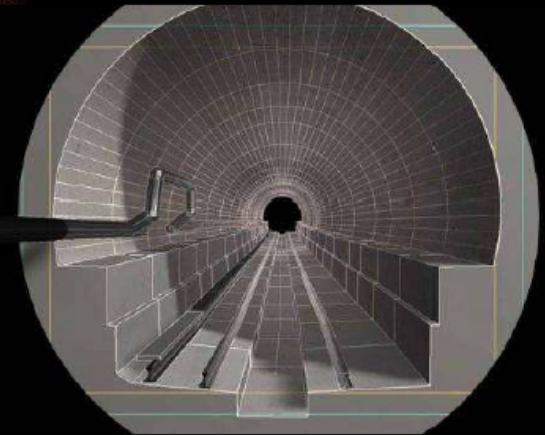
Creation of new steel reinforcing panels from 3D Model



Raw Point Cloud Scan

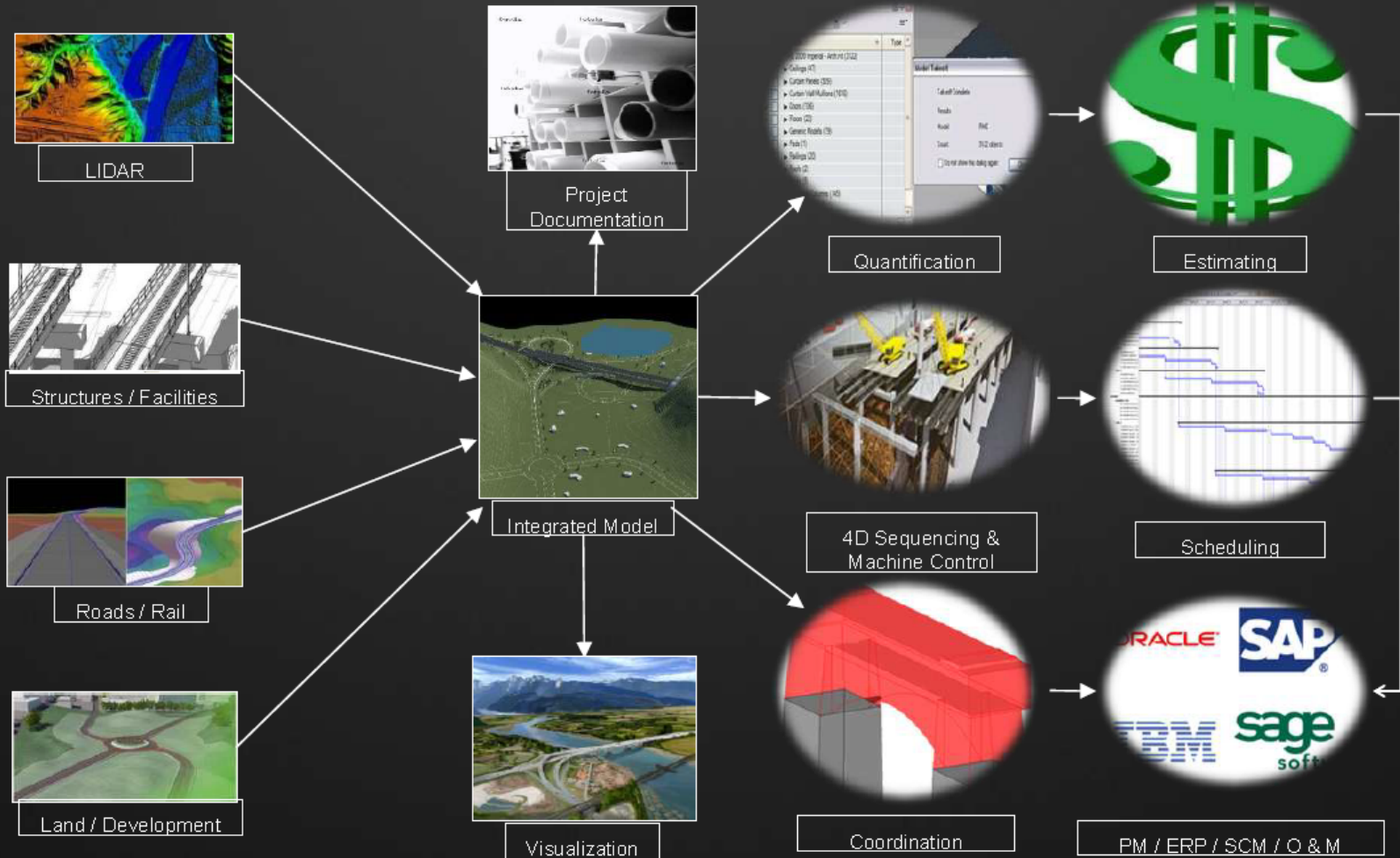


3D Geometric Model

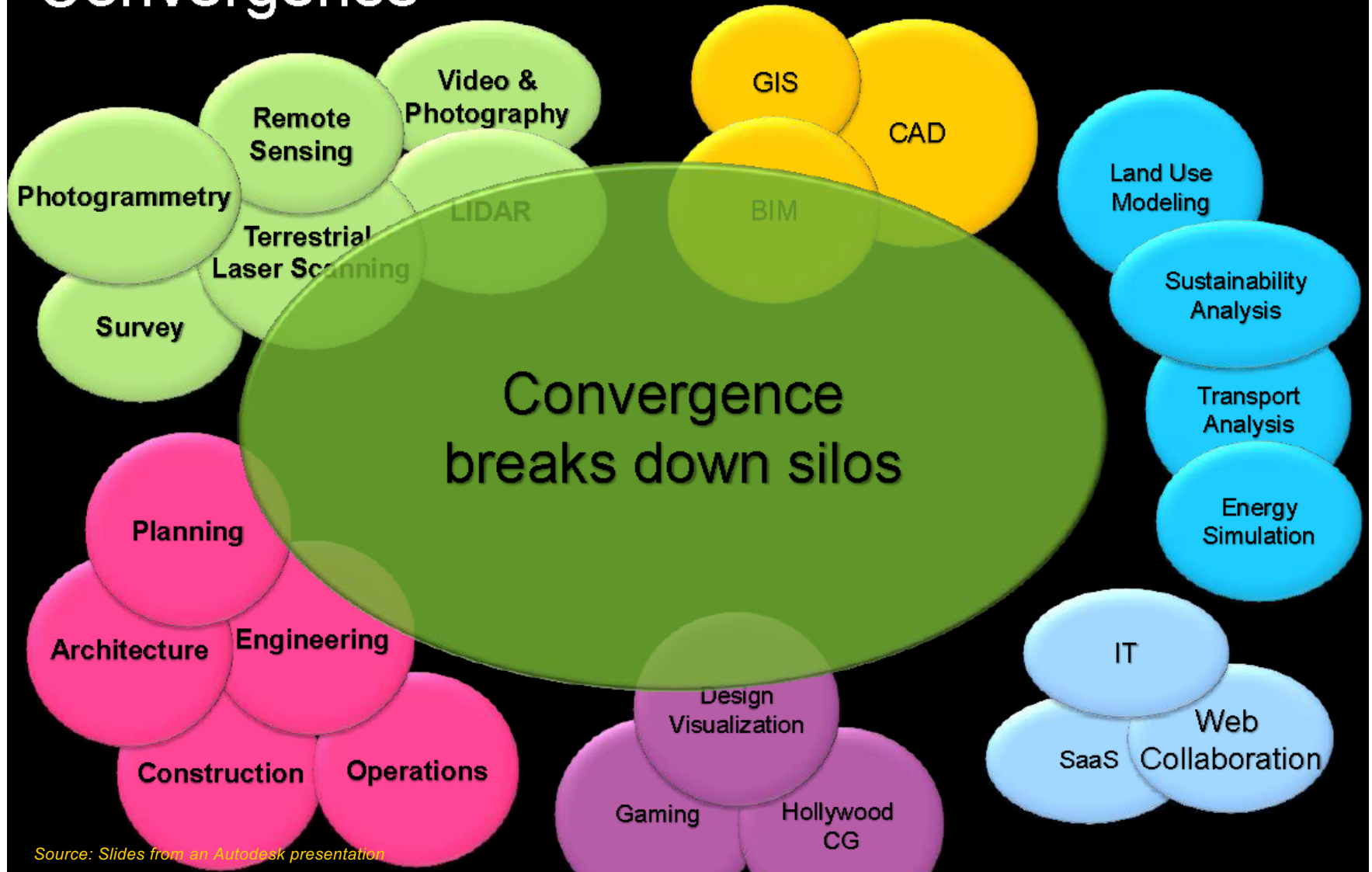


As-Built Tunnel Model

# Heavy civil construction projects – BIM + geospatial



# Convergence



# Information management and BIM

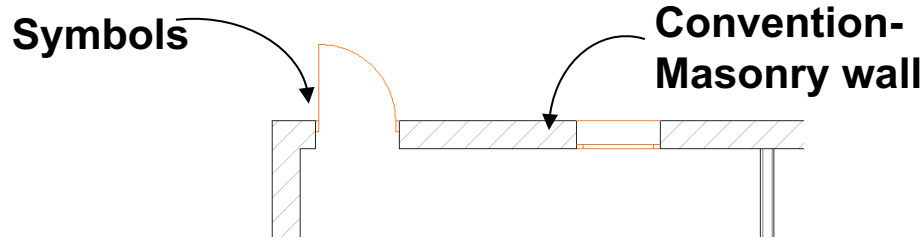
# BIM Definition

“A Building Information Model ... is a **digital representation** of the physical and functional characteristics of the Project ... which term may be used ... to describe a **Model element**, a single Model or multiple Models used in the aggregate. ‘Building Information Modelling’ means the **process and technology** used to create the Model.”

American Institute of Architects (2008)

# Digital **representation**





## Known and acceptable representation in construction sector

We create **symbols and conventions**

Conventions and norms work in a given **social context**

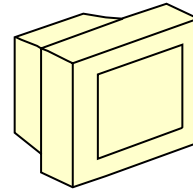
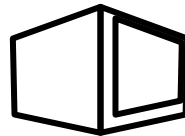
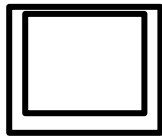
Representations **evolve and change as our capability changes**

**Documentation is important**

Have you ever **shot** a bird?



or



Brand: BBB  
Model: MMM  
Colour: CCC  
Energy Rating: A  
Size: SSS  
Cost: €€€  
Others: 000

Symbolic

Virtual



# What is desired in a representation?

## Efficiency

Should be **clear**/ disambiguous/ distinct

**Reduced effort**, volume, cost, time...

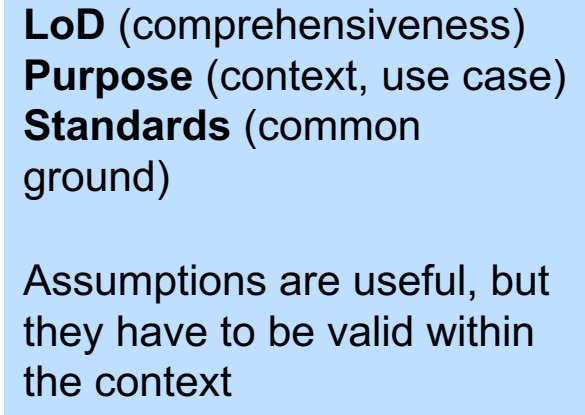
**Deliverable** (skill wise- **typically inclusive?**)

**Comprehensive** (**complete**)

**Common ground** across context and groups!

How?

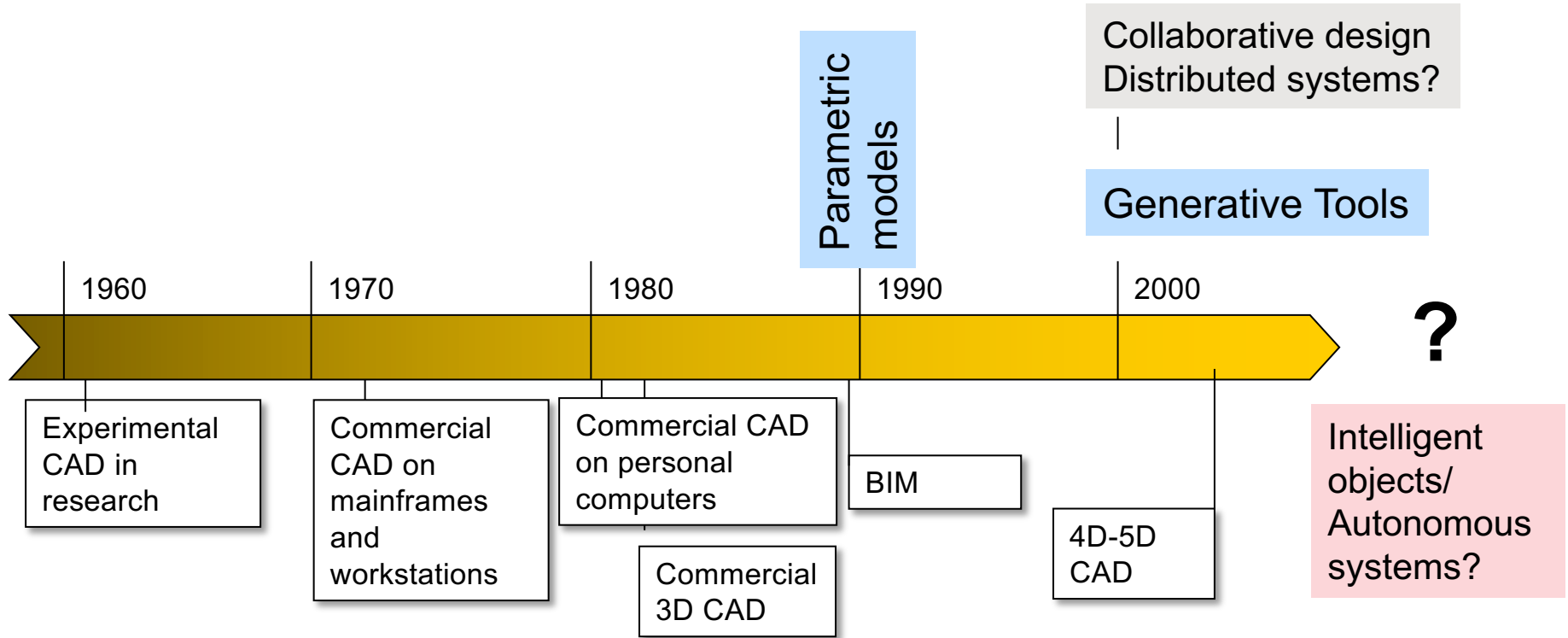
**Abstraction as close an approximation to the real!**



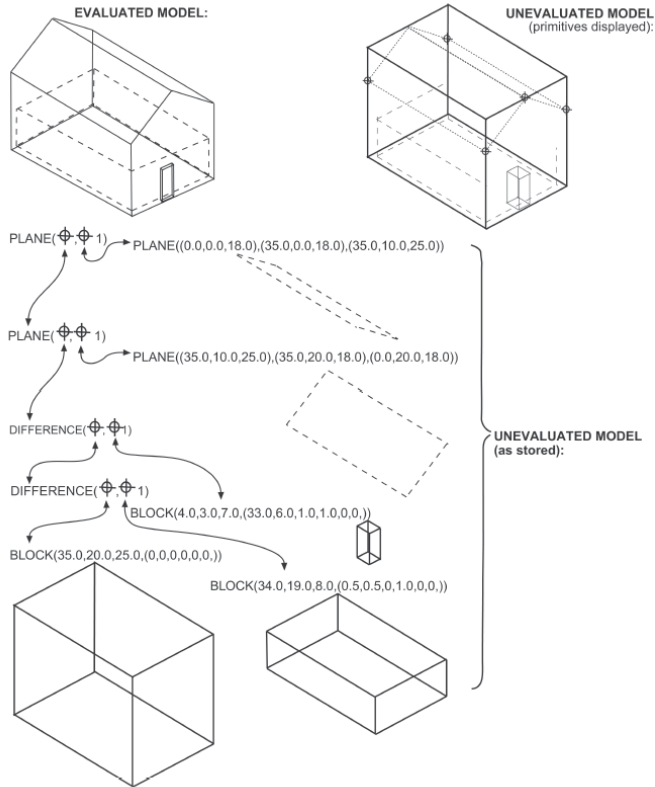
**LoD** (comprehensiveness)  
**Purpose** (context, use case)  
**Standards** (common ground)

Assumptions are useful, but they have to be valid within the context

# AEC CAD Timeline



# 3D CAD- CSG model



# Object-based CAD

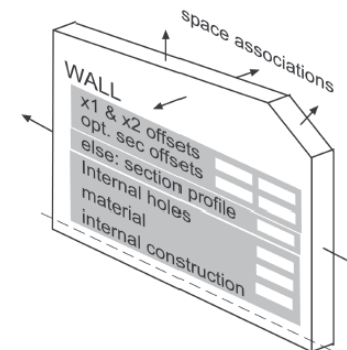
Object instances with **properties**

Objects with **attributes allow**

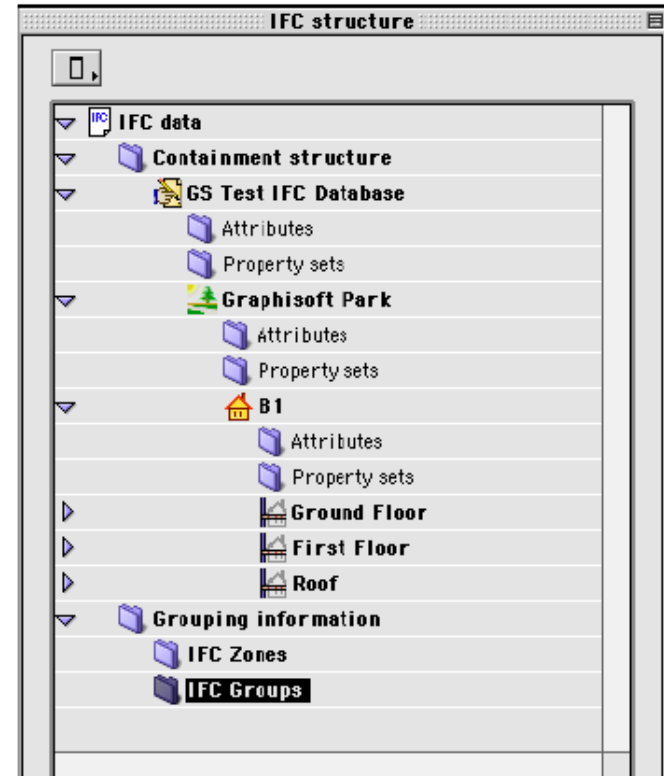
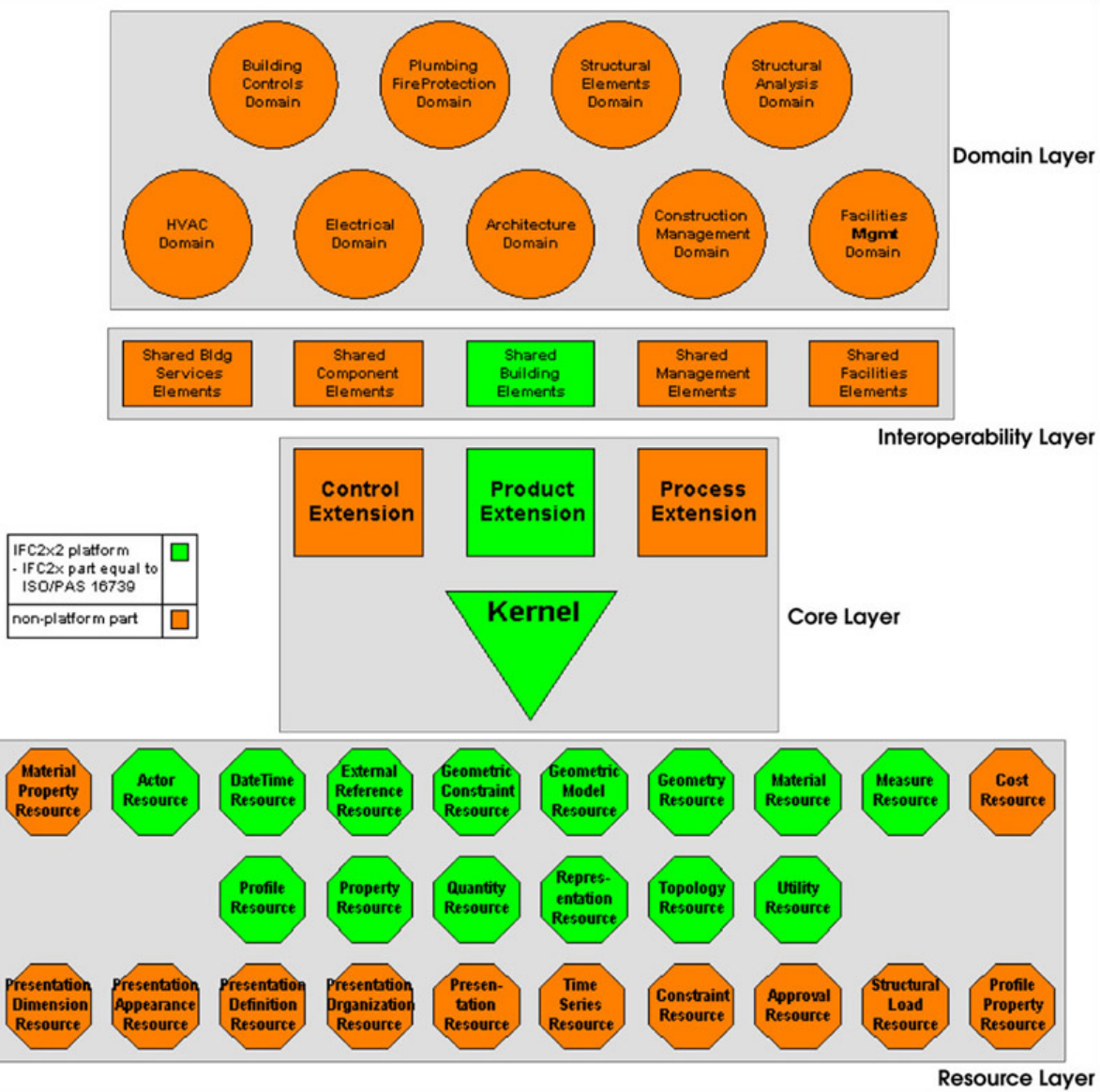
**Associations and relationships**

Creates a **database** for information management

Need for **standards!**



# Industry Foundation Classes (IFC)



# Information management basics

What data to seek?  
How to make sense of the data?  
Do we have enough data?

Map of the world

Knowledge

Capture data and knowledge

Information

Knowhow of the mapping process is Information...

Mapping, analysis of new new information creates new knowledge

Data

Adding context to data/  
Mapping data to make sense

What Product?

Seat or paper weight?



Dimension



Cube

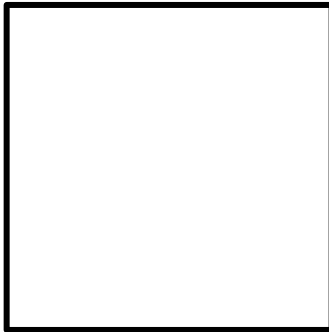
Cost?



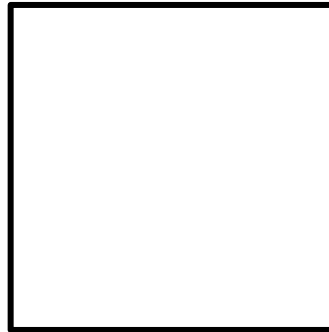
Material



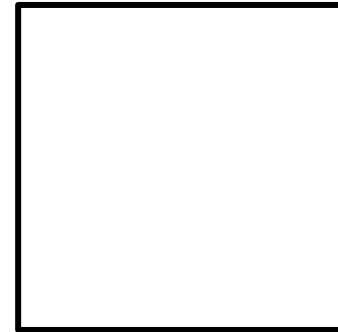
Top view



Front view



Side view





# Representations: Changing context!

## Traditionally

**For whom?** Human to human

**For what?** communication of intent (instruction + interpretation, collaboration, feedback)

## Increasingly

**For whom?** Human to human + Human to machine + Machine to human

**For what?** Communication of intent + Command for (re)production

**Again, since context and use case is changing...**

What are the LoD considerations?

### What is desired in a representation?

#### Efficiency

Should be **clear**/ disambiguous/ distinct

**Reduced effort**, volume, cost, time...

**Deliverable** (skill wise- **typically inclusive?**)

**Comprehensive** (**complete**)

**Common ground** across context and groups!

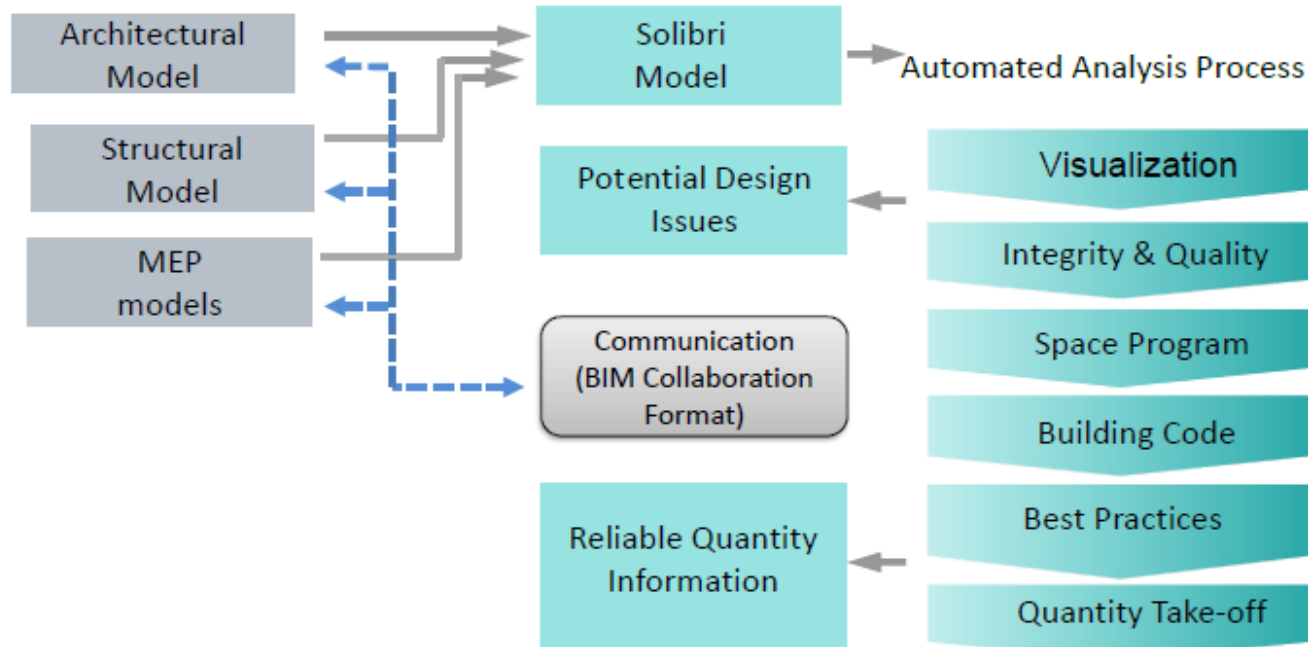
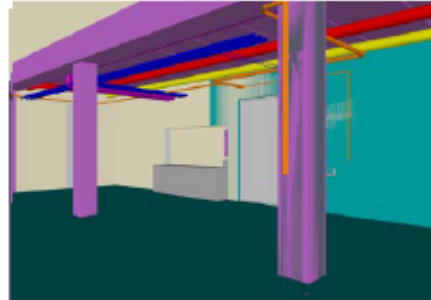
How?

**Abstraction as close an approximation to the real!**

LoD (comprehensiveness)  
Purpose (context, use case)  
Standards (common ground)

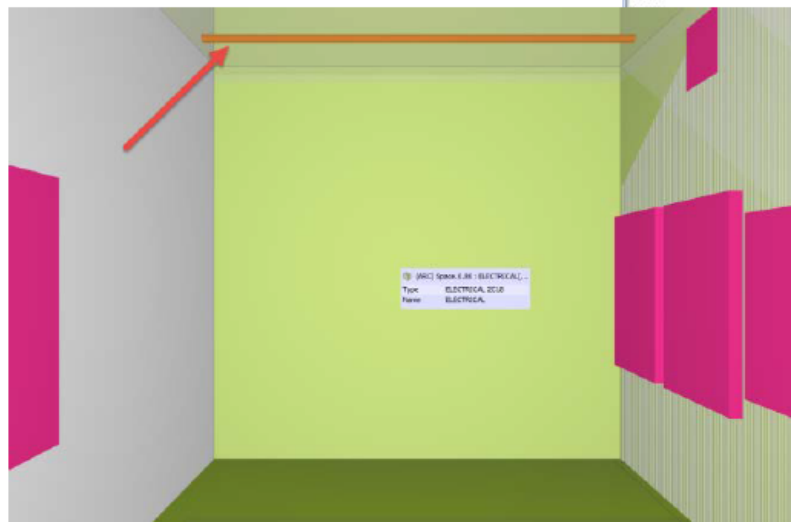
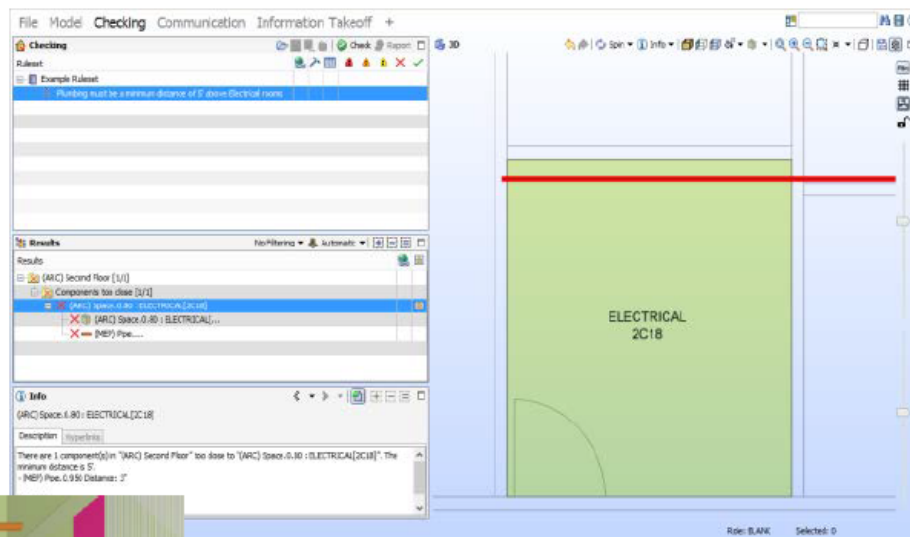
Assumptions are useful, but they have to be valid within the context

# Solibri Model Checker Solution



# Logic Check: Plumbing above electrical rooms

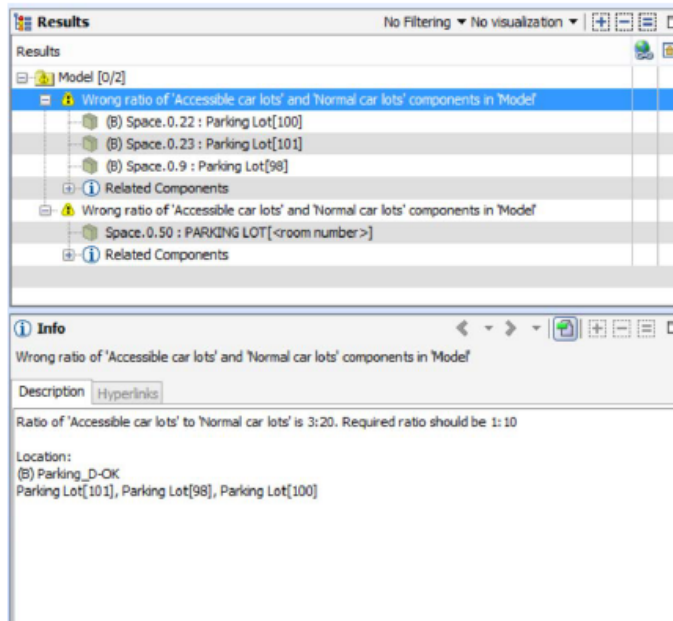
A logical statement to check against the model is: "IF a space is an electrical room THEN no plumbing system that is of type cold water domestic, hot water domestic, or sanitary should run above that space."



# Logic Check - Tabulation of Space - accessible spaces

Ratio of Accessible car park lots vs normal car park lots (Building, site, floor) - > 1:10

Ration of W.Toilets vs M.Toilets (Floor) -> 2:2



**Results** No Filtering No visualization

Results

- Model [0/2]
  - Wrong ratio of 'Accessible car lots' and 'Normal car lots' components in 'Model'
    - (B) Space.0.22 : Parking Lot[100]
    - (B) Space.0.23 : Parking Lot[101]
    - (B) Space.0.9 : Parking Lot[98]
  - Related Components
  - Wrong ratio of 'Accessible car lots' and 'Normal car lots' components in 'Model'
    - Space.0.50 : PARKING LOT[<room number>]
  - Related Components

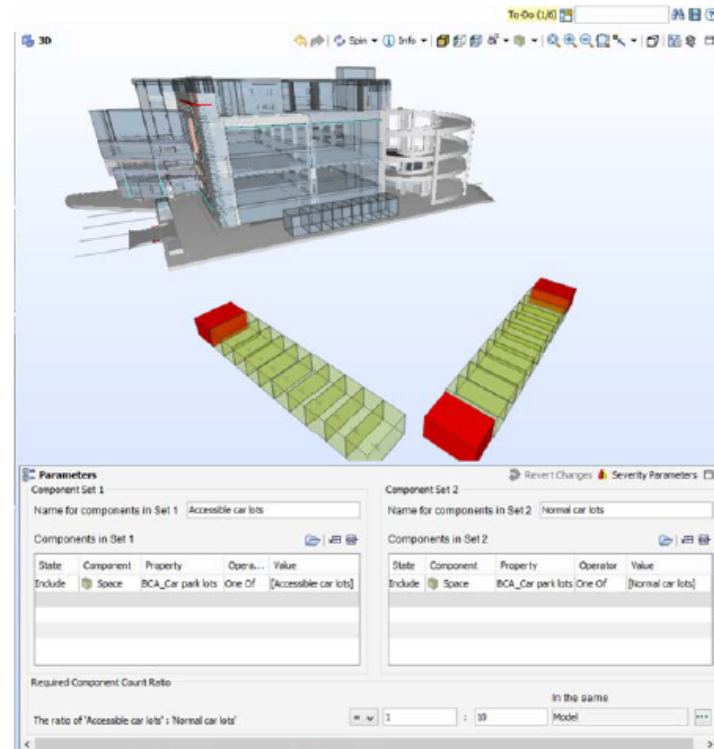
**Info**

Wrong ratio of 'Accessible car lots' and 'Normal car lots' components in 'Model'

Description [Hyperlinks](#)

Ratio of 'Accessible car lots' to 'Normal car lots' is 3:20. Required ratio should be 1:10

Location:  
(B) Parking\_D-OK  
Parking Lot[101], Parking Lot[98], Parking Lot[100]



3D

To Go (1/0)

**Parameters** Revert Changes Severity Parameters

Component Set 1

Name for components in Set 1 Accessible car lots

Components in Set 1

State	Component	Property	Operator	Value
Include	Space	BCA_Car park lots	One Of	[Accessible car lots]

Component Set 2

Name for components in Set 2 Normal car lots

Components in Set 2

State	Component	Property	Operator	Value
Include	Space	BCA_Car park lots	One Of	[Normal car lots]

Required Component Count Ratio

The ratio of 'Accessible car lots' : 'Normal car lots' 1 : 10 In the same Model

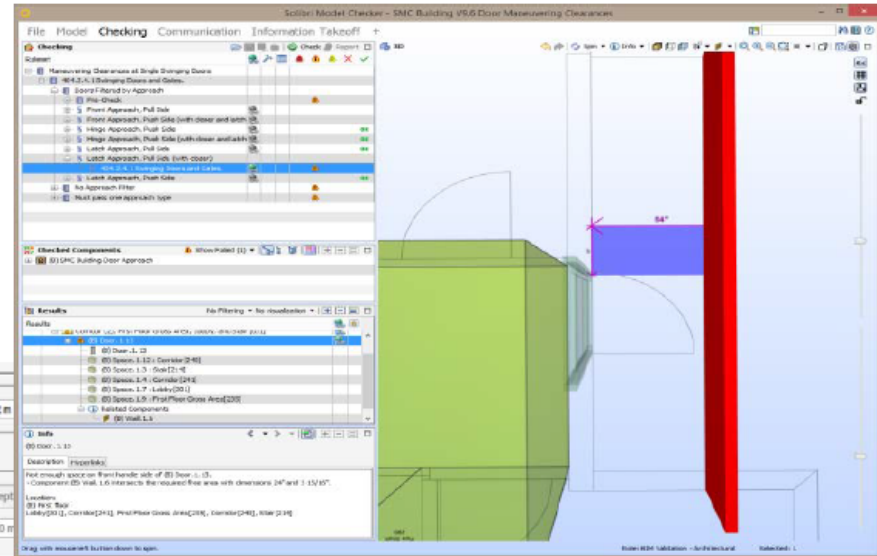
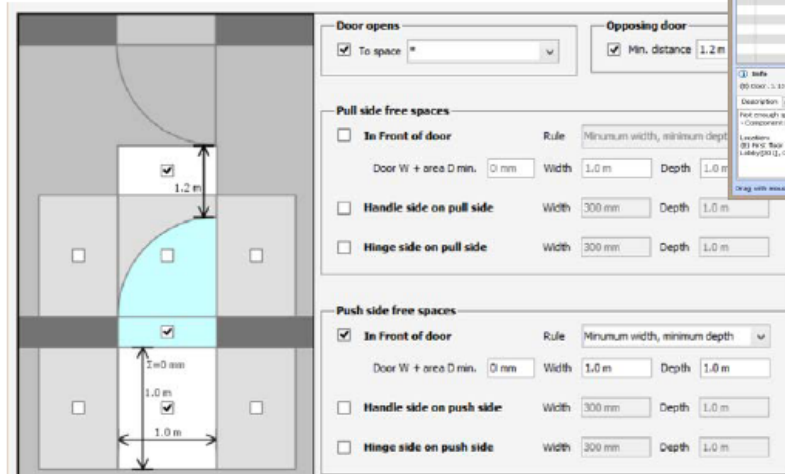
# The Behavior Check: Door components for Accessibility Checks

Door components have an operation property defined which defines the behavior of the door:

- Sliding
- Folding
- Swinging door -> swings left or right

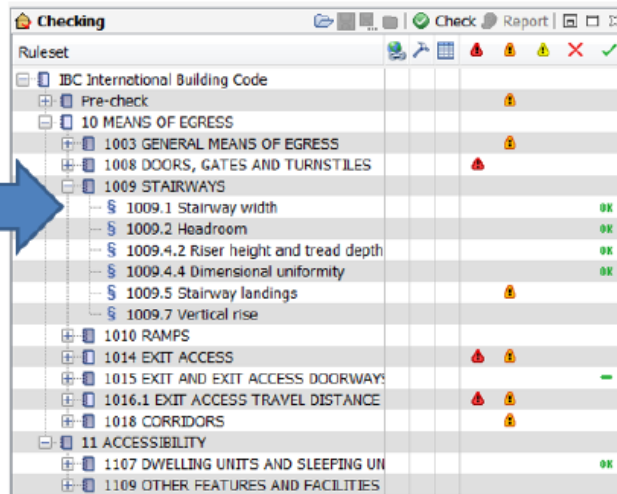
behavior on the part of a person opening the door:

- Pulling
- Pushing



# From Codes to Rulesets

<b>Chapter 9</b>	<b>Fire Protection Systems</b> .....	B-18
	<b>Section</b>	
	903.2.8 Group R.....	B-18
	903.3.1.3 NFPA 13D sprinkler system.....	B-18
<b>Chapter 10</b>	<b>Means of Egress</b> .....	B-19
	<b>Section</b>	
	Table 1004.1.1 Maximum Floor Area Allowances Per Occupant.....	B-21
	1009.5 Stairway landings.....	B-21
	1011.5.1 Graphics.....	B-21
	1014.2 Egress through intervening spaces.....	B-22
<b>Chapter 11</b>	<b>Accessibility (also ICC/ANSI A117.1-2009)</b> .....	B-23
<b>Chapter 12</b>	<b>Interior Environment</b> .....	B-23
	<b>Section</b>	
	1204.1 Equipment and systems.....	B-23
	1208.3 Interior Space Dimensions.....	B-24
<b>Chapter 13</b>	<b>Energy Efficiency (refer to the International Energy Conservation Code)</b> .....	B-24
<b>Chapter 14</b>	<b>Exterior Walls (no amendments)</b> .....	B-24
<b>Chapter 15</b>	<b>Roof Assemblies and Rooftop Structures</b> .....	B-25
	<b>Section</b>	
	Table 1505.1 Minimum Roof Covering Classification for Type of Construction.....	B-25
	1507.2.8.2 Ice barrier.....	B-25



Checking			
Ruleset			
IBC International Building Code			
Pre-check			
10 MEANS OF EGRESS			
1003 GENERAL MEANS OF EGRESS			
1008 DOORS, GATES AND TURNSTILES			
1009 STAIRWAYS			
§ 1009.1 Stairway width			OK
§ 1009.2 Headroom			OK
§ 1009.4.2 Riser height and tread depth			OK
§ 1009.4.4 Dimensional uniformity			OK
§ 1009.5 Stairway landings			
§ 1009.7 Vertical rise			
1010 RAMPS			
1014 EXIT ACCESS			
1015 EXIT AND EXIT ACCESS DOORWAYS			
1016.1 EXIT ACCESS TRAVEL DISTANCE			
1018 CORRIDORS			
11 ACCESSIBILITY			
1107 DWELLING UNITS AND SLEEPING UNITS			OK
1109 OTHER FEATURES AND FACILITIES			

We have rulesets for the following building codes, checkable with typical architectural BIM files:

- Finnish Building Code F1/E1
- ISO Accessibility Standard (ISO/DIS 21542)
- ICC/ANSI A117.1(North America)
- ADA (Americans with Disabilities Act)
- ABA (Architectural Barriers Act)
- Statsbygg Building Requirements (Norway)
- + more than 40 additional standard rulesets for Quality Assurance/Quality Control

## 1.6 Model development phases

Ideally, building models develop over time with increasing levels of detail and complexity, but in different ways for different users. The model evolves as the information required as models develop and when this data is likely to be required.

Model development, as a linear development will seldom occur, can be described in the following general phases:

Phase 1 – Conceptual design

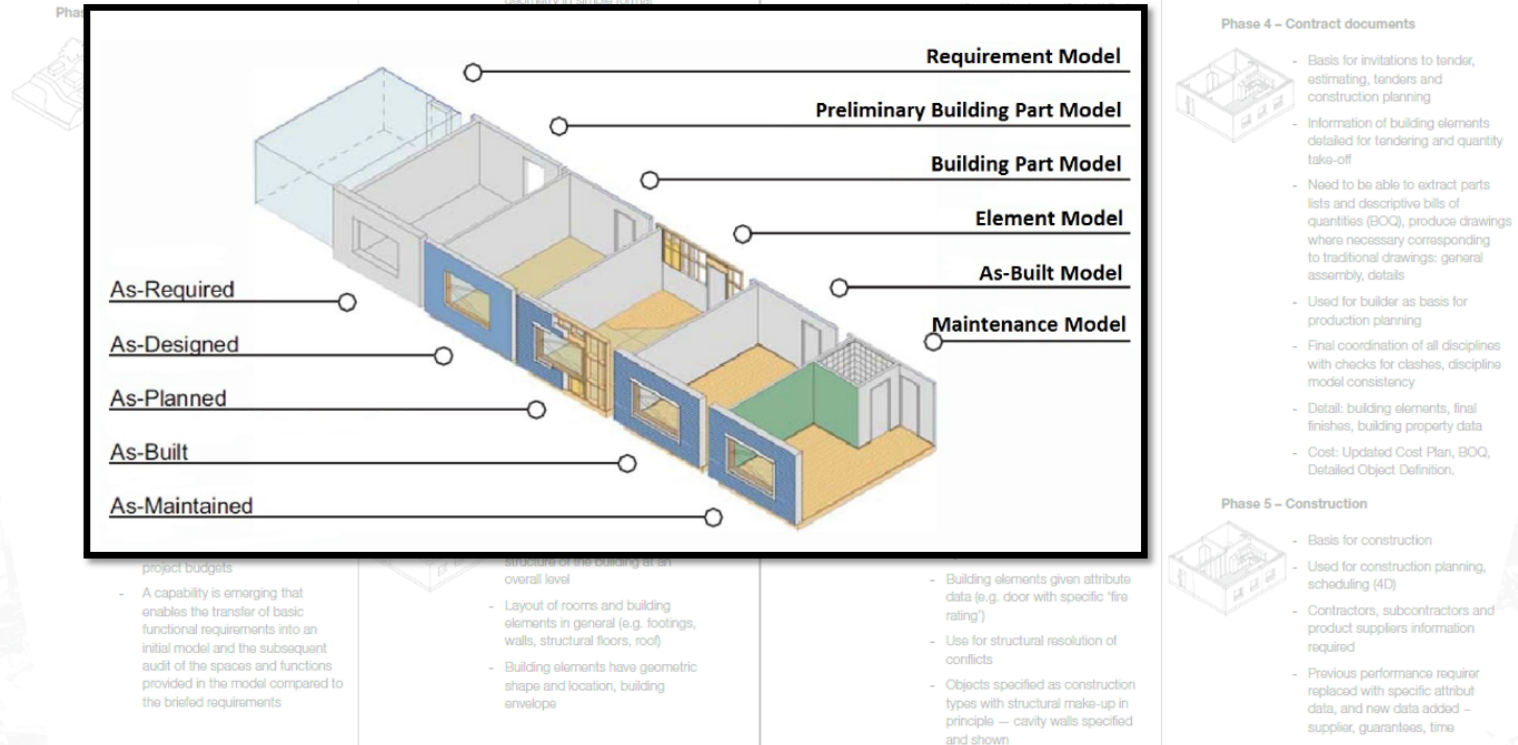
### Phase 1 – Conceptual design

- Clarification at an early stage of the project intent, overall concept and the key objectives of possible options
- Building's overall form, structure and relationships to surroundings, plus rooms and their relationships
- Volumes of building's external envelope in simple format

- Used to develop basic structure for assessment of building's overall physical and functional properties, used for spatial coordination between disciplines
- Used for preliminary assessment of evacuation, fire, simulation of indoor environment, lighting, thermal, acoustic performance
- Can be used for early tendering
- Building objects shown in simple

- Detail: building elements, preliminary finishes, building property data
- Basis of basic 4D/5D model
- Cost: Updated Cost Plan, Updated Cash Flow, Updated Life Cycle Cost Plan
- FM: model of existing buildings at Phases 2-3 where detailed construction information is not required for FM purposes.

# Level of Detail



- project budgets
- A capability is emerging that enables the transfer of basic functional requirements into an initial model and the subsequent audit of the spaces and functions provided in the model compared to the briefed requirements

- structure of the building at an overall level
- Layout of rooms and building elements in general (e.g. footings, walls, structural floors, roof)
- Building elements have geometric shape and location, building envelope

- Building elements given attribute data (e.g. door with specific 'fire rating')
- Use for structural resolution of conflicts
- Objects specified as construction types with structural make-up in principle — cavity walls specified and shown

### Phase 4 – Contract documents

- Basis for invitations to tender, estimating, tenders and construction planning
- Information of building elements detailed for tendering and quantity take-off
- Need to be able to extract parts lists and descriptive bills of quantities (BOQ), produce drawings where necessary corresponding to traditional drawings: general assembly, details
- Used for builder as basis for production planning
- Final coordination of all disciplines with checks for clashes, discipline model consistency
- Detail: building elements, final finishes, building property data
- Cost: Updated Cost Plan, BOQ, Detailed Object Definition.

### Phase 5 – Construction

- Basis for construction
- Used for construction planning, scheduling (4D)
- Contractors, subcontractors and product suppliers information required
- Previous performance required replaced with specific attribute data, and new data added — supplier, guarantees, time



# LEVEL of DETAIL

G0

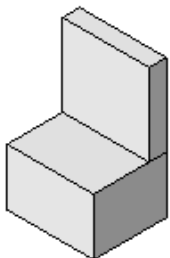
G1

G2

G3



Schematic



Concept



Defined



Rendered

**DESCRIPTION:**

Office Chair

**WIDTH:**

700

**DEPTH:**

450

**HEIGHT:**

1100

**MANUFACTURER:**

Mirra

**DESCRIPTION:**

Office Chair

**WIDTH:**

700

**DEPTH:**

450

**HEIGHT:**

1100

**MANUFACTURER:**

Mirra

**DESCRIPTION:**

Office Chair  
Arms, Wheels

**WIDTH:**

700

**DEPTH:**

450

**HEIGHT:**

1100

**MANUFACTURER:**

Herman Miller, Inc

**MODEL:**

Mirra

**DESCRIPTION:**

Office Chair  
Arms, Wheels

**WIDTH:**

700

**DEPTH:**

450

**HEIGHT:**

1100

**MANUFACTURER:**

Herman Miller, Inc

**MODEL:**

Mirra

(based on AEC [UK] BIMprotocol v2.0 - Component Grade)

practicalBIM.net © 2013

# LEVEL of DEVELOPMENT

LOD 100

LOD 200

LOD 300

LOD 400

LOD 500



Concept (Presentation)



Design Development



Documentation



Construction



Facilities Management

**DESCRIPTION:**

Office Chair  
Arms, Wheels

**WIDTH:**

700

**DEPTH:**

450

**HEIGHT:**

1100

**MANUFACTURER:**

Herman Miller, Inc.

**MODEL:**

Mirra

**LOD:**

100

**DESCRIPTION:**

Office Chair  
Arms, Wheels

**WIDTH:**

700

**DEPTH:**

450

**HEIGHT:**

1100

**MANUFACTURER:**

Herman Miller, Inc.

**MODEL:**

Mirra

**LOD:**

200

**DESCRIPTION:**

Office Chair  
Arms, Wheels

**WIDTH:**

700

**DEPTH:**

450

**HEIGHT:**

1100

**MANUFACTURER:**

Herman Miller, Inc.

**MODEL:**

Mirra

**LOD:**

300

**DESCRIPTION:**

Office Chair  
Arms, Wheels

**WIDTH:**

685

**DEPTH:**

430

**HEIGHT:**

1085

**MANUFACTURER:**

Herman Miller, Inc

**MODEL:**

Mirra

**LOD:**

400

**DESCRIPTION:**

Office Chair  
Arms, Wheels

**WIDTH:**

685

**DEPTH:**

430

**HEIGHT:**

1085

**MANUFACTURER:**

Herman Miller, Inc

**MODEL:**

Mirra

**PURCHASE DATE:**

01/02/2013

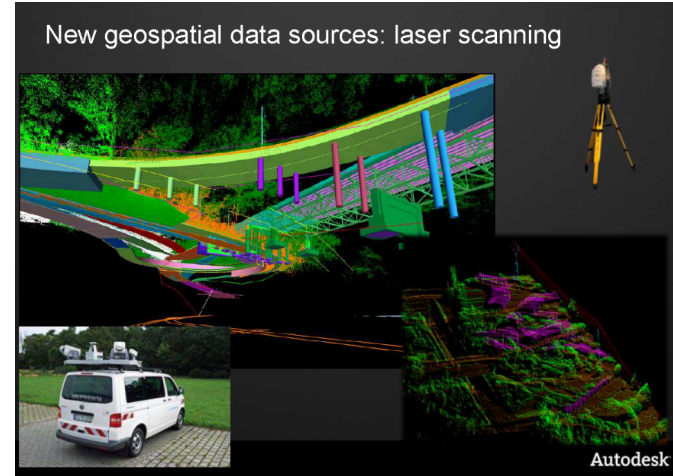
(Only data in red is useable)

practicalBIM.net © 2013

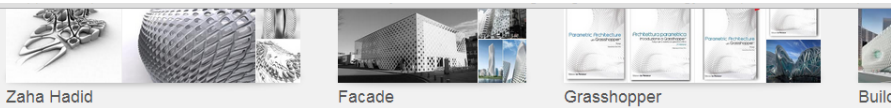


# How does it work the other way round?

- Laser scanning
- Photogrammetry
- Other documentations



That is not enough?  
Integration of information from  
as-designed with as-built

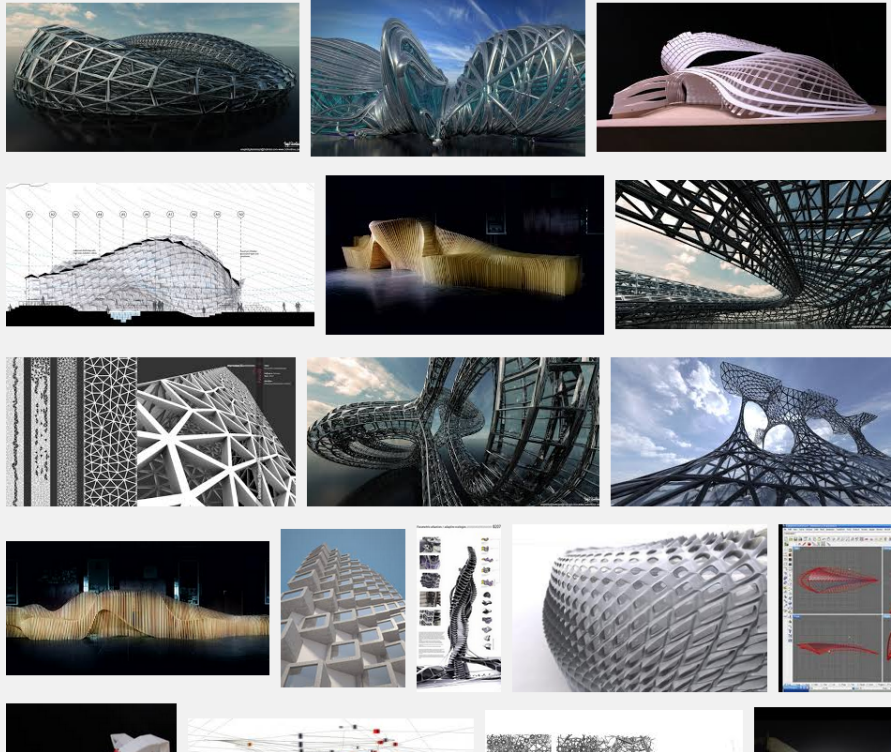


Zaha Hadid

Facade

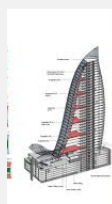
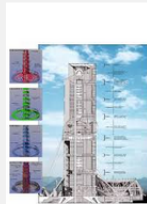
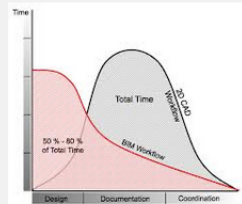
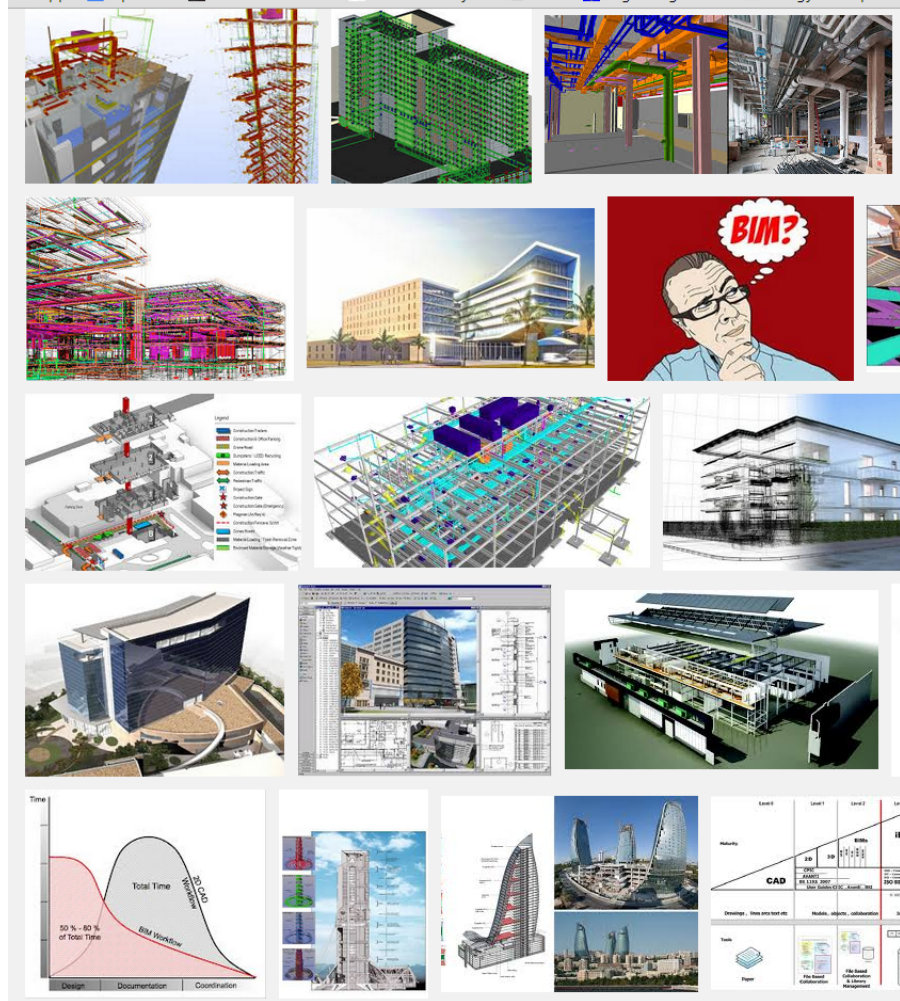
Grasshopper

Built



Generative design

# BIM



Level 1	Level 2	Level 3	Level 4
20	30	40	50
CAD			
BIM			
3D			
4D			
5D			
6D			
7D			
8D			
9D			
10D			

# BIM and generative design

- Design based on design rules
- Numerous design alternatives
- Solution driven and not just information
- Design flexibility **vs** benefits of standardization



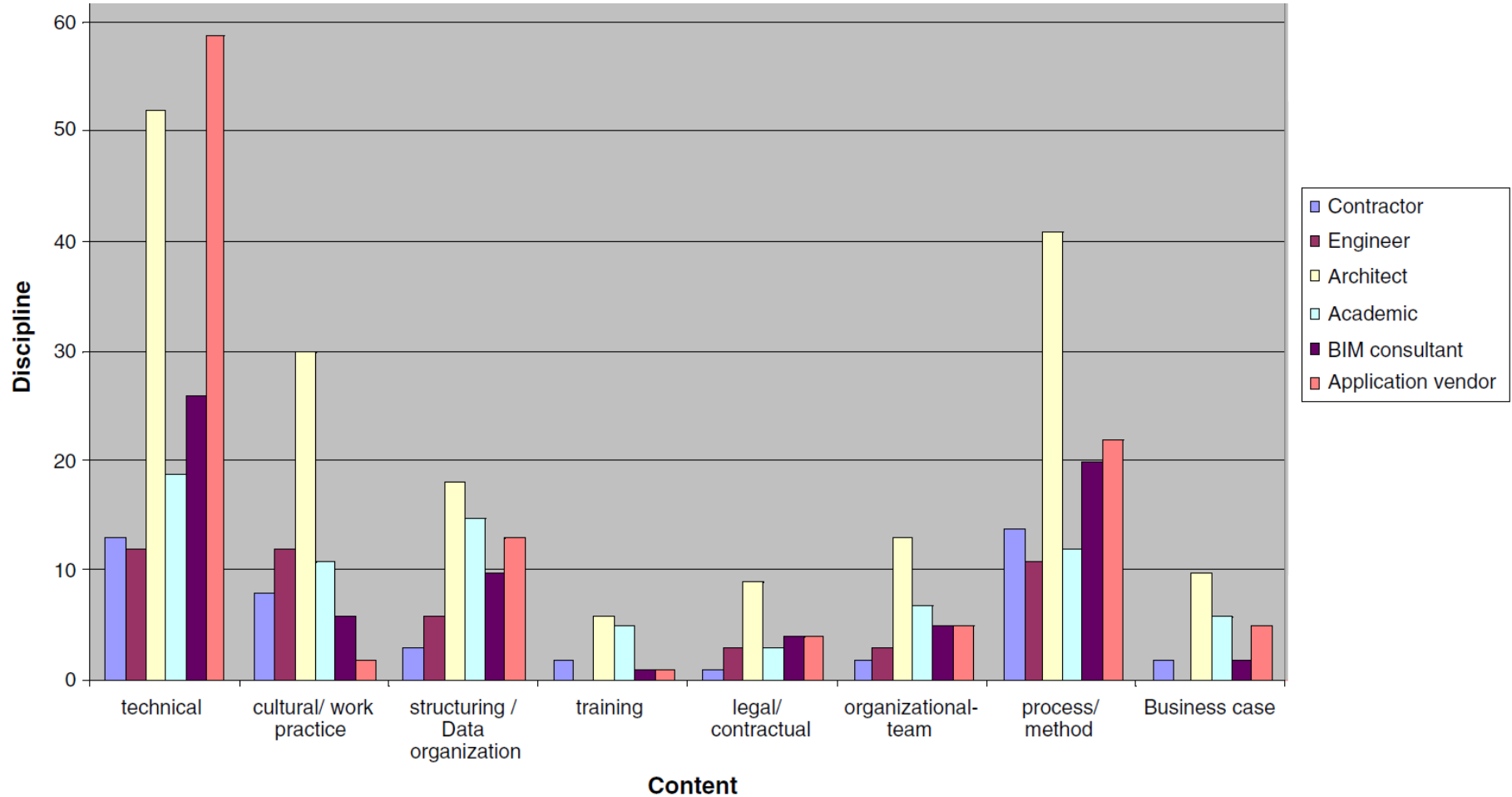


# Aggregate Dynamics for Dense Crowd Simulation

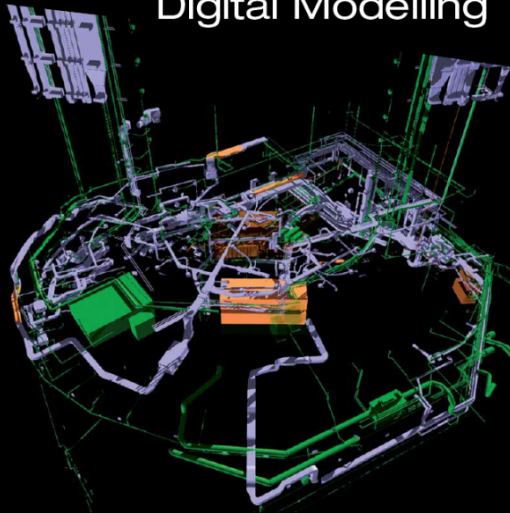
Submission 0042



# Beyond technology: Aspects to consider



# National Guidelines for Digital Modelling



# BIM Execution plans/ guidelines

HOME INFO STANDARDS NEWS CALENDAR **COBIM 2012** CONTACT

 buildingSMART Finland 

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## Common BIM Requirements 2012

Common BIM Requirement 2012, COBIM, is based on the BIM Requirements published by Senate Properties published in . The update project was funded by Senate Properties in addition to several other real estate owners and developers, construction companies and software vendors. BuildingSMART Finland participated also in the financing of the project. As a result, the updated Series 1-9 and new Series 10-13 were released in Finnish on March 27th 2012.

- Series 1: General part
- Series 2: Modeling of the starting situation
- Series 3: Architectural design
- Series 4: MEP design
- Series 5: Structural design
- Series 6: Quality assurance
- Series 7: Quantity take-off
- Series 8: Use of models for visualization
- Series 9: Use of models in MEP analyses
- Series 10: Energy analysis
- Series 11: Management of a BIM project
- Series 12: Use of models in facility management
- Series 13: Use of models in construction

### COBIM 2012 In English

The Common BIM Requirements, that were published March 27th 2012, are now available also in English. Click on the link COBIM 2012 in the menu.

### News

- 5/23/13  
Reijo Hänninen was elected to Deputy Chair of buildingSMART International  
[Read more »](#)
- 3/25/13  
IFC4 released!  
[Read more »](#)
- 3/17/13  
IC meeting in May moved to Helsinki, Finland  
[Read more »](#)

### Contact

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# BIM

operate.construct.design.plan

## PROJECT EXECUTION PLANNING GUIDE

VERSION 2.0  
RELEASED - JULY 2010  
<http://www.enr.gov.edu/bim>

A buildingSMART alliance™ project

Sponsored by:  
The Charles Pankow Foundation  
The Construction Industry Institute  
The Pennsylvania State University Office of Physical Plant  
The Partnership for Advancing Construction Excellence

Developed by:  
The Computer Integrated Construction Research Program  
of The Pennsylvania State University



The Computer Integrated Construction Research Program  
The Pennsylvania State University

# Knowledge creation cycle in BIM projects

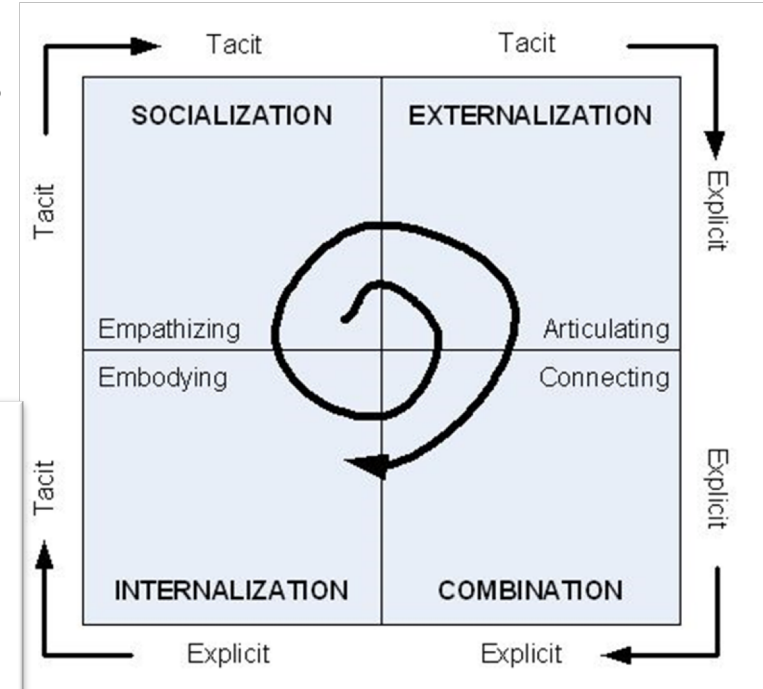
**About the product-** e.g. object libraries and families

**About the process-** e.g. rules and conditions

**About BIM and BIM management-** e.g. guidelines and best practices, product updates and fixes...

The screenshot shows the Autodesk Knowledge Network interface for BIM 360 forums. It includes a search bar, navigation tabs for 'KNOWLEDGE' and 'FORUMS', and a list of forum topics with their respective post counts and timestamps.

Forum Name	Post Count	Time Ago
BIM 360 Document Management Forum	4895 Posts	5 hours ago
BIM 360 Field Management Forum	162 Posts	13 hours ago
BIM 360 Model Coordination Forum	129 Posts	yesterday
BIM 360 Project Management Forum	90 Posts	7 hours ago





# Conclusion!

- Modeling requires understanding of the purpose
- Purpose determines the level of detail (LOD)
- Execution Plan is critical
- Tools are only as good as the users!

# Questions?

# Thank You!