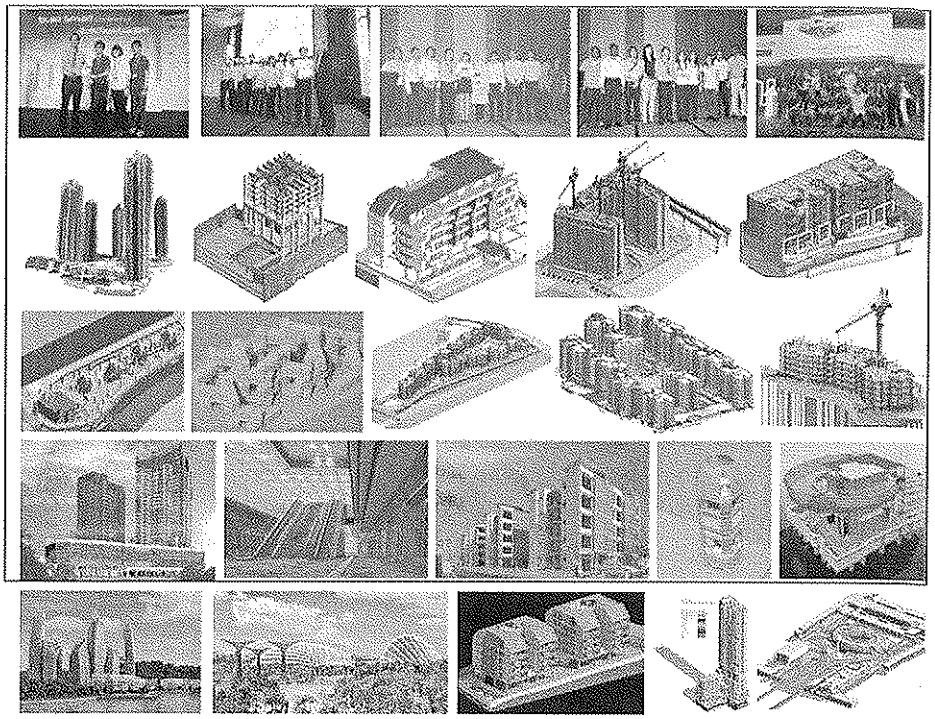
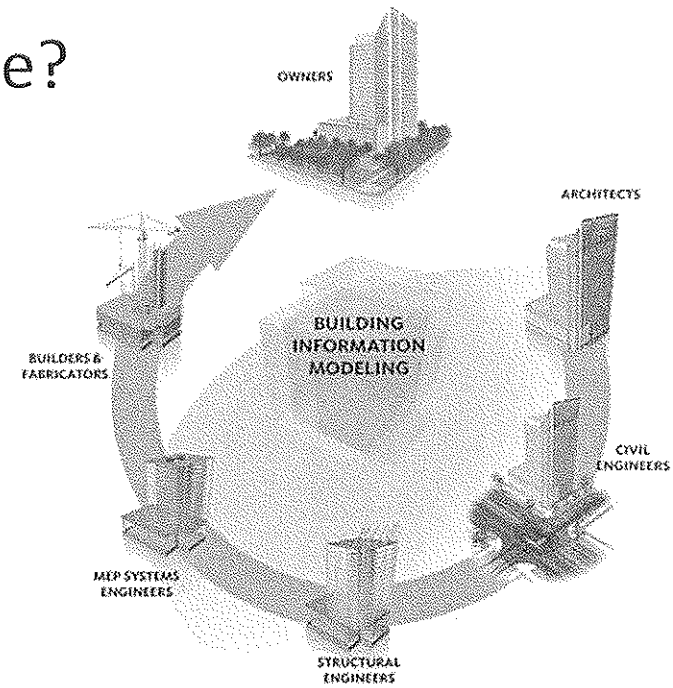


BIM EVOLUTION IN WOH HUP

Contents

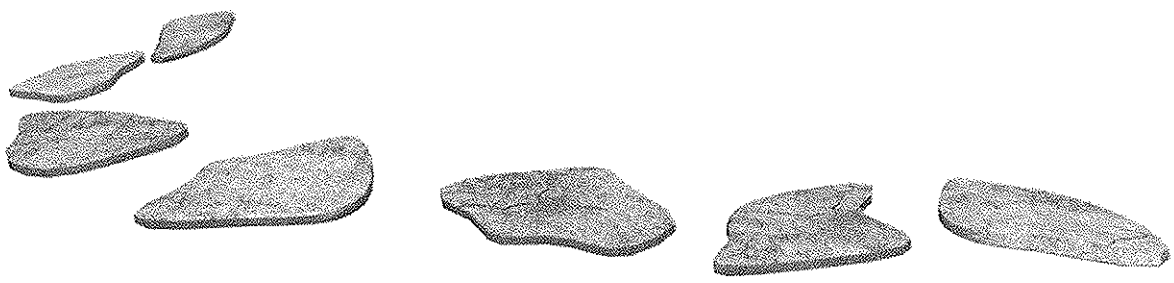
- What have we done?
- What have we learned?
- Case study

What have we done?



BIM

A little history about the BIM in Woh Hup



July 2010

Oct 2010

Dec 2010

May 2011

June 2011

Sep 2011

May 2012

July 2013

Oct 2014



WH won BIM awards for 2 BIM projects

BIM Team

Head Office BIM Team

- Archi (6)
- Struct (7)
- M&E (4)
- QS (1)

1. Tender Project
2. On-going Project
3. Standard & Library Maintenance
4. Conduct BIM Training for WH staff, consultant & subcontractor
5. Research & Development

BIM Software

Currently:

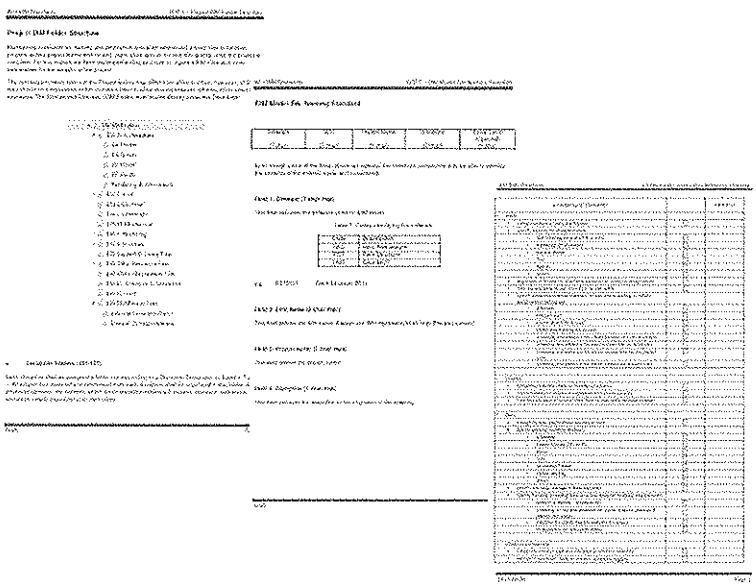
- ✓ 186 Autodesk Design Suite (Revit)
- ✓ 3 Bentley AECOsim (Microstation)
- ✓ 6 Graphisoft Archicad
- ✓ 10 Glodon
- ✓ 1 Autodesk Infrastructure Design Suite
- ✓ 1 Rhino
- ✓ Autodesk Buzzsaw (50 user accounts with 50GB)
- ✓ Tekla BIMsight (Free)

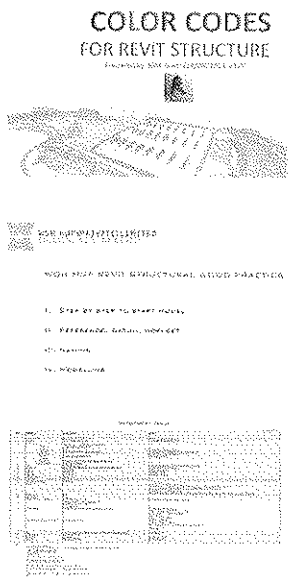
Design software compatible with BIM:

- ✓ Orion
- ✓ SAP2000
- ✓ Etabs
- ✓ SAFE

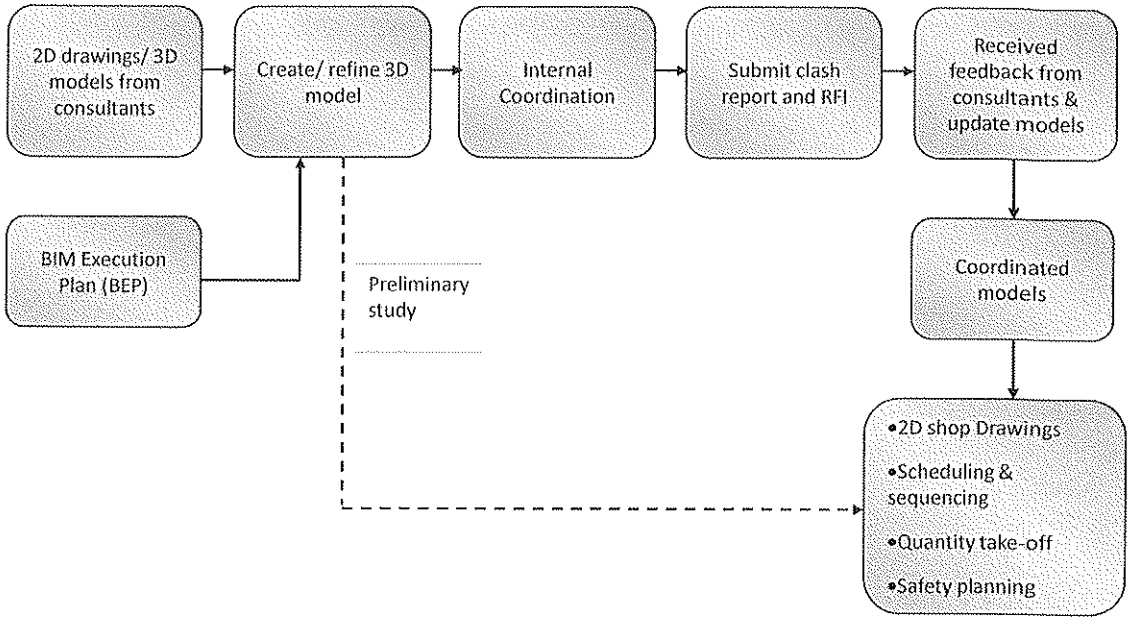
BIM Use	Software
Modelling	- Autodesk Revit - Bentley AECOsim - Autodesk Infrastructure
Design Review & 3D Coordination	- Revit - Autodesk Design Review - Navisworks - Tekla BIMsight
Quantity Take-off	- Revit/ Archicad/ Glodon
Model Management	- Revit Server/ Project Server
Data Management & Collaboration	- Autodesk Buzzsaw

BIM Standards and Good Practices

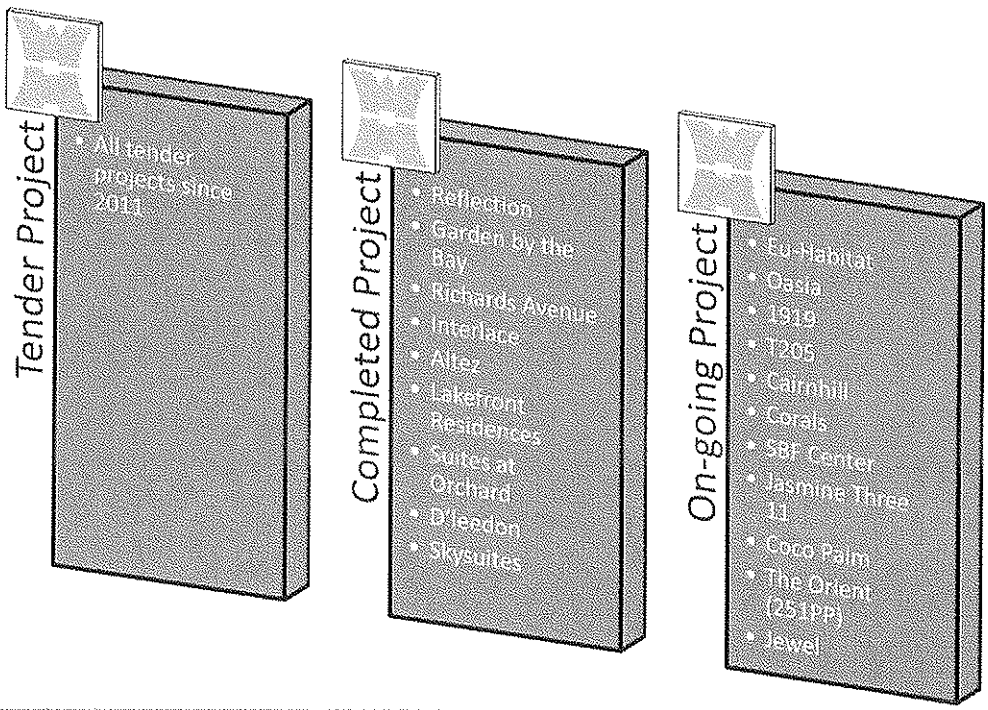




BIM-based Process Workflow

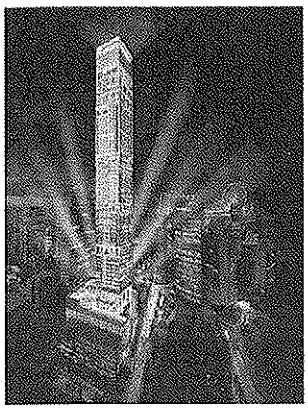


BIM Projects

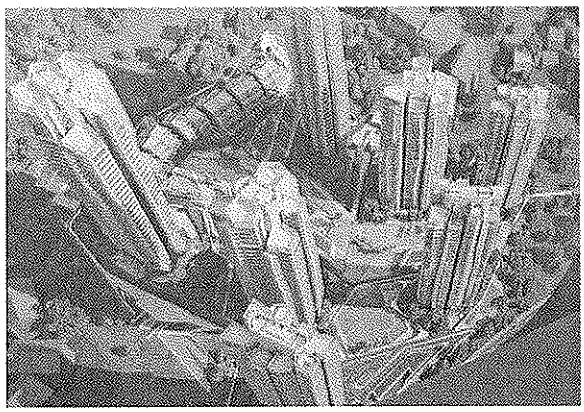


BCA BIM Funding Projects

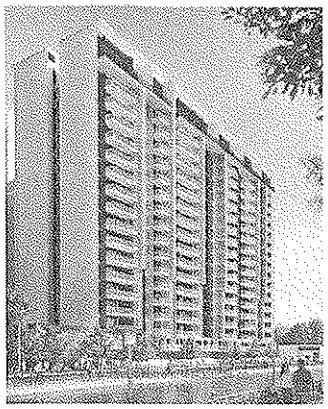
1st to 3rd Project



Altez



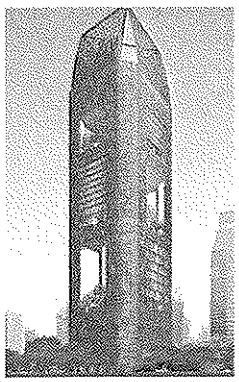
D'Leedon



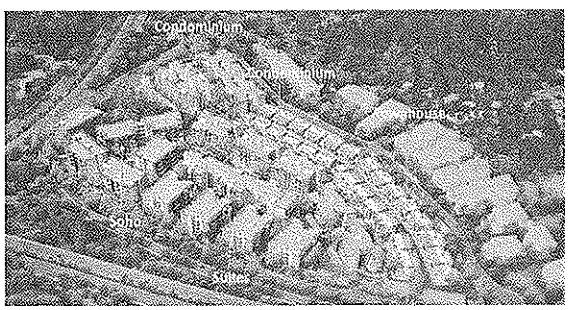
Lakefront

BCA BIM Funding Projects

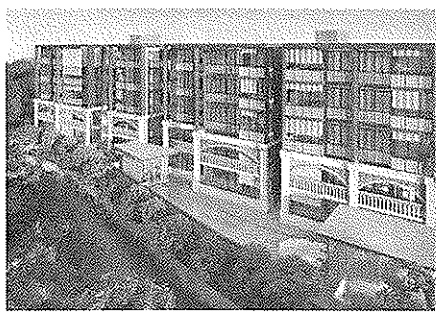
4th to 6th Project



Oasia



Euhabitat



Sophia 1919

BCA BIM Award 2014



BCA BIM AWARDS 2014

Projects

GOLD AWARD

presented to

Woh Hup (Private) Limited

as the Builder for

Mixed Development at 15 Cairnhill Road

CHIEF EXECUTIVE OFFICER
Building and Construction Authority

CHAIRMAN
BIM Steering Committee

Date of Issue: 14 October 2014

Building and Construction Authority



BCA BIM AWARDS 2014

Projects

GOLD AWARD

presented to

Woh Hup (Private) Limited

as the Builder for

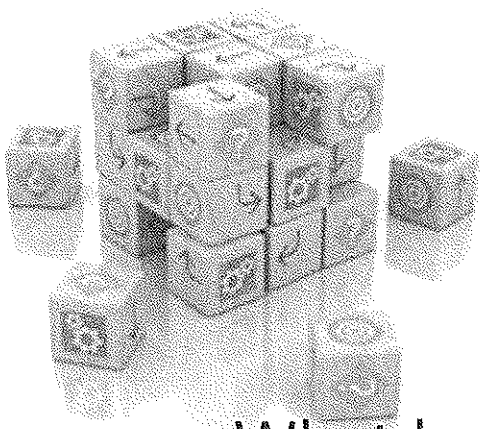
1919 The Black and White Residences

CHIEF EXECUTIVE OFFICER
Building and Construction Authority

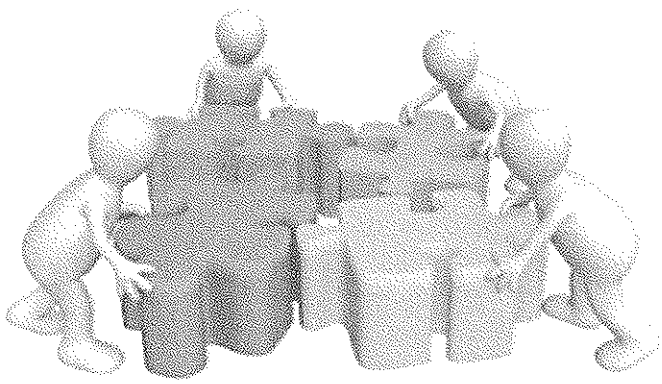
CHAIRMAN
BIM Steering Committee

Date of Issue: 14 October 2014

Building and Construction Authority



What have we learned?



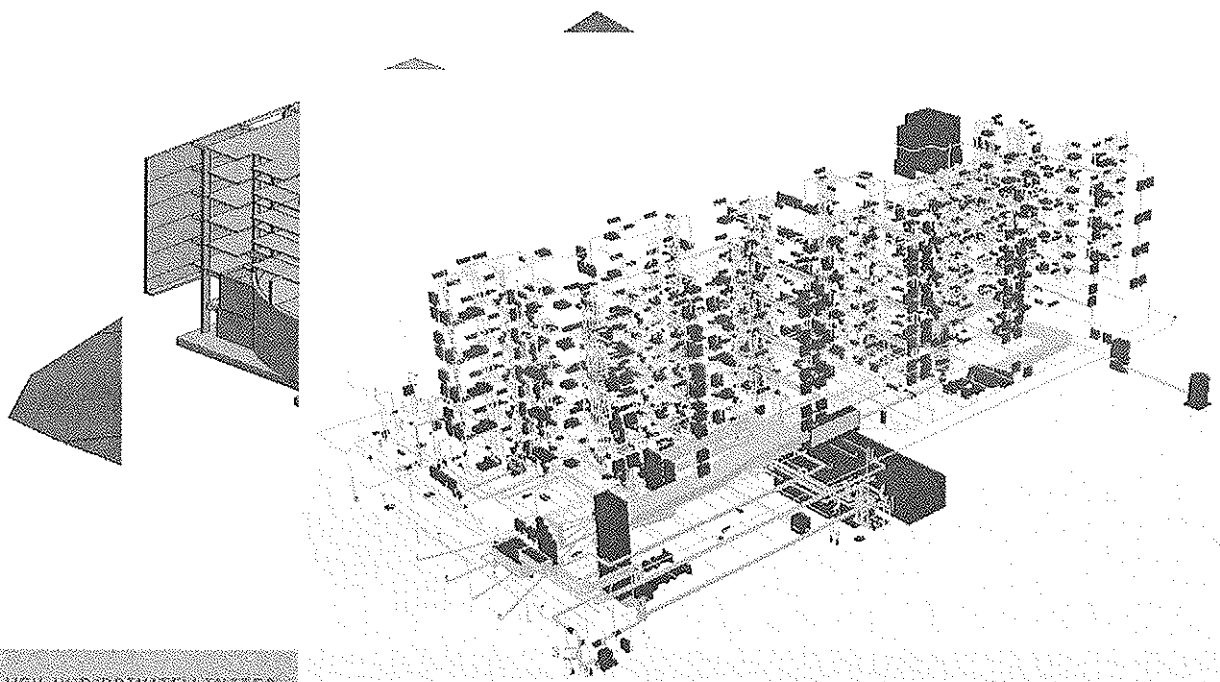
The need to focus on certain BIM Uses

There are huge potential in BIM.

We have identified the ~~six~~ seven most common BIM uses, but there is a need to review and set clear BIM objectives at the beginning of each project.

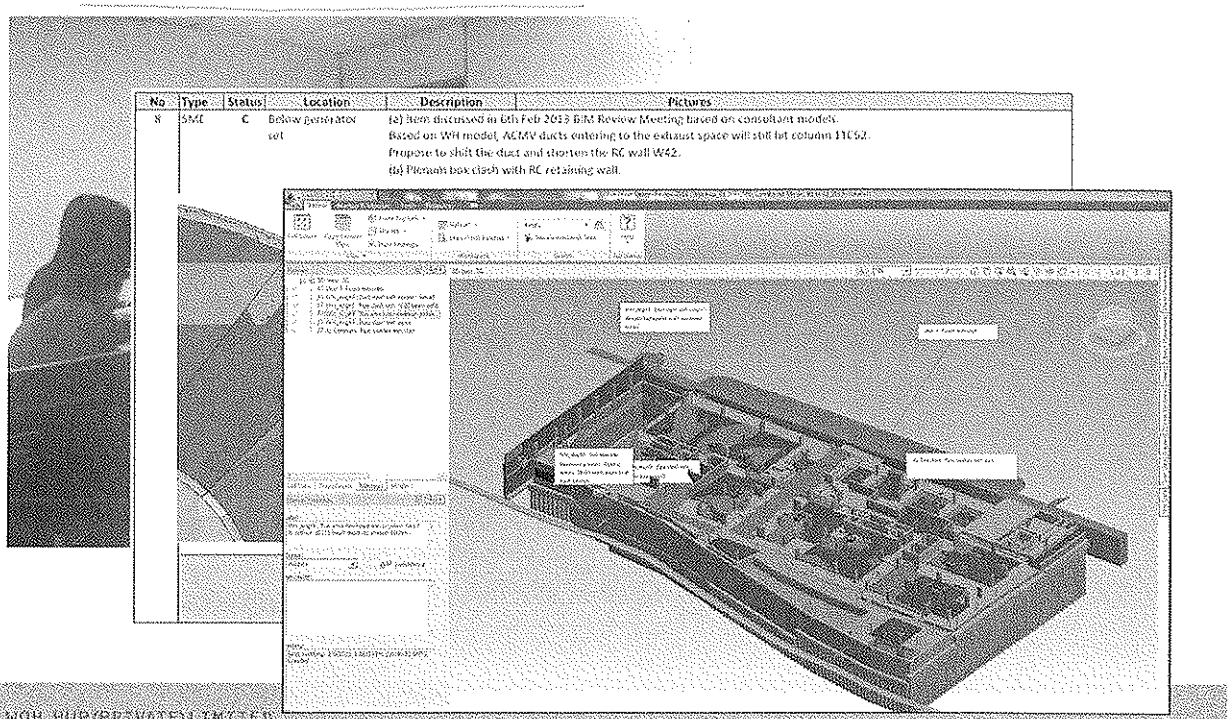
The need to focus on certain BIM Uses

1. Visualization (3D picture, rendering & animation)



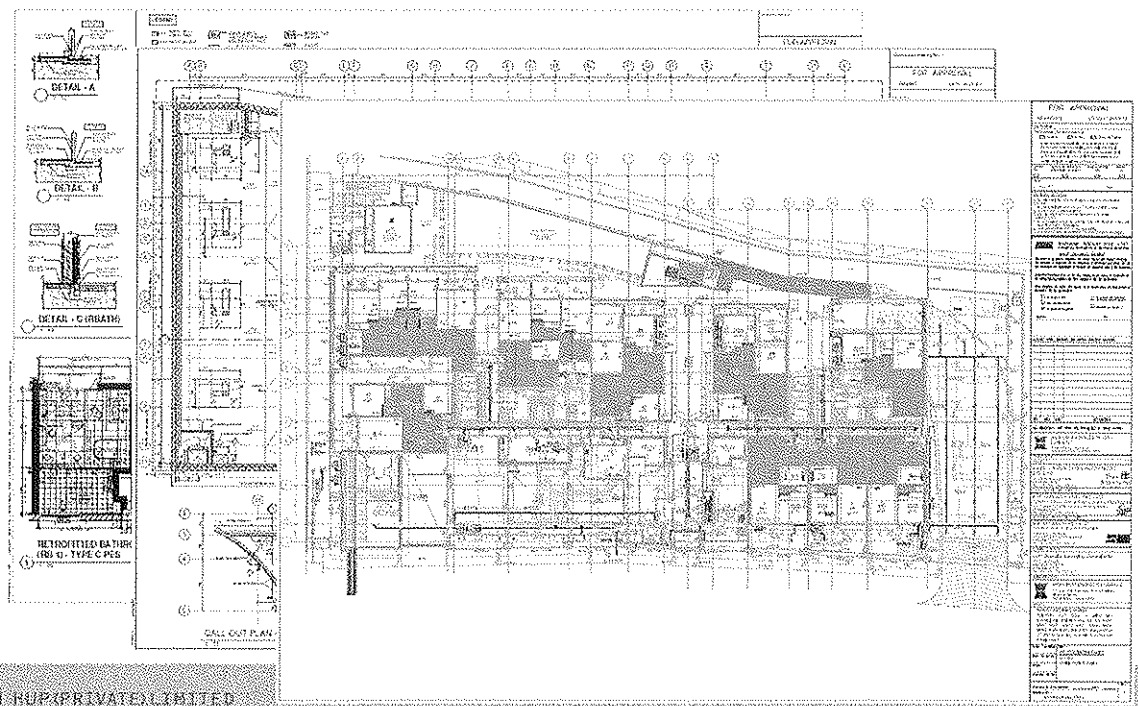
The need to focus on certain BIM Uses

2. 3D Coordination & clash detection



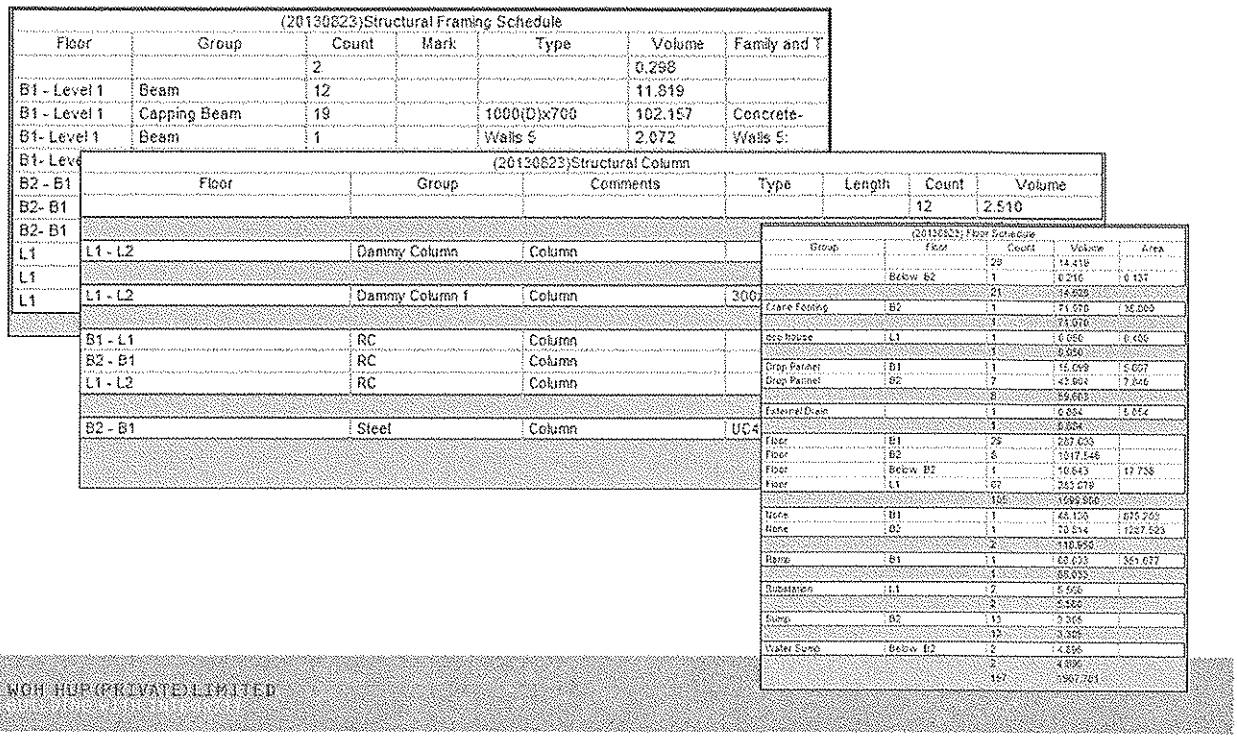
The need to focus on certain BIM Uses

3. 2D Shop Drawings



The need to focus on certain BIM Uses

4. Quantity Take-off



(20130823)Structural Framing Schedule

Floor	Group	Count	Mark	Type	Volume	Family and T
		2			0.298	
B1 - Level 1	Beam	12			11.819	
B1 - Level 1	Capping Beam	19		1000(D)x700	102.157	Concrete-
B1- Level 1	Beam	1		Walls 5	2.072	Walls 5:

(20130823)Structural Column

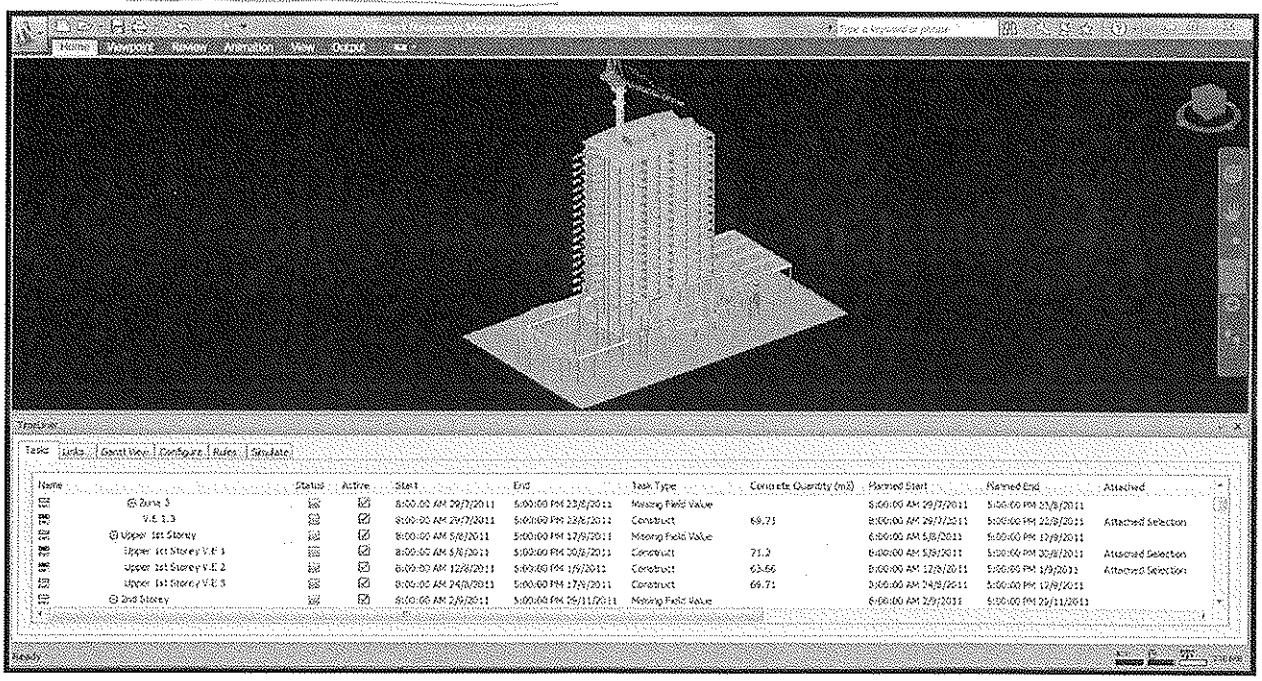
Floor	Group	Comments	Type	Length	Count	Volume
					12	2.510
L1 - L2	Dammy Column	Column				
L1 - L2	Dammy Column 1	Column	300			
B1 - L1	RC	Column				
B2 - B1	RC	Column				
L1 - L2	RC	Column				
B2 - B1	Steel	Column	UC4			

(20130823) Floor Schedule

Group	Floor	Count	Volume	Area
		29	14.418	
	Below B2	1	0.216	0.137
		21	14.628	
Crane Footing	B2	1	71.070	35.000
		1	71.070	
ess house	L1	1	0.050	0.100
		1	0.050	
Drop Panel	B1	1	15.049	5.007
Drop Panel	B2	7	43.864	7.845
		8	58.913	
External Drain		1	0.854	0.854
		1	0.854	
Floor	B1	29	287.035	
Floor	B2	8	1017.546	
Floor	Below B2	1	10.643	17.738
Floor	L1	67	283.079	
		105	1598.906	
None	B1	1	48.150	675.909
None	B2	1	70.514	1287.523
		2	118.664	
Ramp	B1	1	60.033	361.677
		1	60.033	
Substation	L1	2	5.566	
		2	5.566	
Sump	B2	13	3.305	
		13	3.305	
Water Sump	Below B2	2	4.896	
		2	4.896	
		167	1967.761	

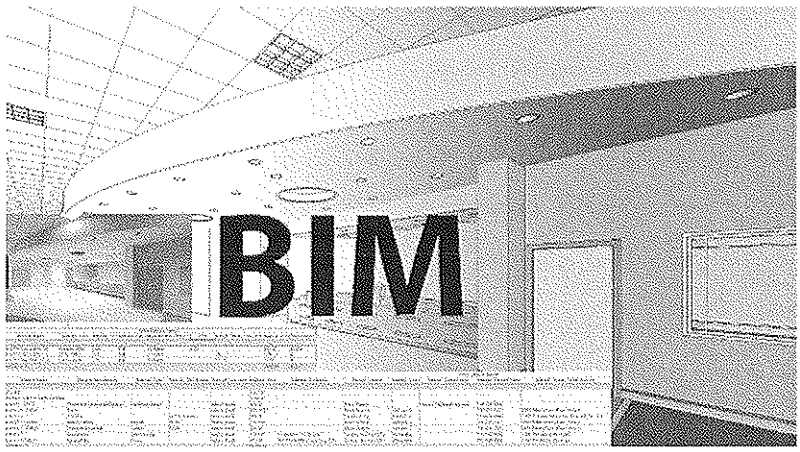
The need to focus on certain BIM Uses

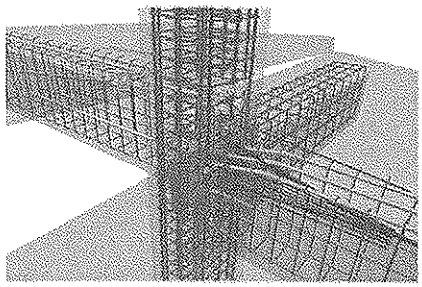
5. 4D Sequencing & scheduling

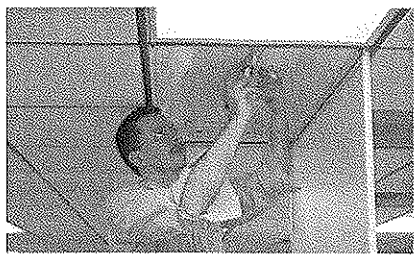


The need to focus on certain BIM Uses

6. As-built Model

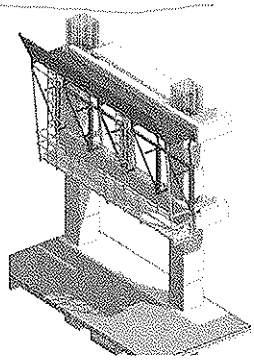






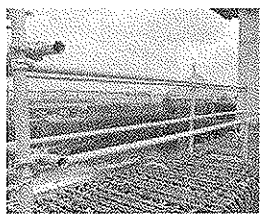
The need to focus on certain BIM Uses

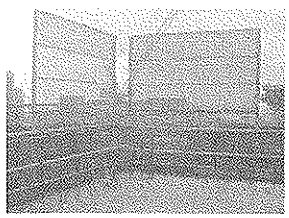
7. Safety Management

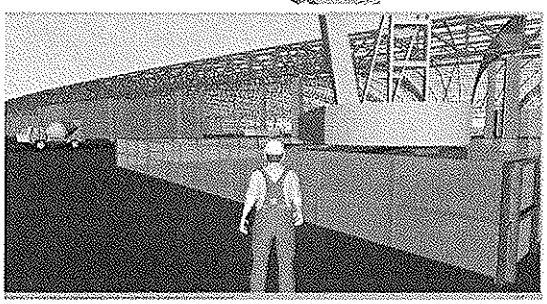


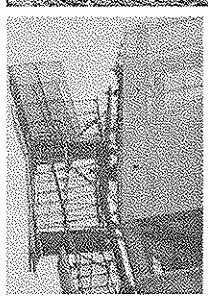
WOH HUP STANDARDIZED
SAFETY PROVISIONS MANUAL

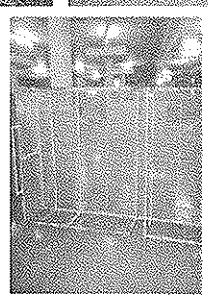
FOR PROJECT SITE

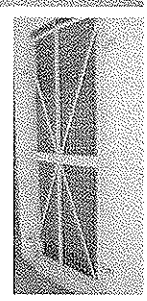












The need for standardization

BIM aim to achieve integration among project team with **better sharing and understanding** of the works handled by each party. The more we share, the more standards will be required.

1. Modelling practice
2. Library objects
3. Folder structure
4. Workflow
5. In-house Construction standards

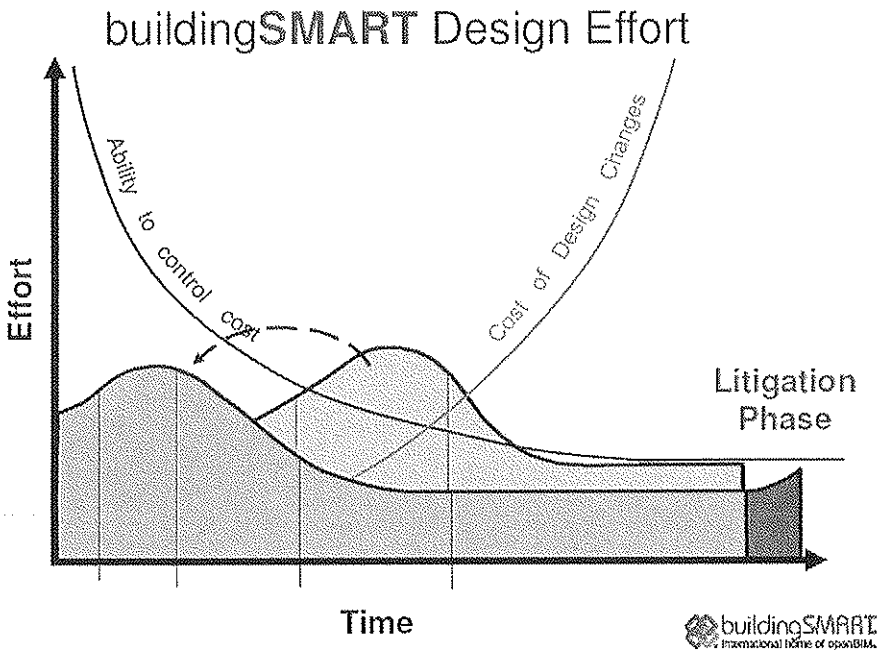
The need for more resources

Constructing a 3D model can be fast, but to have a coordinated model need time.

Are consultants BIM-ready? In current stage, changes always come in late for construction, there is a need to put in more man power to speed up the modelling.

In the long run, there will be significant manpower savings.

The need for more resources



Thank You!

MAINTAIN FILE SIZE TO A MAX 150MB. PER FILE.

BIM EXECUTION PLAN IS IMPORTANT.

BCA ACADEMY

Certificate Course in BIM Management
(38th Intake)

Assignment

BIM Implementation Strategy

In Certificate Course in BIM Management, you have learnt about BIM Technology, BIM Processes, and BIM implementation strategy on the company level and project level. In this assignment you are required to write a plan/report on BIM implementation strategy on the company/project level. Requirements for this assignment are as follow:

- You should **work individually**.
- Select **one topic** out of the five topics below:
  - Company BIM Deployment Plan (BIM Roadmap) for your own firm
  - Outline of your BIM Company Standard (give explanation for each chapter)
  - BIM Execution Plan
  - Legal and contractual issues in BIM implementation
  - BIM Maturity Matrix
- Write the assignment in Microsoft Word document with the maximum of 10 pages.
- File name: FullName_NRIC
- Marking Criteria:
  - Organization of the plan/report that enhances readability and/or understandability
  - Data table and graph (if any) neatly completed and accurate
  - Logical explanation for findings (if any) and completeness on addressing the selected topic
  - Zero mark will be given if plagiarism is found
- Submit the assignment by the latest: 19 January 2014, 6.00 PM to jusuf_anggono@bca.gov.sg and cc to nelson_teo@bca.gov.sg

Any query on the assignment can be addressed to: jusuf_anggono@bca.gov.sg
Any query on the Certification Course result can be addressed to: nelson_teo@bca.gov.sg

www.dropbox.com
ID: bim.bcaa@gmail.com
Pswd: managementBCAA
} TO RETRIEVE TEMPLATE FROM HERE FOR TOPICS 1 TO 3.

→ BIM MGMT → BIM MANUAL TEMPLATE

MCQ (40%) + ASSIGNMENT (60%)

Important Notes to Course Participants

On Attendance/Examination/Assessment/Assignment

Please remember to sign on the attendance sheet daily and promptly upon arriving at the class. Course participants are **not allowed** to sign for lesson(s) not attended or for someone else. Participants are to monitor their attendance throughout the whole course.

To sit for the examination, we would like to remind that all participants to obtain at least **75% of attendance**. Participant will be **debarred** and **disqualified** from sitting for the end-of-course examination/assessment, supplementary paper or re-test if the minimum attendance requirement is not met, and will be required to re-do the course.

Submission of assignment/project report (if any) will have to be made by the given deadline. Failure to do so, will result in incompetency/unsuccessful completion of the course.

Late submission of assignment will not be accepted.

BCA Academy

Certification Course in BIM Management

BCA ACADEMY
of the built environment

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Welcome to BIM Management Course

- Instructor(s)
- Participant Introductions:
  - Name, company, and position
  - Level of BIM experience
  - Expectation from this course

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BIM Management Outline

- Day 1
  - BIM Fundamentals
  - BIM Technology
  - BIM Design Analysis (Green Building Analysis)
  - BIM Design Analysis (Structural Analysis)
- Day 2
  - BIM Design Review
  - BIM Quality Assurance and Coordination
  - BIM Phase Planning & Cost Estimation

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BIM Management Outline

- Day 3
  - BIM Company Deployment Plan
  - BIM Standards
  - Singapore BIM Guide
  - BIM Legal and Contractual Issue
- Day 4
  - BIM Project Execution Plan
  - BIM Case Study
  - Assessment

Day 1 – Course Schedule Outline

Time	Topic
09.00 – 10.45	Session 1 – BIM Fundamentals
10.45 – 10.55	Break
10.55 – 13.00	Session 2 – BIM Technology
13.00 – 13.40	Lunch
13.40 – 15.40	Session 3 – BIM Design Analysis (Green Building Analysis)
15.40 – 15.50	Break
15.50 – 18.00	Session 4 – BIM Design Analysis (Structural Analysis)

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BIM Fundamentals

Presented by :

Jusuf Anggono
jusuf_anggono@bca.gov.sg

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What is BIM ?

- BIM = Building Information Modeling
- BIM is a process
  - From silo-based environment to collaborative and coordinated practice
- Data rich digital model
- Object-based relational database
- Intelligent objects

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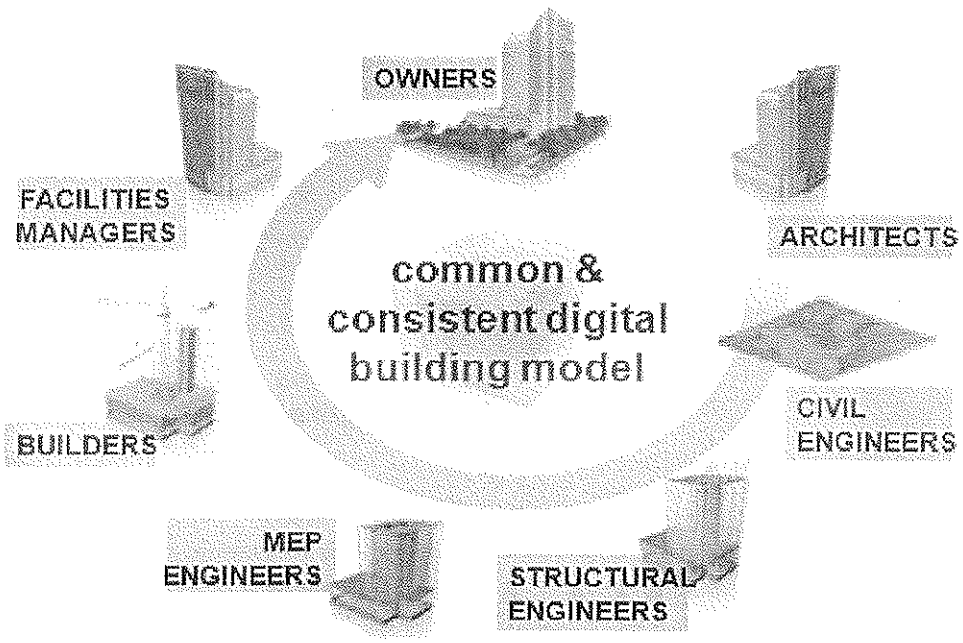
What is BIM ?



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VALUE OF BIM

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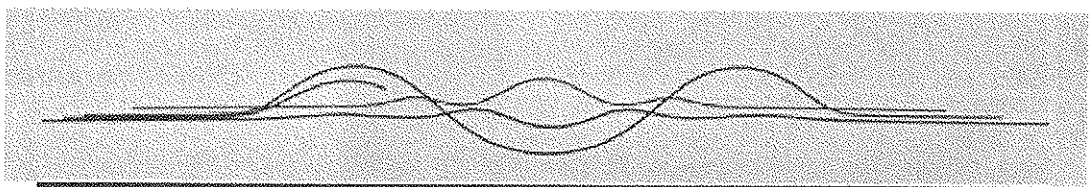
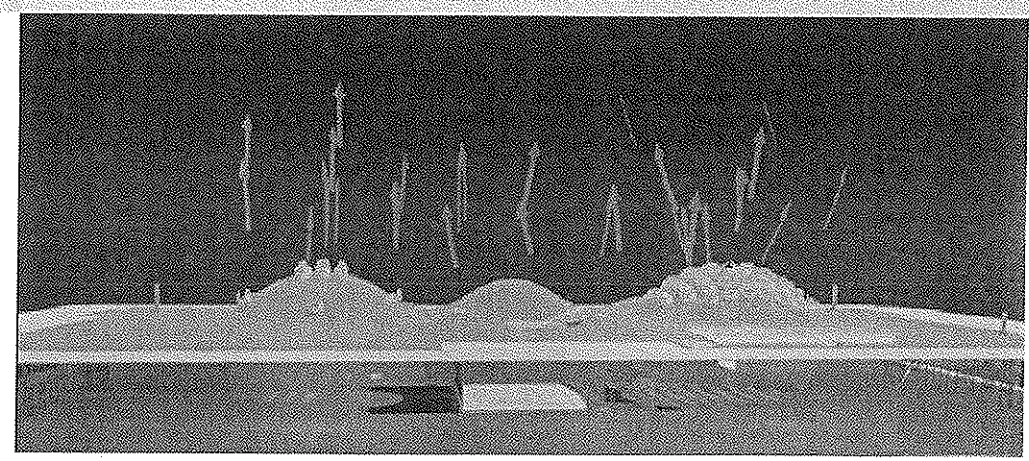
Value of BIM





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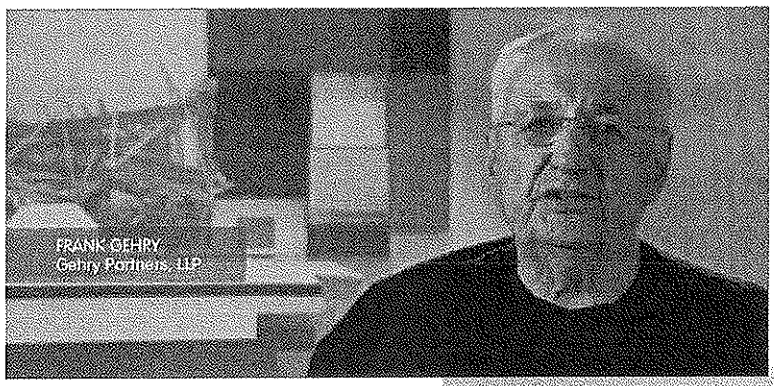
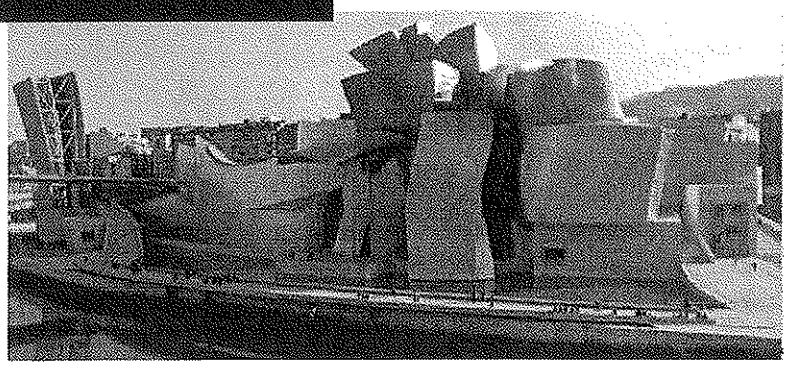
Value of BIM
Architect's Perspective



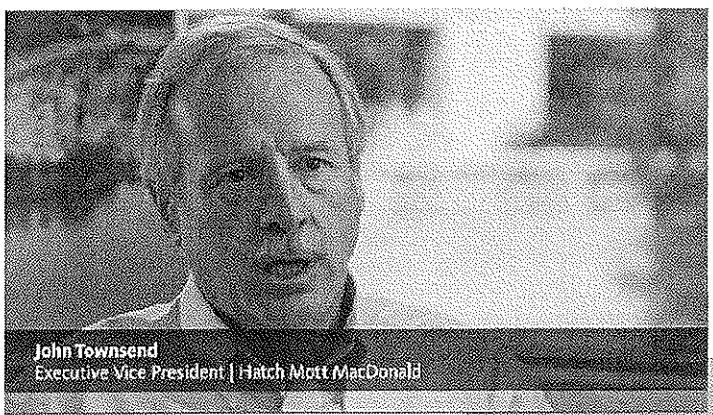
Focus on design



Precision of technology

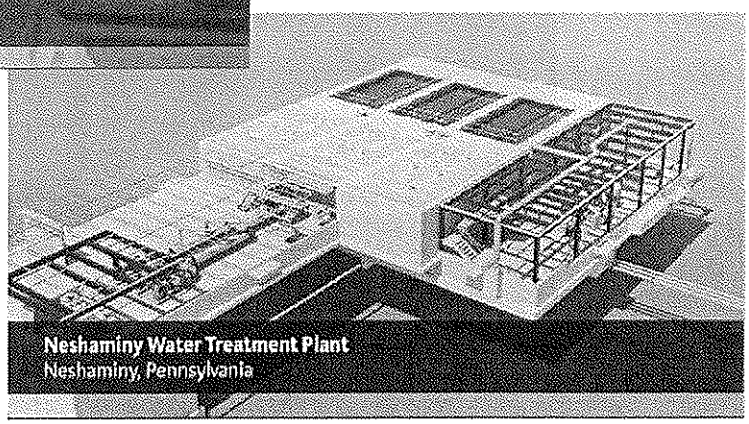
BCA ACADEMY of the built environment

Value of BIM
Engineer's Perspective



Clarify requirements

Explore alternatives



Powerful visual aids

Richness of Information

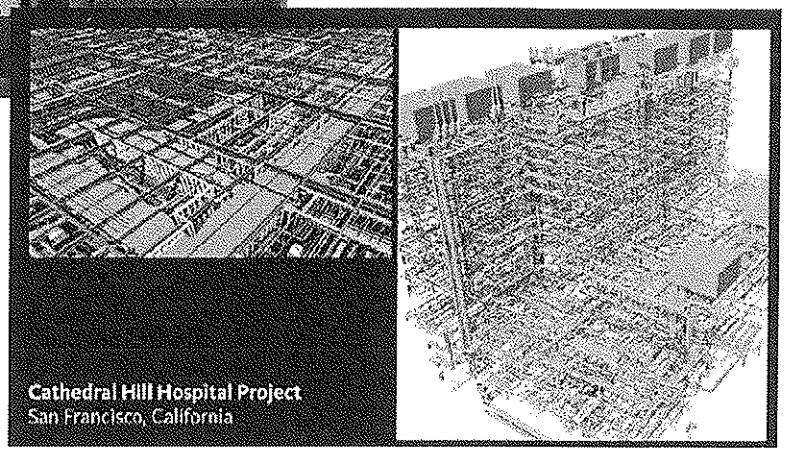
BCA ACADEMY of the built environment

Value of BIM
Project Manager's Perspective



Virtual construction

Resolve conflict, avoid rework



Predictability of technology

Up-to-date information

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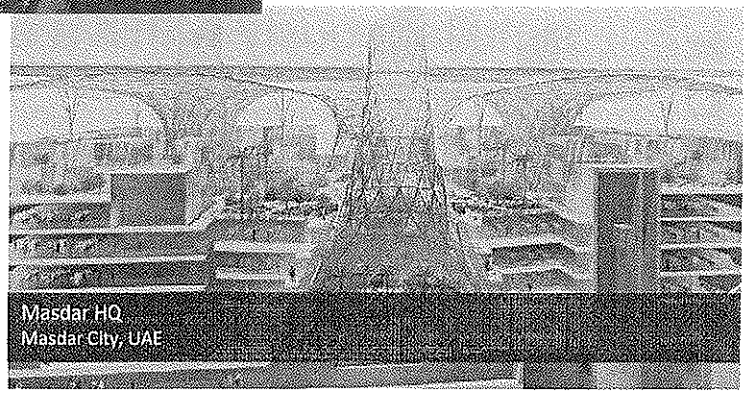
Value of BIM
Team's Perspective



Integrated Solution

Complex simulation



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Value of BIM
Owner

- More informed decisions about the suggested project
- Better design quality
- Better performing building
- Efficient handover (data exchange for O/M)

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Value of BIM
Architects

- Production of well-coordinated documentation
- Allows model checkers to assist with quality control
- Design Analysis (space, lighting, energy, etc)
- Study multiple design alternatives simultaneously within a single model

Value of BIM
Structural Engineers

- Production of well-coordinated documentation
- Integrated modeling, analysis and design can be achieved without splitting up the tasks
- Less costly clashes when examine structural elements and building services before the commencement of the construction

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Value of BIM
M&E Engineers

- Production of well-coordinated documentation
- Accurate bills of materials and cost reports, and schedules
- Clash detection if any items are crossing each other, such as piping and ductwork

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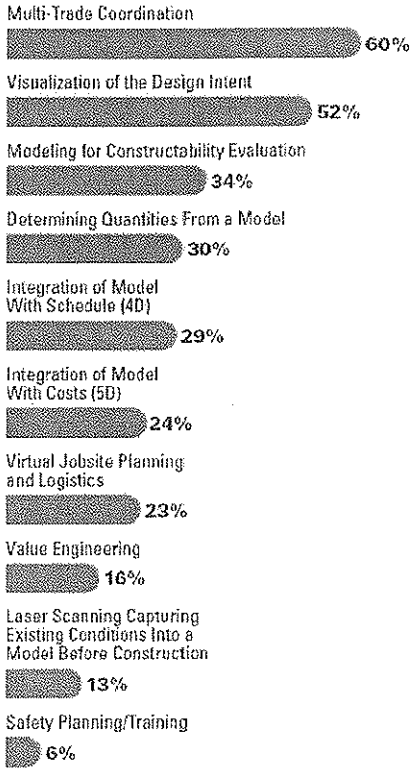
Value of BIM
Contractors

- Percentage of Contractors citing the top three activities for which their organisation leverages BIM during design/pre-construction stage (source: McGraw Hill Construction, 2013)



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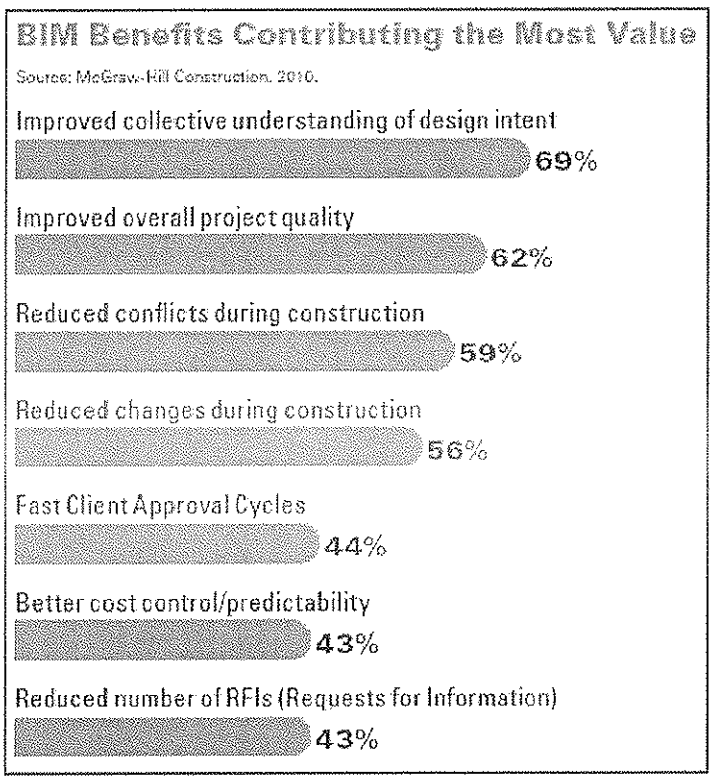
Value of BIM
Most Value



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of the built environment

2D CAD, 3D CAD, AND 3D BIM

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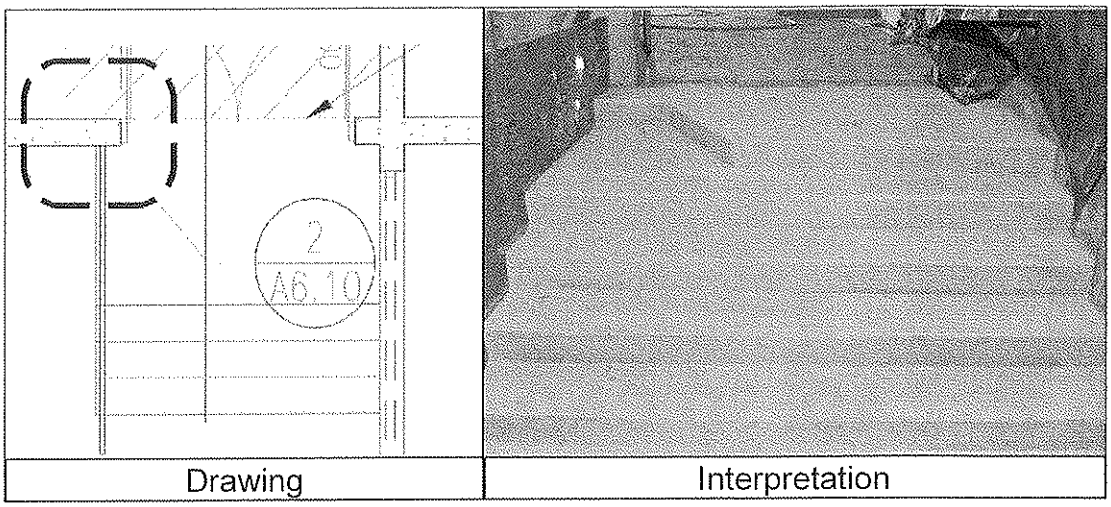
of the built environment

2D (Two-Dimensional)

- Points, Lines, Hatches
- Advantage
  - Standardised
  - Dimensionable
- Disadvantage
  - Replicates manual drafting process
  - Ambiguity of design (requires interpretation)
  - Hard to coordinate among various trades
  - Conflicts detected at construction site, expensive to fix

2D Interpretation



*Source: AGC BIM Education Program

3D (Three-Dimensional)

- Objects that are constructed on three planes (X, Y, and Z)
- Length x Width x Height
- No additional information attached to objects

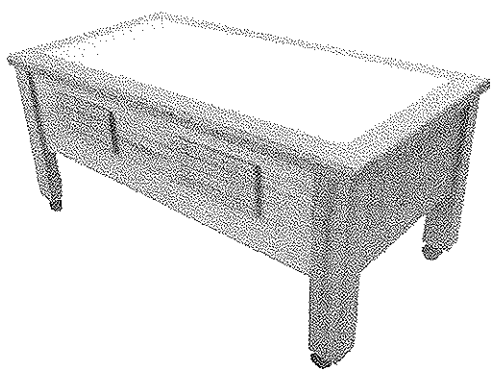
3D (Three-Dimensional) BIM

- Intelligent attributes of all objects (named object)
- Additional information attached to objects
- Floor plans, sections, elevations, and details are derived from BIM model within the same software platform

Evolution of BIM

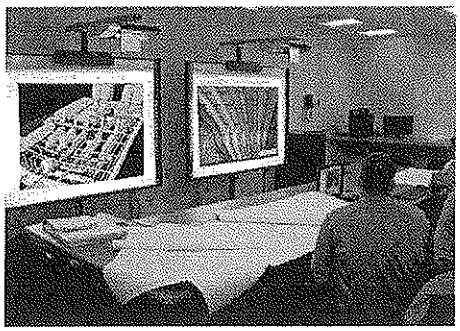
Past

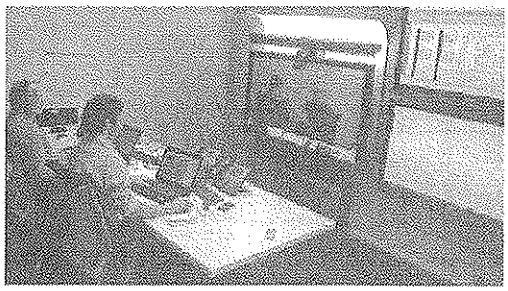
- 2D CAD layers
- 2D Light Tables
  - Time consuming
  - Error prone



Evolution of BIM
Present/Future

- BIM Coordination Room
  - A dedicated room for BIM design review and clash detection/coordination meeting
  - Collaboration meetings using web conferencing (webinar)





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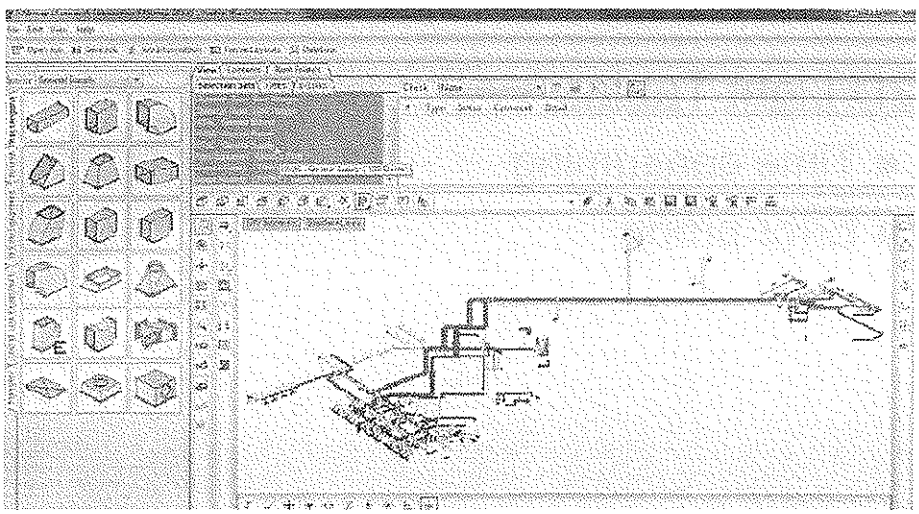
Evolution of BIM
Present/Future

- Digital Fabrication from the model



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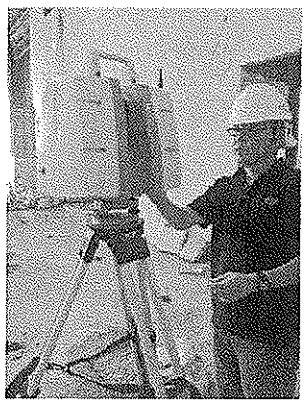
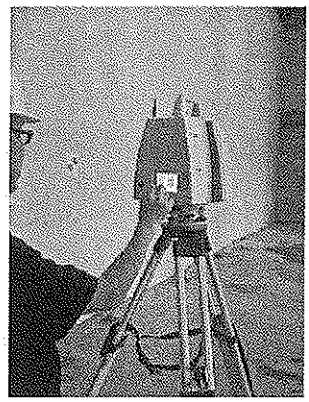
Evolution of BIM
Present/Future

- 3D Imaging Technology (3D Scanner)
  - Capture As-Built condition (e.g. A&A project)
  - As QC tool (BIM Model vs Work-in-progress)





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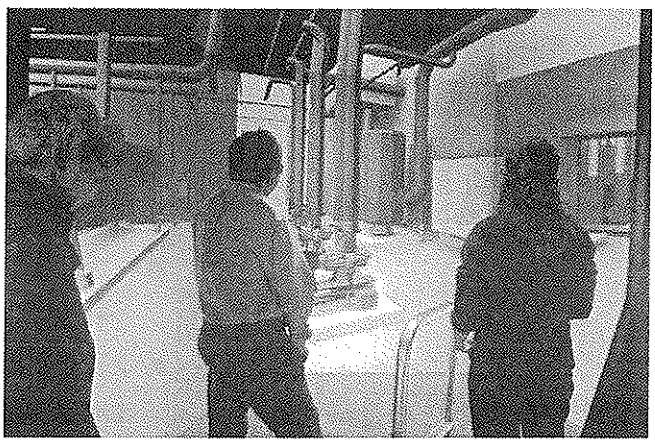
Evolution of BIM
Present/Future

- BIM Cave
  - Portable trailer devoted to BIM



*Source: http://www.tjeg.com/innovation/3d-cave/

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of the built environment

Evolution of BIM
Present/Future

- BIM Augmented Reality



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Typical BIM Process
BIM Usage

- Design Stage
  - Modelling
  - Design Analysis or Simulation
  - Coordination
  - Documentation
  - Presentation
- Operation and Maintenance
  - Space Planning
  - Asset Management
  - Building Operation
- Construction
  - Site Planning
  - Constructability Review
  - Construction Details
  - Coordination
  - Formwork Optimisation
  - Drywall Prefabrication
  - Construction Sequencing (4D)
  - Model-based Cost Estimation (5D)
  - Field BIM

Typical BIM Process
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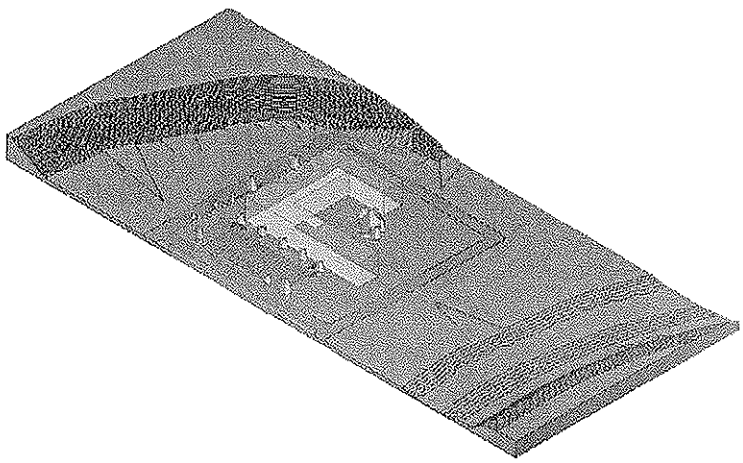
BIM for Consultants
Modelling



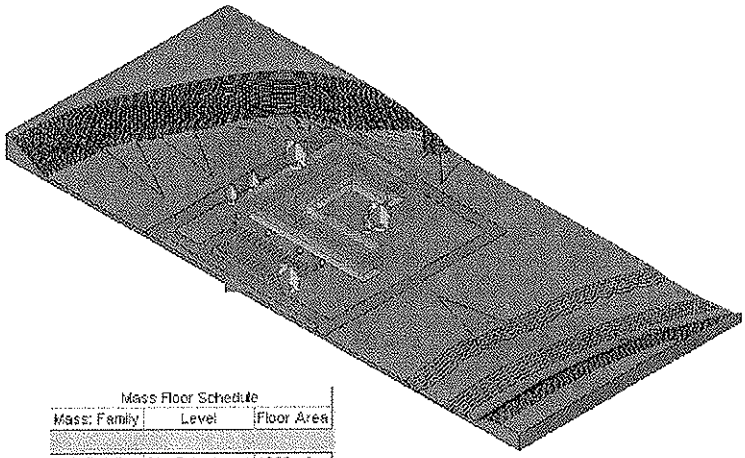
Creating a Toposurface

Creating a Topographic Subregion

Adding a Building Pad and Planting Components

Using Massing Tools

BIM for Consultants
Modelling



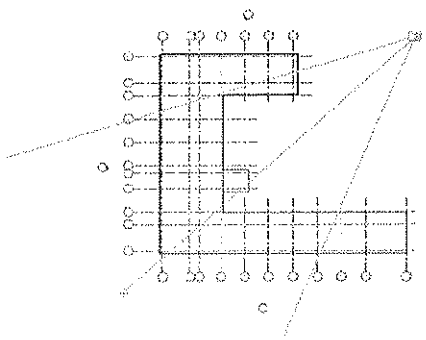
Mass Floor Schedule

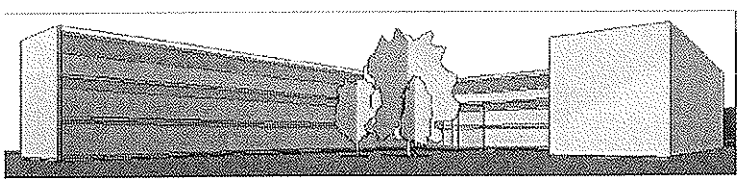
Mass: Family	Level	Floor Area
Main Building	01 - Entry Level	1659 m²
Main Building	02 - Floor	1659 m²
Main Building	03 - Floor	1659 m²
Pavilion	01 - Entry Level	41 m²
		5016 m²

- Creating a Toposurface
- Creating a Topographic Subregion
- Adding a Building Pad and Planting Components
- Using Massing Tools
- Creating Mass Study Analysis

BCA ACADEMY
of the built environment

BIM for Consultants
Modelling





- Creating a Toposurface
- Creating a Topographic Subregion
- Adding a Building Pad and Planting Components
- Using Massing Tools
- Creating Mass Study Analysis
- Creating a Perspective View

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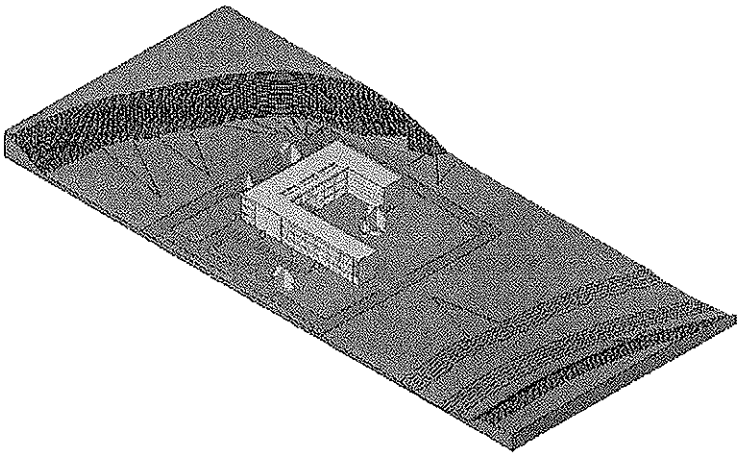
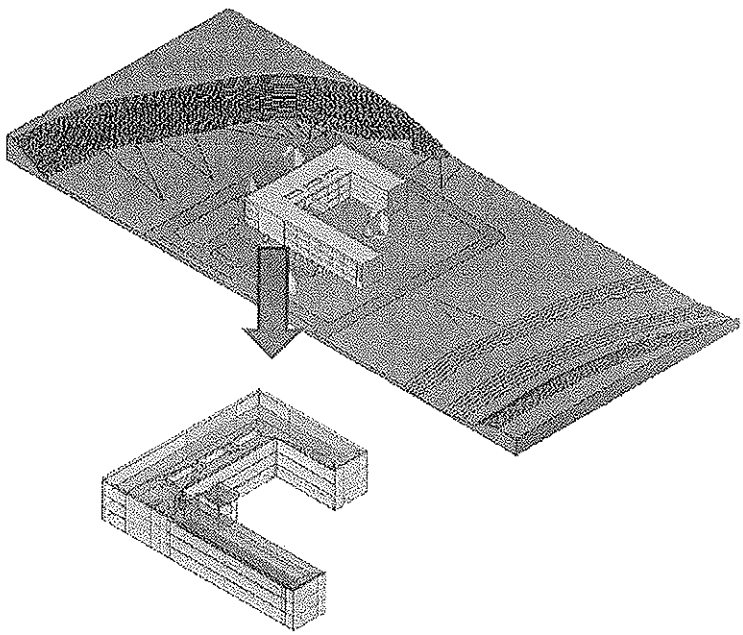
of the built environment

BIM for Consultants
Modelling



Adding Basic Building Elements

BIM for Consultants
Design Analysis

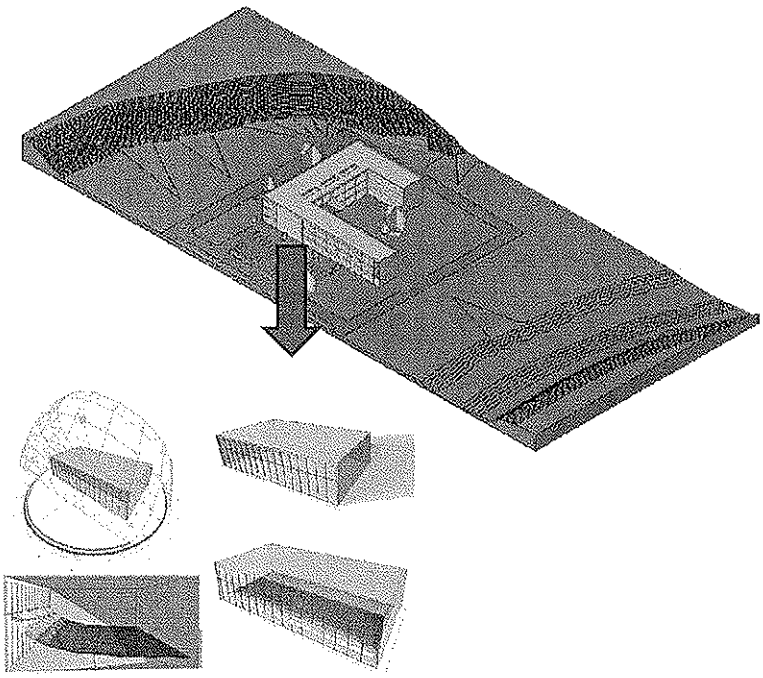


Adding Basic Building Elements

Exporting to gbXML

BCA ACADEMY of the built environment

BIM for Consultants
Design Analysis



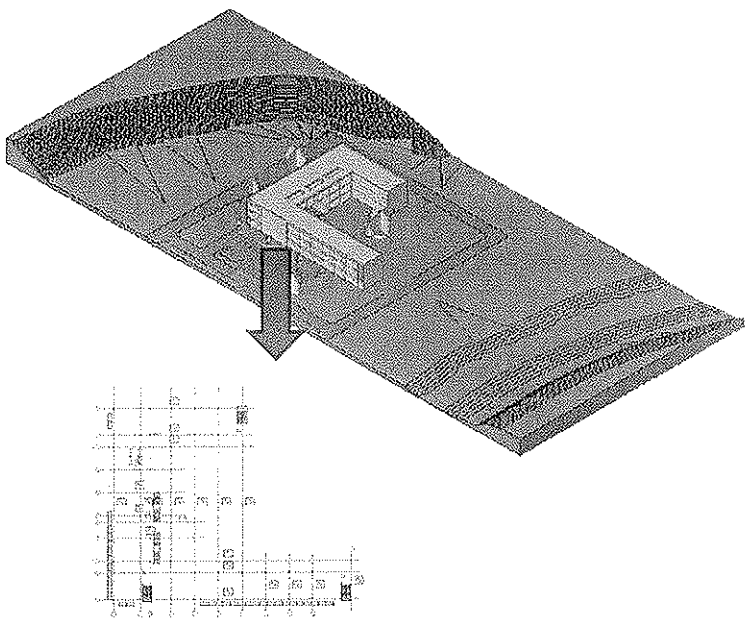
Adding Basic Building Elements

Exporting to gbXML

Performing Energy Analysis

BCA ACADEMY of the built environment

BIM for Consultants
Collaboration



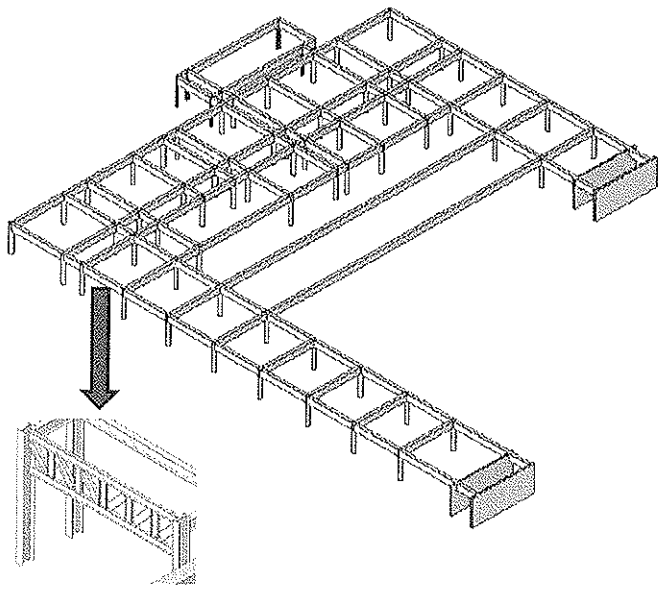
Adding Basic Building Elements

Exporting to gbXML

Performing Energy Analysis

Sharing with Structural and MEP for their Design and Model

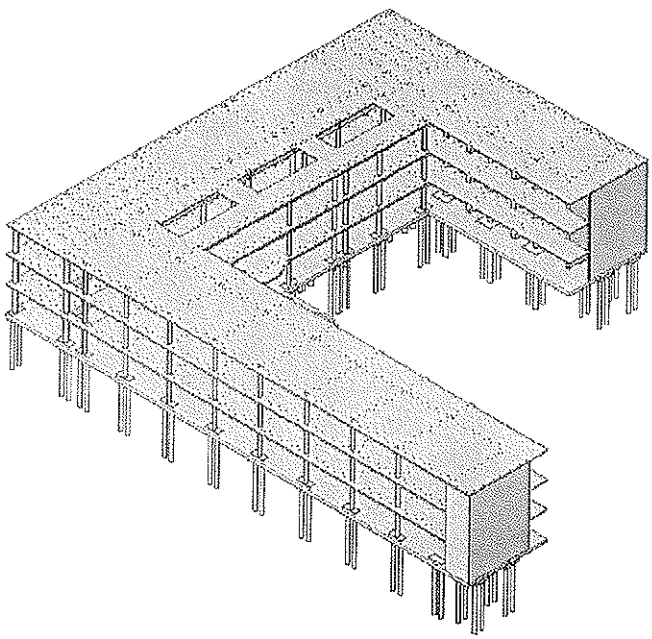
BIM for Consultants
Modelling



Adding Structural Columns, Walls, and Beams

Adding Trusses

BIM for Consultants
Modelling



Adding Structural Columns, Walls, and Beams

Adding Trusses

Adding Structural Slabs

Adding Openings

Adding Structural Foundations

Adding Isolated Foundations

Extending to the Roof Level

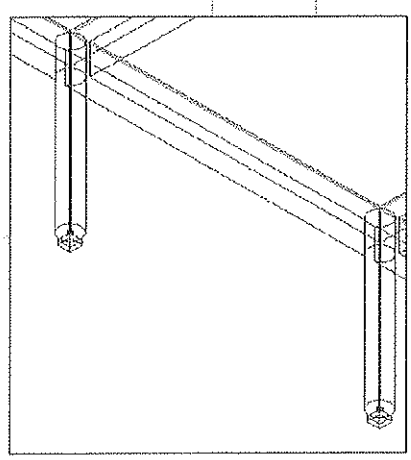
BIM for Consultants
Design Analysis

Load Cases

	Name	Case Number	Nature	Category
1	DL1	1	Dead	Dead Loads
2	LL1	2	Live	Live Loads

Load Combination

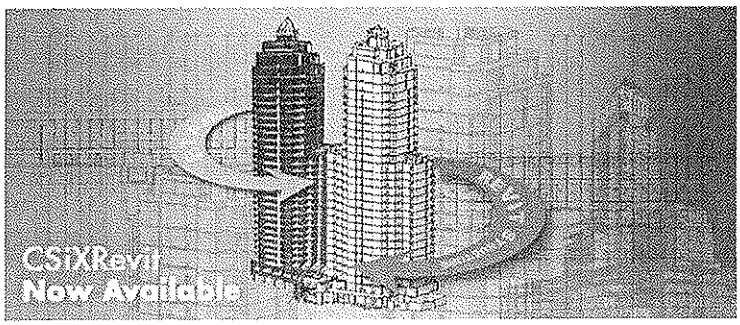
	Name	Formula	Type	State	Usage
		(all)	(all)	(all)	(all)
1	DL+LL	1.4*DL1 + 1.6*LL1	Combination	Serviceabilit	
2	DL+LL+W	1.2*DL1 + 0.5*LL1 + 1.3*WIND1	Envelope	Ultimate	

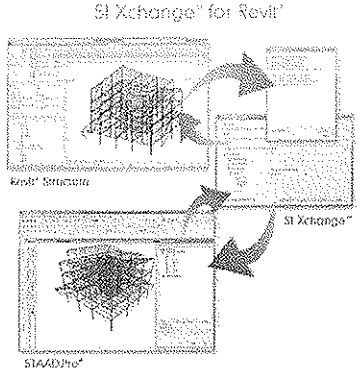


Analysing the Project

BCA ACADEMY
of the built environment

BIM for Consultants
Design Analysis





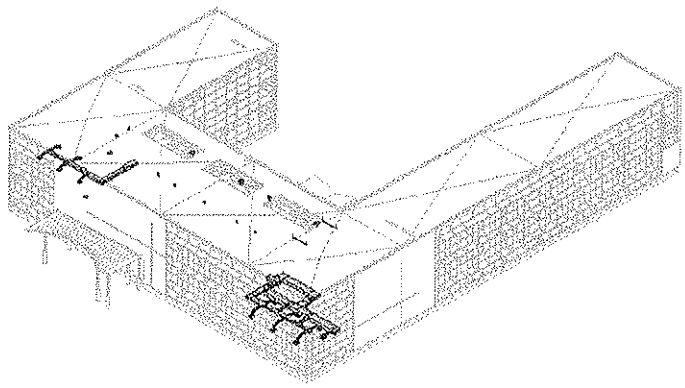
Analysing the Project

Exporting to Analysis Tools

BCA ACADEMY
of the built environment

BIM for Consultants
Modelling

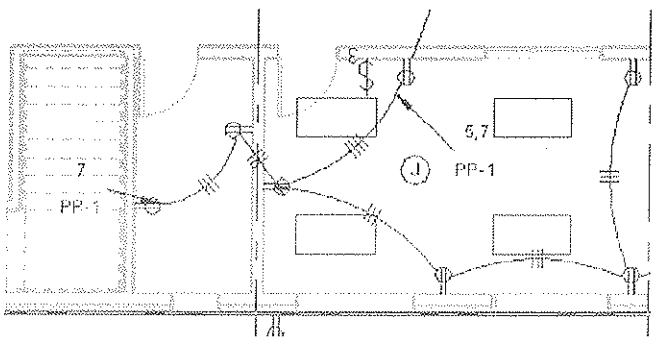
Designing Mechanical Air System



BIM for Consultants
Modelling

Designing Mechanical Air System

Designing Electrical System



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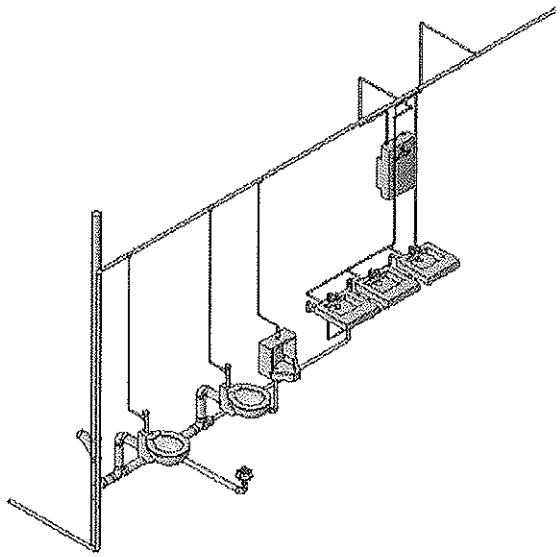
BIM for Consultants
Modelling



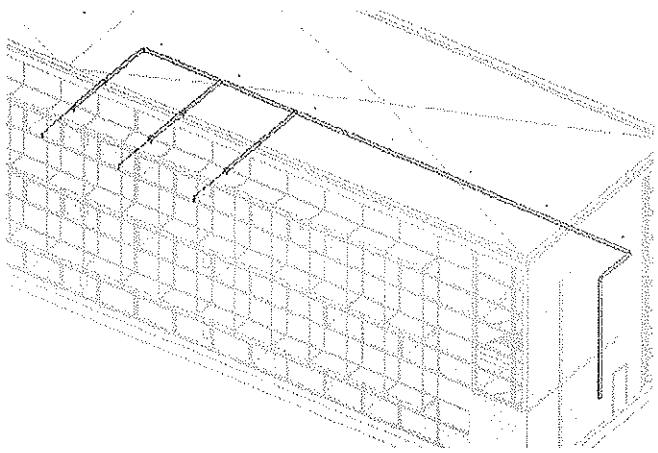
Designing Mechanical Air System

Designing Electrical System

Designing Plumbing System

BCA ACADEMY of the built environment

BIM for Consultants
Modelling



Designing Mechanical Air System

Designing Electrical System

Designing Plumbing System

Designing Fire Protection System

BIM for Consultants
Design Analysis

BIM Model

Analysis Model (Heat Load Calculation, Computational Fluid Dynamics)

Designing Mechanical Air System

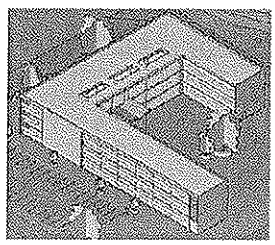
Designing Electrical System

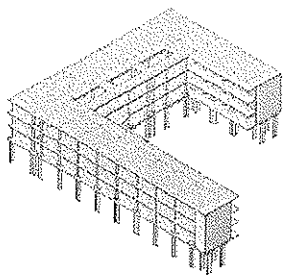
Designing Plumbing System

Designing Fire Protection System

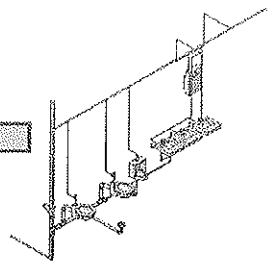
Integrating with Analysis Tools

BIM for Consultants
Coordination



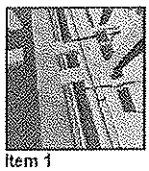


Clash Detection



BIM for Consultants
Coordination

The coordination with an automatic clash detection



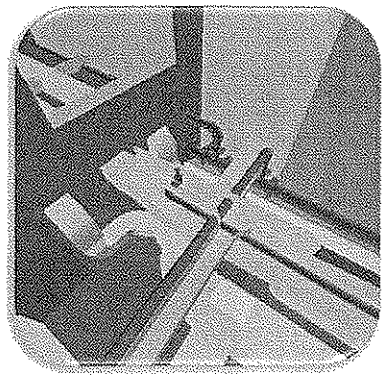
Name	Clash37
Distance	-0.03m
Description	Hard
Status	Active
Clash Point	5.70m, -0.17m, 133.80m
Date Created	2011/4/26 07:29:19

Item 1

Layer	<No level>
Path	File ->File ->FAD.nwc -><No level> ->FAD ->Solid
Item Name	FAD
Item Type	Solid

Item 2

Element ID	1221567
Layer	<No level>
Path	File ->File ->Power D.nwc -><No level> ->Channel Cable Tray ->Solid
Item Name	Channel Cable Tray
Item Type	Solid



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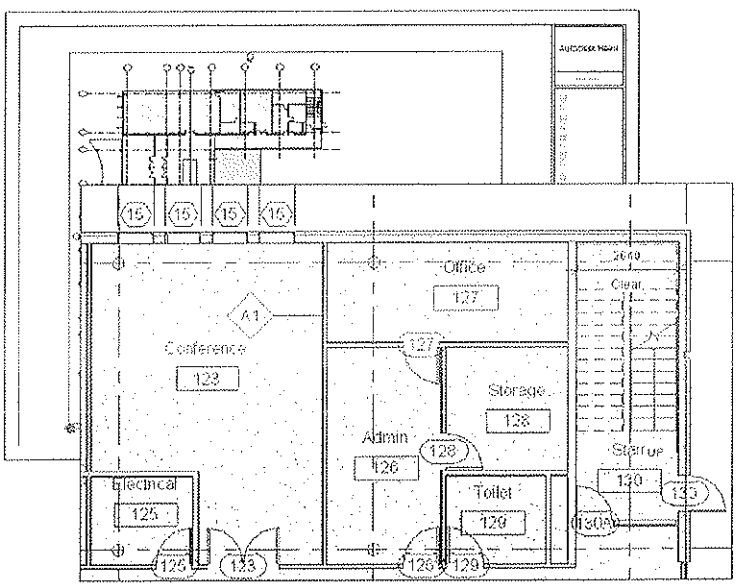
BIM for Consultants
Documentation



Adding Views and Sheets

Annotating, Dimensioning and Tagging

BIM for Consultants
Documentation

Door Schedule

Door #	Size		Operation	Frame		Fire Rating	Comments
	Width	Height		Type	Material		
101A	1830	2134					
101B	1830	2134					
101C	1830	2134					
101D	1830	2134					
103	915	2134					
104A	915	2134					
104B	915	2134					
105A	915	2134					
105B	915	2134					
106A	915	2134					
106B							
108A							
108B							
109							
110							
111							
112							
114							

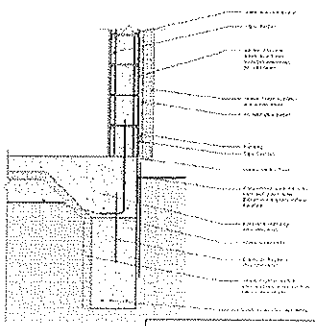
02 Floor - Room Finish Schedule

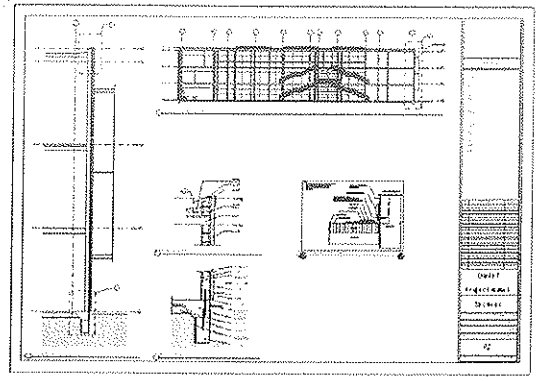
Number	Name	Finishes				Area	Comments
		Base	Floor	Wall	Ceiling		
201	Stair					19 m²	
202	Instruction					31 m²	
203	Computer Lab					32 m²	
204	Instruction					48 m²	
205	Instruction					32 m²	
206	Lounge					32 m²	
207	Copy/Print					32 m²	
208	Drafting					48 m²	
209	Computer Lab					73 m²	
210	Men					13 m²	

- Adding Views and Sheets
- Annotating, Dimensioning and Tagging
- Schedules

BCA ACADEMY
by the building and construction authority

BIM for Consultants
Documentation



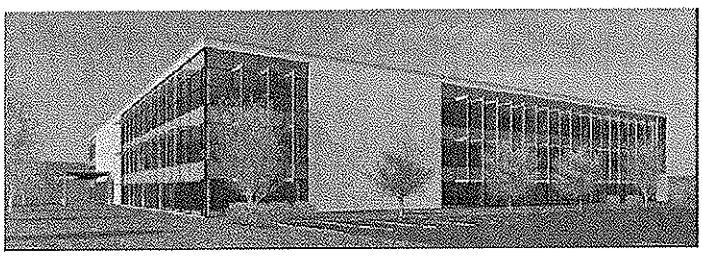


- Adding Views and Sheets
- Annotating, Dimensioning and Tagging
- Schedules
- Detailing

(NOTE: TO KEEP DETAILS TO A MINIMUM AS FILE SIZE WILL INCREASE)

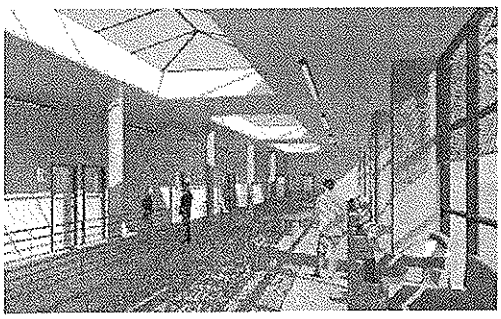
BCA ACADEMY
of the built environment

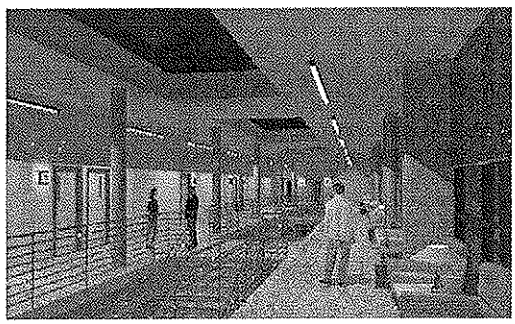
BIM for Consultants
Presentation



Rendering Exterior

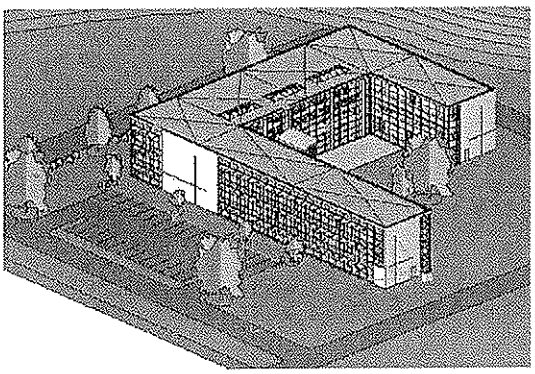
Rendering Interior





BCA ACADEMY
of the built environment

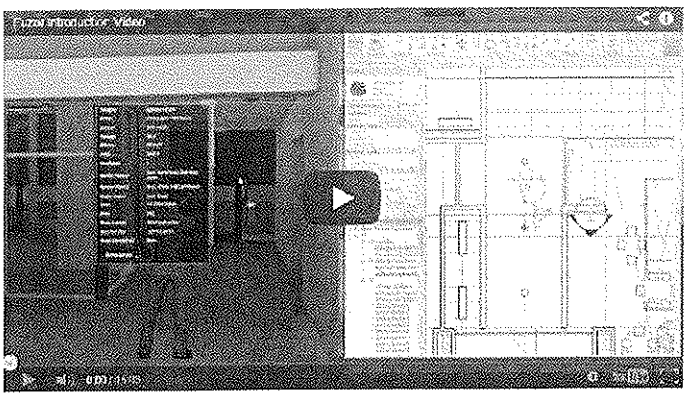
BIM for Consultants
Presentation



Rendering Exterior

Rendering Interior

Walkthroughs

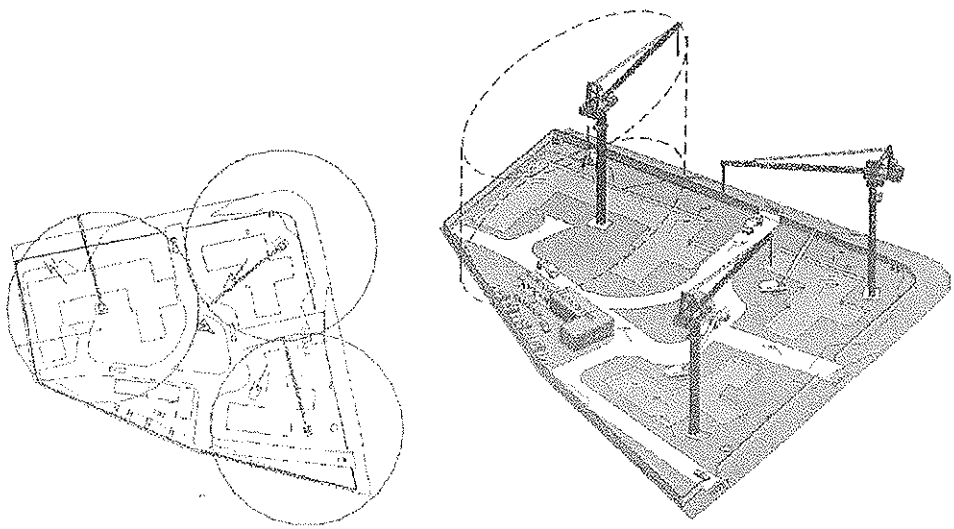


BIM Visual Simulation Software

Typical BIM Process
BIM Usage

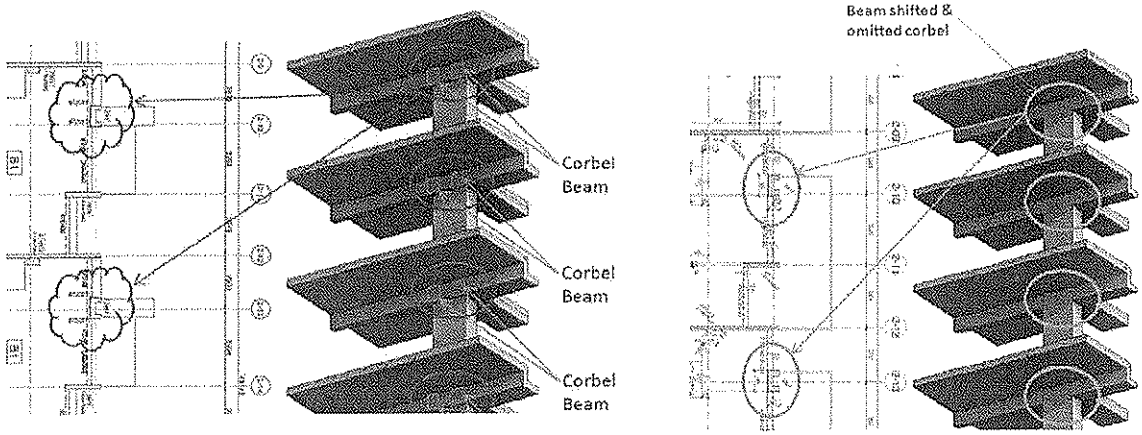
- Design Stage
  - Modelling
  - Design Analysis or Simulation
  - Coordination
  - Documentation
  - Presentation
- Operation and Maintenance
  - Space Planning
  - Asset Management
  - Building Operation
- Construction
  - Site Planning
  - Constructability Review
  - Construction Details
  - Coordination
  - Formwork Optimisation
  - Drywall Prefabrication
  - Construction Sequencing (4D)
  - Model-based Cost Estimation (5D)
  - Field BIM

BIM for Contractors
Site Planning



Plan locations of Tower Cranes
(Source: BIM Essential Guide for Contractors)

BIM for Contractors
Constructability Review



Contractor proposed design alternatives to ease the construction process - Image courtesy of Woh Hup Pte. Ltd
(fSource: BIM Essential Guide for Contractors)

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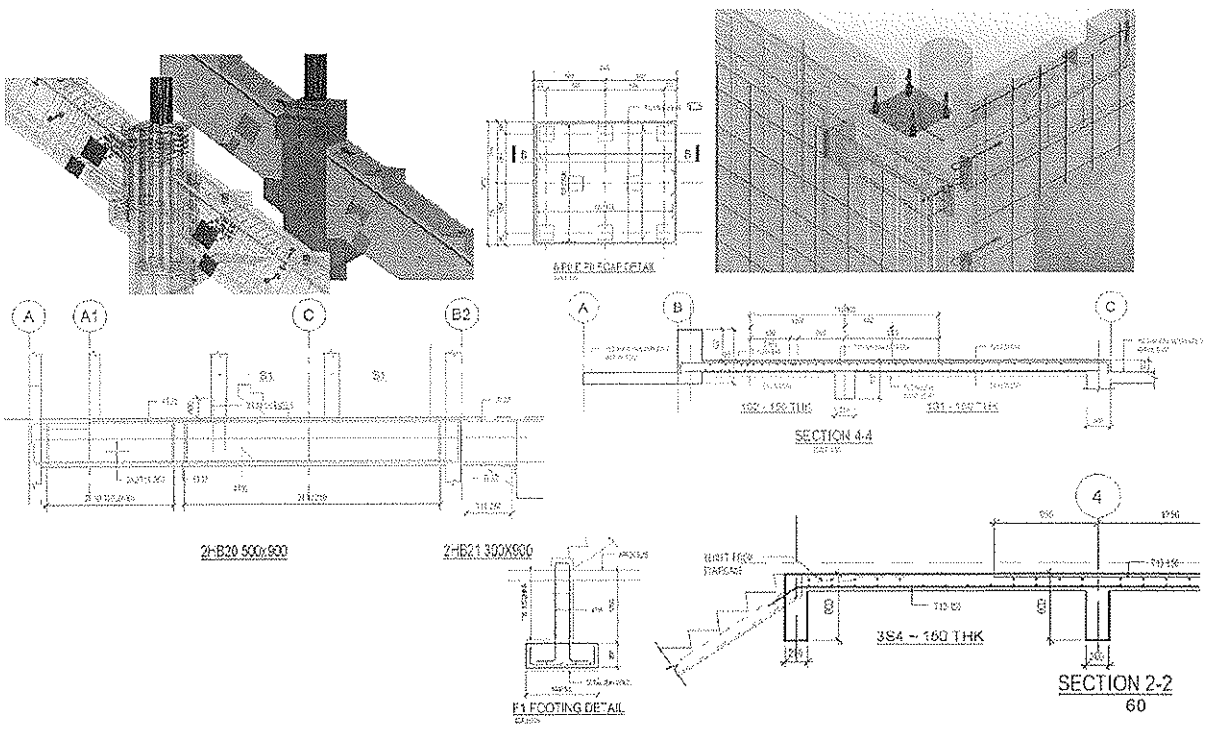
BIM for Contractors
Construction Details



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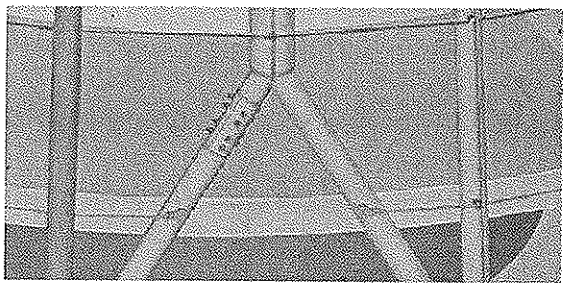
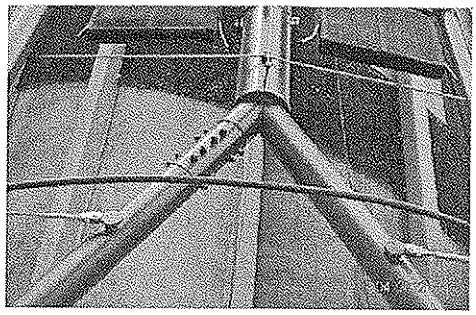
BIM for Contractors
Construction Details





TTJ used Tekla to generate the shop drawings for fabricating every steel part needed and the joints, right down to the bolts – Supertrees at Gardens by the Bay (Source: http://www.ies.org.sg/publication/se/oct13.pdf)

BCA ACADEMY of the built environment

BIM for Contractors
Coordination

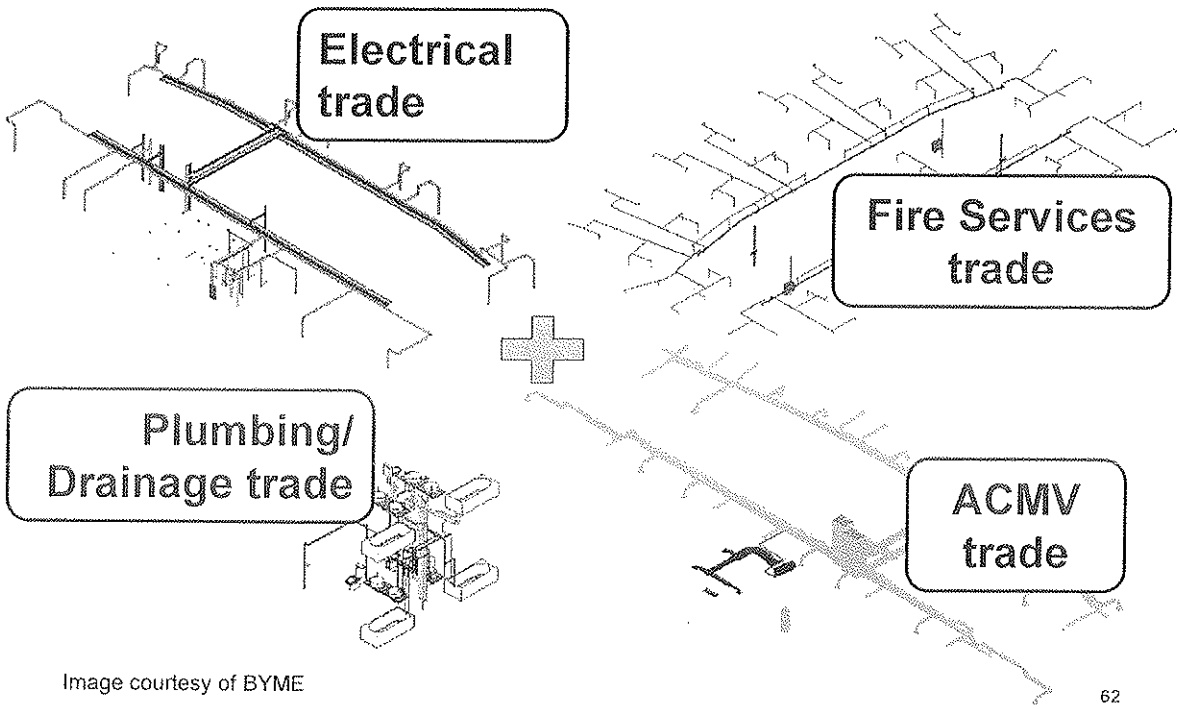


Image courtesy of BYME

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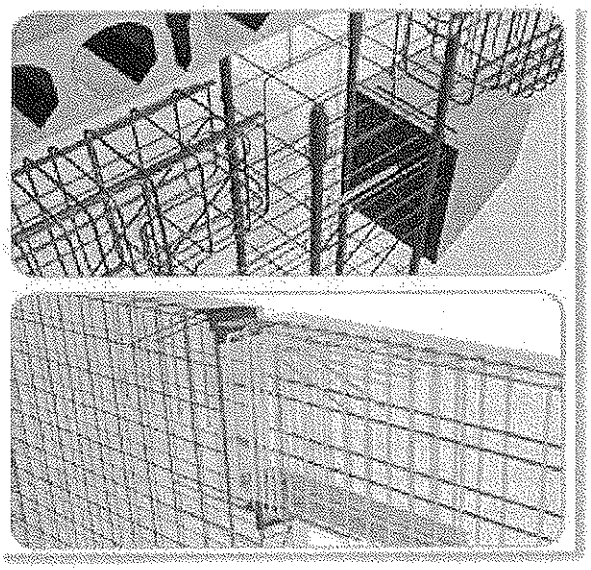
BIM for Contractors
Coordination



Prefabrication

Model-based Rebar Coordination

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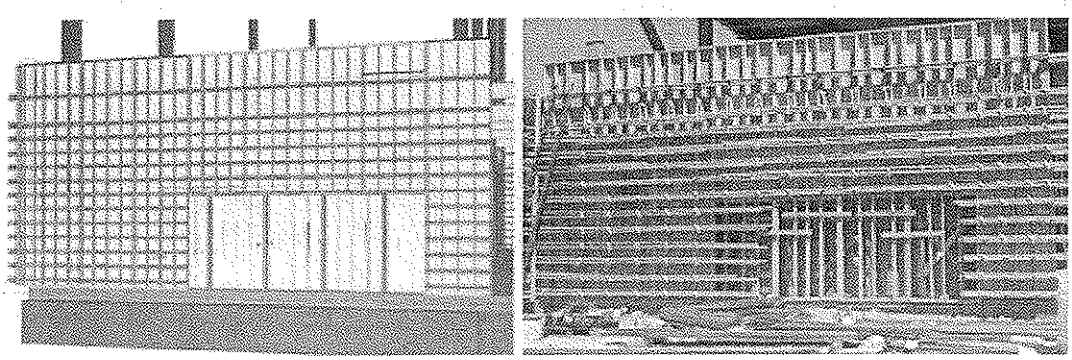
BIM for Contractors
Formwork Optimisation



Formwork Optimisation
(Source: http://www.tekla.com/references/formwork-modeling-dpr-construction)

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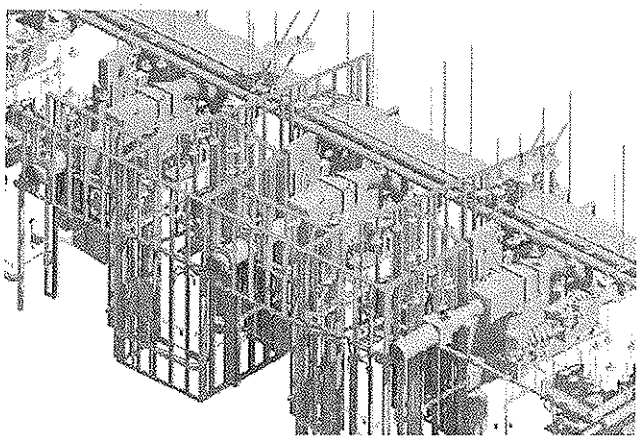
BIM for Contractors
Drywall Prefabrication

- Benefit of modelling drywall:
  - Virtual mockups is faster and less expensive than building live mockups
  - Help to resolve potential requests for information (RFIs) during pre-construction
  - Use the model for estimating and quantity trending



Multiple combinations of heights, lengths and sizes were tested using modeled conditions as a guide prior to erecting a material mockup (Source: http://www.dpr.com/assets/docs/technical-papers/2010_Drywall%20Modeling.pdf)

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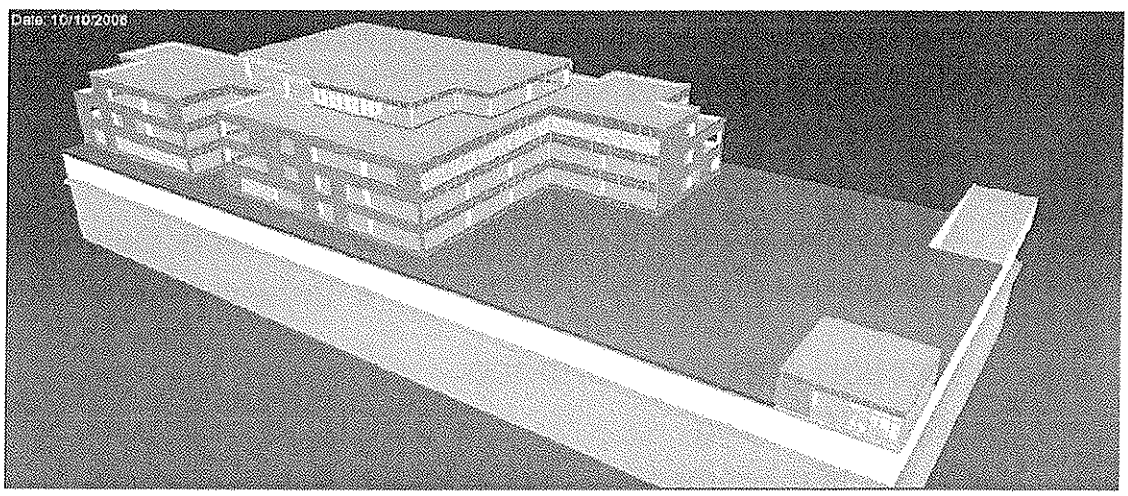
BIM for Contractors
4D & 5D

4D = Bim + Time
5D = Bim + Cost + Time = 4D + Cost



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of the built environment

BIM for Contractors

Field BIM



BIM → Field → BIM
(Source: http://www.youtube.com/watch?v=QGOVitzA-QU)

LBMS : LOCATION BASE MGMNT SYSTEMS.

Typical BIM Process

BIM Usage

- Design Stage
  - Modelling
  - Design Analysis or Simulation
  - Coordination
  - Documentation
  - Presentation
- Operation and Maintenance
  - Space Planning
  - Asset Management
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- Construction
  - Site Planning
  - Constructability Review
  - Construction Details
  - Coordination
  - Formwork Optimisation
  - Drywall Prefabrication
  - Construction Sequencing (4D)
  - Model-based Cost Estimation (5D)
  - Field BIM

BIM for FM

Space Management, Maintenance, etc

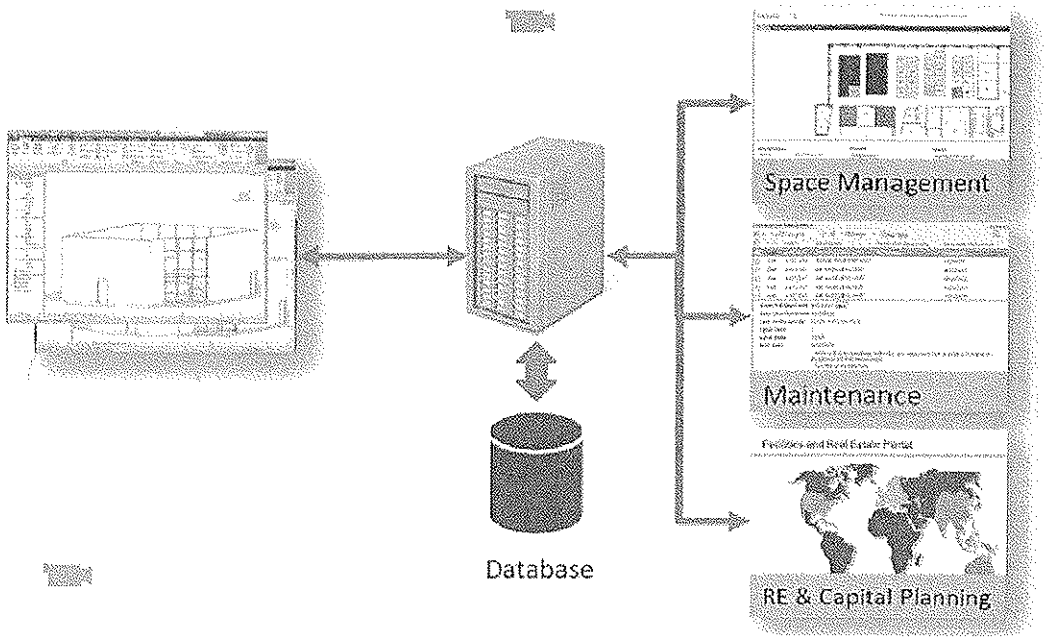

Image courtesy of FM:Systems

* BIM FM - COMPULSORY FOR CONSTRUCTABILITY FOR SUBMISSIONS IN CORE.

BIM Technology

Presented by :

Jusuf Anggono
jusuf_anggono@bca.gov.sg

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BIM TOOLS

BCA ACADEMY of the built environment

BIM Tools

- Authoring tools
- Analysis tools
- Coordination tools
- Model review tools
- Model Quantity Takeoff tools
- File sharing tools
- Facility Management tools

BIM Tools

- Authoring tools:
  - Create the actual model
  - Populate the model with data
  - Users: designers, 2D to 3D conversion teams, subcontractors
  - When: schematic design phase to construction documents

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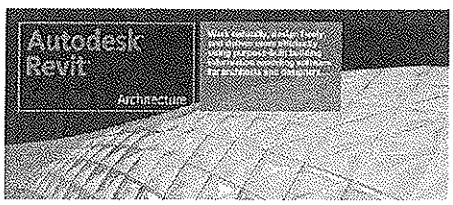
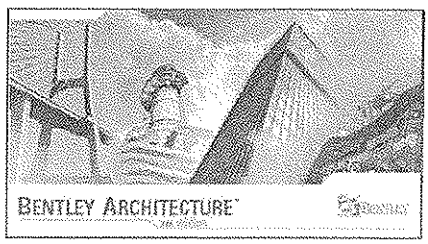
of the built environment

BIM Tools

- Authoring tools examples (Architecture)

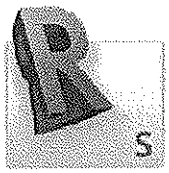


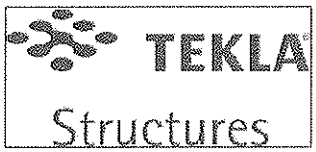


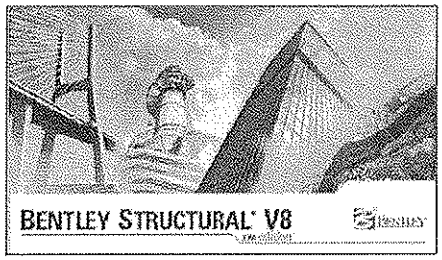
GRAPHISOFT
ARCHICAD 15

BIM Tools

- Authoring tools examples (Structure)







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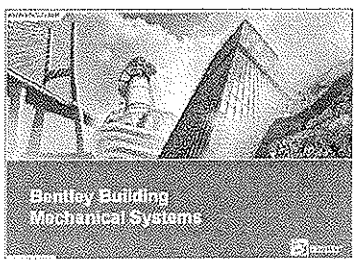
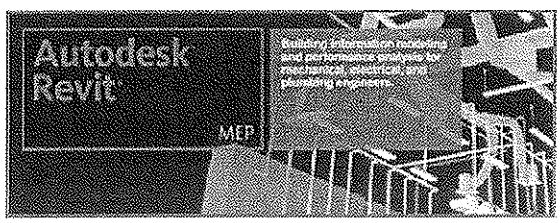
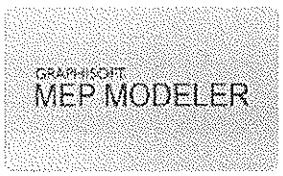
of the built environment

BIM Tools

- Authoring tools examples (MEP)







BIM Tools

- Analysis tools:
  - Analyse and predicting model behavior
  - Validate model compliance with standards/codes
  - Users: designers, consultants
  - When: all phases

BCA ACADEMY

BIM Tools

- Analysis tools examples

SOLIBRI





ies INTEGRATED ENVIRONMENTAL SOLUTIONS

ENERGY TOOLS

FLUENT

CSC

STRUCTURAL TOOLS

ETABS

STAAD.Pro

BCA ACADEMY

BIM Tools

- Coordination tools:
  - Perform clash detection analysis
  - Visualize the assembly of the building based on scheduling input
  - Users: designers, general contractors/construction managers
  - When: design phase to construction phase

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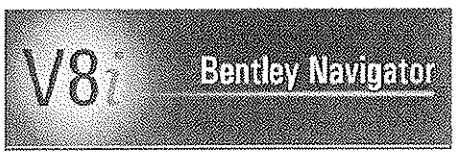
BIM Tools

- Coordination tools examples





TEKLA BIMSIGHT (FREE SOFTWARE)
PERMIT : IFC.

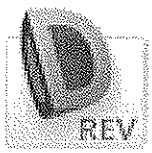
BIM Tools

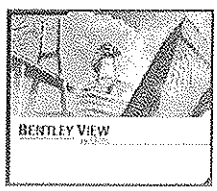
- Model Review tools:
  - Understand and evaluate model content
  - Users: owners, designers, consultants
  - When: schematic design phase to construction phase

BCA ACADEMY
Building Excellence

BIM Tools

- Model Review tools examples





BCA ACADEMY
Building Excellence

BCA ACADEMY
of the built environment

BIM Tools

- Model Quantity Takeoff tools:
  - Extract quantities automatically the design files
  - Users: designer, QS engineer
  - When: schematic phase to construction phase

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of the built environment

BIM Tools

- Model Quantity Takeoff tools examples

cost

RIB

nomicon

VICO SOFTWARE

BIM Tools

- File Sharing tools:
  - Archive files, view or review files
  - Model transfer
  - Users: all
  - When: all phases

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BIM Tools

- File Sharing tools examples

(BENTLY)
PROJECTWISE V8
XM edition

FTP

Microsoft Office
SharePoint

Newforma.
PROJECT INFORMATION MANAGEMENT

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for the built environment

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of the built environment

BIM Tools

- Facility Management tools:
  - Space management, strategic planning, asset management, facility maintenance, etc
  - Users: owners, facility managers, operators
  - When: after construction phase

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of the built environment

BIM Tools

- Facility Management tools examples

FM:Systems

ARCHIBUS



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BIM FILE FORMATS

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BIM File Formats

- One tool does not fit all
- Different software vendors come with different file formats
- Some considerations:
  - Open or proprietary
  - Compatible applications

BIM File Formats

- Open file format:
  - IFC (Industry Foundation Classes)
- Proprietary file formats:
  - RVT (Revit)
  - DGN (Bentley)
  - PLN (ArchiCAD)
- Lightweight file formats:
  - DWF
  - 3D PDF

} INTERMEDIATE FOR 3D-SHARE.

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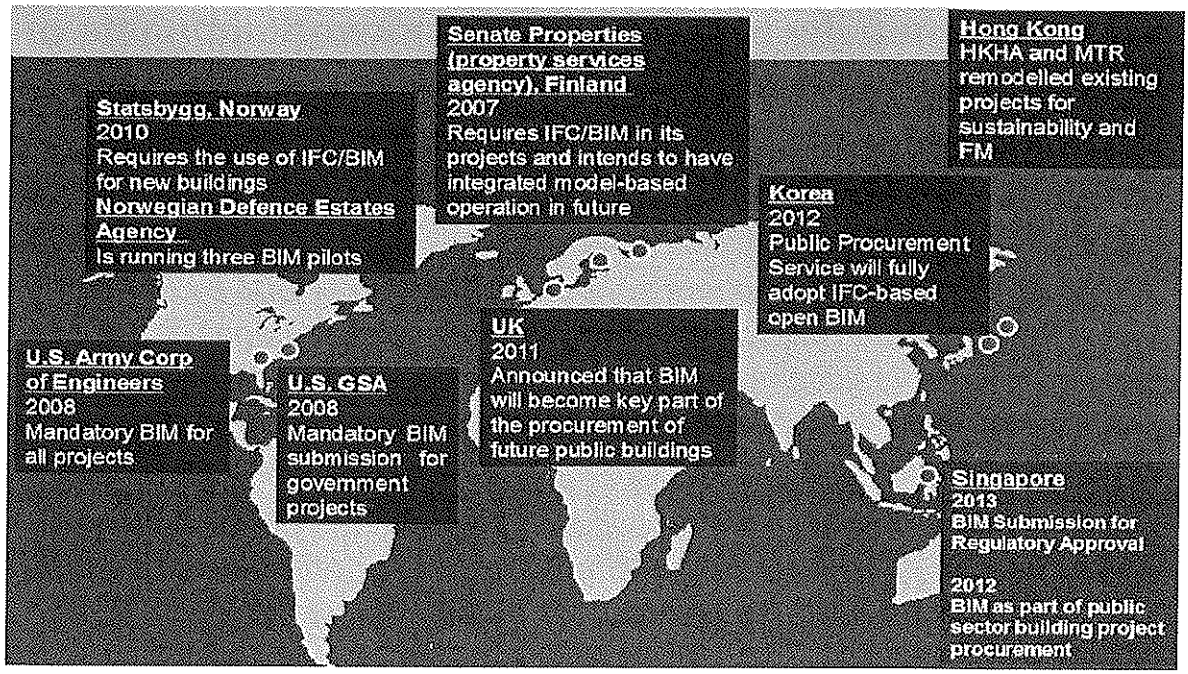
BIM ADOPTION WORLDWIDE AND SINGAPORE

BIM Adoption Worldwide



BIM Adoption Worldwide

Advancing the Competitiveness and Efficiency of US Construction Industry

(study by the US National Institute of Standards and Technology in 2009)

BIM has been identified as one of five interrelated activities that could result in breakthrough improvements in the capital facilities sector of the construction industry in the next 2 to 10 years

BIM Adoption Worldwide

Productivity in the buildings network: impacts of Building Information Models

(study by the Australia Built Environment Industry & Innovation Council – BEIIC in Oct 2010)

Concerted government support for the use of BIM by the notoriously fragmented Buildings Network could increase usage in 2025 by 6-16%. This accelerated rate of BIM adoption would produce an economic benefit equivalent to $5 billion added to Australia's GDP

Widespread use of BIM will also increase the performance of buildings in: material consumption; energy efficiency; carbon emissions; and the productivity of the occupants

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BIM Adoption Worldwide

UK Strategy Paper for Government Construction Client Group

(report by UK BIM Industry Working Group in March 2011)

The Cabinet Office will co-ordinate Government's drive to the development of standards enabling all members of the supply chain to work collaboratively through BIM

This will be a phased process working closely with industry groups, in order to allow time for industry to prepare for the development of new standards and for training

Government will require fully collaborative BIM level 2 (with all project and asset information, documentation and data being electronic) as a minimum by 2016

BIM Adoption Worldwide

Commonalities in the Various National Initiatives:

Set deadline for mandatory use of BIM
implementing in stages based on project size and complexity

Specify client's requirement guidelines
to define goals, work processes and expected output to guide the project team in collaborative manner.

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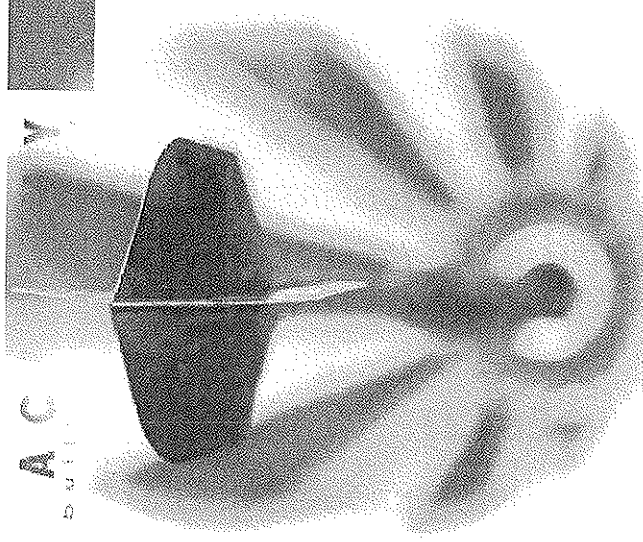
BIM Adoption in Singapore



Local Construction Industry to Use BIM Widely by 2015

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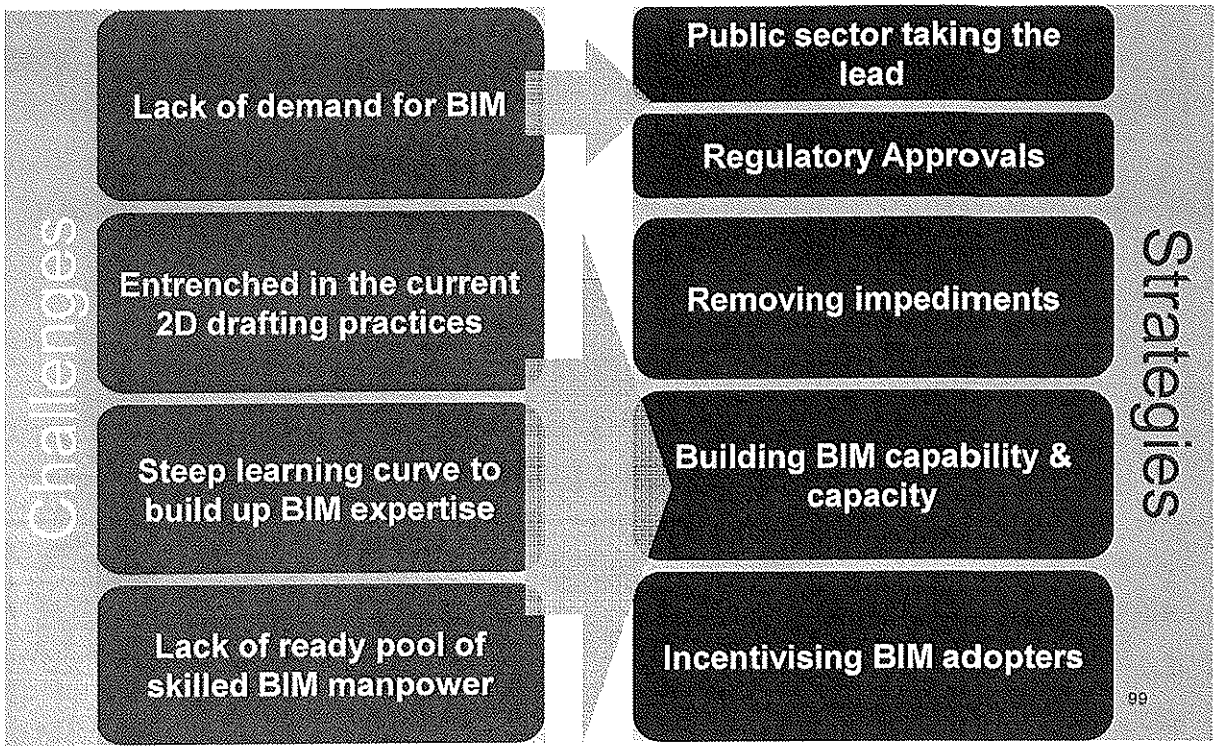
Singapore BIM Roadmap



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Singapore BIM Roadmap
Public Sector Taking The Lead

1st Advisory Notes (11 Aug 2011)

To draw on collective effort of all Government Procurement Entities (GPEs) to work towards stipulating BIM for new public sector building projects with estimated contract value > $10 million

2nd advisory Note (June 2012)

To provide clarity and certainty when stipulating BIM by referring to BIM Requirements & BIM Particular Conditions

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for the built environment

Singapore BIM Roadmap
Public Sector Taking The Lead

- The following Government Procurement Entities (GPE) have started requesting for BIM in their projects:
  - *MOE*
  - *BCA*
  - *WDA*
  - *PA*
  - *PUB*
  - *CAG*
  - *LTA*
  - *Singapore Custom*
  - *HDB*
  - *JTC*
  - *NUS*

Private Sector:
- *CDL*
- *CapitaLand*
- *WingTai*
- *GuocoLand*

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Singapore BIM Roadmap
Regulatory Approvals

July 2013	Mandatory Architecture BIM e-Submissions for all new building projects > 20,000 m^2
July 2014	Mandatory Engineering BIM e-Submissions for all new building projects > 20,000 m^2
July 2015	Mandatory Architecture & Engineering BIM e-Submissions for all new building projects > 5,000 m^2

Singapore BIM Roadmap
Regulatory Approvals

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25 JANUARY 2010 → 1 APRIL 2011

Architectural BIM e-Submission
(BCA, URA, FSSD, CBPU, PUB, LTA, NParks, HDB, JTC)

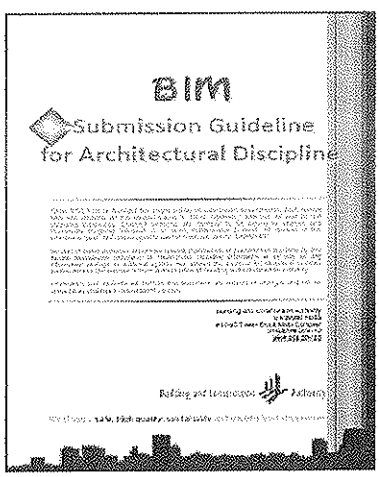
Structural BIM e-Submission
(BCA)

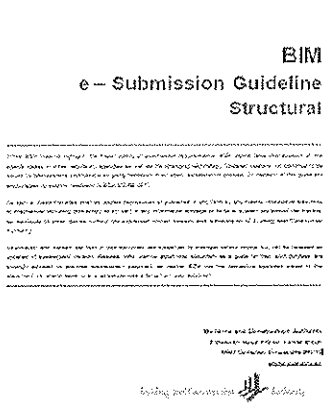
MEP BIM e-Submission
(FSSD, CBPU, PUB, IDA, CITYGAS)

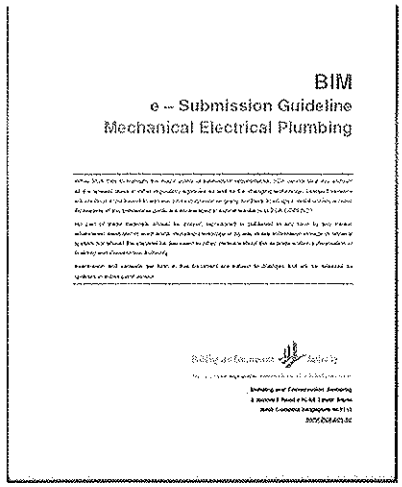
Singapore BIM Roadmap
Regulatory Approvals

BCA ACADEMY of the built environment

- Guideline: BIM e-submission Guidelines (Archi, Structure, MEP)
- Purpose: applications for regulatory approval
- Intended users: QPs and regulatory agencies
- Content: BIM model for regulatory compliance







Singapore BIM Roadmap
Removing Impediments



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Singapore BIM Roadmap
BIM Steering Committee

- Objective: To provide strategic direction and guidance on the development of local BIM standards and supporting resources
- Chairman/Deputy-Chairmen:
  - Mr Lee Chuan Seng, BCA Deputy CM
  - Mr Lam Siew Wah, BCA , DCID
  - Mr Lai Huen Poh, BCA Board Member
- Members:
  - Council members of SIA, IES, ACES, REDAS, SCAL, SISV and BuildingSmart Singapore
  - Government Procurement Entities Rep
  - Regulatory Agencies' Rep

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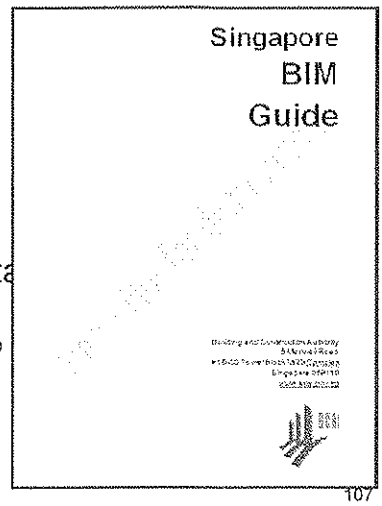
Singapore BIM Roadmap
Client's Requirement WG

- Objective : To spearhead the development of BIM guidelines that capture client's requirements for typical types of construction projects
- Co-Chair:
  - REDAS Rep
  - HDB Rep
- Members:
  - Private Developer (WingTai, CDL, Capita
  - Government Procurement Entities (LTA,
- Deliverable: Singapore BIM Guide



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Singapore BIM Roadmap
Legal and Contractual WG

- Objective : To provide strategic direction and guidance on the development of local BIM legal and contractual framework
- Chairman:
  - Mr Lee Chuan Seng, BCA Deputy CM
- Members:
  - Council members of SIA, IES, ACES, REDAS, SCAL, SISV and BuildingSmart Singapore
  - Government Procurement Entities Rep
  - Partner, Rodyk & Davidson LLP Rep
- Deliverable: BIM Legal and Contractual Guide

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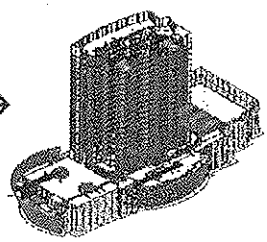
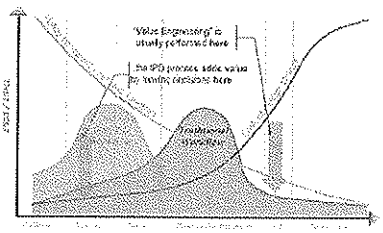
Singapore BIM Roadmap
Legal and Contractual WG

2D →



BIM Addendum



BIM Payment Compensation

* NOTE: NEED TO REVISE/INCORPORATE CLAUSE INTO SPEC/CONTRACTS.

Singapore BIM Roadmap
BIM Manager Forum

- The workgroup will provide technical support to the BIM Steering Committee in addressing technical and practices issues faced by the industry, for example process transformation, drawing production, training needs, etc.
- A core group of 2 representatives from each discipline (Architecture, C&S, M&E, QS, Contractor)
- Representatives from other firms can be involved in the Discipline Specific Workgroup

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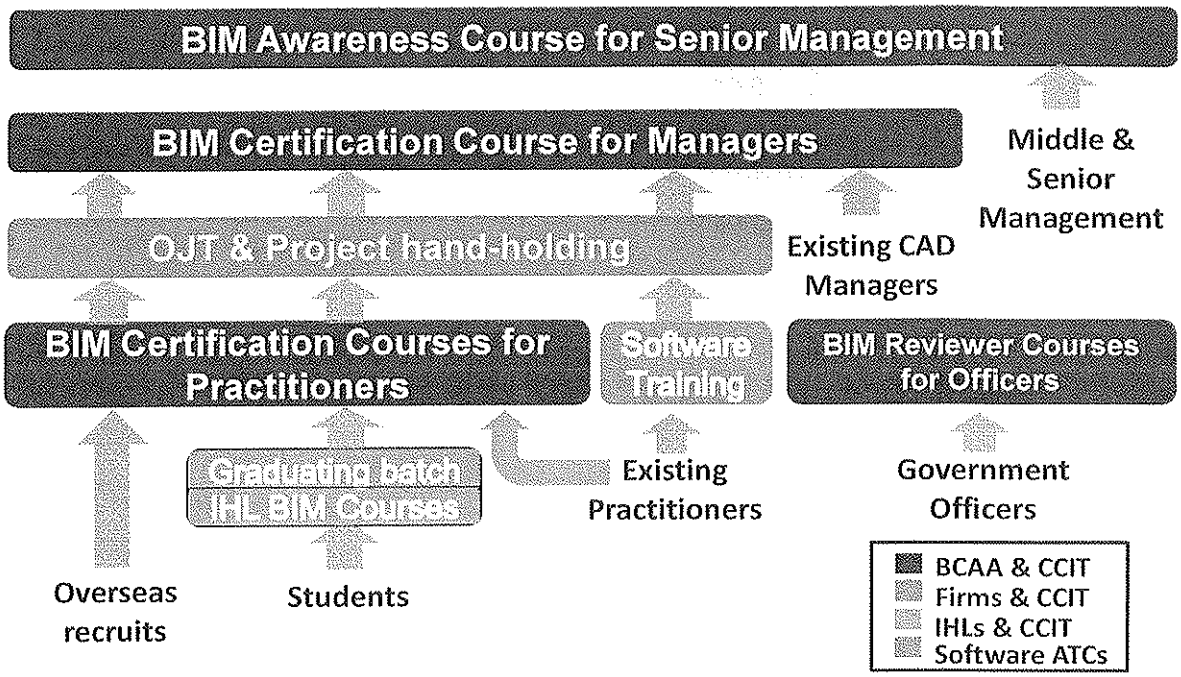
Singapore BIM Roadmap
Building BIM Capability & Capacity



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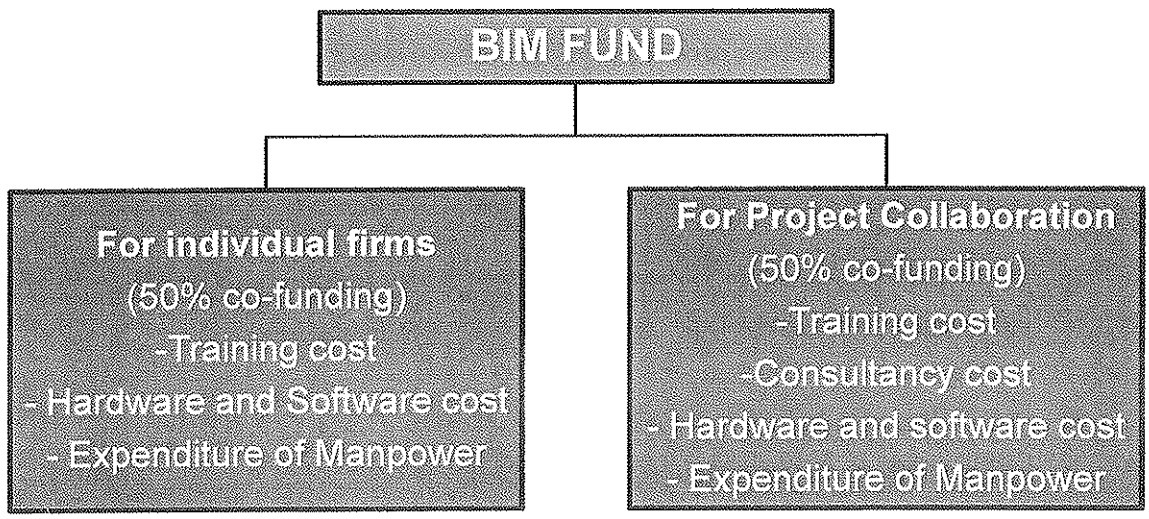
Singapore BIM Roadmap
Incentivising BIM Adopters



For more information, please visit http://www.bca.gov.sg/BIM/bimfund.html

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Thank You

Sustainable Design
(Green Building Design)

Presented by :

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CEO (Asia) BIM HVACTool
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Presentation Summary

In this presentation, we will discuss:

- The Definition of Sustainable Design
- Why is this important
- Performance Rating systems
- Integrated Green Building Design
  - **Building Siting, Massing and Orientation**
  - **Building Envelope**
  - **Natural Ventilation**
  - **Building Greenery and Landscaping**

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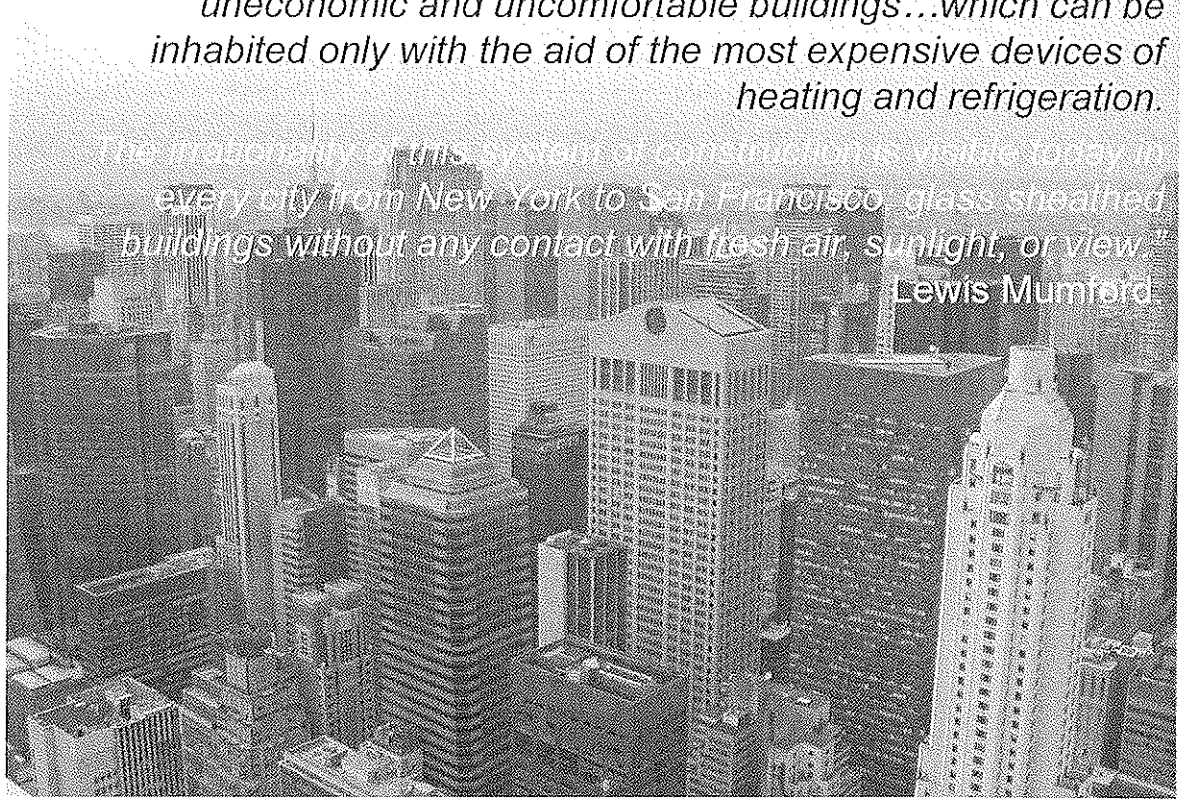
What is Sustainable Design?

What is Environmental Design?

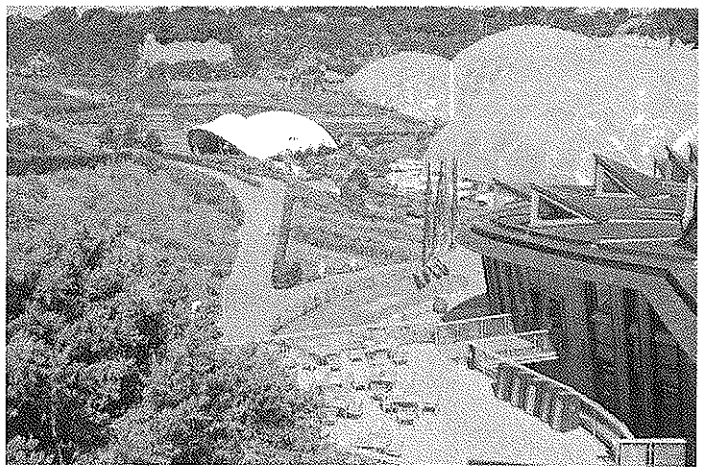
"the modern architect has produced the most flagrantly uneconomic and uncomfortable buildings…which can be inhabited only with the aid of the most expensive devices of heating and refrigeration.

The indifference of this style of construction is visible today in every city from New York to San Francisco, glass sheathed buildings without any contact with fresh air, sunlight, or view."

Lewis Mumford



Environmentally sensitive design looks to design in harmony with, and in response to the climate. It attempts to use the natural solar and ventilation characteristics of the local climate/environment to inform the building design so to minimize use and dependency on consumptive non renewable energy sources. Sustainable building design looks to "live lightly on the earth" so that there will be quality and resources remaining for generations to come.



Eden Project, United Kingdom – incorporating nature and innovative architectural design

The Sustainable Ethic:

Sustainable building is not a new style of building. It is a way to think about how we design, construct, and operate buildings. Its primary goal is to lessen the harm poorly designed buildings cause by using the best of ancient building approaches in logical combination with the best of new technological advances.

Its ultimate goal is to make possible offices, homes, even entire subdivisions that are net *producers* of energy, food, clean water and air, beauty, and healthy human and biological communities.

Green buildings try to take less from the earth and give more to people.

Definitions of Sustainable Design

Sustainable development is seeking to meet the needs of the present without compromising those of future generations.

Sustainability envisions the enduring prosperity of all living things.

Sustainable design seeks to create communities, buildings, and products that contribute to this vision.

"The world will not evolve past its current state of crisis by using the same thinking that created the situation."

– Albert Einstein

The current environmental problems of the world are the result of Design ...the world of DESIGN needs some Radical thinking if we are to Design ourselves *out* of the problem!

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ENERGY CONSUMPTION IN SINGAPORE

BUILDINGS USE MORE ENERGY THAN CARS AND TRUCKS!

Industry 25%

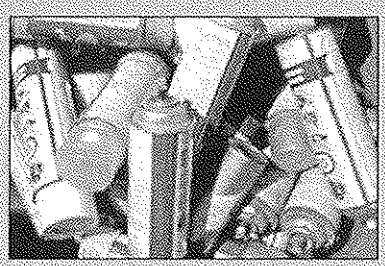
Transportation 27%

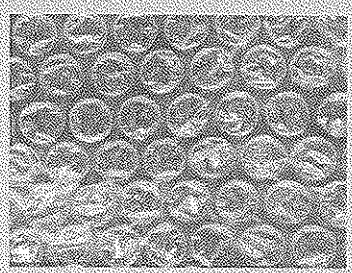
Buildings 48%

POLLUTION IS AN ACT OF DESIGN

Remember, EVERYTHING that is called 'disposable' was DESIGNED from day one to be garbage--as its PRIMARY and overriding design consideration."








EVEN THIS BUILDING
Was designed to be
thrown out!


SEALED BUILDINGS CANNOT BREATHE
ELEVATORS AND LIGHTS NEED POWER

CO_2 Production by Country in 1997

Country	CO_2 Produced (tonnes of carbon) Total (millions)	Per Capita
U.S.	1,489.6	5.48
China	913.8	0.75
Russia	390.6	2.65
Japan	316.2	2.51
India	279.9	0.29
Germany	27.4	2.77
UK	142.1	2.41
Canada	133.9	4.42
Italy	111.3	1.94
Ukraine	100.4	1.97

Source: Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Tennessee

CO_2 Production by Country in 2006

Country	CO_2 Produced metric tonnes	% total world emissions
U.S.	5,752	20.2%
China	6,103	21.5%
European Union	1,314	13.8%
Russia	1,564	5.5%
India	1,510	5.3%
Japan	1,293	4.6%
Canada	545	1.9%

The Global situation in the past 10 years has become many times WORSE. China's emissions INCREASED by 668% in 10 years.

Source: Wikipedia, accessed Sept 3, 2009

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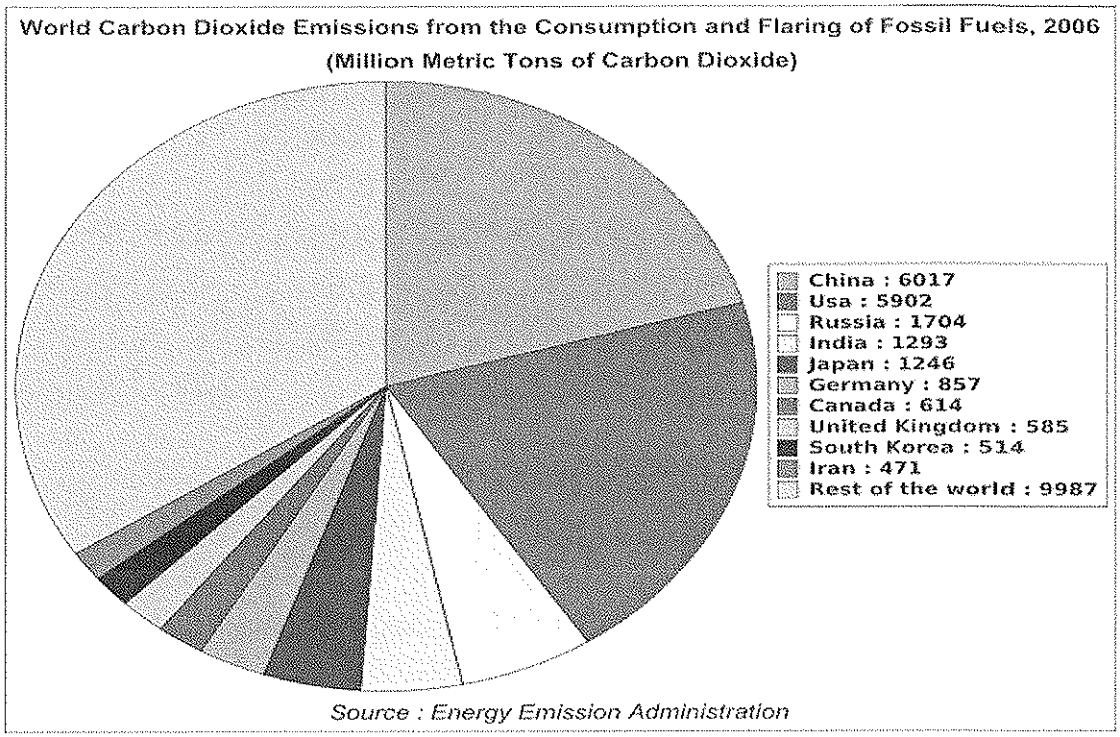
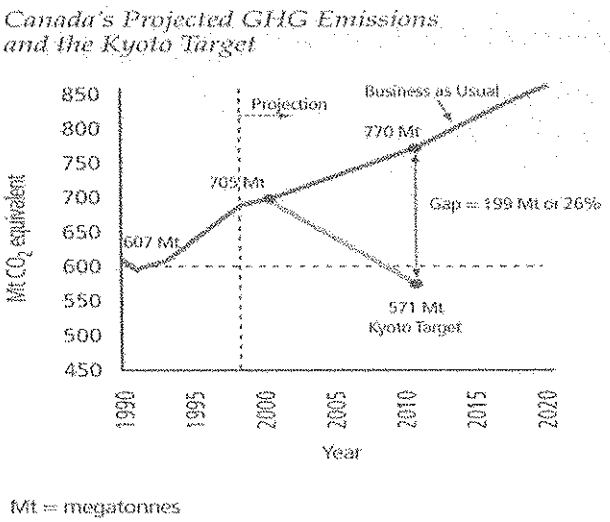


Kyoto Protocol:



Mt = megatonnes

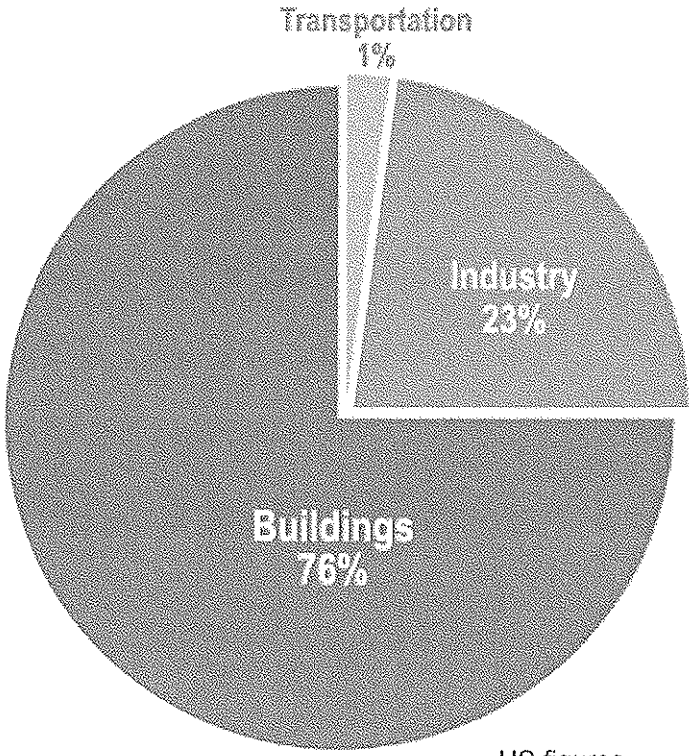
To stabilize atmospheric concentrations of greenhouse gases at today's levels will require reducing human-generated emissions by 80 percent immediately

There are six greenhouse gases covered under the protocol to the international convention on climate change (the Kyoto Protocol) – carbon dioxide (CO2), methane, nitrous oxide, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6).

The Kyoto protocol was agreed upon through international co-operation under the United Nations Framework Convention on Climate Change (UNFCCC), which was created in 1992.

The Kyoto protocol came out of the UNFCCC's December 1997 meeting held in Kyoto, Japan.

Under the agreement, industrialized nations must *reduce their emissions of greenhouse gases by an average of 5.2 per cent (from 1990 levels) by the period 2008 to 2012.*



US figures

Consider the percentage of energy used as a direct result of "buildings"...

Who designs buildings?

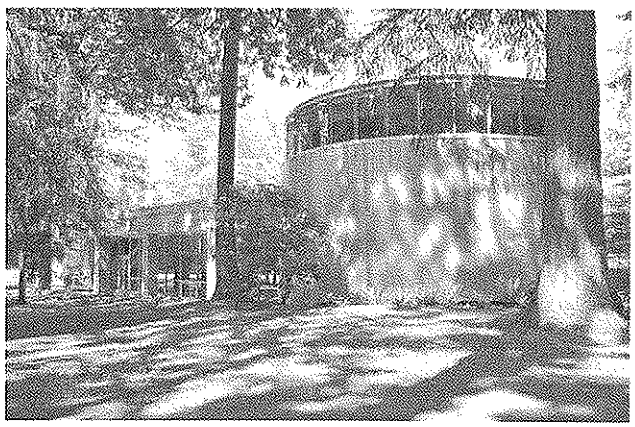
So, who should be held responsible for them?

Sustainable Checklist:

"Treat the Earth well. It was not given to you by your parents. It was loaned to you by your children." --- Kenyan Proverb.

Ideally a sustainable building should:

- make appropriate use of land
- use water, energy, lumber, and other resources efficiently
- enhance human health
- strengthen local economies and communities
- conserve plants, animals, endangered species, and natural habitats
- protect agricultural, cultural, and archaeological resources
- be nice to live in
- be economical to build and operate



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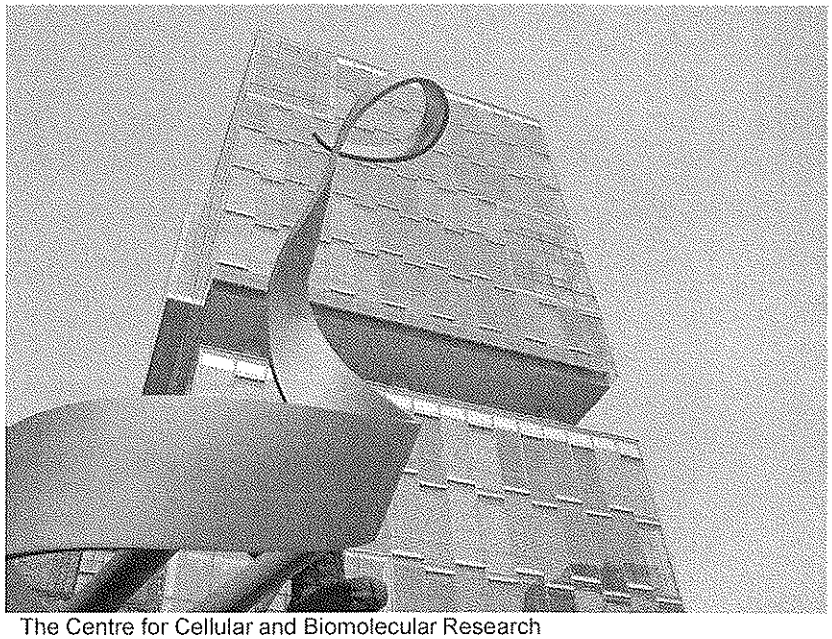
Five principles of an environmental Architecture:

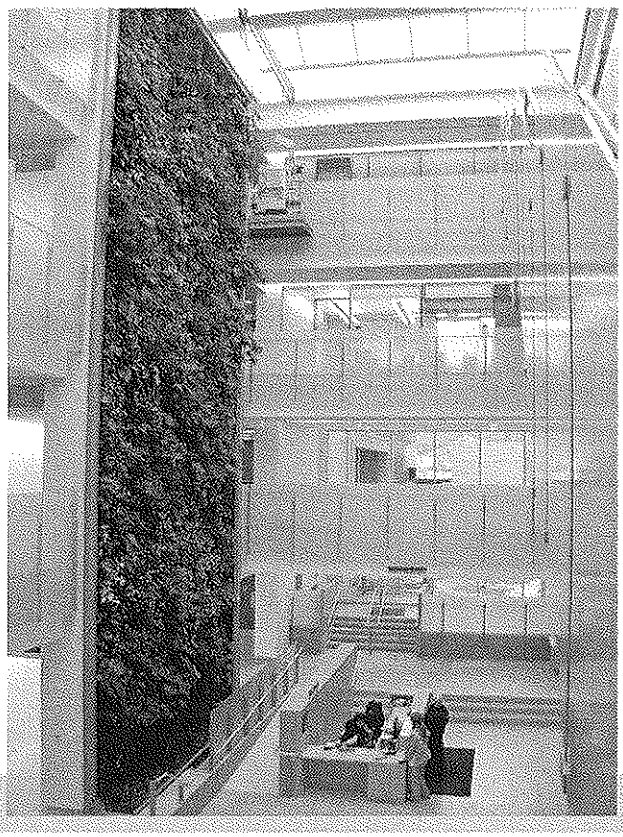
(Thomas A. Fisher, AIA, November, **1992**)

* Healthful Interior Environment.
* Energy Efficiency.
* Ecologically Benign Materials.
* Environmental Form.
* *Good Design.*



The Centre for Cellular and Biomolecular Research
University of Toronto
Benisch and Architect Alliance Architects

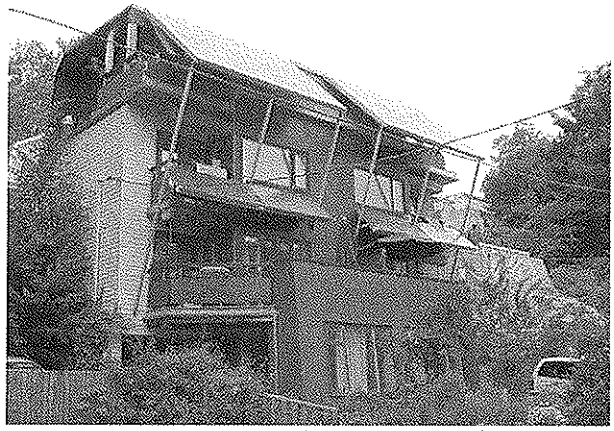
Healthful Interior Environment.

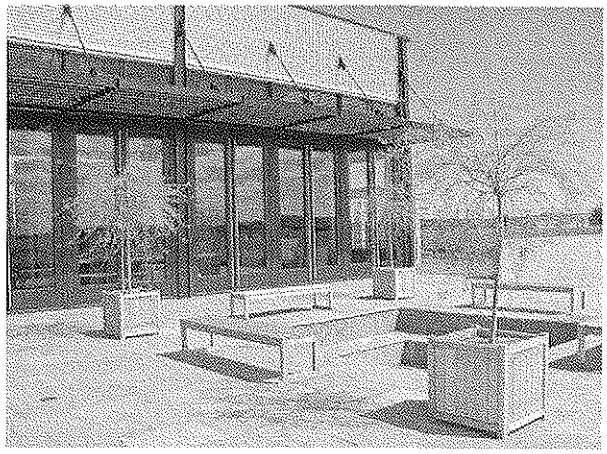


* All possible measures are to be taken to ensure that materials and building systems do not emit toxic substances and gasses into the interior atmosphere. Additional measures are to be taken to clean and revitalize interior air with filtration and plantings.

Energy Efficiency.

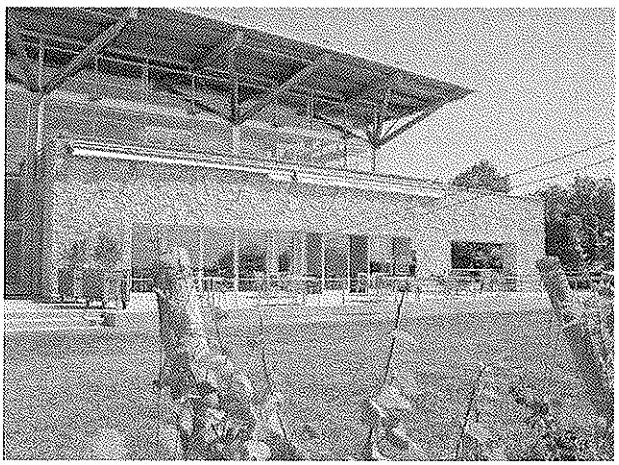
* All possible measures are to be taken to ensure that the building's use of energy is minimal. Cooling, heating and lighting systems are to use methods and products that conserve or eliminate energy use.





Ecologically Benign Materials.

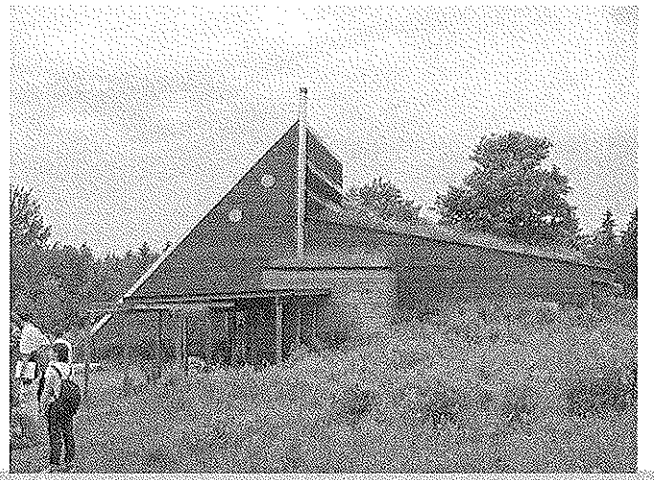
* All possible measures are to be taken to use building materials and products that minimize destruction of the global environment. Wood is to be selected based on non destructive forestry practices. Other materials and products are to be considered based on the toxic waste output of production.





Environmental Form.

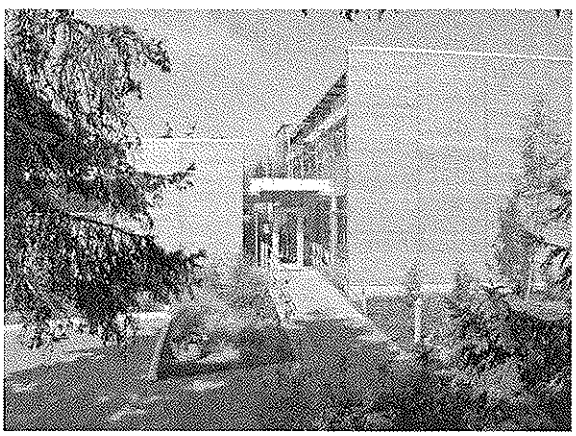
* All possible measures are to be taken to relate the form and plan of the design to the site, the region and the climate. Measures are to be taken to "heal" and augment the ecology of the site. Accommodations are to be made for recycling and energy efficiency. Measures are to be taken to relate the form of building to a harmonious relationship between the inhabitants and nature.

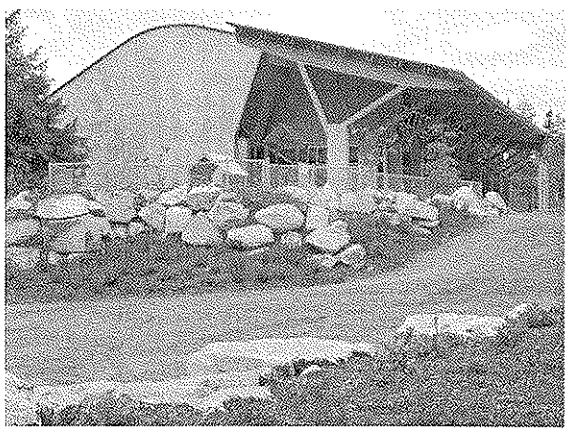


YMCA Environmental Learning Centre
Paradise Lake, Ontario
Charles Simon Architect

Good Design.

* All possible measures are to be taken to achieve an efficient, long lasting and elegant relationship of use areas, circulation, building form, mechanical systems and construction technology. Symbolic relationships with appropriate history, the Earth and spiritual principles are to be searched for and expressed. Finished buildings shall be well built, easy to use and beautiful.





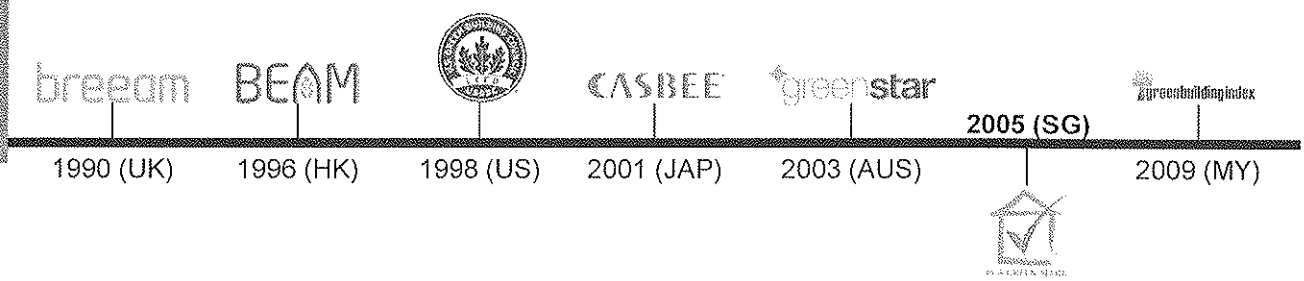
「無後為大」－孔子

"Future generation is the most important" --- Confucius.

"Sustainable development is seeking to meet the needs of the present without compromising those of future generations."

"It's not easy being green." -- Kermit the Frog, 1972.

Performance Ratings



The **BCA Green Mark Scheme** was launched in January 2005 as an initiative to drive Singapore's construction industry towards more environment-friendly buildings

Target: 80% of the existing building are to achieve Green Mark Certification Rating by **2030**

Energy Efficiency Target: 35% reduction from **2005 - 2030**

http://www.bca.gov.sg/greenmark/green_mark_buildings.html

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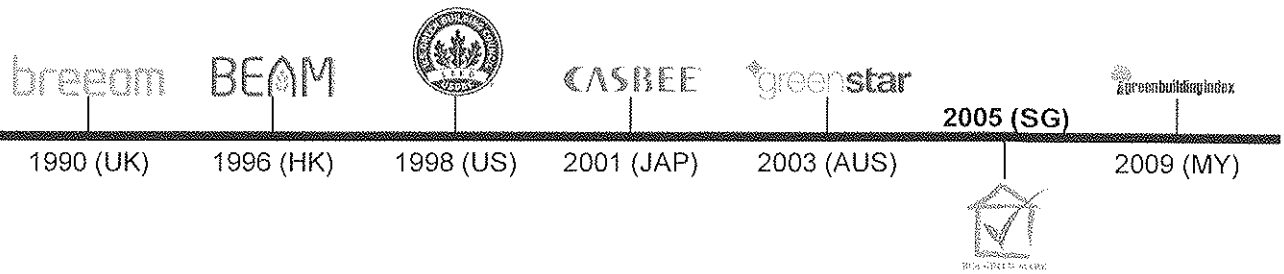
Performance ratings



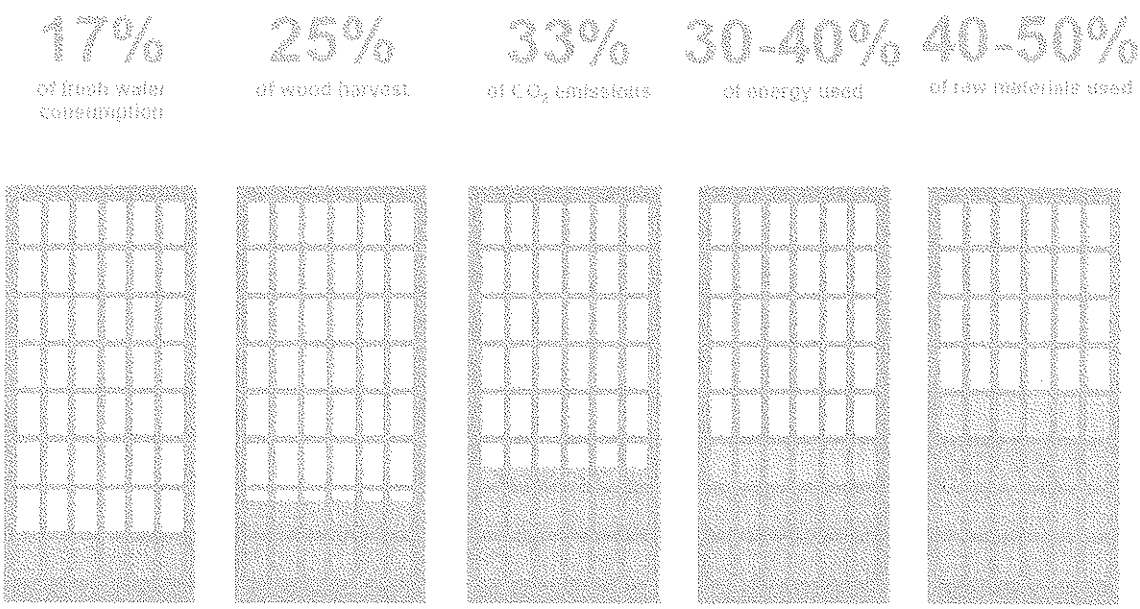
Benefits of Green Mark

- Facilitate reduction in water and energy bills
- Reduce potential environmental impact
- Improve indoor environmental quality for a healthy and productive workplace
- Provide clear direction for continual improvement

http://www.bca.gov.sg/greenmark/green_mark_buildings.html

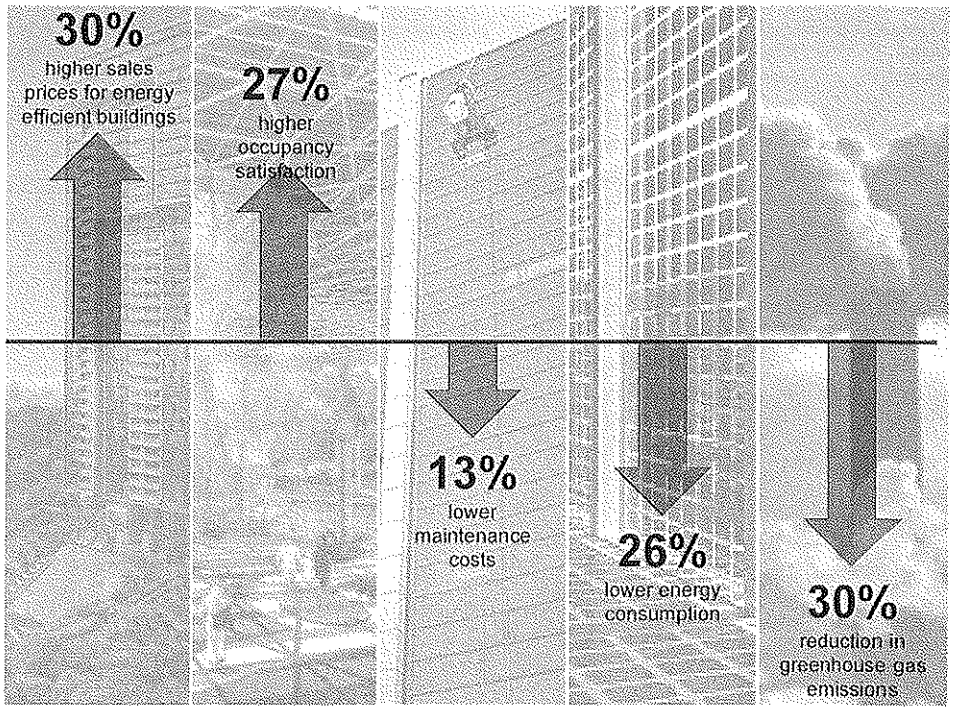
Environmental impact of buildings

Worldwide buildings account for…



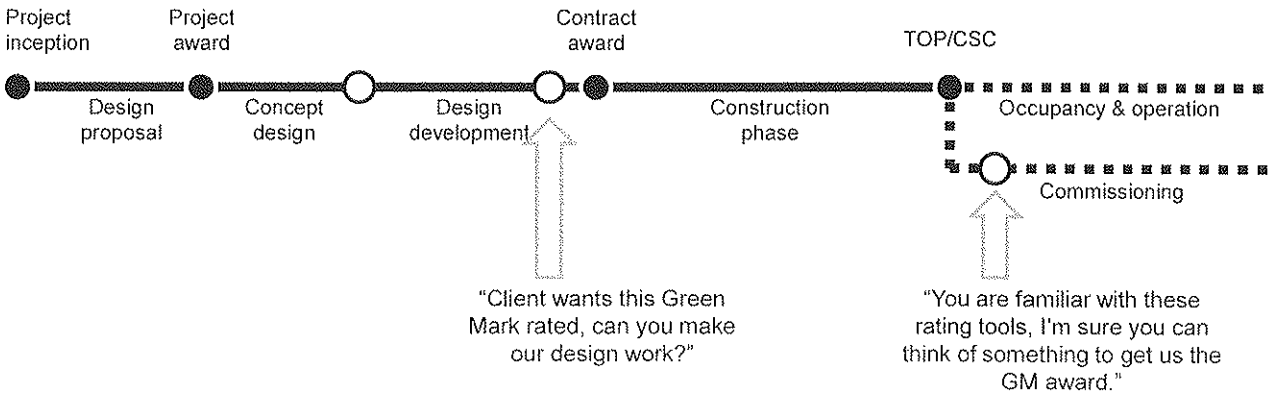
Source: Dr. Nirmal Kishnani

Benefits in practicing sustainable design



Source: US Green Building Council

Typical Design Process



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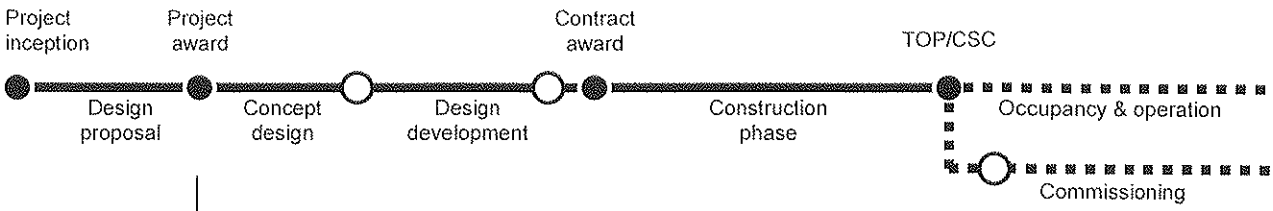
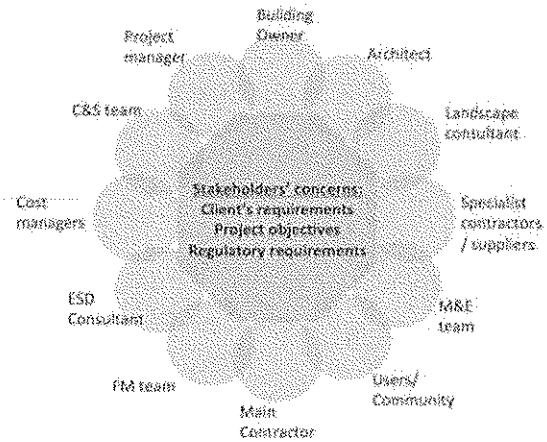
Integrated design approach

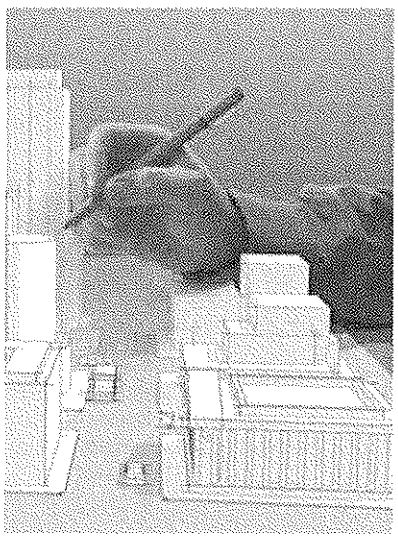


Maintaining a sustainable perspective throughout building process

Adopting an **Integrated Design Approach**



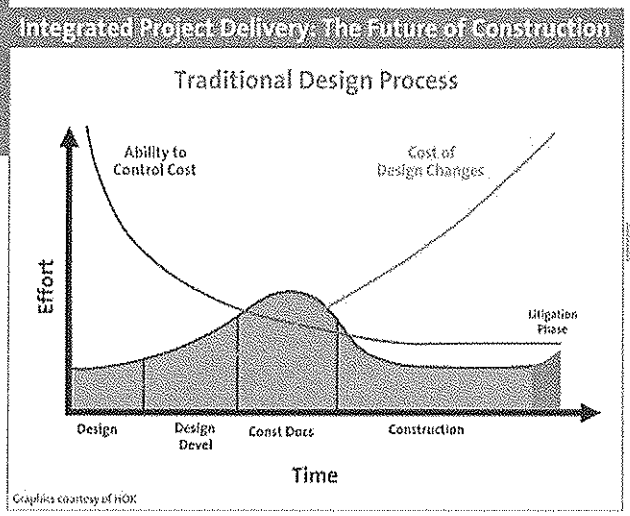
[Decisions by Building Owners and Architects]

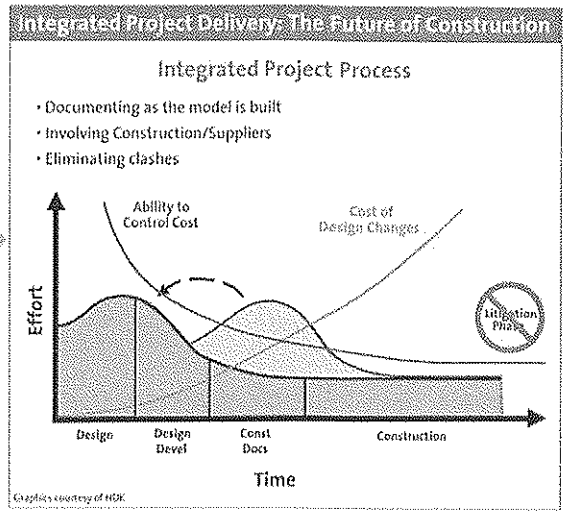


For owners and architects, the most important decisions in initial planning involve designing and developing a solution that meets both architect's intent and owner's aspirations. The key decision is in prioritising design issues during the planning phase and understanding site constraints. For instance, the specific site boundary could limit massing options, or the preferred form or massing of the building may work against passive design principles. Still, despite site constraints, establishing good passive design strategies at the onset of the planning phase, puts the project on the right path towards achieving sustainability. Some questions to ask include:

- How much of the site area should the building and overall development footprint occupy and how much open or green space should be provided?
- Is all or part of the building to be natural ventilated?
- Where is the main entrance to the site? Where are building entrances and primary routes of circulation (vehicular and pedestrian)?
- Is daylighting of spaces or providing shade a priority? Or both?
- What is the energy efficiency or Green Mark target, or sustainability objectives to be achieved?

Integrated design approach

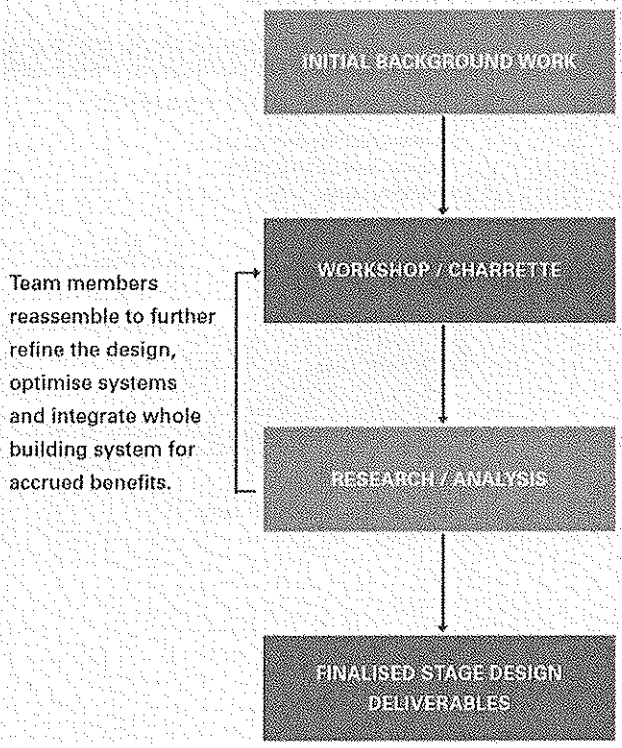




Key differences moving from traditional planning and design process to integrated green building design approach

TRADITIONAL PLANNING AND DESIGN APPROACH	INTEGRATED GREEN BUILDING DESIGN APPROACH
Involvement of the project members is limited to their trade and specialisation.	Project members are included right from start of project to draw inputs that will help to shape the design and planning process.
Project gets more intensive as it progresses. Less time is spent at the early stages.	Project starts off intensively with time spent on meetings, charrettes and discussions.
Decisions are made typically by a few stakeholders such as owners, architects and contractors.	Decisions are made by the team. Brainstorming sessions, research and iterative discussions are held amongst as many stakeholders as possible before decisions are made.
A linear process is adopted.	A whole system thinking approach is adopted.
The focus is to reduce up-front capital costs.	The project team aims towards reducing long term operation and maintenance costs by using highly efficient systems.
Systems are considered in isolation and often result in over-designing / over-sizing.	Total building performance is used to assess how each system affects one another to deliver the optimum design.
Project members undertake limited responsibilities.	All team members share equal responsibilities and work together to solve problems.
The linear process ends when construction of the project is completed.	This design approach emphasises on the long term performance of the building and users' satisfaction through commissioning, Post Occupancy Evaluation (POE) surveys and energy audits.

[Implementing Integrated Green Building Design Approach]



Team members develop rough issues to create a common understanding on issues including ecological systems, energy systems, water systems, material resources, skill resources and construction.

Team members come together to compare ideas, set performance goals and share expertise as a one cohesive team of co-designers.
E.g. goals on solar heat gain reduction, energy saving, water saving, water recycling, etc.

Team members work on their respective issues – refining the analysis, testing alternatives, comparing notes and generating ideas in smaller or focused meetings.

Finalised documentation becomes the basis for further design development work by team members at the next stage.

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PASSIVE DESIGN - MOST EFFICIENT

Optimising passive design is the first step towards reducing the energy demand of a building or project. Initial site planning establishes the orientation, massing and location of the components and uses of a project, all of which impact and set the parameters for passive design strategies. Some of the primary issues to consider are:

1) SOLAR HEAT GAIN

Solar heat gains (via direct solar radiation) increase the cooling load of a project and hence energy use. In naturally ventilated spaces, solar heat gains heat up spaces such that they typically become thermally uncomfortable to occupants. The first step in minimising solar heat gains is to optimise the orientation and massing of a project specific to its location. Certain orientations (east and west for example) provide more exposure to the sun and therefore greater heat gains. This varies according to the location of a project so the sun path needs to be looked at for different locations (e.g. for a project in Singapore versus Bangkok) and at different times of the year. Likewise, the massing of a project could provide shade to itself or other blocks to further mitigate solar heat gains.

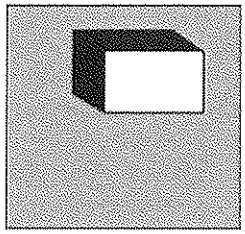
2) NATURAL VENTILATION

Maximising the amount of space to be naturally ventilated is another strategy towards reducing energy demand on a project since natural ventilation requires little energy use as compared to air-conditioning. Establishing and understanding prevailing wind directions and how they work on your specific site will affect massing and orientation decisions.

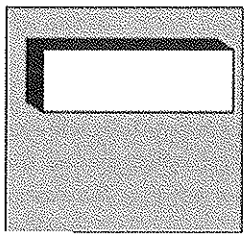
3) DAYLIGHT

While minimising solar heat gains is important, it is also important to take advantage of and harness natural daylight for spaces. This reduces the need for artificial lighting which requires significant amounts of energy. Bringing in daylight via window openings at appropriate heights, skylights and/or atrium spaces are all effective strategies that will affect massing and orientation decisions.

4,200 m² SITE AREA – 15 STOREY BUILDING



3,700 m² SITE AREA – 8 STOREY BUILDING



Buildings with same GFA but different footprint.

Strategies to address the green building issues associated with initial site planning include:

DEVELOPMENT AND BUILDING FOOTPRINT

Minimising the development footprint (building footprint, roadway, walkway, parking areas, or other hardscape) of a project has impacts on heat island effects, stormwater generation, and green and open space. The overall intent for a green building is to minimise its impact on its site, surrounding environment and resources which is why minimising impervious surfaces and maximising green and open space are key initial steps towards meeting that goal. While this can be challenging in high density urban areas, like Singapore, it is still important to take these issues into consideration and maximise their potential.

Strategies to minimise the development footprint include:

- Design a taller building with a smaller footprint, rather than a shorter building with a larger footprint (given the GFA is the same in both cases)

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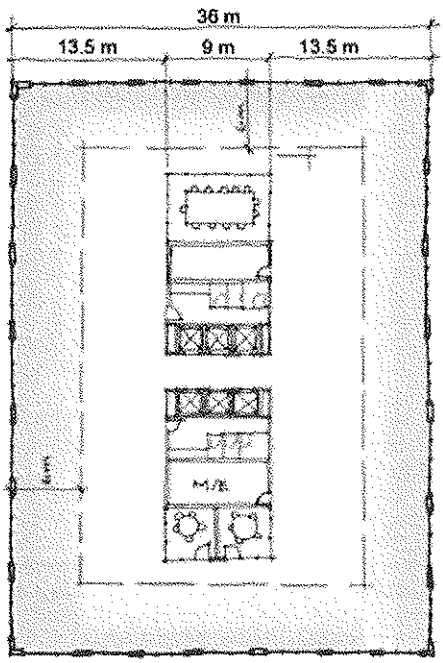
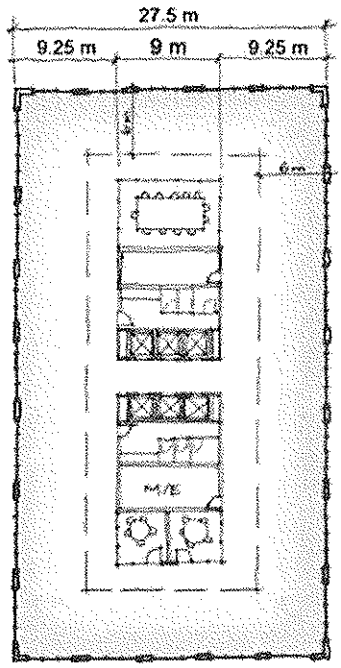
[Massing and Site Planning]

FLOOR PLATE > 27.5 m = MORE ARTIFICIAL LIGHTING



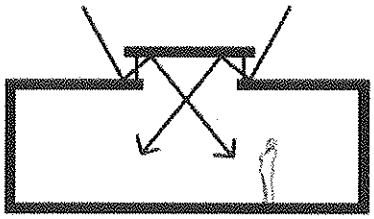
FLOOR PLATE < 27.5 m = LESS ARTIFICIAL LIGHTING



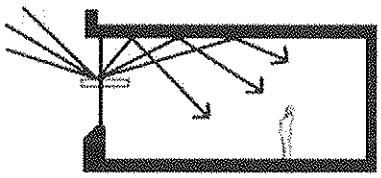
FOR DAYLIGHT

- Plan for daylight by minimising floor plate depth, especially in office buildings. The deeper the floor plate, the harder it is to bring natural daylight into spaces therefore increasing the dependence on artificial lighting. Floor plates in excess of 27.5 m will have difficulty achieving effective daylighting to spaces

CLERESTORY FOR DAYLIGHTING
(NORTH / SOUTH FACING IS BEST)



HOW LIGHT SHELVES WORK



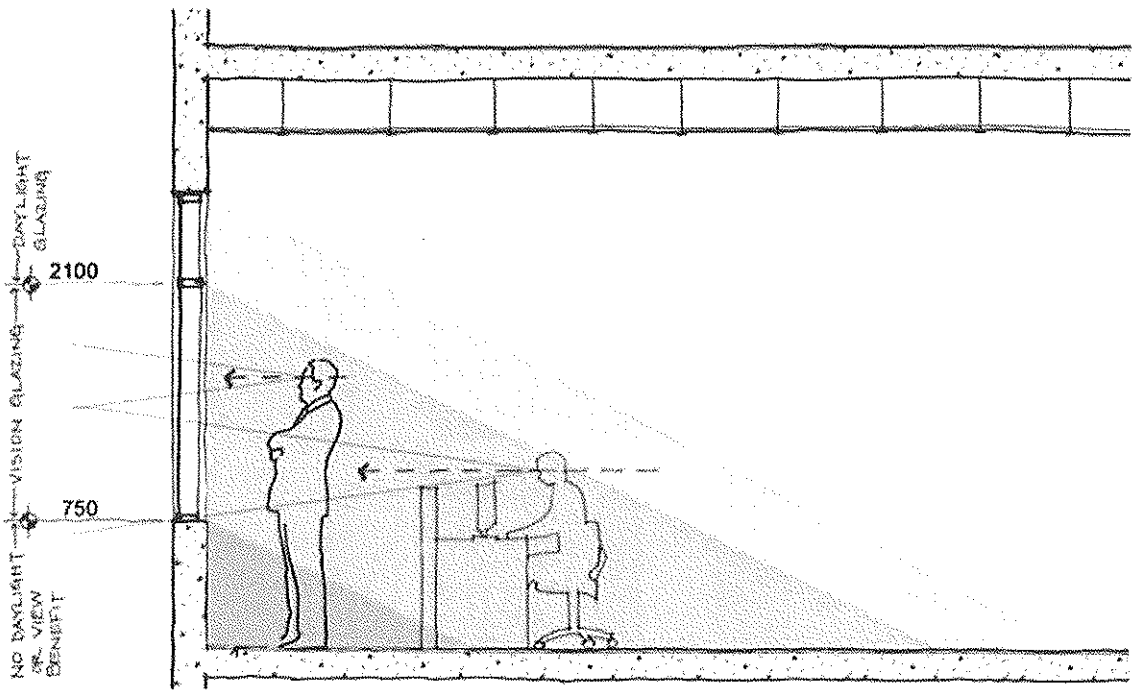
If the floor plate is deep, consider

- Adding clerestory lighting or atrium spaces through the building to bring more natural light in. In general, clerestory lighting (indirect light) is better than providing skylights since glare and solar heat gains are reduced.

- Adding light shelves to bring daylight further into spaces, up to 8 m. Mirror ducts and sun pipes are also effective at bringing daylight into spaces.

- Plan for daylight by adjusting floor-to-floor heights. Consider slightly larger floor-to-floor heights and providing glazing above 2,100 mm. This enables natural light to penetrate deeper into spaces. Daylight glazing is most effective above 2,100 mm However, one has to be careful not to introduce glare into the space.

- Optimise views. Providing glazing from floor to ceiling is not the most effective way to provide views as it will also bring in more solar radiation. Vision glazing is typically applied between 750 mm and 2,100 mm to accommodate sitting and standing occupants Areas below 750 mm therefore do not require glazing for either daylight or vision purposes. This can save in material cost and also reduce the amount of solar radiation entering into the space through the glass.



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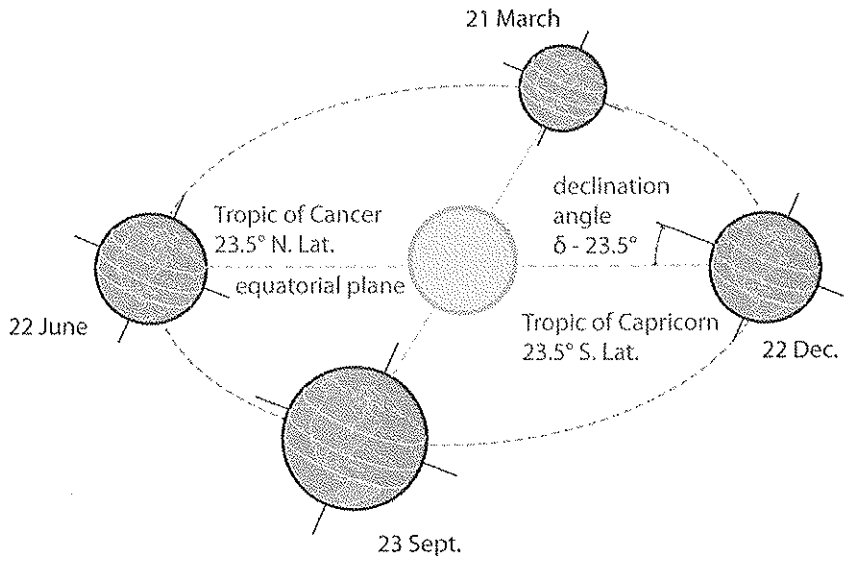
Solar Geometry



Earth's motion around the sun.

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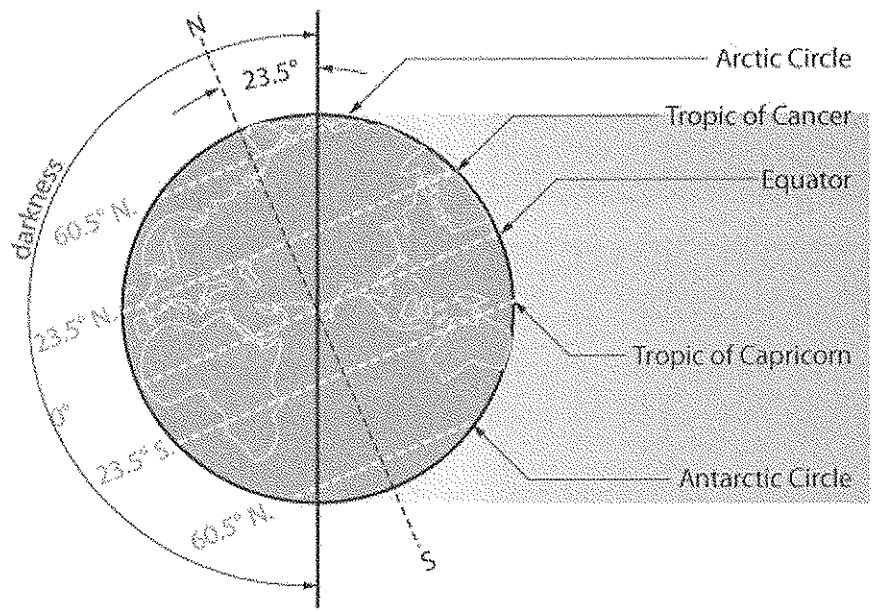
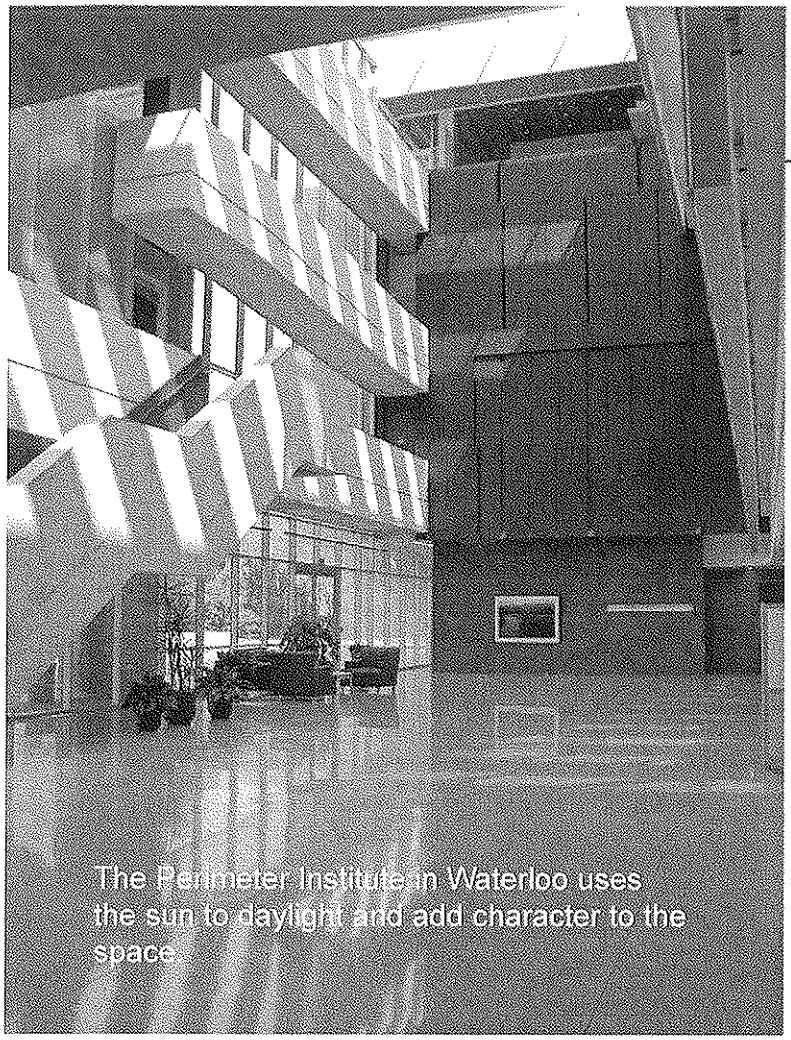
Solar Position



Earth relative to sun at winter solstice.



The Perimeter Institute in Waterloo uses the sun to daylight and add character to the space.

Why Solar Geometry?

Understanding solar geometry is essential in order to:

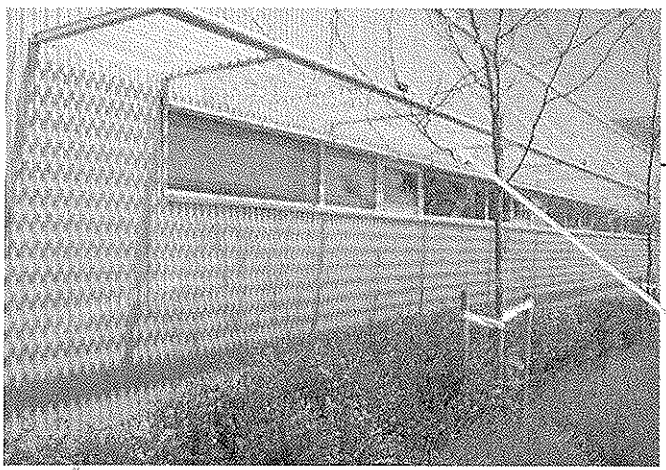
- do passive building design (for heating and cooling)

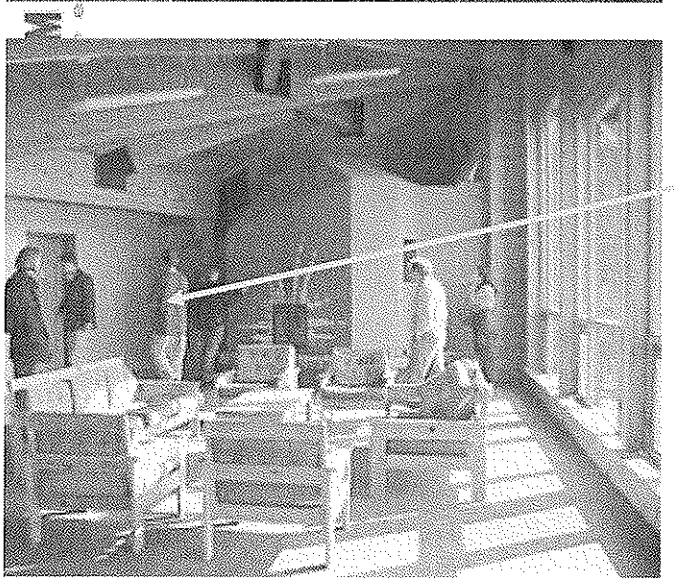
- orient buildings properly

- understand seasonal changes in the building and its surroundings

- design shading devices

- use the sun to animate our architecture





Solar geometry works for us because the sun is naturally HIGH in the summer, making it easy to block the sun with shading devices.

And it is naturally LOW in Winter, allowing the sun to penetrate below our shading devices and enter the building - with FREE heat.

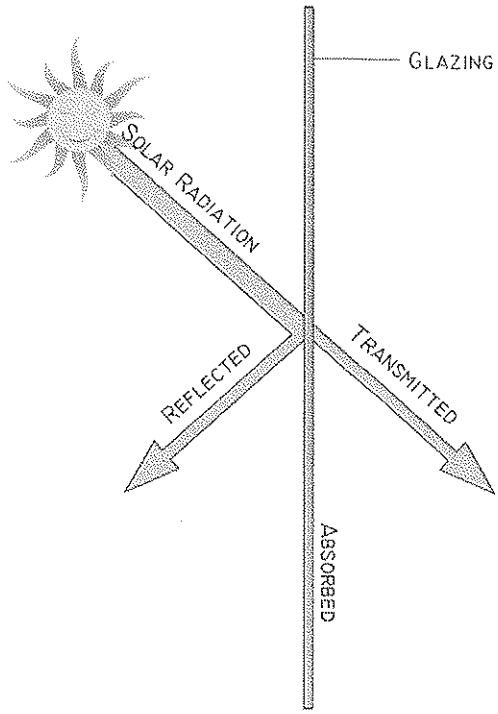
Solar Transmission Through Glass

When sun strikes the glass part of the solar radiation is transmitted through the glass and proceeds to heat up the interior space.

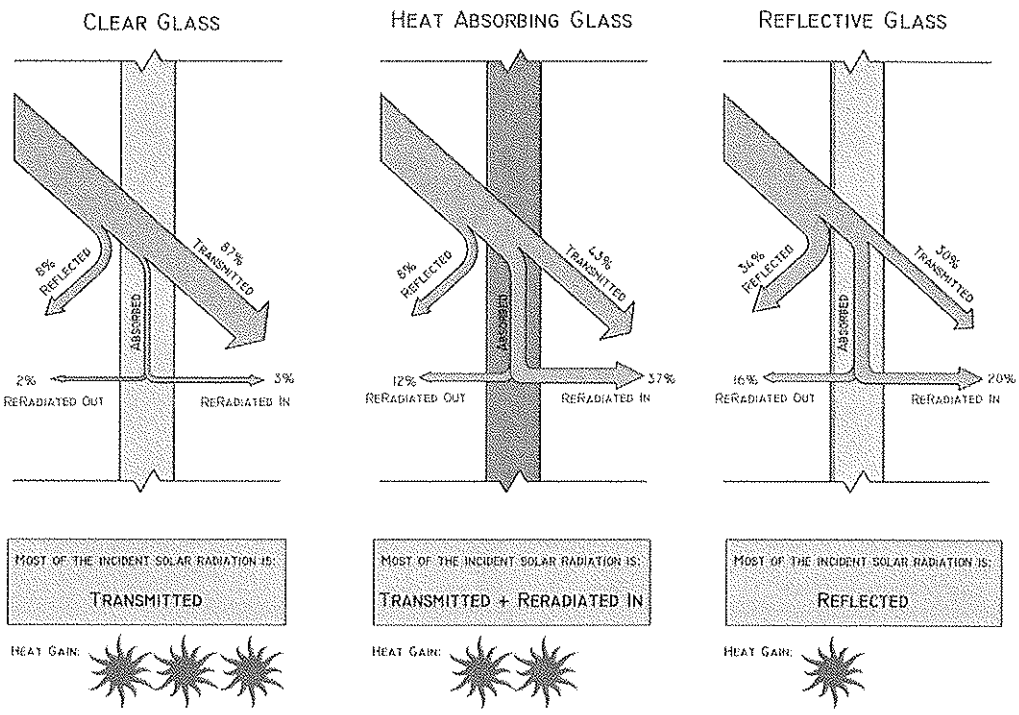
Part of the solar energy is reflected off of the glass. The amount is dependent on the angle of incidence.

Part of the solar energy is absorbed into the glass, then reradiated both inwards and outwards.

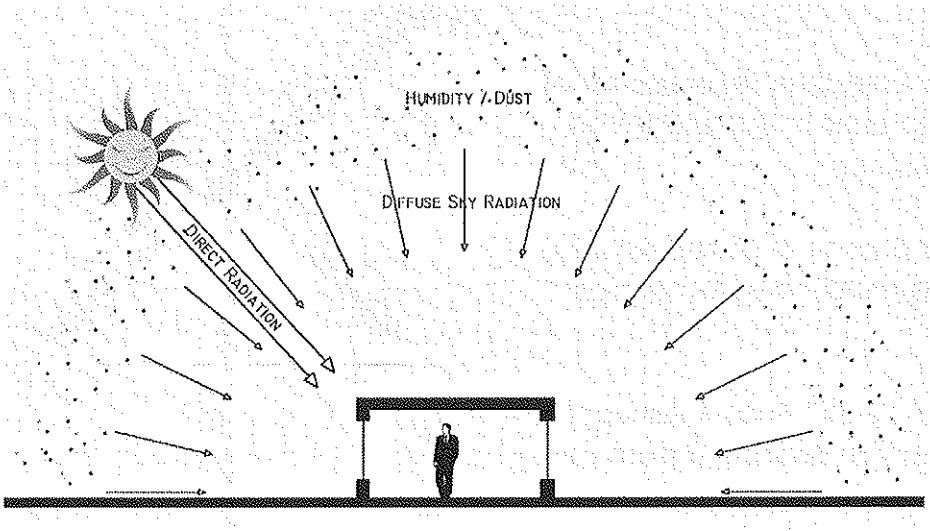
When looking to AVOID heat entering the building it is critical to prevent it from this initial transmission through the glass – as once the heat is in, it is IN.

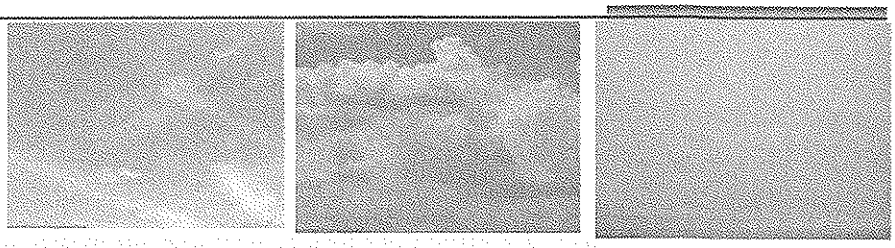


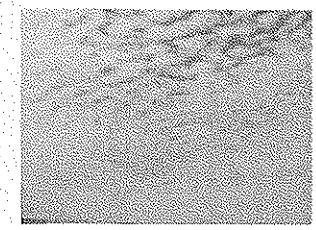
Solar Transmission through Varying Types of Glass



The Function of the Atmosphere









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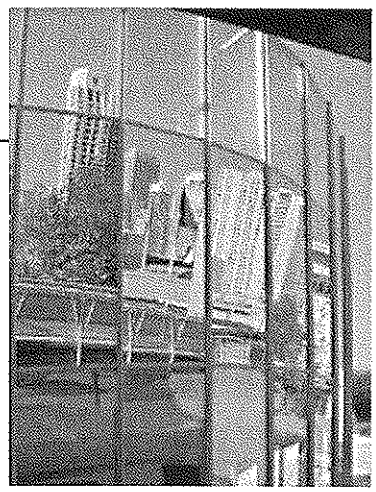
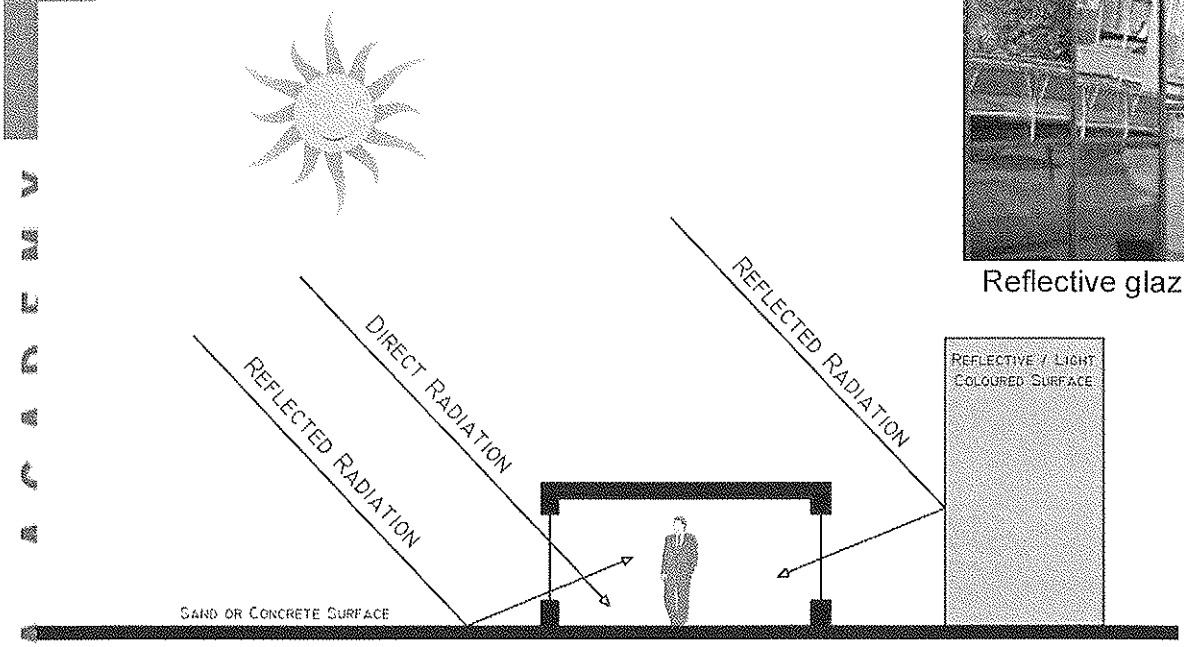
Types of Radiation



Reflective glazing



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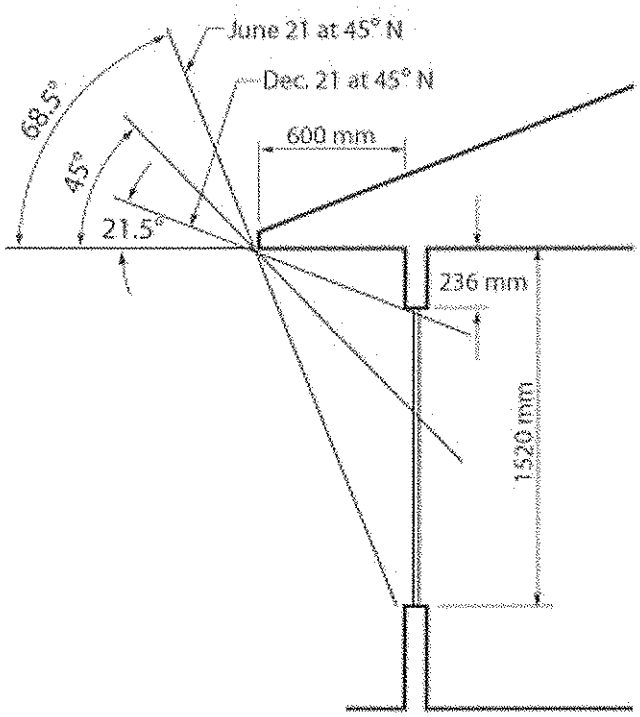
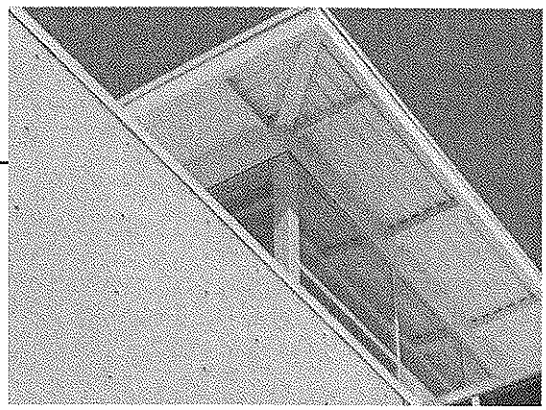
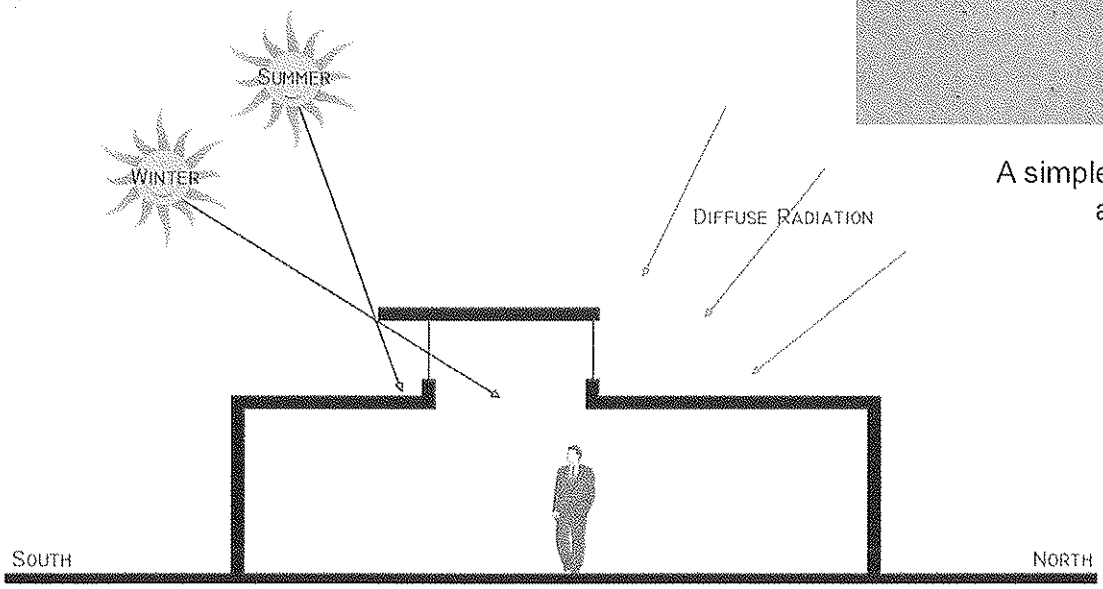
The Geometry of Shading Devices



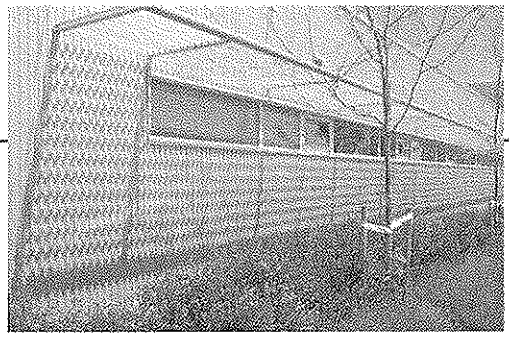
Shading angles for a south wall at 45°N

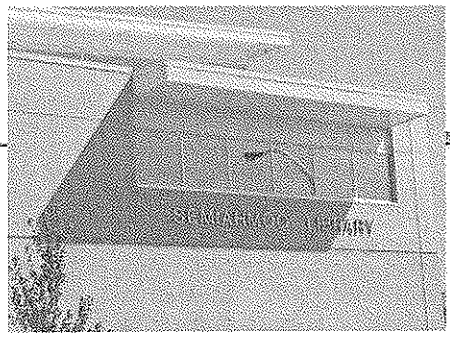


A simple roof overhang acts as a shading device.

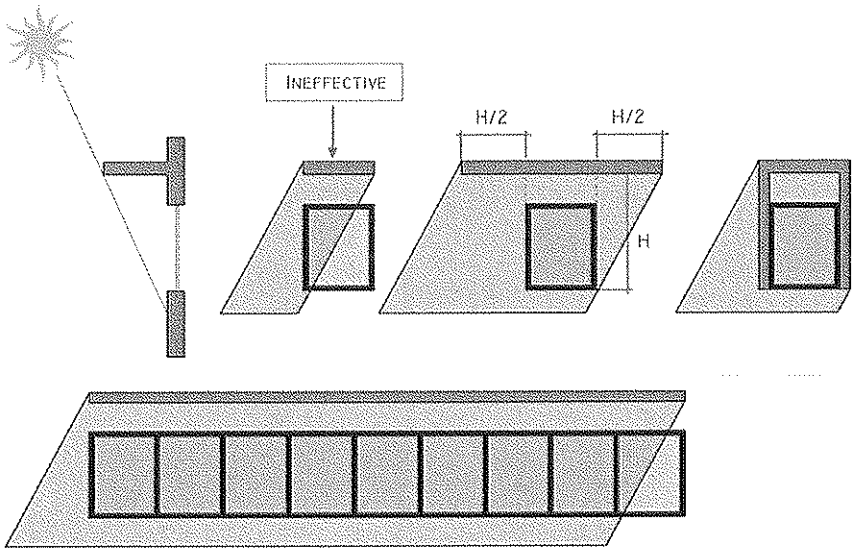


CLERESTORY WINDOW

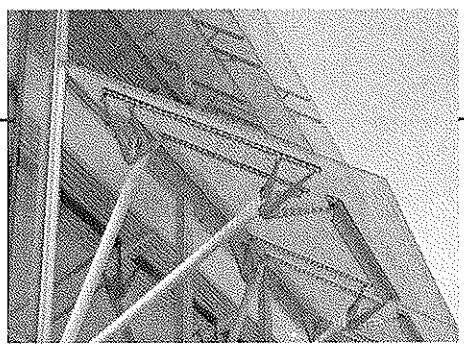


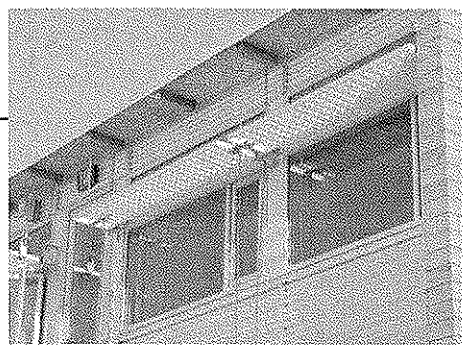


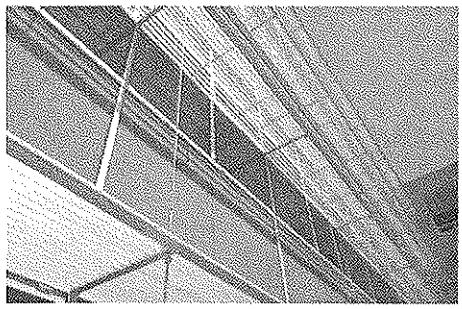
…extend device for full shading

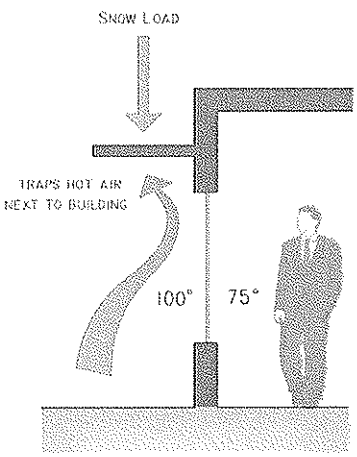


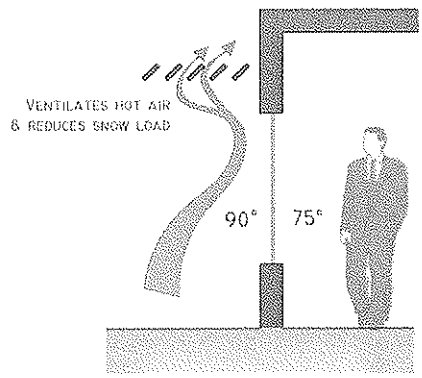
This one uses ceramic fritted glass that is sloped, to allow some light but shed rain and wet snow.





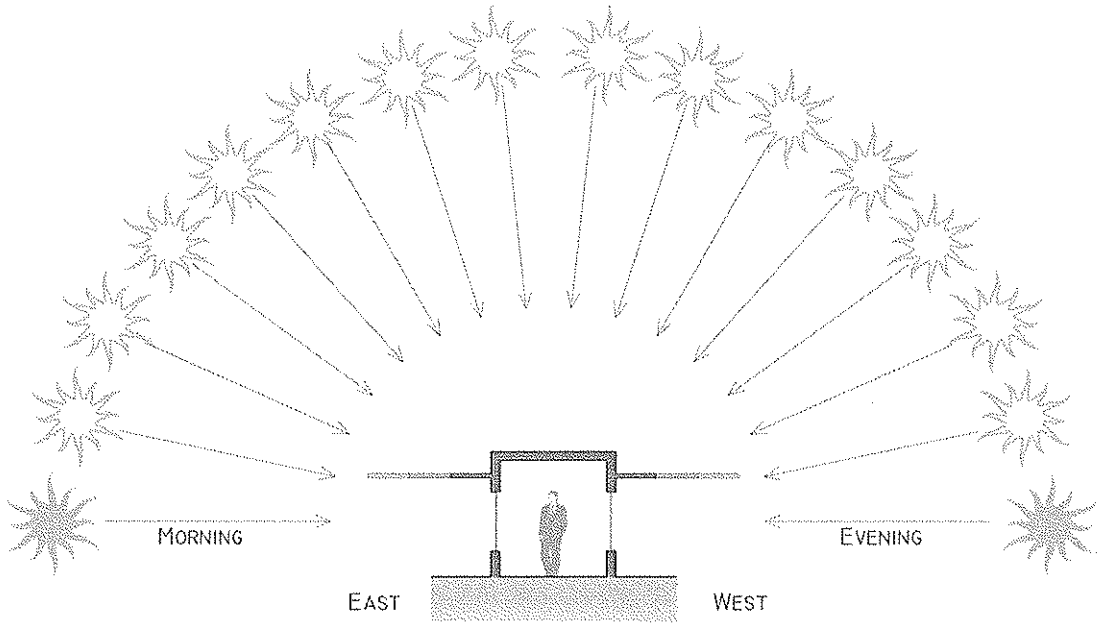






The above two use louvres or grates that will let snow, rain and wind through.

Shading Strategies for East and West Orientations

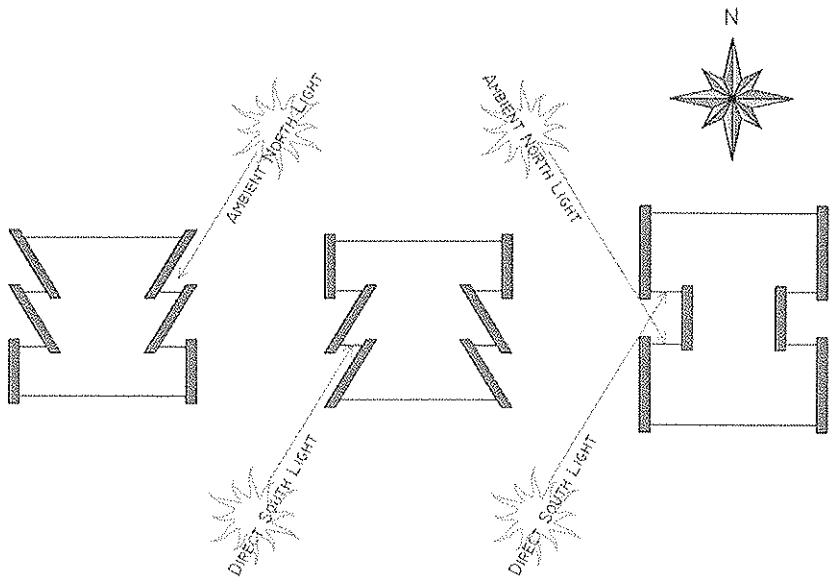


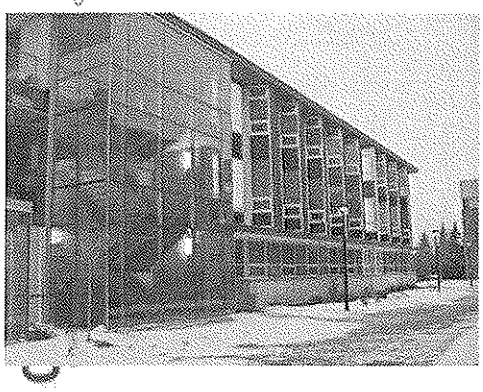
HORIZONTAL OVERHANGS DO NOT WORK ON EAST & WEST FACADES

Shading Strategies for East and West Elevations

1. The best solution by far is to limit using east and especially west windows (as much as possible in hot climates)

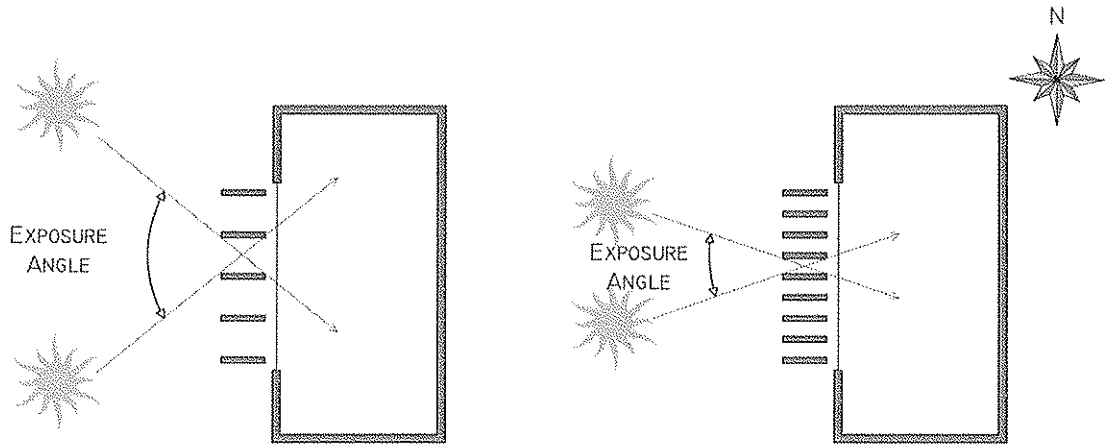
AVOID WINDOWS ON THE EAST & WEST FACADE
BY SHIFTING THE WINDOWS TO FACE NORTH OR SOUTH:





2. Next best solution is to have windows on the east and west façades face north or south

Shading Strategies for East and West Elevations

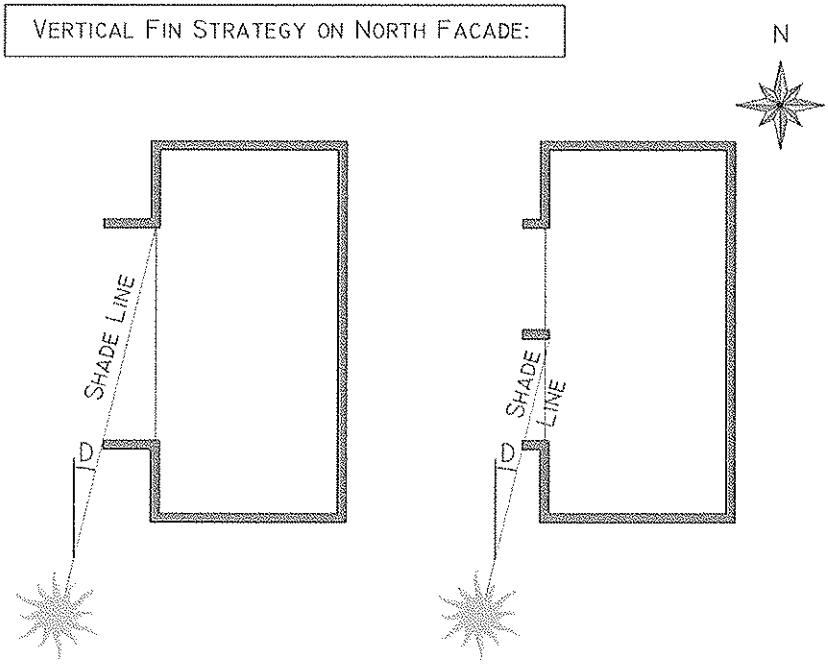


SOLAR PENETRATION IS REDUCED BY MOVING FINS CLOSER TOGETHER, MAKING THEM DEEPER, OR BOTH.

3. Use Vertical Fins. Spacing is an issue, as well as fin length. Must be understood that if to be effective, they will severely restrict the view.

Shading Strategies for the North Elevation

VERTICAL FIN STRATEGY ON NORTH FACADE:



THE "SHADE LINE" AT ANGLE "D" DETERMINES FIN SPACING & DEPTH.

The sun also hits the façade from the north east and north west during the summer. Fins can be used to control this oblique light as well. It is a function of the latitude, window size and fin depth/frequency.

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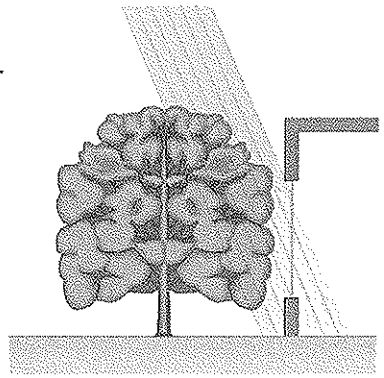
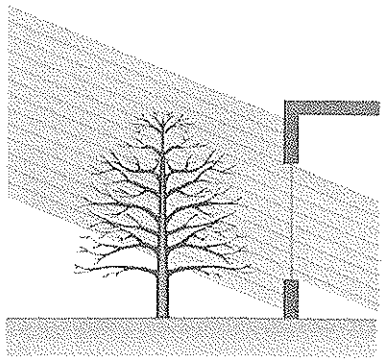
Living Awnings

SOLAR TRANSMISSION CAN BE AS LOW AS 20% FOR A MATURE TREE IN THE SUMMER

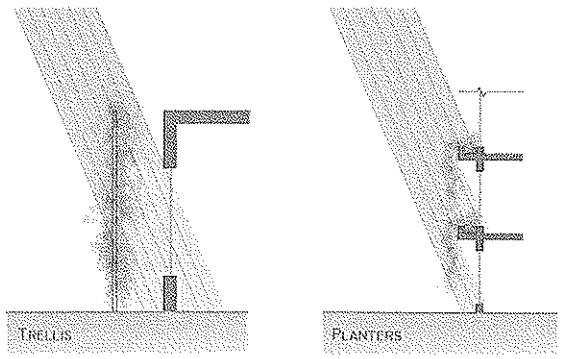


SOLAR TRANSMISSION CAN BE AS HIGH AS 70% FOR A MATURE TREE IN THE WINTER



Living Awnings such as deciduous trees and trellises with deciduous vines are very good shading devices. They are in phase with the thermal year – gain and lose leaves in response to temperature changes.

OTHER LIVING SHADE OPTIONS:



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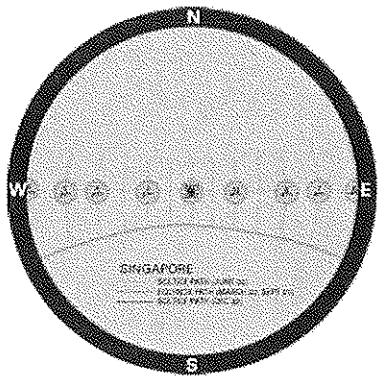
PASSIVE DESIGN: SOLAR HEAT GAIN MITIGATION AND SHADING



In Singapore, the sun is almost directly overhead throughout the year since Singapore is located only 1° north of the equator. East and West orientations receive the most solar exposure here and therefore have the most potential for solar heat gains. The Sun Path diagram for Singapore indicates that both North and South orientations also receive solar exposure for a portion of the year.

Several strategies should be considered in the planning phase to address solar exposure:

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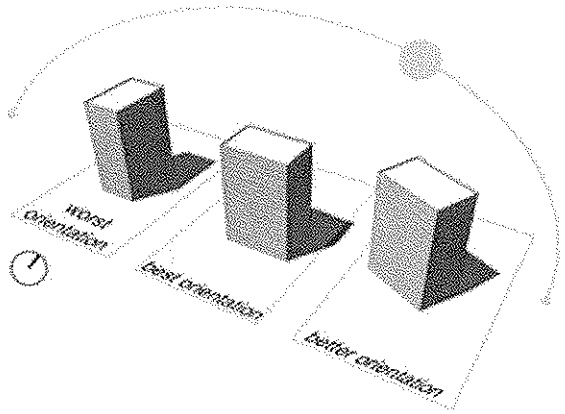

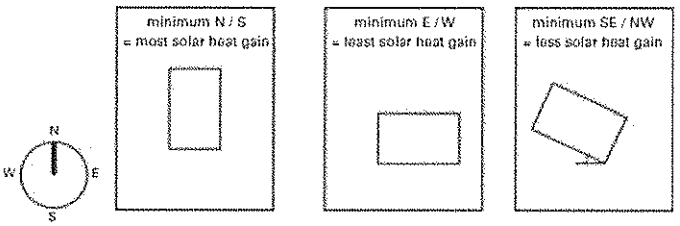

First, plan the massing and orientation to minimise East and West facing façades

North and South facing façades have significantly less exposure to solar gains, especially in Singapore. East and West facing façades are typically defined as siting within a 0° - 22.5° angle North / South to East / West.

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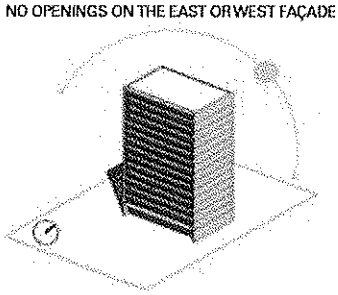
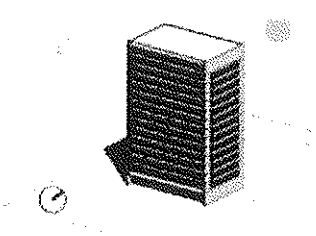
OPTIMISE SOLAR ORIENTATION:
NO OPENINGS ON THE EAST OR WEST FAÇADE

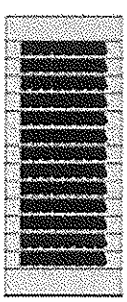


- On East and West facing façades, consider minimising the number and size of openings
  The more opaque the wall area, the better since that almost always mitigate solar heat gain better than glazing. A good strategy is to plan stairs, elevators, bathrooms or other 'non-core' spaces towards the East and West.

MINIMISE SOLAR HEAT GAIN: SHADE ALL EAST AND WEST FAÇADE OPENINGS

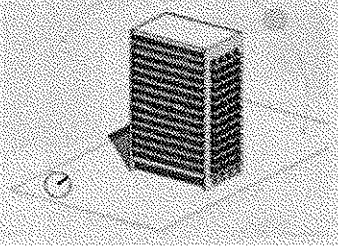


EAST ELEVATION

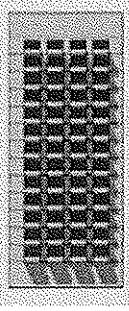


- For openings on East and West façades, incorporate some type of shading into the façade design to block direct solar exposure to mitigate heat gains
  Shading can take many forms including, horizontal or vertical projections, light shelves, exterior screening, greenery and/or balconies.

MINIMISE SOLAR HEAT GAIN:
BALCONIES AS SHADING DEVICES

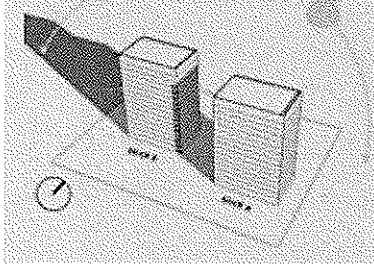


EAST ELEVATION



- Plan balconies to be located on East and West façades. Balconies are effective shading devices that also provide outdoor access (amenity) to the building.

SELF-SHADING: BLOCK A SHADES
BLOCK B EAST FAÇADE



- For projects with multiple buildings, use the massing to shade each other, particularly for East and West facing façades (i.e. self-shading)

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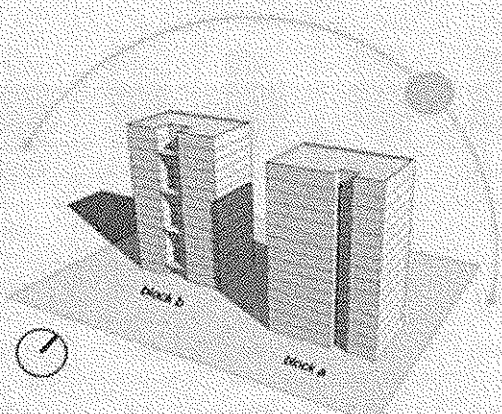
SELF-SHADING: REVEALS IN BUILDINGS SHADE WALLS OR EXTERNAL AREAS

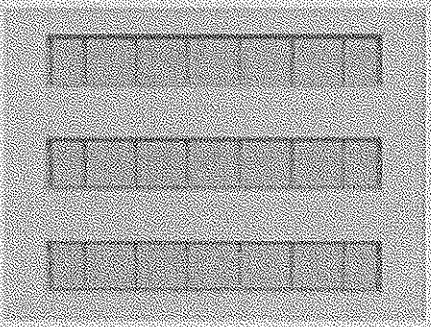


- Other strategies for self-shading include:
  - Any building mass or overhang will produce a shadow / shade at some time during the day [Figure 18]. Understanding this and how the shadows / shade materialise can help to optimise the massing and orientation of the building(s). For example, an exterior courtyard is shaded in the afternoon hours (the hottest time of the day) or that a building is rotated just off 'true north' to help shade it from the afternoon sun

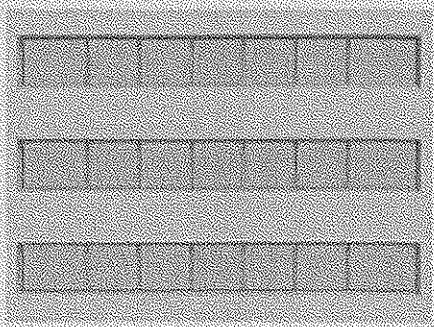
WINDOW-TO-WALL RATIO

Adjusting the window-to-wall ratio (WWR) of the building envelope affects the amount of heat entering a space

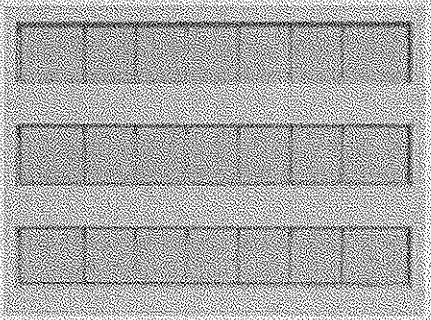
WINDOW AREA = 40%
WALL AREA = 60%



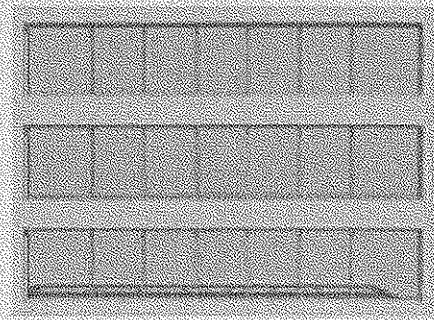
WINDOW AREA = 50%
WALL AREA = 50%



WINDOW AREA = 60%
WALL AREA = 40%



WINDOW AREA = 70%
WALL AREA = 30%



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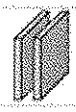
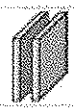
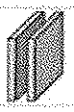
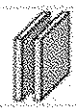
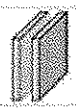
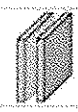
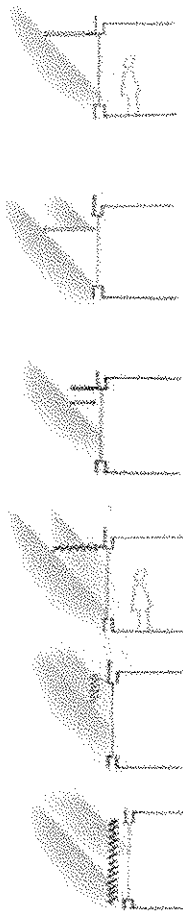
Examples of Achievable Glazing Performance

Double Glazing (Vertical)

Glazing Terminology	Uncoated	Reflective Hard Low-E	Hard Low-E	Soft Low-E	Reflective Low-E	Fritted Glass + Low-E	Fritted Glass + Low-E	Fritted Glass + Low-E
	G1	G2	G3	G4	G5	G6	G7	G8
Glazing Layout All glass thickness = 6 mm Airfilled Cavity = 12 mm Glass - Low-E Coating - Selective Interlayer - Fritted Coating-								
U-value * Achievable centre of pane value	2.8 W/m²K	2.0 W/m²K	1.9 W/m²K	1.6 W/m²K	1.6 W/m²K	1.6 W/m²K	1.6 W/m²K	1.6 W/m²K
Shading Coefficient	0.81	0.64	0.71	0.45	0.33	0.39	0.33	0.28
T_L Visible Light Transmittance	0.79	0.60	0.73	0.68	0.42	0.59	0.49	0.38
T_{Sol} Solar Transmittance	0.61	0.46	0.52	0.33	0.23	0.27	0.22	0.17
R_{Vis1} External Visible Light Reflectance	0.14	0.29	0.16	0.10	0.34	0.15	0.20	0.25
R_{Vis2} Internal Visible Light Reflectance	0.14	0.31	0.17	0.11	0.14	0.16	0.22	0.28
STC/OITC (db)	35/30	35/30	35/30	35/30	35/30	35/30	35/30	35/30

*All values are calculated as centre of pane values for vertical applications. Spacer bars, frames and edge effects will increase the overall U value of the glazing unit.

NB. Performance data (except acoustic) has been calculated using the LBNL Window 6.3a Software with environmental conditions NFRC 100-2001 Summer.



HORIZONTAL OVERHANG

- Simple to construct
- Effectively blocks high-angle sun
- Ineffective in blocking low-angle east and west sun
- Requires maintenance as leaves and bird droppings may reside on i

HORIZONTAL OVERHANG BELOW WINDOW HEAD

- Simple to construct
- Blocks high angle sun
- Also acts as a light shelf and brings more diffuse light in
- Ineffective in blocking low-angle east and west sun
- Requires maintenance as leaves and birds dropping may reside on i

MULTIPLE SHALLOW OVERHANGS

- Blocks high-angle sun within vision panel
- Exposes lower portion of glazing to direct solar radiation
- Can also act as a small light shelf
- Ineffective in blocking low-angle east and west sun
- Requires some maintenance

LOUVERED OVERHANG

- Blocks high-angle sun and diffuses sunlight effectively
- More complicated form, hence more maintenance
- Ineffective in blocking low-angle east and west sun

LOUVERED SCREEN

- Blocks low-angle east and west sun only at high-level
- Exposes lower portion of glazing to direct solar radiation
- More complicated form, hence more maintenance

FULL-HEIGHT LOUVERED SCREEN

- Blocks low-angle east and west sun
- Diffuses light effectively to create even daylighting
- More complicated form, hence more maintenance
- Obstructs views to the outdoors

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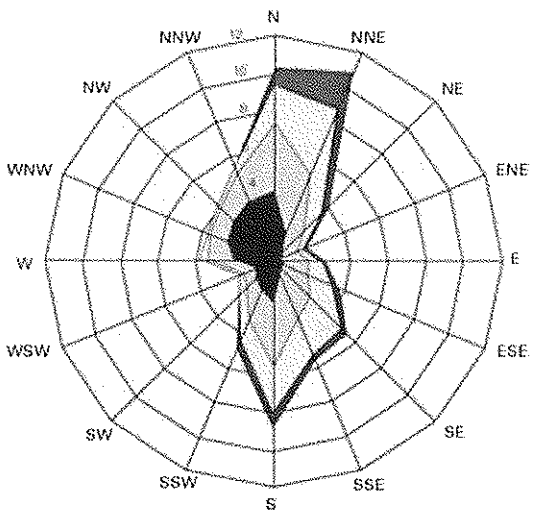
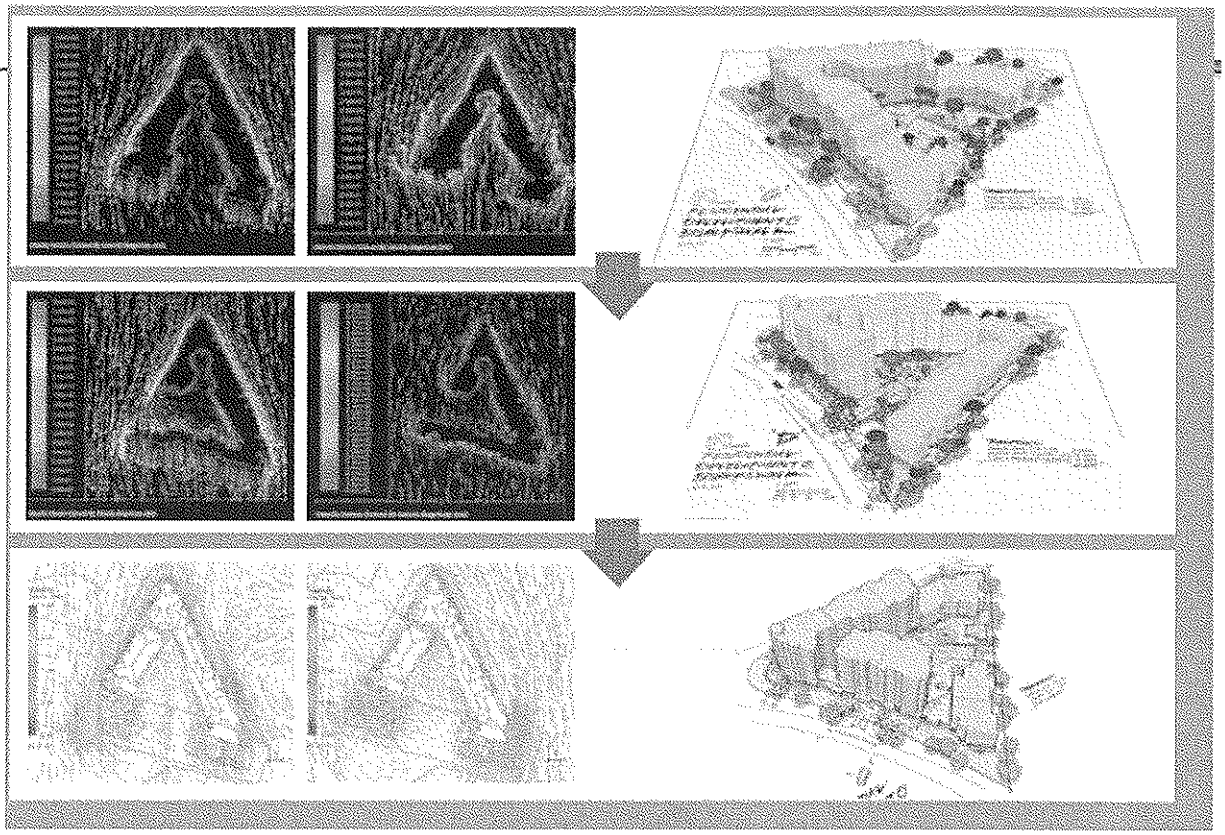
FOR NATURAL VENTILATION

At the initial planning, it is critical to take advantage of existing wind conditions and site-specific conditions as these will impact the massing and planning decisions.

In Singapore, wind directions are predominantly N-NNE and S-SSE throughout the year depending on the monsoon season. Although Singapore generally has low wind speeds, the velocities achieved are enough to provide comfort to spaces with the help of optimised design. Please refer to the table below for annual wind speed information

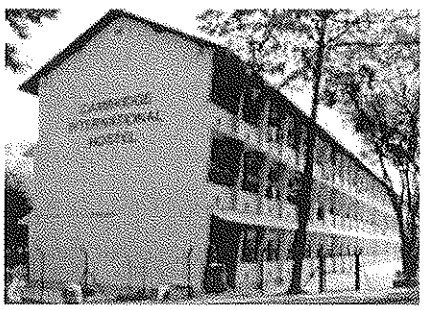


WIND SPEED (m/s)	ANNUAL % OF TIME
< 0.3	20.2
0.3 - 1.5	25.6
1.6 - 3.3	28.1
3.4 - 5.4	20.5
5.5 - 7.9	5.5
8.0 - 10.7	0.1
10.8 - 13.8	< 0.1

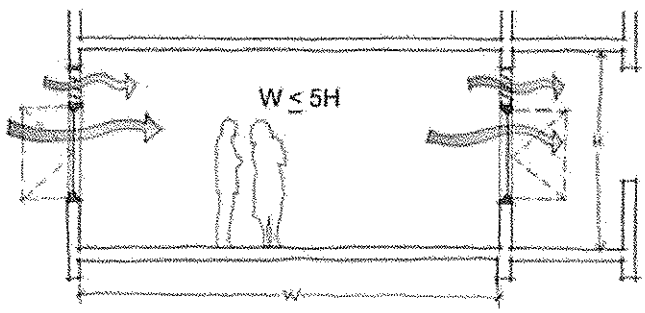


Design naturally ventilated spaces with single loaded corridors or narrow floor plate depths to encourage air flow. The narrower the floor plate, the easier it is to achieve effective cross ventilation

SINGLE LOADED CORRIDOR BUILDING

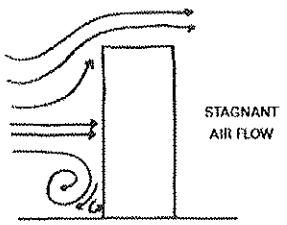


CROSS VENTILATION DIAGRAM

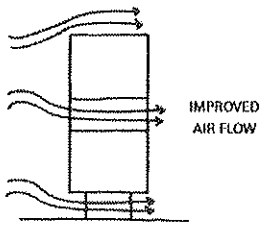


Provide void decks at the ground floor, higher floor-to-floor heights and/or void spaces in between buildings to encourage air flow through and around buildings. This helps to mitigate stagnant air flow areas

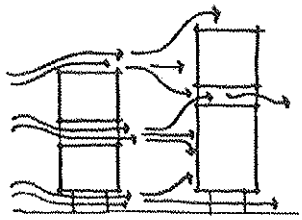
TYPICAL BUILDING: SOLID MASSING



BUILDING WITH VOID DECKS



MULTIPLE BLOCK CONFIGURATION: STAGGER BUILDING HEIGHTS AND VOID DECKS FOR BETTER AIR FLOW



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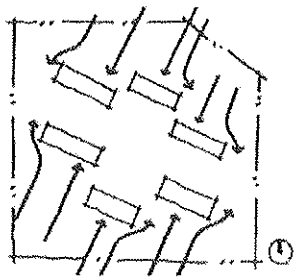
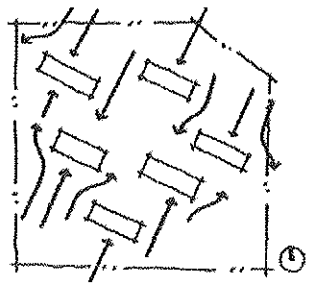
However, simply sticking to the NE / SW wind direction assumption may prove wrong on certain sites. The following conditions may affect the wind direction:

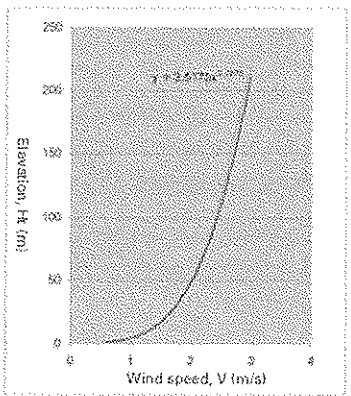
BLOCK CONFIGURATION 1



BLOCK CONFIGURATION 2



- The buildings adjacent and around your site. They can serve to create different wind directions. For instance, in the city area e.g. Central Business District (CBD), wind directions vary significantly due to the number of tall buildings in the area that redirect wind flows. Similarly, in a project with multiple blocks, simply orienting the buildings to NE / SW does not ensure good natural ventilation

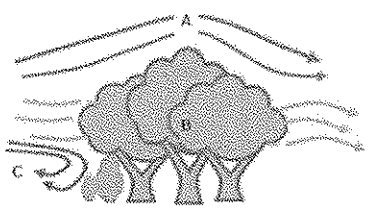


VARIATIONS WITH HEIGHT

Wind speed varies with height where its intensity increases exponentially with the height from the ground. Typically at 100 m above the ground, the wind speed may rise up to 2.5 m/s. The wind profile power law is usually used to determine wind speeds at greater heights.

WIND FLOW AROUND VEGETATION

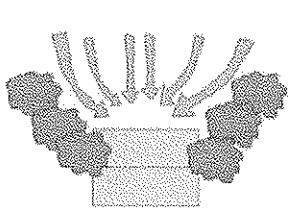
The form, density and rigidity of vegetation will affect air movement differently. They may even reduce the heat content of the air passing through its foliage to bring about a temperature reduction of the wind. Shrubs outside a window can also create positive and negative pressure zones, thereby channelling and increasing the wind velocity as it enters the room.



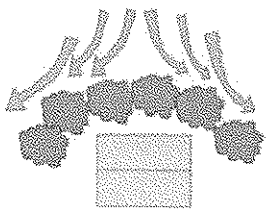
A: Wind guided over tree

B: Wind is slowed down and distributed depending on tree's porosity

C: Wind is obstructed and deflected



Plan view



Plan view



TOOLS FOR AIRFLOW PREDICTION AND ASSESSMENT

The commonly used tools for the study of airflow are wind tunnel testing and Computational Fluid Dynamics (CFD) simulation. Unlike wind tunnel testing, CFD simulation is based on computer modelling and hence allows wind patterns due to each design change to be studied quickly.

WIND TUNNEL

In wind tunnel testing, scaled models (usually 1:500) are placed in the wind tunnel and subjected to wind effects generated by a fan unit placed at the end of the wind tunnel | Wind sensors are then placed at areas where wind velocities and pressures are monitored. Though it allows data on wind movements and velocities around and in building to be assessed, the method is typically expensive and tedious since scaled models of the building have to be made and tested under laboratory conditions.

A qualitative investigation of the effect of wind movement around and in a building is usually made using visual assessment aided by photographic and flow visualisation techniques. A quantitative investigation obtains point velocities in and around buildings. This can also be made usually for wind-load considerations of high rise buildings.

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Recommended wind velocity for use as boundary conditions.

NORTH	2.0 m/s
NORTHEAST	2.9 m/s
EAST	3.0 m/s
SOUTHEAST	3.2 m/s
SOUTH	2.8 m/s
SOUTHWEST	2.3 m/s
WEST	1.8 m/s
NORTHWEST	1.4 m/s

COMPUTATIONAL FLUID DYNAMICS (CFD) SIMULATION

Computational Fluid Dynamics (CFD) simulation is an alternative tool to predict wind movement accurately. It allows the impact of design changes to be effectively studied before the design is confirmed.

CFD simulation generally involves 3 stages:

1 » Pre-processing. This is the first step in building and analysing a flow model. It includes building the model, creating and applying computational mesh, and entering flow boundary conditions. Typical flow boundary conditions generally applicable for use in Singapore include:

- Flow domain with minimum 3 times the characteristic lengths of development buildings.
- Mesh density at estate level set at 10 m at far field.
- Finer resolutions mesh of 0.5 - 1 m near buildings and at ground level.

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CASE STUDY
Natural Ventilation

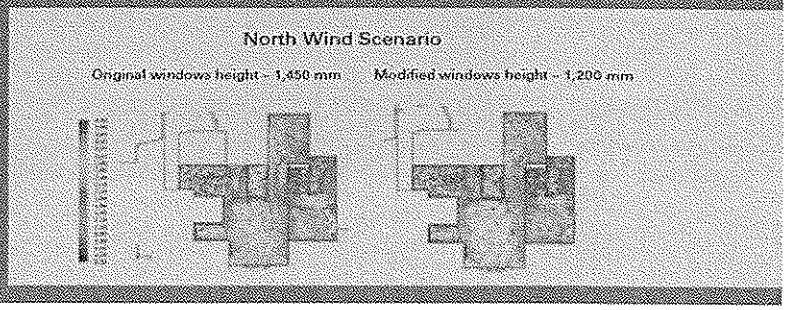
VOLARI CONDOMINIUM
12 BALMORIAL ROAD
SINGAPORE 259870

- 1 block of 12 storey residential development
- Total of 85 units
- Targeting Green Mark Platinum certification

Key initiatives to improve natural ventilation in residential units:

- Extensive airflow simulations were conducted to assist in design development and ensure good natural ventilation.
- Simulations were used in one particular instance to study if changes in window opening sizes would affect airflow velocities and profiles.
- It was noted that under prevailing South wind conditions, the reduction in opening sizes resulted in a 30% reduction in air velocities. However, the wind velocities remained within comfort ranges.
- The simulations assisted the designers in determining the optimum window sizing for comfort conditions.





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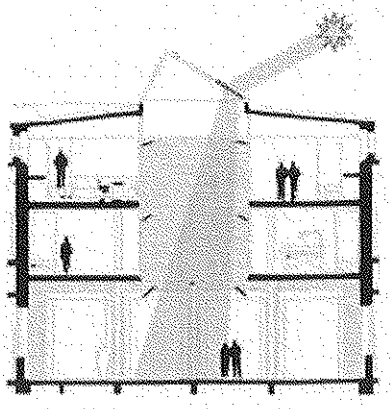

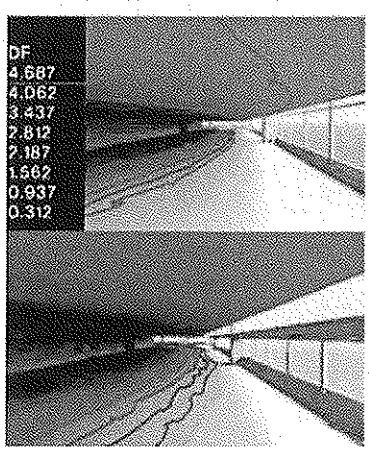

DAYLIGHT AND GLARE

The presence of adequate daylight has been shown to be both beneficial for reducing the reliance on artificial lighting, and for occupant health and well-being. Good lighting design maximises the use of natural daylight to provide illumination. This minimises electrical lighting consumption and reduces internal heat gains from luminaires.

Good daylighting strategies and concepts are also discussed in the guide on BUILDING SYSTEMS.

When designing windows or openings for daylighting, it is good to consider some guidelines established from architectural practice and analysis of light in buildings:

Glazing that stands above 2,100 mm is considered 'daylight panels' – these are the parts of a window that are most effective in bringing daylight into a space. The closer a panel is to the ceiling, the more effective it is in providing natural daylight.

Light shelves help to improve daylighting by throwing reflected daylight further into a space . They can also provide shading and reduce glare in the perimeter zone. In this manner, light shelves help achieve a greater uniformity in daylight distribution on the working plane.

Window blinds are another means to modulate daylight and reduce glare. These are often manual systems which allow individual control. This enables users to block out unwanted daylight and glare during sunny days. However, oftentimes blinds remain drawn even during cloudy or overcast days. This reduces the daylighting potential of the window, and increases reliance on artificial lighting. Because of this, it is best to have blinds automated, with manual overrides for individual users. This ensures that the blinds are drawn up automatically during the day to maximise daylighting.

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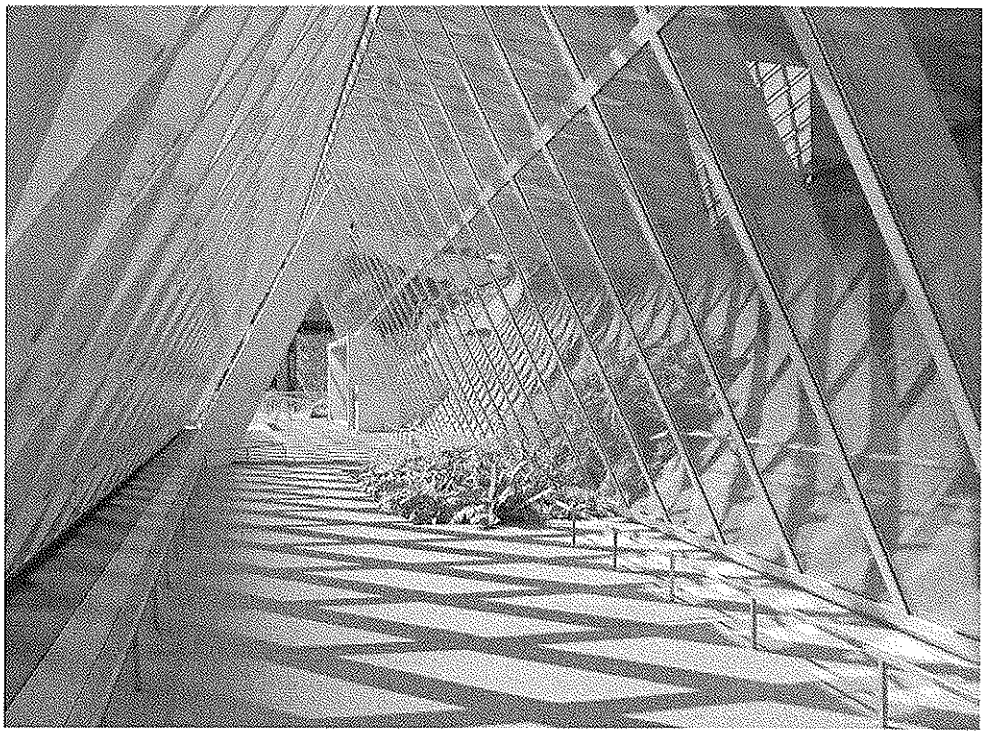
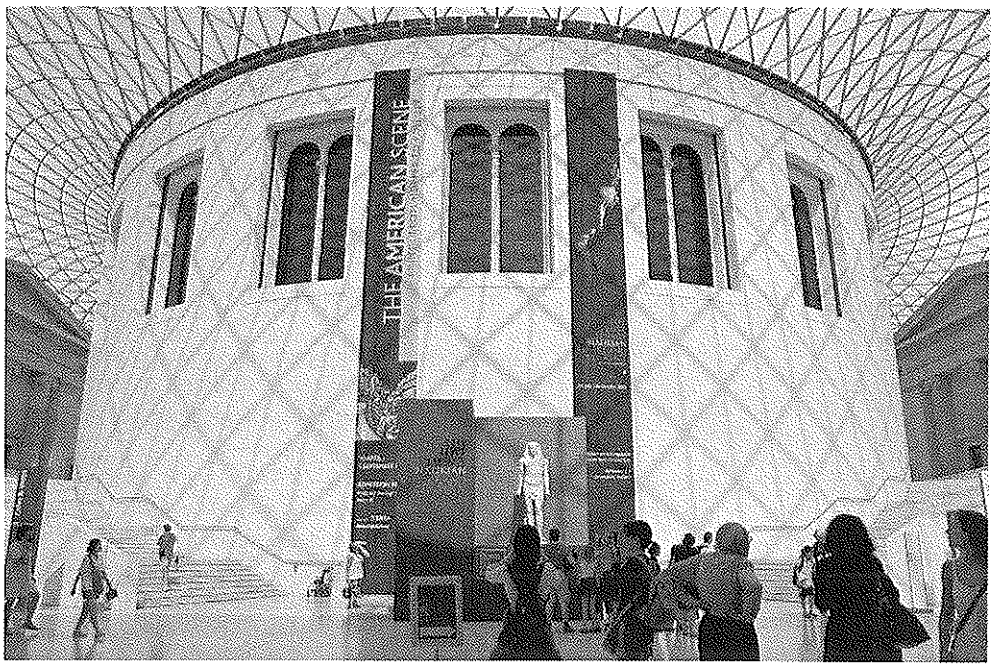
Light can be use to reveal EXPERIENCE



Seattle Public Library | Rem Koolhaas

BCA ACADEMY of the built environment

Light can be use to reveal SPACE



British Museum, Norman Foster

Light can be used to reveal MEANING

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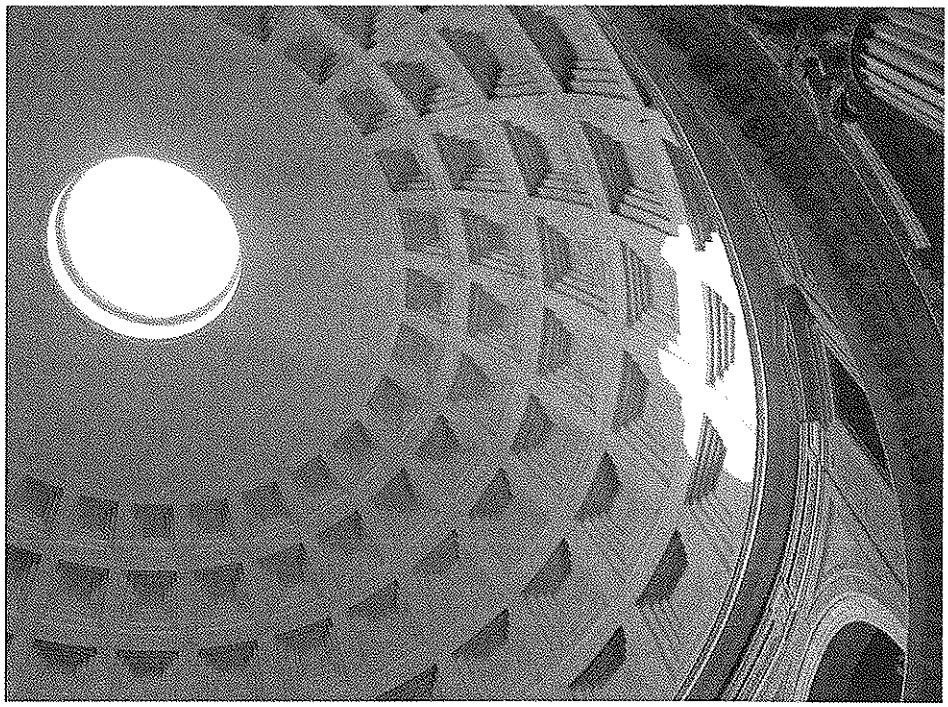
of the built environment



The Pantheon, Rome

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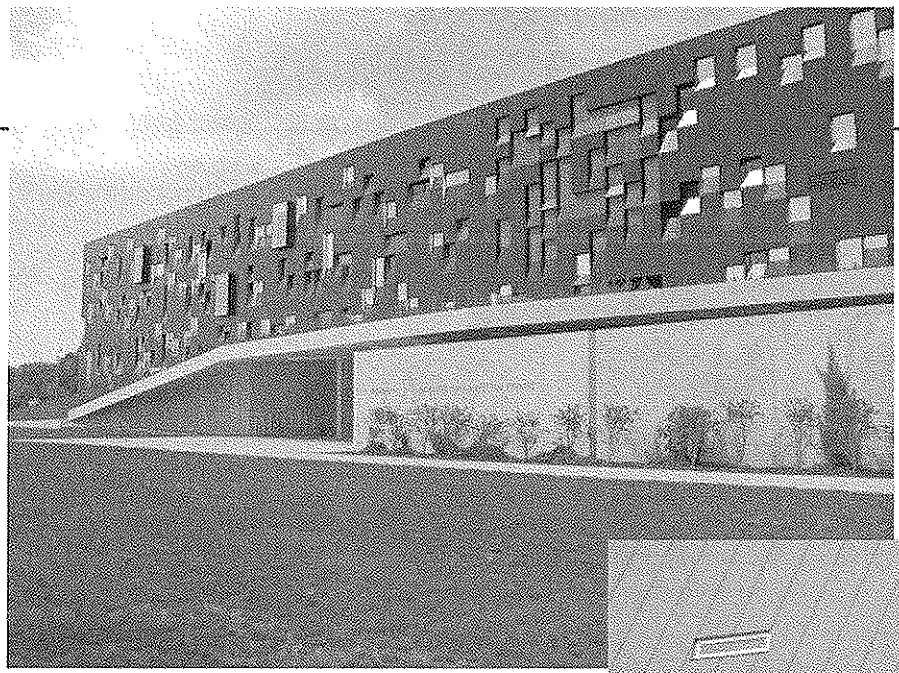
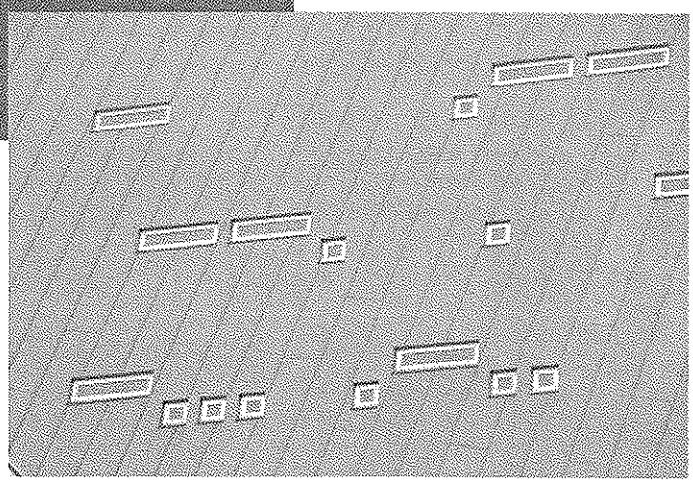
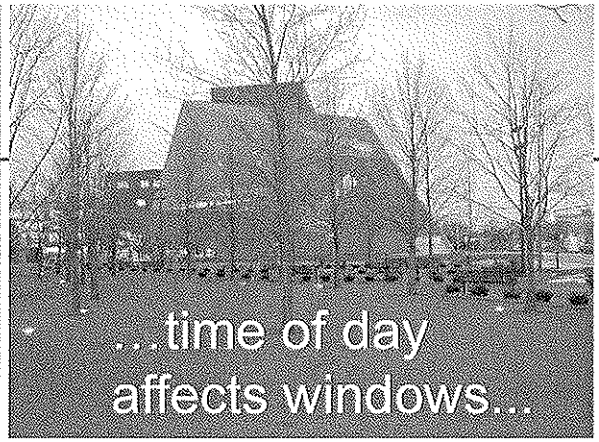
of the built environment

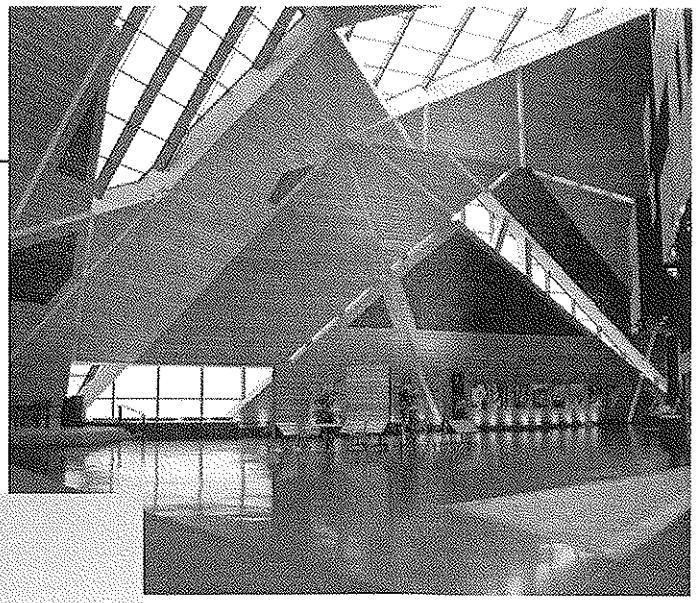


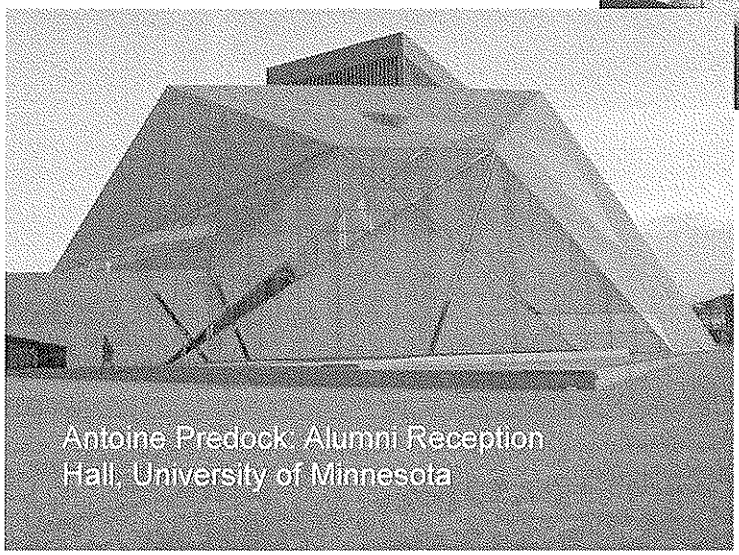
There are large numbers of buildings that treat windows as patterning devices, and that do not take advantage of the sun in *obvious* ways.

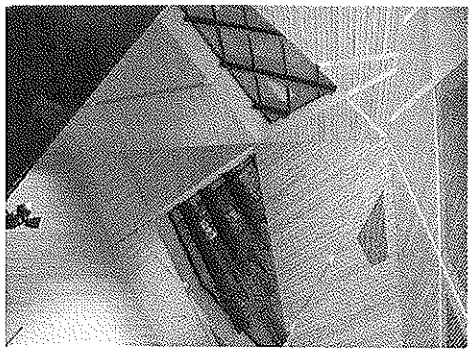
In fact, the windows at the right ARE Morse Code.











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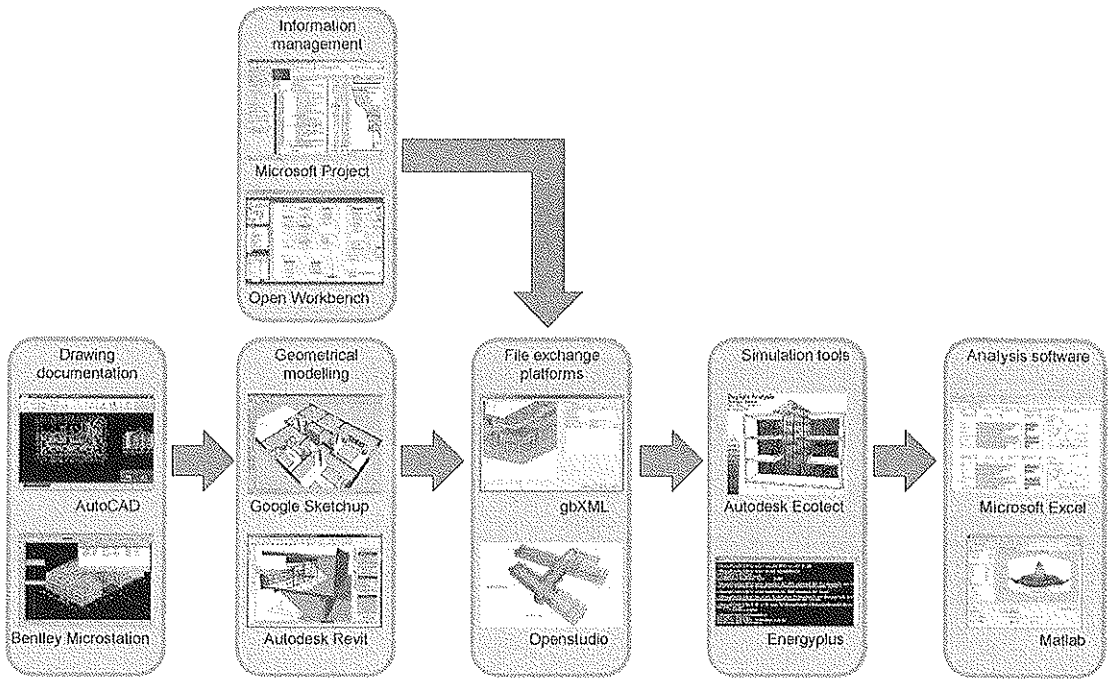
Quantitative design evaluation

Plethora of simulation tools, which to use? Which works well with my modelling software?



Quantitative design evaluation

Various software tools for each stage of the simulation process



Interoperability problems

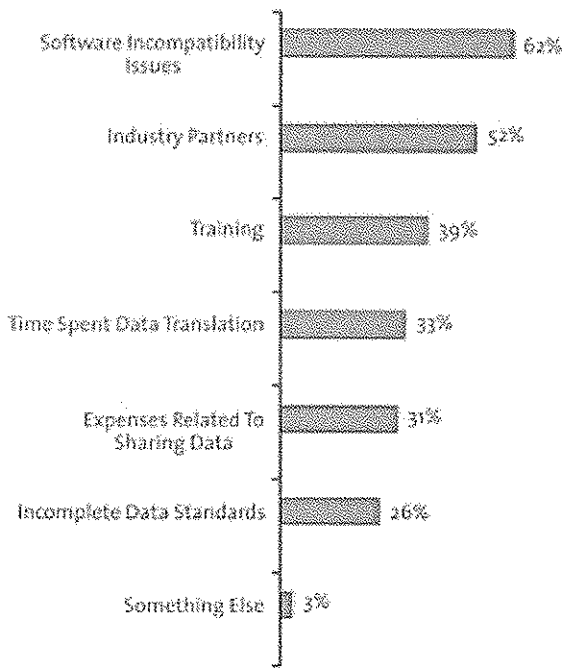
Data Exchange critical to Construction

July 2007 survey of 295 companies*

*Equal % Architects, Engineers, Contractors, Owners

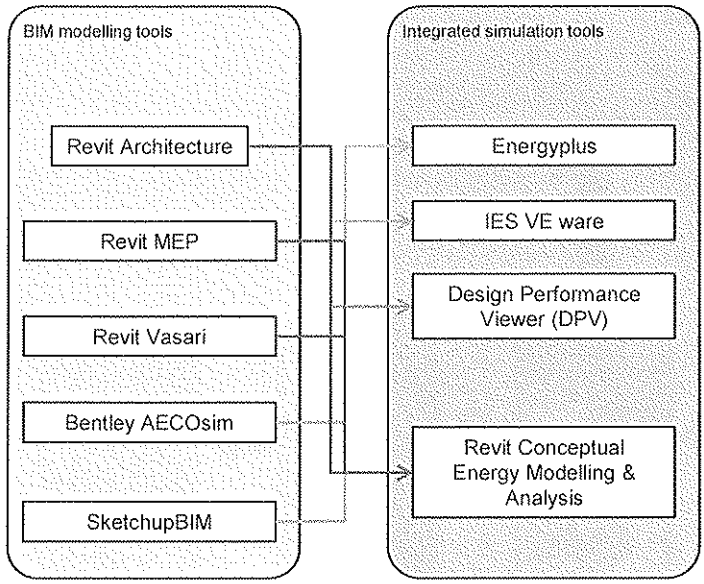
Common obstacles to effective information exchange:

- Incompatible software tools
- Partners different information formats
- Time data translation
- Costs for sharing



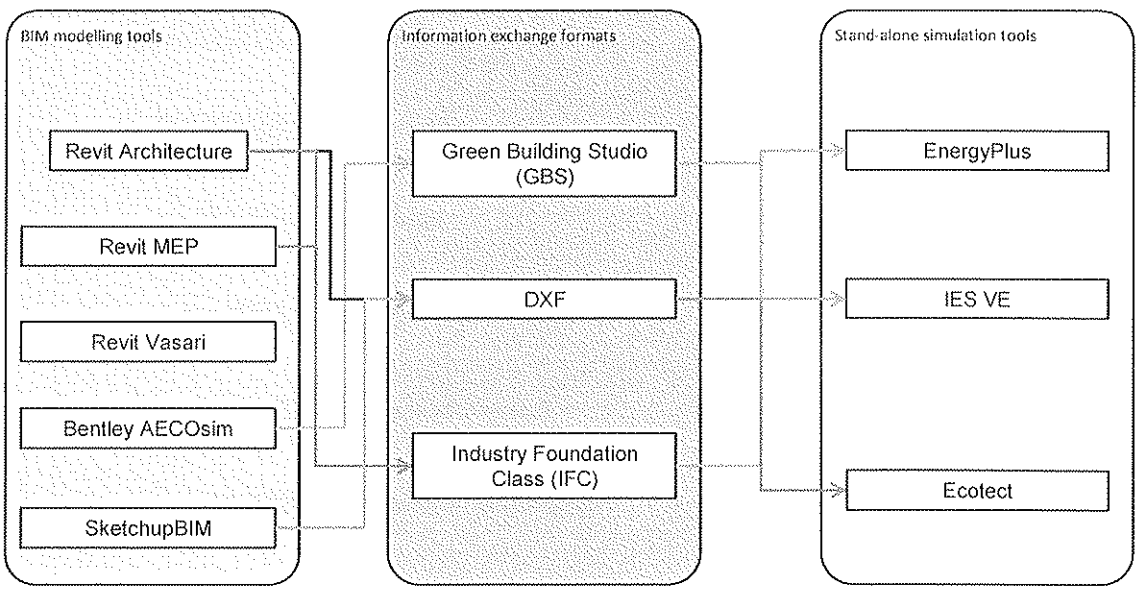
Data Source: McGraw-Hill Construction

Levels of interoperability



Levels of interoperability

Sustainability Holistic thinking Quantitative design (simulation) Applying BIM Case studies



So many tools, which to use?

Common questions:

- Which BIM software to use?
- How much must I model?
- Which file exchange format should I use?

Approaches:

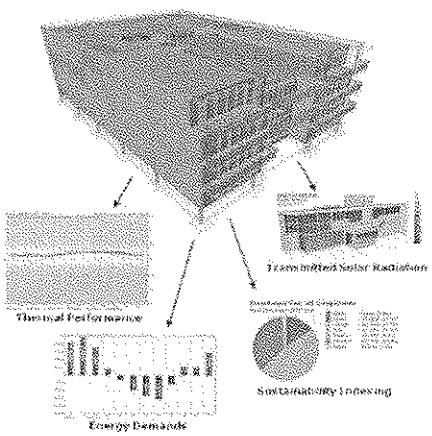
- Know what is your intent and design question
- Know what each simulation tool can do for you
- Be consistent and systematic
- What is your acceptable level of accuracy

So many tools, which to use?

Approaches:

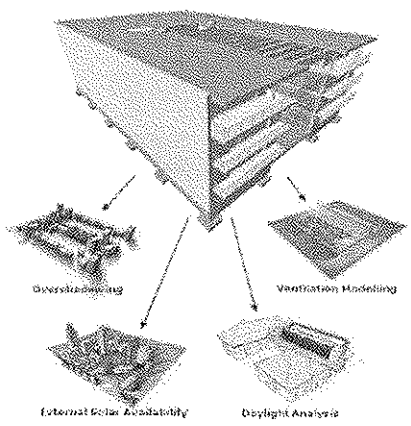
- Know what is your intent and design question
- Know what each simulation tool can do for you

Zone & Space-based model



- Thermal performance
- Energy dynamics
- Acoustics performance
- Transmitted solar radiation

Geometry-based model



- Shadows & overshadowing
- Air flow & ventilation
- Lighting analysis
- External solar availability

So many tools, which to use?

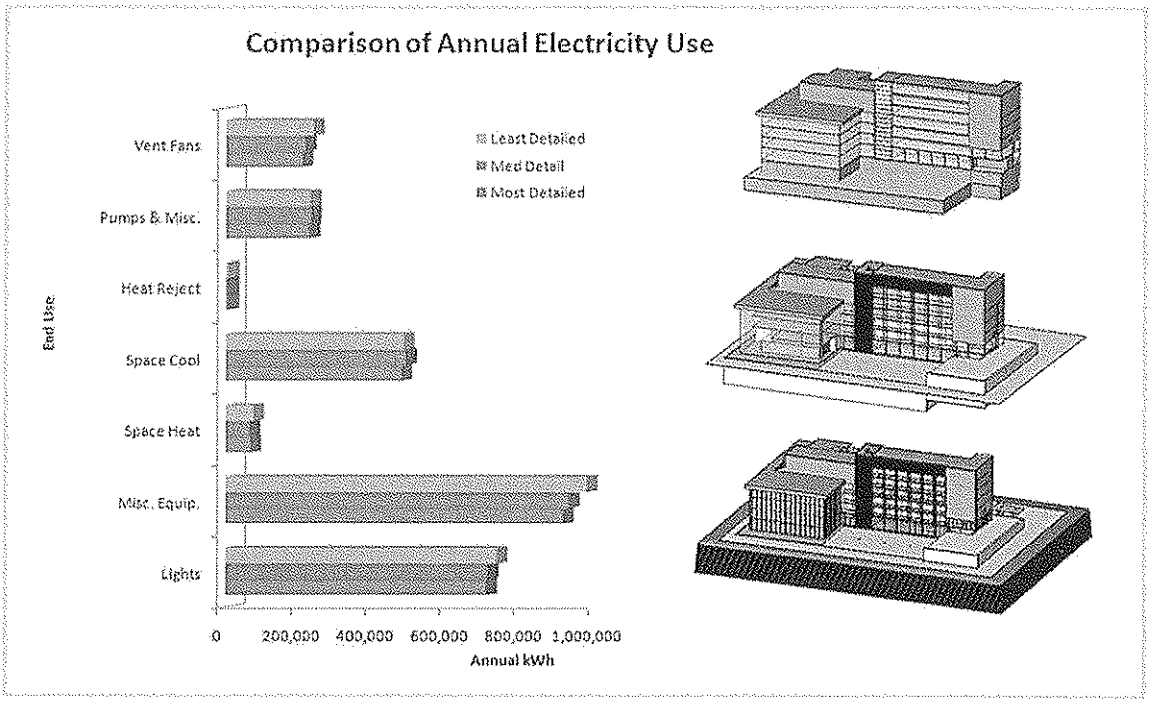
General Guidelines:

Simulation Types	Building Model
CFD	Ifc, stl, dxf, skp
Energy/Thermal Modelling	gbXML, ifc
Daylight / Shadow / Solar	Ifc, skp, stl, dxf

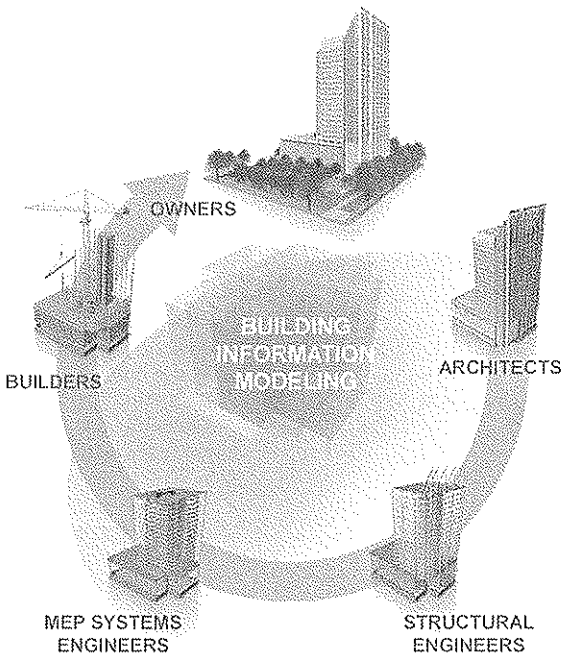
So many tools, which to use?

Approaches:

- Be consistent and systematic
- What is your acceptable level of accuracy



Benefits of BIM in sustainable design



BIM is a Catalyst for Efficient and Effective Sustainable Design

- Holistic design approach, supports collaborative process
- Consistent data exchange & communication among stakeholders
- Minimized redundancies, improved efficiencies
- Incremental design optimization

BCA ACADEMY of the built environment

Principles of sustainable design

	Principles	Strategies
Energy	Improved efficiency Reduced demand Minimize operating energy Renewable resources	Spatial organization Solar heating & photovoltaic Smart technologies – HVAC, lighting, equipment Organizational behavior
Water	Improved efficiency Reduced demand Renewable resources	Potable water supply Grey water management Rainwater harvesting Eco-sanitation
Occupant	Occupancy comfort – physiology & psychology	Thermal, visual, acoustical comfort Indoor air quality
Materials	Efficient use Sustainable resource flow Renewable resources	Sustainable materials for structure, envelope, finishes Smart facades Design for disassembly & reuse
Site	Low impact development Urban planning & consideration	Sustainable use of site Greening spaces

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Quantitative design evaluation

Sustainability | Holistic thinking | Quantitative design (simulation) | Applying BIM | Case studies

	Strategies	Performance quantification methods
Energy	Spatial organization Solar heating & photovoltaic Smart technologies – HVAC, lighting, equipment Organizational behavior	Energy simulation Performance benchmarking
Water	Potable water supply Grey water management Rainwater harvesting Eco-sanitation	Water usage calculation
Occupant	Thermal, visual, acoustical comfort Indoor air quality	Psychometric chart Indoor environment evaluation Thermal, Visual, Daylight simulation Acoustical simulation Performance benchmarking
Materials	Sustainable materials for structure, envelope, finishes Smart facades Design for disassembly & reuse	Life-cycle assessments Embodied energy Thermal calculations
Site	Sustainable use of site Greening spaces	Urban heat island calculation Green plot ratio Proximity analysis

THANK YOU!

Dr. Alex K.H Lee | CEO (Asia) BIM HVACTool

a.lee@building-engineering.de

https://www.dial.de · daylight & lighting modelling.

1. shadow
2. solar
3. acoustic
4. ventilation
5. PMV/PPD

BIM Design Analysis (Structural Analysis)

Presented by :

Sonny ANDALIS
sonny_andalis@bca.gov.sg

BCA ACADEMY
of the built environment

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Agenda

- Structural Analysis - Current vs BIM Approach
- BIM Maturity
  - Modeling, Analysis Interoperability, Detailing
- BIM C&S Scope
- BIM Structural Analysis Interoperability- Theory
  - Integration vs Interoperability
  - Design Coordination vs Validation
- BIM Structural Analysis Interoperability-Examples
- BIM Structural Detailing
  - Rebars & Tendons
  - Weld & Bolts

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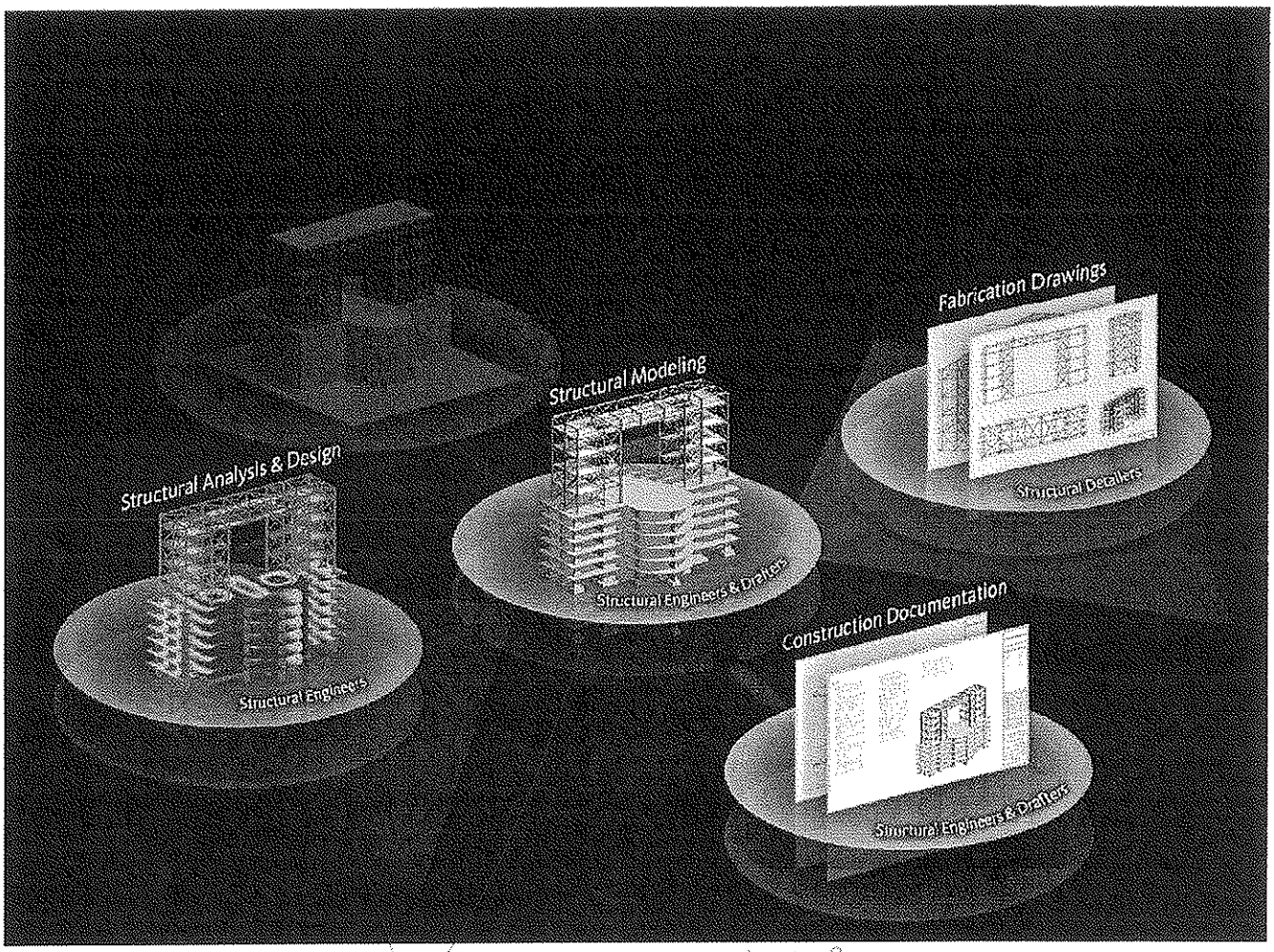
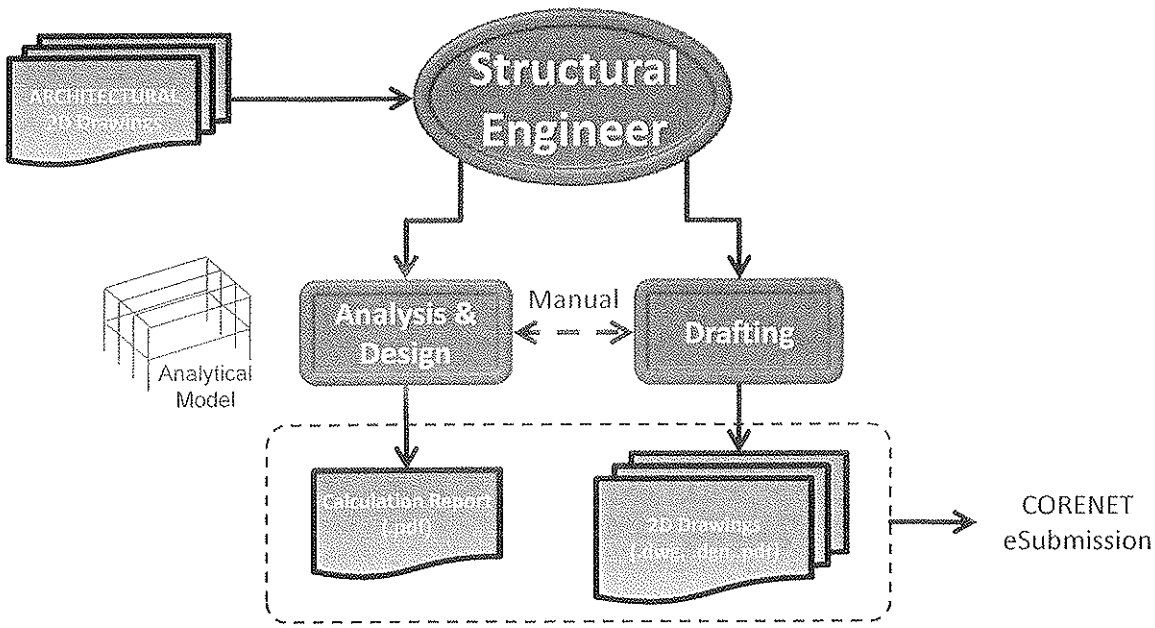


CAD/BIM SIMULTANEOUSLY. PHYSICAL MODEL? ANALYTICAL MODEL?

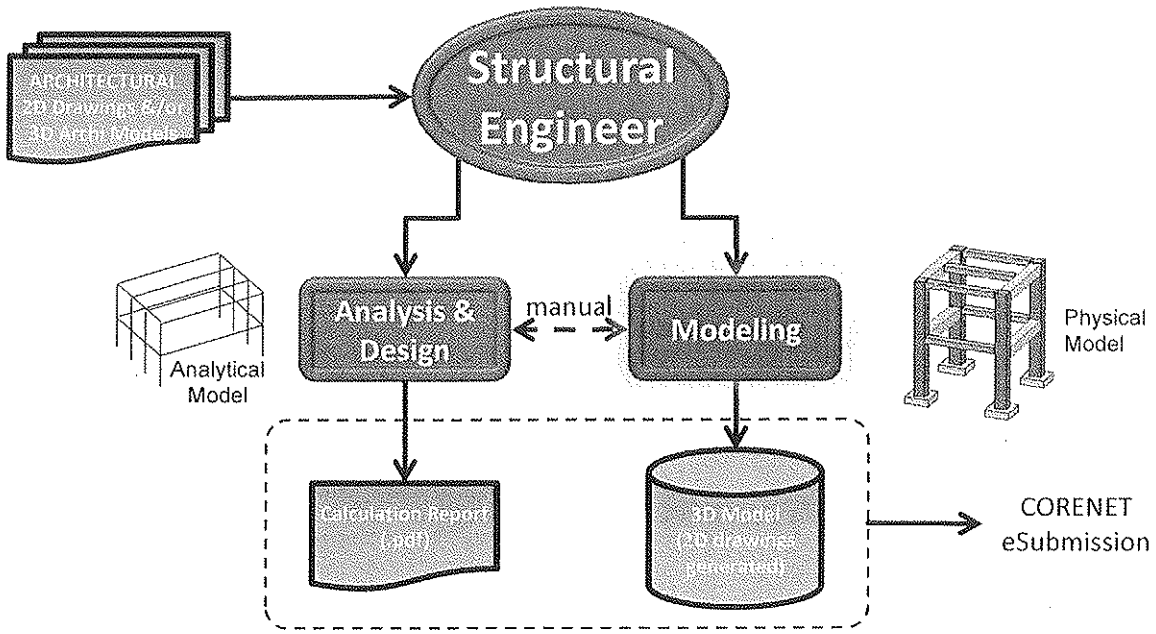
STRUCTURAL BIM TO MEP → INSTALLATION DWGS.
→ FABRICATION DWGS

Current VS BIM

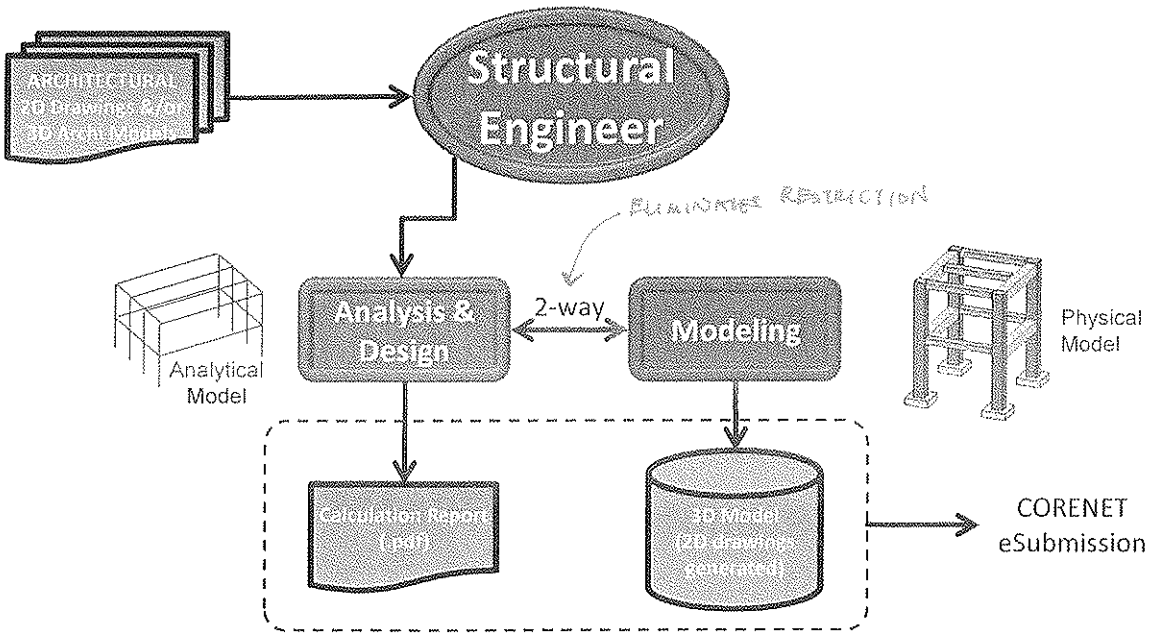
Current 2D Workflow (Typical)



Current BIM Workflow



Expected BIM Practices



BIM Maturity

- PHASE 1-Modeling

1 → Structural BIM model
Output: 3D Model & 2D Submission Drawings (.pdf/dwf)

- PHASE 2- Analysis Interoperability

2 → Transfer of Physical to Analytical Models
Output: Calculation Report(.pdf)
& Analytical Models (.std, edb, rtd etc)

- PHASE 3- Detailing

3 → Connections/Fabrication/Erection
Output: Rebar & Steel Detail Drawings
(.pdf/dwf)

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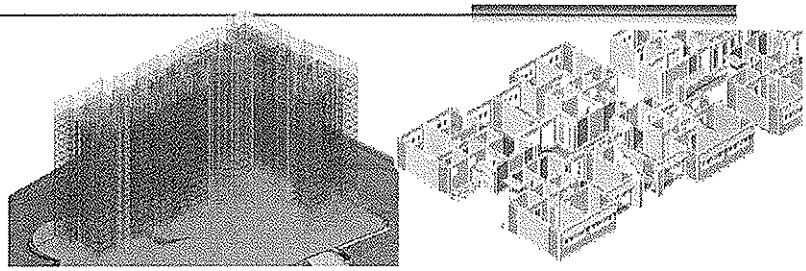
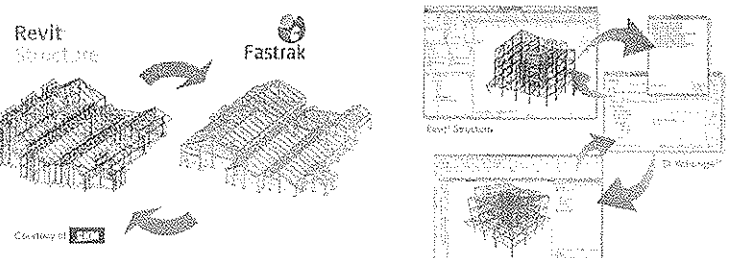
BIM Maturity

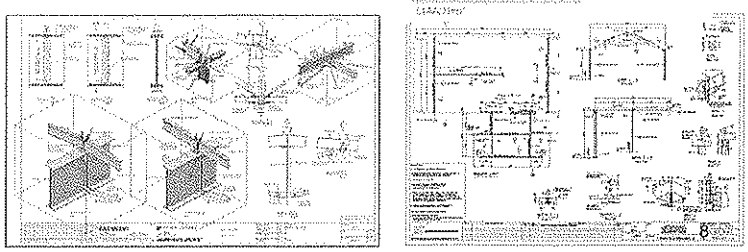
- Level 1-Modeling



- Level 2- Analysis



- Level 3- Detailing



BIM in Singapore

Architectural BIM e-Submission
Agencies (BCA, URA, FSSD, CEPU, PUB, LTA, NParks, HDB, JTC)
accepted since 25 Jan 2010
Mandatory by 2013 for projects >20,000 m2

2013

Structural BIM e-Submission
Agency (BCA)
accepted since 01 April 2011
Mandatory by 2014 for projects >20,000 m2

2014

All BIM e-Submission
Mandatory for projects >5,000 m2
(Gross Floor Area)

2015

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Building environment

BIM Scope

CAD eSubmission

- Submission Drawings (2D)
- Calculation Report (2D)

Future BIM eSubmission

- Submission Drawings (2D)
- Calculation Report (2D)
- BIM Model (3D)
- Analysis Native File (3D)

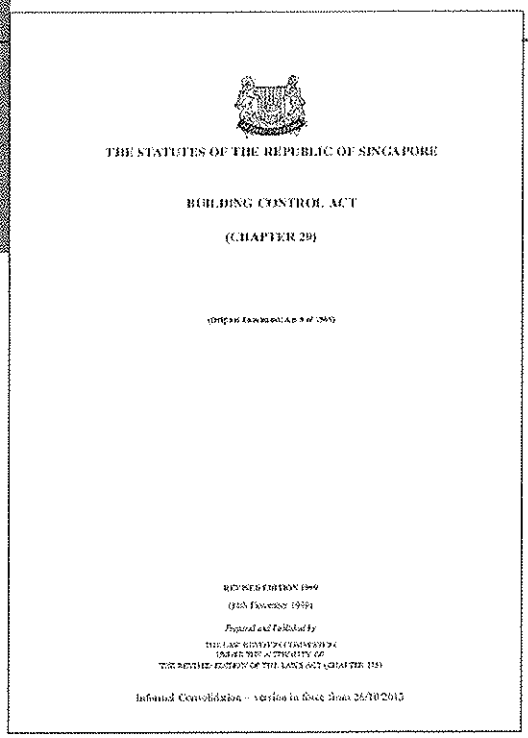
BIM eSubmission

- Submission Drawings (2D)
- Calculation Report (2D)
- BIM Model (3D)

← NOT IN LEGAL DOCUMENT

BCA ACADEMY
Building environment

What is Required?

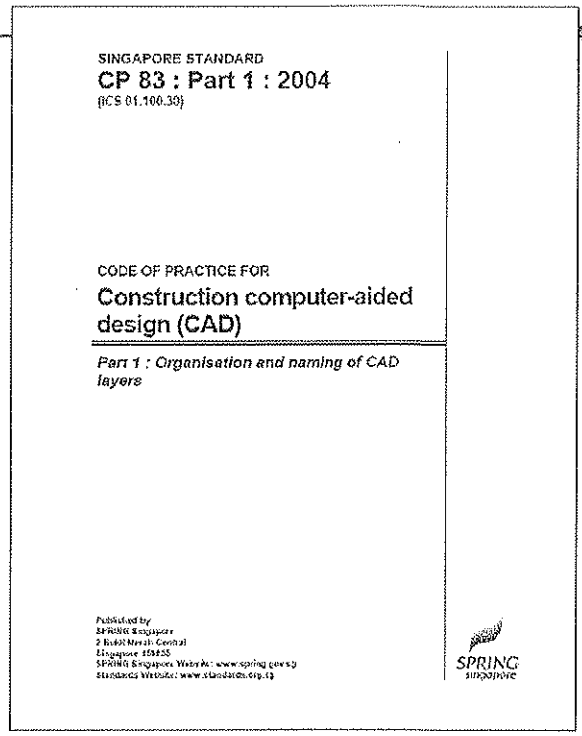


THE STATUTES OF THE REPUBLIC OF SINGAPORE

BUILDING CONTROL ACT

(CHAPTER 29)

Informal Consolidation – version in force from 26/10/2013



SINGAPORE STANDARD

CP 83 : Part 1 : 2004

CODE OF PRACTICE FOR

Construction computer-aided design (CAD)

Part 1 : Organisation and naming of CAD layers

SPRING singapore

Building Control Act and Singapore Standards (SS)

BCA ACADEMY
Building environment

What is Required?

Typical ST Drawings Contents

- General Notes
- Typ. Details for Slab, Beam, Columns and Walls
- Typ. Details of Staircase, Openings, Connections & Joints

- Layout of Piles, Grade Beams, Mat Foundation
- Typ. Details of Pilecap, Footing and Earth Retaining & Stabilizing Structures (RC)

- 1st Storey Plan, 2nd Storey Plan, 3rd Storey Plan, Roof Plan
- North, South, East & West Elevations
- Longitudinal and Cross Sections
- Column, Beam and Slab Schedules

What is Required?

Typical ST eSubmission Package

- Architectural Drawings
  (for reference)
- Structural Drawings
  - General Assemblies (FP, EL, CS, LS)
  - Schedules (Beam, Column, Slab etc)
  - Detail Drawings (rebars, welds, bolts)
- Calculations Report
  - Foundation Design
  - Global Frame Analysis
  - Element Design & Sizing
  - Connections Design (rebars & steel joints)
  - Manual Calculations

S-BIM Phase 1

S-BIM Phase 3

S-BIM Phase 2

Structural Analysis Engines

SPECIFIC SOFTWARES FOR DIFFERENT ANALYSIS.

Autodesk

Autodesk Robot Structural Analysis Professional

Bentley Sustaining Infrastructure

STAAD.Pro V8i

RAM Structural System V8i

CSC

CSC Orion
The complete solution for concrete building systems

Fastrak
Structural Steelwork Analysis and Design

CSi COMPUTERS & STRUCTURES, INC.

ETABS

SAP2000

S-FRAME SOFTWARE

ESTEEM 8
The Ultimate Reinforced Concrete

PROKON Software Consultants

Scia Engineer

MIDAS

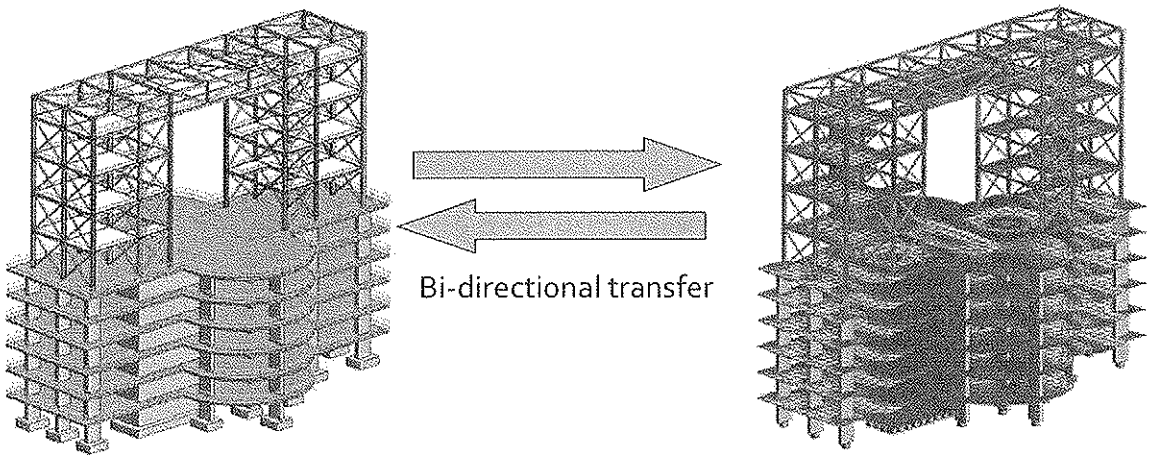
SOFiSTiK

Dlubal

Oasys

SPACE GASS
Structural Engineering Software

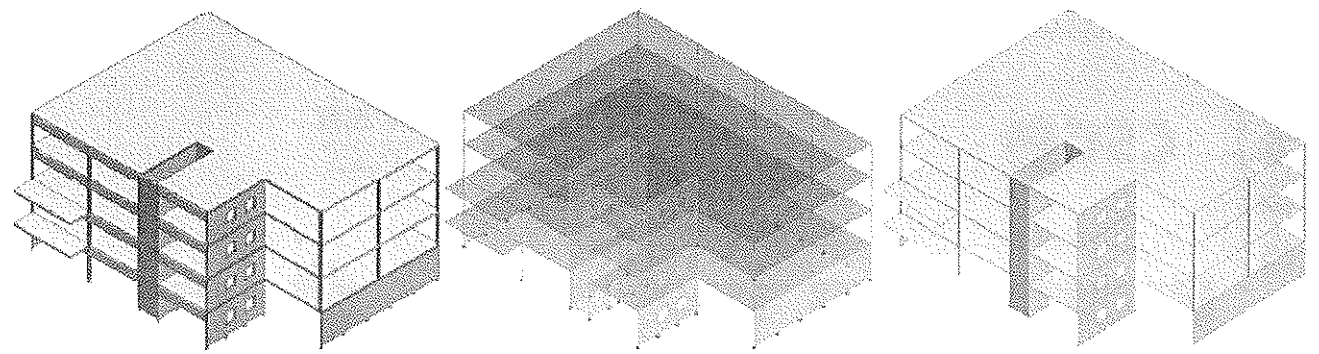
Stru BIM Interoperability



3D BIM Physical Model

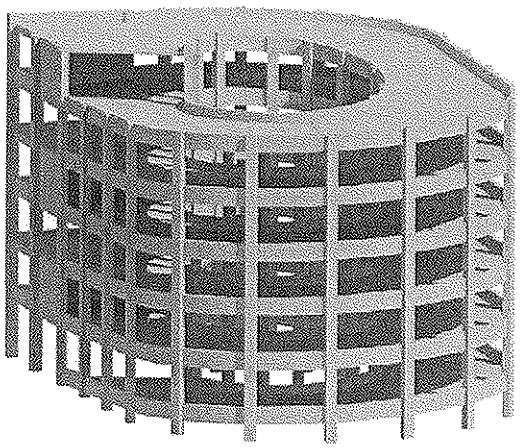
Equivalent 3D Analytical Model exported to Analysis Engines

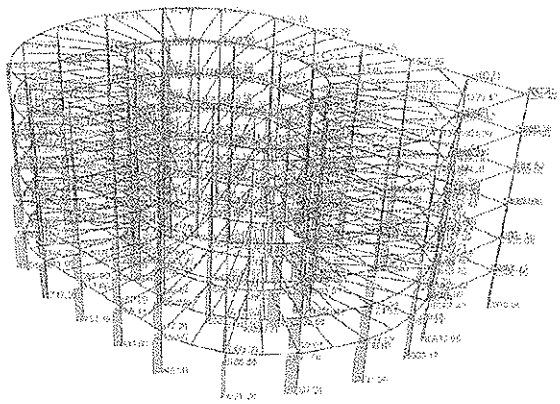
Stru BIM Interoperability



Physical model in Revit Structure | Analytical model in Revit Structure | Model exported to FEM-Design

Stru BIM Interoperability





KWE Jurong West Project-Double Spiral Container Ramp Structure

THE ABILITY OF A COMPUTER SYSTEM TO RUN APPLICATIONS / WORK WITH OTHER SYSTEMS / VENDORS, etc

*Integration vs Interoperability

DIFFERENT VENDORS → THIS WILL occur.

INTEGRATION:

*the act of forming, coordinating, or blending into a functioning or unified whole.

*allows data from one software to be read or manipulated by another, resulting in ease of use

Example:
Tekla Xsteel 10.0- fabrication drawings
REI's Staad Pro-design & analysis

INTEROPERABILITY:

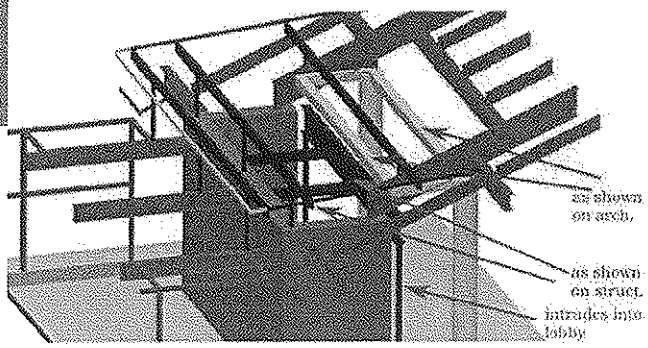
*The ability of two separate systems or software programs to communicate and exchange data with each other and to use the information that has been exchanged.

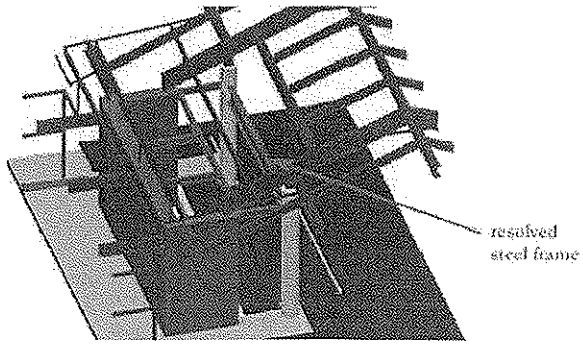
*the capability of different programs to exchange data via a common set of procedures, and to read and write the same file formats and use the same protocols

Example:
Autodesk Revit Structures- documentation
Csi Etabs –design & analysis

Open Standards such as IFC and CIS/2 facilitate interoperability

Design Validation vs Coordination

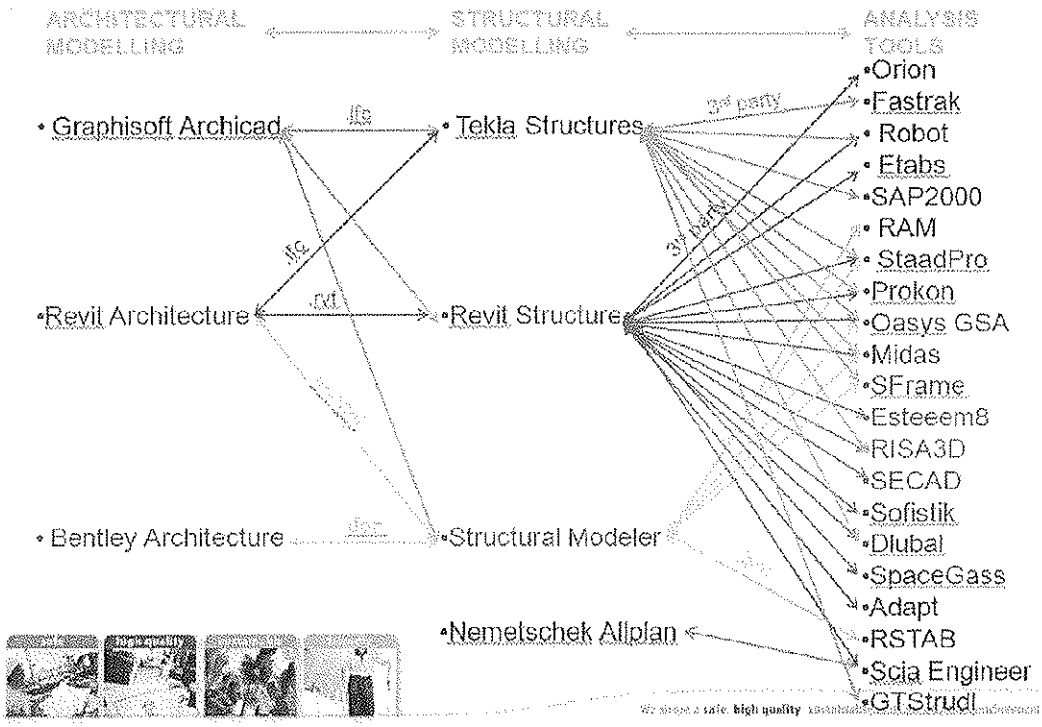




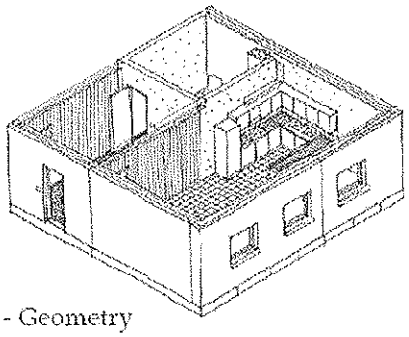
*"**Design Validation**" is a tasked performed by contractor by detecting significant clashes or constructability issues.*

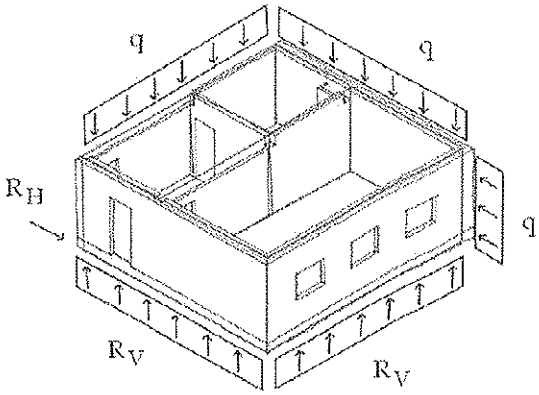
*"**Design Coordination**" is a tasked performed by the consultants/design team to integrate all disciplines (architecture, structural, mechanical, electrical, plumbing etc....)*

Stru BIM Interoperability



Stru BIM Interoperability





- Geometry
- Rooms
- Location of openings
- Overall decor
- Orientation
- Non-structural elements
- Material
- Descriptions
- Budget
- Time schedule

- Statical system
- Structural elements
- Strength parameters
- Boundary conditions
- Loads
- Load combinations

BIM Physical & Analytical Models

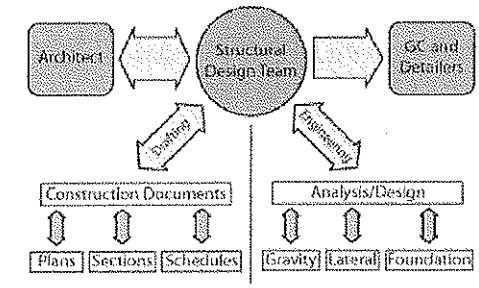
Stru BIM Interoperability

	Data Exchange Mapping		
	Revit Structure	Transfer	StaadPro V8i
Reference	Cartesian Grid	<>	Cartesian Grid
	Circular Grid	<>	Circular Grid
	Radial Grid	<>	Radial Grid
	Level	<>	Level
Material	Concrete	<>	Concrete
	Steel	<>	Steel
	Aluminum	<>	Aluminum
	Timber	<>	Timber
Supports	Point Boundary Condition	<>	Point Boundary Condition
	Line Boundary Condition	<>	Line Boundary Condition
	Area Boundary Condition	<>	Area Boundary Condition
Substructure	Wall Footing	<>	Wall Footing
	Isolated Footing	<>	Isolated Footing
	Foundation Slab	<>	Foundation Slab
Superstructure	Structural Column	<>	Structural Column
	Structural Beam	<>	Structural Beam
	Beam System	>	Beam System
	Curved Beam	?	?
	Tapered Beam	<>	Tapered Beam
	Brace	<>	Brace
	Truss	<>	Truss
	Structural Floor	<>	Structural Floor
	Composite Deck	<>	Composite Deck
	Structural Wall	<>	Structural Wall
	Structural Curtain Walls	?	Structural Curtain Walls
	Curved Structural Wall	?	Curved Structural Wall
	Wall Opening	<>	Wall Opening
	Slab Opening	<>	Slab Opening
	Vertical or Shaft Opening	<>	Vertical or Shaft Opening

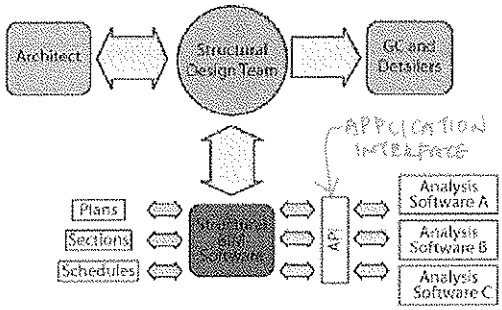
Analytical	Offset	<>	Offset
	Rigid Link	<>	Rigid Link
	Cross-Section Rotation	<>	Cross-Section Rotation
	End Release	<>	End Release
Connections	Flexural Rebar (Main)	<>	Flexural Rebar (Main)
	Shear Rebar (Links)	<>	Shear Rebar (Links)
	Area Reinforcement	<>	Area Reinforcement
	Path Reinforcement	<>	Path Reinforcement
	Weld	<>	Weld
	Bolt	<>	Bolt
Loads	Load Nature	<>	Load Nature
	Load Case	<>	Load Case
	Load Combination	<>	Load Combination
	(Hosted) Point Load	<>	(Hosted) Point Load
	(Hosted) Line Load	<>	(Hosted) Line Load
	(Hosted) Area Load	<>	(Hosted) Area Load

Legend		
	<>	both directions
	> or <	one direction only
	>	not transferred/supported

Stru BIM Interoperability



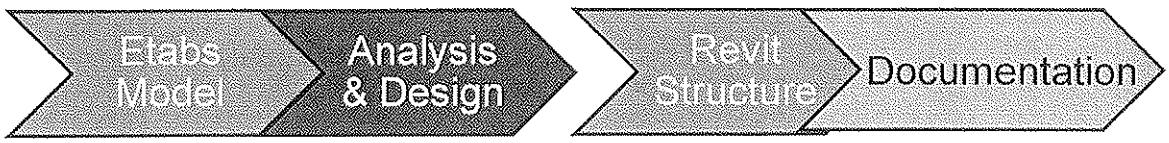
Traditional Workflow



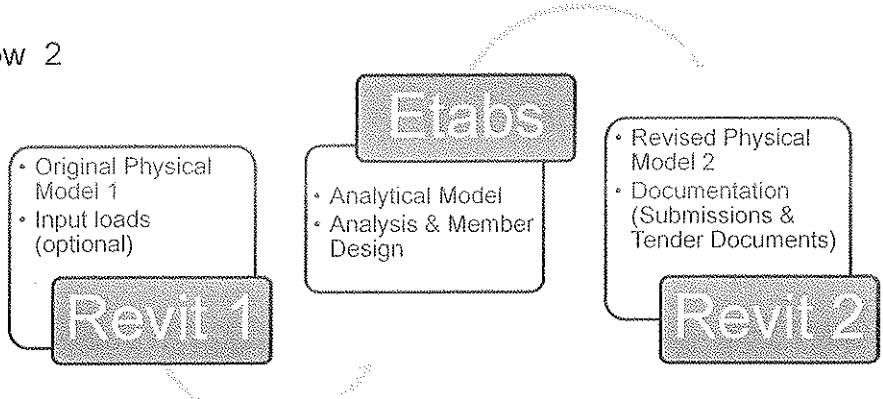
Workflow with Structural BIM Software

Stru BIM Interoperability

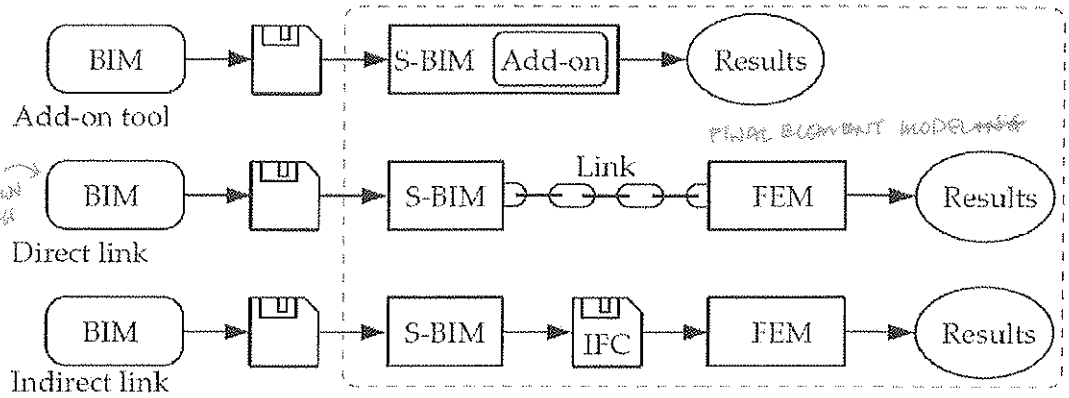
Workflow 1



Workflow 2



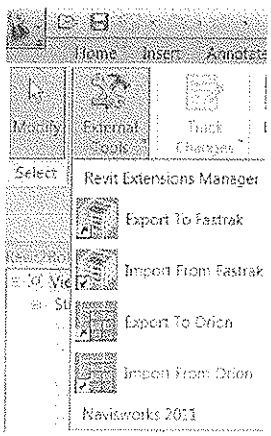
Stru BIM Interoperability

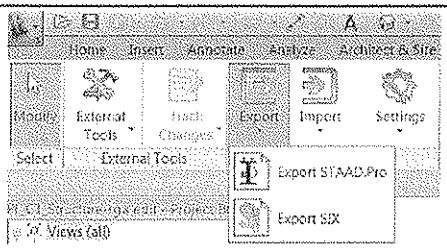


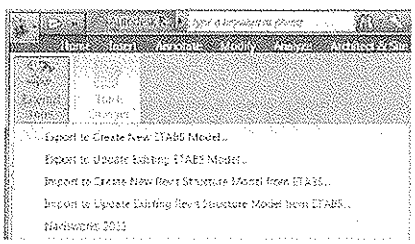
Transfer Protocols & Workflows

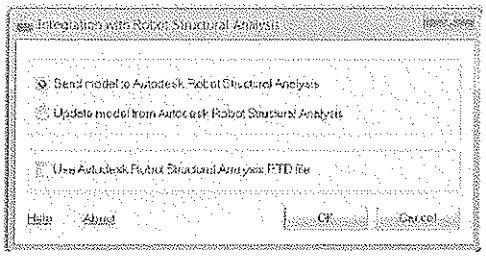
BCA ACADEMY

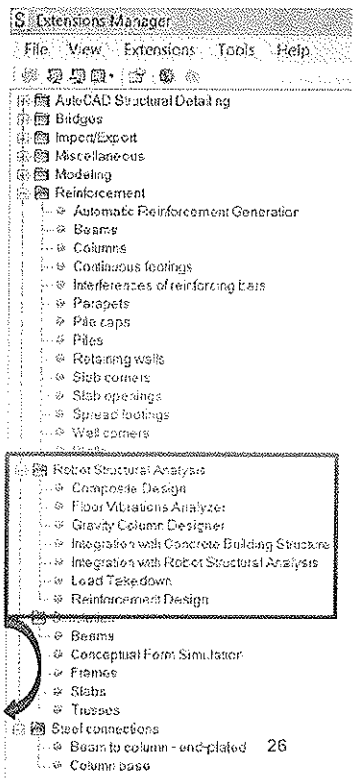
Stru BIM Interoperability











BCA ACADEMY

Stru BIM Interoperability

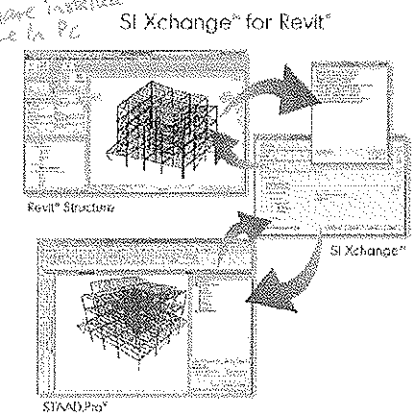
ANALYSIS SOFTWARES:

Etabs Model	Staad Model	Robot Model
1) Revit model is transferred to a proprietary file format called ".exr" by CSixRevit add in for Revit 2009 & 2010. CsixRevit is available in 32 & 64bit versions ".exr" is then imported & read in Etabs where it is Save as to native file ".edb"	1) Revit model is transferred to a proprietary file format called ".six" by SI-Xchange add in for Revit 2009-2011. SI-Xchange is available in 32 & 64bit versions ".six" is then imported & read in Staad where it is Save as to native file ".std"	1) Revit model is transferred instantaneously to Robot by default add in located at Extension Manager for Revit 2010-2011.
static 2step implementation=.rvt-->.exr ->.edb	*two choices a) static 2step transfer=.rvt-->.six-->.std or b) dynamic 1step transfer=.rvt-->.std*	*dynamic 1step transfer=.rvt-->.rtd*

must have installed software in PC

CSiXRevit

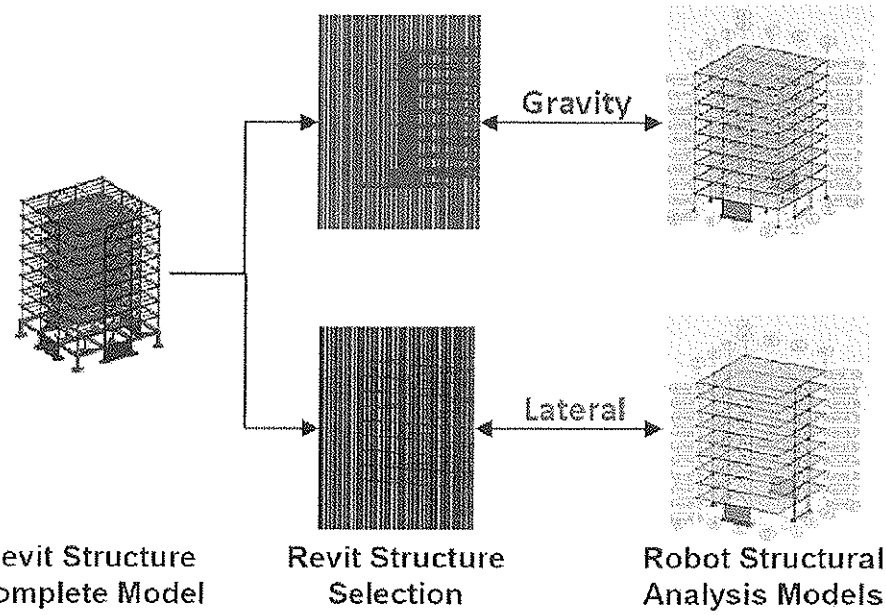
ETABS® and Revit® Structure 2009/2010
Data Exchange Documentation



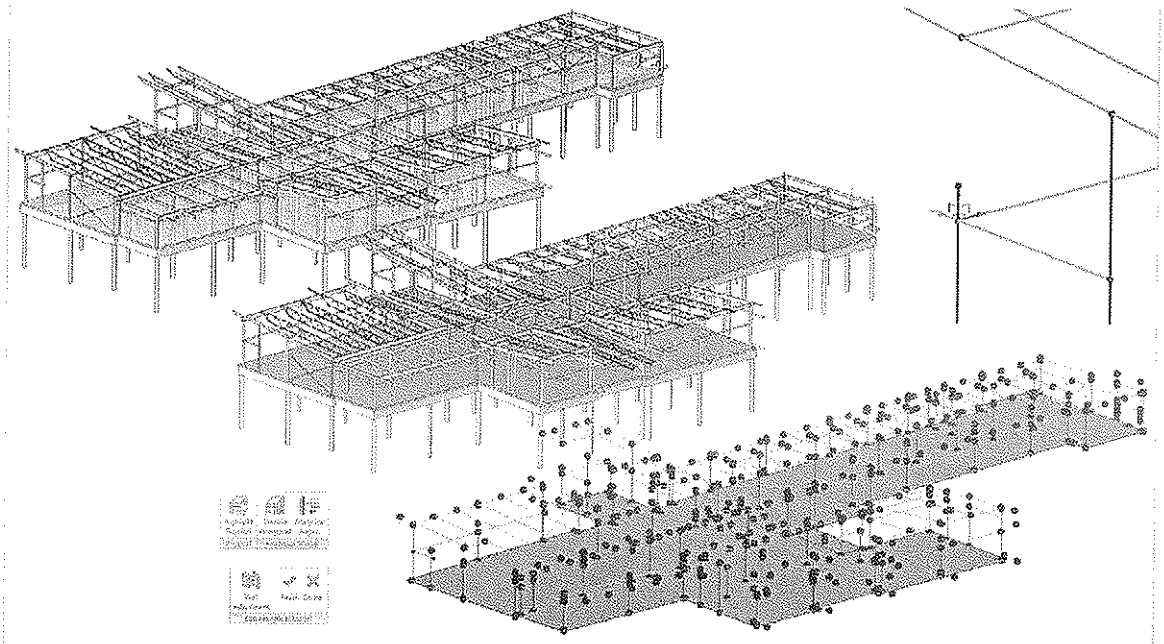


REVIT – ROBOT INTEGRATION

Autodesk Robot-Revit Integration



Autodesk Robot-Revit Integration



Physical model -> Convert to Analytical Stick Model lines & Nodes

BCA ACADEMY
at the built environment

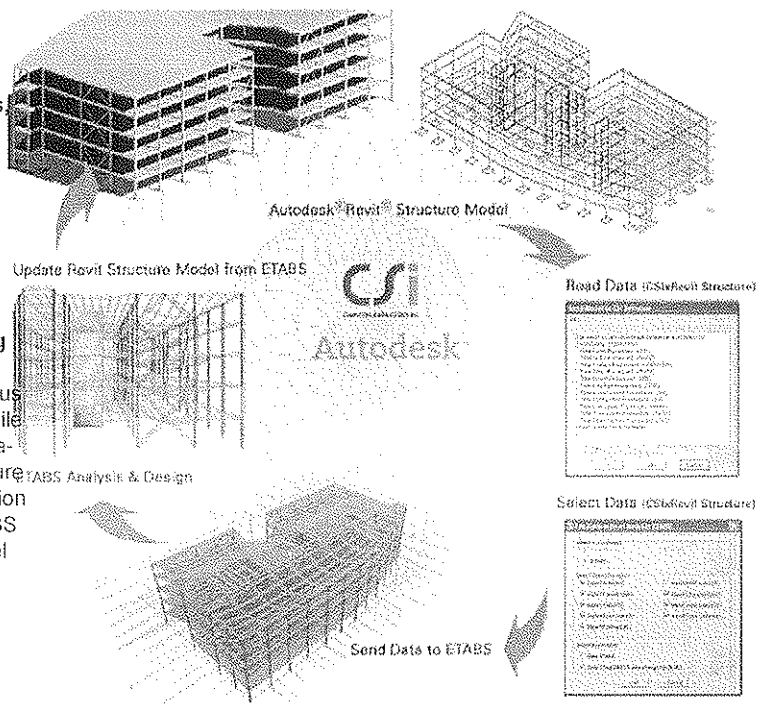
REVIT – ETABS INTEROPERABILITY

BCA ACADEMY
at the built environment

Revit-Etabs Interoperability

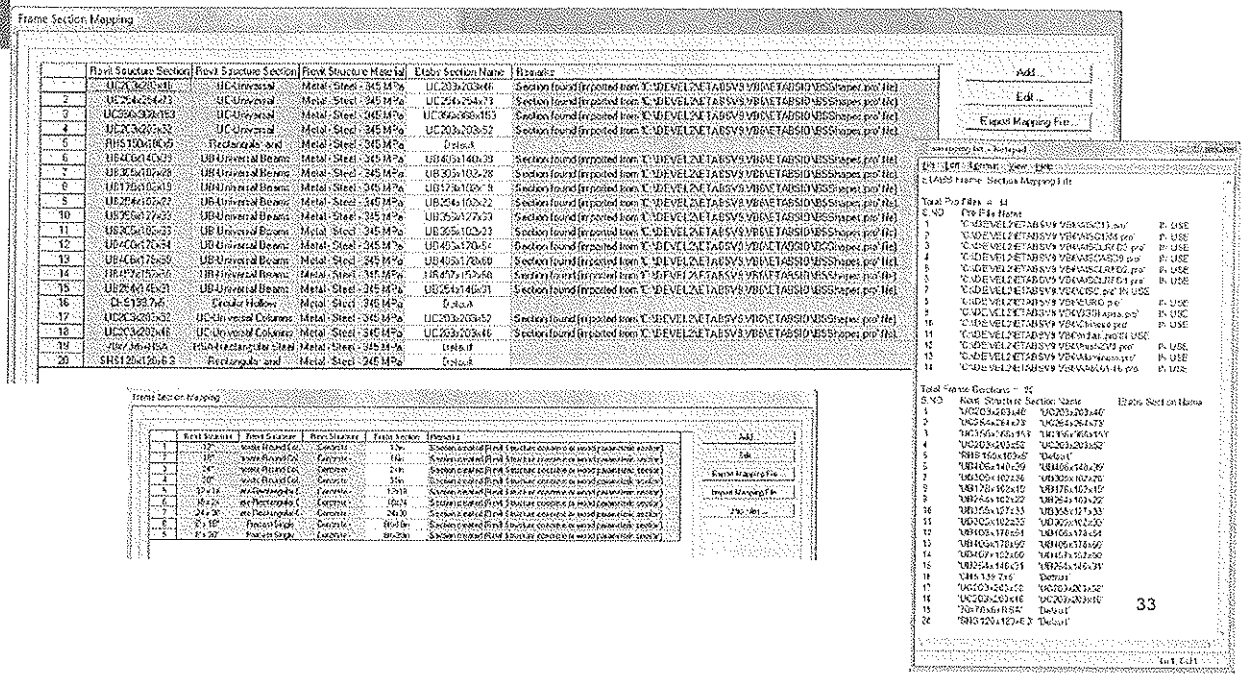
Import: Import from AutoCAD: Arbitrary nonrectangular grid systems, Framing plans, 3D Framing
models; CIS/2 (.step), FrameWorks Plus (.sfc), Strudl-Staad (.gti, .std), Prosteel (.mdb), IFC-Tekla- Xsteel (.ifc), IGES (.igs), Autodesk Revit Structure (.exr) 2009

Export: Export to AutoCAD: Floor plans w/ composite design info, User defined framing elevations;
ACCESS (.mdb), CIS/2 (.step), FrameWorks Plus (.sfc), Prosteel (.mdb), Steel Detailing Neutral File (SNDF)-Xsteel, CSI DETAILER (.adi), IFC-Tekla-Xsteel (.ifc), IGES (.igs), Autodesk Revit Structure (.exr) 2009 Export Stories to SAFE for Foundation Analysis/Design, Capture graphics of any ETABS Window, Cut & Paste Portions of Model to Excel Spreadsheet for Editing



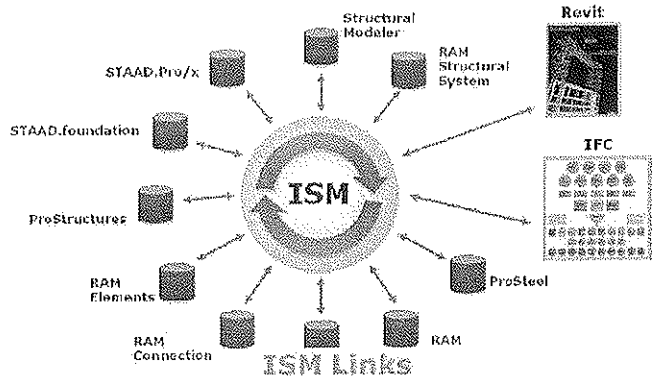
Revit-Etabs Interoperability

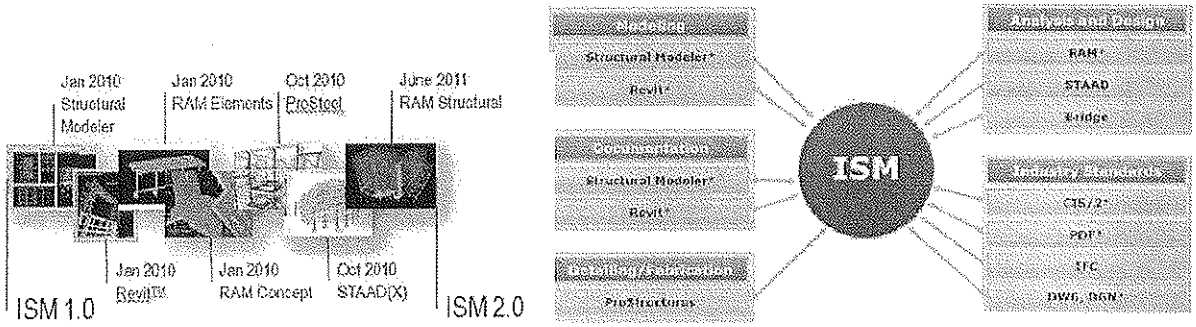
*Caution when accepting default mapping suggestions. User must make sure section property are equal or nearly the same. In doubt, User can override properties in Etabs using .PRO files (most specifically precast & steel members)



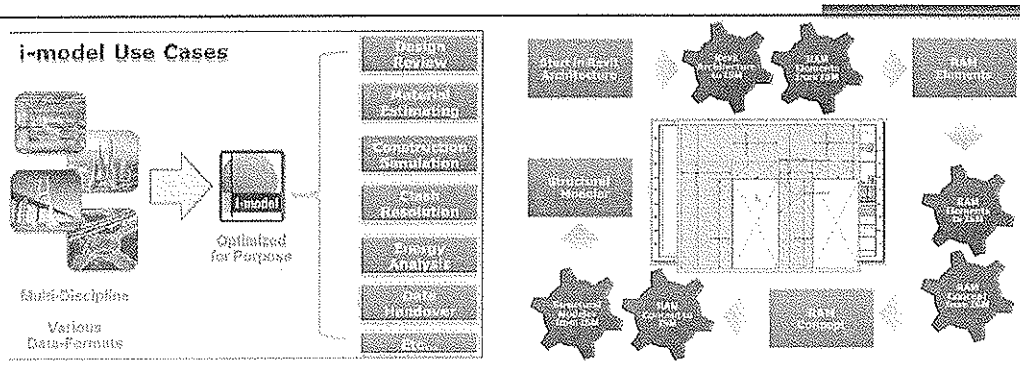
BENTLEY
INTEGRATED STRUCTURAL MODELING(ISM)

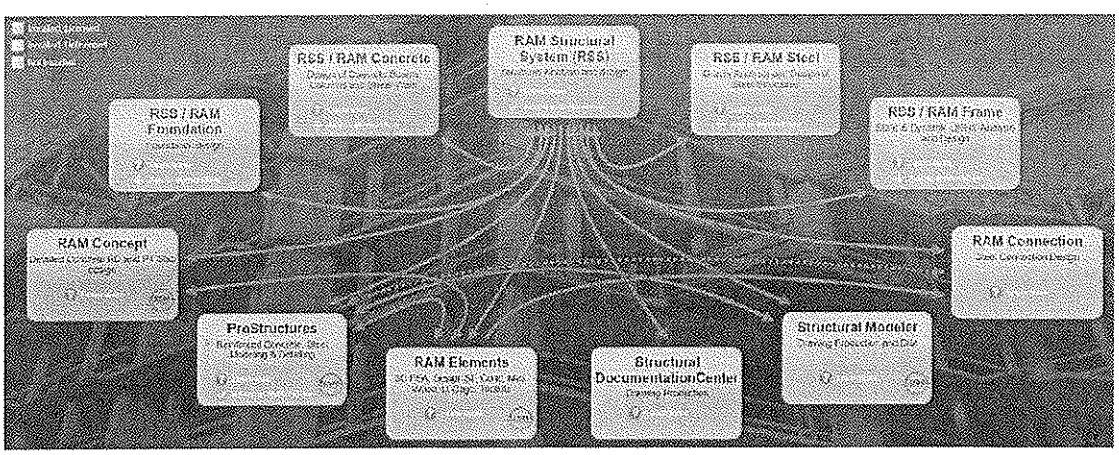
Bentley ISM





Bentley I-model





BCA ACADEMY
Building environment

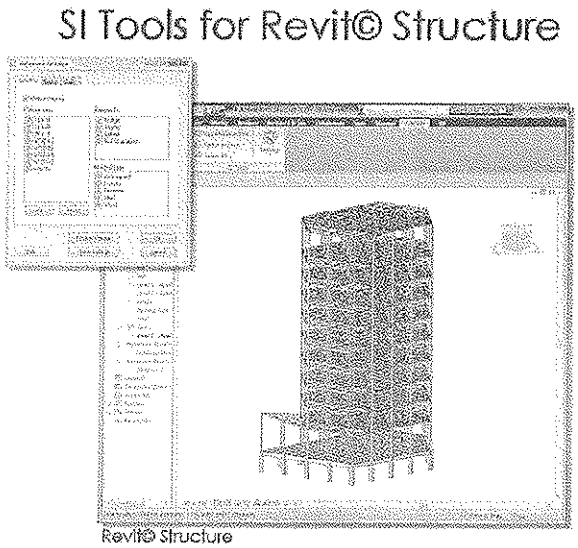
REVIT - STAAD.PRO INTEROPERABILITY

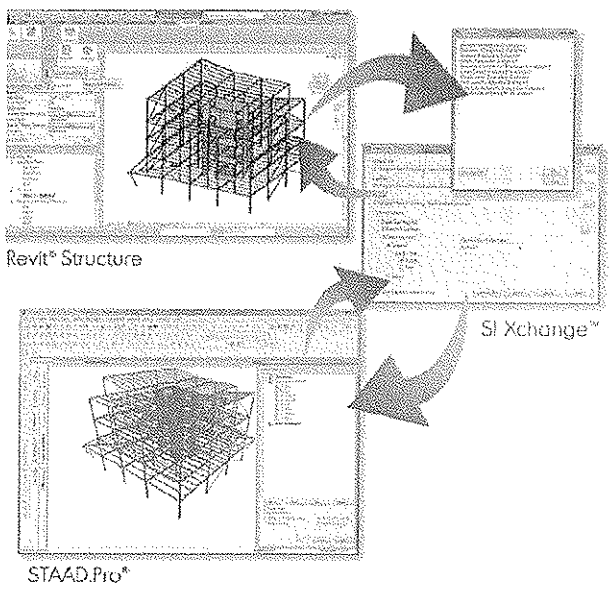
BCA ACADEMY
Building environment

Revit-Staad Interoperability

SI Xchange™ for Revit®

SI Tools for Revit© Structure





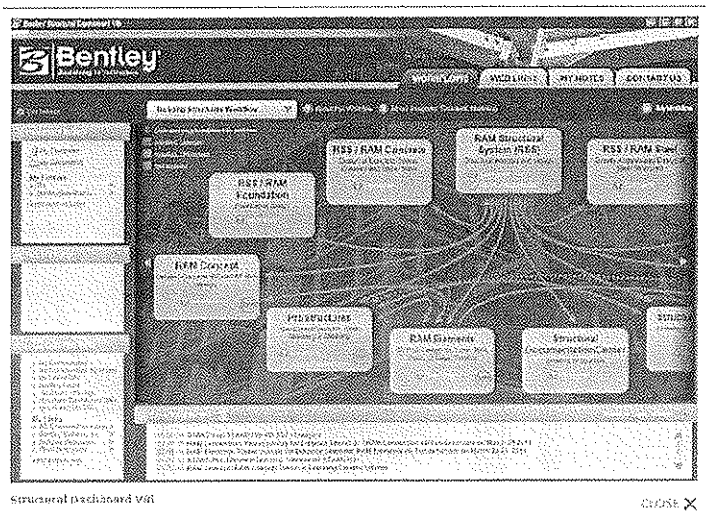
BCA ACADEMY
of the built environment

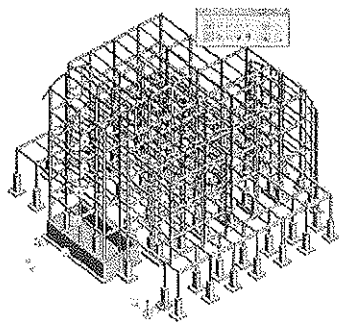
REVIT –BENTLEY RSS INTEROPERABILITY

BCA ACADEMY
of the built environment

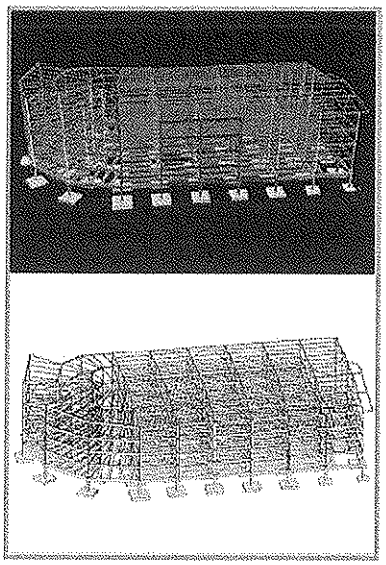
Revit-RAM Interoperability

- Round tripping with Detailing and Analysis products such as RAM though ISM format.





Revit-RAM Interoperability



Benefits for Structural Engineers:

Start in RAM Structural System or Revit Structure

Import or Export from Revit Structure

Make changes in either application

Update and synchronize models

The RAM Structural System / Revit link version 3.0 features, including:

Import/export of slab edge and deck properties

Import/export wall openings

New import/export interface

Selectively update class of elements for both import or export

A new mapping file format allows the creation of per project or per office standard mapping files.

Multiple Revit families can now be mapped to RAM elements

Improved cantilever import/export

Castellated and cellular beams import and export

Updating of level name and elevation changes

REVIT – CSC ORION & FASTRAK INTEROPERABILITY

Revit-CSC Interoperability

Fastrak

Integration

Integration of Fastrak Building Designer and Autodesk Revit Structure

For support and training on the full range of CSC products, please contact...

Support: support@cscworld.com
Training: training@cscworld.com

Delivered by CSC

Orion

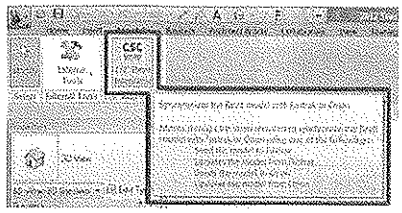
Integration

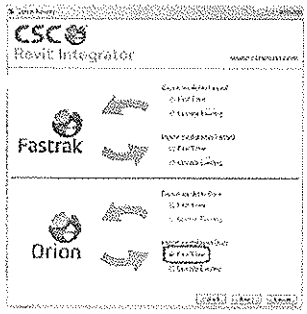
Integration of Orion and Autodesk Revit Structure

For support and training on the full range of CSC products, please contact...

Support: support@cscworld.com
Training: training@cscworld.com

Delivered by CSC





Revit-CSC Interoperability

Start in BIM Software

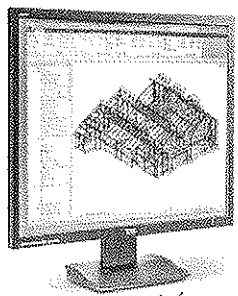
The technician can start in BIM Software

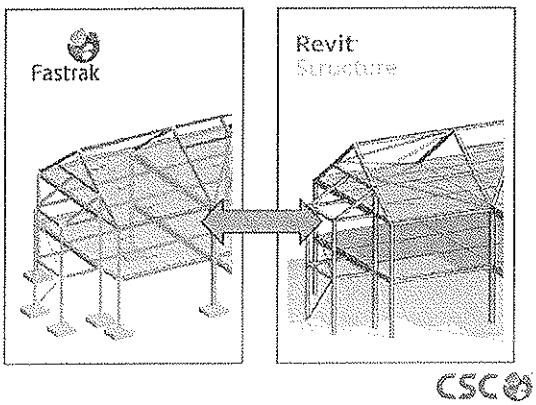
↓

Export to Fastrak for 'code-based' design

↓

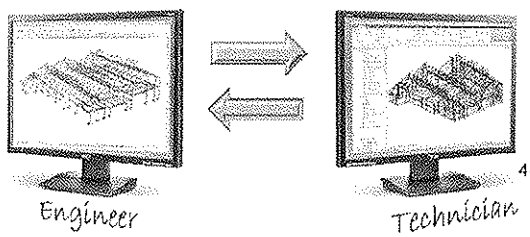
Synchronize BIM model with Fastrak



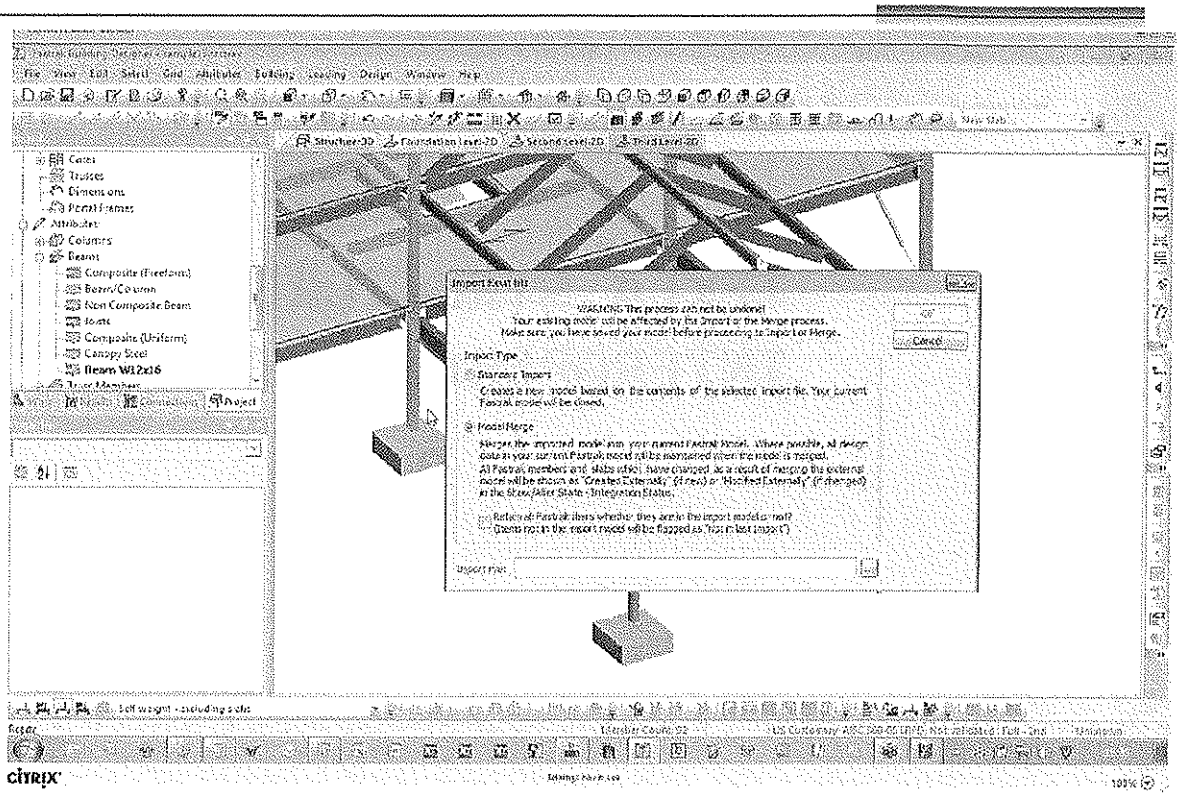


Fastrak synchronizing

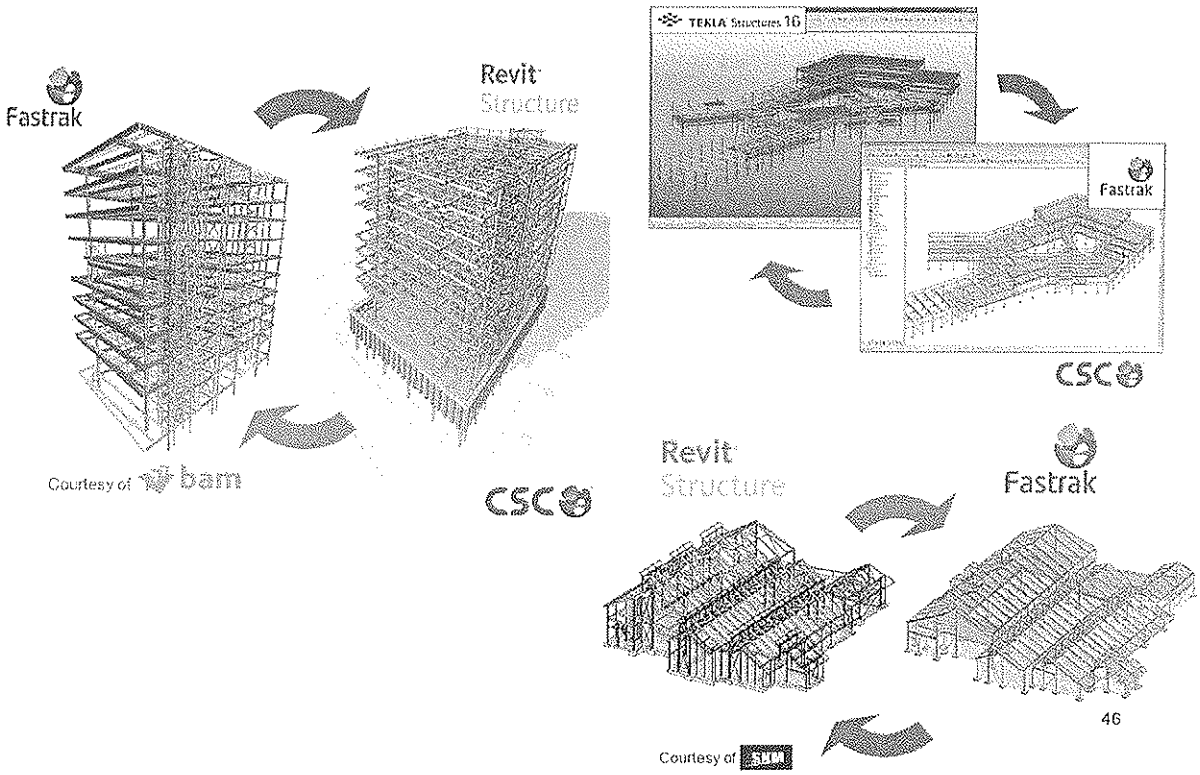
Refined models can be synchronized as often as required – without compromising the existing model.



Revit-CSC Interoperability



Revit-CSC Interoperability

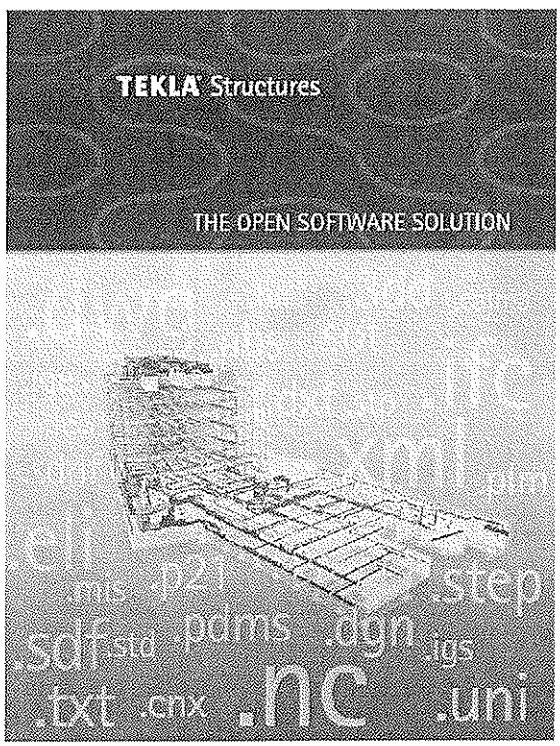


BCA ACADEMY
of the built environment

TEKLA STRUCTURES INTEROPERABILITY

BCA ACADEMY
of the built environment

Tekla Interoperability



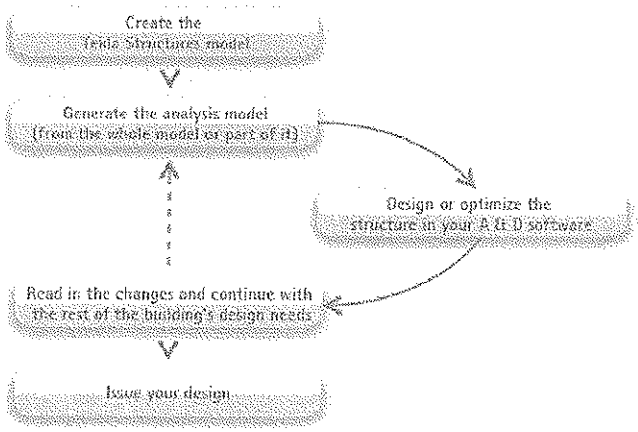
Xsteel®

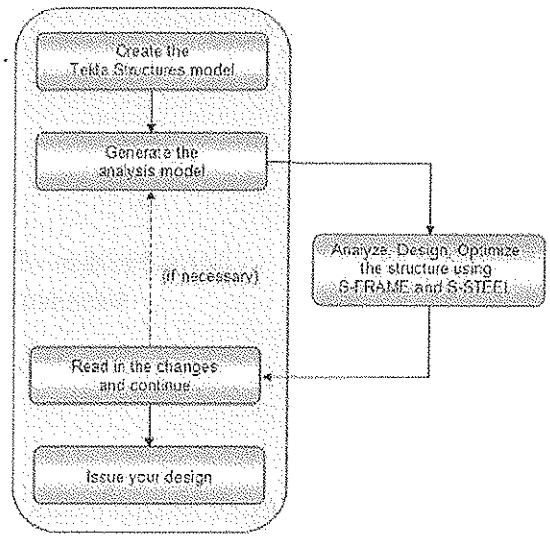
Seamless Integration with Other Systems

> Xsteel includes a number of links that facilitate data transfer with other systems (AutoCAD, STAAD, PDMS, MicroStation, Frameworks Plus, etc.). Xsteel also incorporates the latest CIMsteel integration standards – CIS/2. These links allow you to exchange models quickly and accurately throughout the design process.

Linking upstream with design and analysis software and linking downstream with M.Sproduction control systems effectively integrates the entire process – from layout and design to fabrication and erection. This type of data exchange greatly increases productivity and decreases cost.

Tekla Interoperability





Steel industry

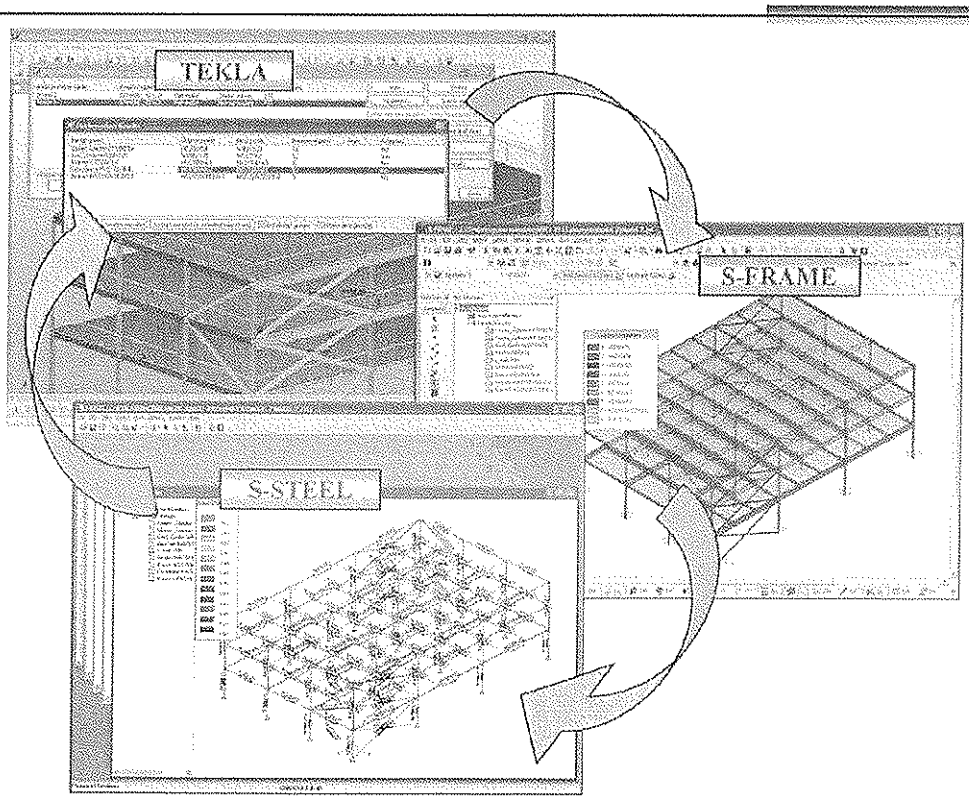
CONSTRUSTEEL · FabTrol MRP · Steel Projects · lantek

Precast industry

BETSY · ELIPLAN · progress · Unitechnik

Dlubal · SAP2000 · GT STRUDL · Robobat · SCIA · GEN · AxisVM 9 · BuildSoft · CONSTEEL · NISA · PROKON · StruSoft · CSC

Tekla Interoperability

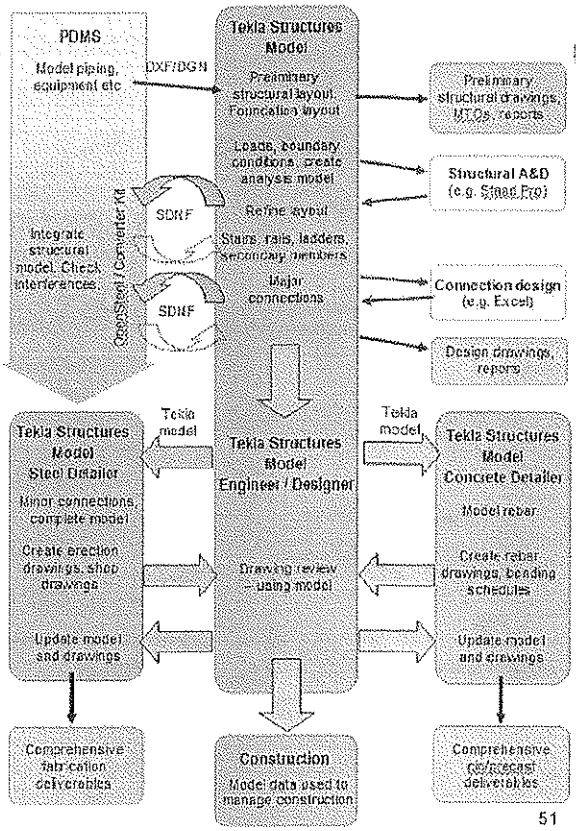


Tekla Interoperability

TEKLA

Tekla Structure - PDMS Interoperability

Guide



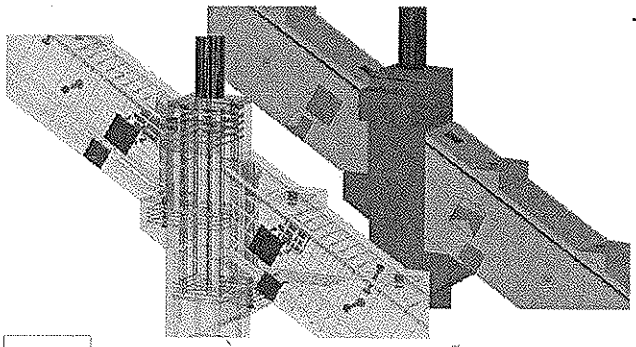
51

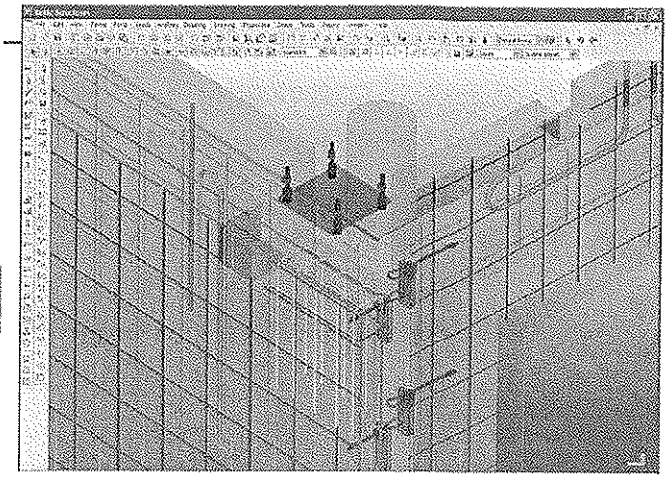
BCA ACADEMY
Better Built Environment

STRUCTURAL BIM DETAILING

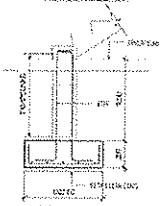
BCA ACADEMY
Better Built Environment

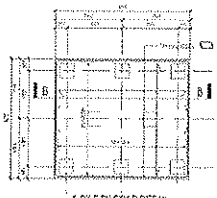
Level of Detail (rebars)

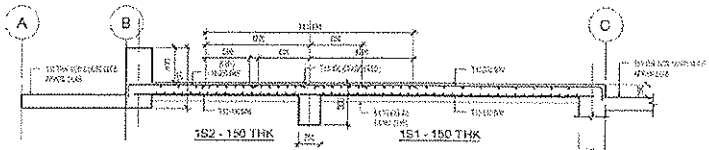


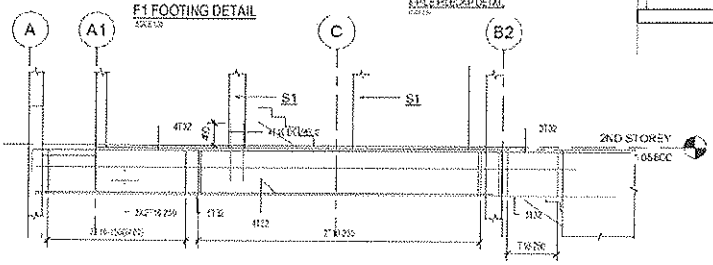


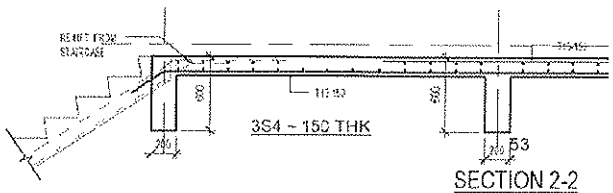






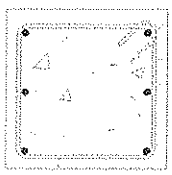


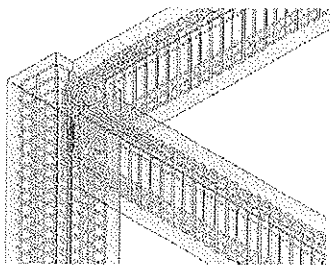


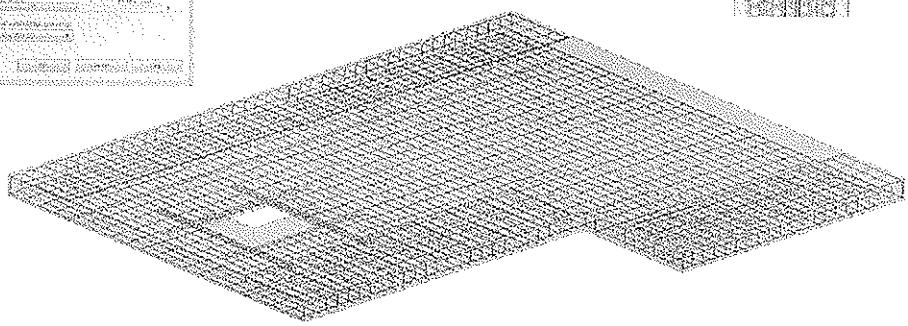


Level of Detail (rebars)

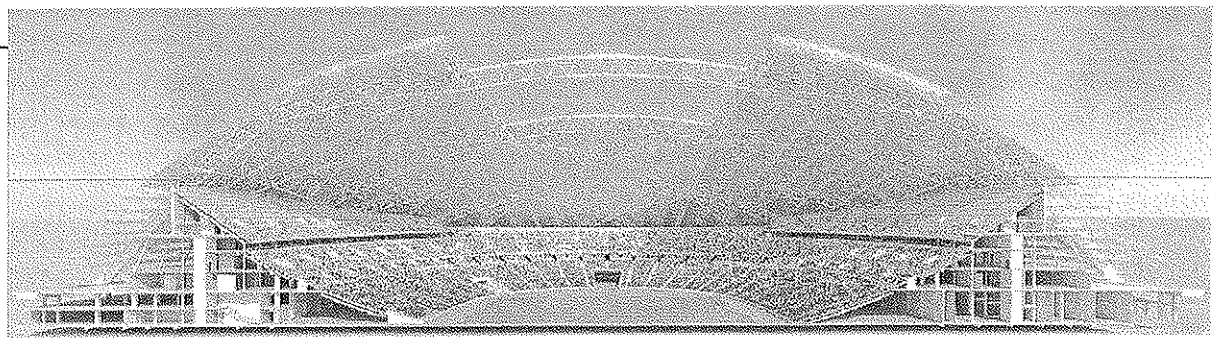


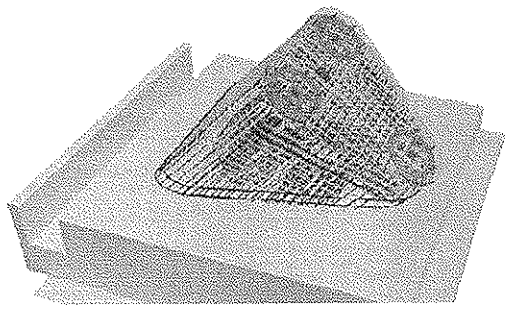


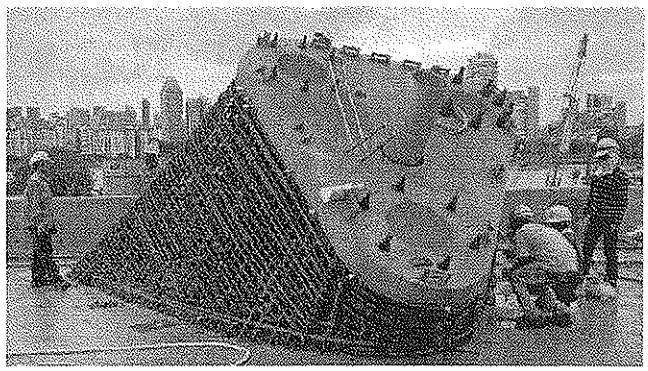




Level of Detail (rebars)

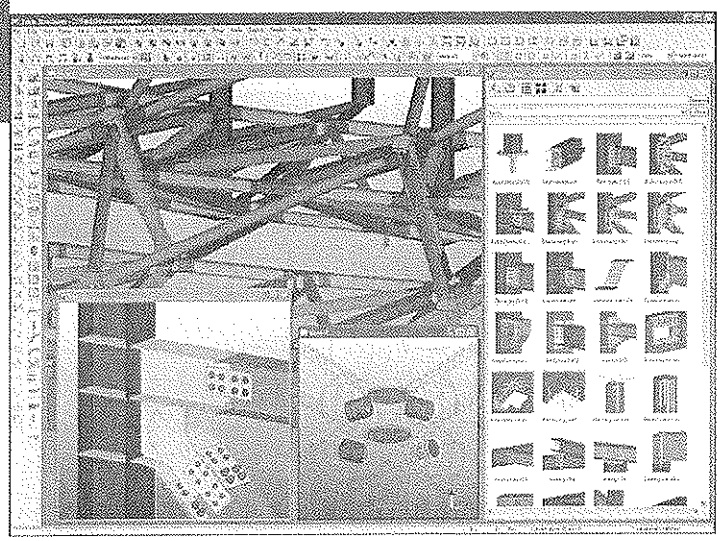


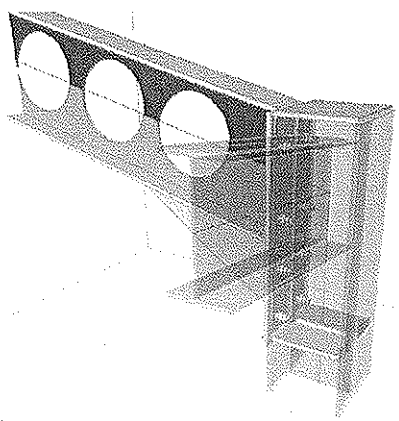




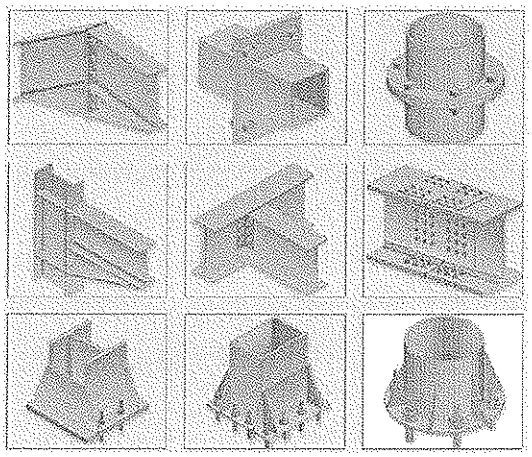
Singapore Sports Hub by Arup

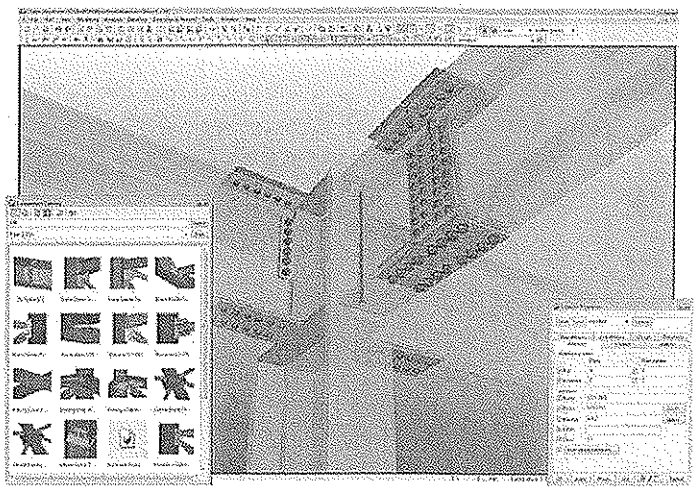
Level of Detail (welds & bolt)





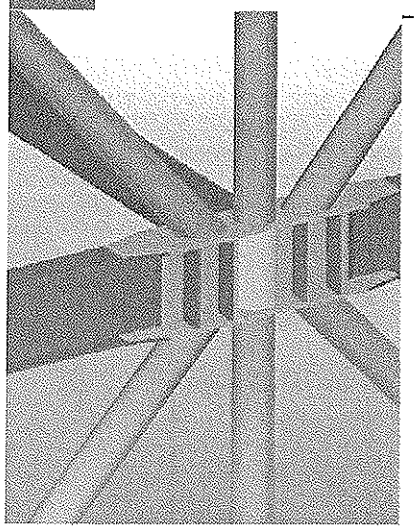
Level of Detail (welds & bolt)

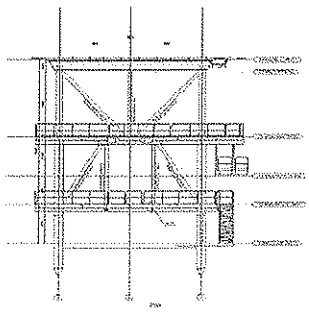


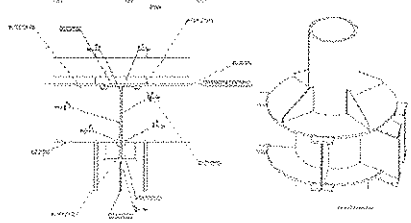


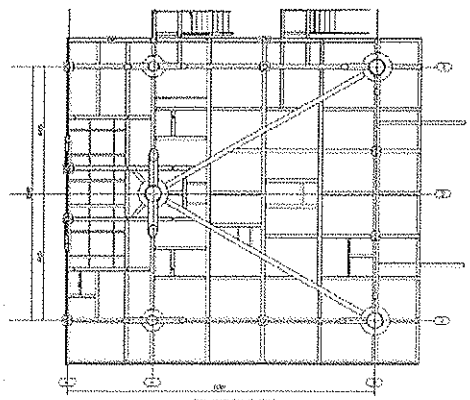
Tekla Structures Connection Macros

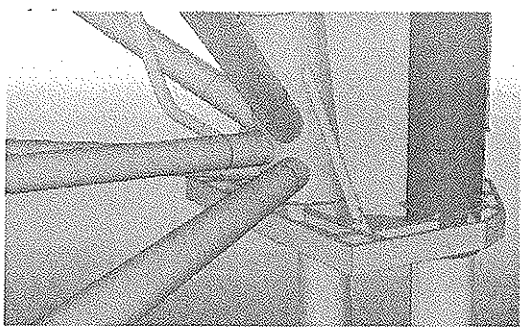
Level of Detail (welds & bolt)

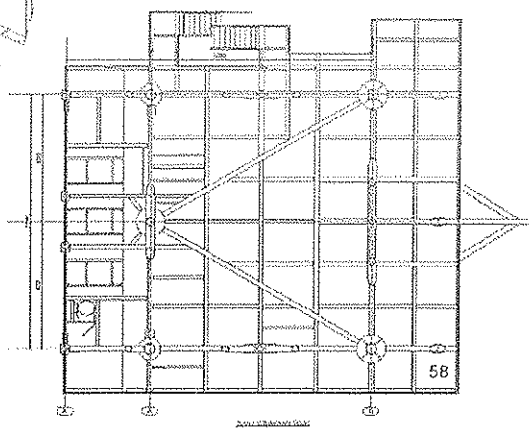




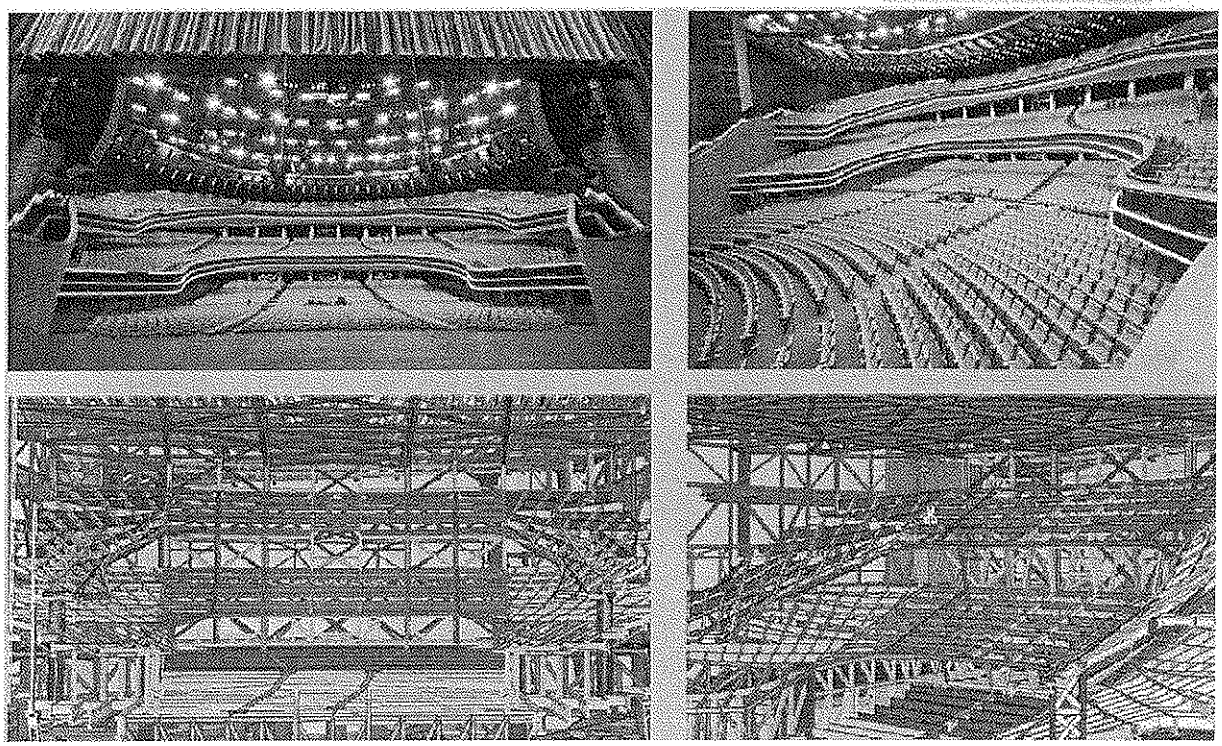






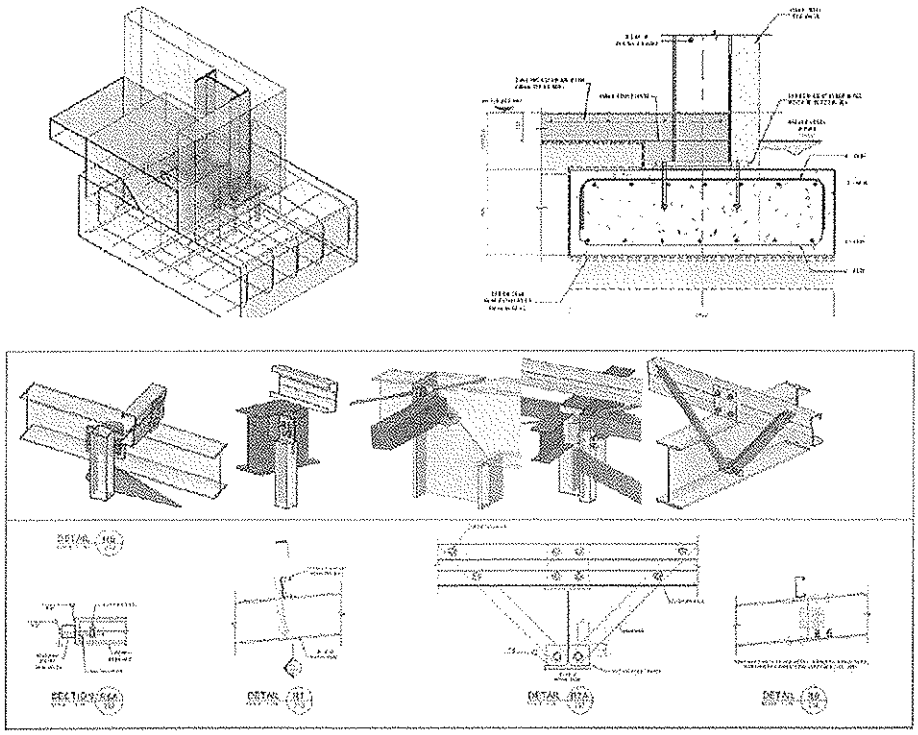


Level of Detail (welds & bolt)



Star Vista by Parsons Brinckerhoff

Level of Detail (welds & bolt)



Revit Structures Detailing

Thank You

Certification Course in BIM Management

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Day 2 – Course Schedule Outline

Time	Topic
09.00 – 10.30	Session 1 – BIM Design Review
10.30– 10.45	Break
10.45 – 13.00	Session 2 – BIM Quality Assurance and Coordination
13.00 – 13.40	Lunch
13.40 – 15.30	Session 3 – BIM Quality Assurance and Coordination
15.30 – 15.45	Break
15.45 – 18.00	Session 4 – BIM Phase Planning & Cost Estimation

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BIM Design Review

INFORMATION MODELLING & DOCUMENTATION (3D & 2D):-
REVIT, TEKLA, BENTLY, AUTOCAD, MICROSTATION, DESIGN REVIEW, 3D & 2D PDF
PROJECT MANAGEMENT & REVIEW (4D):-
MS PROJECT, ORACLE PRIMAVERA, TILOS, NAVIS WORK, BENTLY NAVIGATOR & SOLIBRI MODEL CHECKER.
ESTIMATION & COSTING (5D):-
AUTODESK QTO, COST OS & COSTX
FACILITY MANAGEMENT (6D):-
FM SYSTEMS
DOCUMENT MANAGEMENT:-
AUTODESK VAULT, ACONEX & CONJECT

Presented by :
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karthik.v@bybitech.com

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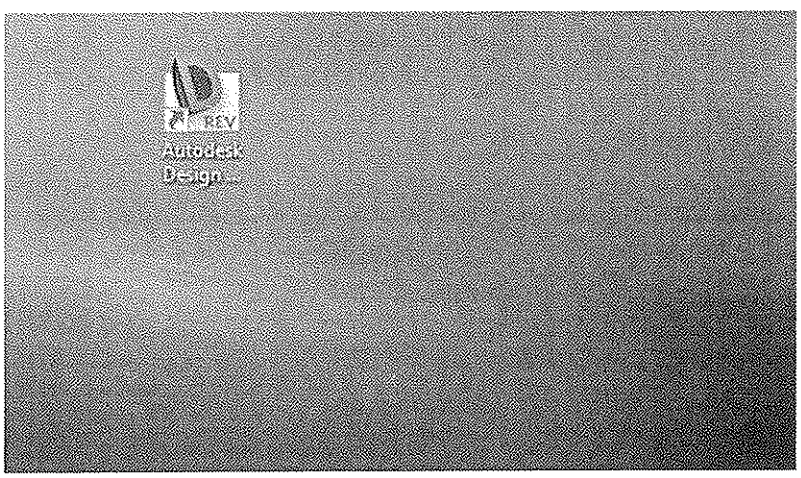
3D & 2D : INFORMATION MODELLING & DOCUMENTATION
4D : PROJECT MGMT & REVIEW (SCHEDULING & COORDINATION)
5D : ESTIMATION & COSTING
6D : FACILITY MGMT.
DOC MGMT.

DWF – Design Web Format

DWF – Design Web Format, can be used to organize drawing sheets, models, animations as well as other project-related files, into a single, highly compressed file.

Autodesk Design Review can be used to open DWF for Reviewing the content.



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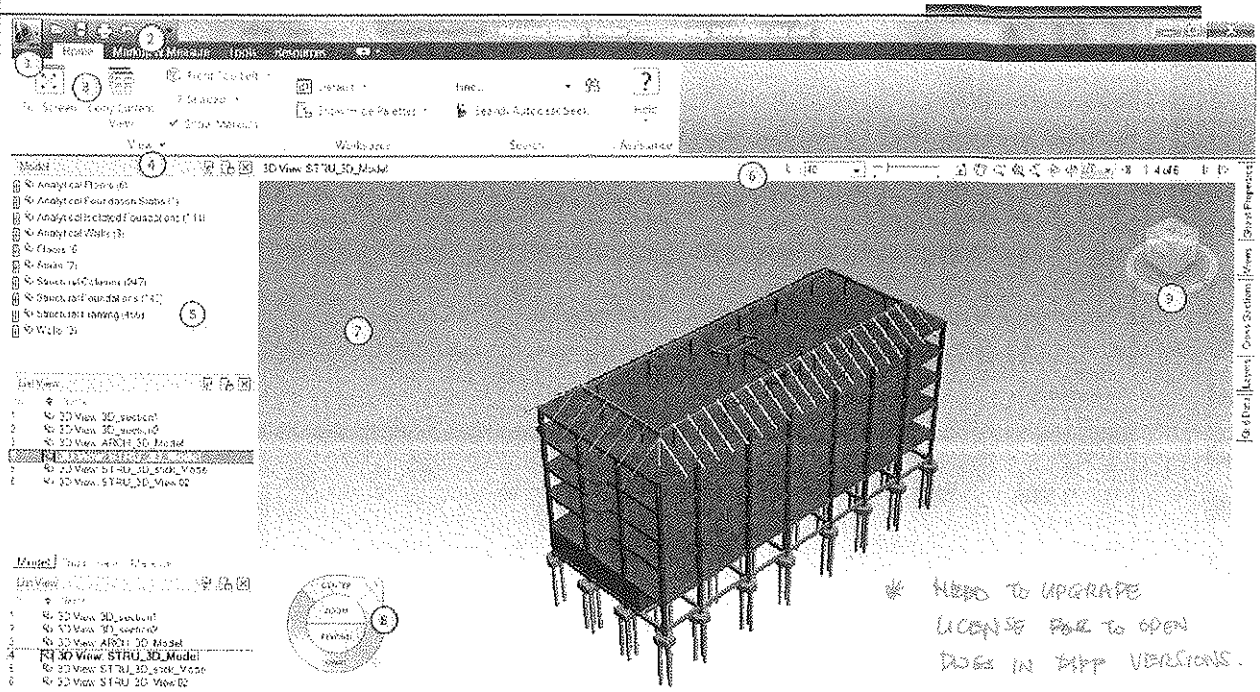
User Interface



1. Application Button
2. Quick Access Toolbar
3. Ribbon (TABS)
4. Palette Title Bar
5. Palettes
6. Canvas Toolbar
7. Canvas
8. Steering Wheel
9. View Cube

2D → 3D : CONVERSION

3D → 2D : BIM

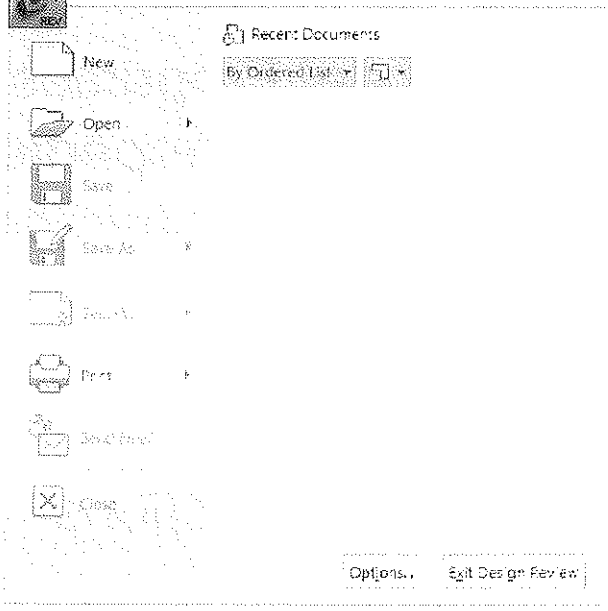
4D : BIM + TIME (COORDINATION / TIMELINER/ CRASH DETECTION & SIMULATION)

5D : 4D + COST

6D : FACILITY MGMT

User Interface

Application Menu

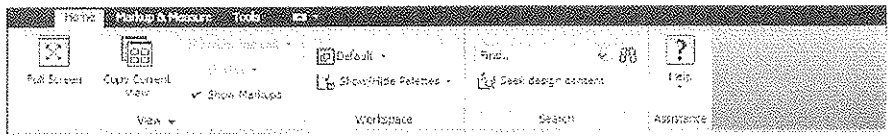


- Recent Documents
- New
- Open
- Save
- Save As
- Print
- Options

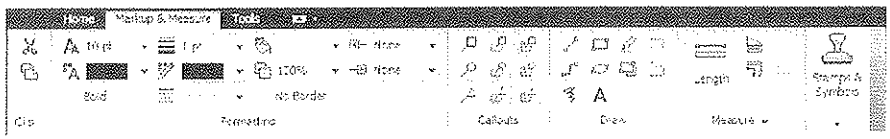
User Interface



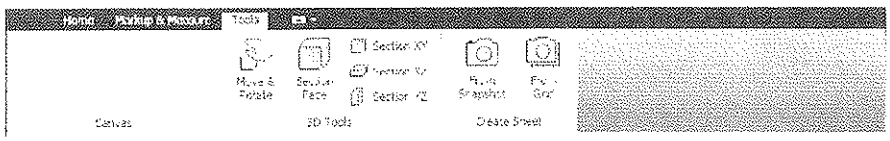
The Quick Access toolbar Canvas toolbar



The Home tab



The Markup & Measure tab



The Tools tab

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User Interface

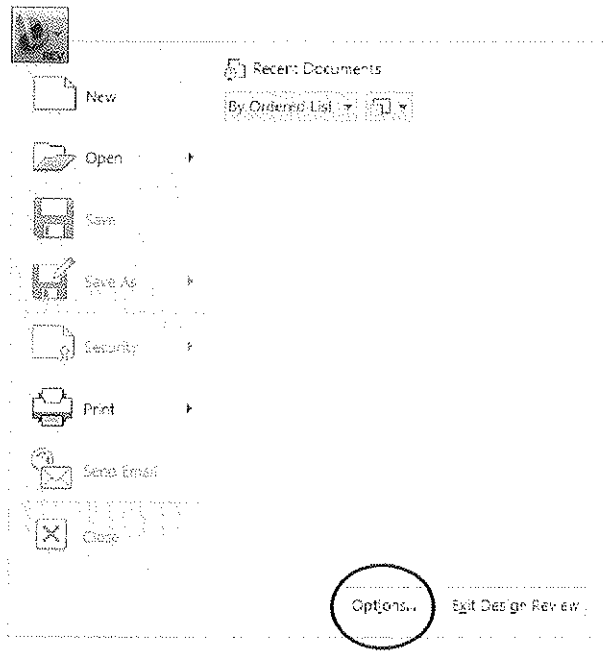


Key Palettes

- List View
- Sheet Properties
- Markup Properties
- Object Properties
- Markups
- Model
- Views
- Cross Sections
- Find

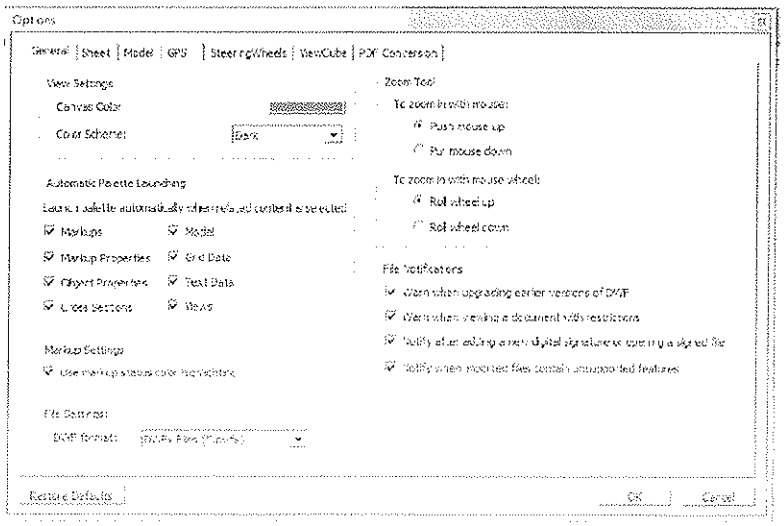
BCA ACADEMY

Customising UI



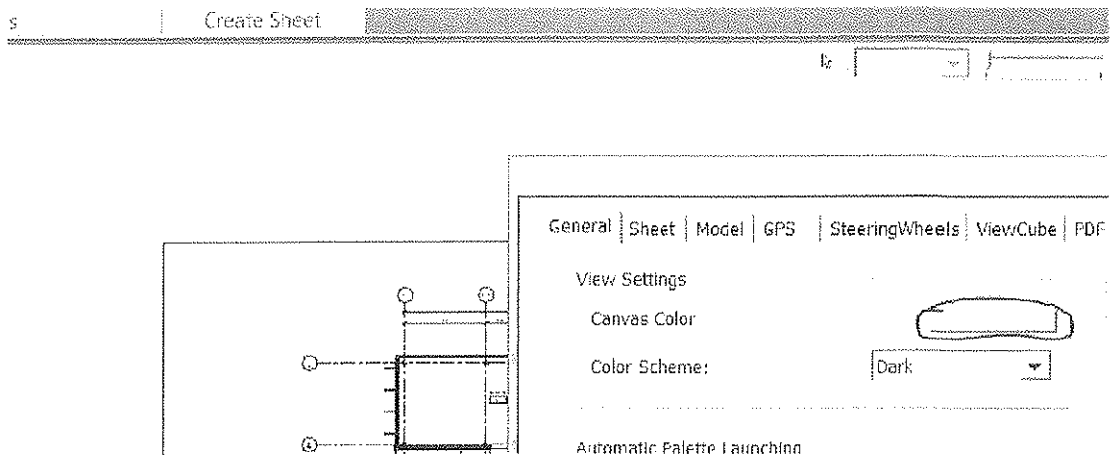
- Go to **Options...** in the Application Menu

Customising UI



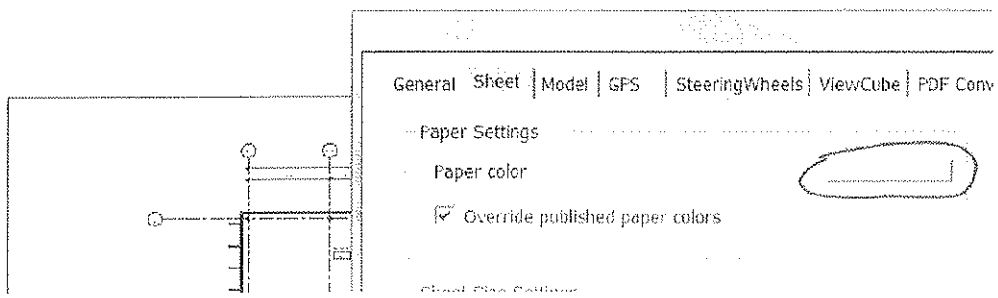
- The Canvas Color and Paper Color can be changed in the Options dialog box.
- There are other settings as well…

Customising UI



- Canvas Color can be changed from the General tab.

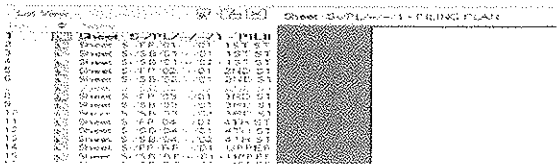
Customising UI



- Paper Color can be changed from the Sheet tab.

Project Reviewing

Navigate between Views



2D drawing or image

3D model

3D part

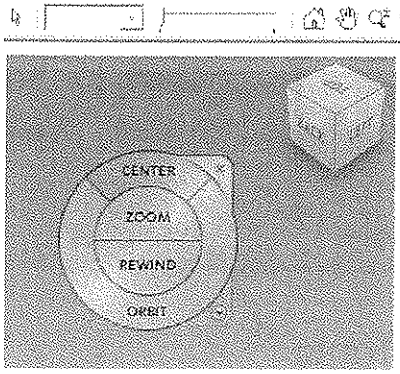
iAssembly

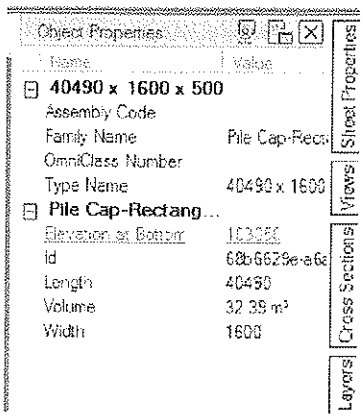
iPart

table

presentation

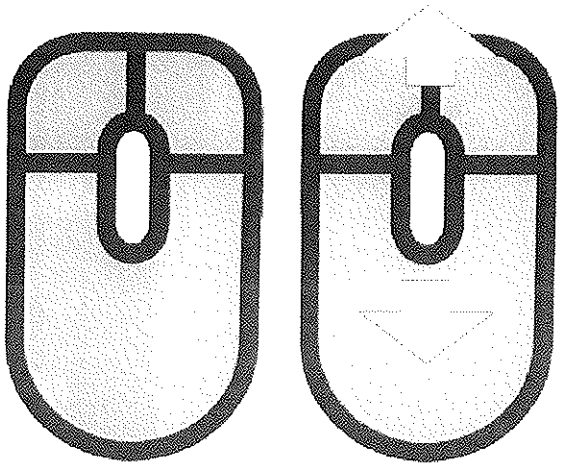
Navigate and Review in 2D and 3D





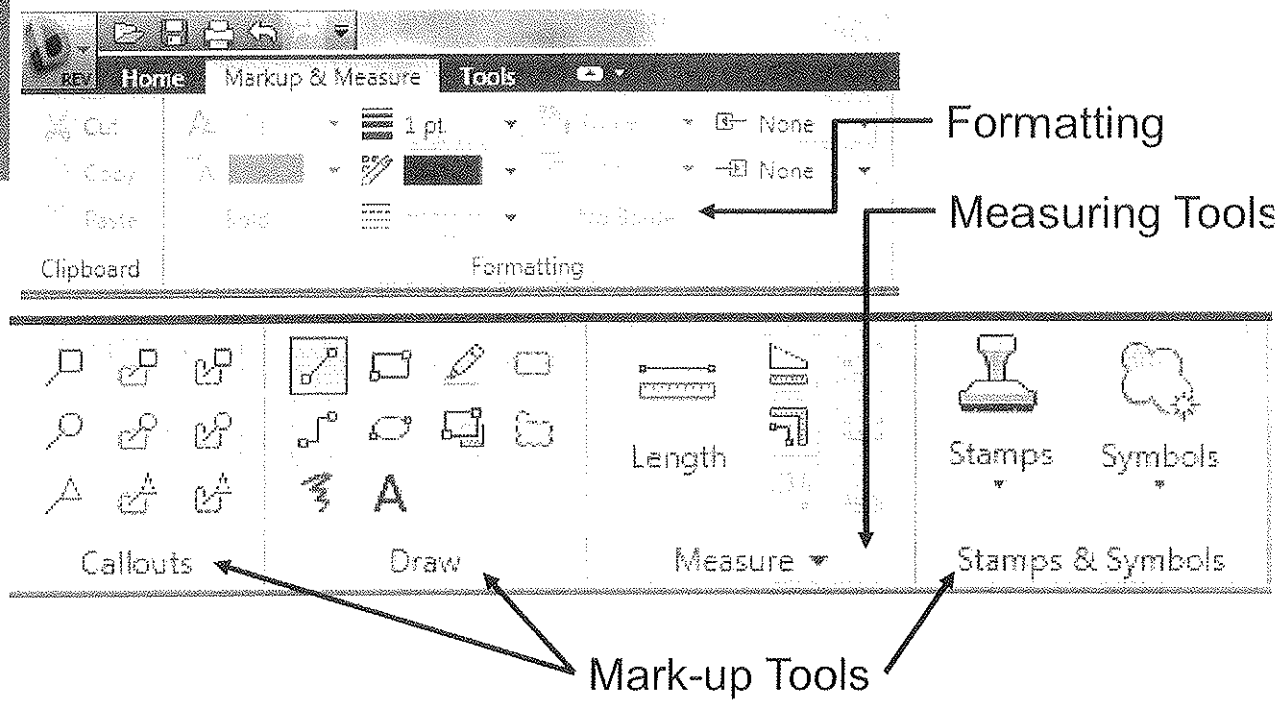
Project Reviewing

Alternatively use the mouse to navigate

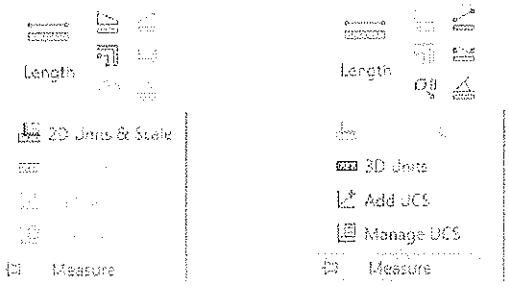


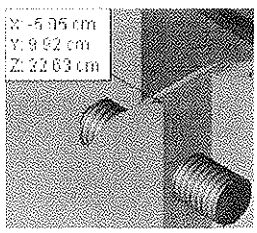
Pan Zoom

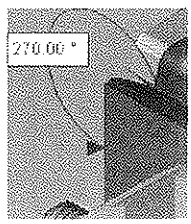
Measuring and Mark-up

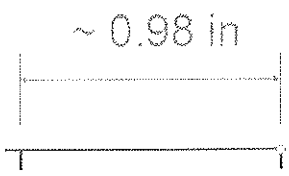


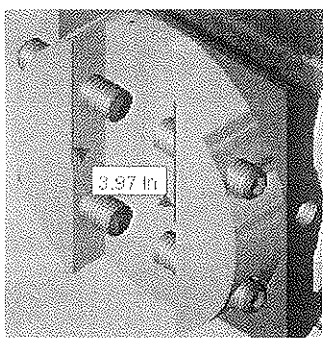
Measurement



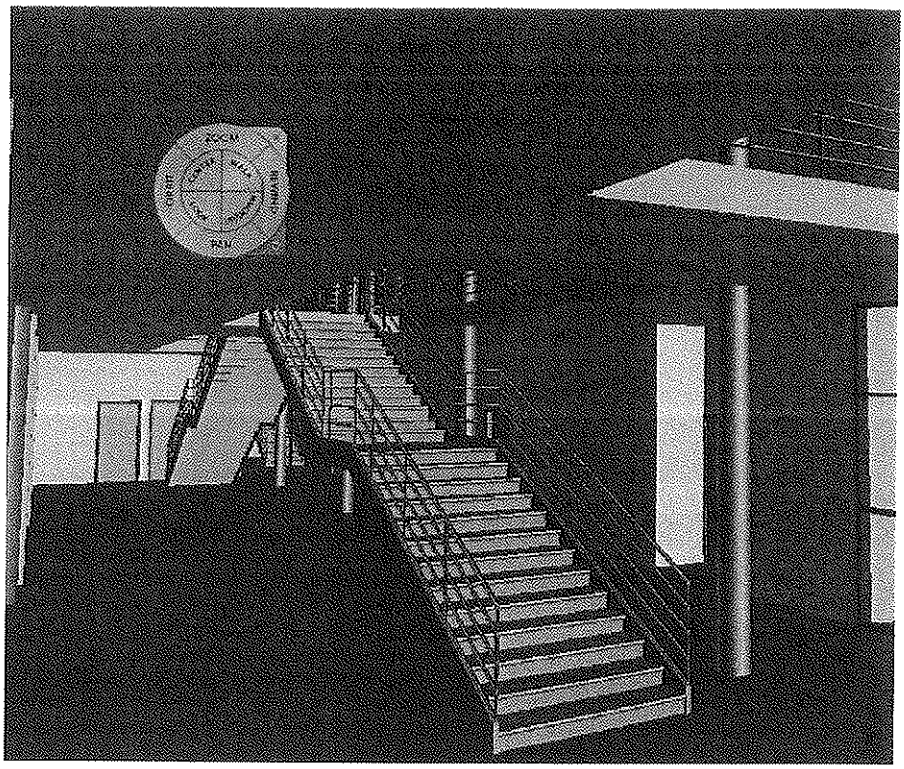








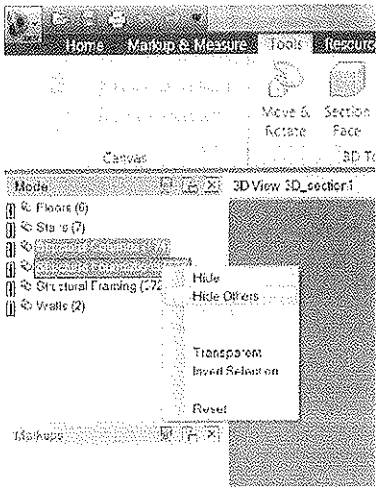
Navigate in 3D - Walkthrough

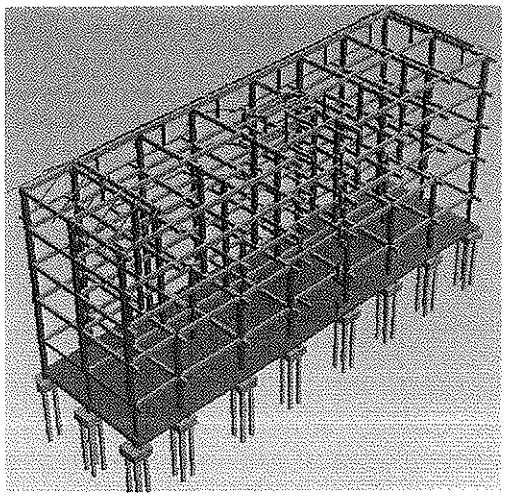


Navigate in 3D - Sectioning



Show & Hide Elements



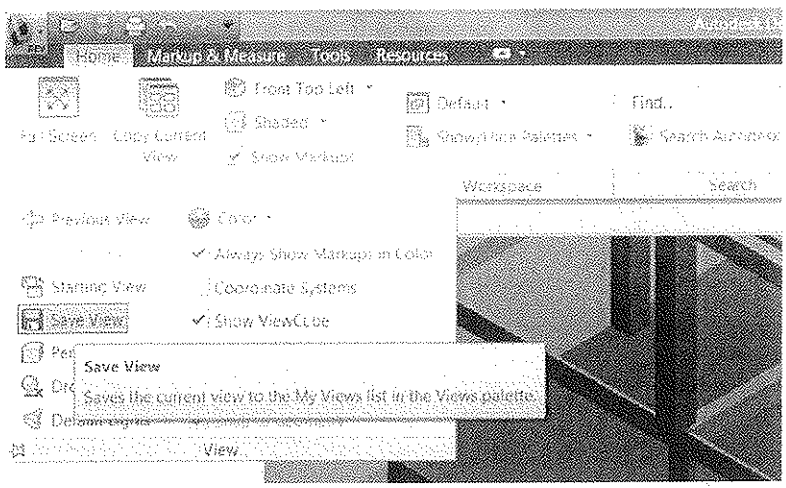


- Select the elements from the **Model Palette**
- Right click and choose **Hide Others**. Which hides the other elements.
- This allows user to explore the model with ease
- Any time right click on the hidden elements and choose Show All

Save Views

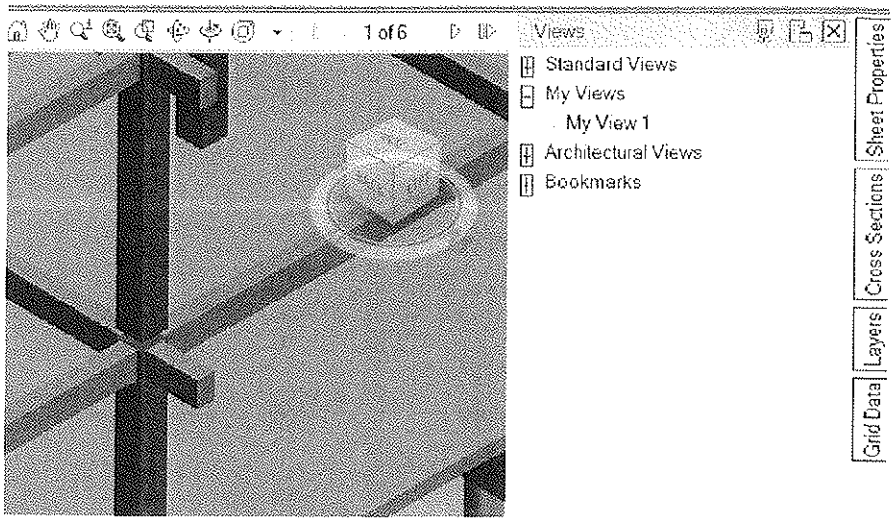
- The following steps allows users to save the views while navigating in 3D view. This is useful to come back to the same position.

Menu: Home→View→Save View



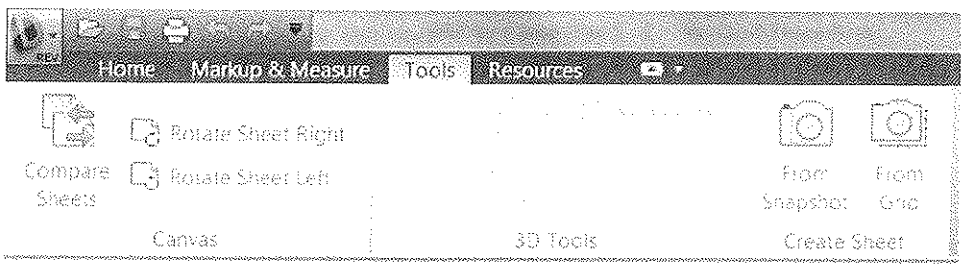
Save Views

- The view will be saved in the View Palette on the right side. Open the View Palette and click on the saved view to return to the view.



Comparing Versions

- Open the DWF (Contains Version 1 View/Sheet)
- Choose Compare Sheets from the Tools Tab.

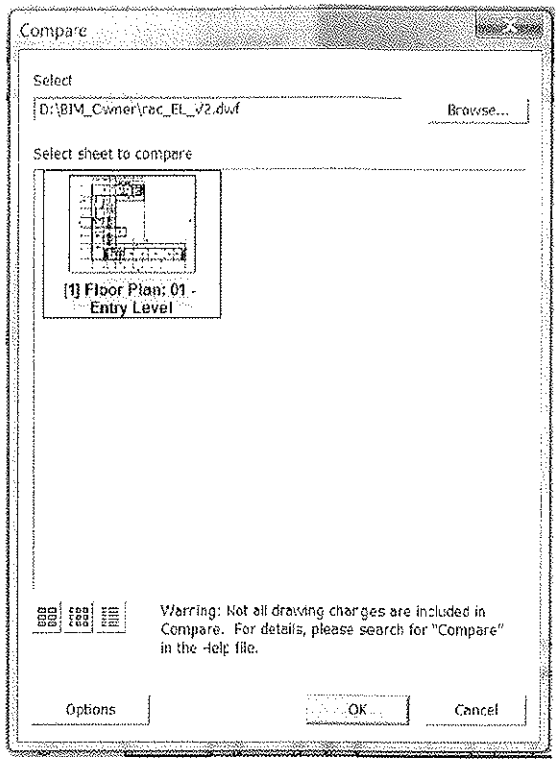


Comparing Versions

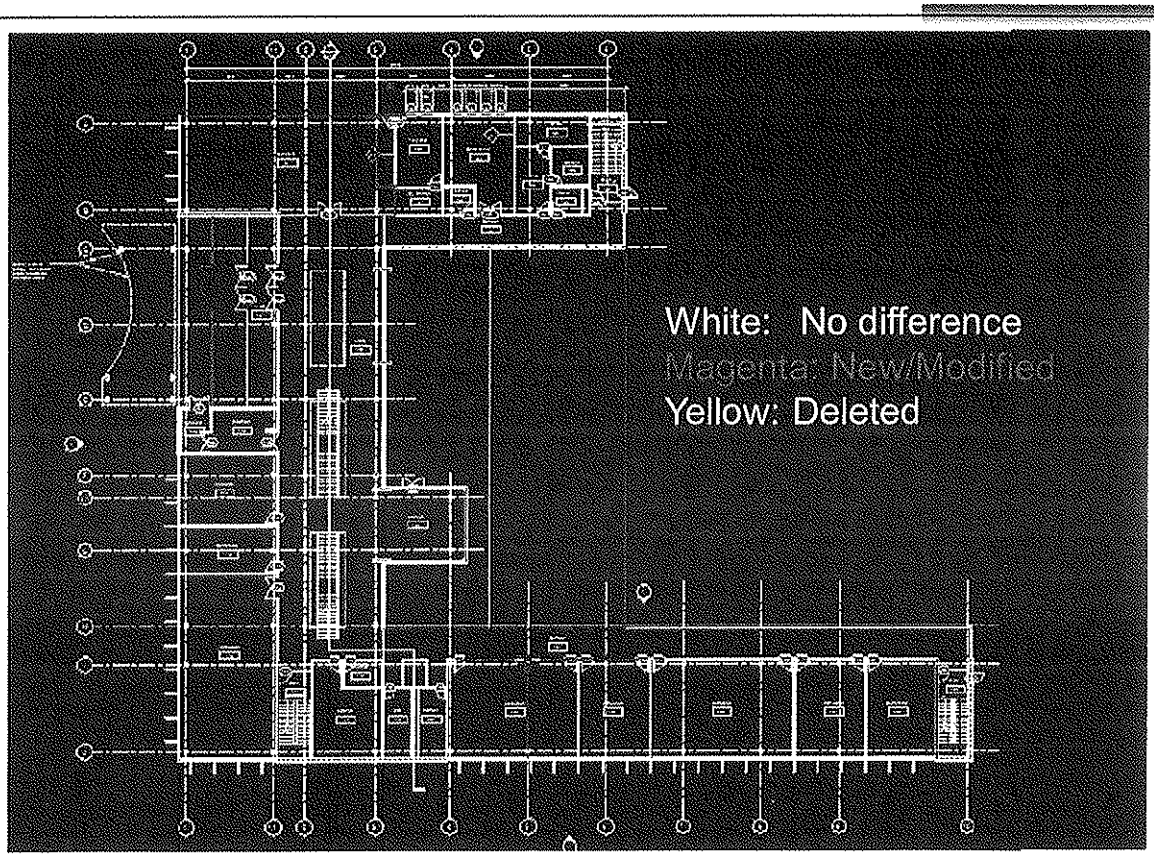
- Select DWF
  (Contains Version 2 View/Sheet)
- Select the View
- Click OK

Note: In Revit Switch-off the display of slab projection pattern to avoid confusion.

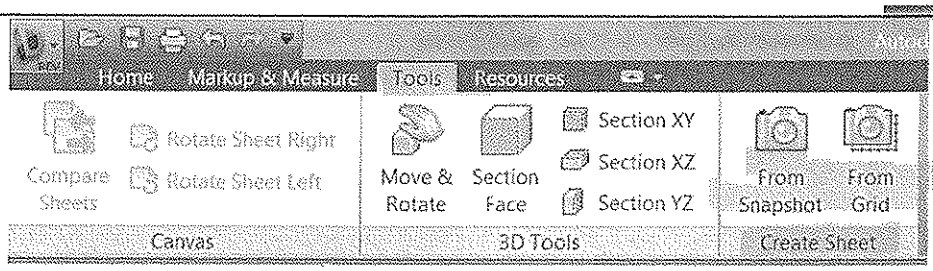
If exported with pattern then the whole model will be shaded with colors highlighting the difference, which will cause confusion.

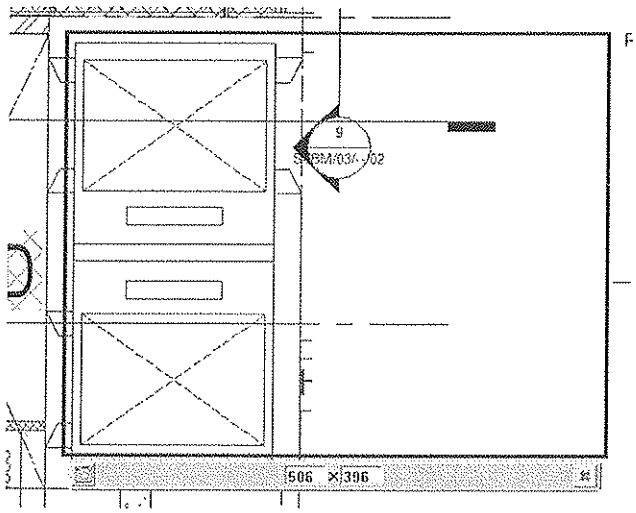


Comparing Versions



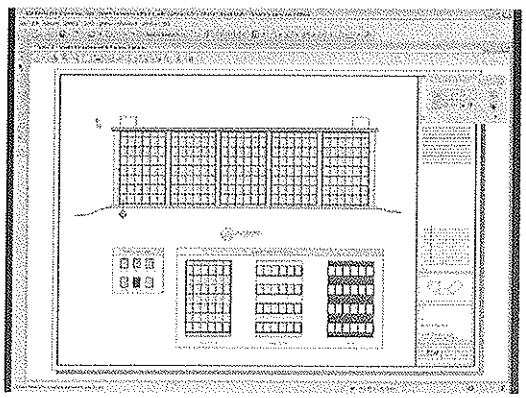
Snap Shots and Printing

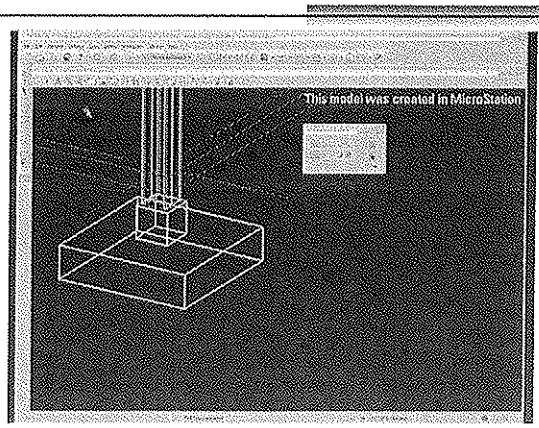


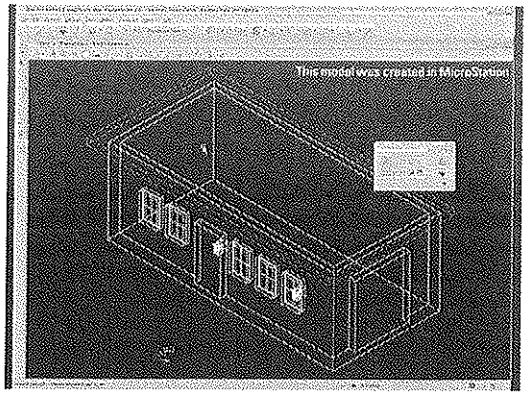


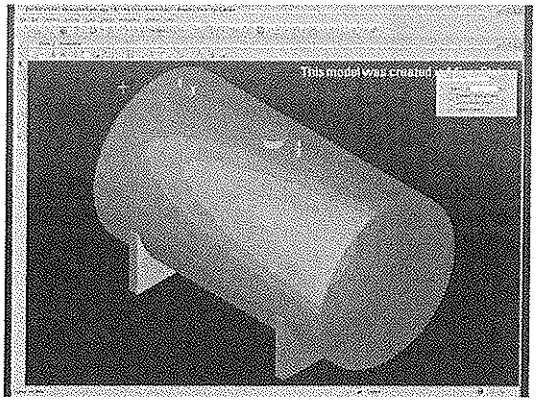
- This is to save a snap-shot of the View with in the same DWF File

Bentley Viewer









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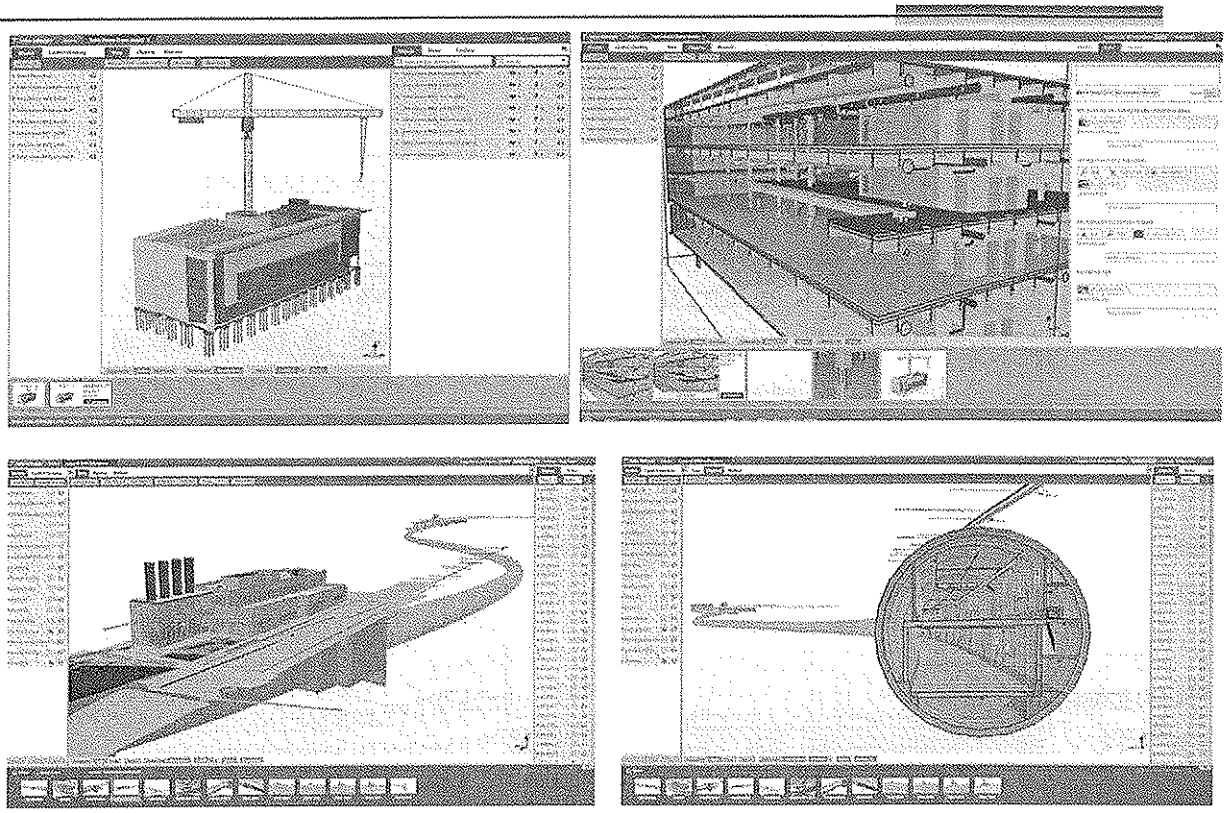

BIM Quality Assurance & Coordination

Presented by :

Karthik V
karthik.v@bybitech.com

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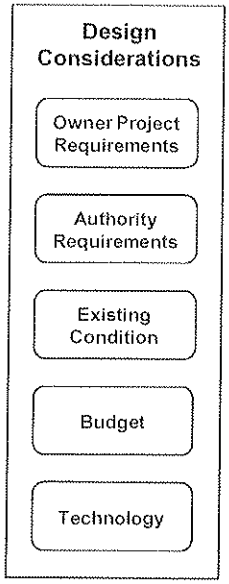
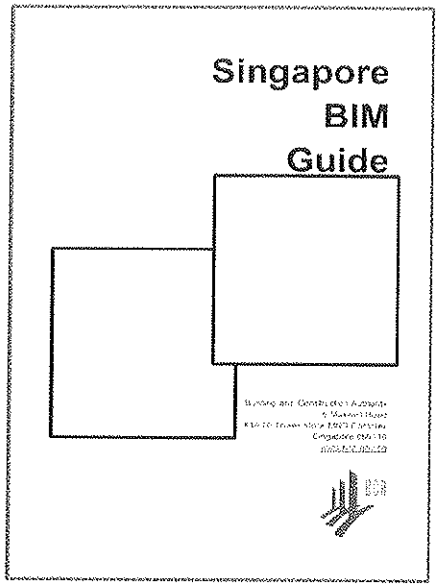
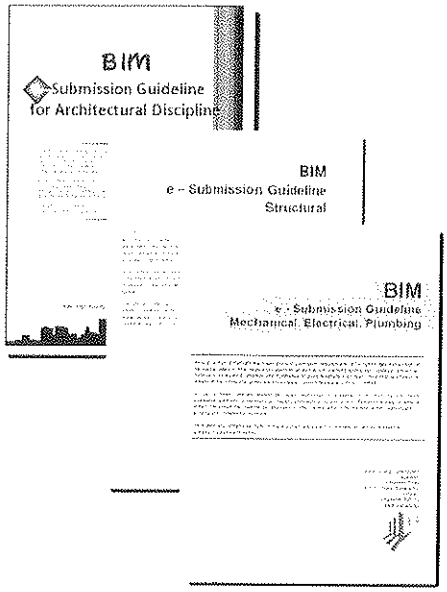
Quality Checking

What is BIM QA?

Observing BIM standards and guidelines







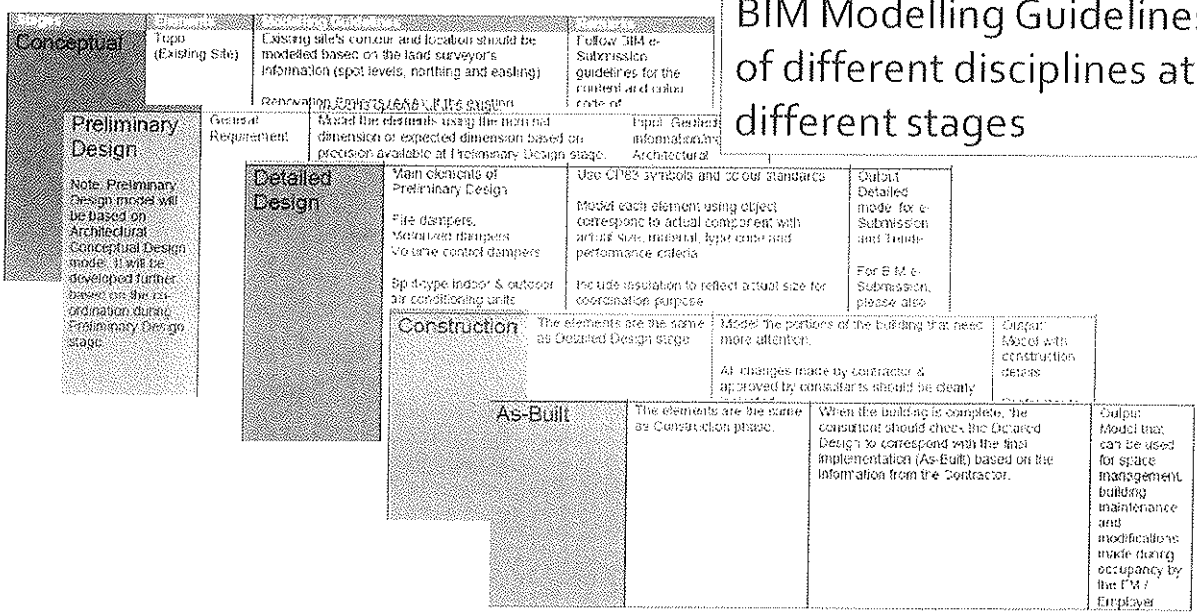
To check:
① Filename / Doc No.
②

Quality Checking

What is BIM QA?

Observing BIM standards and guidelines

BIM Modelling Guidelines of different disciplines at different stages



Quality Checking

What is BIM QA?
Observing BIM standards and guidelines

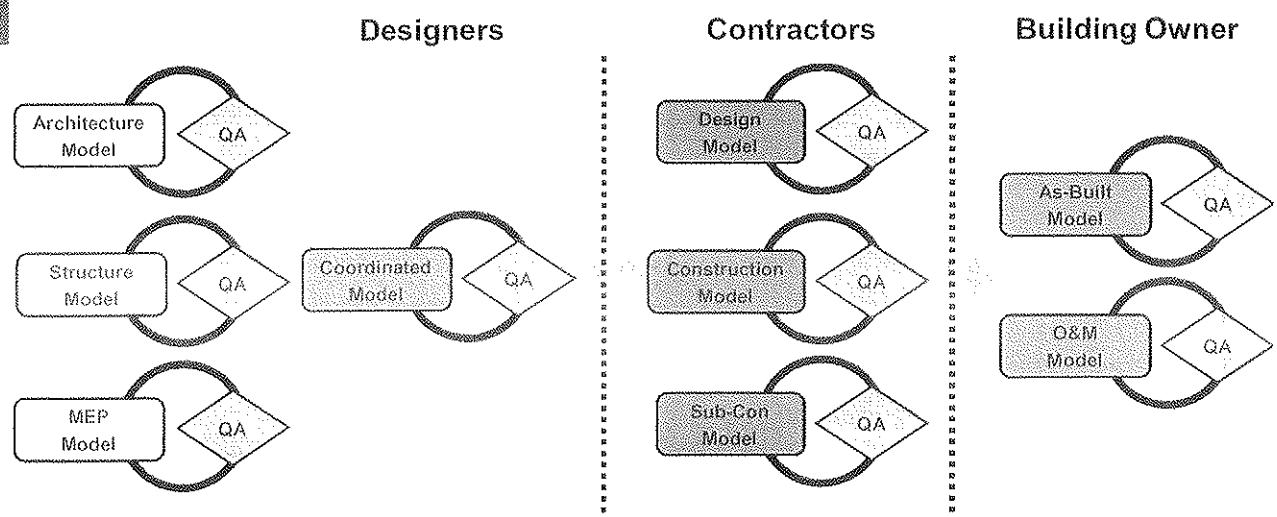
Appendix A – Typical BIM Elements by Discipline

(i) Architectural BIM Elements

	Element
Site Model	Site infrastructure within site boundary (roads, pavements, car park spaces, access and parking arrangements and surrounding land use)
	Street fire hydrant (only indication of locations necessary)
	Surface drainage (only indication of locations necessary)
	External drainage & underground drainage
	Hard landscaped areas within site boundary
	Planter boxes including sub-soil drainage systems
	Massing of adjacent buildings relevant to project
Rooms / Spaces	Room spaces, corridors, other spaces, plant and equipment rooms (including designated use)
Walls and Curtain Walls	Interior / Exterior walls / Non-structural walls / Blockwork walls (*including finishes to identify if tiled / painted / plastered*)
	Studs* and individual layers of drywall
	Curtain wall with mullions and transoms with true profile and window glazing units including shading devices
Doors,	Interior / Exterior doors
	Interior / Exterior windows

Quality Checking

Teams need to do QA:



* QA = Quality Assurance

Quality Checking

Types of Quality Check

goal	contents
self check	Quality of a model itself checked by the modelers
coordination check	Coordination check including clash check between different models
version check	Comparison between old and new models

subject	contents
Non-Geometrical Information	Information like fire ratting, material, acoustic ratting, FM data, etc.
Geometrical Information	Geometrical completeness, clash of elements etc.
logical information	Building codes, other logical requirements etc.

method	contents
Automatic check	Checking by software using build-in function
Numerical check	Extracting and analyzing the numerical data
Visual check	Visual checking by model viewer

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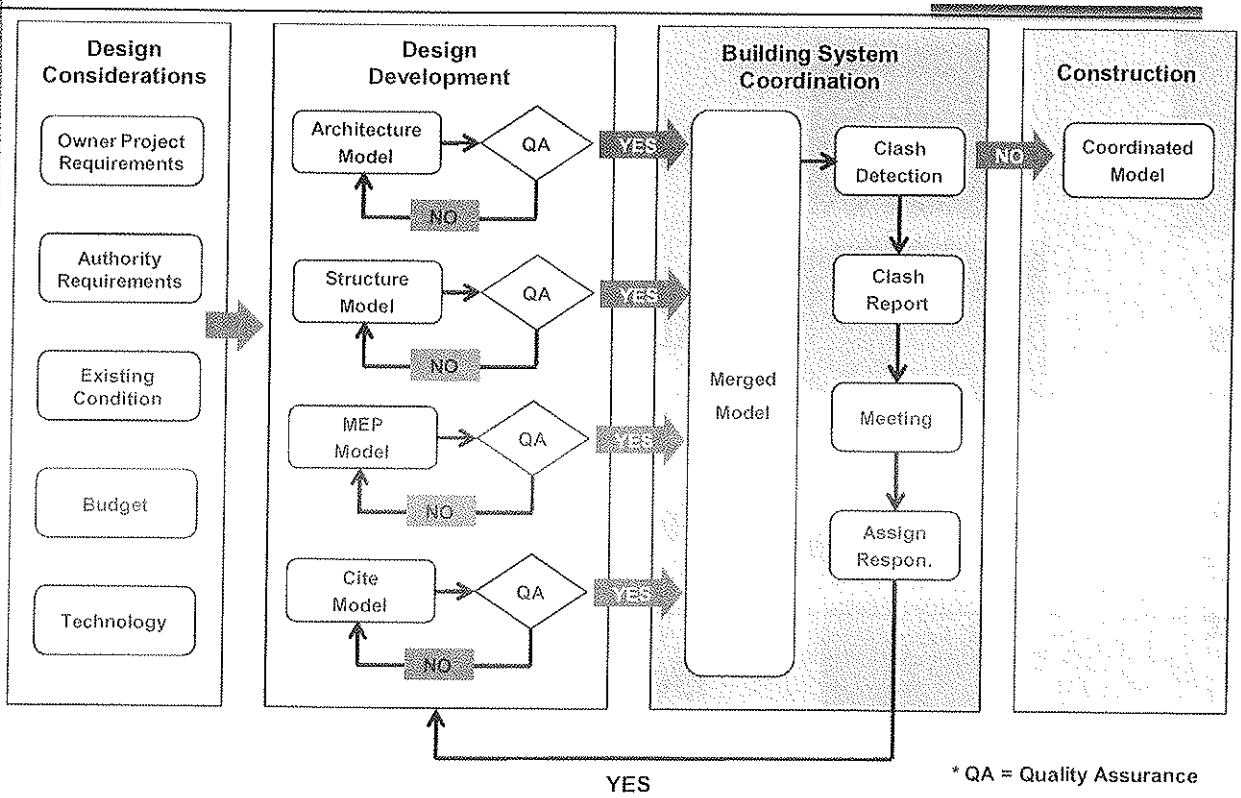
Quality Checking



Source : LACCD (The Los Angeles Community College District) DB

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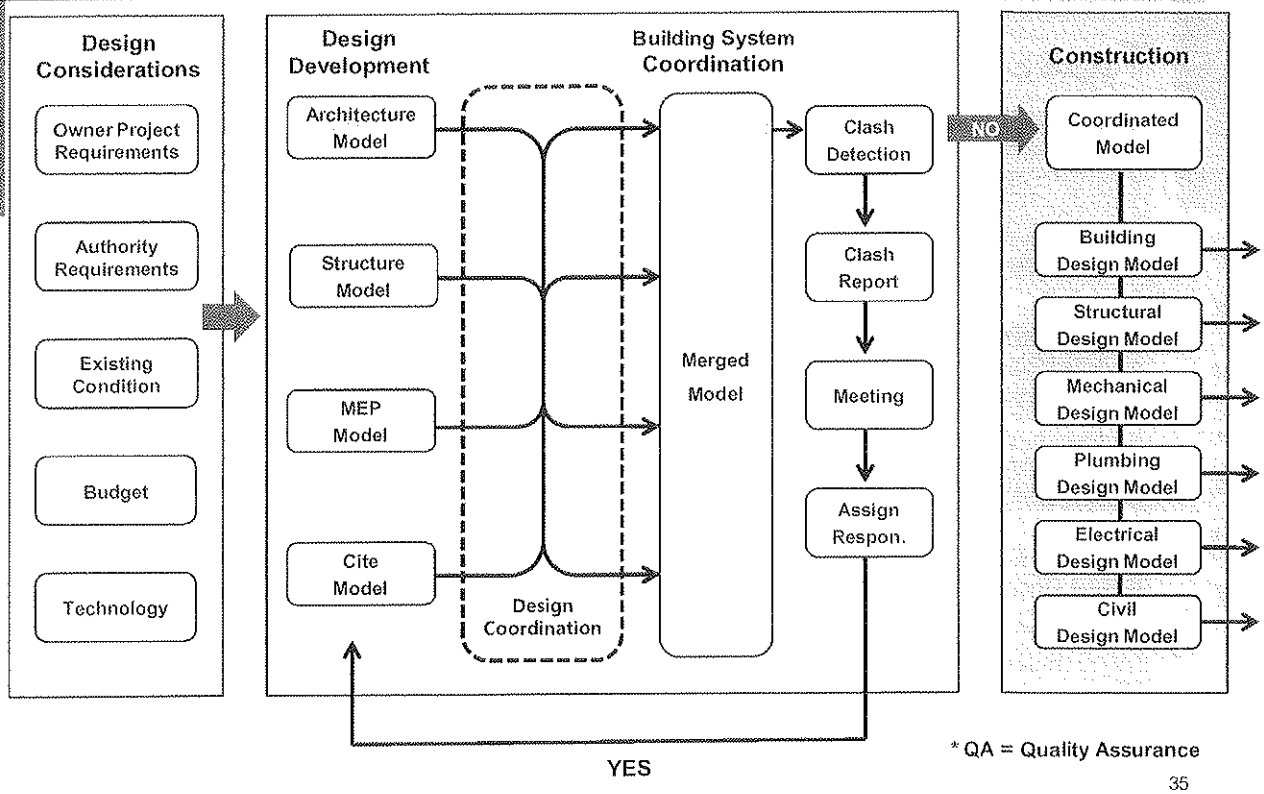
Quality Checking



* QA = Quality Assurance

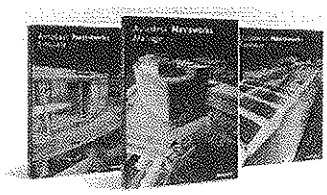
Source : LACCD (The Los Angeles Community College District) DBB

DESIGN, BUILD & BUILT.

Software for Quality Checking

SOLIBRI

Solibri Model Checker



Autodesk Navisworks

TEKLA BIMSIGHT

Tekla BIMsight



Bentley ProjectWise Navigator

Software for Quality Checking

BIM Authoring tools (ORIGINATOR)



TEKLA Structures

GRAPHISOFT. ARCHICAD

Bentley AECOsim Building Designer

BCA ACADEMY

Authoring Tools

- Schedules
- Intelligent objects
- Color Coding
- Add-ons

BCA ACADEMY

Authoring Tools

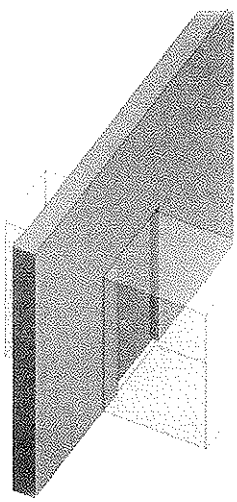
- Schedules
  - Using schedules to identify objects that can be standardized

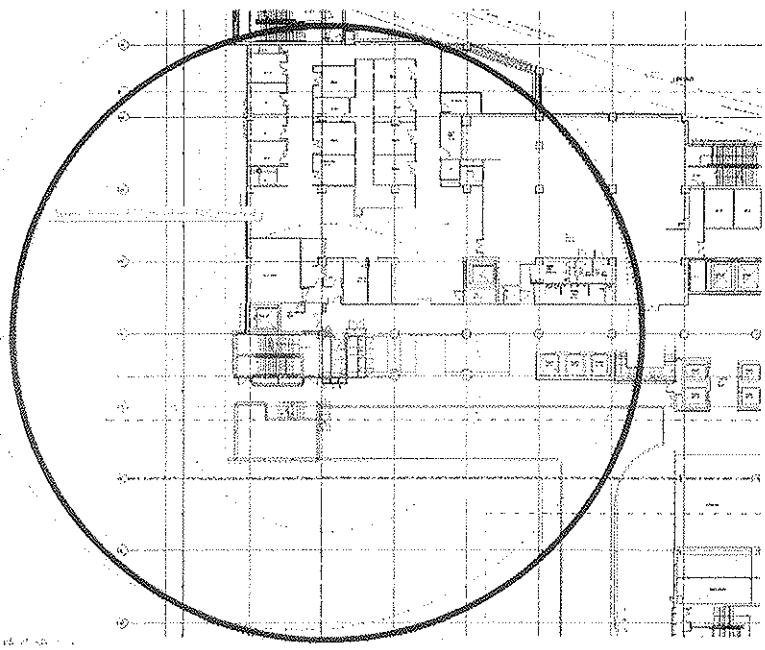
Door Schedule

Family	Door Type	Height	Width	Count
1st Storey Level				
Dbl Glass (3)		2375	1975	1
1				
M_Double-Flush		2100	1600	1
M_Double-Flush		2100	1800	
M_Double-Flush		2100	1852	5
M_Double-Flush	FD	2324	1200	6
M_Double-Flush		2324	1900	12
M_Double-Flush	FD	2324	1950	4
30				
M_Single-Flush		2324	600	6
M_Single-Flush	FD	2324	600	6
M_Single-Flush		2324	800	20
M_Single-Flush		2324	1000	5
M_Single-Flush	FD	2324	1050	3
40				
Single - Steel Frame		2100	600	1
1				
2nd Storey Level				
M_Double-Flush		2100	1800	2
M_Double-Flush		2100	1852	5
M_Double-Flush	FD	2324	1200	8
M_Double-Flush		2324	1900	15
M_Double-Flush	FD	2324	1950	7

Authoring Tools

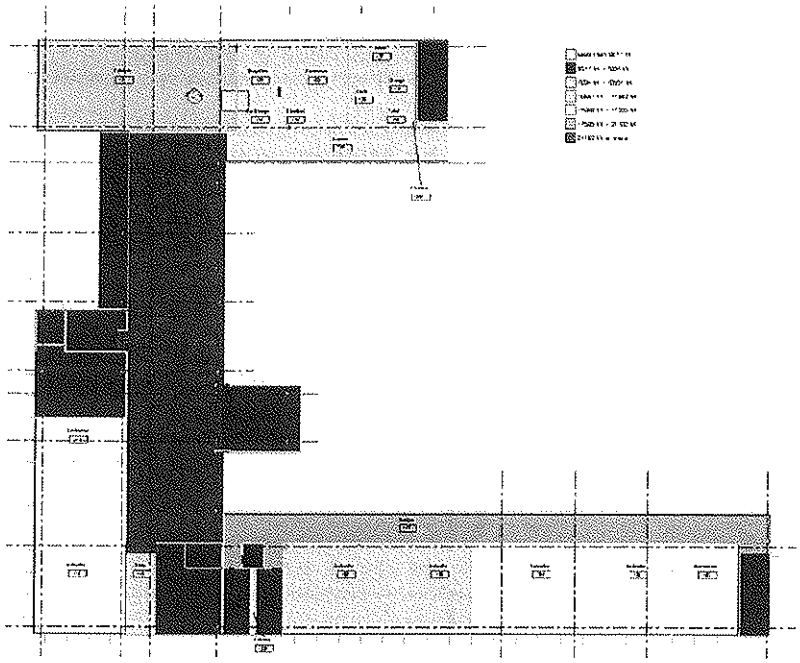
- Intelligent objects





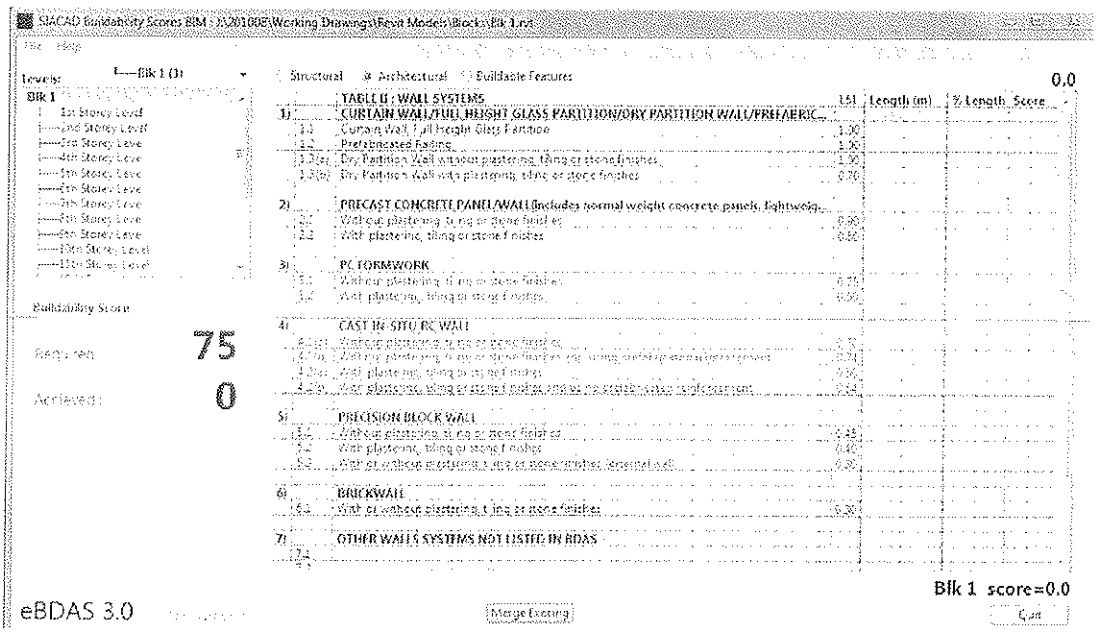
Authoring Tools

- Color Coding

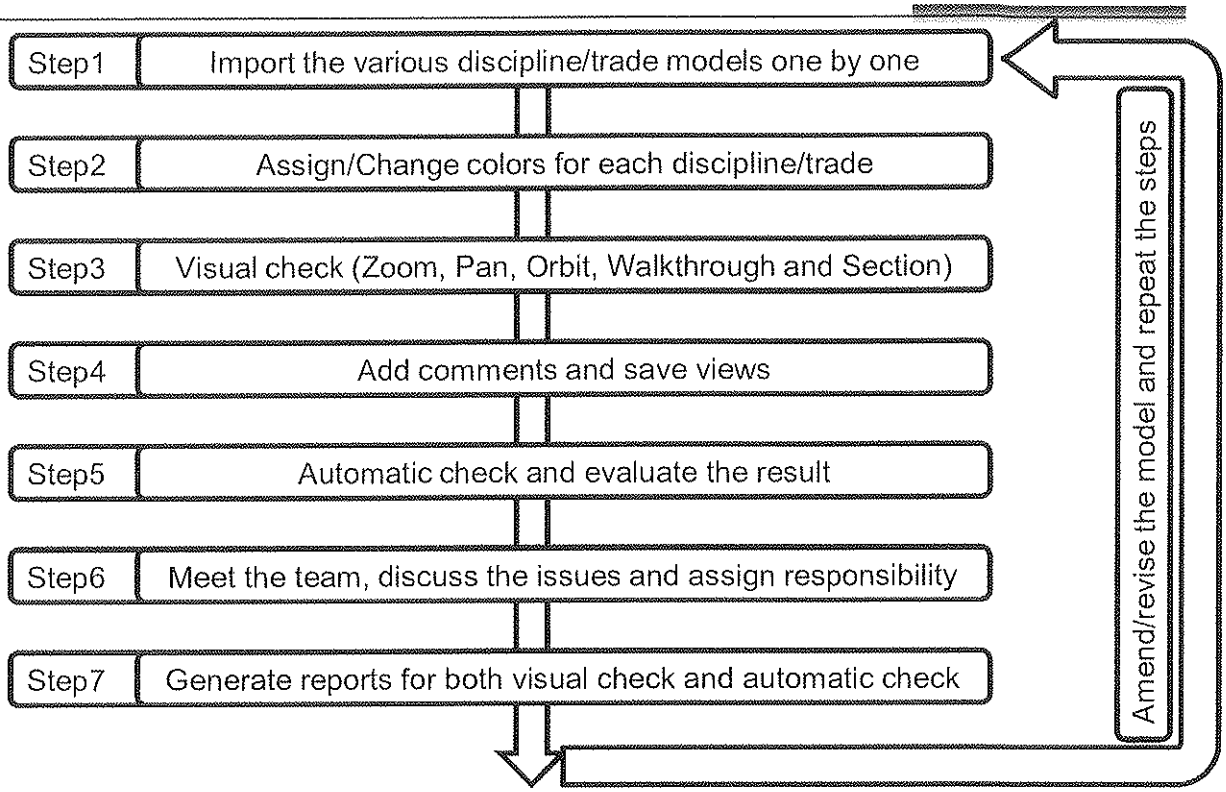


Authoring Tools

- Add-ons



Typical Quality Checking Process



BCA ACADEMY

Compare & review model

Solibri Model Checker

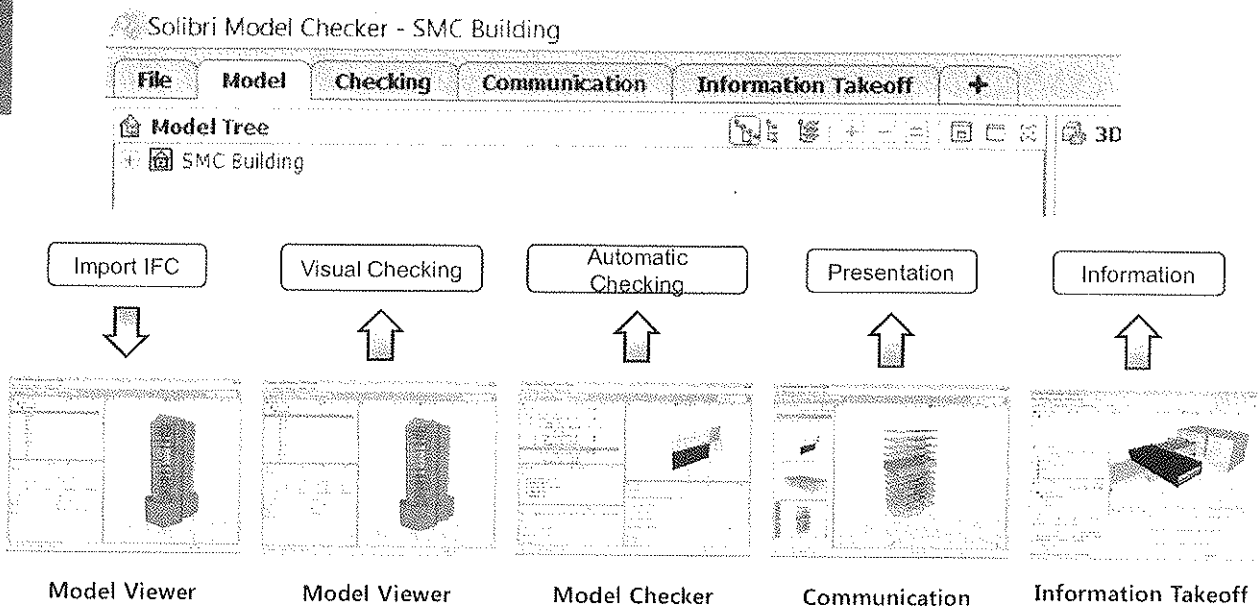
'Rule' → built in software

- SMC is a "Rule based" checker.
- SMC can be used for
  - Visual Check
  - Automatic Checking
  - Logical Checking (ex. Handicap Requirement)
  - Version Comparison
  - Numeric Checking

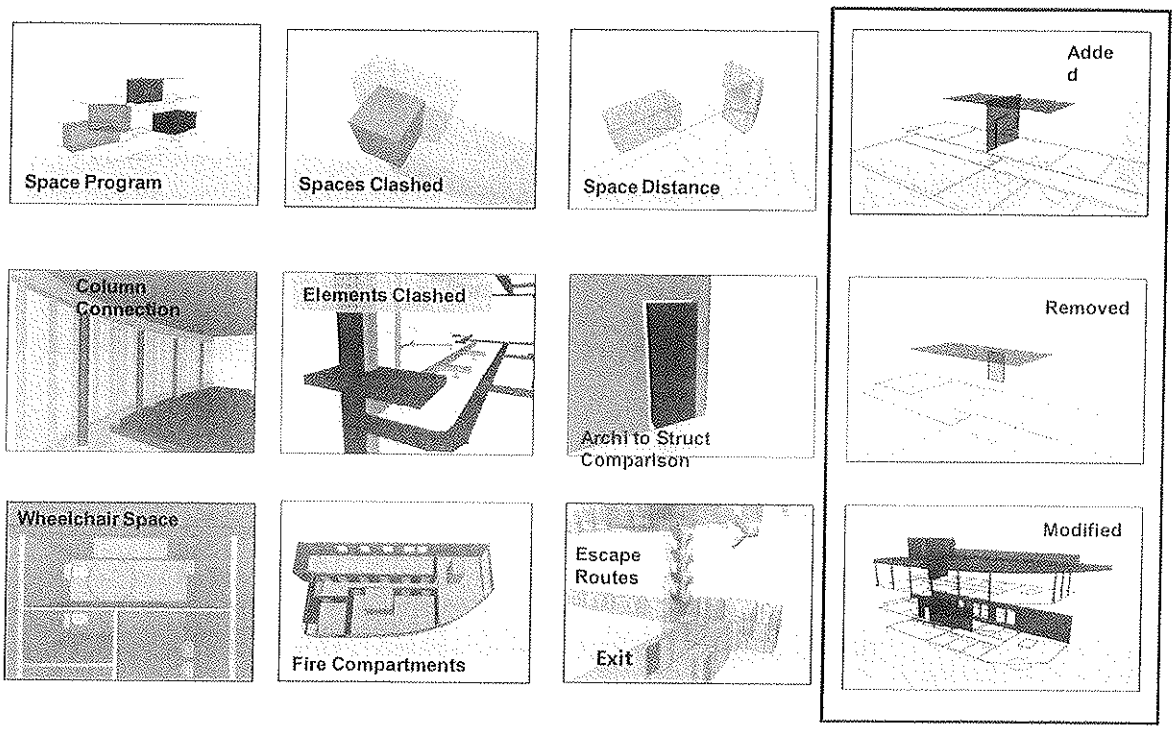
must import model to IFC.

BCA ACADEMY

Checking Practice



Checking Practice



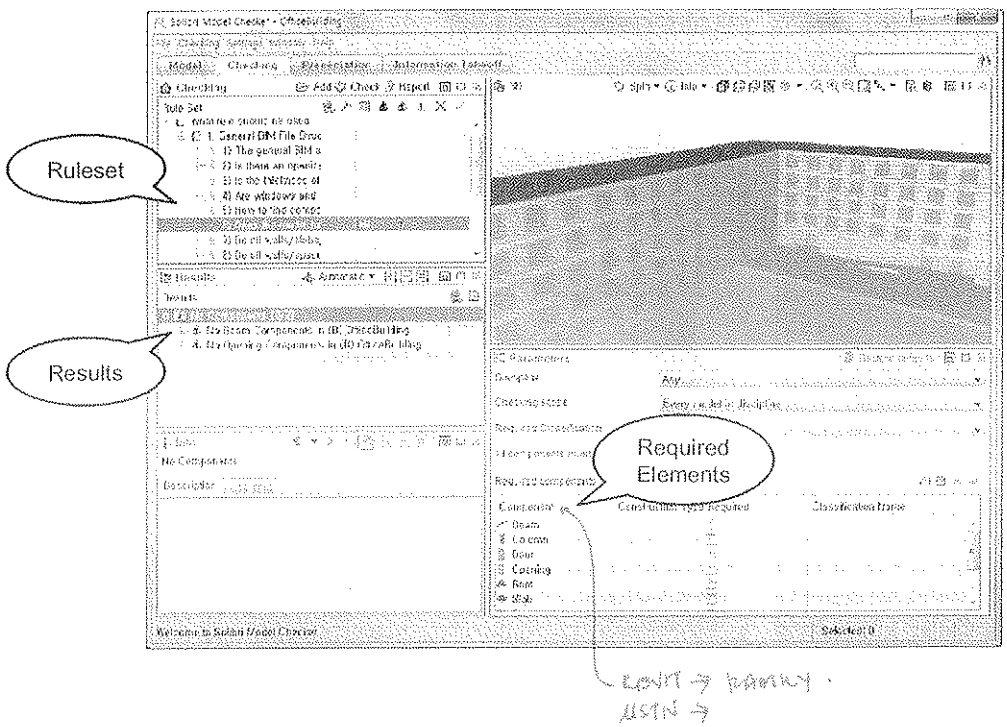
Checking Practice

Model Should Have Components

This rule checks that the model has components of selected types. It also checks that all components have a construction type (if required). It can be used, for example, before quantity take-off to be sure, that the model is complete (e.g. the model includes spaces, if they are required).

BCA ACADEMY

Checking Practice

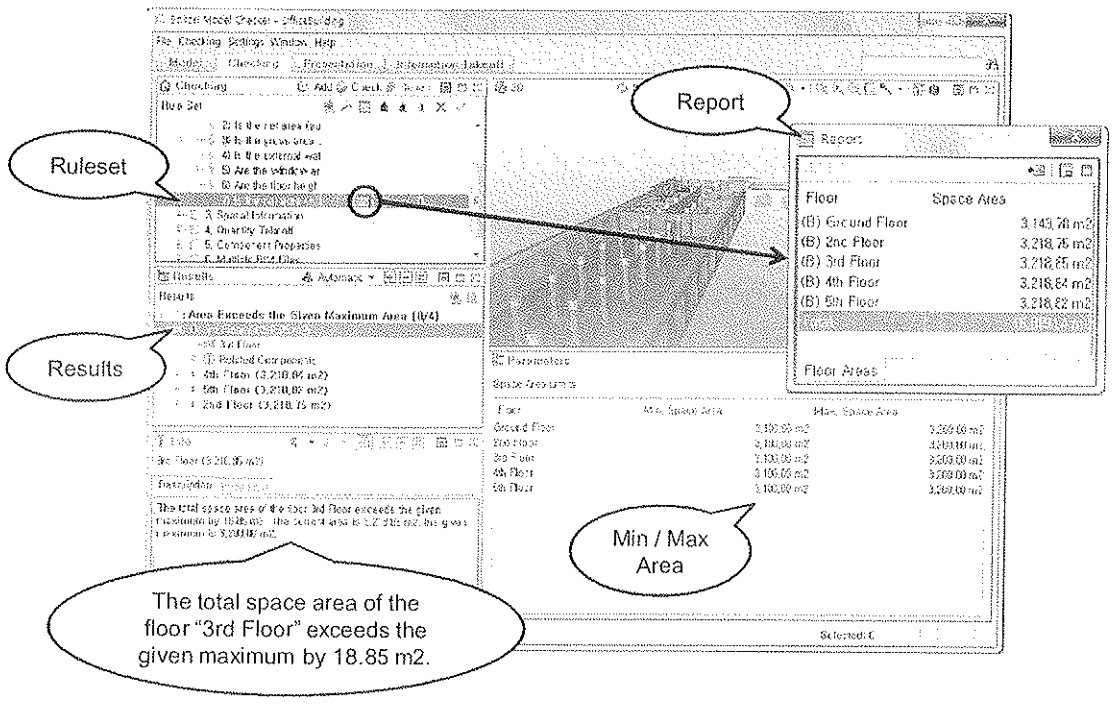


Checking Practice

Total Space Area on Each Floor

This rule checks the area of spaces in each building floor. The user can define the maximum and minimum allowed area for each building floor. The rule reports the space areas for each building floor.

Checking Practice

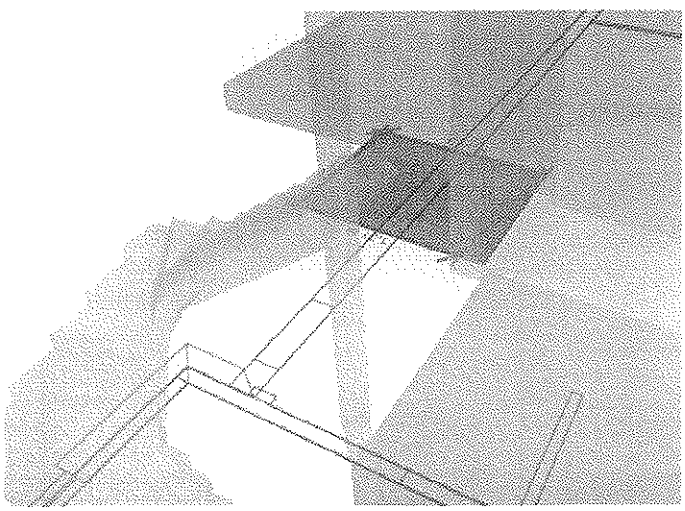


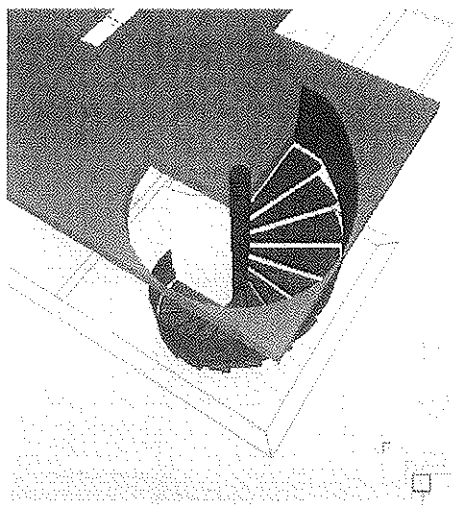
Checking Practice

Accessible Stair Rule

This rule checks the accessibility of stairs from different perspectives. It checks the number of steps, dimensions of steps, dimensions of intermediate landings, free space at the beginning, and at the end of the stair. Head clearance above and under the stair is also checked.

Checking Practice



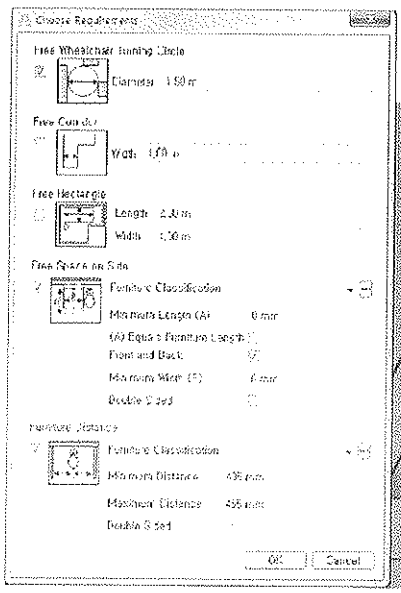


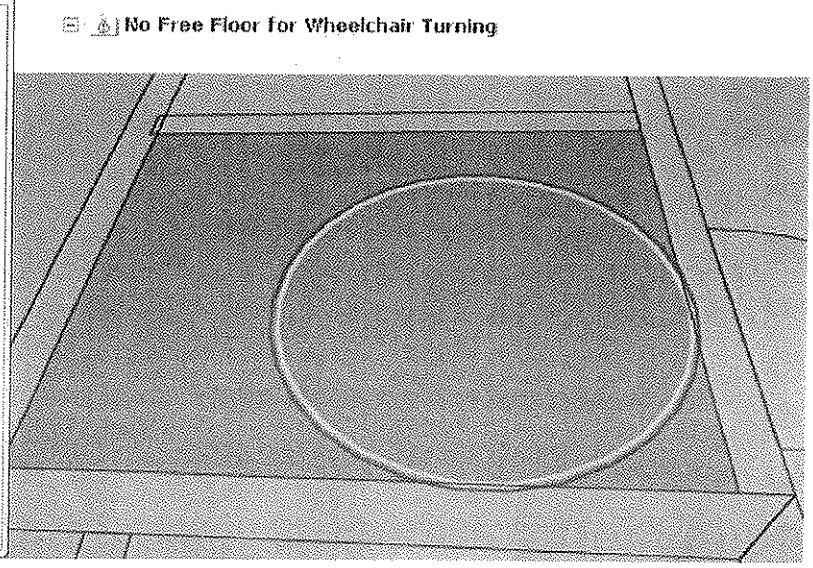
Checking Practice

Free Floor Space

This rule can be used to check different accessibility-related requirements for free space. For example, the rule can be configured to check that a corridor has unobstructed width of 1.2 meters or that a washroom has room for a 1.5 meter wheelchair turning circle.

Checking Practice



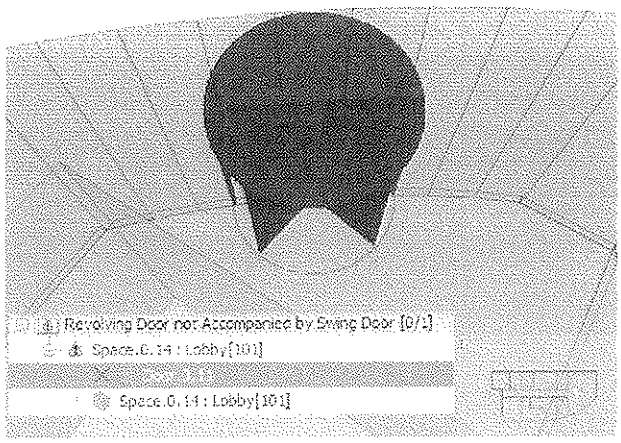


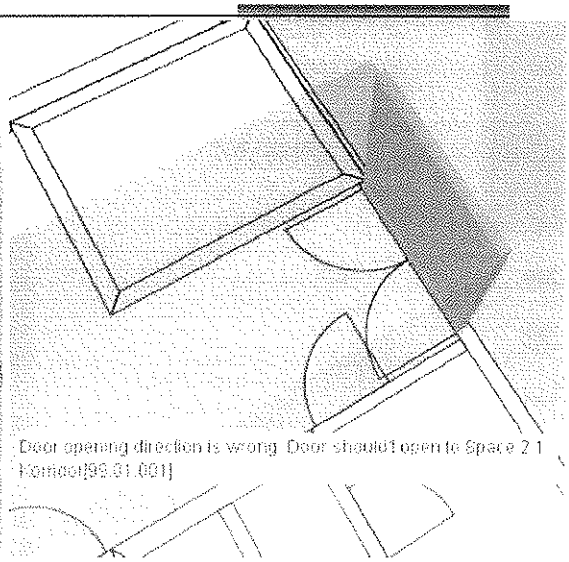
Checking Practice

Accessible Door Rule

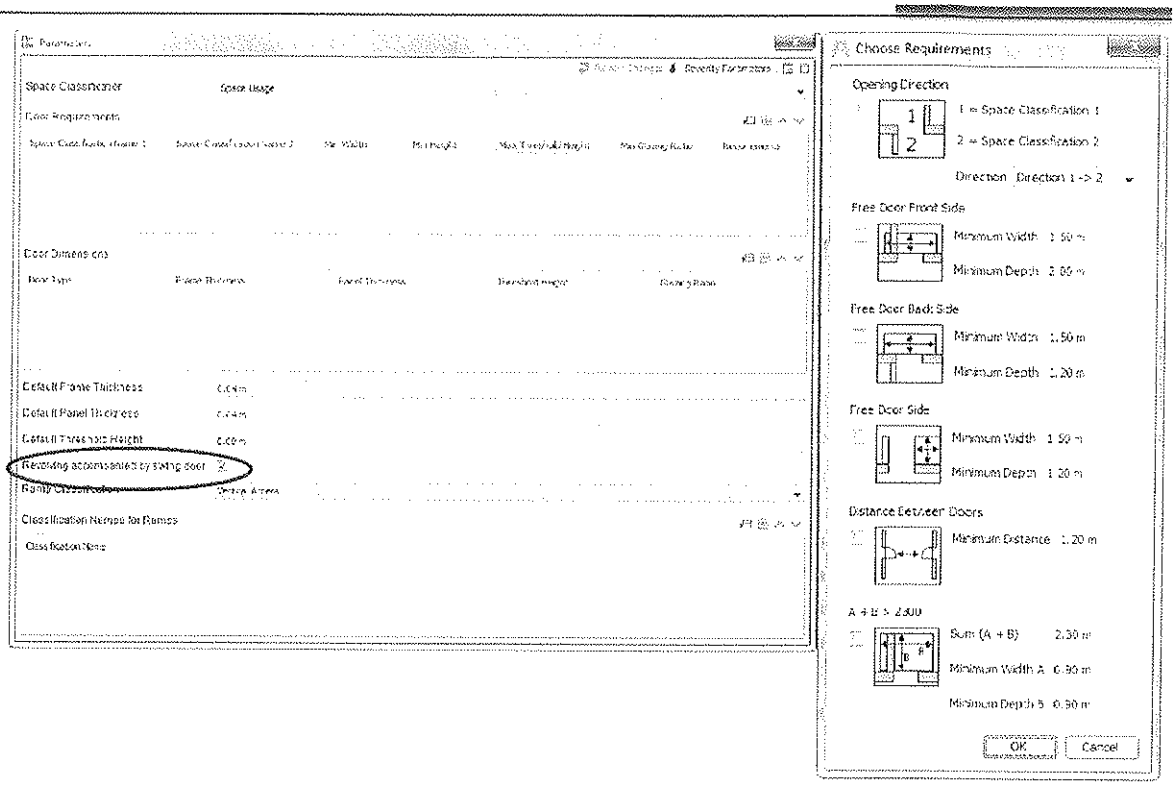
This rule checks the accessibility of door from different perspectives. It checks the dimensions, glazing ratios, opening directions, and free spaces of the door.

Checking Practice





Checking Practice



Checking Practice

1. General BIM File Structure

1. The general BIM structure of the file?
2. Is there an opening in a wall for every door and window?
3. Is the thickness of a wall, slab or roof same as sum of its material layer thicknesses?
4. Are windows and doors located in the same floor than a wall they belong to?
5. How to find components with very complicated geometry or potential problems with geometry?
6. Does the model have walls/slabs/spaces/....?
7. Do all walls/slabs/... have a construction type defined?
8. Do all walls/spaces/.. have a specific property set or property?
9. Have specific properties values in all components?
10. Is there a relation (used by downstream applications) between windows/doors and spaces?

Source : Solibri Inc.

Checking Practice

2. Building Floor and Gross Area Analysis

1. Does the model have gross building areas in each floor?
2. Is the net area (sum of space areas) large enough compared to gross area?
3. Is the gross area covered with spaces, walls and columns? Anything missing?
4. Is the external wall area/gross area ratio large enough?
5. Are the window area/external wall ratios reasonable in each floor and/or in whole building?
6. Are the floor heights consistent in each floor (you can ignore lowest and topmost floors)?
7. Is the net area (= total area of spaces) of building the same as required?

Source : Solibri Inc.

BCA ACADEMY

Checking Practice

3. Spatial Information

1. Are space areas within given min/max limits?
2. Do all apartments (or other group of spaces) contain required spaces?
3. Do all spaces have a name, number, and/or type?
4. Has the model all spaces required in the room schedule/housing plan?
5. How to compare spaces and space areas against the room schedule/housing plan?
6. Are space areas aligned with surrounding walls?
7. Is the height of spaces at least the minimum value required?
8. Do all spaces touch slabs below and/or top themselves?
9. Are there walls or columns insides spaces?
10. Are the used space names from the list of acceptable space names?
11. Does number of spaces in each floor match the list of required spaces?
12. Does the model have fire compartments?
13. Are all spaces included in fire compartments?

etc.

Source : Solibri Inc.

Checking Practice

4. Quantity Takeoff

1. Can I have list of component quantities?
2. Can I have list of component quantities sorted by building floors?
3. Are the walls/slab thicknesses per type consistent in the model?
4. Are the wall heights per type consistent in each floor?
5. Are the windows/door widths/heights per type consistent?
6. What is the volume of clashes per material type (extra material)?
7. Does the model have duplicate columns, walls, doors, ...?
8. Does the model have overlapping components?

Source : Solibri Inc.

BCA ACADEMY

Checking Practice

5. Component Properties

1. Are the window top elevations for all windows consistent in each floor?
2. Are the construction types according to a list of approved types?
3. Can you visualize walls/windows/slabs.. by construction types using color codes?
4. Are all walls/slabs/columns/... located at correct layer?
5. Are all walls in the model higher than a given limit value?
6. Is there any window in the model, which elevation is less than given limit value?
7. Are all walls in the model longer than a given limit value?
8. Are all window areas in the model larger than a given limit value?
9. Are all window areas in the model smaller than a given limit value?
10. Are external walls set in a correct way?
11. Are columns touching a slab, beam, wall or other column underneath? (correct column elevations)

etc.

Source : Solibri Inc.

Checking Practice

6. Multiple BIM Files

1. What are the differences between two model versions of the same design discipline?
2. What are the differences in quantities between two model versions of the same design discipline?
3. Are columns similarly located in structural and architectural model?
4. Are load bearing walls similarly located in structural and architectural model?
5. Are openings similarly located in structural and architectural model?

Source : Solibri Inc.

BCA ACADEMY

Checking Practice

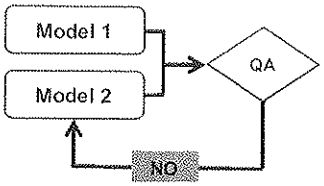
7. Building Code

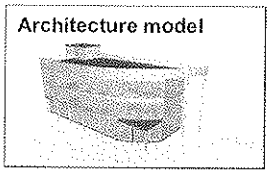
1. Is the width of the doors between specific space types large enough?
2. Is the height of the doors between specific space types large enough?
3. Is the threshold height of the doors between specific space types small enough?
4. Is the glazing ratio of the doors between specific space types large enough?
5. Is the opening direction of doors between specific space types correct?
6. Is there enough space in front of the doors between specific spaces?
7. Is there enough space in side of the doors between specific spaces?
8. Is there enough space in back of the doors between specific spaces?
9. Is the sum of width and height of the free area in front of the door big enough?
10. Are the ramps in the model acceptable according the accessibility rules (length/height)?
11. Is it always possible to use stairs instead of a ramp?
12. Is the width or the free width of the ramps big enough?
13. Are there enough free spaces before and after ramps/stairs?

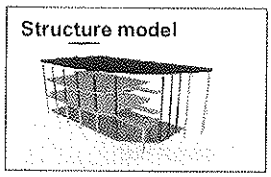
etc.

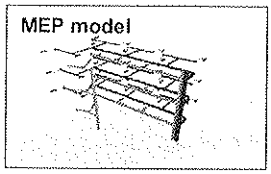
Source : Solibri Inc.

Interference Checking - SMC

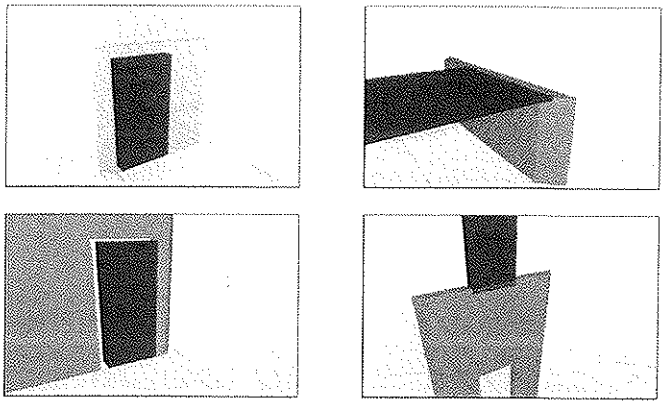




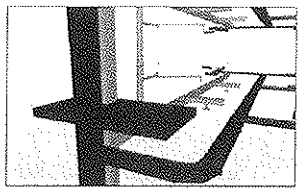




Architecture & Structure Models



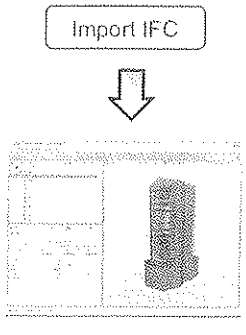
Architecture & MEP Models



BCA ACADEMY

Interference Checking - SMC

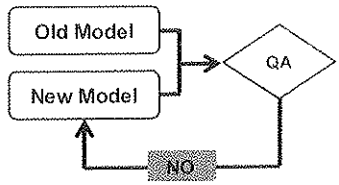
1. Import the models discipline by discipline in IFC format that need to be checked for interference.
2. Add the rules for interference checking.
3. Check the models.
4. Verify the checking result.
5. Generate the report.

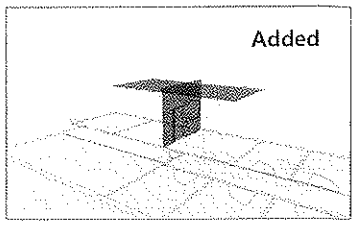


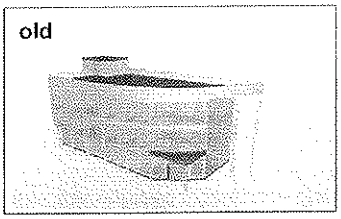
Model Viewer

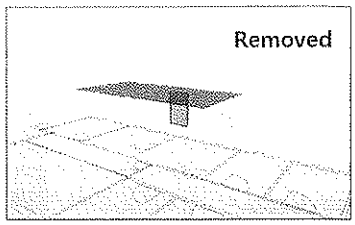
BCA ACADEMY

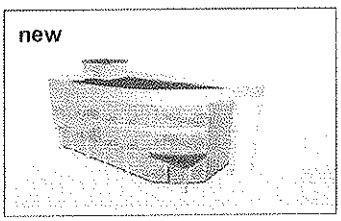
Version Comparison - SMC

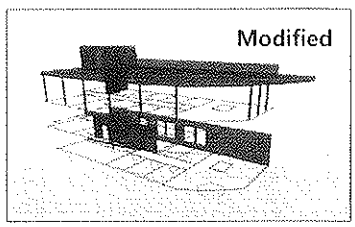






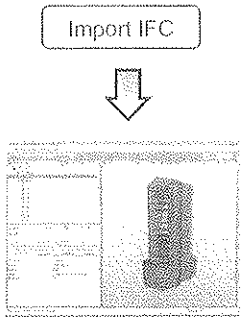






Version Comparison - SMC

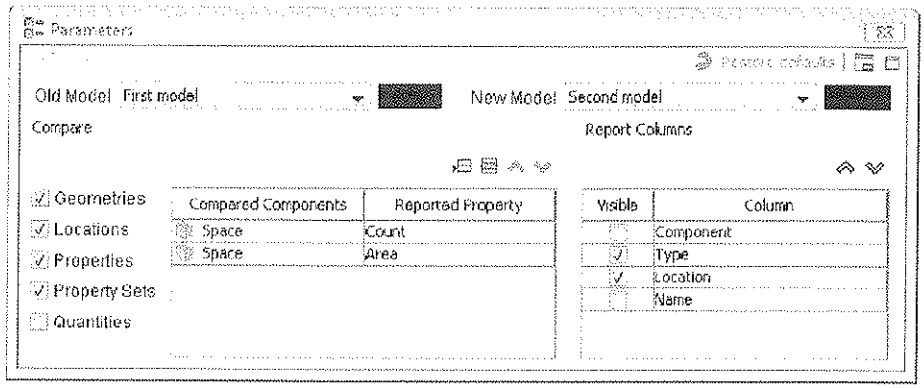
1. Import both the models in IFC format that need to be checked for version.
2. Add the rules for model comparison.
3. Check the models.
4. Verify the checking result.
5. Generate the report.



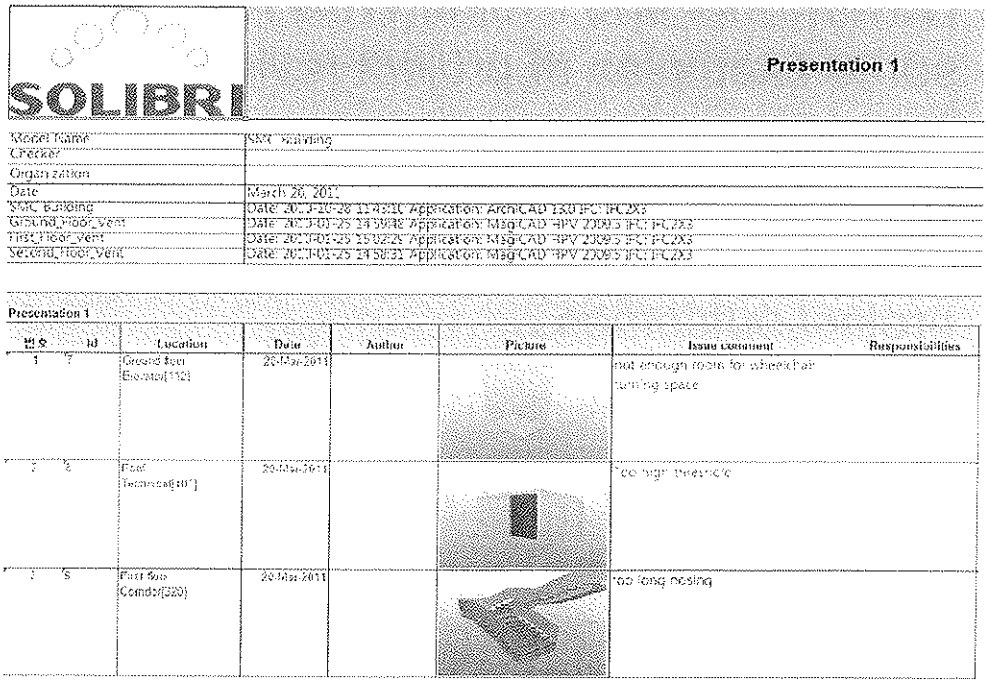
Model Viewer

Version Comparison - SMC

- Model Comparison
  - The rule compares two models and reports their differences
  - used to compare modifications between two version of the same model



Quality Checking Report - SMC



DEMO (SMC)

BCA ACADEMY

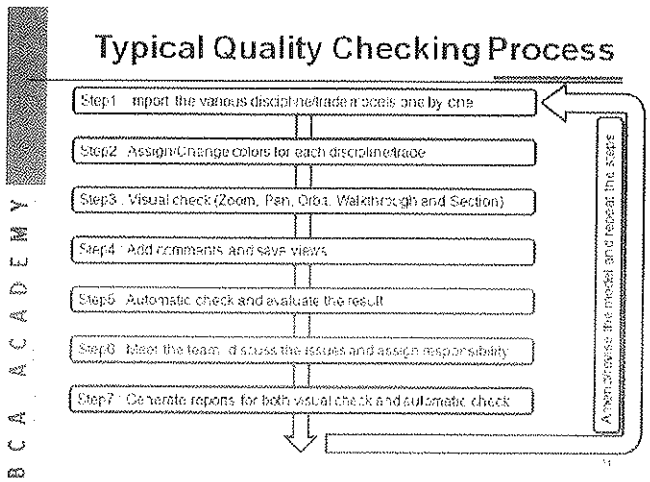
Project Review Software

- Navisworks and ProjectWise Navigator are some examples of project review software.
- Project review software helps designers and construction professionals to gain control over project outcomes.
- Allows users to integrate, share, and review 3D models and multi-format data.
- Allows users to **coordinate**, resolve conflicts, and **Plan Projects** before construction begins.

HANDS-ON (NAVISWORK)

Interference Checking - Navisworks

1. Follow the typical quality checking process shown earlier.



REVIT 2014 CAN BE IMPORTED DIRECTLY.

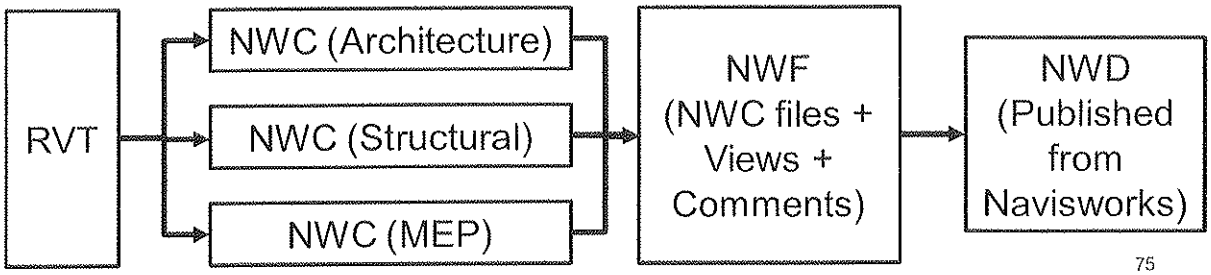
2. Preferred format is Navisworks format. Navisworks can import other formats as well.

Navisworks – File Formats

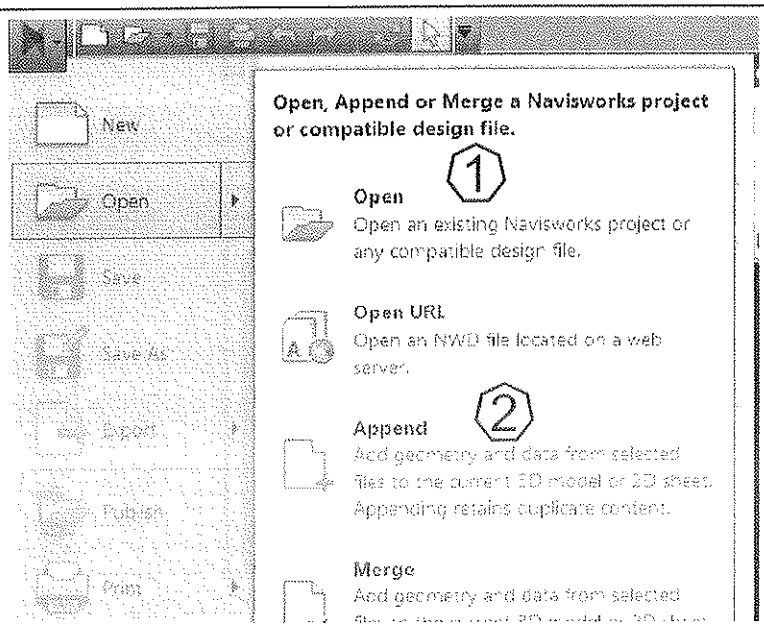
NWC – These are simply cache files that can be exported from Revit.

NWD – These files can be published from Navisworks for viewing in Navisworks Freedom.

NWF – These files simple reference a collection of other files and do not contain 3D geometry. The user need the other NWC files to view the model.



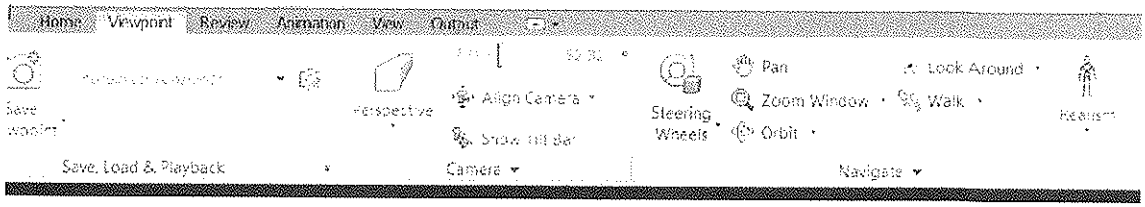
Loading the Models - Navisworks



1. Open the first model
2. Append the other models

Navigating the Models - Navisworks

Go to the menu Viewpoint → Navigate and choose the tool.





Steering Wheel

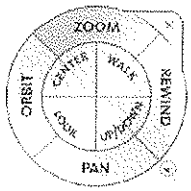
Pan

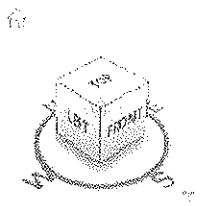
Zoom

Orbit

Look Around

Walk



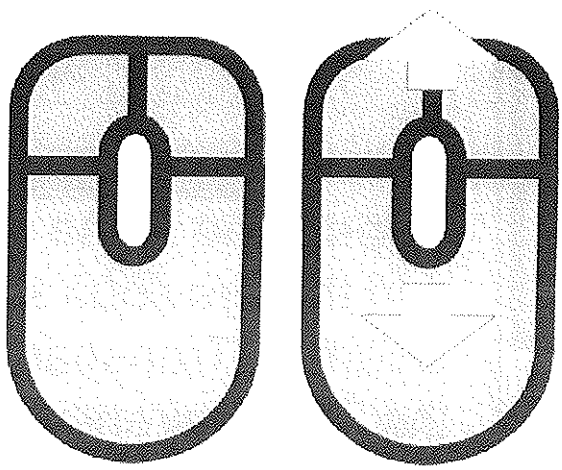


Navigation Bar Steering Wheel View Cube

BCA ACADEMY

Navigating the Models - Navisworks

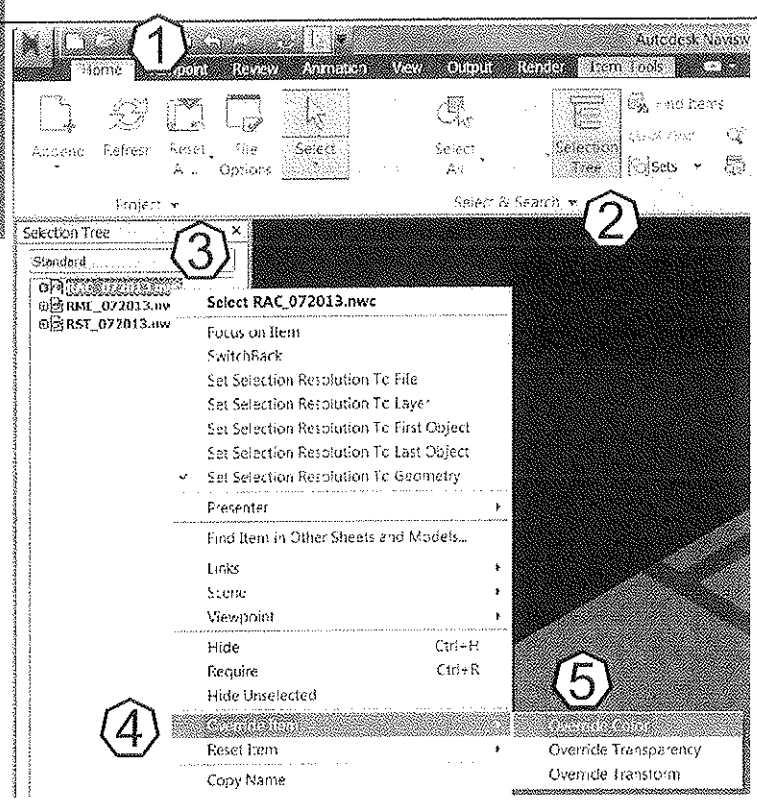
Alternatively use the mouse to navigate



Pan Zoom

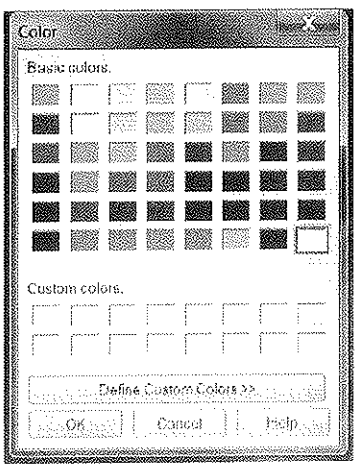
BCA ACADEMY

Changing Color - Navisworks

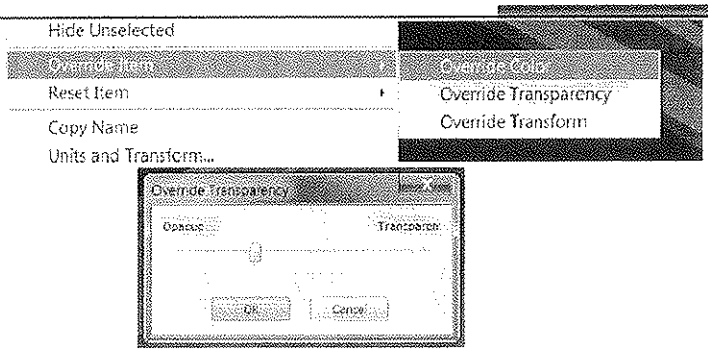


1. Go to Home menu
2. Activate Selection Tree
3. Select the model and right click to get the context menu
4. Go to Override item
5. Choose Override Color.

Changing Color - Navisworks



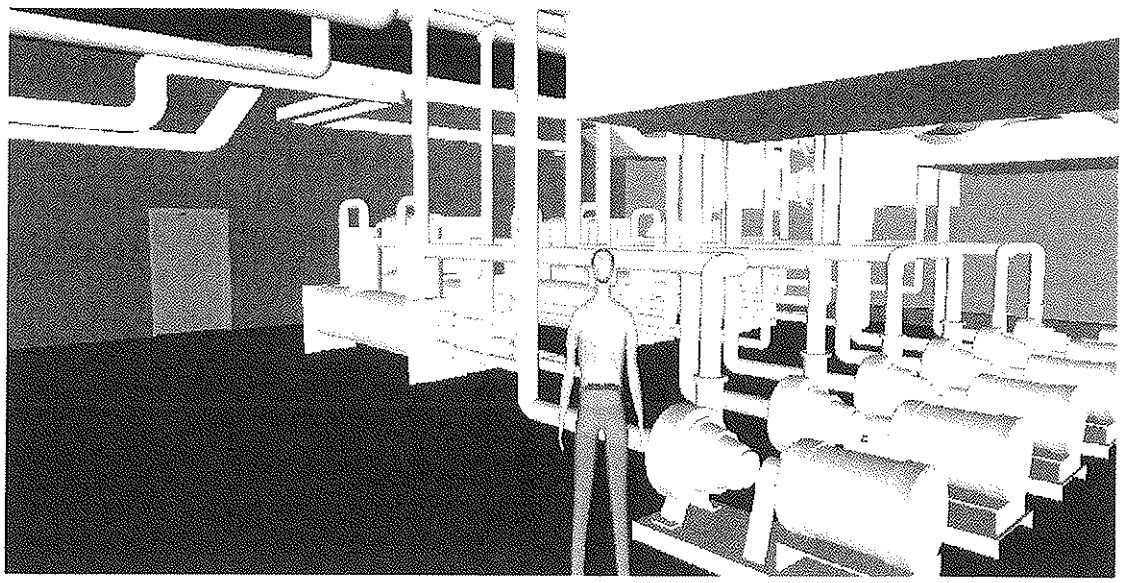
Select the desired color and click ok.



Repeat the same steps from 1 to 4 in the previous slide and choose Override Transparency to change the Transparency.

* Good to change the transparency for the Architectural model

Visual Checking - Navisworks



Visualisation with **Third Person** can be used to visual check

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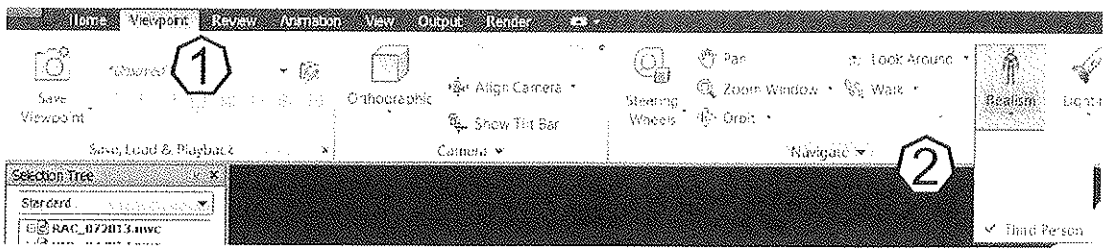
Visual Checking - Navisworks



1. Open the files and go to the menu Viewpoint (1) → Navigate → Realism(2).
2. Choose Third Person. – Avatar will appear on the screen.

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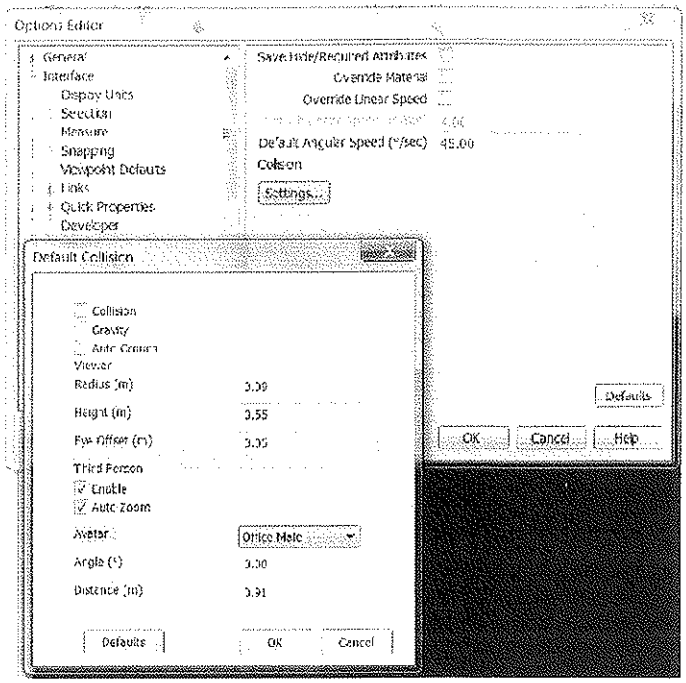
Visual Checking - Navisworks

1. To change the settings of the Avatar
   - Right click on the empty area in the view area.
   - Choose Global Options in the context menu.
   - Choose the Settings… button in Viewpoint Defaults → Collision

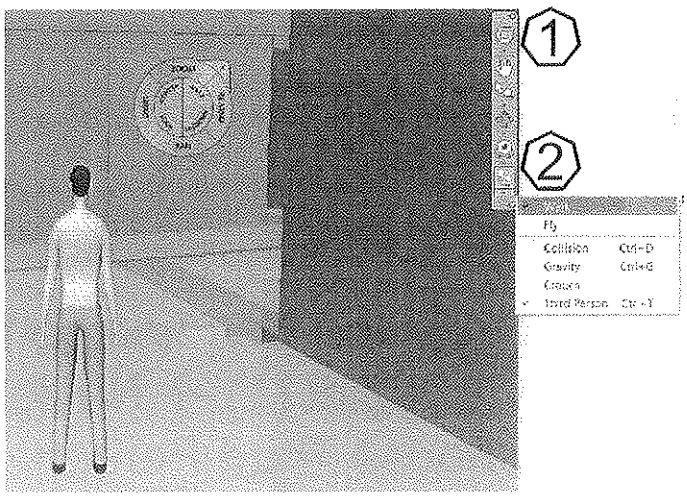


Visual Checking - Navisworks

1. Choose "Steering Wheel" from the Navigation Bar.

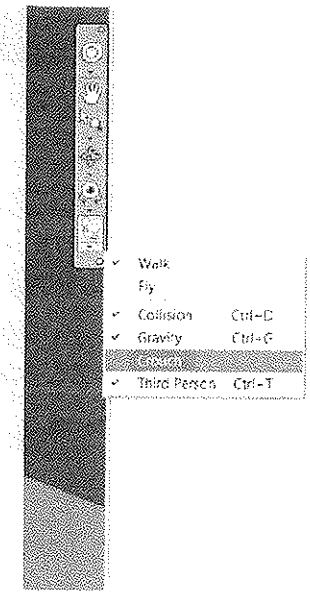
   Set the starting view point using the tools Zoom, Pan, Orbit and Look in the Steering Wheel.

2. Choose "Walk" from the Navigation Bar. Click on the screen and start walking…



Visual Checking - Navisworks

1. Choose some of the visual checking aides "Collission", "Gravity" and "Crouch" as you required.
   - When "Gravity" is selected make sure there is slab or ground surface for the Avatar to land on. (when start walking the Avatar will land on the slab and move on the slab)
   - When "Collision" is selected the Avatar will be stopped by obstacles. Ex Wall.
   - When "Crouch" is selected the Avatar will crouch if there is not enough headroom.



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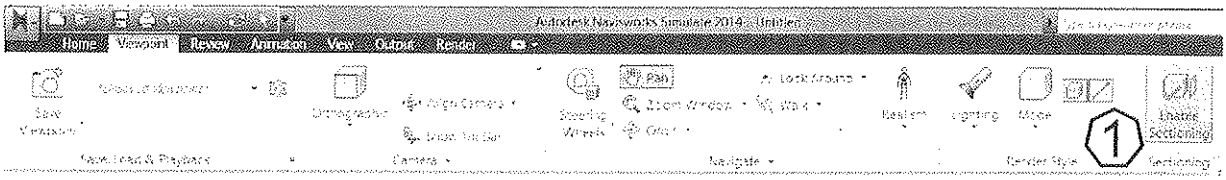
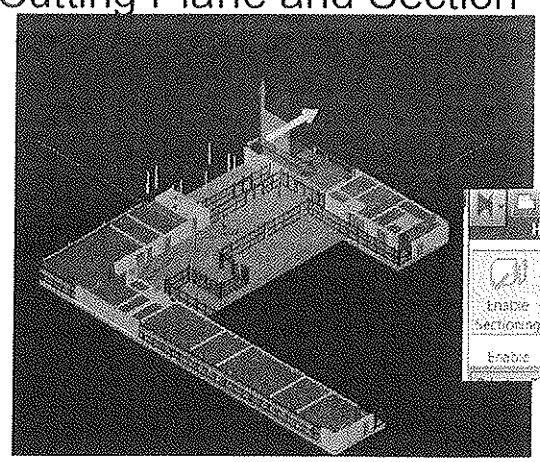
Visual Checking - Navisworks

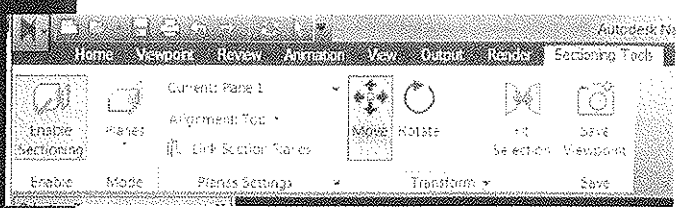
Section Tool



1. From the **Viewpoint** menu enable the section

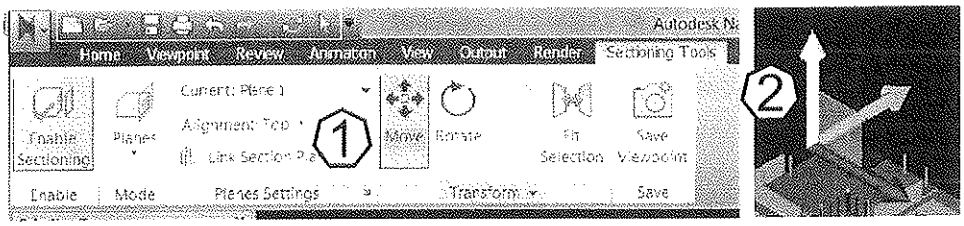
Cutting Plane and Section Tools menu will appear as shown below, if not activate it by choosing a transform command.





BCA ACADEMY

Visual Checking - Navisworks



Moving the Section Plane

1. Select the Move command from the **Sectioning Tools → Transform** Menu
2. Hold one of the axis and move the section plane

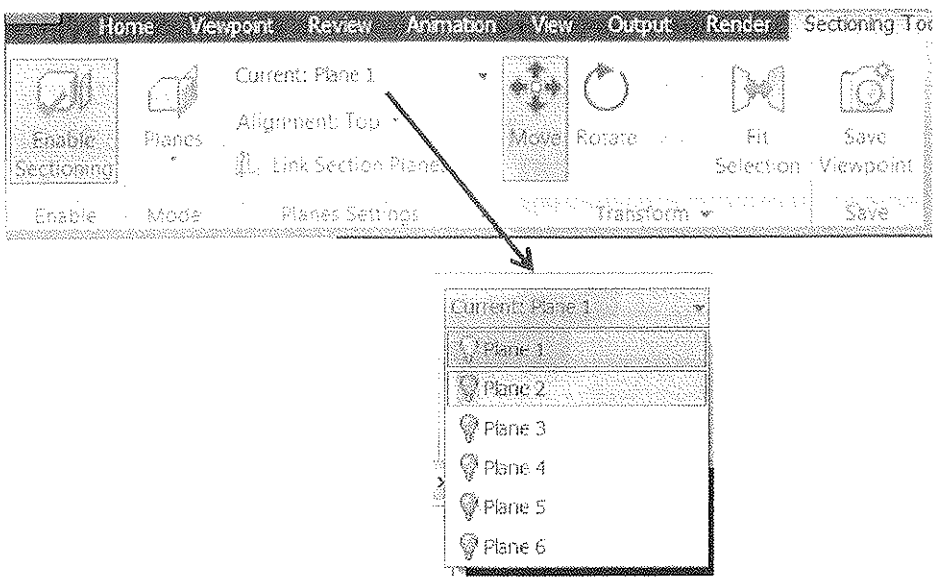
Similarly the section plane can be rotated

To switch-off the display of the section plane deselect all the Transform tools.

Visual Checking - Navisworks

Section Plane Settings

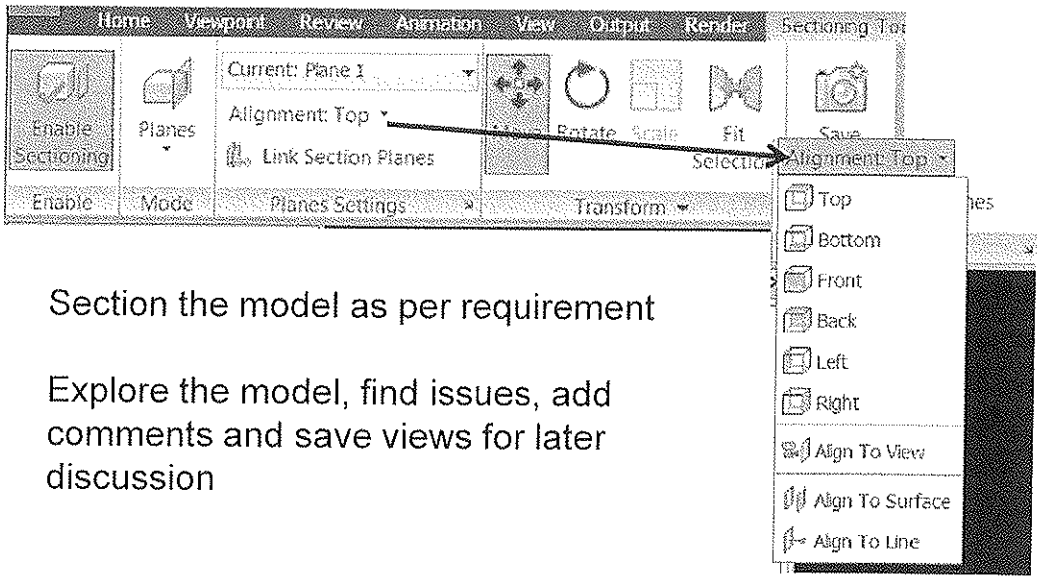
1. The section planes can be selected as current and also can be switched on and off from the menu **Sectioning Tools → Planes Settings → Current**



Visual Checking - Navisworks

Section Plane Settings

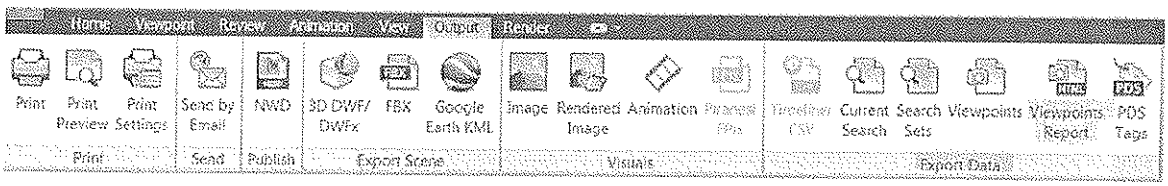
1. Current section plane's alignment can be changed from the menu **Sectioning Tools → Planes Settings → Alignment**



Section the model as per requirement

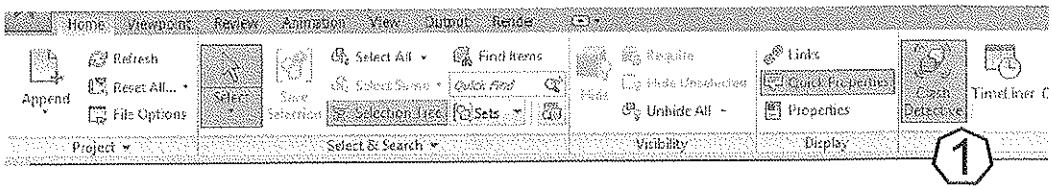
Explore the model, find issues, add comments and save views for later discussion

Visual Checking - Navisworks

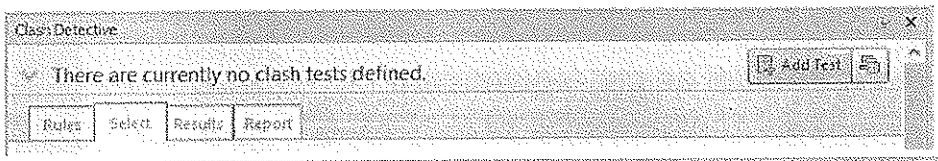


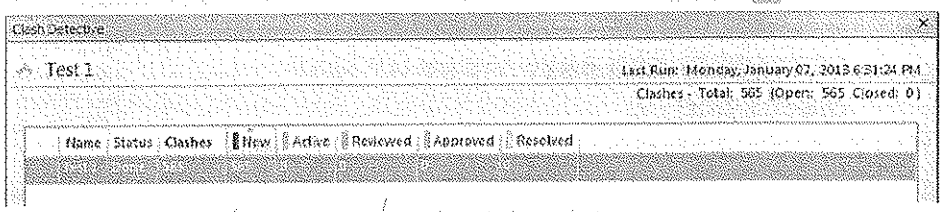
1. The views can be saved as report from the menu Output → Viewpoints Report

Automatic Checking - Navisworks



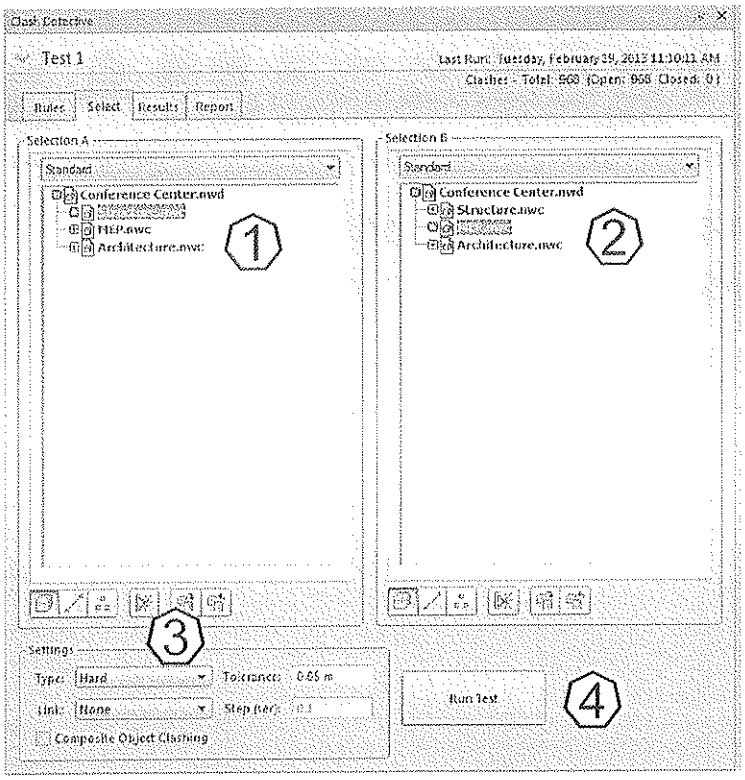
1. Choose the Clash Detective from the the menu Home → Tools
2. Click on the **Add Test** Button,
   When you are running it first time, its on the top right hand corner of the dialog box.





HARD
HARD (INTERFERENCE) ① 'HARD' CLASH - 2 OBJECTS 'TOUCHING' ONE ANOTHER.
CLEARANCE
② 'SOFT' CLASH - CLEARANCE, QUITE CLOSE TO EACH OTHER.
INSERT
DUPLICATES
③ 'ANIMATION' CLASH - 'MOVEMENT' CLASH.
④ 'TIME' CLASH - SCHEDULE CLASH, SEQUENCE OF WORK.

Automatic Checking - Navisworks

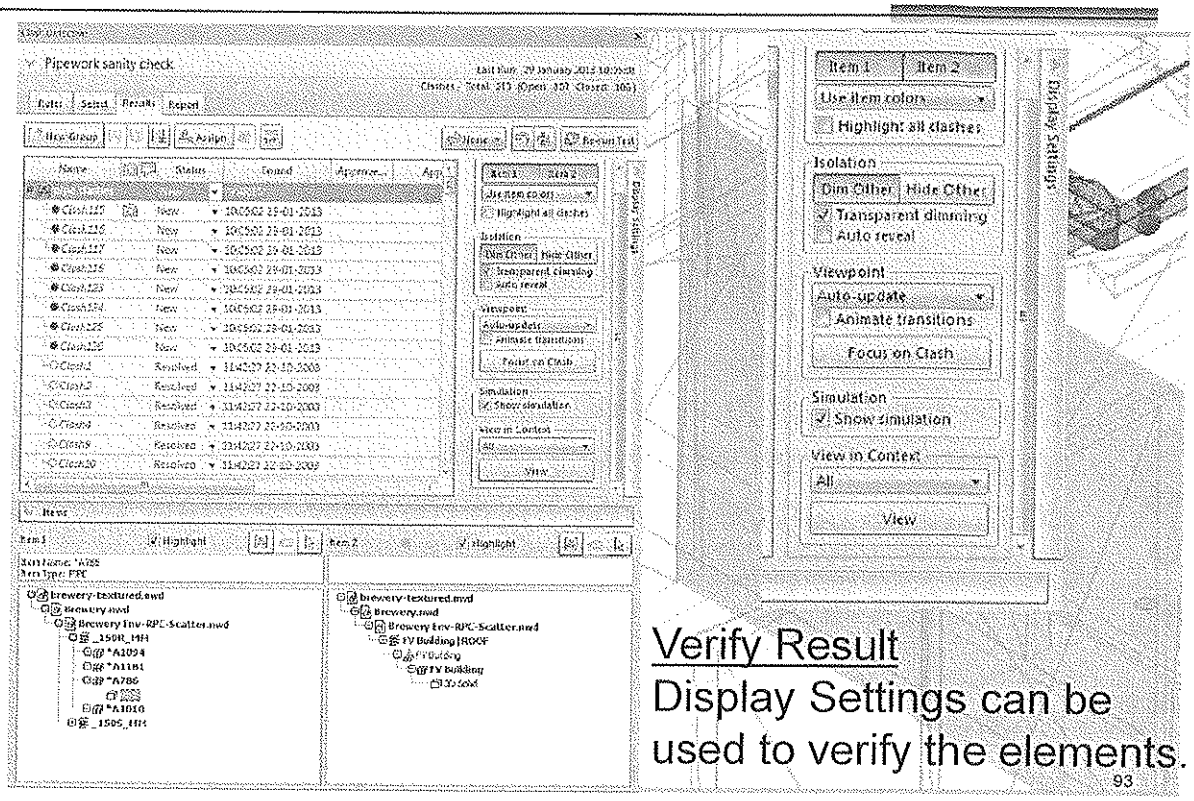


1&2. Select the models/sets to check

3 Select the type of checking

4 Click Run Test to perform the check

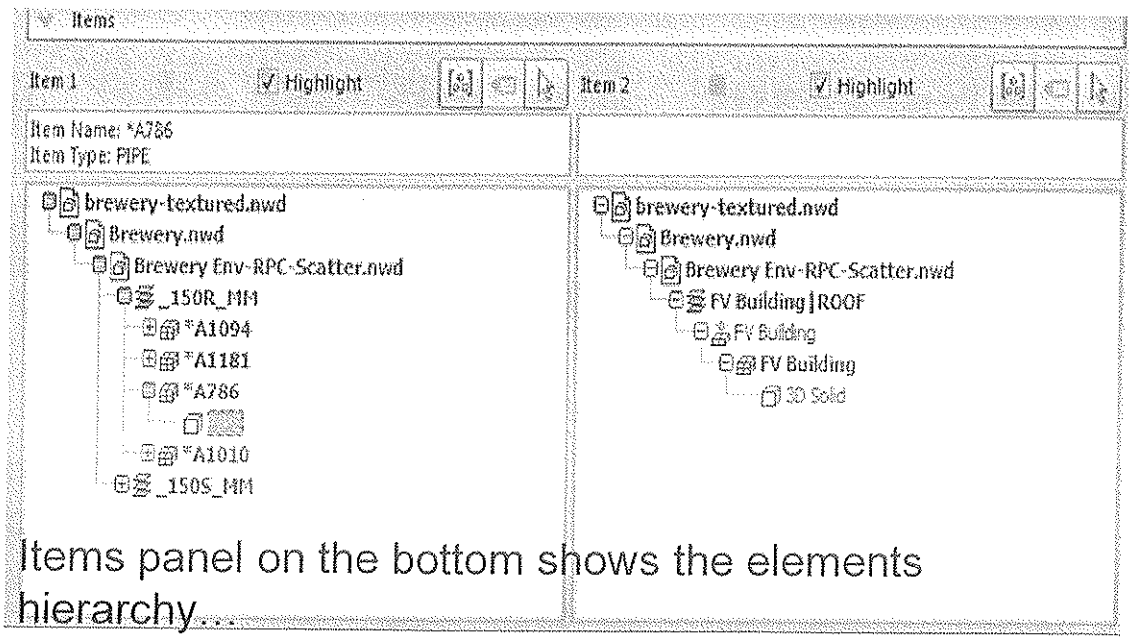
Automatic Checking - Navisworks



Verify Result

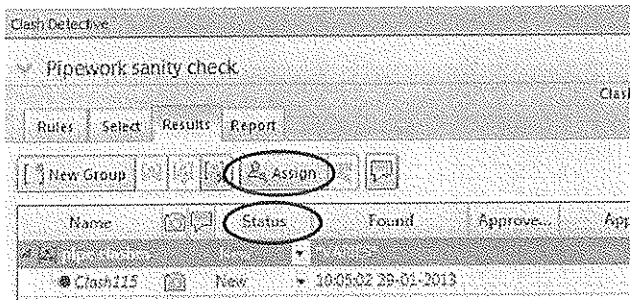
Display Settings can be used to verify the elements.

Automatic Checking - Navisworks



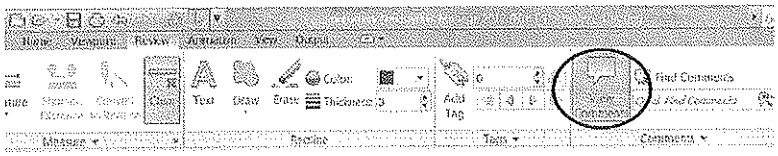
Items panel on the bottom shows the elements hierarchy...

Automatic Checking - Navisworks



Assign Responsibility

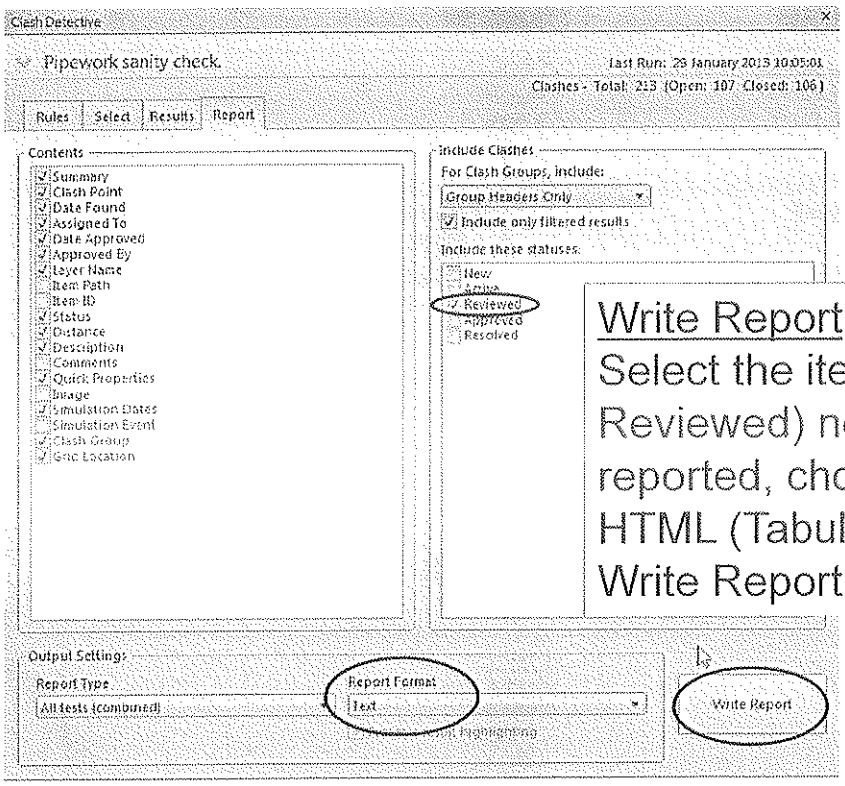
Once the result is verified click on **Assign** button to assign responsibility on whom will update the model. View the comments can be viewed from **Review → View Comments**



Change the status

Change the status of the result to **Reviewed**

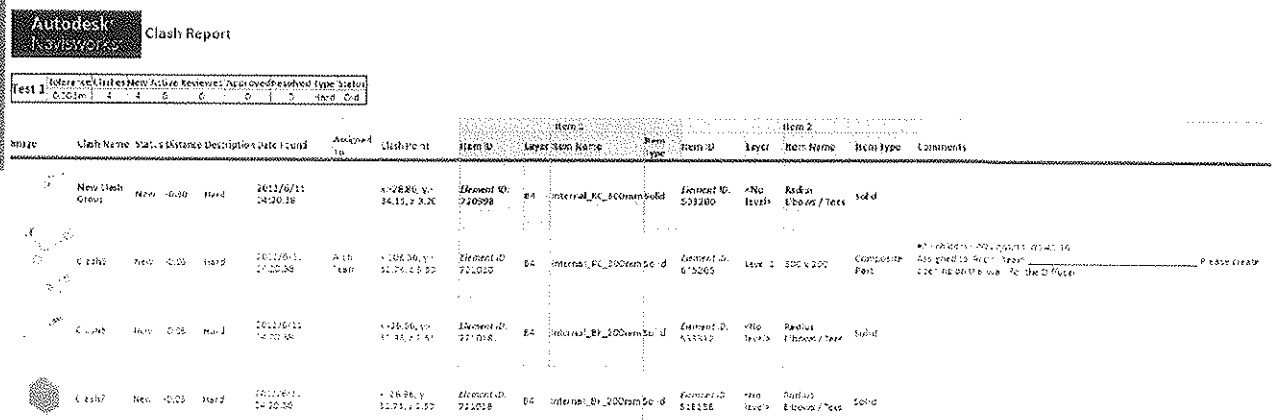
Automatic Checking - Navisworks



Write Report

Select the items (e.g. Reviewed) need to be reported, choose the format as HTML (Tabular) and Click on Write Report button.

Automatic Checking - Navisworks



Autodesk Navisworks Clash Report

Test 1	Tolerance	Clashes	New	Active	Reviewed	Approved	Resolved	Type	Status
	0.001m	4	4	0	0	0	0	Hard	Old

Image	Clash Name	Status	Distance	Description	Date Found	Assigned To	Clash Point	Item 1	Layer	Item Name	Item Type	Item 2	Layer	Item Name	Item Type	Comments
	New Clash Group	New	-0.30	Hard	2012/6/11 04:20:38		x:-28.86, y:-34.11, z:3.20	Element ID: 920998	84	Internal_RC_800mmSolid	Solid	Element ID: 593280	<No Item>	Radius Elbows / Tees	Solid	
	Clash5	New	-0.03	Hard	2012/6/11 04:20:38	Arch' Team	x:-108.36, y:-32.74, z:3.30	Element ID: 931060	84	Internal_RC_300mmSolid	Solid	Element ID: 675065	Level 1	300 x 300	Composite Part	Assigned to: Arch' Team Please Create a new group with this clash
	Clash6	New	-0.03	Hard	2012/6/11 04:20:38		x:-26.86, y:-31.93, z:2.51	Element ID: 931058	84	Internal_RC_300mmSolid	Solid	Element ID: 633532	<No Item>	Radius Elbows / Tees	Solid	
	Clash7	New	-0.03	Hard	2012/6/11 04:20:38		x:-26.86, y:-31.73, z:2.50	Element ID: 931058	84	Internal_RC_300mmSolid	Solid	Element ID: 618156	<No Item>	Radius Elbows / Tees	Solid	

BCA ACADEMY

Automatic Checking - Navisworks

Autodesk Navisworks Clash Report

Test 1	Tolerance	Clashes	New	Active	Reviewed	Approved	Resolved	Type	Status
	0.001m	4	4	0	0	0	0	Hard	Old

Image	Clash Name	Status	Distance	Description	Date Found	Assigned To	Clash Point
	New Clash Group	New	-0.30	Hard	2012/6/11 04:20:38		x:-28.86, y:-34.11, z:3.20
	Clash5	New	-0.03	Hard	2012/6/11 04:20:38	Arch' Team	x:-108.36, y:-32.74, z:3.30
	Clash6	New	-0.03	Hard	2012/6/11 04:20:38		x:-26.86, y:-31.93, z:2.51
	Clash7	New	-0.03	Hard	2012/6/11 04:20:38		x:-26.86, y:-31.73, z:2.50

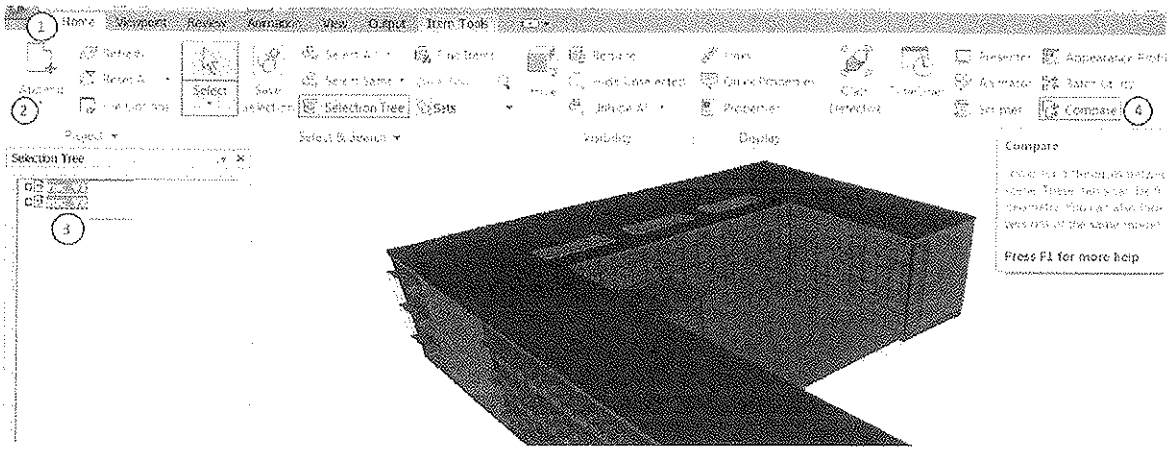
Automatic Checking - Navisworks

Item 1				Item 2				
Item ID	Layer	Item Name	Item Type	Item ID	Layer	Item Name	Item Type	Comments
Element ID: 720998	B4	Internal_RC_300mm	Solid	Element ID: 503280	<No Level>	Radius Elbows / Tees	Solid	
Element ID: 721010	B4	Internal_RC_300mm	Solid	Element ID: 645265	Level 1	500 x 200	Composite Part	#2 - chidom - 2012/6/11 05:45:35 Assigned to: Archi Team Please create opening on the wall for the Diffuser
Element ID: 721018	B4	Internal_BK_200mm	Solid	Element ID: 533512	<No Level>	Radius Elbows / Tees	Solid	
Element ID: 721018	B4	Internal_BK_200mm	Solid	Element ID: 518158	<No Level>	Radius Elbows / Tees	Solid	

Version Comparision - Navisworks

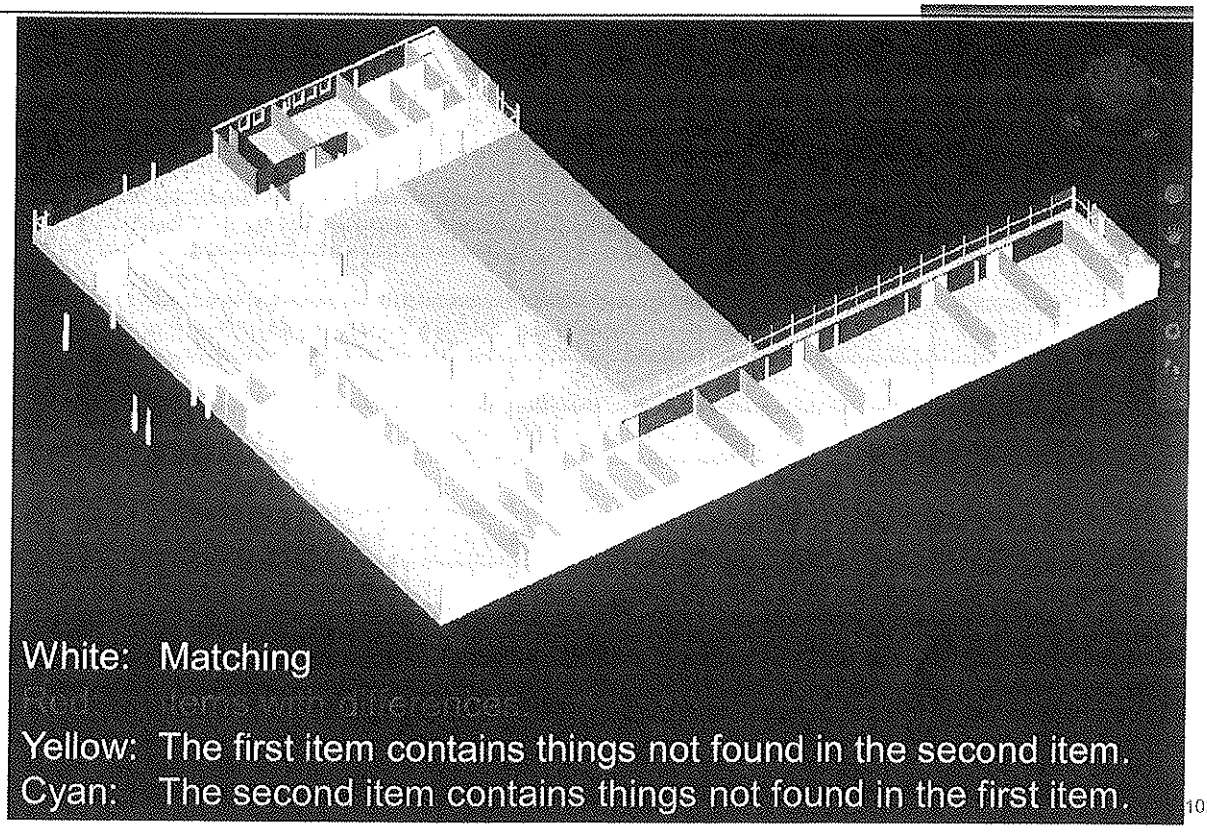
1. Open the old model and append the new model that need to be compared.
2. Compare the models.
3. Verify the checking result.
4. Save the views and print to Report.

Version Comparision - Navisworks



1. Open the version 1 model
2. Append the version 2 model
3. Select the Models in the Selection Tree
4. Choose compare function

Version Comparision - Navisworks



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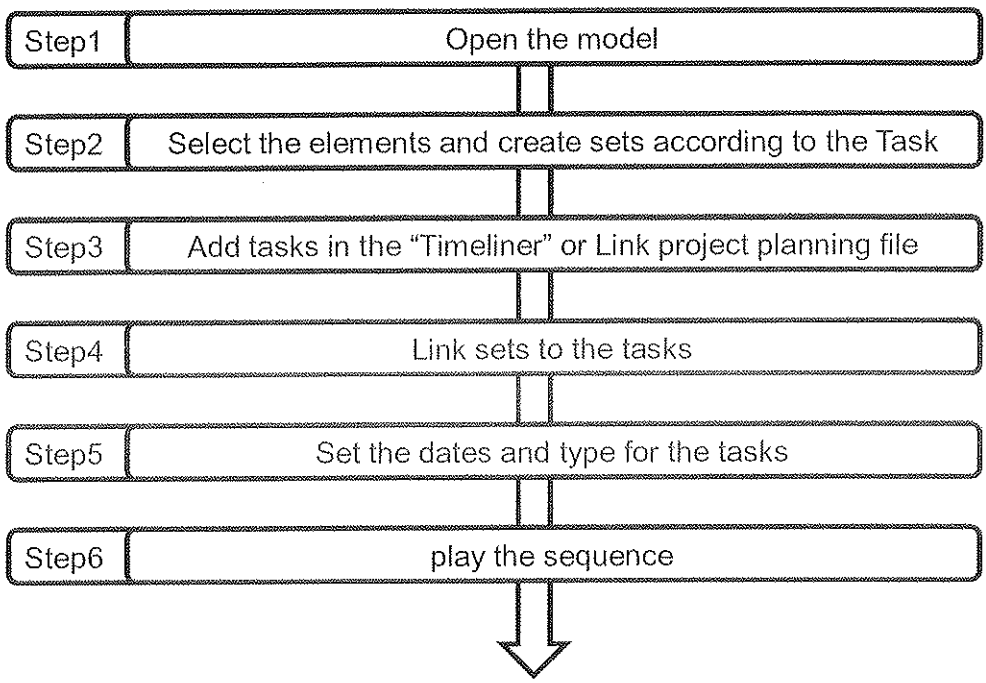
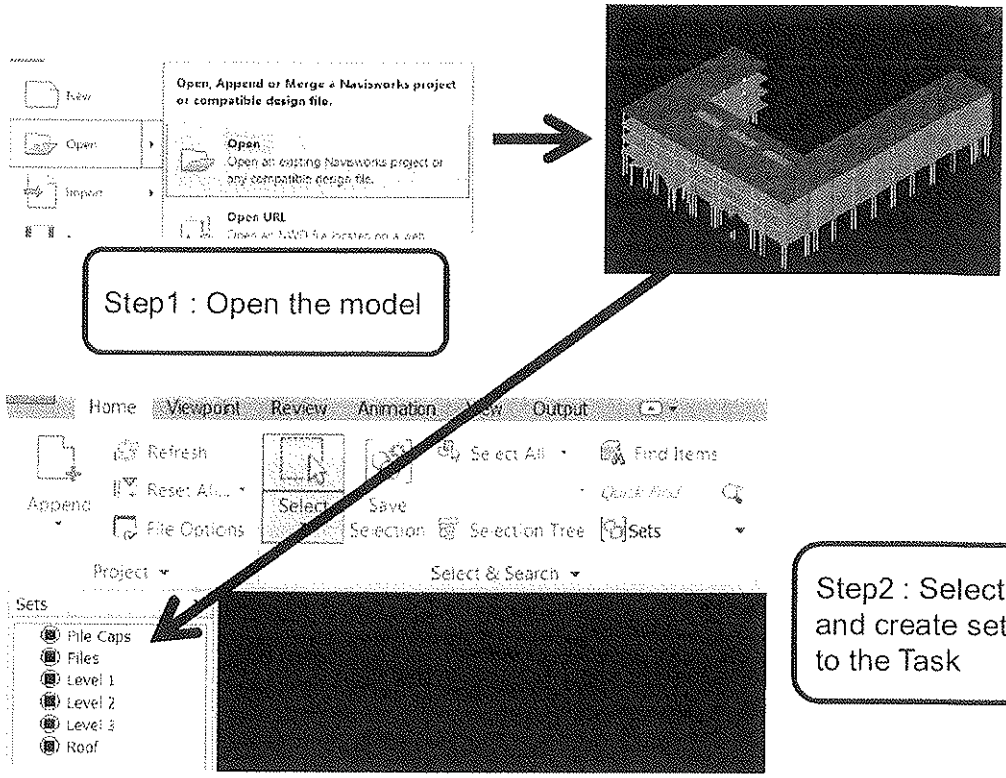
HANDS-ON Phase Planning (NAVISWORKS)

BCA ACADEMY

Typical Sequencing Process

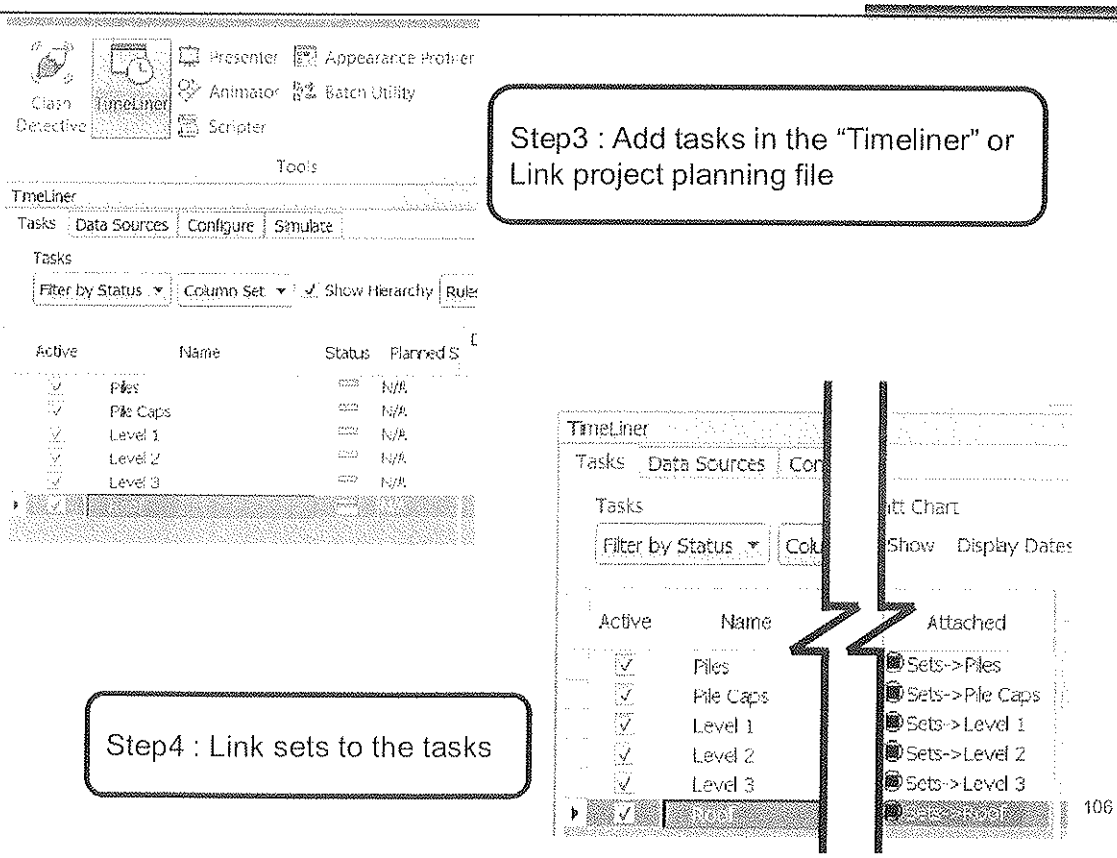


Sequencing - Navisworks



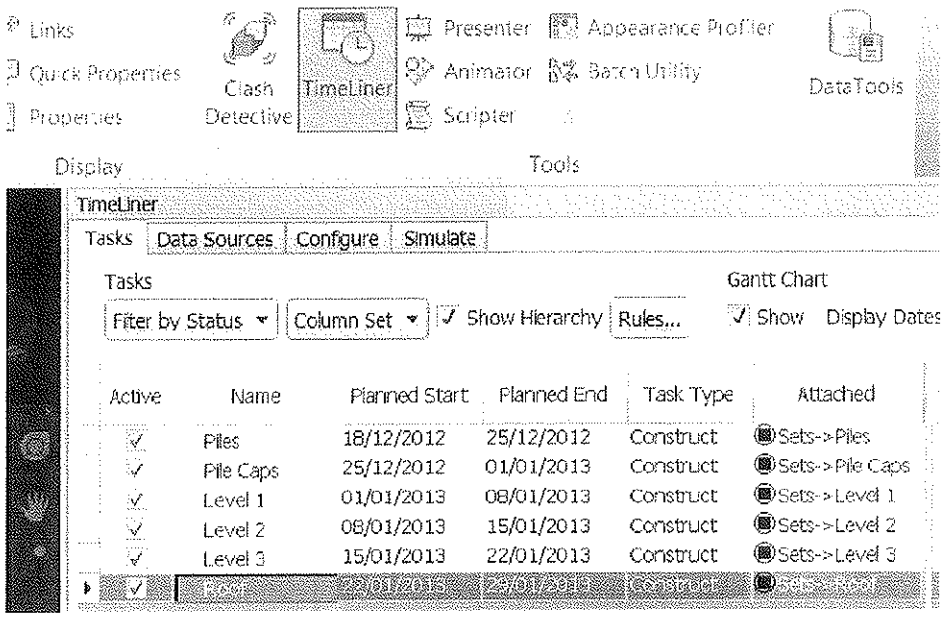
BCA ACADEMY

Sequencing - Navisworks



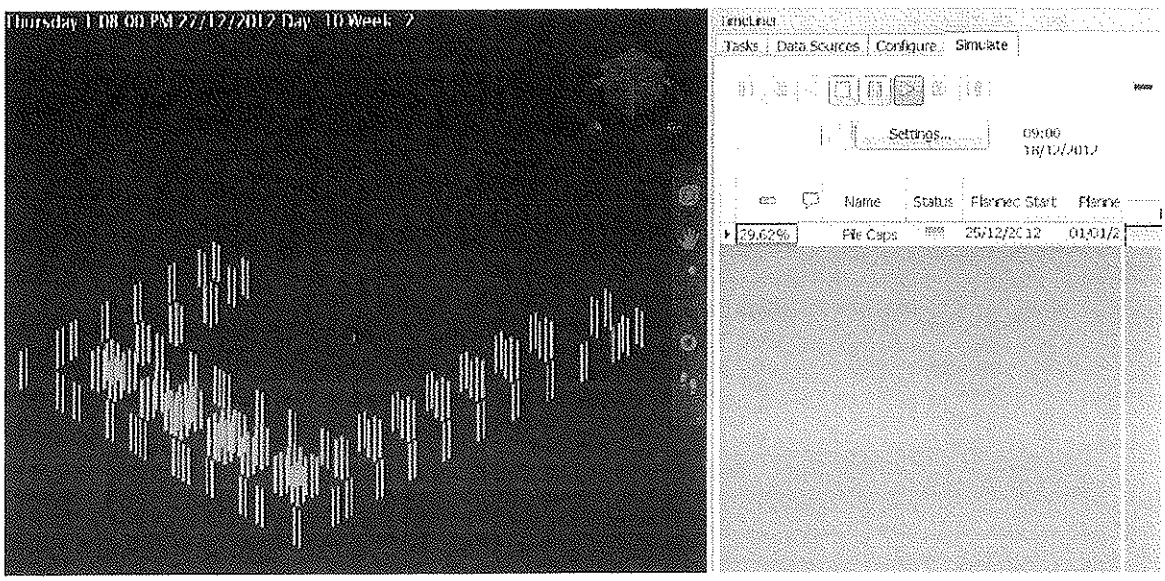
BCA ACADEMY

Sequencing - Navisworks



Step5 : Set the dates and type for the tasks

Sequencing - Navisworks



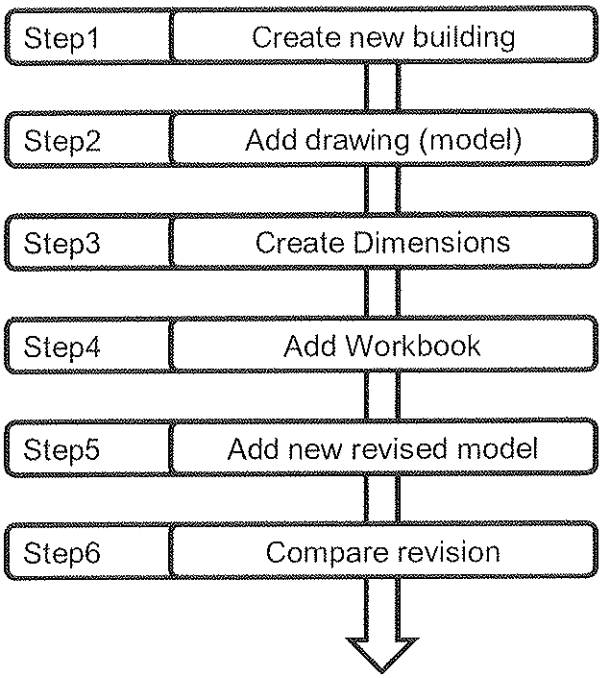
Step6 : Play the sequence

HANDS-ON COST ESTIMATION (COSTX) ← THIS IS A STUDENT VERSION

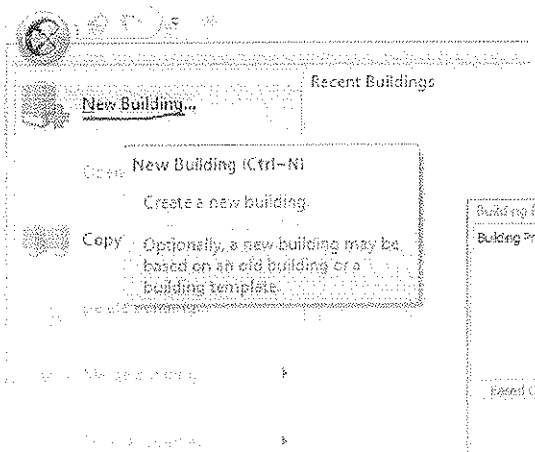
Cost Estimation - CostX

- CostX is from Exactal.
- Allows users to measure from drawings, PDF and image.
- CostX now enables user to generate automatic quantities from 3D BIM and prepare estimates, bills of quantities and tenders easily.
- Has a model comparison feature for the purpose of BOQ.

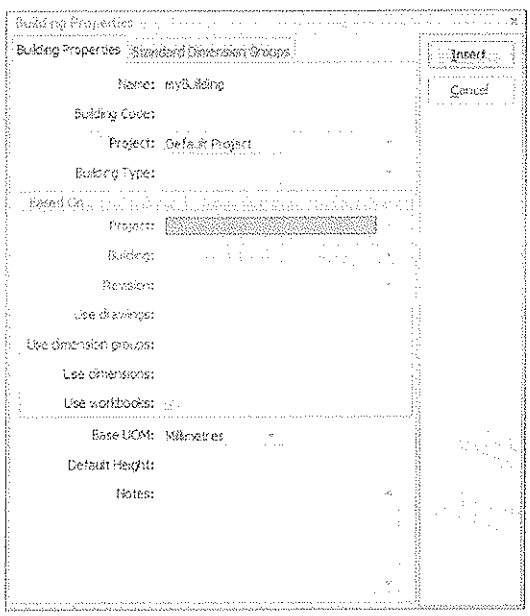
Cost Estimation - CostX



Cost Estimation - CostX

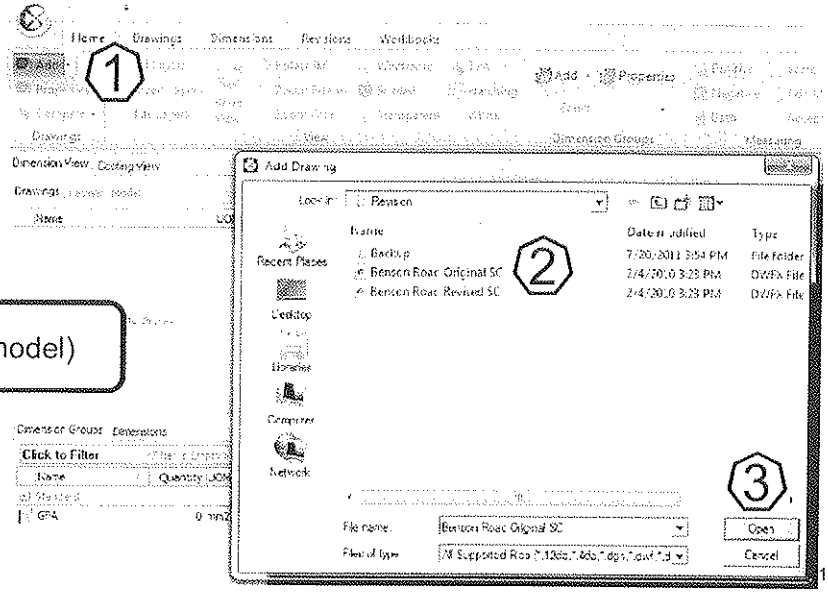


Step1 : Create new building



Cost Estimation - CostX

- The Drawings either in DWF or IFC can be added in from the menu **Home → Add (1)**. Choose the file(2) and Click on the Open Button(3).



Step2 : Add drawing (model)

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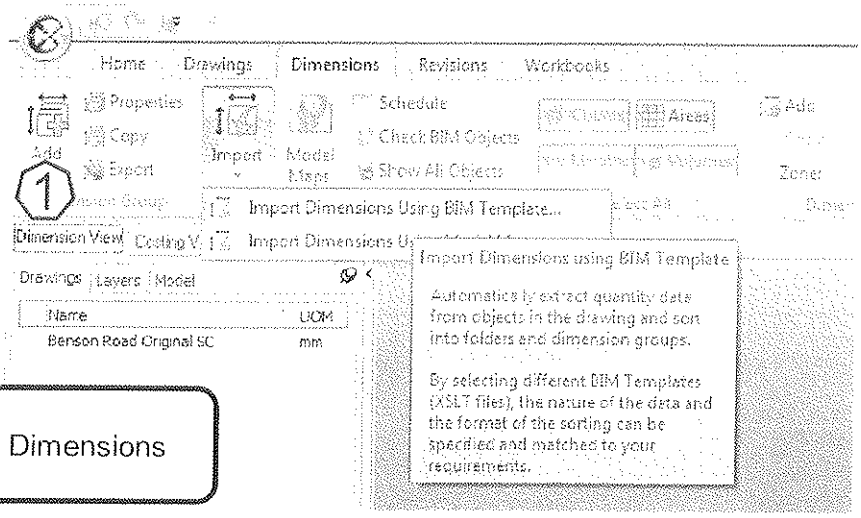
Cost Estimation - CostX

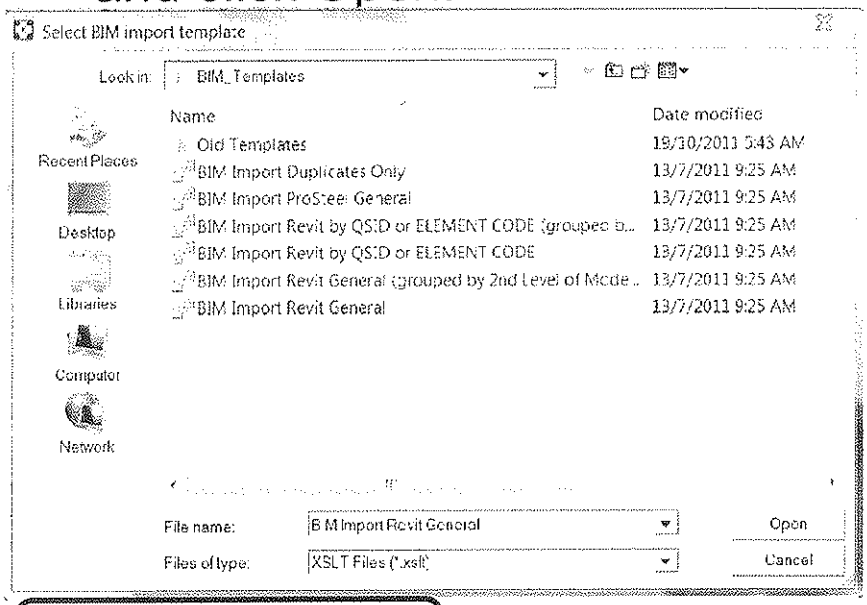
- CostX provides templates to measure BIM models. Use Import Dimensions Using BIM Template…(1) to create Dimensions and Dimension Groups automatically.

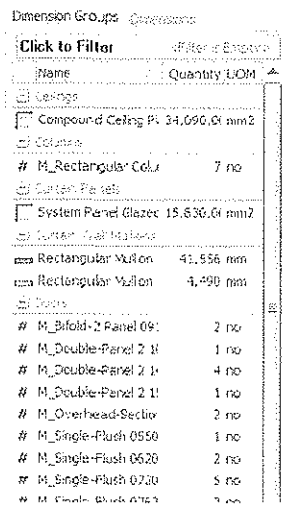


Step3 : Create Dimensions

Cost Estimation - CostX

- Choose the template BIM Import Revit General and click Open.

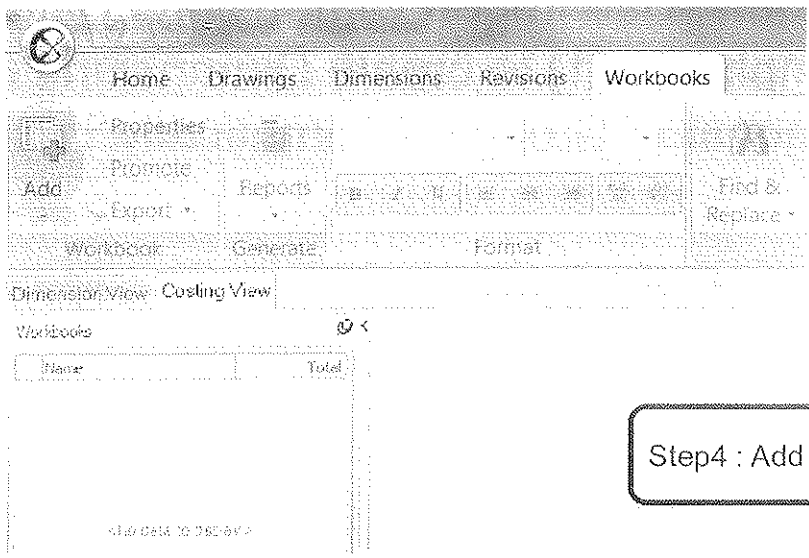




Step3 : Create Dimensions

Cost Estimation - CostX

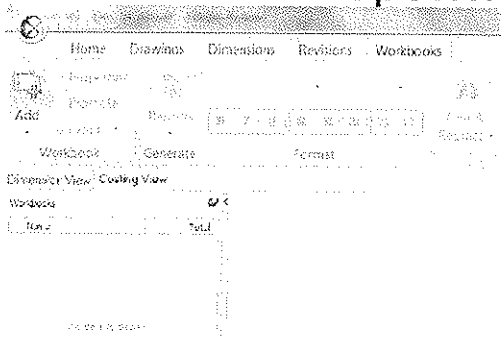
- Click on Workbooks → Workbook → Add

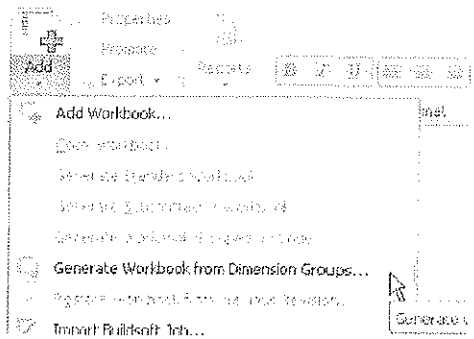


Step4 : Add Workbook

Cost Estimation - CostX

- Click on Workbooks → Workbook → Add
- Alternatively Choose Generate workbook from Dimension Groups….





Step4 : Add Workbook

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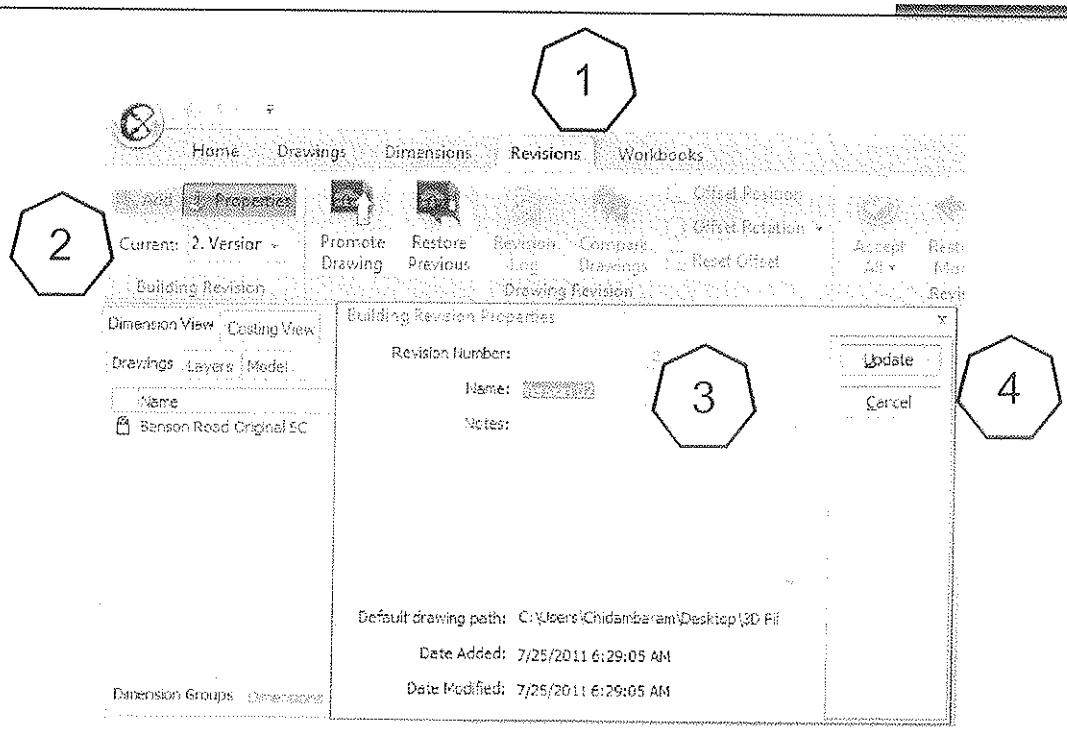
Cost Estimation - CostX



Step5 : Add new revised model

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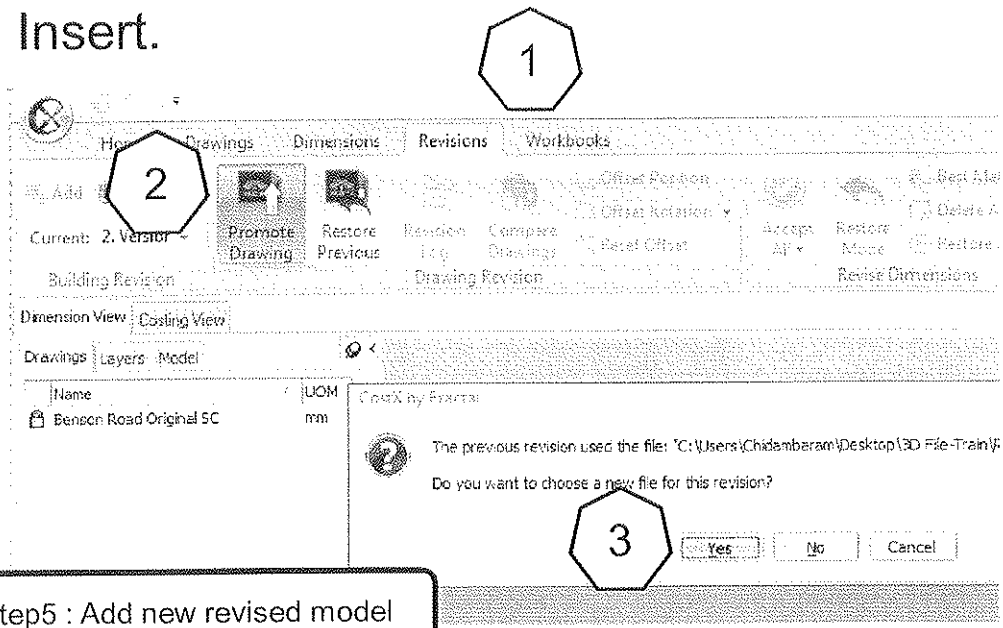
Cost Estimation - CostX

1. Promote Drawing to the newer version.
2. Leave the Drawing Properties as default and Insert.



Step5 : Add new revised model

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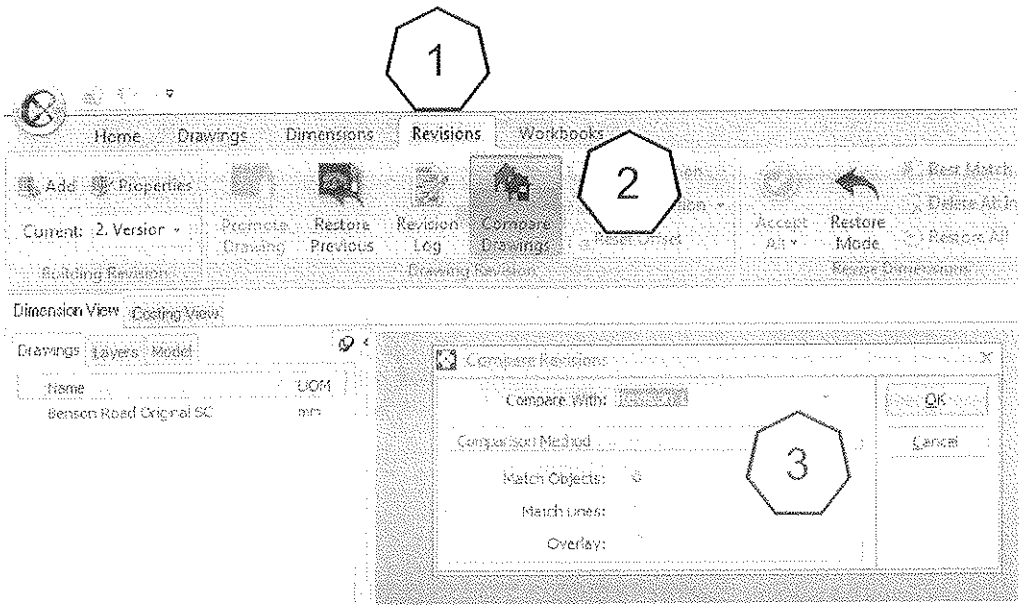
Cost Estimation - CostX



Step6 : Compare revision

1. Layers can be used to visualise.



Step6 : Compare revision

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Thank You

Certification Course in BIM Management

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Day 3 – Course Schedule Outline

Time	Topic
09.00 – 10.45	Session 1 – BIM Company Deployment Plan
10.45 – 10.55	Break
10.55 – 13.00	Session 2 – BIM Standard
13.00 – 13.40	Lunch
13.40 – 15.40	Session 3 – Singapore BIM Guide
15.40 – 15.50	Break
15.50 – 18.00	Session 4 – BIM Legal and Contractual Issues

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BIM Company Deployment Plan

Presented by :

Steven Tan
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Introduction

- *How does an organization start BIM?*
- *Company BIM Deployment Plan*
  - *Implement BIM technologies at the organizational level*
- *BIM Project Execution Plan*
  - *Implement BIM technologies at the project level → BIM Execution Plan*

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BIM Adoption

TOP DOWN
Dictated
Required
Profit, Survival

PARALLEL
BIM Used as "Test Case"
Independent Pilot Study
Semi-Visible/Semi-Private
If Successful, BIM Used on Other Projects

BOTTOM UP
Grass Roots Movement
Not Much Mgmt. Support
Unappreciated
Passion

ORGANIC
Mixture of All Three
Supported
Mgmt. has Knowledge of BIM
Young Employees Interested
Starting Out with Small Investment of BIM

*Source: AGC BIM Education Program

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BIM Adoption

- *BIM implementation depends on the company culture, business model, and market position*
- *Companies should develop their priorities and strategy and employ BIM in a way:*
  - *Strengthen their existing market position*
  - *Develops new opportunities based on their existing capabilities*

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BIM Return on Investment

- *Achieve max ROI by balancing investments into:*
  - *BIM tools*
  - *Workforce Skills*
  - *A process that leverages existing tools and skills while developing new ones*

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BIM Company Implementation Plan

Phase	Implementation Step
Phase 1	Company internal assessment relative to BIM
Phase 2	Development of the company BIM Deployment Plan
Phase 3	Build BIM Competency

Phase 1 Company Internal Assessment

- *Do you need to hire a BIM expert or a BIM consultant?*
  - *Ans.: if you do not have in-house BIM expert, you might want to engage BIM consultant*
- *Consider current staff as possible BIM leaders:*
  - *A potential career change*
- *Involve IT department since communications, hardware, and software need to operate seamlessly when project kick off (e.g. model and file sharing protocol)*

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Phase 2 Company BIM Deployment Plan

- *Developing a plan should be a team activity*
- *Contain information of the company capabilities and what the company needs to do for a particular project*
- *It is a "Live" document → the plan can be updated as the company's ability to execute BIM project improves. It also means someone needs to accept the ownership of the document*

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Phase 3 Build BIM Competency

- Individual level
  - Competency to create data-rich BIM model according to a *delivery standard*
- Company level
  - Competency to deliver BIM products/services *consistently*
- Project Level
  - Competency to jointly deliver BIM products/services that comply to *BIM Project Guideline*

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Phase 3 Build BIM Competency
Individual Level

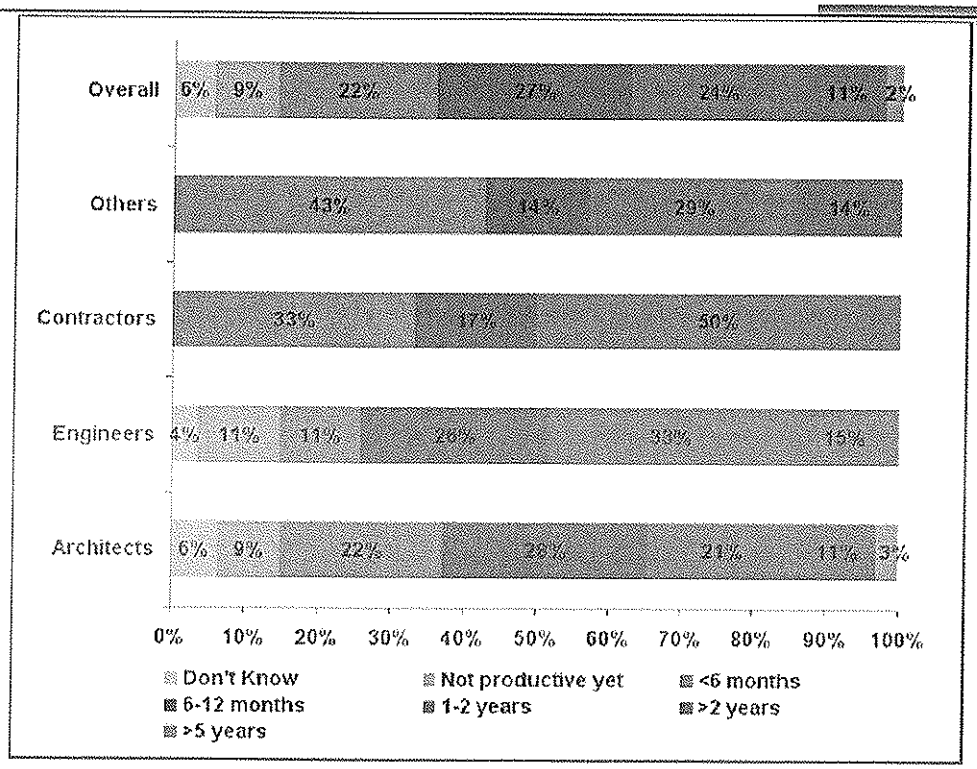
- *BIM tools basic/advance training course*
  - *2-5 days*
  - *How to use the tools*
  - *BCA Academy/Vendor training course*
- *The real cost for training is the learning curve associated with applying the techniques taught*
  - *Which tools to use and when*
  - *Best practice approach*
  - *Standard (e.g. e-submission guide)*

Phase 3 Build BIM Competency
Individual Level

- *Develop a strategy to collect and apply lessons learned*
  - *Corporate knowledge site*
  - *Company BIM Manual/Standard*

- *Join Community of BIM Users → Build up and disseminate BIM good practices*
  - *BCA BIM Facebook (http://www.facebook.com/BcaBim)*
  - *Autodesk Discussion Groups (http://forums.autodesk.com)*
  - *ArchiCAD (http://archicad-talk.graphisoft.com)*
  - *Tekla Structures (http://xsteeler.net)*
  - *etc.*

Time Taken To Become Productive in Using BIM



Source: buildingSMART Australasia

Phase 3 Build BIM Competency
Company Level

- *Identify the potential BIM Managers from your existing personnel*
- *Create BIM Manager peer group to share best practices, lesson learned, etc*

Phase 3 Build BIM Competency
Company Level

- *Most experienced modellers should be assigned at the start of the project*
- *This person will work directly with the Architect/ Engineer to develop the model*
- *Opportunity to share and strengthen the intellectual resources of your team by allowing the Architect/Engineer to mentor and provide technical guidance while the modeller shares and teaches Architect about BIM software and other digital tools.*

Phase 3 Build BIM Competency
Company Level

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Stages	Manpower
Conceptual Design	
Prelim Design	
Detailed Design	

PA/PE/PM/BIM Coordinator → Keynote Database and Specification

Most Experienced Modeller →

Less Experienced Modeller →

Phase 3 Build BIM Competency
Company Level

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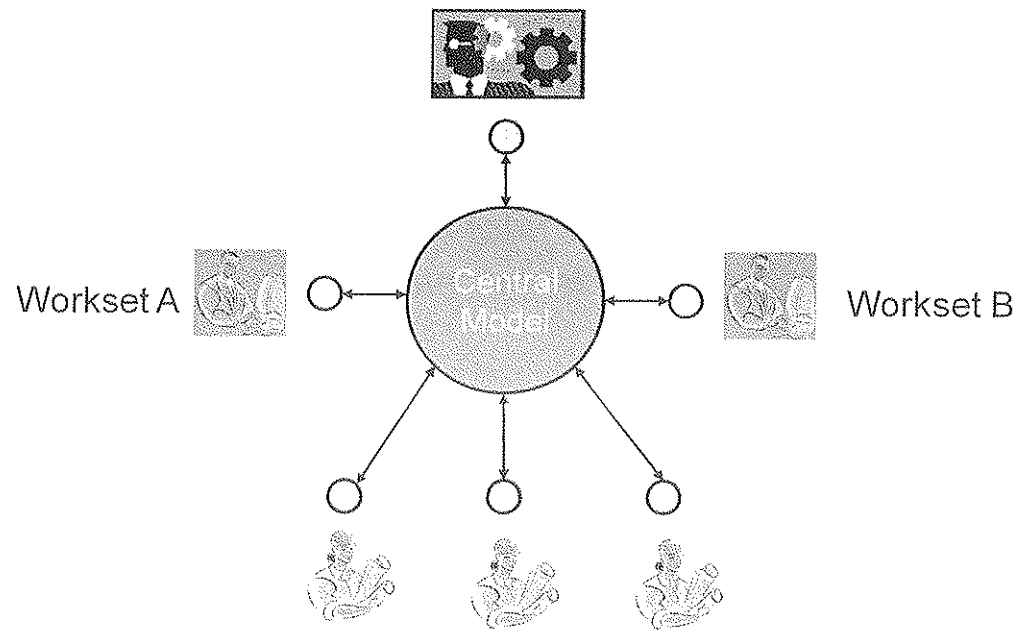
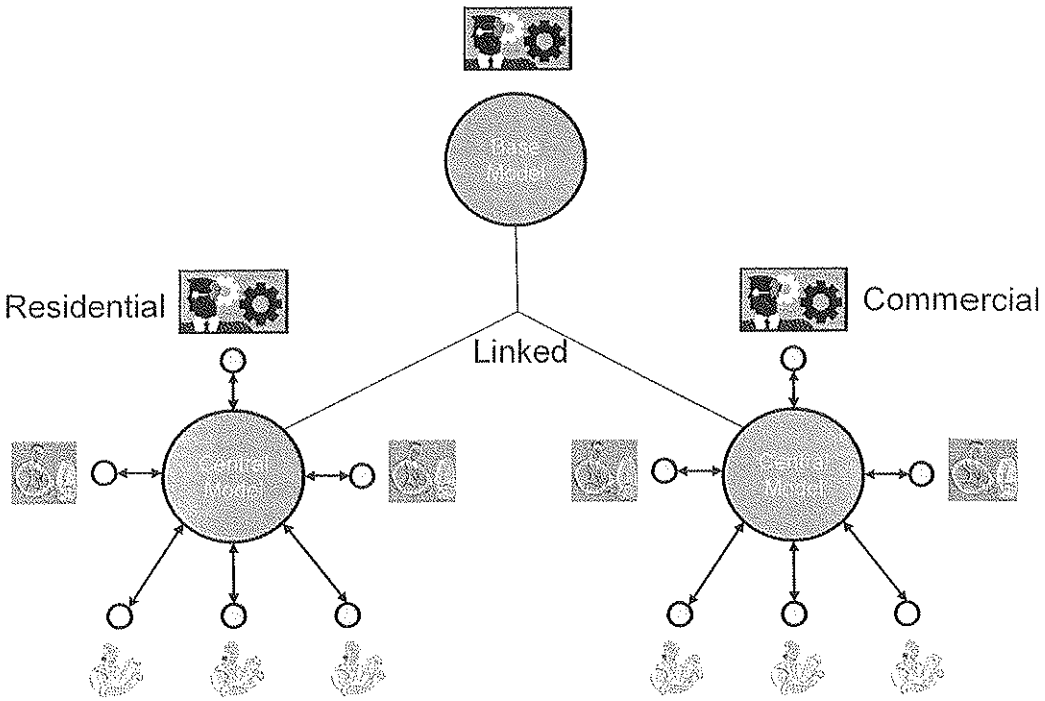


○ Local Model

Phase 3 Build BIM Competency
Company Level



Phase 3 Build BIM Competency
Project Level

- *Identify the potential BIM Managers from your existing personnel*
- *Create BIM Manager peer group to share best practices, lesson learned, etc*
- *Understand how to prepare BIM Execution Plan*
- *Start small (2-3 BIM uses for pilot project)*

BIM Maturity Metrics

- *BIM Maturity Metrics is a tool to assist individuals, organisations and project teams to assess their BIM competencies or compare that against an industry benchmark*
- *Example: the Indiana University BIM Proficiency Metrics*

BIM Maturity Metrics

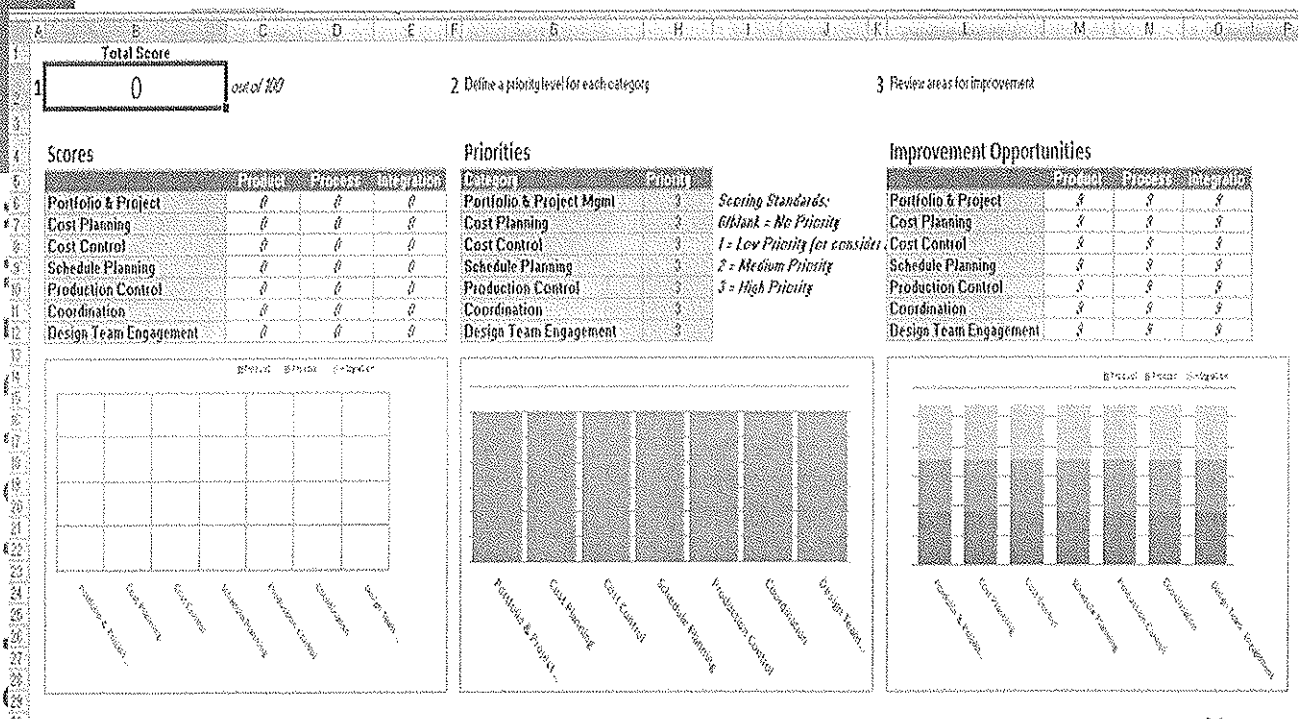
Category / Level	A - Physical Accuracy of Model	B- IPD Methodology	C - Calculation Mentality	D - Location Awareness	E - Content Creation	F - Construction Data	G - As-Built Modeling	H- FM Data Richness
1	Basic Model Geometry A.1	Creation of A BIM Execution Plan B.1	Basic Model Information Export C.1	Site Orientation D.1	Geometrically Correct Content E.1	Quantity Takeoffs F.1	Post Bid Model Documentation G.1	Space Management Data H.1
2	Design Requirements A.2	Introduction of Structural and MEP Model B.2	IPD Integration C.2	Existing Environment Awareness D.2	Manufacturer's Specific E.2	Object Scheduling F.2	Coordination Modeling G.2	Asset Management H.2
3	Design Side Collision Detection A.3	Model Managers Role Defined B.3	Interdisciplinary Calculations C.3	Global Accuracy D.3	Design Intent E.3	Material Procurement F.3	Recapturing Design Intent G.3	Manufacturer Specific Information H.3
4	Model Accuracy Innovation A.4	IPD Methodology Innovation B.4	Calculations Innovation C.4	Location Innovation D.4	Content Innovation E.4	Construction Innovation F.4	As-Built Innovation G.4	FM Data Innovation H.4

Category	Points Achieved	BIM Maturity Score	BIM Standard		
A - Physical Accuracy of Model	0	0	BIM Score Between 0-12	=	Working Towards BIM
B- IPD Methodology	0		BIM Score Between 13-18	=	Certified BIM
C - Calculation Mentality	0		BIM Score Between 19-24	=	Silver
D - Location Awareness	0		BIM Score Between 25-28	=	Gold
E - Content Creation	0		BIM Score Between 29-32	=	Ideal
F - Construction Data	0				
G - As-Built Modeling	0				
H- FM Data Richness	0				

BIM Score

- *Vico BIM Score:*
  - *Evaluate your current solutions for clash detection, scheduling, and estimating in terms of three aspects: functionality/capability, best practices, and enterprise integration*
  - *http://www.vicosoftware.com/resources/calculating-bim-score/tabid/273811/Default.aspx*

VICO BIM Score



Total Score

0 out of 880

2 Define a priority level for each category

3 Review areas for improvement

Scores

	Project	Phase	Enterprise
Portfolio & Project	0	0	0
Cost Planning	0	0	0
Cost Control	0	0	0
Schedule Planning	0	0	0
Production Control	0	0	0
Coordination	0	0	0
Design Team Engagement	0	0	0

Priorities

Category	Priority
Portfolio & Project Mgmt	3
Cost Planning	3
Cost Control	3
Schedule Planning	3
Production Control	3
Coordination	3
Design Team Engagement	3

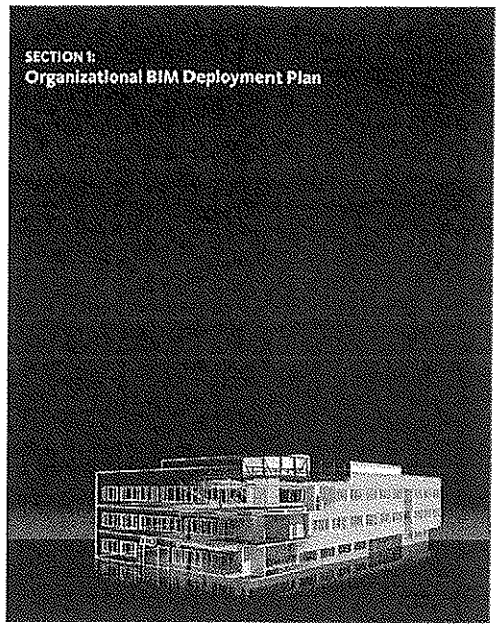
Scoring Standards:
0/Blank = No Priority
1 = Low Priority (or consider
2 = Medium Priority
3 = High Priority

Improvement Opportunities

	Project	Phase	Enterprise
Portfolio & Project	0	0	0
Cost Planning	0	0	0
Cost Control	0	0	0
Schedule Planning	0	0	0
Production Control	0	0	0
Coordination	0	0	0
Design Team Engagement	0	0	0

BIM Company Deployment Plan Content

1. *Organizational BIM Vision*
2. *Modeling Plan*
3. *Staffing Plan*
4. *Systems Implementation Plan*
5. *Corporate Collaboration Plan*
6. *Corporate Technology Plan*



BIM Company Deployment Plan Content (1)

1. *Organizational BIM Vision*
   - *What do you want to achieve with BIM?*
   - *How to measure the achievements?*
   - *Projected Timeframe*

Measures for Achievements

- *Design Management*
  - *Spotting mistakes before they occur onsite?*
  - *#Technical Queries and RFI on project?*
  - *Consistent output?*
- *Resource Management*
  - *Fewer people on production side?*
- *Success Rate*
  - *More projects secured at competition stages?*
  - *Improve client's satisfaction rating?*

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BIM Company Deployment Plan Content (2)

2. *Modeling Plan*
   - *Planned Models*
     - *Outline the models that your organization may create in a typical project and the model authoring tool to be used*
   - *Modeling Standards [Refer to BIM Standards]*
     - *Include all appropriate dimensioning as needed for design intent, analysis, and construction*
     - *How much information will be stored in object properties*
     - *Identify which components will be modelled, by whom, during which project phase or milestone, and at what level of detail*
     - *Standard Unit Convention*

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Planned Models (Example)

Model Name	Authoring Tool
Architectural Model	Autodesk Revit Architecture
Structural Model	Tekla
Structural Analysis Model	…
MEP Model	…
Construction Model	…
Coordination Model	…
…	…

BIM Company Deployment Plan Content (3)

- *Analysis Models*

  Are you planning to use any of these analysis tools?

  - *Quantity Takeoff Analysis: use modeling property data to automate or simplify the quantity takeoff process → tied to cost-estimating software*
  - *Scheduling Analysis: use the project model to analyze the timeline and sequencing for construction → modify or adjust the construction schedule*
  - *Clash Detection Analysis: check for interferences between the designs of one or many models*
  - *Green Mark/Energy Analysis: evaluate the impact of design decisions on sustainability and energy consumption*
  - *Structural Analysis: analyse the building's structural properties*

BIM Company Deployment Plan Content (4)

3. *Staffing Plan*
   - *Organization Structure*
     - *Outline your current organizational structure, and recommendations for your future organizational structure as it relates to BIM technologies and services*
   - *Personnel Skills and Training Requirements*
     - *Outline your organization's current skills, and recommendations for skills your organization will need to implement BIM technologies*
   - *Staff Acquisition*

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BIM Company Deployment Plan Content (5)

4. *Systems Implementation Plan*
   - *Communication Plan*
   - *Support Plan*
     - *How do you want to get any support throughout the implementation process?*
5. *Corporate Collaboration Plan*
   - *Document Management*
     - *Data Segregation, Technological Solutions*
     - *Data Validation and Data Saving*
     - *Folder Structure, File Naming Convention*
     - *Interoperability*

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Document Management: Data Segregation

- *Several reasons for subdividing a model:*
  - *Multi-user access*
  - *Operational efficiency on large projects*
  - *Inter-disciplinary collaboration*
- *Technological solution:*
  - *Revit → Worksets and Linking*
- *Best practices in subdividing a model:*
  - *A model file shall contain data from one discipline / project stakeholder only*
  - *Segregation of the geometry may be required if the file size exceed 50MB (performance issue); Ideally files shall not exceed 100MB*
  - *For the purpose of coordination/clash detection purposes, use container model that link multiple models on a single project*

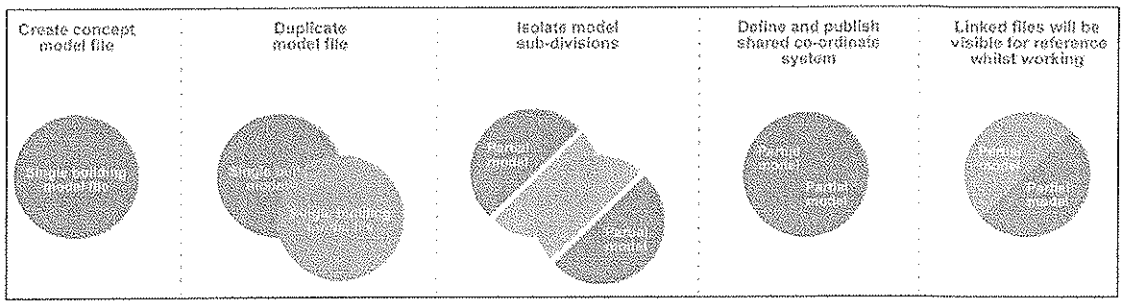
OPTIONAL? REPOSITORY WHICH CAN BE USED TO COMPILE COMPONENTS & ASSEMBLIES FOR SPECIFIC PURPOSES.

Document Management: Data Segregation - Example

Discipline	Breaks in Design
Architecture	Floor by floor or groups of floors
Structure	Major geometry splits such as east-wing or west-wing
MEP	HVAC, Plumbing, Fire Safety, Electrical

Document Management: Technological Solution (e.g. Revit)

- *Linking: enables additional geometry and data to be referenced into a model*
  - *Single Discipline Linked Files*
    - *Splitting a file into sub-models workflow*



Document Management: Technological Solution (e.g. Revit)

- *Linking: enables additional geometry and data to be referenced into a model*
  - *Inter-Disciplinary Linked Files*
    - *Each separate discipline shall have its own model*
    - *A discipline can Link in another discipline's Shared model for reference*
    - *Shared Coordinates and Project North rotation shall be agreed and documented*
    - *The difference between Finished Floor Level (FFL) and Structural Slab Level (SSL) shall be fully documented*
    - *Copy and Monitor tools in Revit*

Document Management: Technological Solution (e.g. Revit)

- *Worksets*
  - *Multiple users simultaneously work on a model file through use of a CENTRAL file and synchronised LOCAL copies*
  - *E.g.*

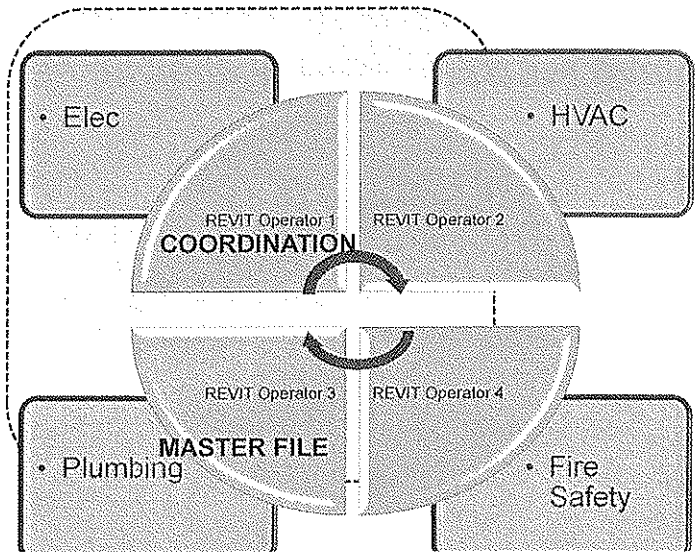


Image courtesy of BYME

Document Management: Data Validation

- *BIM model shall be published to DWF, PDF or other non-editable format so that they can be checked:*
  - *All unnecessary drawing sheets and views have been removed from the BIM model*
  - *Model is correctly assembled through visual inspection*
- *File format and naming conventions conform to project Data Exchange protocols and/or e-submission guidelines*
- *Model files are up-to-date*
- *Prior to sharing, model files are detached from central file and any linked reference files have been removed*

Document Management: Data Saving

- *Regular back-ups for all BIM project data that reside on network servers*
- *A working model back-ups shall be set to 3*
- *LOCAL files shall be saved back to CENTRAL*
- *Save reminder interval shall be set to 30mins*

Document Management: Folder Structure (1a)

- *[Central] Project-specific:*
  - *<Server Name>\Project\<Project Name>*
    - *01-WIP* — *[WIP data repository]*
      - *CAD_Data* — *[CAD files]*
      - *BIM_Models* — *[Design models]*
      - *Sheet_Files* — *[Sheet/DWG files]*
      - *Export* — *[e.g. gbXML or images]*
      - *Families* — *[Created during this project]*
    - *02-Shared* — *[Verified shared data]*
      - *CAD_Data* — *[CAD data/output files]*
      - *BIM_Models* — *[Design models]*
      - *Coord_Models* — *[Compilation models]*
    - *03-Published* — *[Published data]*
      - *YYMMDD_Desc* — *[Submission folder]*
    - *04-Archived*
      - *YYMMDD_Desc* — *[Archive folder]*

Document Management: Folder Structure (1b)

- *[Central] Project-specific:*
  - *<Server Name>\Project\<Project Name>*
    - *05-Incoming* *[Incoming data repository]*
      - *<Source>* *[Data originator]*
        - *YYMMDD_Desc* *[Incoming folder]*
    - *06-Resource* *[Project support files]*
      - *Titleblocks*
      - *Logos* *[Project logos]*
      - *Standards* *[Project standards]*

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Document Management: Folder Structure (2)

- *[Central] Non-project-specific:*
  - *<Server Name>\Resource\Autodesk_Revit*
    - *Titleblocks*
    - *Standards*
    - *Templates*
    - *Families*
      - *<software version>*
      - *2011*
        - *Architecture*
          - *Balusters*
          - *Casework*
          - *…*
        - *Mechanical_Services*
        - *Structure*
        - *General [non-discipline specific; e.g. annotation]*
        - *Material_Library*

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Document Management: Folder Structure (3)

- *[Local] Project-specific:*
  - *D:*
    - *BIM_Projects*
      - *<Project Name>*

• Central file shall never be opened, only copied to create local files
• Untrained users shall not open the native files. For the purpose of interrogation and mark-up, convert the native files into 3D DWF or PDF

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Document Management: Naming Conventions

- *General Naming Conventions (files and folders)*
  - *The existing naming convention for 2D CAD can be re-used for BIM naming convention.*
  - *To avoid incompatibility with certain file management tools and collaboration across the internet:*
    - *Use only letters A-Z, hyphen, underscore and numbers 0-9 for all fields*
    - *Do NOT use spaces, instead use either CamelCase or an underscore "_" or a hyphen character "-" to separate words*
- *Model File Naming, View Naming, and Sheet Naming Conventions*
  - *Please follow the e-submission guideline*

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Document Management: Interoperability (1)

- *Incoming CAD/BIM data management*
  - *The project BIM manager shall verify the suitability of incoming CAD/BIM data prior to making it available project-wide*
  - *Modification of incoming CAD/BIM data shall be kept to absolute minimum*
  - *Remove any irrelevant or extraneous data prior to importing or linking to the BIM model*
  - *CAD data may need be shifted to 0,0,0 prior to import*
    - *E.g. CAD data modelled more than 1 mile from the origin (in any plane) shall be shifted to 0,0,0 prior to importing into Revit to avoid accuracy issues.*
  - *Ownership of this cleansed data is transferred from the originator to the cleansing discipline. Cleansed data is then stored within the discipline's WIP area*

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Document Management: Interoperability (2)

- *Data transfer between packages*
  - *Understand the requirement/limitation of the target software*
    - *E.g. When modelling structural frames, some analysis software may dictate that columns need to be stopped at each floor level regardless of whether, in reality they continue as a single length*
  - *2D output from the BIM shall be constructed in a manner that is usable to the team*
    - *Use appropriate export layer tables during export to CAD*
  - *Do sample testing to ensure data integrity*

EXPORTING LAYERS → CHOOSE CPYS SETTING → HOW AUTOMATICALLY CONVERT LAYERS TO CPYS.

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BIM Company Deployment Plan Content (6)

6. *Corporate Technology Plan*
   - *Software selection*
   - *Hardware selection*
   - *BIM Server*

Software Selection: Examples

Software	Available
Authoring – Design (Architecture, Structural)	Revit Architecture, Bentley BIM, ArchiCAD, Tekla or equal
Authoring - MEPF (design & construction)	Revit MEP, AutoCAD MEP, Bentley BIM, CAD-Duct, CAD-Pipe, AutoSprink, PipeDesigner 3D or equal
Authoring - Civil	Bentley Inroads and Geopak, Autodesk Civil 3D
Coordination (spatial conflict, clash detection)	NavisWorks Manage or Bentley Navigator
4D Scheduling	Synchro, Vico, NavisWorks Simulate, Primavera, MS Project , Bentley Navigator
Cost Estimate	Innovaya, Vico or equal
Energy Analysis	Green Building Studio, IES, Ecotect, Hevacomp, TAS, or equal
Specifications	E-Specs or equal
Model Checking Validation, IFC File Optimizer	Solibri or equal
Water Management	Bentley WaterGem

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Software Selection: A Guide

- *Work scope and produced results*
  - *Features*
  - *Interoperability*
- *Learning curve*
- *Technical Support – email or web*
- *Type of licenses – desktop or network license*
- *Number of license*

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Hardware Selection

- Considerations in Specifying New BIM Workstations requirements
- 32-bit vs. 64-bit Operating Systems
- Choices in Today's Processors?
- System RAM Considerations? 32-BIT CANT ONLY RUN ON 3.5GB RAM / 16G OR ABOVE WILL BE GOOD | 32G & ABOVE FOR FILES AVAILABLE
- Graphics Cards – "Workstation" vs. "Gaming" Solutions? [DOESN'T REALLY MATTER.
- Mass Storage Considerations?
- Specifying a Laptop
- Should I Buy a Mac? → TURN TO PC-MODE TO RUN REVIT.

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Hardware Selection

- Revit stresses the ***CPU and RAM:***
  - Long application load times
  - ***Very large single files, long project load times***
- Revit stresses the ***hard disk & infrastructure network:***
  - Saving / Synchronizing with Central
  - Copying new daily Local Files
  - Working with remote offices

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Hardware Selection

- Infrastructure network:
  - Either LAN (Local Area Network) or WAN (Wide Area Network)
  - Enable communication and access corporate data, model files, and documents
  - Please consult and discuss with IT department or IT network experts to setup network for BIM

BIM Server (CHECK OUT AUTODESK VIDEOS)

WORKSHARING IN AUTODESK REVIT VIA THE FOLLOWING:-

1) ■ BIM Server for ArchiCAD — PERFORMANCE AND WAITING TIMES.
2) ■ Revit Server — FREE (SAME AS ABOVE)
3) ■ Bentley ProjectWise Integration Server (NO UPDATING) (CONSTANT UPDATING) — PAY

↖ recommended.

BIM Standard

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Agenda

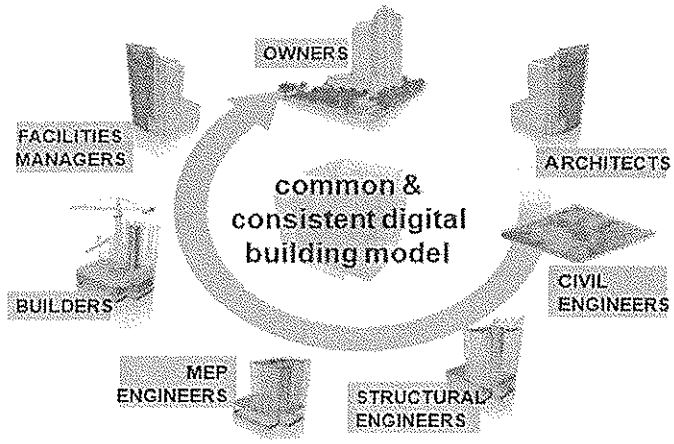
- Background
- BIM Standard Examples
- Defining Company BIM Standard

Background

- What is BIM Standard/Guide?
- Do I/We need a standard?
- How firmly the standard need to be followed?

Background

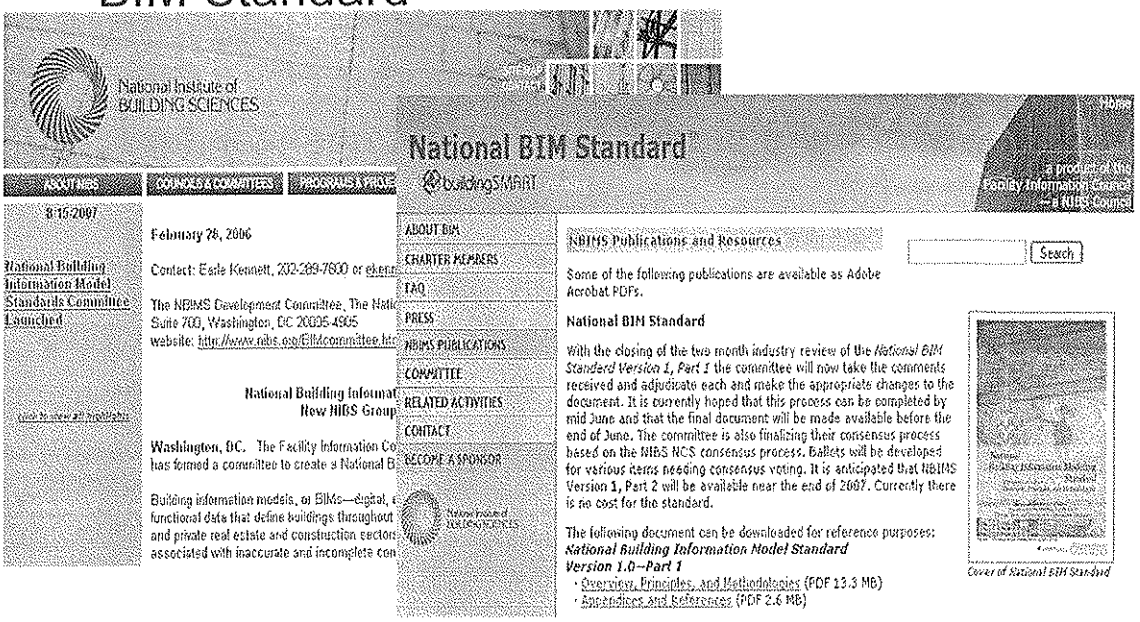
- Yes we need a standard (follow cpds & w's std)
  - Produce consistent output
  - Easy to understand others work
  - Better if the project team adopt one standard



BIM STANDARD EXAMPLES

BIM Guidelines - USA

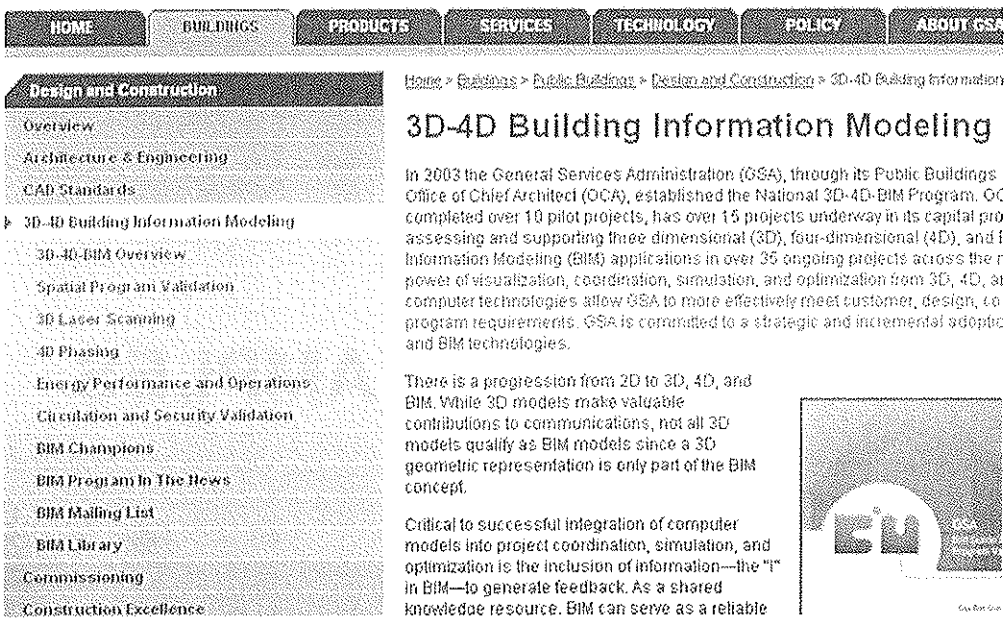
■ National Institute of Building Science, National BIM Standard



BCA ACADEMY of the built environment

BIM Guidelines - USA

■ U.S. General Services Administration – BIM Guide Series

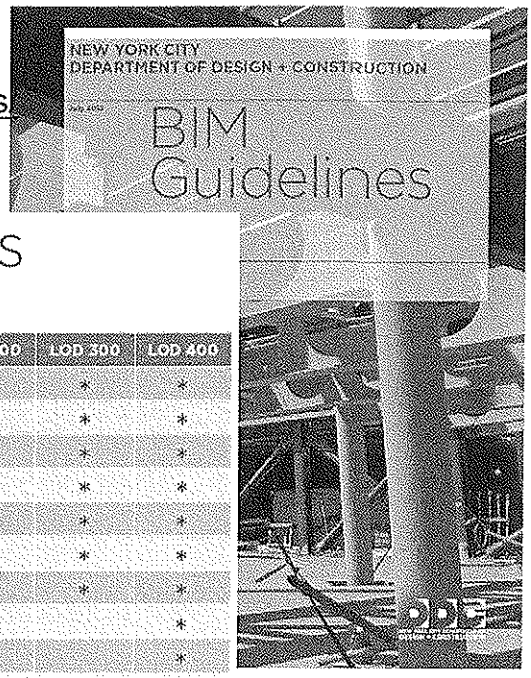


BCA ACADEMY of the built environment

BIM Guidelines - USA

- New York City BIM Guidelines

http://www.nyc.gov/html/ddc/html/pubs/publications.shtml



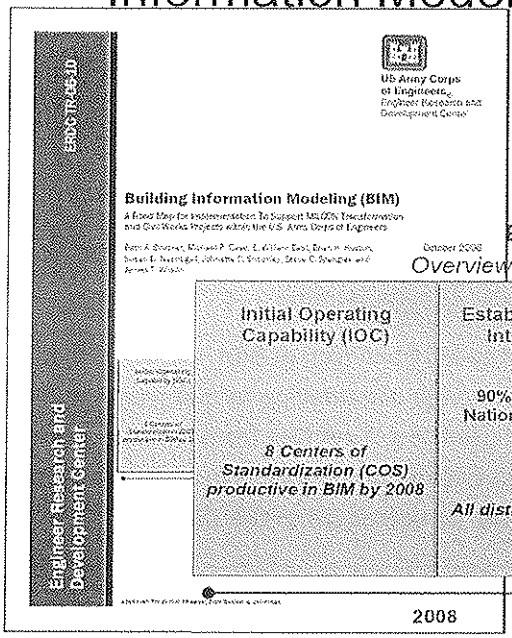
Object Requirements

AIR TERMINALS

Requirements	LOD 100	LOD 200	LOD 300	LOD 400
Type/Dimensions	N/A	*	*	*
Level	N/A	*	*	*
System Classification	N/A	*	*	*
System Type	N/A	*	*	*
System Name	N/A	*	*	*
Pressure Drop	N/A		*	*
Flow	N/A		*	*
Material	N/A			*
Mark	N/A			*
Phase Created	N/A			*
Phase Demolished	N/A			

BIM Guidelines - USA

- U.S. Army Corps of Engineer, Building Information Modelling



https://cadbim.usace.army.mil/

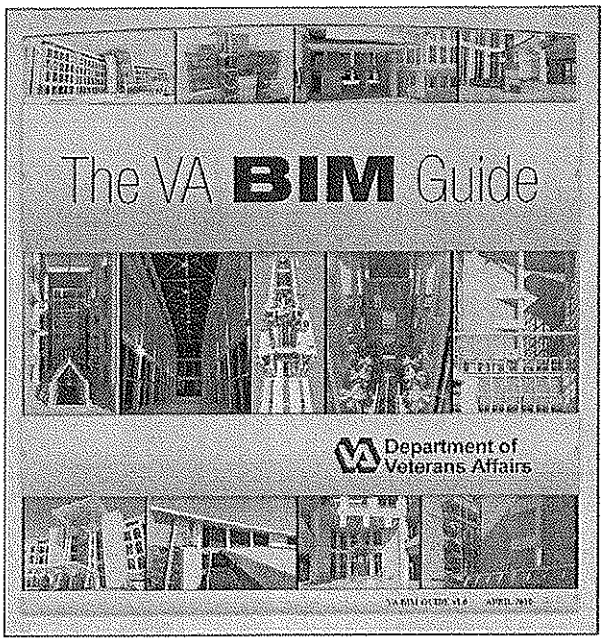
Building Information Modeling

Overview: U.S. Army Corps of Engineer Roadmap

Initial Operating Capability (IOC)	Establish Life-Cycle Interoperability	Full Operational Capability (FOC)	Automation of Life-Cycle Tasks
8 Centers of Standardization (COS) productive in BIM by 2008	90% compliant with National BIM Standard (NBIMS) *All districts productive in NBIMS*	*NBIMS used for all projects as part of contract advertisement, award, submittals*	*Leverage NBIMS data for substantial reduction in cost and time of constructed facilities*
2008	2010	2012	2020

BIM Guidelines - USA

- BIM Guide related to hospital projects



http://www.cfm.va.gov/til/bim/BIMGuide

https://facilities.health.mil/home/

MHS Facility Life Cycle Management (FLCM) Building Information Modeling (BIM) Minimum Requirements

Building World Class Healthcare

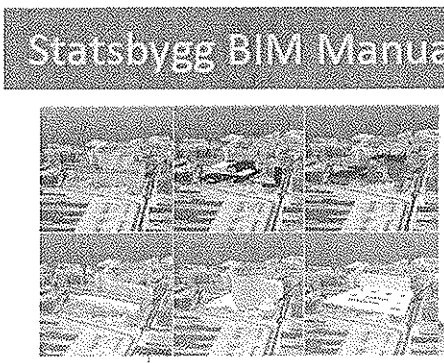
http://www.tricare.mil/ocfo/ppmd/index.cfm
www.mhsworldclassfacilities.org

This document represents the details of the minimum BIM requirements for the DoD's MHS facilities projects as noted in the UFC 4-510-01. Additional BIM requirements should be incorporated on projects where appropriate in support of definitive objectives.

The primary function of this document is to ensure coordinated BIM standards for the MHS with a FLCM perspective.

BIM Guidelines - Norway

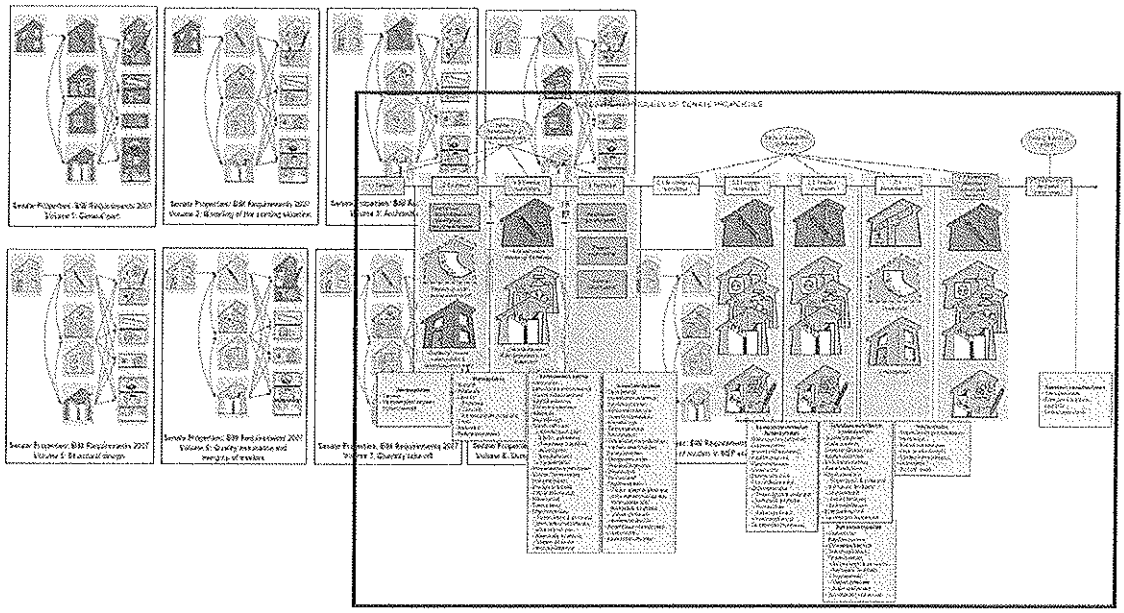
- Statsbygg BIM Manual



7.	Original digital storage format for BIM to be submitted to client	MAND	In addition to the IFC open format BIM – which is the main deliverable - the *original* modelling format from the BIM authoring tool used (e.g. ***.rvt** files from Revit or **.pla** from Archicad) , inclusive of library objects in active use in the model, shall also be submitted to the client.

BIM Guidelines - Finland

■ Senate Properties, BIM Requirements 2007



BIM Guidelines – United Kingdom

■ AEC (UK) BIM Standard for Autodesk Revit

AEC (UK) BIM STANDARD COMPLIANT

http://aecuk.wordpress.com/documents/

Documents

Download the AEC (UK) documents here.

AEC (UK) BIM Protocols

AEC (UK) BIM Protocol v2.0 (Main document)

AEC (UK) BIM Protocol – BIM Execution Plan v2.0

AEC (UK) BIM Protocol – Model Matrix v2.0

AEC (UK) BIM Protocol For Autodesk Revit v2.0 (Supplementary document for Autodesk Revit)

AEC (UK) BIM Protocol For Autodesk Revit – Model Validation Checklist v2.0

AEC (UK) BIM Protocol For Bentley ABD v2.0 (Supplementary document for Bentley AECOsim Building Designer)

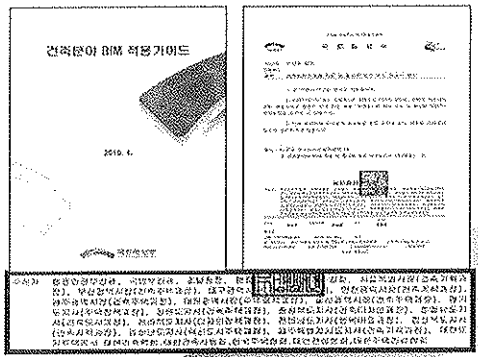
AEC (UK) BIM Protocol For Bentley ABD – Model Validation Checklist v2.0

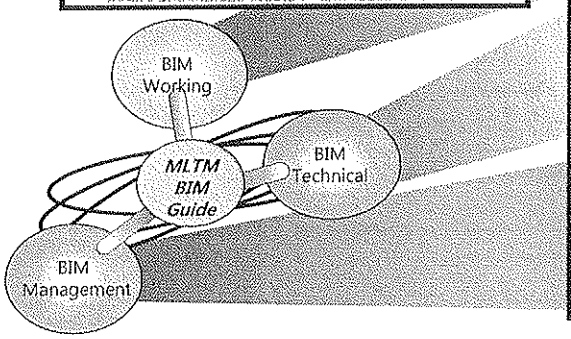
AEC (UK) BIM Standard for Autodesk Revit

A work-in-progress implementation of the AEC (UK) BIM Standard for the Architectural, Engineering and Construction industry in the UK

BIM Guidelines – Korea

■ Ministry of Land, Transport and Maritime Affairs, National BIM Guide

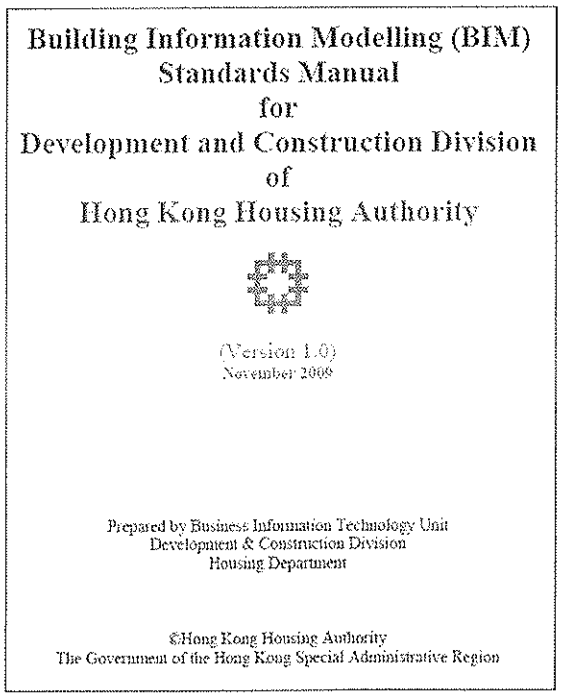




1. Overview	1.1 Purpose
	1.2 Contents
	1.3 Referenced standards
	1.4 Terminology
	1.5 Acronym
	1.6 Revision of the guide
2. BIM Working Guide	2.1 Purpose of BIM uses
	2.2 BIM data modeling requirements
	2.3 BIM data generation
	2.4 BIM activity
3. BIM Technical Guide	3.1 BIM data format
	3.2 BIM software
	3.3 BIM data file
	3.4 BIM information classification
4. BIM Management Guide	4.1 Organization and roles
	4.2 Activities according to management stage
	4.3 BIM quality management
	4.4 BIM deliverables submission
	4.5 Responsibility and right

BIM Guidelines – Hong Kong

■ Hong Kong Housing Authority



Building Information Modelling (BIM)
Standards Manual
for
Development and Construction Division
of
Hong Kong Housing Authority

(Version 1.0)
November 2009

Prepared by Business Information Technology Unit
Development & Construction Division
Housing Department

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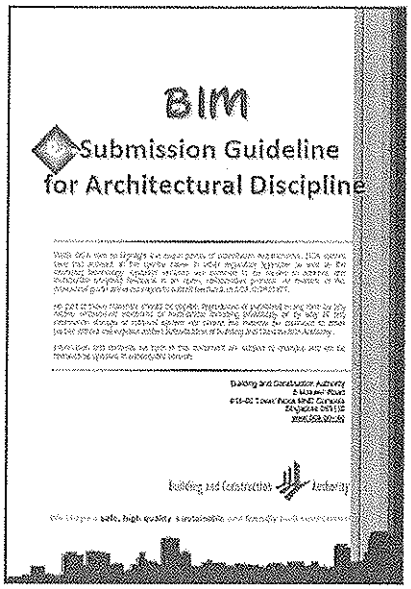
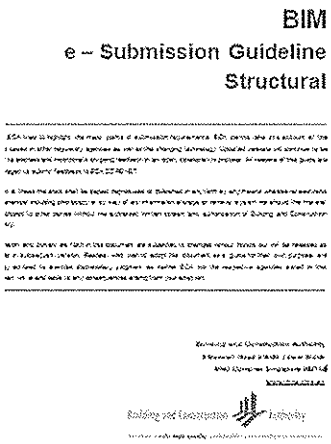
The Government of the Hong Kong Special Administrative Region

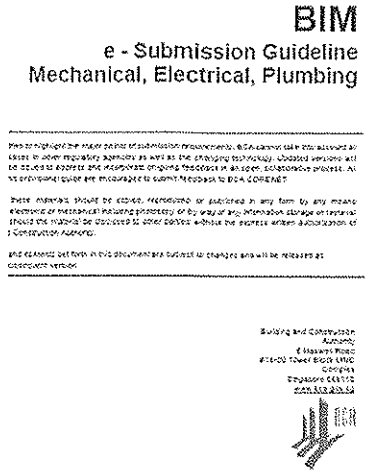
http://www.housingauthority.gov.hk/en/business-partnerships/resources/building-information-modelling/index.html

BIM Guidelines – Singapore

e – Submission Template and Guidelines







http://www.corenet.gov.sg/index.html

BIM Guidelines – Singapore

e – Submission Template and Guidelines

Building Information Modeling (BIM) e-Submission

Architectural BIM e-Su
BCA will start to accept Arcl

Architectural Guidelines

For Revit Users
i) Template

ii) Guidelines

For Archicad Users
i) Template

ii) Guidelines

Structural BIM e-
BCA will start to accep

Structural Guideline:

Structural Annex

For Revit Users
i) Templates

ii) Annex 1

For Bentley Users
i) Template

ii) Annex 2

MEP BIM e-Submission
CBPU, FSSD, IDA, PUB and CityGas will start to accept MEP (Mechanical, Electrical and Plumbing)
BIM e-Submission officially from 1 April 2011

MEP Guidelines — Click Here: MEP Guidelines

For Revit Users
i) Templates
- Click Here: Revit MEP Template v2010
- Click Here: Revit MEP Template v2011
- Click Here: Revit MEP Template v2012
- Click Here: Revit MEP Template v2013

ii) Guidelines — Click Here: Revit MEP Template Training Guidelines

For Bentley Users
i) Templates — Click Here: Bentley AECOsim V8i MEP Template*

ii) Guidelines — Click Here: Bentley AECOsim V8i MEP Template Training Guidelines

currently under testing

For enquiry on MEP BIM template and guidelines, please email to liu_ziwen@bca.gov.sg

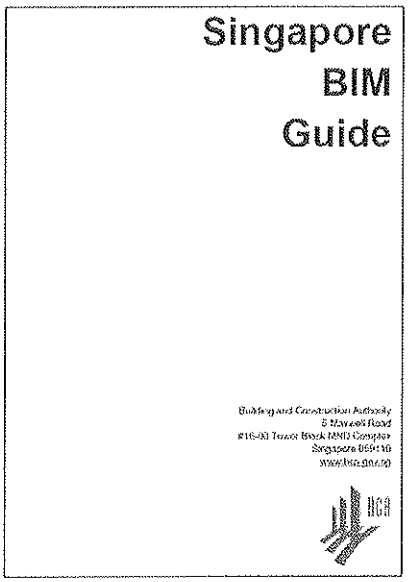
Click Here: Template for Bentley AECOsim v8i*

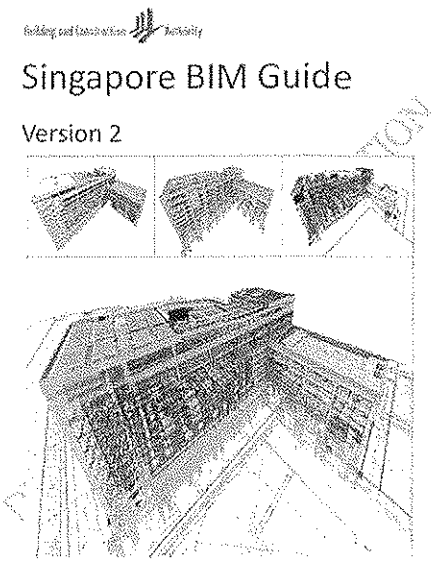
Click Here: Annex2a Recommended Process for AECOsim Building Designer v8i*

BCA ACADEMY of the built environment

BIM Guidelines – Singapore

■ Singapore BIM Guide Version 1.0 & 2.0





http://bimsg.wordpress.com/

BCA ACADEMY of the built environment

BIM Guidelines – Singapore

■ Singapore BIM Guide Version 1.0 & 2.0

Singapore BIM Guide Version 2.0

The **Singapore BIM Guide** is a reference guide that outlines the roles and responsibilities of project members when using Building Information Modelling (BIM) at different stages of a project. It is used as a reference guide for the development of a BIM Execution Plan, which will be agreed between the Employer and project members, for the successful implementation of a BIM project.

The Singapore BIM Guide consists of both BIM Specifications and BIM Modelling and Collaboration Procedures.

The Singapore BIM Guide Version 1.0 was launched in May 2012. It was updated and revised into the Singapore BIM Guide Version 2.0, and released on August 2013.

Singapore BIM Guide Version 1.0	Click here	Singapore BIM Guide Version 1.0
BIM Particular Conditions Version 1.0	Click here	BIM Particular Conditions Version 1.0
Singapore BIM Guide Version 2.0 "new"	Click here	Singapore BIM Guide Version 2.0
BIM Particular Conditions Version 2.0 "new"	BIM Particular Conditions Version 2.0 (To be released soon)	

We welcome readers to share your comments, proposed changes and additions to the Singapore BIM Guide and the BIM Particular Conditions. Feedback will be gathered and continuously reviewed; they will be collated to form new revisions at appropriate intervals.

For suggestions, feedback and enquiries, please email to huang_yixiang@bca.gov.sg.

BIM Guidelines – Singapore

■ BIM Essential Guides

BIM Essential Guides

The BIM Essential Guide Series provides references on good BIM practices in an illustrated, easy-to-read format, and are targeted at new BIM users in Singapore.

BIM Essential Guide for:

BIM Adoption in an Organization	Click Here	for BIM Adoption in Organization
BIM Execution Plan	Click Here	for BIM Execution Plan
Architectural Consultants	Click Here	for Architectural Consultants
C&S Consultants	Click Here	for C&S Consultants
MEP Consultants	Click Here	for MEP Consultants
Contractors	Click Here	for Contractors

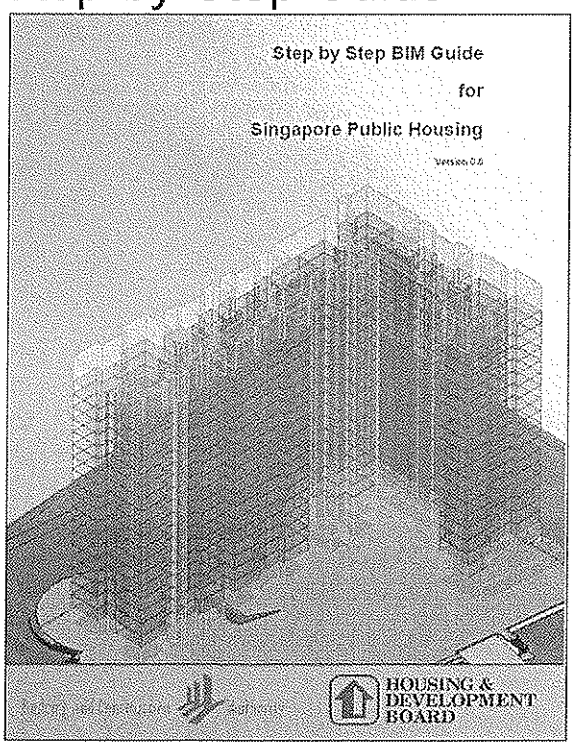
We welcome readers to share your comments, proposed changes and additions to the BIM Essential Guides. Feedback will be gathered and continuously reviewed; they will be collated to form new revisions at appropriate intervals.

For suggestions, feedback and enquiries, please email to:

Architectural	mary_ann_sameniego@bca.gov.sg huang_yixiang@bca.gov.sg
C&S	sonny_andalis@bca.gov.sg
MEP	liu_ziwen@bca.gov.sg qin_hao@bca.gov.sg
Contractors	

BIM Guidelines – Singapore

■ HDB Step-by-Step Guide



BCA ACADEMY of the built environment

DEFINING COMPANY BIM STANDARD/MANUAL

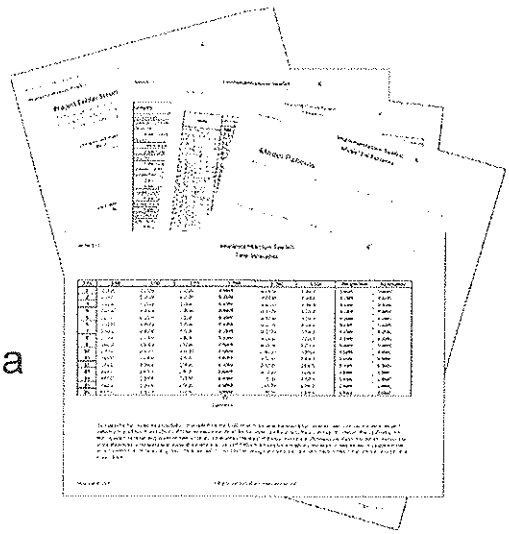
BCA ACADEMY of the built environment

Background

- Focus of this Unit: Content Management
  - Templates
    - Components
    - Annotations
  - Guidelines
    - Naming Conventions
    - Steps

Defining Company BIM Standard

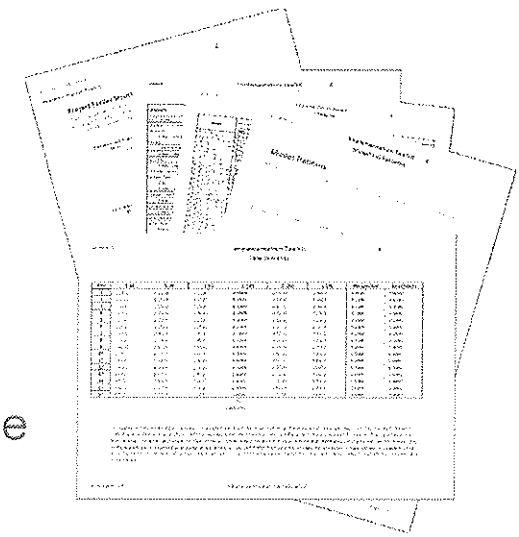
- Steps to defining Standard
  - Information gathering workshop
  - Do not go in with a blank sheet
    - Use a existing standard as a base
    - Identify the items to standardise
  - Get feedback and comments from others



BCA ACADEMY
Building Excellence

Defining Company BIM Standard

- Steps to define Standard
  - Create the template
    - Keep it light weight
    - Add only the necessary items
  - Create the guidelines
  - Revisit, Review and Revise



BCA ACADEMY
Building Excellence

Defining Company BIM Standard

- Items to standardise
  - Location and Orientation
  - Scale
  - Browser Organisation
  - Default Families and Types
  - Object Styles
  - Annotations
    - Annotation Object Styles, Text Styles
    - Dimensions, Tags
    - Leaders
    - Legends
  - Filters

BCA ACADEMY of the built environment

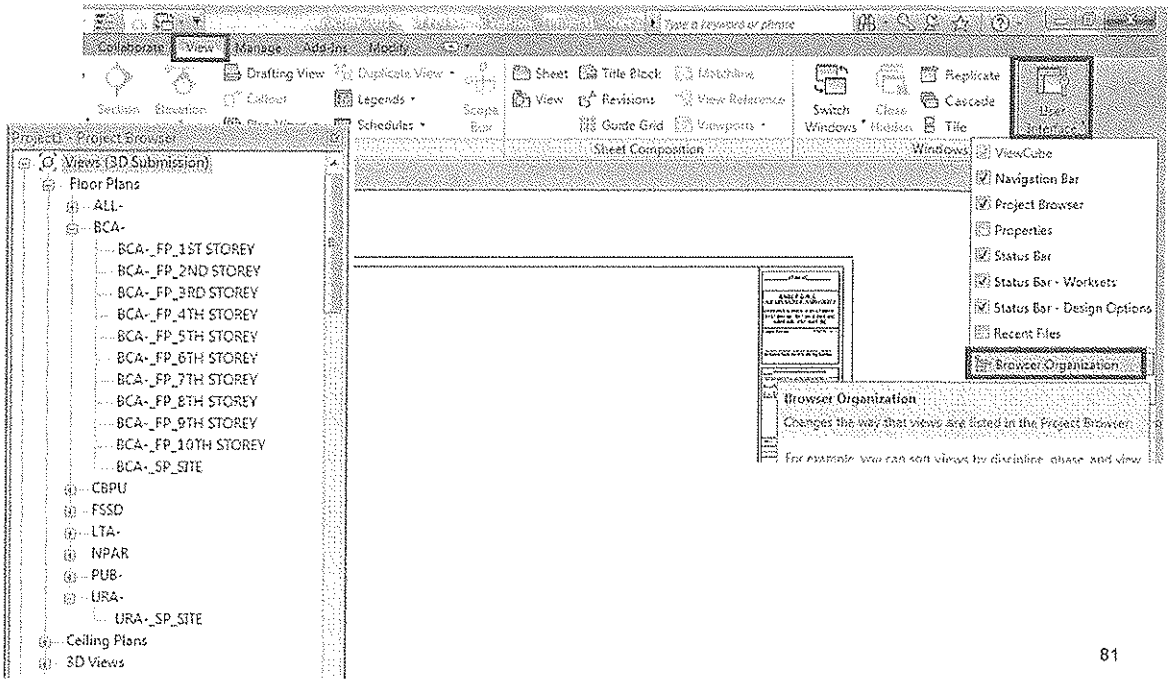
Defining Company BIM Standard

- Items to standardise
  - Keyboard Shortcuts
  - Line Patterns, Styles and Weights
  - Hatch Patterns
  - Materials
  - Naming Conventions
  - Schedules
  - Symbols
  - Titleblocks
  - View Templates
  - Content of each views or sheets

BCA ACADEMY of the built environment

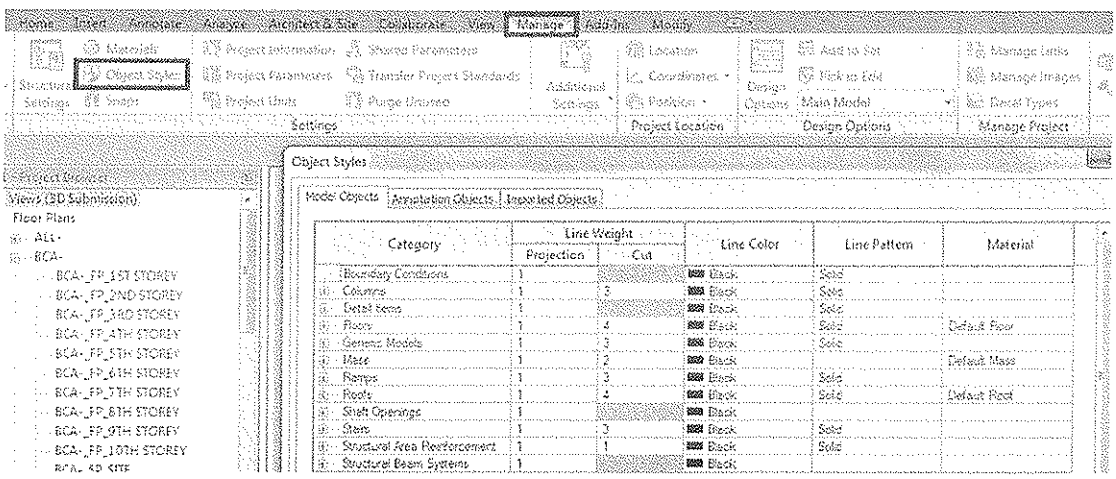
Defining Company BIM Standard

■ Browser Organisation



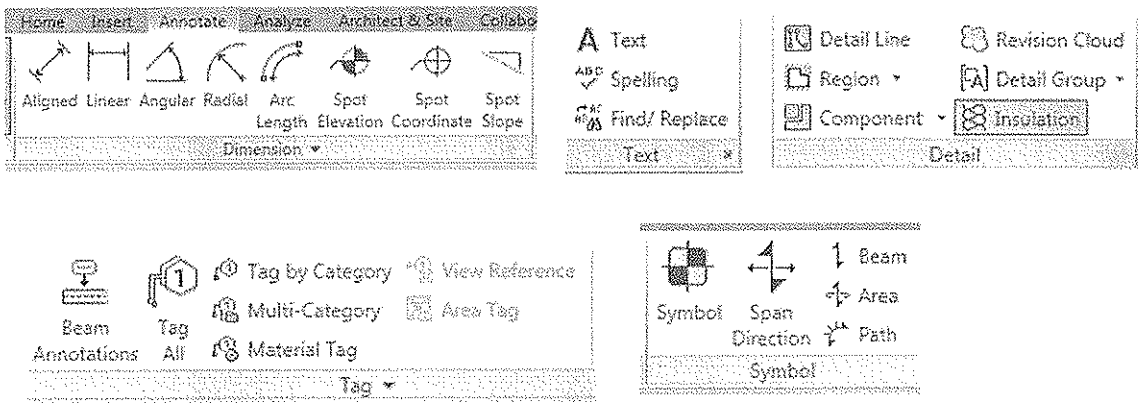
Defining Company BIM Standard

■ Object Styles



Defining Company BIM Standard

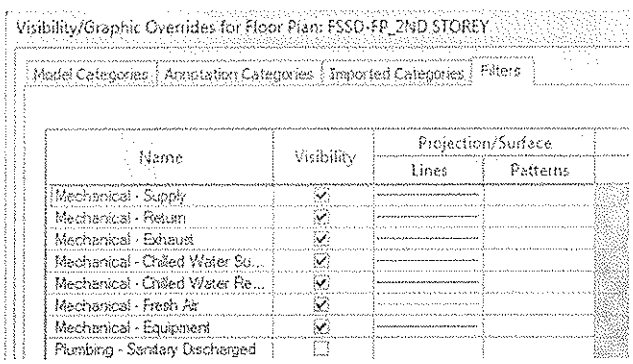
- Annotations
  - Dimensions, Text, Tags, Fills, Symbols and 2D components



BCA ACADEMY
Building Construction

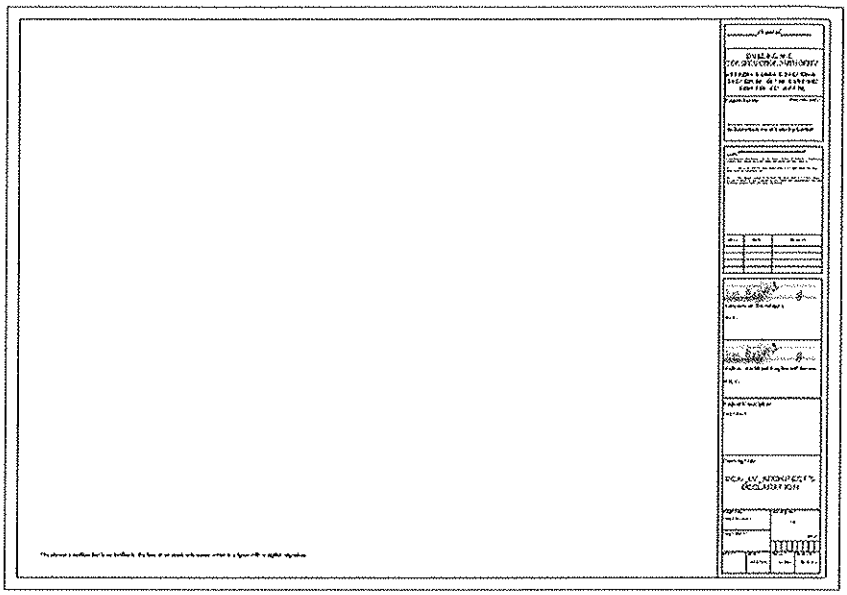
Defining Company BIM Standard

- Filters
  - View property → Visibility Graphics → Filter
  - Setting the object style by filter (more colors and styles)



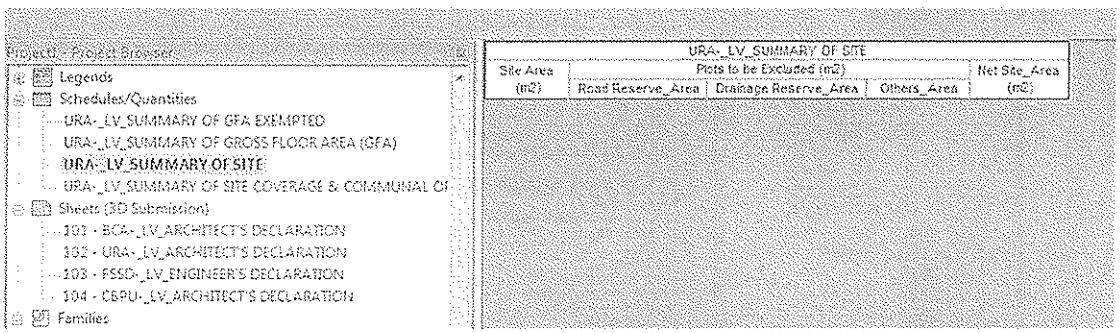
Defining Company BIM Standard

- Titleblocks



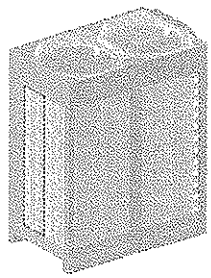
Defining Company BIM Standard

- Schedules
  - View → Schedule



Defining Company BIM Standard

■ Families / Objects / Libraries

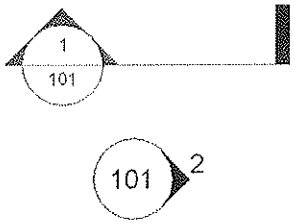


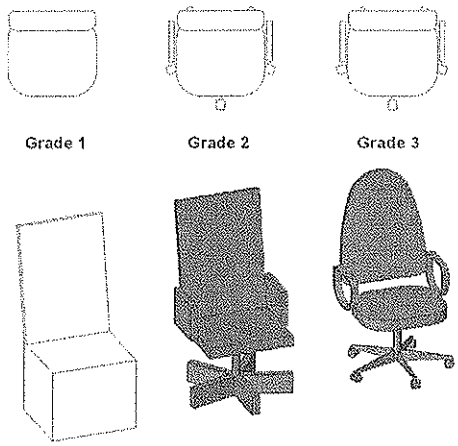
4000 FFL

Level 1

1 **Callout of Level 0**

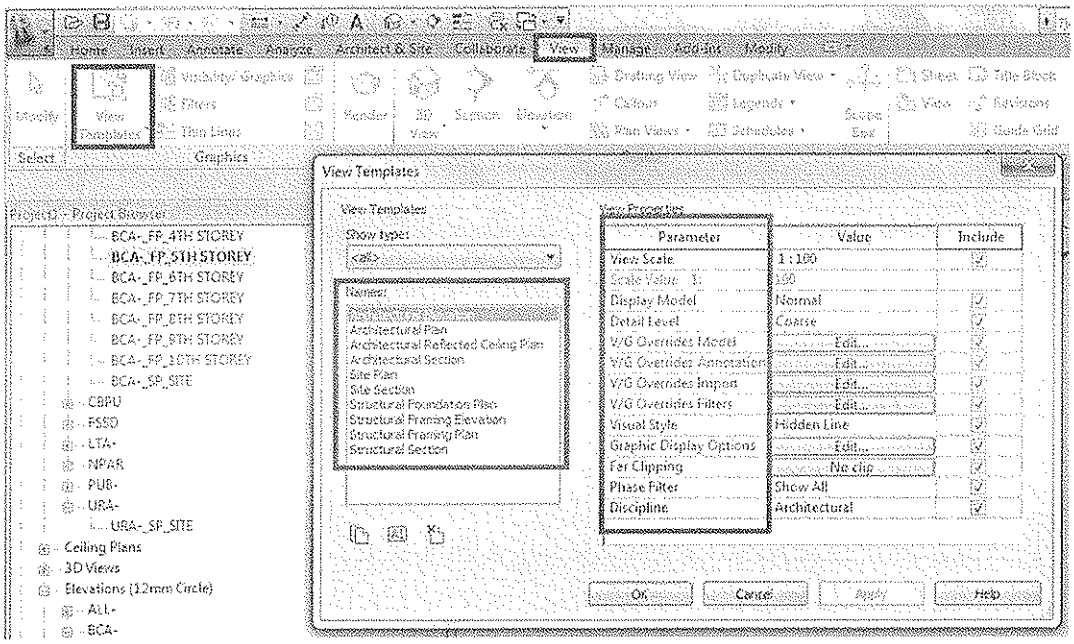
1 : 20





Defining Company BIM Standard

■ View Templates (SAVED VIEWS)



BCA ACADEMY of the built environment

CASE STUDY

BIM E – SUBMISSION TEMPLATE AND GUIDELINES

BCA ACADEMY of the built environment

BIM e – Submission Template and Guidelines

- Requirement from various agencies
- Feedbacks and comments from pilot users

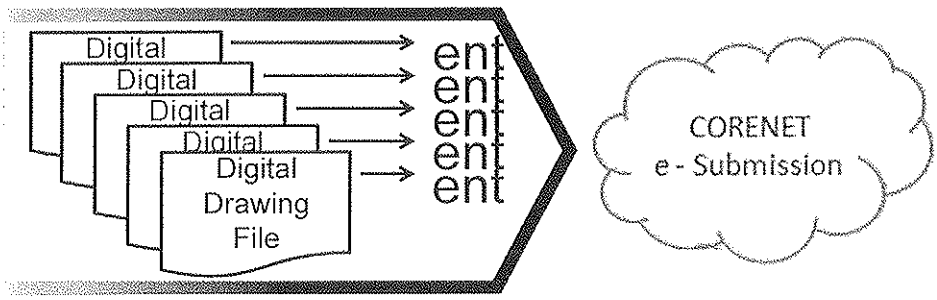
Architectural BIM e-submissions
(BCA, URA, FSSD, CPBU, PUB, LTA, N-Parks, HDB and JTC)

Structural BIM e-Submissions
(BCA)

MEP BIM e-Submission
(FSSD, CPBU, PUB, CityGas and IDA)

BIM e – Submission Template and Guidelines

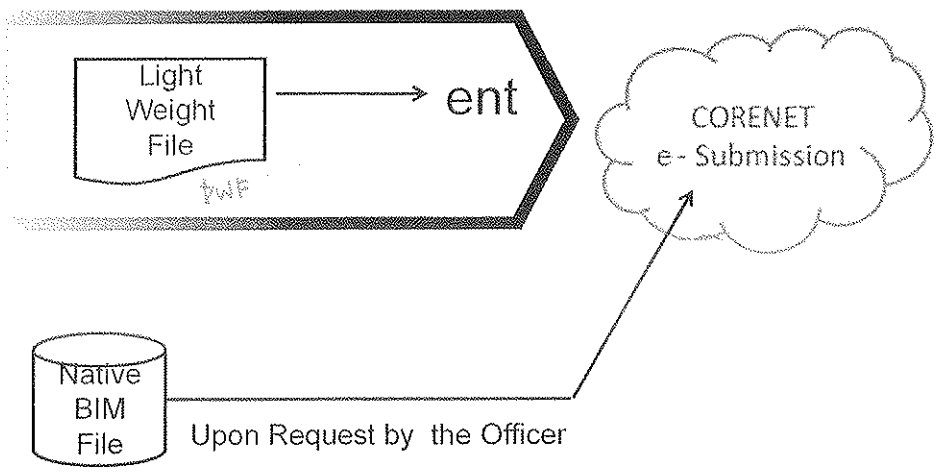
Current e - Submission



BCA ACADEMY of the built environment

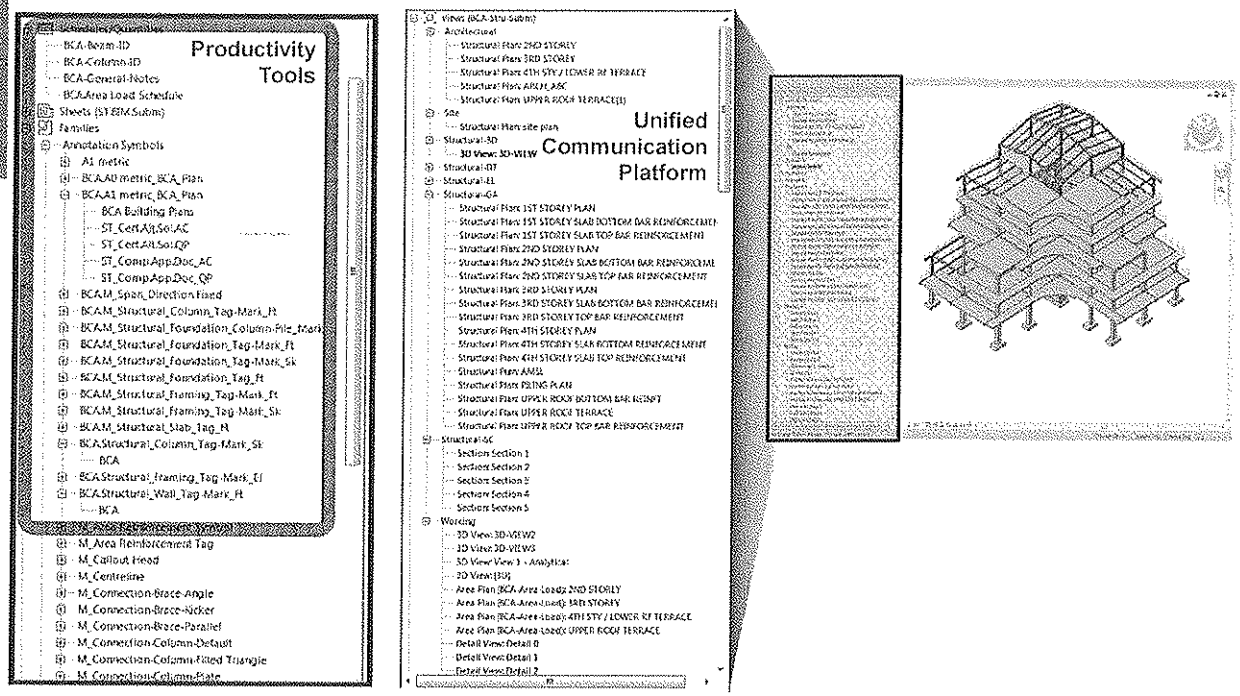
BIM e – Submission Template and Guidelines

BIM e - Submission



BCA ACADEMY of the built environment

BIM e – Submission Template and Guidelines



BCA ACADEMY
Building Environment

BIM e – Submission Template and Guidelines

File Naming Convention

Mandatory | Optional

Part 1		Part 2		Part 3		Part 4		Part 5		Part 6
Project ID		ST #		Author		Zone		Version		User Defined
A1100-00001-2011	_	ST01	_	S	_	01	_	A	_	Foundation
A1100-00001-2011	_	ST02	_	S	_	01	_	A	_	Superstructure

View Naming

Mandatory

Part 1		Part 2		Part 3
Discipline		View		User Defined
STRU	_	FP	_	1st Storey Plan View
STRU	_	FP	_	2nd Storey Plan View

Sheet Naming

Mandatory

Part 1				
Sheet Number				User Defined
0	0	1	_	BPM/10/0030/ST/001/GENERAL NOTES
0	0	3	_	BPM/10/0030/ST/003/BEAMANDCOLUMN
0	1	0	_	BPM/10/0030/ST/010/LAYOUT OF PILES AND PILECAPS
0	5	0	_	BPM/10/0030/ST/050/1st STOREY BEAM SCHEDULE

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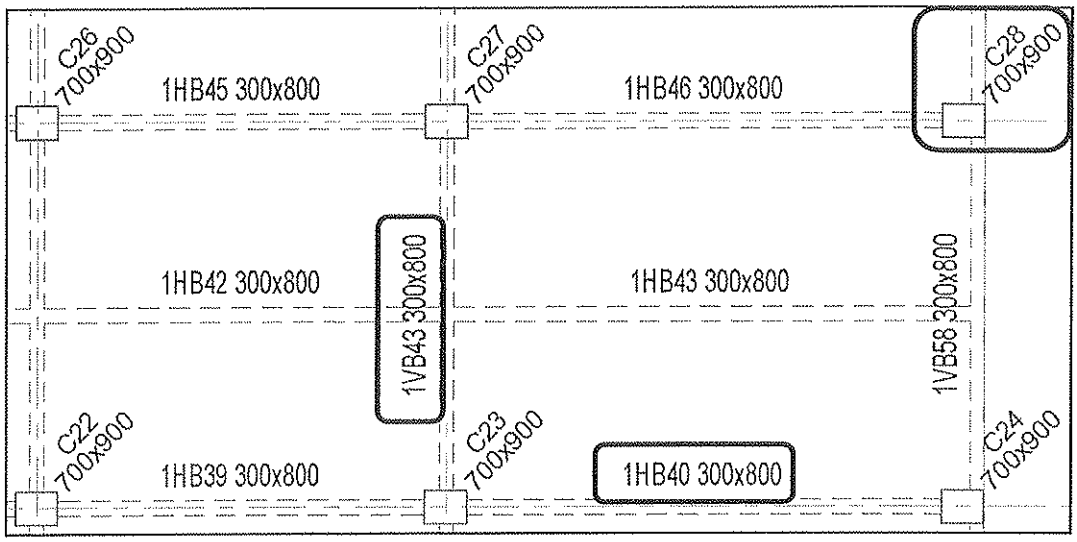
BIM e – Submission Template and Guidelines

■ Standardised Annotations



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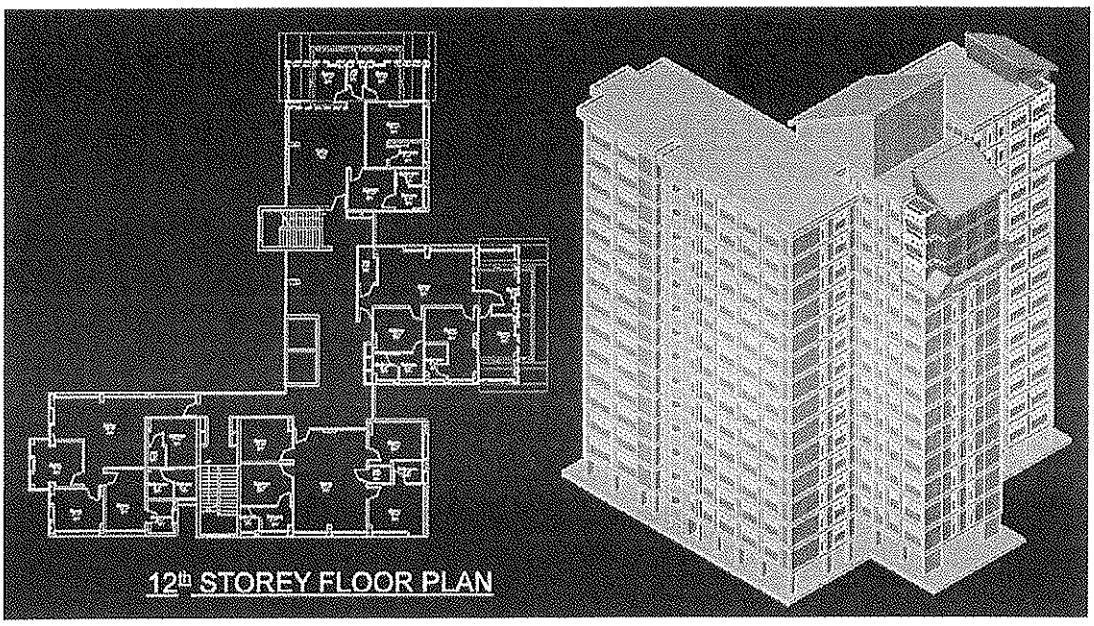
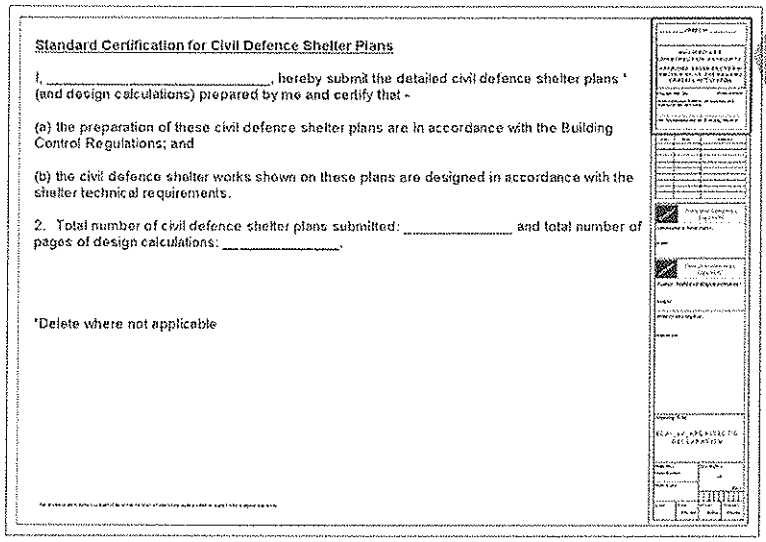
BIM e – Submission Template and Guidelines

■ A&A Color Code



BIM e – Submission Template and Guidelines

■ Titleblock with Declaration



Standard Certification for Civil Defence Shelter Plans

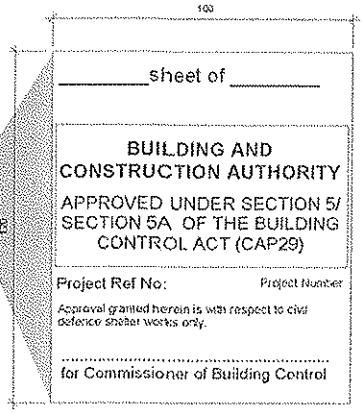
I, _____, hereby submit the detailed civil defence shelter plans * (and design calculations) prepared by me and certify that -

(a) the preparation of these civil defence shelter plans are in accordance with the Building Control Regulations; and

(b) the civil defence shelter works shown on these plans are designed in accordance with the shelter technical requirements.

2. Total number of civil defence shelter plans submitted: _____ and total number of pages of design calculations: _____.

*Delete where not applicable



BIM e – Submission Template and Guidelines

■ Schedule for GFA Table

SUMMARY OF GROSS FLOOR AREA									
Blk No.	Storey	GFA (m^2)	Breakdown of Gross Floor Area (m^2)						
			Commercial	Residential	Hotel	Industry	Warehouse		
1	Basement								
	1st Storey								
	2nd Storey								
	3rd Storey								
	Roof								
	Subtotal:								
2	1st Storey								
	2nd Storey								
	3rd Storey								
	Roof								
	Subtotal:								
Total:									
Quantum (%):									

BIM e – Submission Template and Guidelines

- The guidelines covers
  - Different agencies requirements
  - Step by Step Guide
  - Information's specific to submission

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Singapore's built environment

Thank You

Singapore BIM Guide

Presented by :

Huang Yixiang
huang_yixiang@bca.gov.sg

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Versions

http://bimsg.org/bim-guide/sbg/

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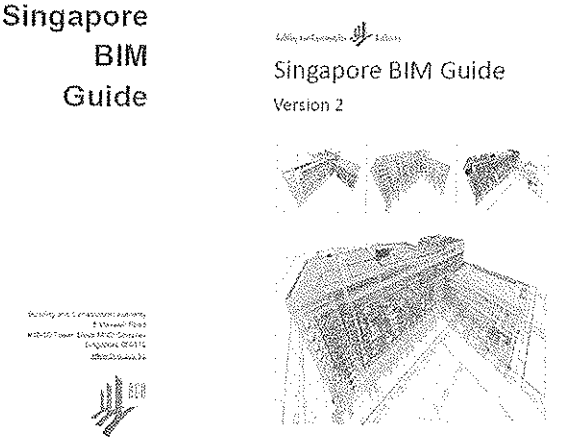
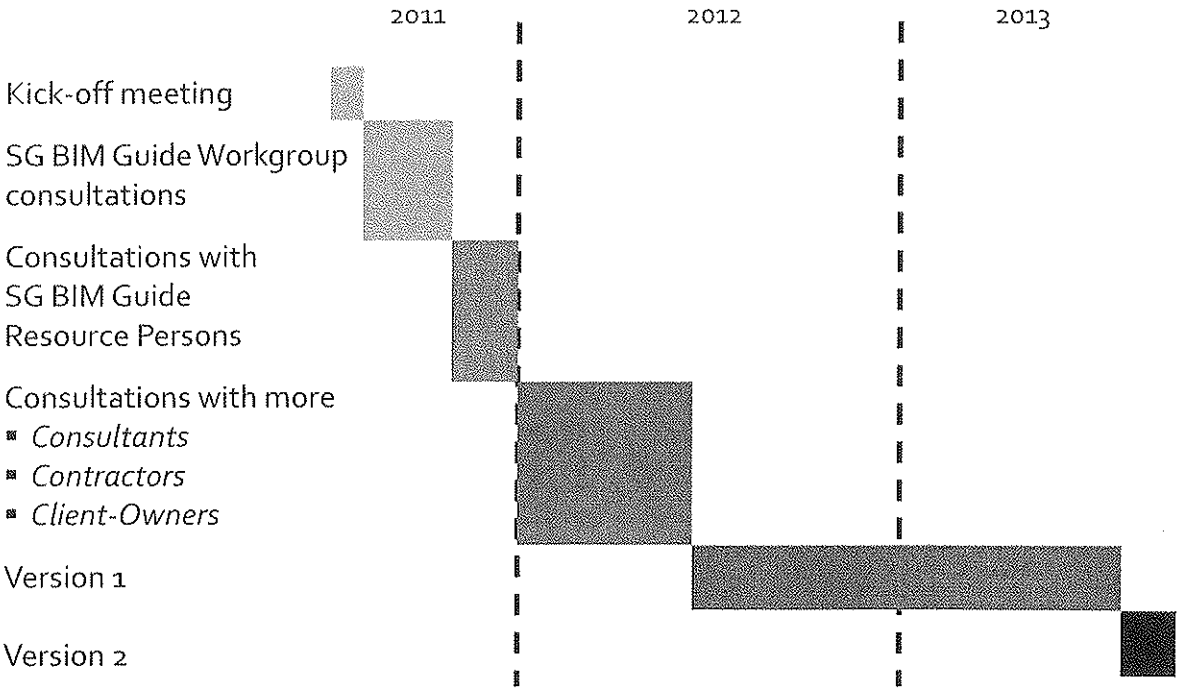


Version 1
(May 2012)

Version 2
(Aug 2013)

Timeline



Acknowledgements

AGENCIES

- BCA
- DSTA
- FSSD
- HDB
- JTC
- LTA
- MOE
- URA
- SLA

ASSOCIATIONS

- ACES
- BUILDINGSMART
- CITC
- IES
- REDAS
- SCAL
- SIA
- SISV

INDUSTRY

- 3PA INTERNATIONAL
- AECOM
- AEDAS
- ARUP
- ATA ARCHITECTS
- BECA
- CAPITALAND
- CEL DEVELOPMENT
- CDL
- CPG
- DCA ARCHITECTS
- DP ARCHITECTS
- GREATEARTH CONSTRUCTION
- HEXACON CONSTRUCTION
- KPK
- LS
- LSW CONSULTING
- LC & T BUILDER
- M & P CONSULTING
- METHOD ENGINEERING
- ONG & ONG
- PH CONSULTING
- P&T CONSULTANTS
- RDC ARCHITECTS
- RLB
- RODYK
- RSP
- SQUIRE MECH
- SIACAD
- SAA ARCHITECTS
- SEAGATE
- SHIMIZU
- TIONG SENG CONTRACTORS
- TSM CONSULTANCY
- T.Y. LIN
- WILLIAM LAU ARCHITECTS
- WING TAI
- WOH HUP
- XCUBE SOLUTIONS

1. Introduction

VERSION (1) 2012

VERSION (2) 2013

VERSION (2.1) 2015

1. Introduction

2. BIM Execution Plan

3. BIM Deliverables **"WHAT"**

"HOW"

4. BIM Modelling and Collaboration Procedures

5. BIM Professionals **"WHO"**

BCA ACADEMY

1. Introduction

2. BIM Execution Plan

3. BIM Deliverables **"WHAT"**

Appendix A *Typical BIM Elements by Discipline*

Appendix B *BIM Objective & Responsibility Matrix (Basic)*

"HOW"

4. BIM Modelling and Collaboration Procedures

Appendix C *BIM Modelling Guidelines*

5. BIM Professionals **"WHO"**

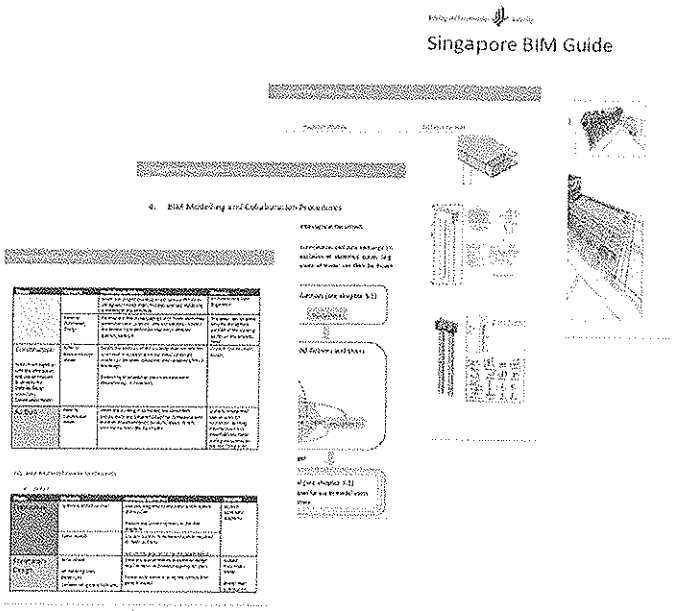
BCA ACADEMY
Building and Construction Authority

2. BIM Execution Plan

BIM Guide vs BIM Execution Plan

Reference guide on
how to make
everyone's BIM scopes work

Singapore BIM Guide
and other derivatives



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of the built environment

BIM Guide vs BIM Execution Plan

Reference guide on
how to make
everyone's BIM scopes work

Singapore BIM Guide
and other derivatives

REFERENCE TO

BIM Execution Plan

Action Plan to carry out
your BIM scope

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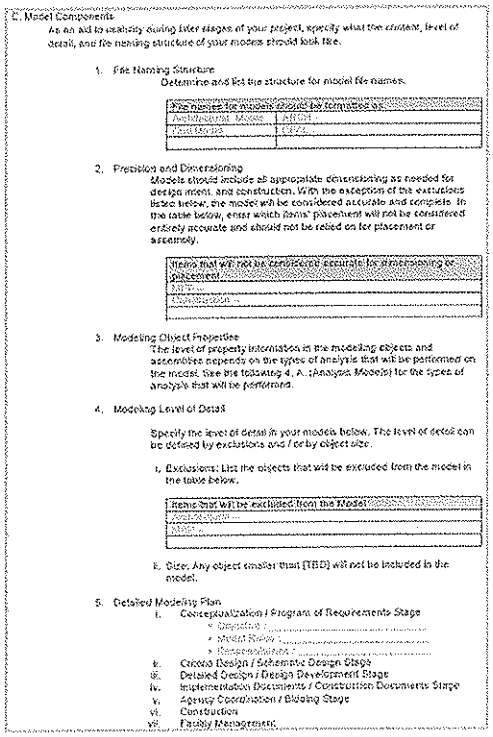
BIM Execution Plan



C. Model Components

As an aid to visibility during later stages of your project, specify what the content, level of detail, and file naming structure of your models should look like.

1. File Naming Structure

Determine and list the structure for model file names.

File names for models should be formatted as:	
Architectural Models	ARCH
Civil Models	CIVIL

2. Precision and Dimensioning

Models should include all appropriate dimensioning as needed for design intent and construction. With the exception of the exclusions listed below, the model will be considered accurate and complete. In the table below, enter which items' placement will not be considered entirely accurate and should not be relied on for placement or assembly.

Items that will not be considered accurate for dimensioning or placement
N/A
Contractor

3. Modeling Object Properties

The level of property information in the modeling objects and assemblies depends on the types of analysis that will be performed on the model. See the following 4. A. (Analysis Models) for the types of analysis that will be performed.

4. Modeling Level of Detail

Specify the level of detail in your models below. The level of detail can be defined by exclusions and / or by object size.

i. Exclusions: List the objects that will be excluded from the model in the table below.

Items that will be excluded from the Model
Contractor
MEP

ii. Size: Any object smaller than [TBD] will not be included in the model.

5. Detailed Modeling Plan

i. Conceptualization / Program of Requirements Stage
- Objective :
- Model Ratio :
- Representation :

ii. Criteria Design / Schematic Design Stage
iii. Detailed Design / Design Development Stage
iv. Implementation Documents / Construction Documents Stage
v. Agency Coordination / Bidding Stage
vi. Construction
vii. Facility Management

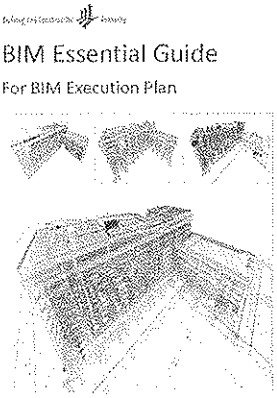
Action Plan to carry out your BIM scope

- Outlines overall vision and implementation details to execute a project through BIM
- To be updated during project
- Example contents:
  1. Modelling Plan
  2. Collaboration Plan
  3. Quality Assurance

BIM Essential Guide for BIM Execution Plan

http://bimsg.org/wp-content/uploads/2013/08/essential-guide-bep.pdf

- Step by step quick guide
- Templates
  1. BIM Execution Plan
  2. BIM Use Cases
- Appendices
  1. Typical BIM Elements by discipline
  2. BIM Modelling Guidelines



Version 1
(Aug 2013)

3. BIM Deliverables

Appendix A *Typical BIM Elements by Discipline*

Appendix B *BIM Objective & Responsibility Matrix (Basic)*

BIM Deliverables – Chapter 3 in SBG

- BIM Elements
- BIM Attributes
- BIM Objective & Responsibility Matrix
- Model Author & Model Users
- Other Additional Value-added BIM Services

Appendix A *Typical BIM Elements by Discipline*

Appendix B *BIM Objective & Responsibility Matrix (Basic)*

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BIM Deliverables

- Site model
- Massing model
- Architectural, structural, MEP models
  - For regulatory submissions
  - For coordination and / or clash detection analysis
  - For visualization
  - For cost estimation
- Schedule and phasing program (In BIM or spreadsheet)
- Construction and fabrication models
- Shopdrawings
- As-built model (in native proprietary or open formats)
- Data for facility management
- Other additional value-added BIM services

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BIM Deliverables

Attributes of BIM Elements

- The amount and quality of the information
- Geometric and non-geometric attributes

	Geometric attributes	Non-geometric attributes
Examples	• Size • Volume • Shape • Height • Orientation	• System data • Performance data • Regulatory compliance • Specifications • Cost

- The attributes will change at different project milestones
- Attributes should be determined to meet their intended usage to avoid over-specifying.

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BIM Deliverables

BIM vs 2D Practices

- 6 project stages
  - Conceptual Design
  - Schematic / Preliminary Design
  - Detailed Design
  - Construction
  - As-Built
  - Facility Management

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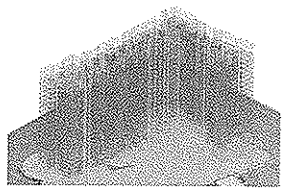
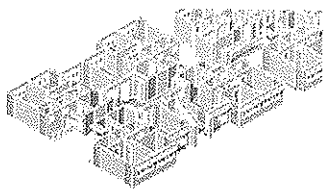
BIM Deliverables

Project Stages • Milestones	2D Drawing Scales	BIM Deliverables	
		General Level of Detail of each BIM Model Element / Assembly	Examples
Conceptual Design • Outline Planning Permission • Project feasibility	1:200 to 1:1000	Building massing studies or other forms of data representation with indicative dimensions, area, volume, location and orientation	Massing Model 
Schematic / Preliminary Design • Planning Approval • Design & Build Tender Documentation	1:200	Generalized building component or system with approximate dimensions, shape, location, orientation, and quantity. May include non-geometric properties.	Schematic Model 

Images courtesy of HDB

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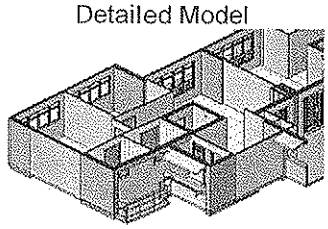
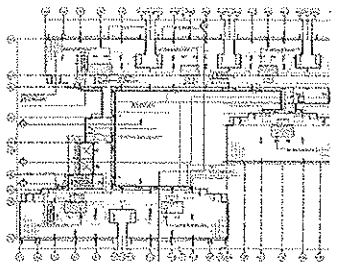
BIM Deliverables

Project Stages • Milestones	2D Drawing Scales	BIM Deliverables	
		General Level of Detail of each BIM Model Element / Assembly	Examples
Detailed Design • Building Plan Approval • Continued Design & Build Tender Documentation; or • Design-bid-build Tender Documentation	1:200	More detailed version of a generalized building component or system with accurate dimensions, shape, location, orientation and quantity. Non-geometric properties should be provided.	Detailed Model  Detailed Model generated from BIM 

Images courtesy of HDB

BIM Deliverables

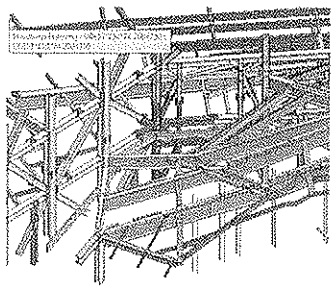
Project Stages • Milestones	2D Drawing Scales	BIM Deliverables	
		General Level of Detail of each BIM Model Element / Assembly	Examples
Construction • Constructability • Fabrication	1:5 – 1:100	BIM element is modeled with complete fabrication and assembly details over and above the Detailed Design stage where applicable or useful for construction works; otherwise, details may be represented in 2D CAD drawings to complement the Detailed Design stage level of detail.	Construction Model 

Image courtesy of Hexacon

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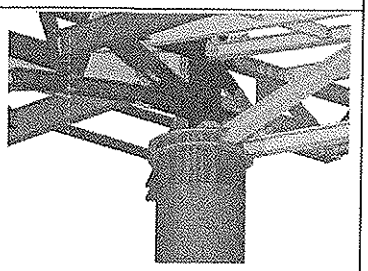
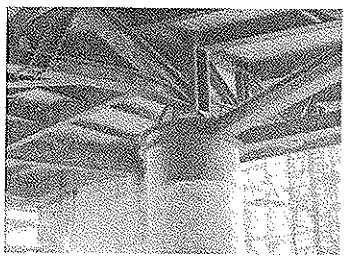
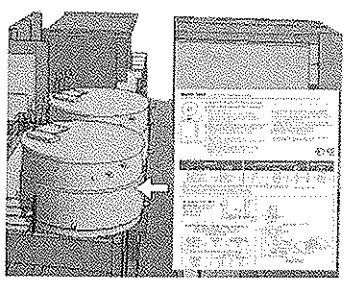
BIM Deliverables

Project Stages • Milestones	2D Drawing Scales	BIM Deliverables	
		General Level of Detail of each BIM Model Element / Assembly	Examples
As-Built • TOP / CSC • Final Completion	1:100	BIM element is similar in level of detail to the Detailed Design stage, but updated with changes during the Construction stage.	  Images courtesy of Hexacon

BIM Deliverables

Project Stages • Milestones	2D Drawing Scales	BIM Deliverables	
		General Level of Detail of each BIM Model Element / Assembly	Examples
Facility Management • O&M	1:50	BIM element is modeled as an actual constructed building component or system and is an as-built representation of the actual completed building.	Water storage tank element with attached specification PDF  Image courtesy of HDB

BIM Deliverables

■ BIM Objective and Responsibility Matrix

2 BIM Project Objective	3 Project members involved in fulfilling the objective A – model author; U – model users Arch	Struc	MEP	PM	Cont-ractor	4
Name of building stage: _____ *General description of BIM in this building stage:* *Example:* ***Detailed Design*** *More detailed version of a generalized building component or system with accurate dimensions, shape, location, orientation and quantity. Non-geometric properties should be provided.*						
BIM Project Objective: _____ BIM deliverable(s) to be achieved through this objective: *Example:* 13. Maintain and update the Structural Model, based on the latest Architectural Model ◦ Design, analysis and detailing ◦ In preparation for regulatory submission ◦ In preparation for tender 1 Suggested Deliverable Structural Model and Calculation	5 U	A	U	U	FOR REFER-ENCE ONLY	

L → R

BIM Deliverables

Project members involved in fulfilling the objective A – model author; U – model users						
Arc	Str	MEP	QS	Con	PM	Others

- Model Author:
  - Responsible for creation and maintenance of a specific model
  - Model author should perform quality control checks of their models
- Model Users:
  - All parties authorised to use the model on the project
  - In native or neutral (IFC) format
  - Use the model for reference only
  - Check, verify and otherwise confirm the accuracy of the model.
  - Where inconsistency is found in the model the model user shall promptly notify the model author for clarification

BIM Deliverables

- example

BIM Project Objective	BIM Manager	Project members involved in fulfilling the objective A – model author; U – model users						
		Arc	Str	MEP	QS	Con	FM	RS
- In preparation for regulatory submission - In preparation for tender Suggested Deliverable • Structural Model and Calculation		✓	✓ A					
14. Maintain and update the MEP Model, based on the latest Architectural Model - Design, analysis and detailing - In preparation for regulatory submission - In preparation for tender Suggested Deliverable • MEP Model and Analysis		✓		✓ A				
15. Apply for and obtain Building Plan Approval		✓	✓	✓				
16. Develop MEP cost estimates based on MEP model (optional)				NA	NA			

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BIM Deliverables

Other Additional Value-added BIM Services

- BIM-related digital analyses that allows better understand the performance of the building; or
- Typical services that are performed in earlier design stages due to BIM;
- etc..

- Owners should understand the potential cost implications of these value-added BIM services

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BIM Deliverables

- **Appendix A: Typical BIM Elements by Discipline defines expected contents of the model**

(VI) FIRE PROTECTION BIM ELEMENTS

Element	Elements or Parameters needed by each non-Fire Protection discipline
System piping, droppers, fittings, valves and sprinkler heads, sprinkler inlets, sprinkler control valve set, subsidiary valves, flow switches	
Pipe supports and brackets *	
Fire alarm gongs & break glass unit	
Fire sprinkler pumps	
Sprinkler tanks	
Hydrants and hose reels (location of street fire hydrant determined by architects)	
Gas piping for suppression systems	
Heat or smoke detectors, control panels, monitoring and control sensors, pump panels, check meter positions	
Fire extinguishers	
Fire shutters & hoods above	
Smoke Curtains	

* these elements may cause BIM models to become too big and unmanageable.

BIM Deliverables

- **Appendix B: BIM Objective & Responsibility Matrix (Basic)**

Appendix B – BIM Objective & Responsibility Matrix (Basic)

BIM Project Objective	BIM Manager	Project members involved in fulfilling the objective A – needs action; O – could assist							
		Arch	Str	M&E	PP	C&S	QS	Spec	Others
Conceptual Design *Building massing studies or other forms of data representation with indicative dimensions, area, volume, location and orientation*									
1. All project members appointed at this stage to agree on needs, objectives, process and outcomes of the project. Suggested Deliverable » BIM Execution Plan agreed and signed by related parties									

BIM Deliverables

- **A simplified version of Appendix B is found in the Essential Guide for BIM Execution Plan**

BIM Essential Guide - For BIM Execution Plan

Appendix A – BIM Use Case Template

BIM Use Cases	Author	Users
Conceptual Design Quality: Model with indicative dimensions, area, volume, location and orientation		
Essential: Create site BIM models for - Site Analysis - Apply an Outline Planning Permission if necessary Expected Deliverable • Site Model		

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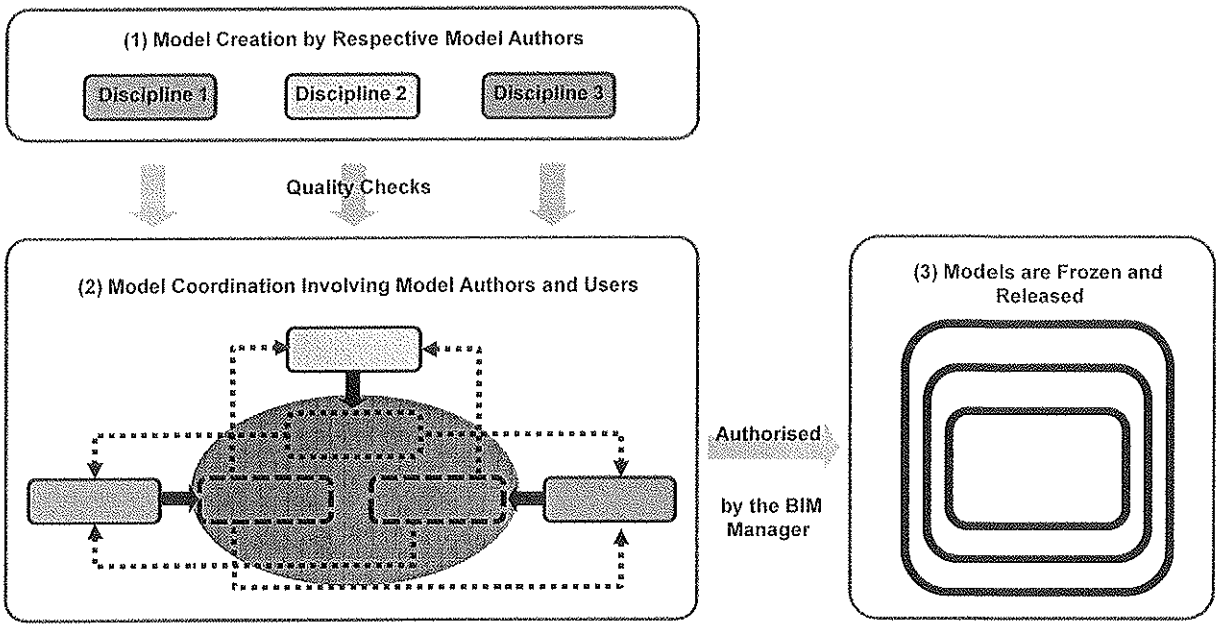
4. BIM Modelling and Collaboration Procedures

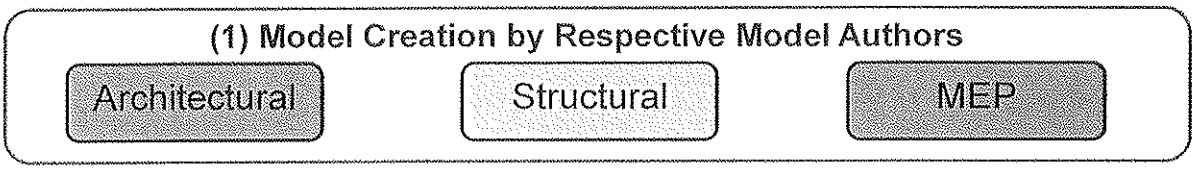
Appendix C BIM Modelling Guidelines

BIM Modelling and Collaboration Procedures

BIM Workflow (How to prepare model)

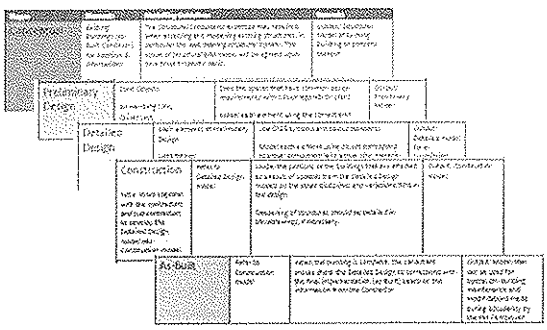


Individual Discipline Modelling



http://bimsg.wordpress.com/singapore-guide/e-submission/

Modelling Guidelines for BIM Elements (Appendix C)



Modelling Guidelines for Regulatory Submission



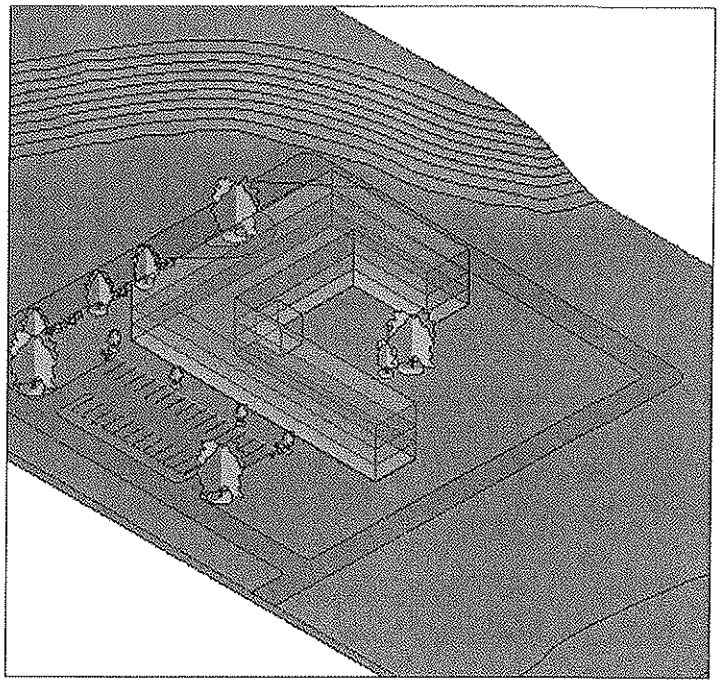
BIM Modelling Requirements

Conceptual Design

- BIM Execution Plan
- Site Model
- Massing Models

Output:

- Concept model



BIM Modelling Requirements

Conceptual Design

- Structural

Output:

- Structural Concept Alternatives

Conceptual Design

- MEP

Output:

- MEP Schematic diagram

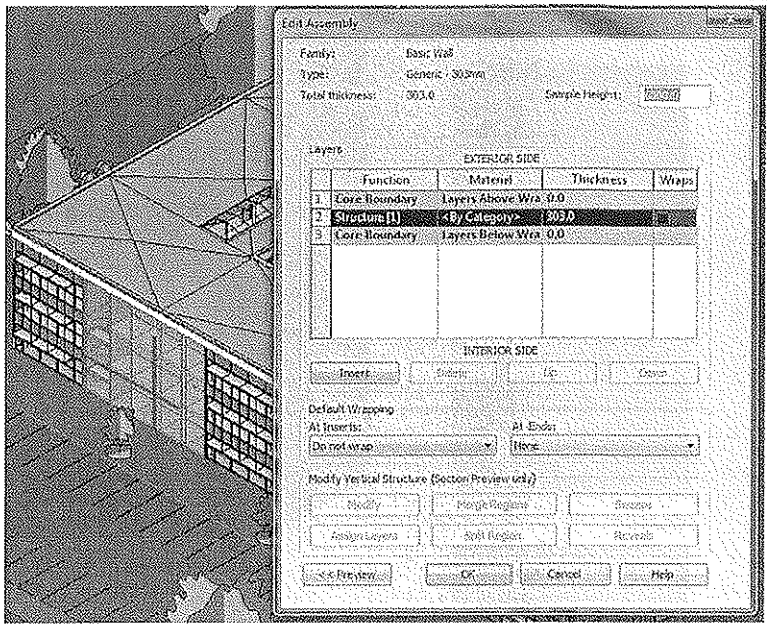
BIM Modelling Requirements

Schematic/ Preliminary Design

- Archi Model
- Struct Model
- Prelim Coordination (Archi + Struct)
- MEP Model
- Prelim Cost Estimate

Output:

- URA Submission
- Model for Coordination



Walls may be modelled without considering the different layers thickness

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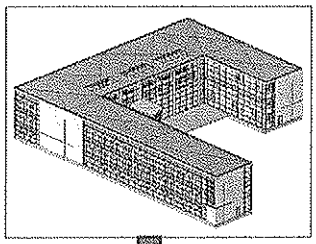
BIM Modelling Requirements

Schematic/ Preliminary Design

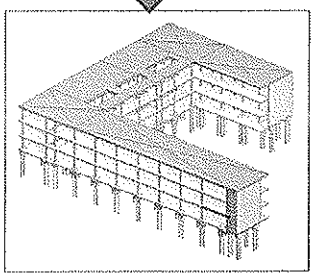
- Archi Model
- Struct Model
- Prelim Coordination (Archi + Struct)
- MEP Model
- Prelim Cost Estimate

Output:

- ST-BCA Submission
- Model for Coordination



Architectural Model



Structural Model

The location of load bearing elements and the elevation of the floor will be based on the info from the Architect.

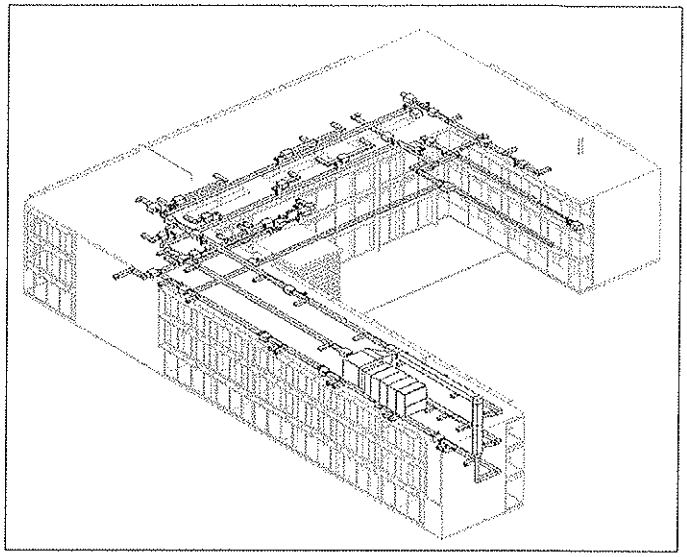
BIM Modelling Requirements

Schematic/ Preliminary Design

- Archi Model
- Struct Model
- Prelim Coordination (Archi + Struct)
- MEP Model
- Prelim Cost Estimate

Output:

- Prelim Model



Show only the main routes of the systems. No duct sizing.

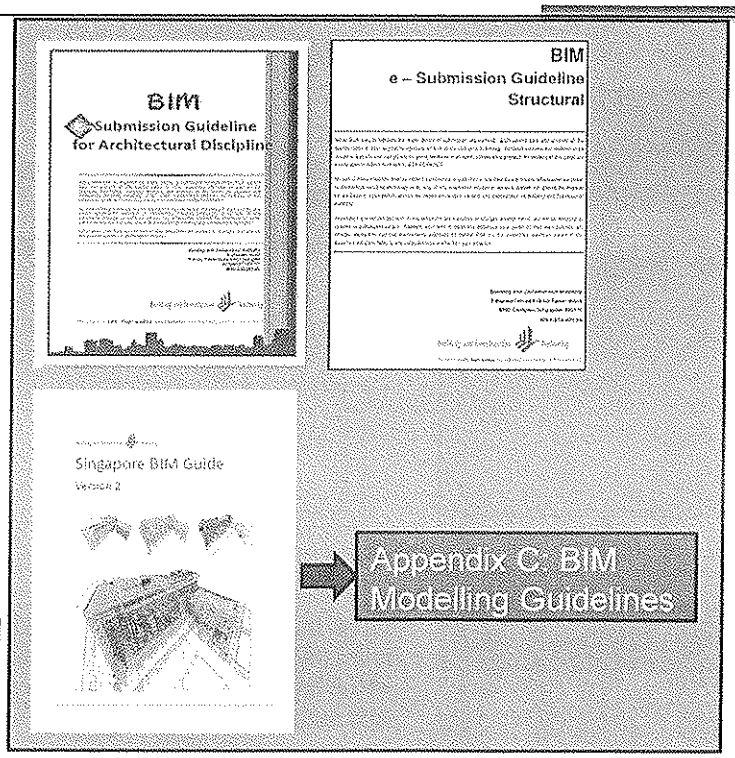
BIM Modelling Requirements

Schematic/ Preliminary Design

- Archi Model
- Struct Model
- Prelim Coordination (Archi + Struct)
- MEP Model
- Prelim Cost Estimate

Output:

- URA Submission
- ST Submission
- Model for Coordination



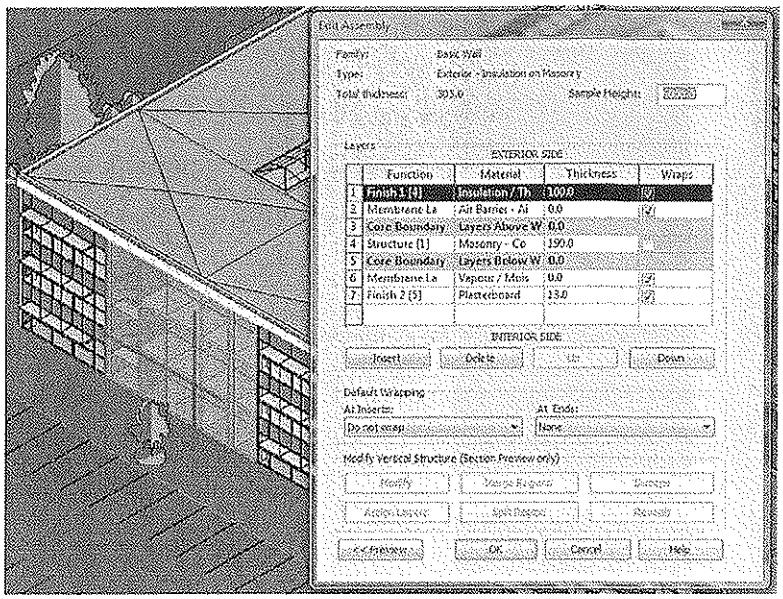
BIM Modelling Requirements

Detailed Design

- Archi Model
- Struct Model & Analysis
- MEP Model & Analysis
- MEP Cost Estimate
- Clash Detection (Archi / Struc + MEP)
- Spatial Validation Report
- Detailed Cost Estimate & BOQ

Output:

- BCA Submission
- Model for Coordination
- Tender Documents



Update the Walls created in the preliminary design with the parameters required for Detail Design, e.g. Add different Layer thickness, Fire Ratting, etc

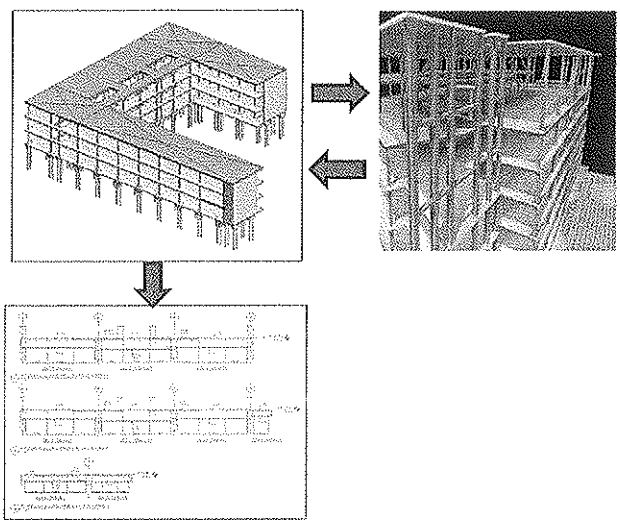
BIM Modelling Requirements

Detailed Design

- Archi Model
- Struct Model & Analysis
- MEP Model & Analysis
- Clash Detection (Archi / Struc + MEP)
- Spatial Validation Report
- Cost Estimate

Output:

- ST-BCA Submission
- Model for Coordination
- Tender Documents



Detail the Connections/Joints and Members based on the BIM authoring tool's capability. The details can be imported as 2D, which is generated automatically by design tools that can link with BIM authoring tool.

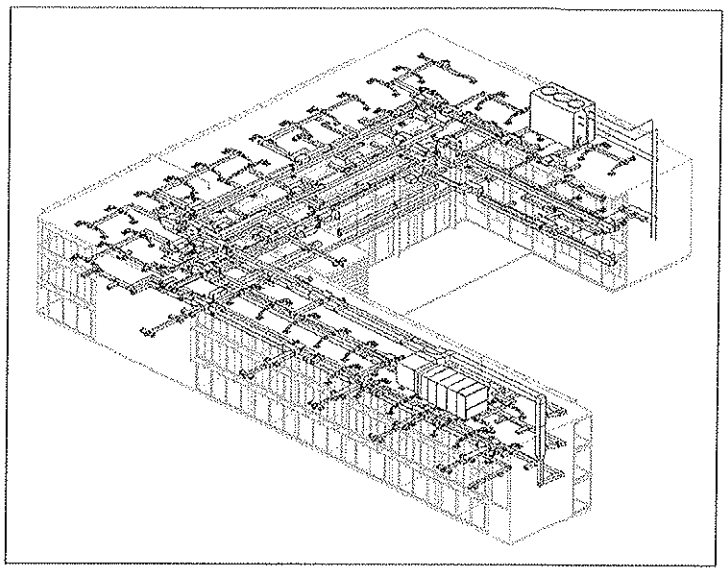
BIM Modelling Requirements

Detailed Design

- Archi Model
- Struct Model & Analysis
- MEP Model & Analysis
- Clash Detection (Archi / Struc + MEP)
- Spatial Validation Report
- Cost Estimate

Output:

- NEA-CPBU, PUB-WRN, PUB-WTR, FSSD, IDA-TFCC, CITYGAS Submission
- Model for Coordination
- Tender Documents



System routing should be connected with fittings, accessories, etc with correct sizing

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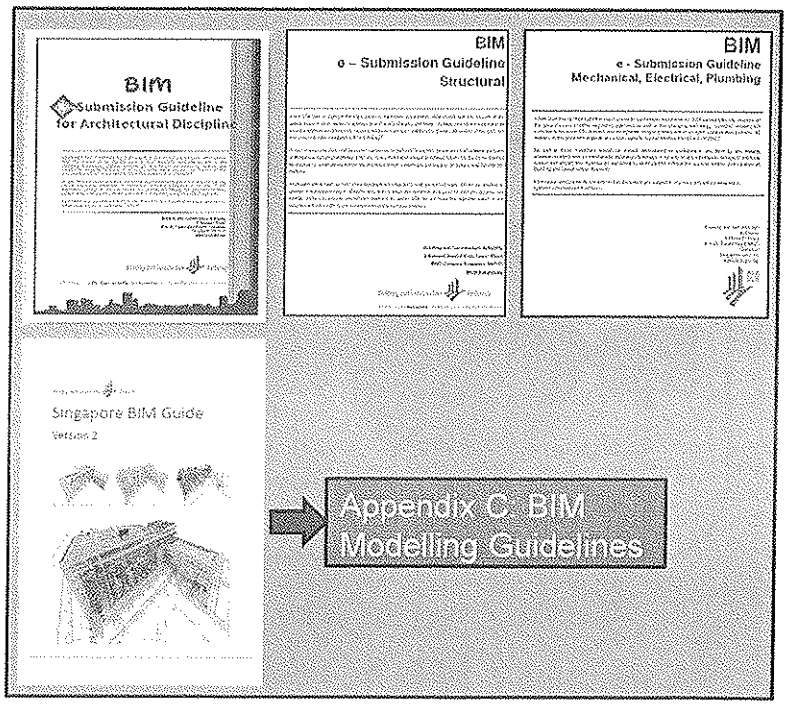
BIM Modelling Requirements

Detailed Design

- Archi Model
- Struct Model & Analysis
- MEP Model & Analysis
- Clash Detection (Archi / Struc + MEP)
- Spatial Validation Report
- Cost Estimate

Output:

- BCA Submission
- ST-BCA Submission
- NEA-CPBU, PUB-WRN, PUB-WTR, FSSD, IDA-TFCC, CITYGAS Submission
- Model for Coordination
- Tender Documents



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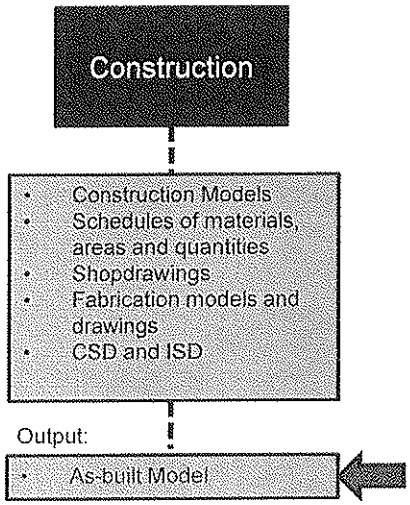
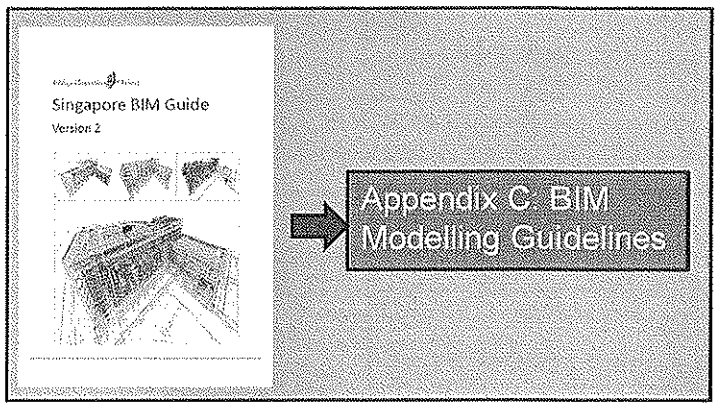
BIM Modelling Requirements

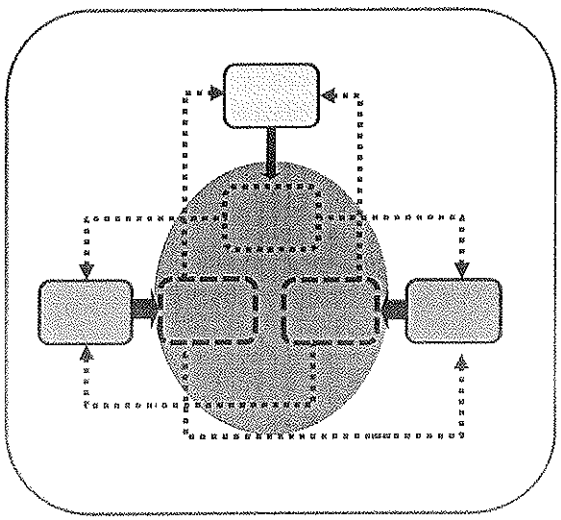


Model the portions of the buildings that are affected as a result of updates from the Detailed Design models by the other disciplines and variations/RFIs in the design.

When the building is complete, the architect must verify the Detailed Design to correspond with the final implementation (As-Built).



Cross-disciplinary Model Coordination



- Prior to sharing, the data should be checked, approved and validated as "fit for coordination"
- Discrepancies discovered during the coordination process should be recorded, managed, and communicated to relevant model owners through coordination reports, including any specific location of interferences and suggested resolutions

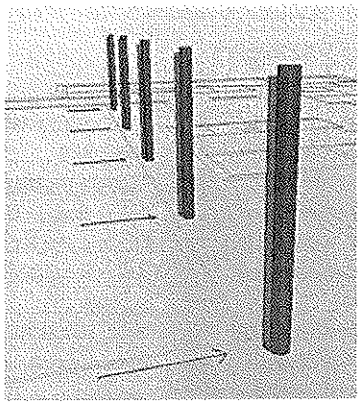
Quality Assurance (Appendix C in SBG)

Architectural Detailed Design BIM	Structural Detailed Design BIM	MEP Detailed Design BIM	Merged model at Preliminary Design, Detailed Design, Construction and As-Built stages
- BIM in agreed version - BIM includes defined stories - Building elements & spaces modelled separately in each story - BIM includes required building elements - Building elements modelled using correct objects - Building elements include types - No excess building elements - No overlapping or doubled building elements - No significant clashes between objects	- BIM in agreed version - BIM includes defined stories - Building elements defined separately in each story - BIM includes required building elements - Building elements modelled using correct objects - Building element types are as agreed - No excess building elements - No overlapping or doubled building elements - No significant clashes between objects	- BIM in agreed version - BIM includes defined stories - Components defined separately in each story - BIM includes required components - Components modelled using correct objects - Components belong to a correct system - System colours are defined systematically - System colours are defined systematically - No excess components - No overlapping or doubled components - No significant clashes between components	- All agreed models available - Models represent the same design version - Models are located in the correct coordinate system - No conflicts between vertical shafts and MEP systems - No conflicts between horizontal reservations and MEP - No conflicts between suspended ceilings and MEP

Quality Assurance (Appendix C in SBG)

Architectural Detailed Design BIM	Structural Detailed Design BIM	MEP Detailed Design BIM	Merged model at Preliminary Design, Detailed Design, Construction and As-Built stages
- No conflicts between structures in architectural and structural BIM - BIM includes GFA spaces objects - Space areas match space program - BIM includes spatial reservations for MEP - Space height defined (including suspended ceilings) - Shape and size of spaces matches with walls - Spaces do not overlap - All spaces have unique IDs	- No conflicts between structures in architectural and structural BIM - No conflicts between penetrations in architectural and structural BIM - Columns and beams converge - MEP penetrations & reservations included in structures	- No clashes between MEP disciplines - No clashes between M&E and electrical BIM - Components fit into their spatial reservations - No clashes between M&E, architectural and structural BIM	- Penetrations of columns OK - Penetrations of beams OK - Penetrations of slabs OK

Structural vs Architectural Model



Columns are located differently in Architectural design and Structural design

- Architectural and structural design should be checked to verify that load bearing walls, columns, beams, slabs, etc. are equally located in the two disciplines. Similarly it should be checked that openings like doors are similar in size and location
- Without this check you may get misleading issues like pipes interfering with columns in the structural design but not in the architectural design

Source: Spatial Coordination with Solibri Model Checker White Paper

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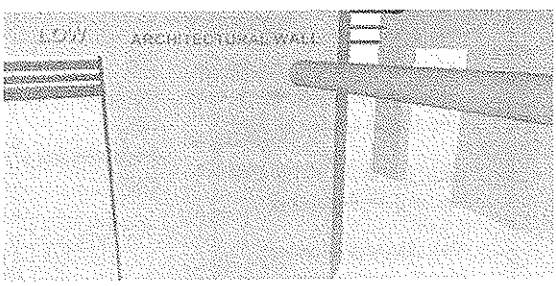
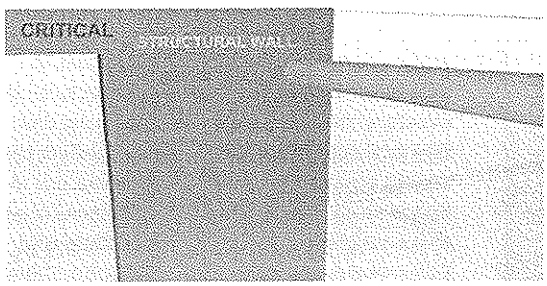
Structural/Architectural vs MEP Model





Severity of clashes: Same collision with an Architectural wall is LOW, but with a Structural wall it is CRITICAL

Source: Spatial Coordination with Solibri Model Checker White Paper

BIM Coordination/Clash Detection Process

- It is the Design/Construction Team's responsibility to conduct and manage an adequate and thorough Coordination/Clash Detection process so that all major coordination/interference issues between building components will have been detected and resolved before construction

- The BIM Manager shall assemble a composite model from all of the model parts of each design discipline for the purpose of performing a visual check of the building design for spatial and system coordination

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BIM Coordination/Clash Detection Process

- On a multi-story project, the models may need to be split on a level-by-level basis for MEPF coordination. If a floor is particularly large, it may also need to be split by zones to reduce file size. Typically, 3D coordination/clash detection continues on a single floor until building systems are fully coordinated, and then continues on the next floor up

- The team shall review the model and the clash reports in coordination meetings on a regular as-needed basis throughout the design phases until all system coordination issues have been resolved

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BIM Clash Detection Matrix (Example)

	A	S	MD	MP	MFP	...
A						
S	N.A					
MD	N.A	5				
MP	N.A	0	4			
MFP	N.A	2	0	1		
...						

BIM Spatial Coordination Requirement (Example)

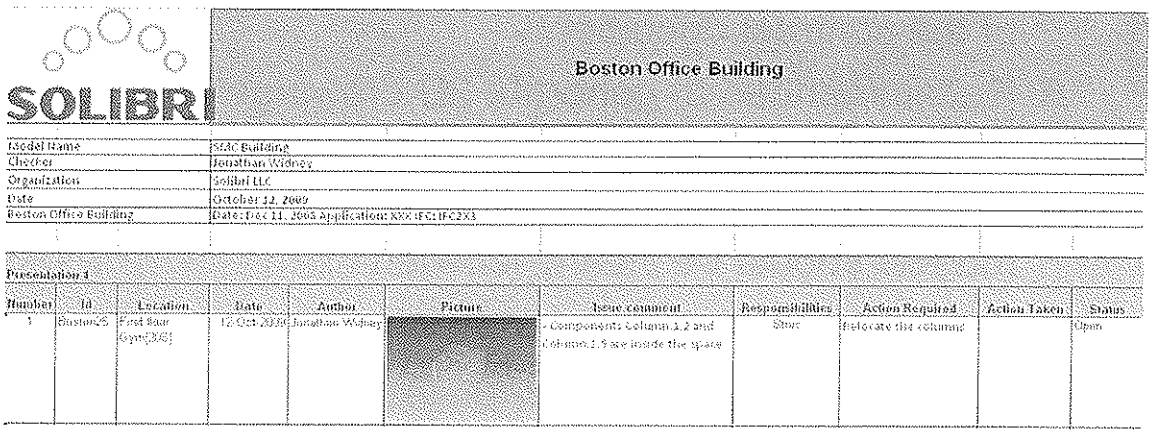
- **Architecture + Structural**: Below-grade spaces, proposed floor plates with major penetrations, floor-to-floor heights, beam clearances, ...
- **Architecture + MEPF**: Structural and space elements, flow and isolation requirements, proposed functional area configurations, floor-to-floor heights, ...
- **MEPF/HVAC + Architecture, Structure, and Telecommunications**: Main distribution and collection systems, configurations and sizes for piping, ...
- **Architecture + Life Safety Fire Protection**: Safe zone and fire suppression pipe location, ...
- **Architecture/HVAC + Interiors**: Merges shall include ductwork and piping + ceilings and Fixture, Furniture & Equipment + HVAC.

BIM Spatial Coordination Requirement (Example)

- **Space Validation**: There shall be no space gaps. Bounding boxes used to represent room and zone spaces shall match with architectural requirements and data values
- **General Model Quality Checking**: All walls shall be properly joined to prevent "space leaks" in areas defined by enclosing walls. Bounding boxes shall not conflict
- **Accessibility Compliance**: Wheelchair pathways and clearances + structure. (If using Solibri Model Checker or other rules-based model checking software, accessibility compliance can be checked automatically.)

Source: VA BIM Guide (http://www.cfm.va.gov/til/bim/bimguide/bmp.htm)

Sample of Spatial Coordination Report



SOLIBRI

Boston Office Building

Model Name	SAC Building
Checker	Jonathan Widney
Organization	Solibri LLC
Date	October 12, 2009
Boston Office Building	Date: Dec 11, 2005 Application: xxx IFC: IFC2X3

Presentation 1

Number	Id	Location	Date	Author	Picture	Issue comment	Responsibilities	Action Required	Action Taken	Status
1	Boston26	First floor Gym[2/6]	12 Oct 2009	Jonathan Widney		- Components Column 1.2 and Column 1.3 are inside the space	Steve	Relocate the columns		Open

Source: Spatial Coordination with Solibri Model Checker White Paper

Model & Documentation Production

Type of Project Deliverable	Current Practice	Transition Phase	Future Practice
• Contractual	• 2D Drawing	• 2D Drawing	• BIM
• Reference	–	• BIM	• 2D Drawing
• Project Handover	• 2D Drawing	• 2D Drawing + BIM	• BIM (native format) + BIM (IFC format)

The changing status of 2D drawings and BIM from current to future practice

Publishing 2D Drawings

- Agree on the standard for 2D drawings that form part of the contract documents
- Recommended to generate 2D drawings from the BIM model
- 2D drawings/details not produced from the BIM models should be clearly labelled

5. BIM Professionals

BIM Manager

ROLE	RESPONSIBILITIES IN MODEL MANAGEMENT
Project BIM Manager (This role can be played by the lead consultant or BIM specialist appointed by the employer or project manager)	Facilitate the definition and implementation of: • BIM Execution Plan (A) • BIM Goal and Uses (B) • Responsibility Matrix (C) • BIM Deliverables (D) • Delivery Schedules (E) • BIM Modelling Quality Control (F) • BIM Coordination (G)

- The BIM Manager's role does not include design, engineering and construction decisions for the project, nor organizational processes for each discipline

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BIM Coordinator

ROLE	RESPONSIBILITIES IN MODEL MANAGEMENT
BIM Coordinator for Consultant	At Design and Construction Stage • Create BIM Design Models and Documentation (a) • Define discipline-specific BIM uses including analysis (b) • Coordinate between BIM modellers, design consultants and cost consultant (c) • Coordinate with contractor and subcontractors (d) • Ensure Modelling Quality Control (e)

ROLE	RESPONSIBILITIES IN MODEL MANAGEMENT
BIM Coordinator for Contractor	At Construction Stage • Coordinate with design consultants and sub-contractors • Study tender documents • Review Design Models and Fabrication Models and Drawings • Use BIM for coordination, sequencing, constructability and cost studies, and field use • Create construction and as built models • Ensure Modelling Quality Control

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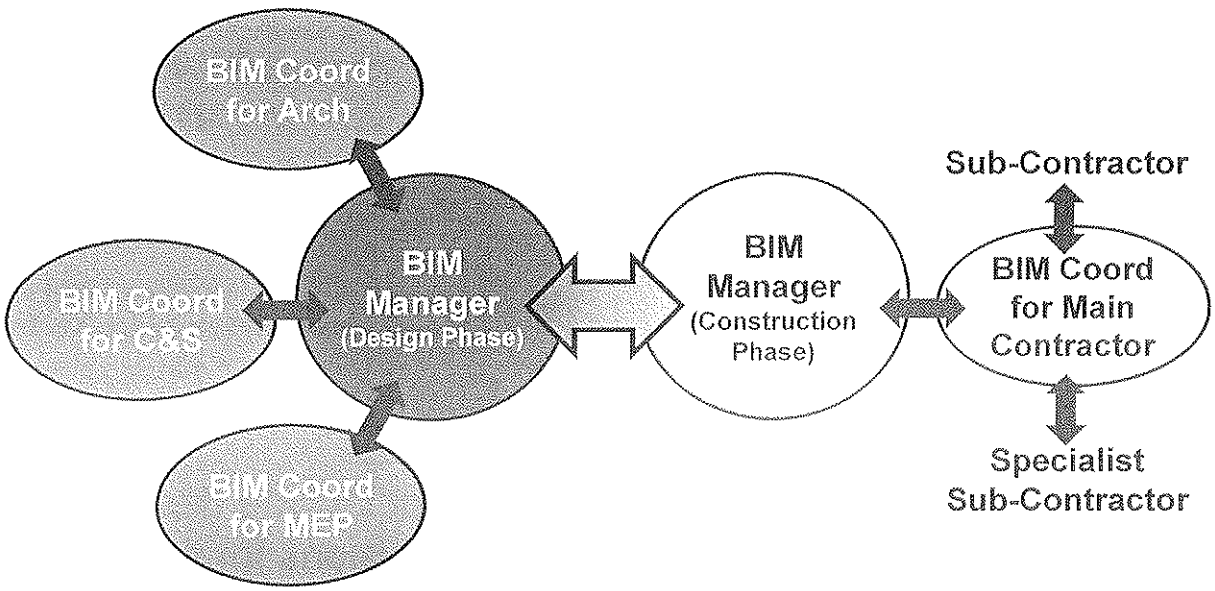
BIM Manager in a Project (example)



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Source: UK BIM Protocol
http://aecuk.files.wordpress.com/2012/09/aecukbimprotocol-v2-0.pdf

	Strategic						Management				Production	
Role	Corporate Objectives	Research	Process + Workflow	Standards	Implementation	Training	Execution Plan	Model Audit	Model Co-ordination	Content Creation	Modelling	Drawings Production
BIM Manager	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N
Coordinator	N	N	N	N	N	Y	Y	Y	Y	Y	Y	N
Modeller	N	N	N	N	N	N	N	N	N	Y	Y	Y

Fig. 1 Skills Matrix

* bimtaskgroup's website: bimtaskgroup.org (UK)
bimforum (USA)

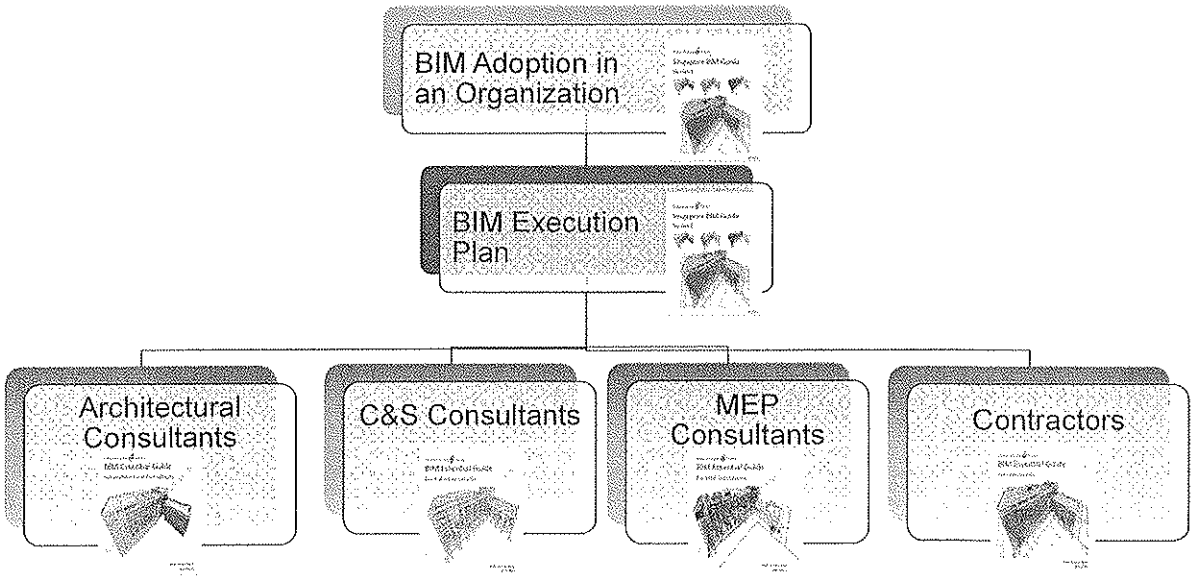
Further Reading – BIM Essential Guides

RELEASED IN 2013.

http://bimsg.wordpress.com/singapore-guide/essential-guides/

BIM Essential Guides

- Further reading and elaboration from the Singapore BIM Guide Version 2



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BIM Essential Guides

Essential Guide for BIM Adoption in an Organization

1. Get Management Support
2. Set up BIM Adoption Plan
   - ***WHO?*** Leaders to carry out BAP
   - ***WHAT?*** Documents to carry out BAP
   - ***HOW?*** Steps to carry out BAP
3. Training for different BIM roles

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BIM Essential Guides

Essential Guide for BIM Execution Plan

- Project Information
- Project Members
- Project Goals
- BIM Use Cases
- BIM Deliverables
- BIM Elements
- BIM Processes
- Technical Environment Needs

Bim Managers Forum

For Architectural Consultants
- Conceptual
- Schematic
- Detailed Design

For C&S Consultants
- Conceptual
- Schematic
- Structural Analysis
- Detailed Design

For MEP Consultants
- Conceptual
- Schematic
- Structural Analysis
- Detailed Design

For Contractors
- Tender
- Pre-Construction
- Construction

BIM Legal & Contractual Issues

Presented by :

Huang Yixiang
huang_yixiang@bca.gov.sg

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Starting on a BIM journey (project) …



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General guide > what to look out for in your BIM journey
> how to reach your BIM destination



provided that the client and the driver know where they want to go.

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Singapore BIM Guide

General guide > what to look out for in your BIM journey
> how to reach your BIM destination

BIM legal / contractual clauses

* Rules of engagement to carry out a BIM project

(with reference to specific documents)

provided that the client and the driver know where they want to go.

BIM Execution Plan

What kind of BIM legal issues could arise?

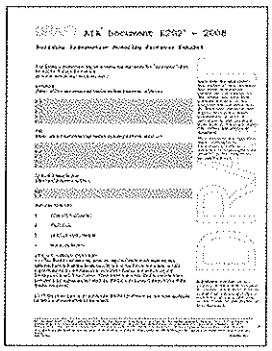
- Increased expectations in accuracy
  (e.g. failure to avoid clashes = negligence of QP?)
- Over-reliance in BIM software
  (e.g. undiscovered error in cost analysis software = responsibility of software user or software vendor?)
- Meeting wrong expectations of another project party or client
- Overlap of responsibilities, misunderstanding of new responsibilities during use of BIM

... etc

Overseas BIM legal references

- In UK
  - Strategy Paper for the Government Construction Client Group From the BIM Industry Working Group – March 2011
    - Little change is required for copyright law, contracts & insurance but potential source of inertia holding back adoption of BIM on projects.
    - Clients can incorporate a simple amendment to existing contract while define a separate BIM protocols to set out their requirements in project delivery and output terms. The protocol should set out the new duties and methods to facilitate collaboration.
    - The use of a BIM protocol outside of the contract means that a graduated approach to increasing the extent of BIM utilisation can be adopted in a phased approach without the need to redraft the contract.

Overseas BIM legal references

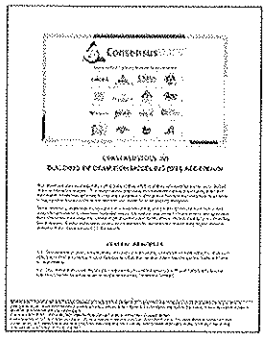


American Institute of Architects

AIA E202-2008 "BIM Exhibit"

ConsensusDOCS

CDOCS 301 "BIM Addendum"



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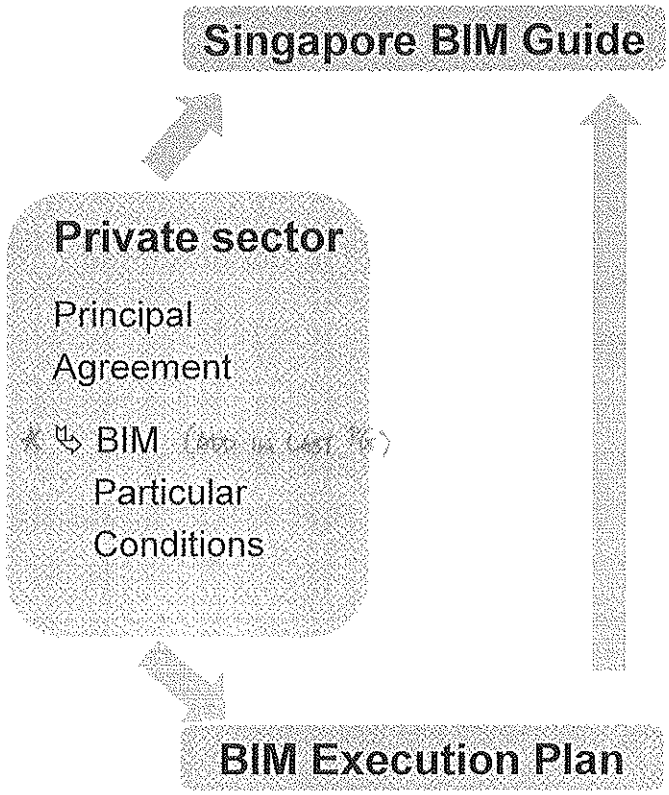
Building and Construction Authority

Overseas BIM legal references

In US:

Building Information Modeling (BIM): Variations, Risks and Risk Management

#	ISSUE	AIA E202	ConsensusDOCS 301
1	Use	• Three (3) variants, depending on project delivery system ◦ Traditional AIA phasing (SD/DD/CD) ◦ IPD phasing (see IPD spreadsheet) ◦ Custom/no phasing • Use with standard AIA form agreements • In the event of conflict, E202 trumps form agreement(s)	• Use with standard ConsensusDOCS form agreements • In the event of conflict, CD301 trumps form agreement(s)
2	Scope	• Purports to establish protocols, expected levels of design development, and assign responsibilities for developing Model elements	• Purports not to be intended to re-structure contractual relations or re-allocate risks
3	Protocols	• (Nothing comparable to BIM Execution Plan) • Protocol: anyone discovering Model conflict should notify Model Element Author	• BIM Execution Plan ◦ executed by all participants ◦ lists 'rules of [BIM] engagement' on multiple issues
4	Design Responsibility	• Does architect implicitly retain 'responsible control'?	• Designer effectively retains 'responsible control' of design
5	Model Elements	• Identifies multiple, detailed Model Elements in accordance with CSI UniFormat classification system (Table)	• Lists Model variants • Does not list Model elements, but defines 'Contribution' as the expression, design, data or information used in Model
6	Model Manager	• not designated • addresses file storage location, transfer processes, clash detection, collection of incoming Models, detailed Model archive requirements, back-up and maintenance, management of access rights	• Designer (receives additional compensation) • addresses file storage location, transfer processes, clash detection, collection of incoming Models, Model archives, back-up and maintenance, management of access rights
7	Model Reliance	• 'Level of Development' ("LOD"); one (1) five (5) objective designations (i.e., LOD100 – LOD500) selected by Model Element Author which specifies Model content requirements and authorized uses; used in matrix with CSI UniFormat classifications • Reliance by other/subsequent Authors and Model Users restricted to LOD level authorizations	• 'Contributor's Dimensional Accuracy Representation' ("CDAR"); subjective Model-specific at time of posting as specified by Contributor



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Incorporation into Contract

- Last 2 pages: How to incorporate the BIM Particular Conditions into the following local standard forms:
  - REDAS Design and Build Conditions of Contract
  - SCAL Standard Agreement for Appointment of Consultants
  - SIA Contract
  - SIA Sub-Contract
  - SIA Conditions of Appointment (for Architect)
  - Association of Consulting Engineers Singapore Agreement

☑ **double-check with the association for updates**

Incorporation into Contract

For the BIM Particular Conditions to apply in a project, the parties must ensure that the BIM Particular Conditions is incorporated as a contract document in the Principal Agreements. This can be done in a variety of ways. Suggestions for the more common local standard forms of contract are set out below.

a. REDAS Design and Build Conditions of Contract

To insert as one of the documents in Appendix 4:

Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force.

For the purposes of Clause 1.2, if it is intended that another guide for BIM be used, then, to insert as one of the documents in Appendix 4:

Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force. For the purpose of Clause 1.2 of the BIM Particular Conditions, the BIM Guide shall be [name of the guide].

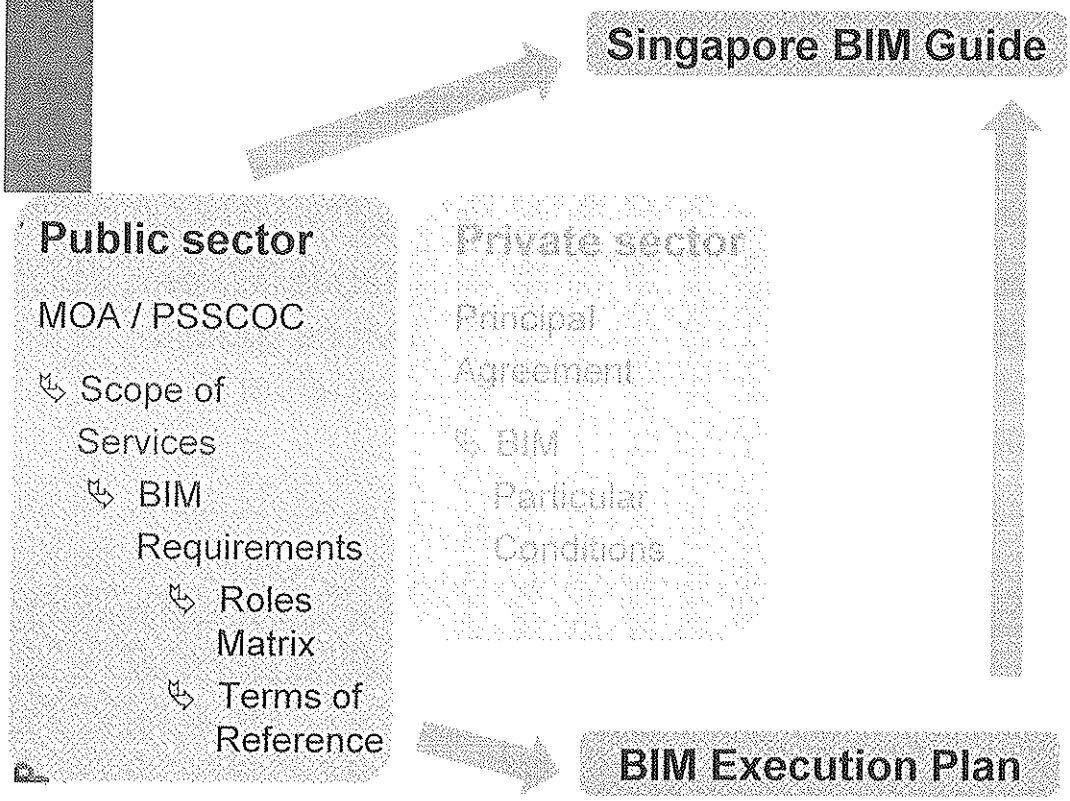
b. SCAL Conditions of Sub-Contract

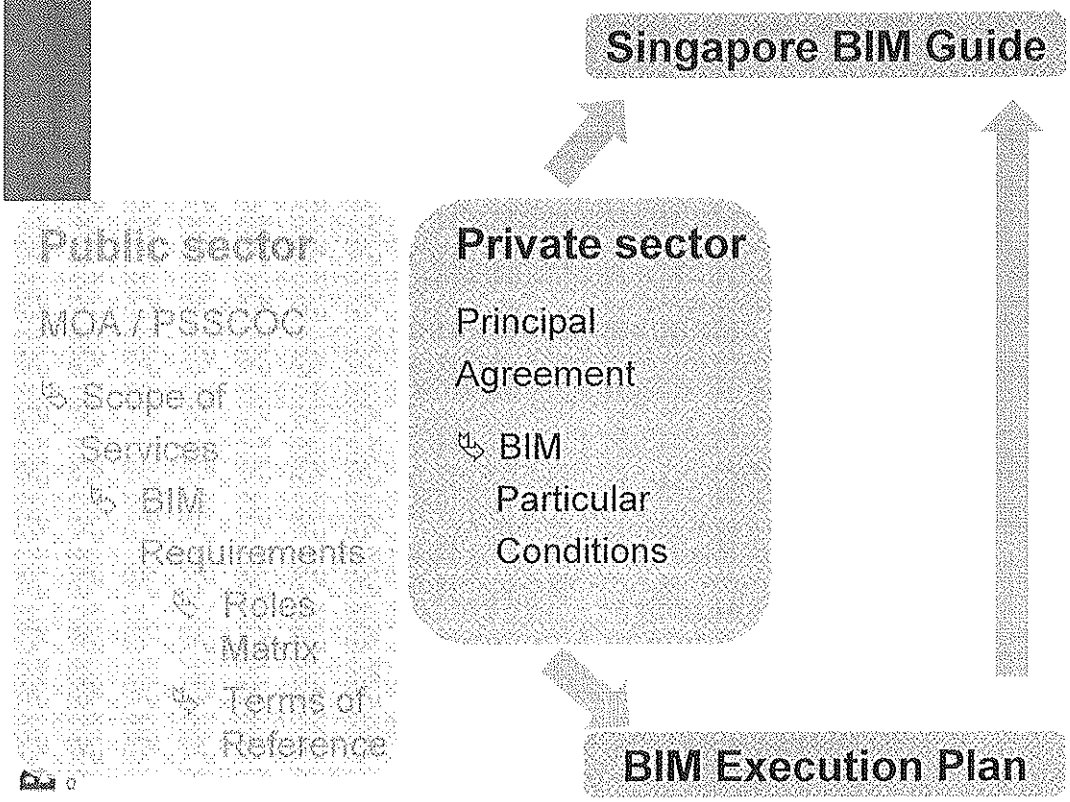
To amend Clause 4 by adding a new Clause 4(j) as follows:

(j) Schedule 10: Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force.

For the purposes of Clause 1.2, if it is intended that another guide for BIM be used, then, to amend Clause 4 by adding a new Clause 4(j) as follows:

(j) Schedule 10: Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force. For the purpose of Clause 1.2 of the BIM Particular Conditions, the BIM Guide shall be [name of the guide].



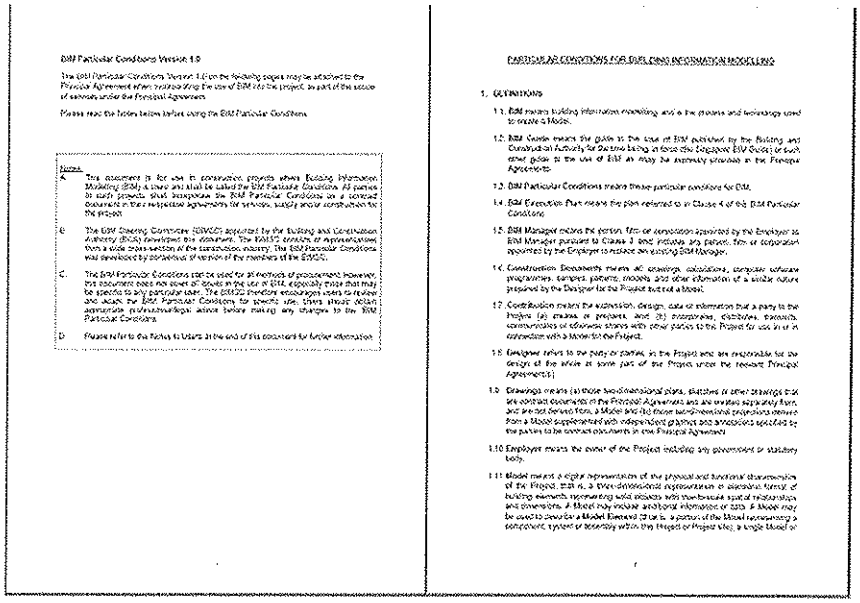


Note for Public/Private Sector

- The following slides highlight clauses in the original BIM Conditions.
- Some of the clauses in the following slides will be revised or omitted in the scope of services (public sector contracts) or in the Principal Agreement (private sector contracts).

BIM Particular Conditions Version 1

http://bimsg.org/bim-guide/sbg/



BIM Particular Conditions Version 1.0

The BIM Particular Conditions Version 1.0 on the following pages may be attached to the Principal Agreement when contracting for the use of BIM on the Project, as part of the scope of services under the Principal Agreement.

Please read the Notes below before using the BIM Particular Conditions.

Notes:

A. This document is for use in construction projects where Building Information Modelling (BIM) is used and shall be called the BIM Particular Conditions. All parties to such projects shall incorporate the BIM Particular Conditions as a contract document in their respective agreements for services, supply and/or construction for the Project.

B. The BIM Steering Committee (BIMSC) appointed by the Building and Construction Authority (BCA) developed this document. The BIMSC consists of representatives from a wide cross-section of the construction industry. The BIM Particular Conditions was developed by consensus of members of the BIMSC.

C. The BIM Particular Conditions can be used for all methods of procurement. However, this document does not cover all issues in the use of BIM, especially those that may be specific to any particular case. The BIMSC therefore encourages users to review and adapt the BIM Particular Conditions for specific use. Users should obtain appropriate professional/legal advice before making any changes to the BIM Particular Conditions.

D. Please refer to the Notes to Users at the end of this document for further information.

PARTICULAR CONDITIONS FOR BUILDING INFORMATION MODELLING

1. DEFINITIONS

1.1. BIM means building information modelling, and is the process and technology used to create a Model.

1.2. BIM Guide means the guide to the use of BIM published by the Building and Construction Authority for the time being in force (the Singapore BIM Guide) or such other guide to the use of BIM as may be expressly provided in the Principal Agreements.

1.3. BIM Particular Conditions means these particular conditions for BIM.

1.4. BIM Execution Plan means the plan referred to in Clause 4 of the BIM Particular Conditions.

1.5. BIM Manager means the person, firm or corporation appointed by the Employer as BIM Manager pursuant to Clause 3 and includes any person, firm or corporation appointed by the Employer to replace any existing BIM Manager.

1.6. Construction Documents means all drawings, calculations, computer software programmes, samples, patterns, models and other information of a similar nature prepared by the Designer for the Project but not a Model.

1.7. Contribution means the submission, design, data or information that a party to the Project (a) creates or prepares, and (b) incorporates, distributes, transmits, communicates or otherwise shares with other parties to the Project for use in or in connection with a Model for the Project.

1.8. Designer refers to the party or parties in the Project who are responsible for the design of the whole or some part of the Project under the relevant Principal Agreement(s).

1.9. Drawings means (a) those two-dimensional plans, elevations or other drawings that are contract documents of the Principal Agreements and are created separately from, and are not derived from, a Model; and (b) those two-dimensional projections derived from a Model supplemented with independent graphics and annotations specified by the parties to be contract documents in the Principal Agreement.

1.10 Employer means the owner of the Project including any government or statutory body.

1.11 Model means a digital representation of the physical and functional characteristics of the Project. Each is a three-dimensional representation or electronic format of building elements incorporating solid objects with their precise spatial relationships and dimensions. A Model may include additional information or data. A Model may be used to describe a Model Element (if it is a portion of the Model representing a component, system or assembly within the Project or Project Site), a single Model or

Version 1
(May 2012)

Content

BIM Particular Conditions

MAIN CLAUSES:-

- *Notes, Definitions*
- *General Principles*
- *BIM Management*
- *BIM Execution Plan*
- *Risk Allocation and IP*

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BIM Particular Conditions

Main Clauses

- Notes, Definitions
- General Principles
- BIM Management
- BIM Execution Plan
- Risk Allocation and IP

- Who will use the Conditions?
- Can we change the Conditions?
- How to attach the Conditions to my contract?

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Notes

BIM Particular Conditions Version 1.0

- The BIM Particular Conditions Version 1.0 on the following pages may be attached to the Principal Agreement when incorporating the use of BIM into the project, as part of the scope of services under the Principal Agreement.
- Please read the Notes below before using the BIM Particular Conditions.

Notes:

A. This document is for use in construction projects where Building Information Modelling (BIM) is used and shall be called the BIM Particular Conditions. All parties in such projects shall incorporate the BIM Particular Conditions as a contract document in their respective agreements for services, supply and/or construction for the project.

B. The BIM Steering Committee (BIMSC) appointed by the Building and Construction Authority (BCA) developed this document. The BIMSC consists of representatives from a wide cross-section of the construction industry. The BIM Particular Conditions was developed by consensus of opinion of the members of the BIMSC.

C. The BIM Particular Conditions can be used for all methods of procurement. However, this document does not cover all issues in the use of BIM; especially those that may be specific to any particular user. The BIMSC therefore encourages users to review and adapt the BIM Particular Conditions for specific use. Users should obtain appropriate professional/legal advice before making any changes to the BIM Particular Conditions.

D. Please refer to the Notes to Users at the end of this document for further information.

Notes

Notes to Users:

1. Clause 1.2 defines the BIM Guide as either the Singapore BIM Guide published by BCA or such other guide as may be expressly provided in the Principal Agreements. If the user intends to use any other guide for a project, then it is absolutely critical that this be stated in the Principal Agreements (see next paragraph for a suggestion on how this can be done)

2. For the BIM Particular Conditions to apply in a project, the parties must ensure that the BIM Particular Conditions is incorporated as a contract document in the Principal Agreements. This can be done in a variety of ways. Suggestions for the more common local standard forms of contract are set out below.

   a. REDAS Design and Build Conditions of Contract

   To insert as one of the documents in Appendix 4:
   Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force.
   For the purposes of Clause 1.2, if it is intended that another guide for BIM be used, then, to insert as one of the documents in Appendix 4:
   Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force. For the purpose of Clause 1.2 of the BIM Particular Conditions, the BIM Guide shall be [name of the guide].

   b. SCAL Conditions of Sub-Contract

   To amend Clause 4 by adding a new Clause 4(j) as follows:
   (j) Schedule 10: Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force.
   For the purposes of Clause 1.2, if it is intended that another guide for BIM be used, then, to amend Clause 4 by adding a new Clause 4(j) as follows:
   (j) Schedule 10: Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force. For the purpose of Clause 1.2 of the BIM Particular Conditions, the BIM Guide shall be [name of the guide].

   c. SCAL Standard Agreement for Appointment of Consultants

   To insert as one of the documents in Appendix C:
   The Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force shall apply for use of building information modelling.
   For the purposes of Clause 1.2, if it is intended that another guide for BIM be used, then, to insert as one of the documents in Part 1 of the Schedule:
   The Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force shall apply for use of building information modelling. For the purpose of Clause 1.2 of the BIM Particular Conditions, the BIM Guide shall be [name of the guide].

   d. SIA Contract

   To amend Article 6 of the Articles of Contract by adding a new Article 6(g) as follows:
   (g) Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force.
   For the purposes of Clause 1.2, if it is intended that another guide for BIM be used, then, to amend Article 6 by adding a new Article Clause 6(g) as follows:
   (g) Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force. For the purpose of Clause 1.2 of the BIM Particular Conditions, the BIM Guide shall be [name of the guide].

   For the purposes of Clause 1.2, if it is intended that another guide for BIM be used, then, to insert as one of the documents in Part 1 of the Schedule:
   Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force. For the purpose of Clause 1.2 of the BIM Particular Conditions, the BIM Guide shall be [name of the guide].

   f. SIA Conditions of Appointment (for Architect)

   To amend the Conditions of Appointment by adding a new Clause 1.1(11) as follows:
   (11) Building Information Modelling
   The Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force shall apply for use of building information modelling.
   For the purposes of Clause 1.2, if it is intended that another guide for BIM be used, then, to amend the Conditions of Appointment by adding a new Clause 1.1(11) as follows:
   (11) Building Information Modelling
   The Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force shall apply for use of building information modelling. For the purpose of Clause 1.2 of the BIM Particular Conditions, the BIM Guide shall be [name of the guide].

   g. Association of Consulting Engineers Singapore Agreement

   To insert at Clause 1.1.1(i) of the Specific Provisions:
   Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force.
   For the purposes of Clause 1.2, if it is intended that another guide for BIM be used, then, to insert at Clause 1.1.1(i) of the Specific Provisions:
   Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force. For the purpose of Clause 1.2 of the BIM Particular Conditions, the BIM Guide shall be [name of the guide].

☑ double-check with the association

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[often asked questions]

BIM Particular Conditions

- *Notes, Definitions*
- *General Principles*
- *BIM Management*
- *BIM Execution Plan*
- *Risk Allocation and IP*

Popular words

"Contribution"

"Drawings"

"Model"

"Model Author"

"Model User"

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Definitions

1.2. BIM Guide means the guide to the use of BIM published by the Building and Construction Authority for the time being in force (the Singapore BIM Guide) or such other guide to the use of BIM as may be expressly provided in the Principal Agreements.

1.3. BIM Particular Conditions means these particular conditions for BIM.

1.4. BIM Execution Plan means the plan referred to in Clause 4 of this BIM Particular Conditions.

1.5. BIM Manager means the person, firm or corporation appointed by the Employer as BIM Manager pursuant to Clause 3 and includes any person, firm or corporation appointed by the Employer to replace an existing BIM Manager.

1.6. Construction Documents means all drawings, calculations, computer software programmes, samples, patterns, models and other information of a similar nature prepared by the Designer for the Project but not a Model.

1.7. Contribution means the expression, design, data or information that a party to the Project (a) creates or prepares, and (b) incorporates, distributes, transmits, communicates or otherwise shares with other parties to the Project for use in or in connection with a Model for the Project.

1.8. Designer refers to the party or parties in the Project who are responsible for the design of the whole or some part of the Project under the relevant Principal Agreement(s).

1.9. Drawings means (a) those two-dimensional plans, sketches or other drawings that are contract documents in the Principal Agreement and are created separately from, and are not derived from, a Model and (b) those two-dimensional projections derived from a Model supplemented with independent graphics and annotations specified by the parties to be contract documents in the Principal Agreement.

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Definitions

1.12. Final Design Model means a Model of those aspects of the Project that are (a) to be modelled as specified in the BIM Execution Plan and (b) have reached the stage of completion that would customarily be expressed in two-dimensional construction documents. This shall not include analytical evaluations, preliminary designs, studies, or renderings. A Model prepared by a Designer that has not reached the stage of completion specified in this definition is referred to as a Model.

1.13. Model Author means the party responsible for developing the content of a specific Model Element to the level of detail required for a particular phase of the Project. Model Authors are identified in the Model Element Table in the BIM Execution Plan.

1.14. Model User means any individual or entity authorised to use the Model on the Project, such as for analysis, estimating or scheduling.

1.15. Principal Agreement in relation to any party in the Project means the agreement for services, supply and/or construction which that party has entered into for the Project.

1.16. Project means the project in which the parties will be carrying out BIM pursuant to their respective Principal Agreements.

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Building environment

BIM Particular Conditions

- *Notes, Definitions*
- *General Principles*
- *BIM Management*
- *BIM Execution Plan*
- *Risk Allocation and IP*

- *Will the BIM PC override my current:*

- terms of contract?

- liabilities?

- practice..?

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Building environment

General Principles

2. GENERAL PRINCIPLES

2.1. The parties to a Project shall incorporate the BIM Particular Conditions into all agreements for services, supply and/or construction where at least one party shall be required to be involved in carrying out BIM. This BIM Particular Conditions shall be passed downstream to subconsultants, suppliers and subcontractors, as applicable.

2.2. The BIM Particular Conditions does not change any contractual relationships or shifts any risks of the parties in a Project as provided in the Principal Agreements. In particular:

2.2.1. Nothing in this BIM Particular Conditions shall relieve a Designer from its obligation, nor diminish the role of the Designer, as the person responsible for and in charge of the design of the Project or any part of the Project.

2.2.2. Where under applicable law or in contract, the Employer warrants to any party the adequacy and/or sufficiency of design, nothing in this BIM Particular Conditions shall diminish the extent to which the Employer warrants to any party the adequacy and/or sufficiency of design.

2.2.3. Participation of a contractor or its subcontractors and suppliers in carrying out BIM shall not constitute performance of design services unless in the Project, the contractor or its subcontractors and suppliers had assumed design responsibility under their respective Principal Agreements.

2.2.4. In the event of any inconsistency between a Model and any Drawings, the Drawings shall prevail.

2.3. In the event of any inconsistency between the BIM Particular Conditions and the applicable Principal Agreement, the BIM Particular Conditions shall prevail.

2.4. As regards the Models produced in BIM:

2.4.1. A Final Design Model is not intended to provide the level of detail needed in order to extract precise materials or object quantities, unless the parties agree in the BIM Execution Plan otherwise.

2.4.2. The dimensional tolerances provided in the Principal Agreement shall apply to the dimensions in a Model, unless the parties agree in the BIM Execution Plan otherwise.

2.4.3. If there is a conflict between a Final Design Model and any other Model, the Final Design Model shall prevail.

2.4.4. If any party to the Project becomes aware of a discrepancy between a Model and either another Model or any contract document in the Principal Agreement, that party shall immediately notify all the other parties to the Principal Agreement and the BIM Manager.

WILL BE REMOVED IN VERSION 2

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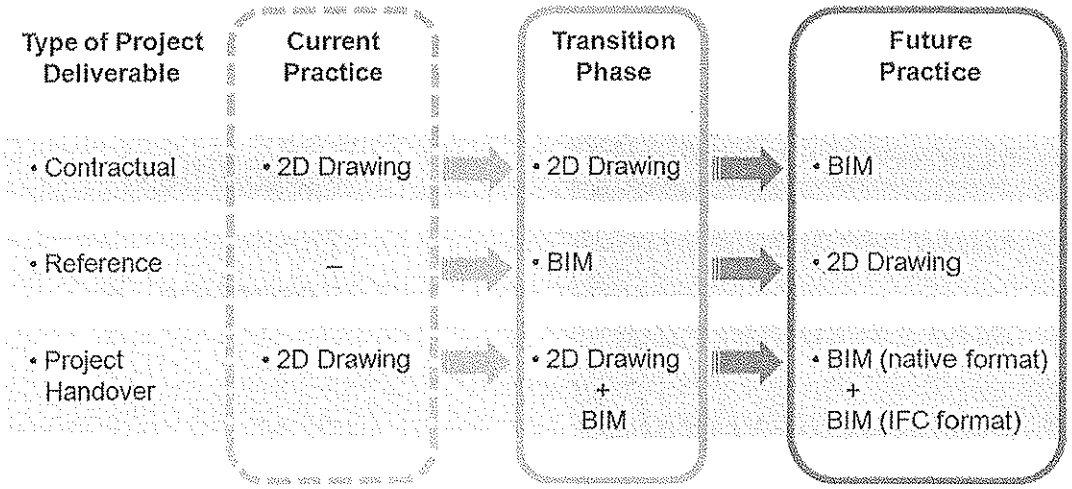
General Principles

Position of the BIM Particular Conditions at the **Transition Phase**:

"In the event of any inconsistency between a Model and any Drawings, the Drawings shall prevail" - cl. 2.2.4



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[often asked questions]

BIM Particular Conditions

- *Notes, Definitions*
- *General Principles*
- *BIM Management*
- *BIM Execution Plan*
- *Risk Allocation and IP*

- *Can my BIM Manager...*
- *What if my BIM Manager...*
- *What is my role before / after I appoint a BIM Manager..?*

BIM Management

3. BIM MANAGEMENT

3.1. The Employer shall appoint one or more BIM Managers for the Project. All compensation and related costs for the BIM Manager shall be paid by the Employer unless otherwise agreed between the parties to the Project. The Employer may appoint any one or more of the parties in a Project as BIM Manager in addition to the duties and obligations of that party under the Principal Agreement.

3.2. The role and responsibility of the BIM Manager shall be as provided in the BIM Guide unless expressly agreed otherwise in the BIM Execution Plan.

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[often asked questions]

BIM Particular Conditions

- *Notes, Definitions*
- *General Principles*
- *BIM Management*
- *BIM Execution Plan*
- *Risk Allocation and IP*

- *BIM Execution Plan gives my BIM Manager too much power... ☹*

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BIM Execution Plan

4. BIM EXECUTION PLAN

4.1. As soon as practicable and from time to time as required, the BIM Manager shall call all parties to the Project involved in the execution of BIM to meet, confer and use their best efforts to agree upon the terms of or modifications to a BIM Execution Plan.

4.2. The BIM Execution Plan and the Model shall be developed in accordance with the BIM Guide.

4.3. As soon as practicable and from time to time as required, the BIM Manager shall call all parties to the Project involved in the execution of BIM to identify and agree on the Final Design Model.

4.4. The BIM Manager shall schedule and chair all meetings. In the event of any disagreement on the terms or modifications to the BIM Execution Plan, the BIM Manager's decision shall be final and conclusive. In the event that more than one BIM Manager has been appointed in accordance with Clause 3, then the decision shall be the joint decision of the BIM Managers.

4.5. If under the BIM Execution Plan for the time being in force, any party is required to perform or carry out any work which is beyond its scope of work under the Principal Agreement; such work shall be treated as additional works or variations under the Principal Agreement.

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[often asked questions]

BIM Particular Conditions

- *Notes, Definitions*
- *General Principles*
- *BIM Management*
- *BIM Execution Plan*
- *Risk Allocation and IP*

- *Can I make ___ share content with me?*
- *Can I refuse to share content with _____?*

- *What should I do if I received content that is*
  -seems inadequate?
  -seems wrong?

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Risk Allocation

5.5. To the extent that any or all Final Design Models are included as contract documents, parties may rely upon the accuracy of information in those Final Design Models (including dimensional accuracy) unless otherwise specified in the BIM Execution Plan.

5.6. The standard of care applicable to each party regarding any Contribution shall be in accordance with the Principal Agreement or if none is specified, in accordance to applicable law.

5.7. Each party shall use its best efforts to minimize the risk of claims and liability arising from the use of or access to its Model or the Final Design Model. Such efforts shall include promptly reporting to the relevant party and the BIM Manager any errors, inconsistencies or omissions it discovers in its Model or the Final Design Model. However, this section shall not relieve any party of liability for any of its Contribution.

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[often asked questions]

BIM Particular Conditions

- *Notes, Definitions*
- *General Principles*
- *BIM Management, BIM Execution Plan*
- *Risk Allocation and IP*

- *???*

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Intellectual Property Rights

Clause 6.1 deals with the point that every contributor's contribution is going to be incorporated into one big model.

So, it is important to make sure that no one "contaminates" the final product.
The 1st sentence tries to make sure that the contributor actually has the right to put in the contribution (ie he is owner of the design or has the licence to use it).
The 2nd sentence makes the contributor indemnify all the others if the contributor actually puts in something that he has no right to put in.
These cover the "contamination" point.
The last sentence deals with a different but related point. When a contributor puts in his contribution, he is only allowing the use of his contribution for this model and this project. Also, he is not giving up his ownership.

Clauses 6.2 and 6.3 – although it all looks a bit complicated – are basically to allow all the parties in the project to use each other's contribution for the project. So, there is this seemingly complicated licensing and sub-licensing of IP rights.

So, simplistically, you could say Clause 6.1 deals with "what goes in to the Model" whereas Clauses 6.2 and 6.3 deal with "what can be taken out of the Model".

Clause 6.4 has been discussed above. This relates to the use of the Final Design Model – parties are free to agree in the Principal Agreement on what rights the employer has to use this (for example, can a developer/employer use the design model for another project?).

Clause 6.5 deals with how long can each party use another party's contribution. It basically says as long as allowed by law but also says that once the project has achieved final completion, the use is limited to keeping an archival copy.

Clause 6.6 is similar in effect to the last sentence of Clause 6.1 In Clause 6.1, it says that the act of putting a contribution does not mean the contributor is transferring his ownership of the contribution. In Clause 6.6, it deals with the reverse – it says that putting in a contribution will not deprive the contributor of his ownership of the contribution.

Intellectual Property Rights

Clause 6.1	Plain English translation
Each party warrants to the other parties to the Principal Agreement that either (a) that party is the owner of all copyrights in all of that party's Contributions, or (b) that party is licensed or otherwise authorised by the holders of copyrights of expression contained in the Contribution to make such Contribution under the terms of this BIM Particular Conditions. Each party agrees to indemnify and hold such other parties harmless against claims of third parties arising out of or relating to, claims or demands relating to infringement or alleged infringement of expression contained in that party's Contribution. Nothing in this BIM Particular Conditions is intended to limit, transfer, or otherwise affect any of the intellectual property rights that a party may have with respect to any Contribution, except for licences or permissions expressly granted by this BIM Particular Conditions or the Principal Agreement	Clause 6.1 deals with the point that every contributor's contribution is going to be incorporated into one big model. So, it is important to make sure that no one "contaminates" the final product. The 1st sentence tries to make sure that the contributor actually has the right to put in the contribution (ie he is owner of the design or has the licence to use it). The 2nd sentence makes the contributor indemnify all the others if the contributor actually puts in something that he has no right to put in. These cover the "contamination" point. The last sentence deals with a different but related point. When a contributor puts in his contribution, he is only allowing the use of his contribution for this model and this project. Also, he is not giving up his ownership.

Intellectual Property Rights

Clauses 6.2, 6.3	Plain English translation
Subject to the provisions of Clause 6.1, each party grants to the other party or parties to the Principal Agreement for the sole purpose of the other party or parties carrying out their respective duties and obligations relating to the Project: A limited, non-exclusive licence to produce, distribute, display, or otherwise use that party's Contribution for purposes of this Project only. A limited, non-exclusive sub-licence to reproduce, distribute, display, or otherwise use, for the purposes of this Project only, the Contributions of those other parties to the Project who have granted that party an identical licence or sub-licence; The right to grant an identical sublicence to any other party to the Project with which the licensee has a contract in which this BIM Particular Conditions is incorporated by reference; and A limited, non-exclusive licence to reproduce, distribute, display, or otherwise use any Model containing such Contributions, or any other Model with which the Model containing such Contributions is federated or otherwise related. The limited licence granted in this Clause shall include any archival purposes permitted in this BIM Particular Conditions or in the Principal Agreement. If a party to a Principal Agreement is the holder of copyrights in the Contribution of another party to the Project or is the grantee of an exclusive licence with respect to such Contribution, then such holder or exclusive licensee hereby grants to the other party or parties to the Principal Agreement the right to grant to other parties to the Project with which that other party has or those parties have a contract in which this BIM Particular Conditions is incorporated, a limited licence in the terms set forth in Clause 6.2.	Clauses 6.2 and 6.3 – although it all looks a bit complicated – are basically to allow all the parties in the project to use each other's contribution for the project. So, there is this seemingly complicated licensing and sub-licensing of IP rights. So, simplistically, you could say Clause 6.1 deals with "what goes in to the Model" whereas Clauses 6.2 and 6.3 deal with "what can be taken out of the Model".

Intellectual Property Rights

Clause 6.4	Plain English translation
The Employer's entitlement to use any Final Design Model after completion of the Project shall be governed by the Principal Agreement(s) between the Employer and the Designer(s).	Clause 6.4 has been discussed above. This relates to the use of the Final Design Model – parties are free to agree in the Principal Agreement on what rights the employer has to use this (for example, can a developer/employer use the design model for another project?).

Clause 6.5	Plain English translation
Unless otherwise limited herein or by express licence-limiting terms in the Principal Agreement, the non-exclusive licence granted in this BIM Particular Conditions shall remain in effect as permitted by law. In addition, after final completion of the Project, the non-exclusive licence shall be limited to keeping an archival copy of Project-related Contributions.	Clause 6.5 deals with how long can each party use another party's contribution. It basically says as long as allowed by law but also says that once the project has achieved final completion, the use is limited to keeping an archival copy.

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of the built environment

Intellectual Property Rights

Clause 6.6	Plain English translation
In the absence of express language to the contrary in the Principal Agreement or in this BIM Particular Conditions, nothing in this BIM Particular Conditions, and no act by any party in the Project in furtherance of this BIM Particular Conditions, shall be deemed or construed to deprive or dispossess any party in the Project of copyrights or licence rights held by that party in its respective underlying Contribution to any Model. Other parties, persons or entities that provide Contributions to a Model shall not be deemed to be co-authors in the Contributions of other parties to the Project.	Clause 6.6 is similar in effect to the last sentence of Clause 6.1 In Clause 6.1, it says that the act of putting a contribution does not mean the contributor is transferring his ownership of the contribution. In Clause 6.6, it deals with the reverse – it says that putting in a contribution will not deprive the contributor of his ownership of the contribution.

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[often asked questions]

BIM Particular Conditions

- *Notes, Definitions*
- *General Principles*
- *BIM Management, BIM Execution Plan*
- *Risk Allocation and IP*

- *???*
- *Most popular question: "Do I own the model even if I didn't create it?"*
- *Why not?*

Intellectual Property Rights

Clause 6.4	Plain English translation
The Employer's entitlement to use any Final Design Model after completion of the Project shall be governed by the Principal Agreement(s) between the Employer and the Designer(s).	Clause 6.4 has been discussed above. This relates to the use of the Final Design Model – parties are free to agree in the Principal Agreement on what rights the employer has to use this (for example, can a developer/employer use the design model for another project?).

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Examples of BIM in a contract

" The (party) shall use BIM for the project and make reference to the (BIM reference document) for the definitions, specifications and guidelines on BIM "

Singapore BIM Guide

BIM legal & contractual clauses

BIM Execution Plan

" The BIM deliverables for the project shall be as indicated in the (BIM contractual document, BIM Execution Plan, etc) "

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Examples of BIM in a contract

" **The (client / client's rep) shall confirm the acceptance of all submitted deliverables identified in (clause) in coordination with the BIM Manager** "

- General Requirements
- Submission Requirements
- Content Requirements
- Ownership and Rights in Data … etc

" **Provide furniture and equipment schedules from the model indicating the materials, finishes, mechanical, and electrical requirements** "

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Thank You

Certification Course in BIM Management

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of the built environment

This set of slides is intended for the use of the individual. If you are not the intended recipient responsible for delivering it to the intended recipient, are hereby notified that any use, dissemination, distribution or copying of this communication is strictly prohibited.

Day 4 – Course Schedule Outline

Time	Topic
09.00 – 10.45	Session 1 – BIM Execution Plan
10.45 – 10.55	Break
10.55 – 13.00	Session 2 – BIM Execution Plan
13.00 – 14.00	Lunch
14.00 – 15.00	Session 3 – BIM Case Study
15.15 – 15.30	Break
15.30 – 16.30	Session 4 – Assessment

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LOD

- If you are a designer/engineer/builder and asked to provide model at LOD### – do you know what you are required to provide?

* To check with client on what is expected from you.

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LOD

- Level Of Detail ?
  - The amount of information and geometry provided by the content author or other project participant
- Level Of Development ?
  - AIA E202 BIM Protocol Exhibit: describes the level of completeness to which a Model Element is developed
- Largely Over Disputed ?

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LOD

INTENT/ANALYSIS / AUTHORITY SUBM
(DESIGN STAGE)

- **LOD300** according to AIA E202 BIM Protocol Exhibit:
  - **Model Content Requirements.** Model Elements are modeled as specific assemblies accurate in terms of quantity, size, shape, location, and orientation. Non-generic information may also be attached to Model Elements
  - **Analysis.** The Model may be analyzed for performance of selected systems by application of specific performance criteria assigned to the representative Model Elements
- LODXXX = Project Phase?

← NUMBER HAS BEEN REMOVED FROM VERSION 2.

LOD 400 → CONSTRUCTION & FABRICATION.
LOD 500 →

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LOD

MODEL ELEMENT AUTHOR.

AIA E202 BIM Protocol Exhibit: Model Element Table

Project Phase											
Model Element Breakdown	LOD	MEA	LOD	MEA	LOD	MEA	LOD	MEA	LOD	MEA
A SUBSTRUCTURE										
Foundations										
Standard Foundations										
Special Foundations										
Slab on Grade										
Basement Construction										
Basement Excavation										
Basement Walls										

LODXXX = Project Phase?

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LOD

- If you are a builder and asked to provide "as-built" model – do you know what you are required to provide?

- If you are an owner and ask for the "as-built" model – do you know what to expect from the model?

LOD

- As-built ≠ LOD500

- As an Owner, you could ask for every element to be LOD 500, but
  - Expect the price of your BIM deliverable ↑ and ROI ↓
  - Some building elements (e.g.: interior partitions) do not really need a manual or maintenance data to operate
  - Some of the information detail is not model data (e.g. O&M manuals)

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LOD

- Separate the milestone deliverables from LOD
- Conceptual ≠ LOD100; Prelim Design ≠ LOD200, …
- At any given project milestone, you will likely have a combination of LOD. For example, at the end of tender documents:
  - Interior walls and doors = LOD300;
  - Furniture = LOD200;
  - Electrical fixtures = LOD100;
- Attach "LOD" on the element level rather than stage/phase level

LOD in US/Australia

- **VA / NATSPEC OBJECT MATRIX**
- **USACE Minimum Modelling Matrix**
- **Object Requirement in New York City BIM Guide**

LOD in SG BIM Guide v1

- The level of detail refers to the generic definition such as:

  "The amount of information (geometry/non-geometry) in a BIM model element"

- In the current version (v2) of SG BIM Guide we will not use the term **LOD100**, **LOD200**, etc to state the level of detail of elements for each project stage/milestone

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LOD in SG BIM Guide v1

- The level of detail of elements for each project stage/milestone may refer to:
  - **Appendix C BIM Modelling Guideline** in SG BIM Guide v2
  - **Annex** of SG BIM Guide v2 developed by the client (GPEs/Developers) which specify client requirement in addition/replacement of **Appendix C BIM Modelling Guideline** in SG BIM Guide v2

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BIM Execution Plan

(FOR PROJECT LEVEL)

Presented by :

Karthik V
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of the built environment

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STORAGE, DOCUMENT CONTROL
SCHEDULE, SEQUENCING, MODEL MANAGEMENT
LEADING THE PROJECT - OWNER, ARCHITECT ?
SOFTWARE, VERSION
ROLES & RESPONSIBILITIES
WORK FLOW

Introduction

- What steps to take to start a BIM project?

PARAMETER → INFORMATION PARAMETRIC → CONTROL BY NUMBERS.

- If not requesting all participants to migrate to BIM immediately, what migration strategy would help to bring about that change?

IT'S BEST FOR ALL TO HAVE THE SAME → BIM.

- Focus on own individual discipline.
  - What should be the aim for that single discipline?

& CHECK WHEN THE PROJECT NEEDS & DELVE ON THE SOFTWARE

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Better built environment

Questions in BIM Project Implementation

- Who is involved and their responsibilities? For whom are the models intended? Assignment of roles and responsibilities, that define the 'How', 'When', 'Why', 'To what level', and 'For what purpose' issues
- What models are required? What range of discipline models is needed, and if an aggregate model is to be created, why is it required?
- When are they required? At what project stage are the models needed?

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Questions in BIM Project Implementation

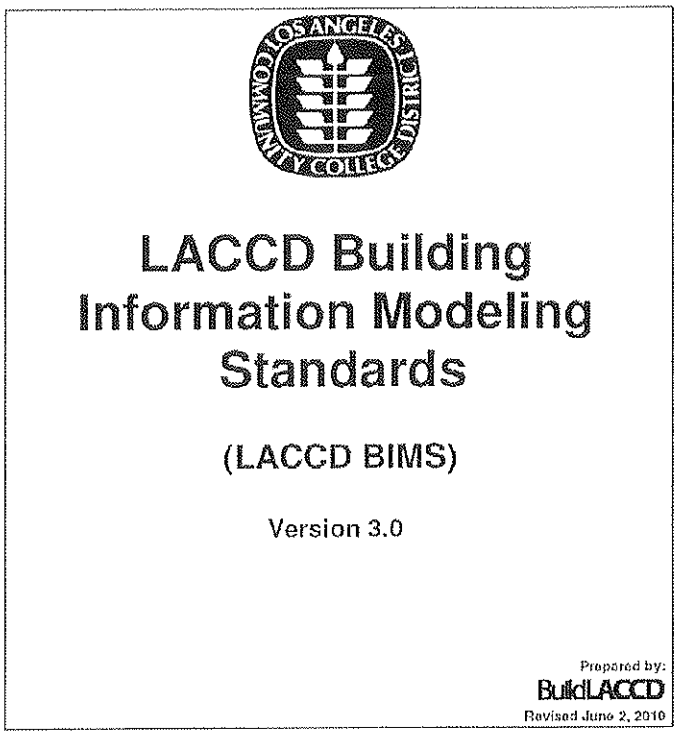
- What are the models to be used for? Uses of models: Visualization, Data extraction, Document production, Simulation and Analysis
- What data is needed in the models and at what level of detail?
- How will the models be exchanged and in what format?

Questions in BIM Project Implementation

- Who is managing the process? Is there a need for a project BIM manager?
- Location of project team participants – eg. Co-location in project office
- What risks are involved and how can they be addressed?
- **Thus there is a need for a something like a 'BIM Execution Plan' (BEP)**

BIM EXECUTION PLAN EXAMPLES

LACCD BIM Guideline



*LACCD: Los Angeles Community College District

LACCD BIM Execution Plan (DB)

- Upon contract award, and before issuance of Notice to Proceed, DB (Design Build) Team shall provide a detailed **BIM Execution Plan** including the following:
  1. Proposed strategy for utilizing BIM during design
     - Strategy for updating and coordinating design changes during construction using BIM
     - Work flow and software to analyze and verify energy and sustainable strategies
  2. Proposed strategy for utilizing BIM during construction including
     - Proposed use of digital fabrication to validate constructability of design
     - Updating as-built conditions and integrating of Record information in to Record BIM
     - Proposed utilization of 4D Scheduling and Sequencing technology

LACCD BIM Execution Plan (DB)

3. Proposed BIM Software to be used
4. File formats to be used for project submittal and file exchange
5. File exchange protocol
6. Strategy for establishing and managing shared file server
7. Project team qualifications and experience in BIM, and a list of individuals with relevant experience assigned to the following roles
   - Virtual Design and Construction Manager
   - Lead BIM Technicians for all major trades (i.e. Architect, Civil, MEP, Structural)
   - Senior Project Designers and Engineers
   - BIM and IT Managers for all applicable trades
   - Lead Fabrication Modelers for all trades

LACCD Roles & Responsibilities

Project Name and Number:

College: College Project Manager:

BIM Roles and Responsibilities Matrix

Firm/Company	Discipline(s)	Project BIM Facilitator Contact Info (one per team)	Contact Info (one per firm/company)	Software and version to be used (list all)	file formats to be used (native and exchange formats)
Cervantes Arquitectos	Architecture		Howard Roark, AIA 1 Division St. #344 New York, NY	1 Revit Architecture 2010 2. Autodesk Navisworks 2010 3. Autodesk Ecotect 2010 4. Autodesk 3dMax 2010 5. Microspec E-Specs	1. .rvt, .dwg for CAD exchange 2. .nwd, .dwg 3. gbXML for analysis 4. .3ds, .dwg 5. .xml
Ascension Builders	General Contractor	Harrison Smith 1124 Granite Road Irwindale, CA	Cenc Bass	1.Revit Architecture 2010 2. Autodesk Navisworks 2010 3. AutoCAD Architecture 2010	1. .rvt, .dwg for CAD exchange 2. .nwd, .dwg 3. .dwg for CAD Exchange
Palace Engineers	Structural Engineer		James Falcon, P.E. 2667 Golden Ave. Rancho Cucamonga, CA	1 Revit Structural 2010 2. RAM Structural Analysis	1. .rvt, .ifc for BIM exchange 2. .rvt, .ifc for BIM Exchange, .dwg for CAD exchange
Phoenix Mechanical	Mechanical Engineer/Contractor		Darlene Williams PE 1255 Business Center Drive Santa Clarita, CA	1 Revit MEP 2010 2 CAD Duct 2010 3. IES VE+	1. .rvt 2. .dwg 3. .gbXML
Hydro Plumbing	Plumbing Engineer/Contractor		Roger Waters 2345 Rocky Mountain Dr. Los Angeles, CA	1. AutoCAD MEP 2. CAD Duct 2010	1. .dwg 2. .dwg
Steel Stew Fast Lee Electrical	Steel Fabrication Electrical Engineers		Sam Kerr 456 Lion Lane Carbon, IL Jane Sparks, P.E. 777 Electric Avenue Downey, CA	1 Tekla Structures 2010 2. Revit Structural 2010 1 AutoCAD MEP 2010	1. .rvt, .dwg for CAD exchange 2. .nwd, .dwg 1. .rvt, .dwg for CAD exchange 2. .nwd, .dwg 3. .gbXML 4. .3ds, .dwg
Tierra Group	Civil Engineer		Joe Dirt, P.E. 777 Hwy St Bend Canyon, CA	1 AutoCAD Civil 3D 2010	1. .dwg
Pflanze Landscape Architecture	Landscape Architecture		Robert Pflanze 777 Oak Street Redwood City, CA	1 AutoCAD Architecture 2010	1. .dwg
Redline Fire Protection	Fire Protection Engineer		Larry Sprky 1256 Pyro Lane Anaheim, CA	1 Sprink CAD 12.4 2. AutoCAD MEP 2010	1. .dwg 2. .dwg
FiberCom	Telecom/Low Voltage		Patrick Bell 122 Grange St Singal Hill, CA	1.AutoCAD MEP 2010	1. .dwg

SAMPLE

Indiana University BIM Guideline

Indiana University

BUILDING INFORMATION MODELING
(BIM)
GUIDELINES and STANDARDS for
ARCHITECTS, ENGINEERS, and
CONTRACTORS

Sept. 10th, 2009

INDIANA UNIVERSITY
UNIVERSITY ARCHITECT'S OFFICE

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Indiana University BIM Guideline

Milestone	Deliverable
Conceptualization Phase	Architectural Massing Model
	Preliminary Energy Model
Schematic Design Phase	Architectural Model
	Schematic Energy Model
	Civil Model
	Initial Collision Report
	Square Foot Cost Estimate
	COBIE Design Data (worksheets 02-05)
Design Development	Architectural Model
	Detailed Energy Model
	MEP Model or Models
	Structural Model
	Civil Model
	Discipline Collision Report
	System Cost Estimate
	Program Validation
	COBIE Design Data (worksheets 02-06)
Construction Documents	Architectural Model
	MEP Model or Models
	Structural Model
	Civil Model
	Pre-Bid Collision Report
	Quantity Estimate
	COBIE Design Data (worksheets 02-07)

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IU BIM Execution Plan

- The Design Team shall submit to Indiana University within thirty (30) days of contract award, a **BIM Execution Plan**. The BIM Execution Plan's template is located on the web for download at: **http://www.indiana.edu/~uao/iubim.html**. The BIM Execution Plan will be reviewed and approved by Indiana University within fourteen (14) days after the submitting of the BIM Execution Plan. The BIM Execution Plan shall identify the entire Design Team including all consulting engineers and any specialty consultant. The BIM Execution Plan also should include roles and responsibilities of the contractor(s) even if that party has not yet been identified. The BIM Execution Plan will be a part of the final bid documents.

IU BIM Execution Plan

BIM Execution Plan

INDIANA UNIVERSITY
UNIVERSITY ARCHITECT'S OFFICE

By signature below, this BIM Execution Plan is hereby adopted and incorporated into the Agreement, dated _____ for Professional Design Services between _____ and Indiana University.

Indiana University	Date
Architect	Date
Construction Manager	Date
Civil Engineer	Date
Structural Engineer	Date
Mechanical Engineer	Date
Electrical Engineer	Date
Plumbing Engineer	Date
Additional Party as Needed	Date
Additional Party as Needed	Date

BIM Execution Plan

- Contents could be arranged as following:
  1. Project Initiation
  2. Modelling Plan
  3. Analysis Plan
  4. Collaboration Plan
  5. Quality Control

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1. Project Initiation

Project information & description

- Project owner
- Project Name
- Project Location and address
- Project Description

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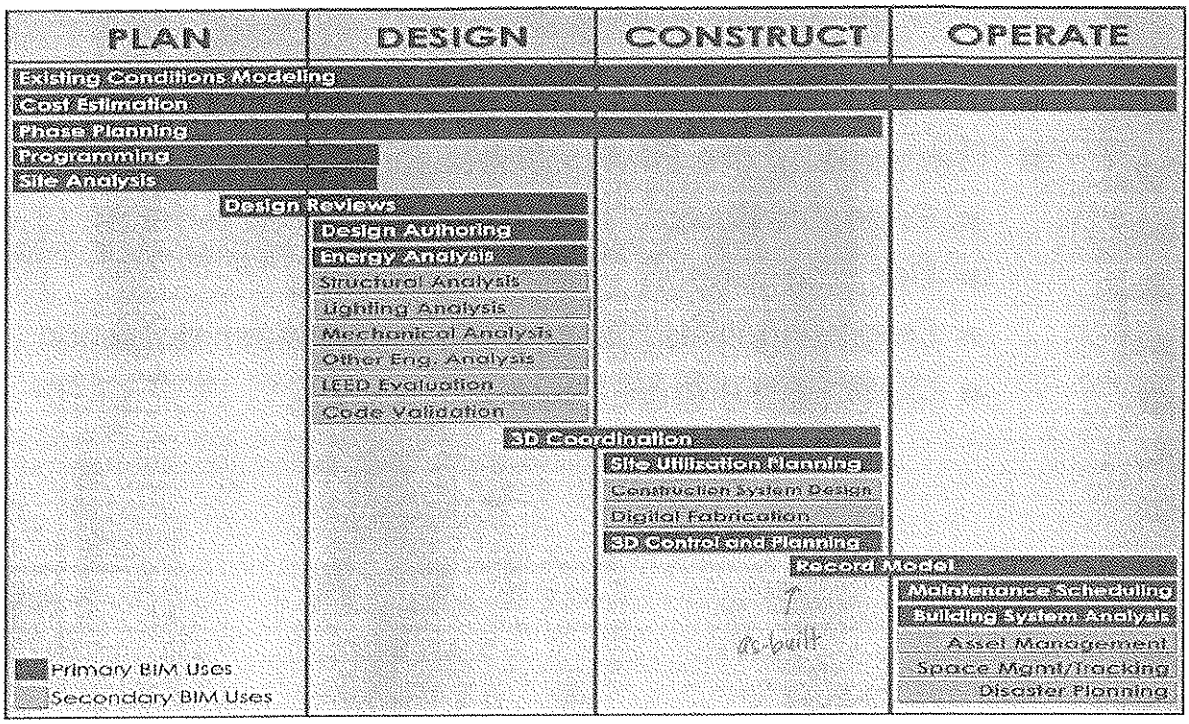
1. Project Initiation
Project Goals

- BIM Modeling goals, preferably by project stage
- The aims of the BIM collaboration for example:
  - Project reviews
  - Decision support
  - Design analysis, Co-ordination and clash detection
  - Quality assurance / control

1. Project Initiation
Project Goals

- Project Modeling Deliverables (IN LINE WITH YOUR GOAL)
  - Fully coordinated and assembled 3D Geometric Design Intent Model in collaborative software format
  - Separate discipline models in original authoring software
  - 3D Geometric Construction co-ordination Model
  - Project data – e.g. schedules, FM data
  - 2D deliverables derived from assembled BIM for contract bidding– propriety & PDF formats

1. Project Initiation
Project Goals – BIM Uses



1. Project Initiation
Project Goals – BIM Uses

Design Authoring

Description:

A process in which 3D software is used to develop a Building Information Model based on criteria that is important to the translation of the building's design. Two groups of applications that are at the core of the BIM-based design process are *design authoring tools* and *audit and analysis tools.*

Authoring tools create models while audit and analysis tools study or add to the richness of information in a model. Most of audit and analysis tools can be used for Design Review and Engineering Analysis BIM Uses. Design authoring tools are a first step towards BIM and the key is connecting the 3D model with a powerful database of properties, quantities, means and methods, costs and schedules.

Potential Value:

- Transparency of design for all stakeholders
- Better control and quality control of design, cost and schedule
- Powerful design visualization
- True collaboration between project stakeholders and BIM users
- Improved quality control and assurance

Resources Required:

- 3D Model manipulation

Team Competencies Required:

- Ability to manipulate, navigate, and review a 3D model
- Knowledge of construction means and methods
- Design and construction experience

1. Project Initiation
Project Goals – BIM Uses

3D Coordination

Description:

A process in which Clash Detection software is used during the coordination process to determine field conflicts by comparing 3D models of building systems. The goal of clash detection is to eliminate the major system conflicts prior to installation.

Potential Value:

- Coordinate building project through a model
- Reduce and eliminate field conflicts; which reduces RFI's significantly compared to other methods
- Visualize construction
- Increase productivity
- Reduced construction cost; potentially less cost growth (i.e. less change orders)
- Decrease construction time
- Increase productivity on site
- More accurate as built drawings

Resources Required:

- 3D Model manipulation
- Model Review application

Team Competencies Required:

- Ability to deal with people and project challenges
- Ability to manipulate, navigate, and review a 3D model
- Knowledge of BIM model applications for facility updates
- Knowledge of building systems.

1. Project Initiation
Project Goals – BIM Uses

- Identify the potential BIM uses based on your project goals
- E.g.:

Priority (1-3)	Goal Description	Potential BIM Uses
1- Most Important	Value added objectives	
2	Increase Field Productivity	Design Reviews, 3D Coordination
1	Increase effectiveness of Design	Design Authoring, Design Reviews, 3D Coordination
3	Accurate 3D Record Model for FM Team	Record Model, 3D Coordination

1. Project Initiation
Project Goals – BIM Uses

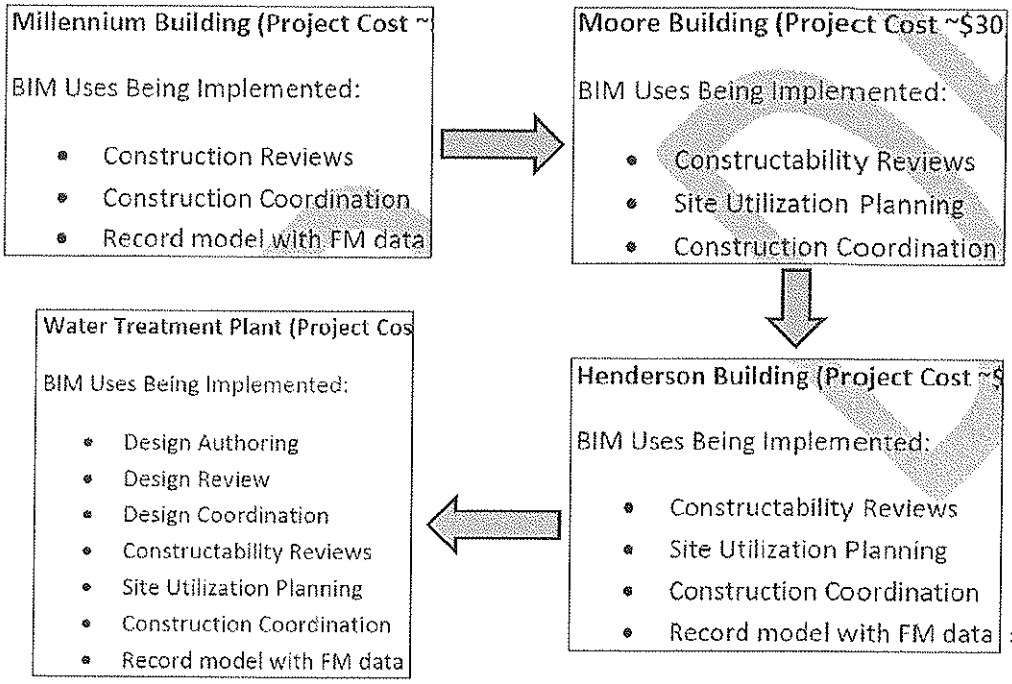
- Identify the value and risk for each of the BIM Uses (High, Medium or Low)
- Identify the responsible parties for each potential BIM Use
- Rate the capabilities of each party for each BIM use
  - Resources
  - Competency
  - Experience
- Determine whether or not to implement each BIM Use

1. Project Initiation
Project Goals – BIM Uses

BIM Use	Value to Project	Responsible Party	Value to Resp. Party	Capability Rating			Additional Resources / Competencies Required to Implement	Notes	Proceed with Use
	High / Med / Low		High / Med / Low	Scale 1-3 (1 = Low)					YES / NO / MAYBE
				Resources	Competency	Experience			
Record Modeling	HIGH	Contractor	MED	2	2	2	Requires training and software		YES
		Facility Manager	HIGH	1	2	1	Requires training and software		
		Designer	MED	3	3	3			
Cost Estimation	MED	Contractor	HIGH	2	1	1			NO
4D Modeling	HIGH	Contractor	HIGH	3	2	2	Need training on latest software	High value to owner due to	YES
							Infrastructure needs	phasing complications	
								Use for Phasing & Construction	

1. Project Initiation
Project Level BIM Uses

- Example of Project Level BIM Uses (from PSU)



1. Project Initiation
Project Team

- Core Collaboration Team should responsible for Completing this BIM Execution Plan
- Project Team contact details
  - BIM manager
  - Discipline BIM Coordinators
  - Discipline modelers
  - Responsibilities

1. Project Initiation
BIM Roles and Responsibilities

Roles	Responsibility in BEP Development	Responsibility
Project Manager	Manages and coordinates project execution and BIM	Oversight
Design Team Project Manager	Team manager and coordinator	Coordination & Review
BIM Manager	Coordinate BIM use on project, determine schedule of use, sharing activities, quality control, modelling responsibilities and documentation in BEP	Oversight, Management Execution and Model Exchange
Architecture Team	Design Execution – formulate with BIM Manager. Map BIM use for architectural design	Modelling and Review

Source: NATSPEC National BIM Guide

1. Project Initiation
BIM Roles and Responsibilities

Roles	Responsibility in BEP Development	Responsibility
Structural Team	Engineering – formulate with BIM Manager. Map BIM use for structural design – determine BIM use for structural simulations, analysis and documentation. Identify tools.	Modelling and Review, Model Exchange
MEP Team	Engineering – formulate with BIM Manager. Map BIM use for MEP design – determine BIM use for simulations, analysis and documentation. Identify tools	Data Development. Modelling and Model Exchange
Interior Design Team	Interior Design Execution – formulate with BIM Manager and architect. Map BIM use for interior design	Data Development, Modelling and Model Exchange

1. Project Initiation
BIM Roles and Responsibilities

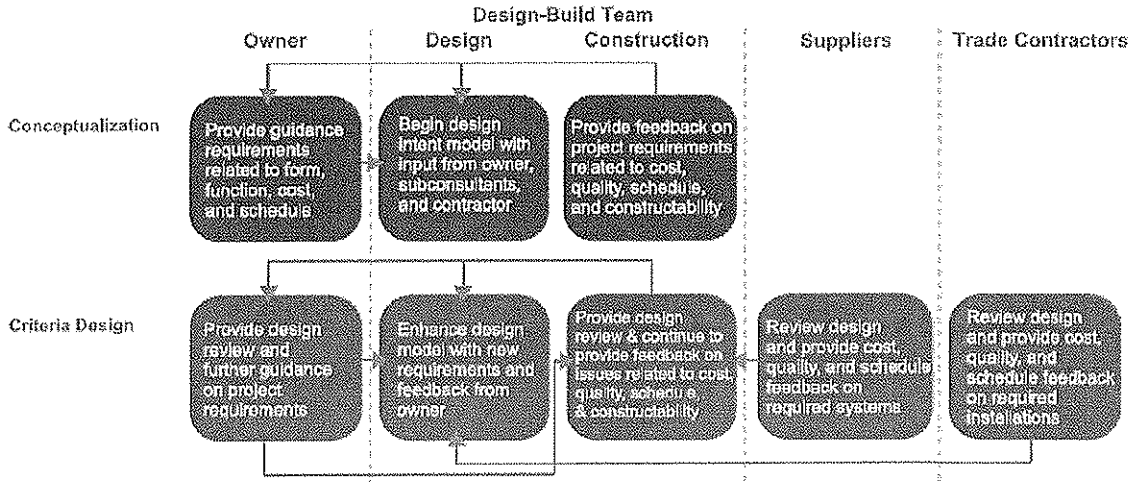
Roles	Responsibility in BEP Development	Responsibility
Sustainability and Energy Team	Engineering – formulate with BIM Manager. Map BIM use for Sustainability, 3rd Party Rating Systems – determine BIM use for simulations, analysis and documentation. Identify tools	Data Development Review and use of model
Contractor	Receive or help create BIM for constructability and handover for field use. Determine Interference checking responsibility	Use of model, Review, Model Exchange
Subcontractor and/or Fabricator (as appropriate)	Off-Site Fabrication – formulate with BIM Manager and designer. Map BIM use for fabrication and shop drawing design. Determine BIM use for simulations of maintenance space analysis and documentation. Identify tools	Use of model, Modelling and Integration

1. Project Initiation
BIM Roles and Responsibilities

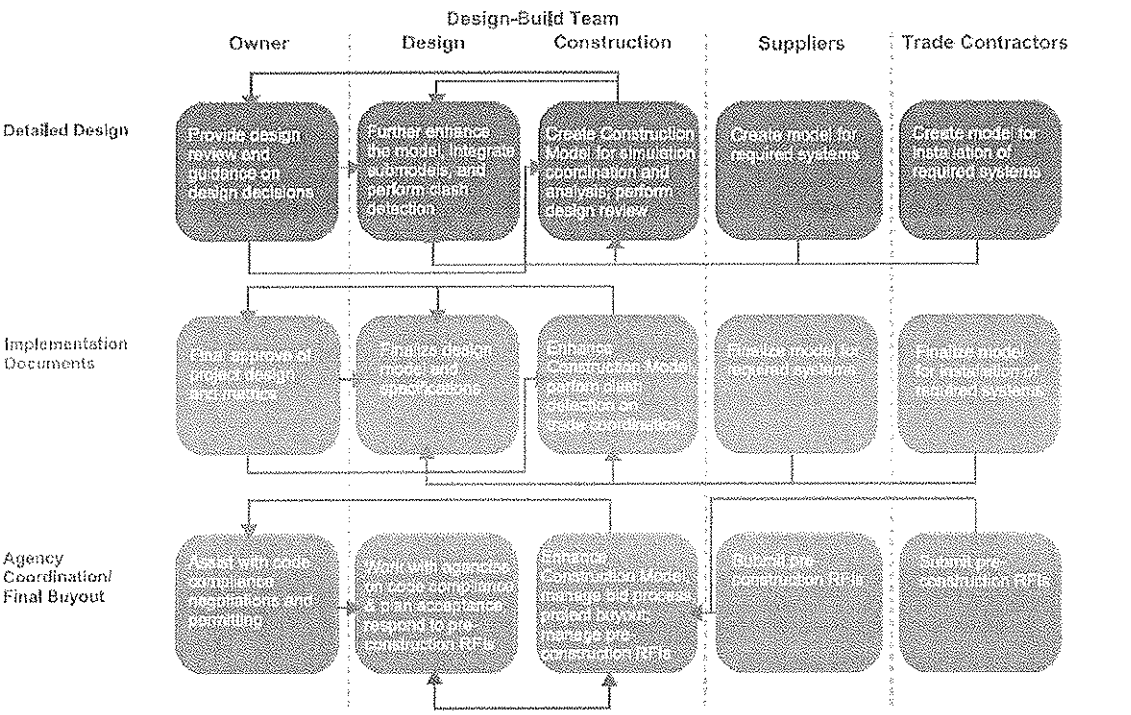
BIM Project Objective	BIM Manager	Project members involved in fulfilling the objective. A – model author; U – model users						
		Arc	Str	MEP	QS	Con	FM	Others
Conceptual Design Overall Building Massing Indicative of Area, Height, Volume, Location and Orientation								
1. All project members appointed at this phase to agree on needs, objectives, process and outcomes of the project. Suggested Deliverable • BIM Execution Plan agreed and signed by related parties								
2. Create site BIM models for master plan site study and feasibility analysis. - Site Analysis - An Outline Planning Permission can be applied if necessary Suggested Deliverable • Site Model								
3. Create and compare BIM massing models - Space areas and volumes								

1. Project Initiation
BIM Process Map

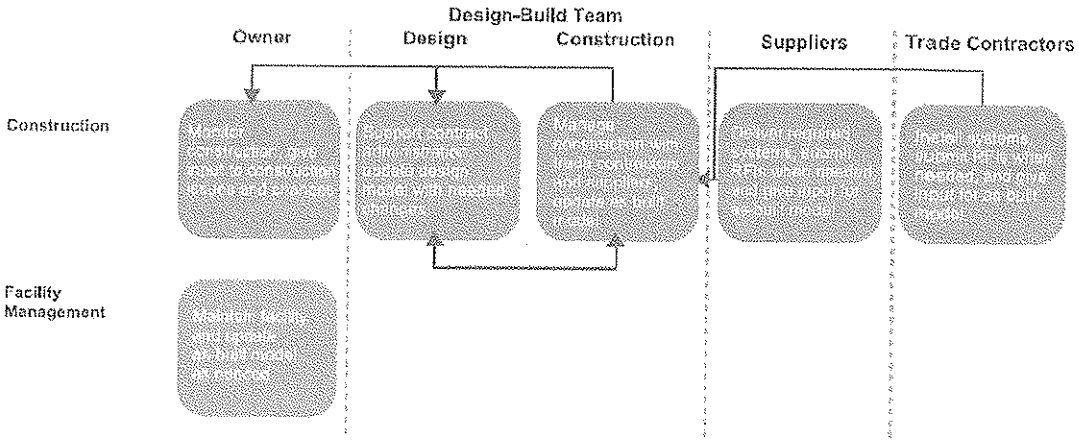
- Understand the project delivery methods process – Example: **Design-Build** Project Delivery



1. Project Initiation
BIM Process Map

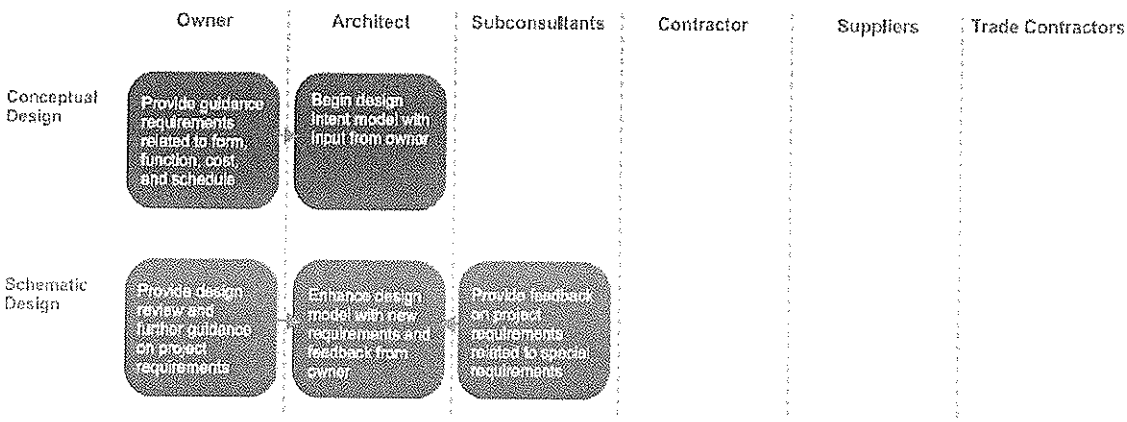


1. Project Initiation
BIM Process Map

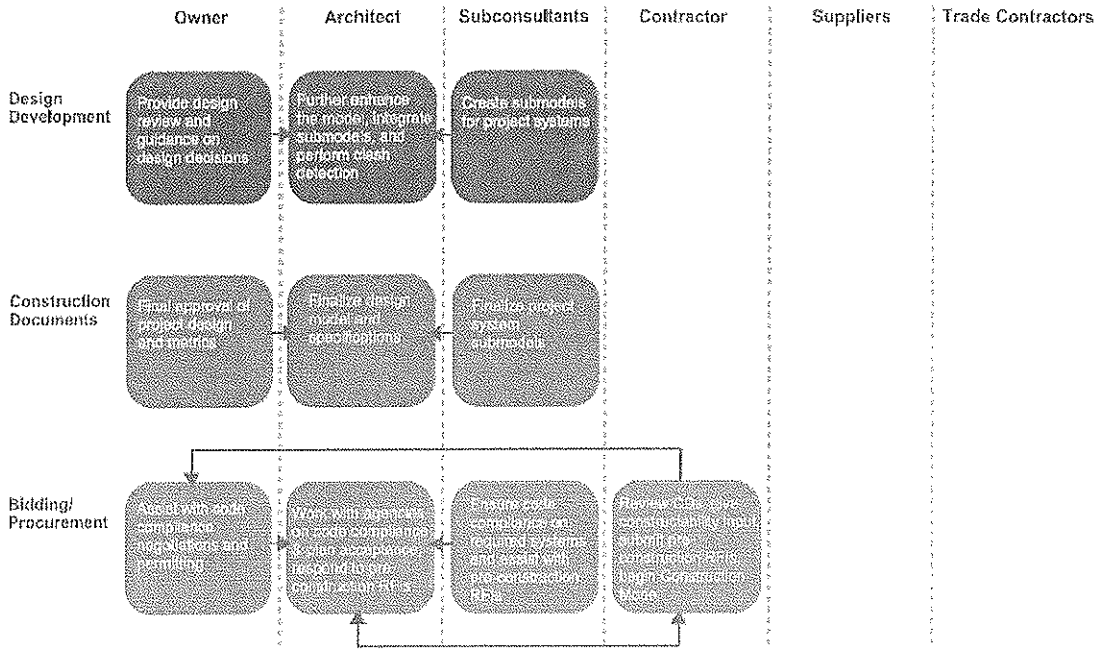


1. Project Initiation
BIM Process Map

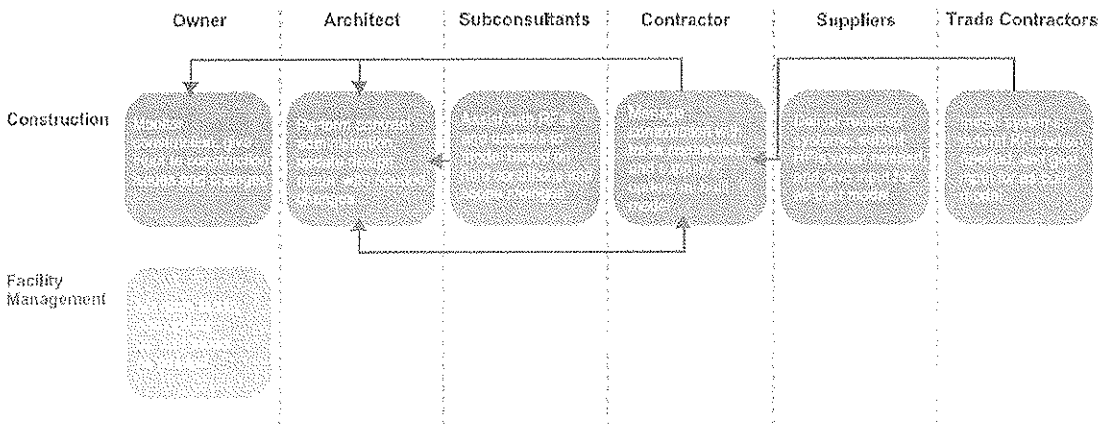
- Understand the project delivery methods process – Example: **Design-Bid-Build** Project Delivery



1. Project Initiation
BIM Process Map

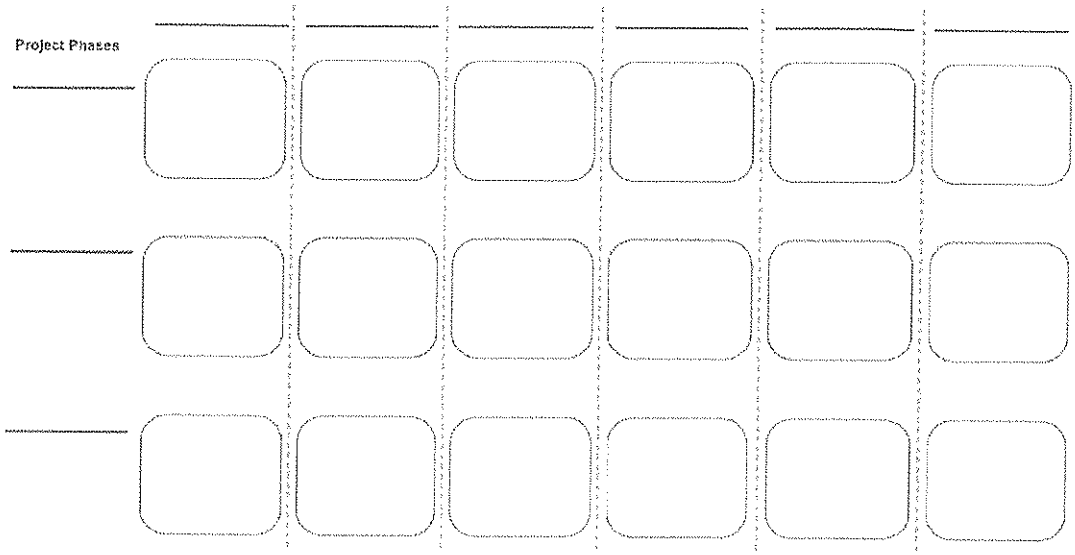


1. Project Initiation
BIM Process Map

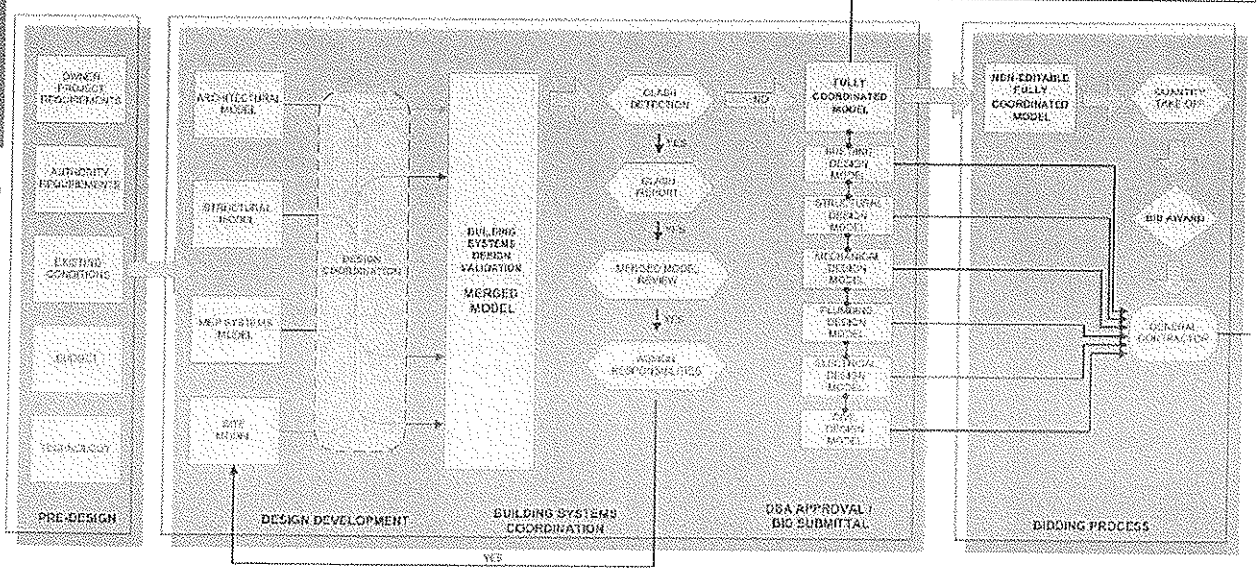


1. Project Initiation
BIM Process Map

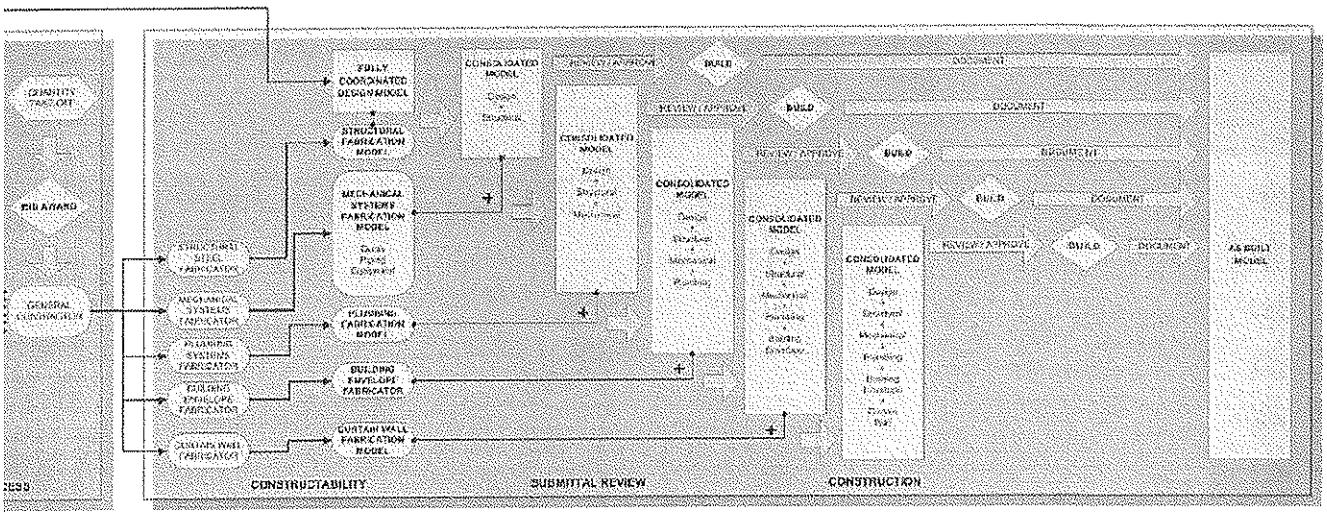
- What is your project delivery methods process?



1. Project Initiation
BIM Process Map DBB

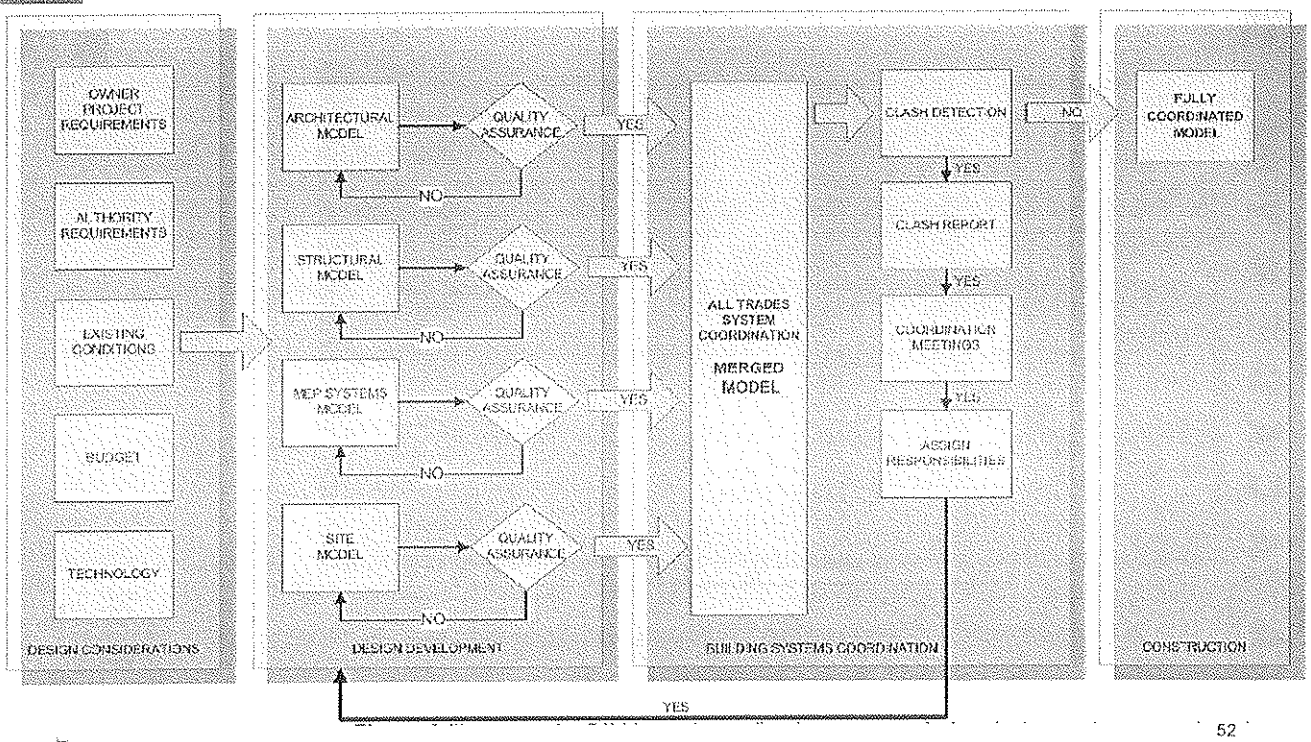


1. Project Initiation
BIM Process Map DBB



GENERAL CONTRACTOR AS BIM LEAD FACILITATOR

1. Project Initiation
BIM Process Map DB



2. Modelling Plan
Planned Model

Model Name	Model Content	Project Phase	Authoring Company	Authoring Tool
Architectural Model	Architectural objects, code information	Conceptualization / Program of Requirements Phase		Autodesk Revit Architecture
Civil Model	Topography, site utilities to within 5 feet of perimeter, hard and soft surfaces, other site objects	Criteria Design / Schematic Design Phase		Autodesk Civil 3D
Structural Model	Structural steel members, bearing and shear walls, analytical structural model, lintels	Criteria Design / Schematic Design Phase		Autodesk Revit Structure
Mechanical Model	Mechanical systems, equipment, load information, utilities within 5 feet of	Criteria Design / Schematic Design Phase		Autodesk Revit MEP

2. Modelling Plan
Model Components

- File Naming
- Modelling LOD

Modeling Level of Detail

Specify the level of detail in your models below. The level of detail can be defined by exclusions and / or by object size.

i. Exclusions: List the objects that will be excluded from the model in the table below.

Items that will be excluded from the Model
Architectural --
MEP --

ii. Size: Any object smaller than [TBD] will not be included in the model.

3. Analysis Plan
Analysis Model

- Analysis Models (QTO, Energy, Structural, etc)

Analysis	Analysis Tool	Model	Analyzing Company	Project Phase	File Format Required
Visualization		Architectural Model			.rvt/.nwf
Structural		Structural Model			.rvt/?
Quantity Takeoff		All Models			.rvt
Scheduling /4D		All Models			.rvt/.nwf/?
Cost Analysis /5D		All Models			.rvt/.nwf
Energy/LEED		Architectural Model			.rvt/.gBXml
Daylight/Lighting		Architectural Model			.rvt/.FBX

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4. Collaboration Plan
Document Management

FILE LOCATION	FILE STRUCTURE / NAME	FILE TYPE	PASSWORD PROTECT	FILE MAINTAINER	UPDATED
FTP SITE: ftp://ftp.****.com/***/****	ROOT PROJECT FOLDER	FOLDER	YES **********	JIM McBIM	ONCE
	ARCH ROOT FOLDER	FOLDER			ONCE
	ARCH-11111-BL001.xyz	.xyz			DAILY
NETWORK drive @ PSU F:\PROJECT\BIM	ROOT PROJECT FOLDER	FOLDER	NO	JIM McBIM	ONCE
Project Management Software www.*****.com					

4. Collaboration Plan
Meeting Procedures

MEETING TYPE	PROJECT STAGE	FREQUENCY	PARTICIPANTS	LOCATION
BIM REQUIREMENTS KICK-OFF				
BIM EXECUTION PLAN DEMONSTRATION				
DESIGN COORDINATION				
CONSTRUCTION OVER-THE-SHOULDER PROGRESS REVIEWS				
ANY OTHER BIM MEETINGS THAT OCCURS WITH MULTIPLE PARTIES				

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4. Collaboration Plan
Information Exchange

INFORMATION EXCHANGE	FILE SENDER	FILE RECEIVER	ONE-TIME or FREQUENCY	DUE DATE or START DATE	MODEL FILE	MODEL SOFTWARE	NATIVE FILE TYPE	FILE EXCHANGE TYPE
DESIGN AUTHORING - 3D COORDINATION	STRUCTURAL ENGINEER	(FTP POST) (COORDINATION LEAD)	WEEKLY	[DATE]	STRUCT	DESIGN APP	.XYZ	.XYZ .ABC
	MECHANICAL ENGINEER	(FTP POST) (COORDINATION LEAD)	WEEKLY	[DATE]	MECH	DESIGN APP	.XYZ	.XYZ .ABC

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4. Collaboration Plan
Information Exchange

- Be aware of Model users' differing views and expectations of model information
- Example: A wall
  - Architect: layout, size, finish, colour, texture
  - Structural engineer: load bearing or non-load bearing
  - Mechanical engineer: enclosure objects with physical thermal properties
  - Quantity surveyor (QS): quantity extraction, object specification and cost
  - Contractor: item to have fabricated off site or assembled on site, with cost, delivery time, construction time, sequencing
  - FM: surface to maintain as part of a room or building

4. Collaboration Plan
Information Exchange

- Architectural to Structural
  - Terrain / site
  - Function of rooms/spaces
- Architectural to MEP
  - Geographic location and orientation
  - Rooms / Spaces fully enclosed
  - Occupancy levels of rooms
  - Zoning
- Architectural to QS
  - Cost codes for modeled elements
- Architectural to Environmental
  - Geographic location and orientation
  - Specific Material properties

4. Collaboration Plan
Information Exchange

- There is a natural increase in required data to enable more complex analyses and simulations. E.g. MEP / Sustainability:
  - Detailed Material Properties:
    - Acoustics, Artificial Lighting, Cost Estimates
  - Latitude, Longitude and Time Zone:
    - Shading Design, Solar Envelopes
  - Site Layout and Surrounding:
    - Overshadowing, Daylight analysis
  - Weather / Climate data:
    - Solar analysis, Photovoltaic collection
  - Zoning, Occupancy, Equipment
    - Thermal & Energy analysis, Loads & Carbon footprinting, Resource Use (Electricity, Water, Gas)

4. Collaboration Plan
Information Exchange

- Understand what information is necessary to deliver each BIM Use

- The Information Exchange Worksheet can be used after designing and mapping the BIM process

5. Quality Control
Quality Control Check

CHECKS	DEFINITION	RESPONSIBLE PARTY	SOFTWARE PROGRAM(S)	FREQUENCY
VISUAL CHECK	Ensure there are no unintended model components and the design intent has been followed			
INTERFERENCE CHECK	Detect problems in the model where two building components are clashing including soft and hard			
STANDARDS CHECK	Ensure that the BIM and CP83 Standard have been followed (fonts, dimensions, line styles, levels/layers, etc)			
MODEL INTEGRITY CHECKS	Describe the QC validation process used to ensure that the Project Facility Data set has no undefined, incorrectly defined or duplicated elements and the reporting process on non-compliant elements and corrective action plans			

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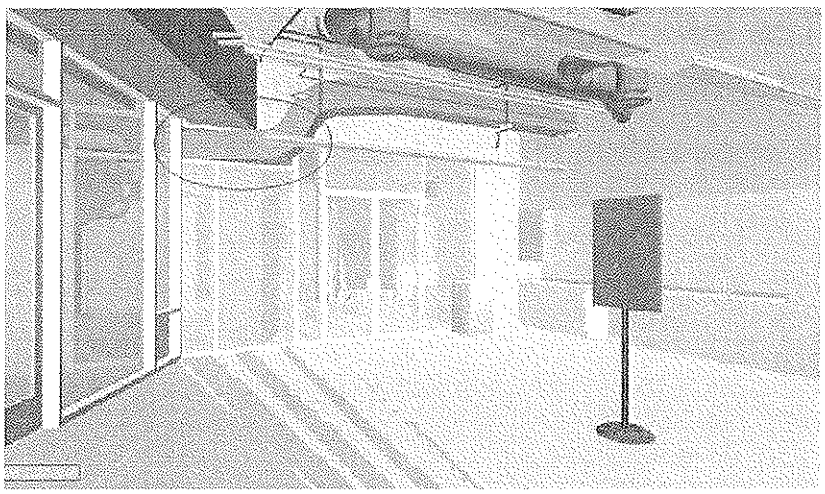
5. Quality Control
Visual Check

- Do not rely only on LOD for deliverables but ask your team: owner, designer, and builder to analyse the model and its content



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Implementing BIM Project Execution Plan

- Meeting Structure for Developing a BIM Project Execution Plan:
  1. Identify BIM Goals and Uses
     - attended by senior management personnel and BIM management staff for all involved participants including the owner, designers, contractors and key subcontractors
  2. Design BIM Project Execution Process
     - attended by the owner, BIM managers and project manager for the project
  3. Develop Information Exchanges and BIM Project Management
     - attended by the BIM managers
  4. Review Final BIM Project Execution Plan
     - attended by the owner, BIM managers, and all parties that are responsible for the identified BIM Uses

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Implementing BIM Project Execution Plan

- Monitoring Progress against the BIM Execution Plan
  - Meet on a monthly basis to discuss the progress of the project and to address any implementation challenges
  - Continuously modify the planned process as needed:
    - Addition of team members
    - Revisions to available technology
    - Changes to the overall project conditions
    - Reflect the actual process that evolved
  - Agree on a formal plan for accepting updates to the plan
  - Document any changes to the original plan for communication to other team members

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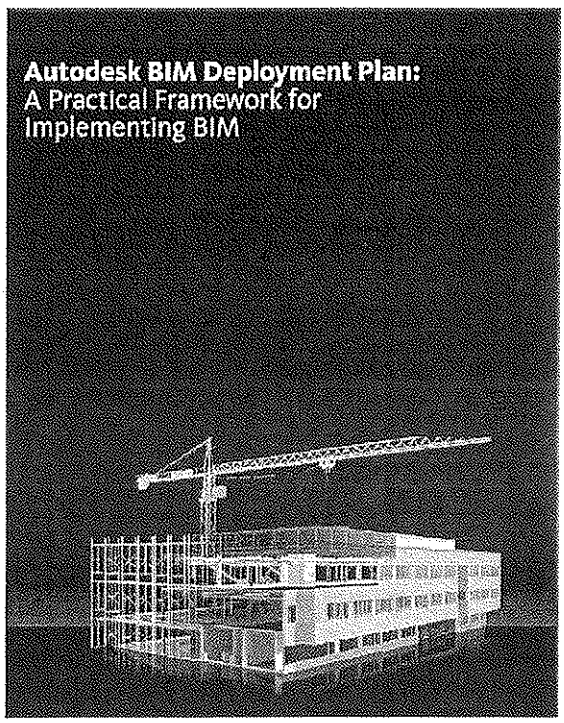
Thank You

References





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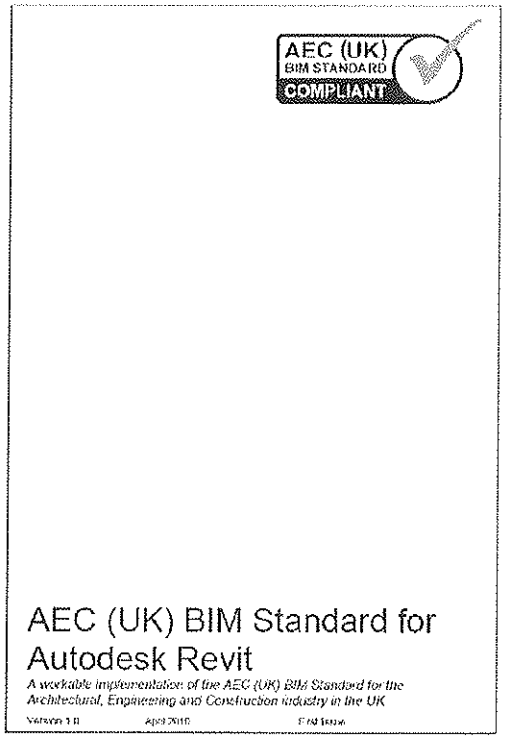
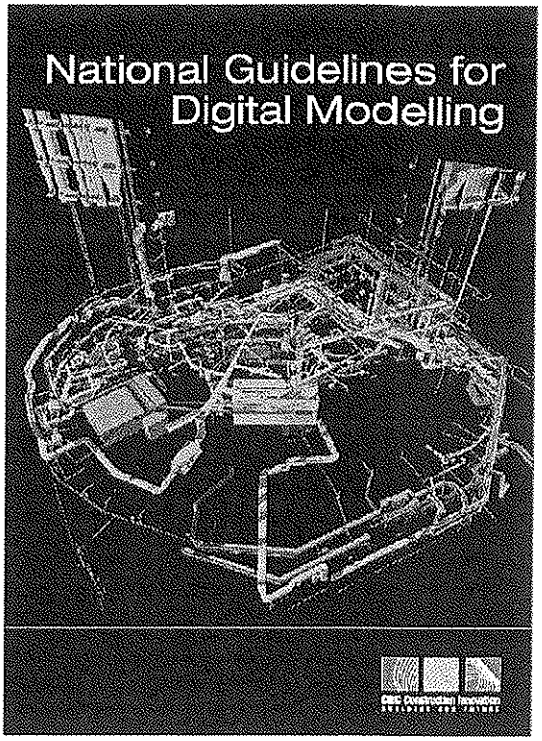
References

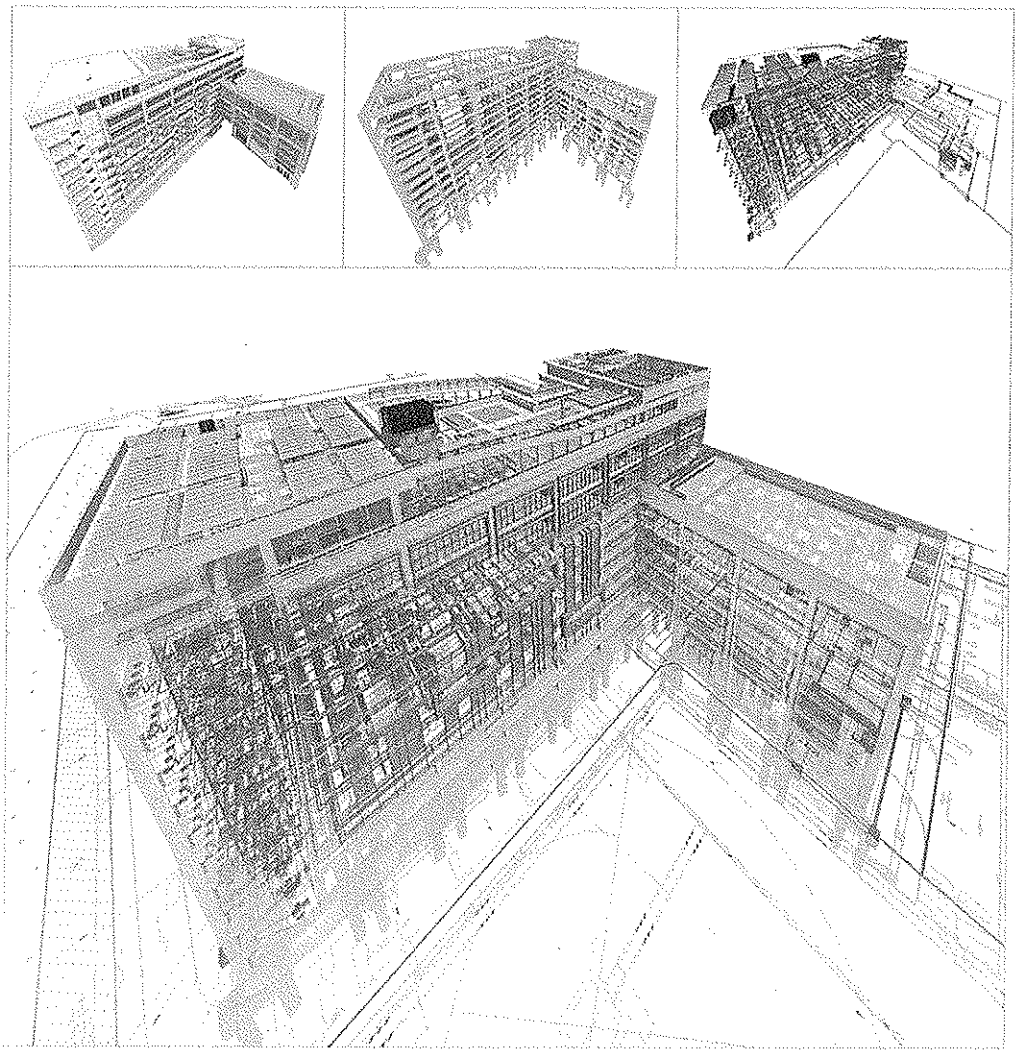

AEC (UK)
BIM STANDARD
COMPLIANT
AEC (UK) BIM Standard for Autodesk Revit
A workable implementation of the AEC (UK) BIM Standard for the Architectural, Engineering and Construction industry in the UK


National Guidelines for Digital Modelling

Building and Construction Authority

Singapore BIM Guide

Version 2



BCA acknowledges the leadership provided by the BIM Steering Committee in support of the production of the Singapore BIM Guide.

The Singapore BIM Guide has been drafted by the BIM Guide Workgroup on behalf of BCA and the BIM Steering Committee.

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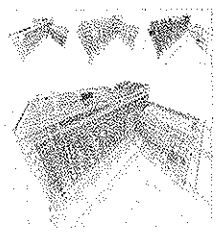

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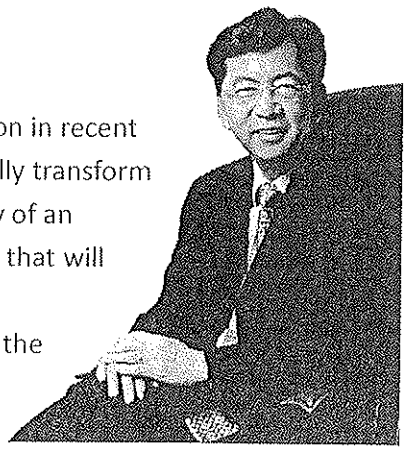

Dear readers,

Building Information Modelling (BIM) has gained much traction in recent years as digital construction technology that will fundamentally transform the building and construction industry practice in the delivery of an excellent built environment. It is a game changing technology that will improve the construction productivity as well as the level of integration and collaboration across the various disciplines in the construction value chain. It is therefore important for the industry to embrace the technology with clarity.

The Singapore BIM Guide Version 2 is part of the industry's efforts to demystify BIM and to give clarity on the requirement of BIM usage at different stages of a project.

Under the leadership of the BIM Steering Committee chaired by Er Lee Chuan Seng, Emeritus Chairman, Beca Carter, and comprising of leaders in BIM, the BIM Guide Workgroup has contributed much time and effort to compile the various best practices to make this Guide possible over a short span of time. We would like to thank them for their contribution.

We hope that every BIM user can truly reap the benefits of BIM by integrating it into his/her day-to-day workflow – from feasibility study to facility management. We hope that BIM users can use these guides as a platform to jumpstart their BIM adoption, before they leap to greater heights, innovating and transforming their workflow.

BIM is a journey. We envisage that it will grow with time and will inspire more advanced and innovative use of BIM. I would like to encourage all BIM practitioners to join in this industry effort to grow this Guide into a wealth of BIM knowledge.

Dr John Keung

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1 INTRODUCTION

The ***Singapore BIM Guide Version 2*** aims to outline the various possible **deliverables, processes and personnel / professionals** involved when Building Information Modelling (BIM) is being used in a construction project.

Users can use the Guide to clarify the **roles and responsibilities** of project members when using BIM in a construction project. The roles and responsibilities are then captured in a **BIM Execution Plan,** to be agreed between the Employer and project members.

BIM DELIVERABLES

- This chapter specifies the ***"what"*** to be produced by the respective project member(s) at different stages of a project to meet a set of BIM objectives. All the agreed deliverables are indicated in the **"BIM Objective and Responsibility Matrix"**.

- Each deliverable usually consists of a set of **BIM model elements** (or **elements**). Each element is usually a digital representation of the physical and functional characteristics of an actual building component to be used in the project.

- Each element usually consists of a set of **geometric representations** and **non-geometric attributes**, which can be increased in details as the project progresses.

- This guide also attempts to address the **additional effort** likely to be expended upfront to build up an information-rich BIM model or to perform other BIM value-added services for the project.

BIM PROCESSES (MODELLING AND COLLABORATION PROCEDURES)

- This chapter defines the *"how"* and the steps taken to create and share the BIM deliverables at different stages of the project.

- A set of possible **modelling guidelines** is provided in this Guide to guide the project members in **creating the BIM deliverables** at different stages of the project.

- A set of possible **collaboration procedures** is also provided in this Guide to assist the project members in **sharing the BIM deliverables** with other project members at different stages of the project.

BIM PROFESSIONALS (BIM MANAGER AND BIM COORDINATOR)

- This chapter outlines the ***"who"*** – typical new professionals known as the **BIM manager and BIM coordinator.** They are responsible for the definition, management and completion of the BIM Execution Plan.

The use of BIM can be incorporated into the project as part of the scope of services under the Principal Agreement with the help of the ***BIM Particular Conditions Version 2.***

2 BIM EXECUTION PLAN

To effectively introduce BIM into the project delivery process, it is important for the project team to develop a BIM Execution Plan at the early stages of a project. It outlines the overall **vision and along with implementation details** for the project team to follow throughout the project. It is usually defined at the start of the project and when new project members have been appointed, to accommodate their participation.

A BIM Execution Plan helps the Employer and project members to document the agreed BIM deliverables and processes for the project. The Principal Agreement can make reference to the BIM Execution Plan to define the roles and responsibilities of the project members for their BIM deliverables.

By developing a BIM Execution Plan, the Employer and project members can:

- Clearly understand the strategic goals for implementing BIM on the project;
- Understand their roles and responsibilities for Model creation, maintenance and collaboration at different stages of the project;
- Design a suitable process for them to participate in the implementation;
- Outline additional resources and services that may be needed; and
- Provide a baseline plan to measure progress throughout the project

The content of a BIM Execution Plan includes the following:

- Project information;
- BIM goal & uses;
- Each project member's roles, staffing and competency;
- BIM process and strategy;
- BIM exchange protocol and submittal format;
- BIM data requirement;
- Collaboration procedures and method to handle shared Models;
- Quality control; and
- Technology infrastructure & software

The BIM Execution Plan can be appended with additional information to facilitate additional members to join the project at later stages. Updates to the BIM Execution Plan should be made with the permission of the Employer or his appointed BIM Manager and should not go against conditions of the Principal Agreement.

For more information on the BIM Execution Plan, please refer to the ***BIM Essential Guide For BIM Execution Plan***, which also includes a BIM Execution Plan template.

3 BIM DELIVERABLES

This chapter defines "what" – the BIM deliverables" to be produced by the respective project member(s) at different stages of a project to meet a set of BIM objectives. All the agreed deliverables are indicated in the "BIM Objective and Responsibility Matrix".

BIM project deliverables should be agreed upon together with deliverable dates at the start of the project and after the main project members have been appointed so as to accommodate their participations. Some of the typical deliverables are shown below:

- Site model
- Massing model
- Architectural, structural, MEP models
  - For regulatory submissions
  - For coordination and / or clash detection analysis
  - For visualization
  - For cost estimation
- Schedule (material, time etc) and phasing program (in BIM or spreadsheet)
- Construction and fabrication models
- Shopdrawings
- As-built model (in native proprietary or open formats)
- Data for facility management
- Other additional value-added BIM services

3.1 BIM ELEMENTS

Each deliverable usually consists of a set of BIM model elements (or elements). Each element is usually a digital representation of the physical and functional characteristics of an actual building component to be used in the project. A typical set of BIM elements for a project can be found in Appendix A, categorized according to discipline.

3.2 ATTRIBUTES OF BIM ELEMENTS

An important aspect of BIM is the ability to contain information in the model. This information can come in geometric and non-geometric forms.

Table 1: Examples of Geometric and Non-Geometric Attributes of BIM Elements

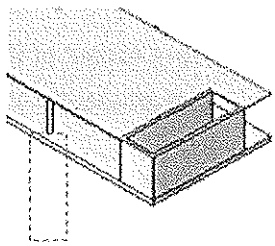
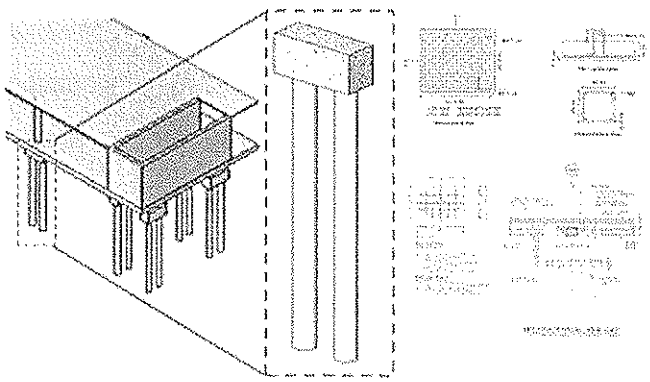
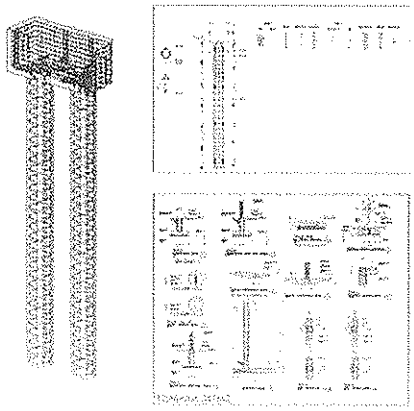
	GEOMETRICAL ATTRIBUTES	NON-GEOMETRICAL ATTRIBUTES
Examples	• Size	• System data
	• Volume	• Performance data
	• Shape	• Regulatory compliance
	• Height	• Specifications
	• Orientation	• Cost

There are a number of national and international efforts attempting to define and standardise the attributes for each BIM element. It is recommended that attributes of a BIM element be determined to meet their intended usage so as to avoid over specifying. References include:

- VA Object/Element Matrix www.cfm.va.gov/til/bim/BIMGuide/downloads/oemf.xls
- Level of Development (LOD) Specification bimforum.org/lod/

3.2.1 Model Progression

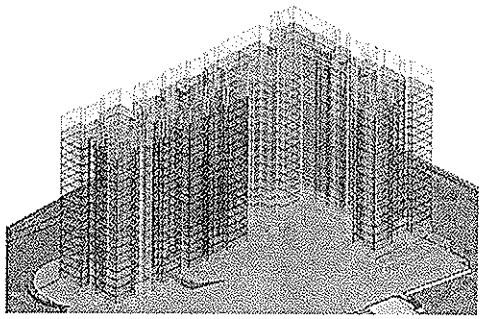
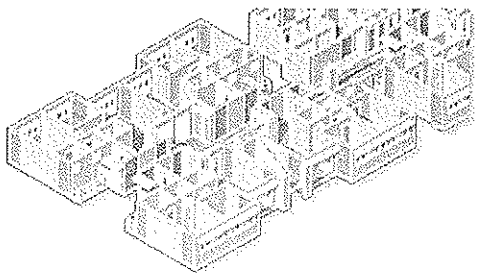
The attributes of a BIM element can change/increase in details as the project progresses. For example, the piling BIM element on the following page shows how its geometric information changes throughout a project, and how this information is represented.

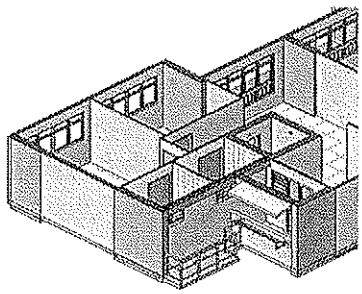
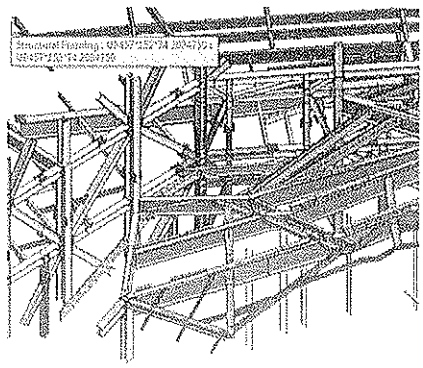
PROJECT STAGES	DETAILS OF BIM
At early design stage, piling may not be modelled due to lack of information	
At the detailed design stage, the piling details have been developed from structural analysis and design. The pile cap and piles are also accurately modelled and located in the BIM model. 2D details such as rebars can be used to complement the BIM model	
During the construction stage, more detailed information is modelled for the piling. Rebars can also be represented in the model in 3D. It is also acceptable to represent the details in 2D shopdrawings	

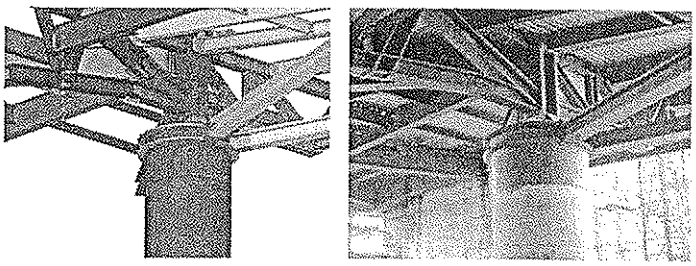
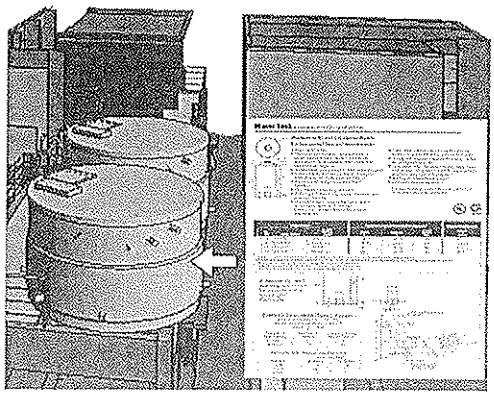
3.2.2 BIM vs 2D Practices

It is essential for local BIM users to relate the BIM deliverables to the current 2D practices. One such example is shown in Table 2.

Table 2: Example of BIM deliverables at different stages

PROJECT STAGES • MILESTONES	2D DRAWING SCALES	GENERAL LEVEL OF DETAIL OF EACH BIM MODEL ELEMENT / ASSEMBLY
Conceptual Design • **Outline Planning Permission** • **Project Feasibility**	1:200 to 1:1000	Building massing studies or other forms of data representation with indicative dimensions, area, volume, location and orientation  **BIM deliverable: massing model (Source: HDB)**
Schematic / Preliminary Design • **Planning Approval** • **Design & Build Tender Documentation**	1:200	Generalized building component or system with approximate dimensions, shape, location, orientation, and quantity. May include non-geometric properties.  BIM deliverable: preliminary design model (Source: HDB)

PROJECT STAGES • MILESTONES	2D DRAWING SCALES	GENERAL LEVEL OF DETAIL OF EACH BIM MODEL ELEMENT / ASSEMBLY
Detailed Design • Building Plan Approval • Continued Design & Build Tender Documentation or • Design-Bid-Build Tender Documentation	1:200	More detailed version of a generalized building component or system with accurate dimensions, shape, location, orientation, and quantity. Non-geometric properties should be provided.  **BIM deliverables (from left): detailed design model, BIM-generated detailed drawings (Source: HDB)**
Construction • Constructability • Fabrication	1:5 – 1:100	BIM element is modelled with complete fabrication and assembly details over and above the Detailed Design stage where applicable or useful for construction works; otherwise, details may be represented in 2D CAD drawings to complement the Detailed Design stage level of detail.  BIM deliverable: Steel Framing model (Source: Hexacon Construction Pte Ltd)

PROJECT STAGES • MILESTONES	2D DRAWING SCALES	GENERAL LEVEL OF DETAIL OF EACH BIM MODEL ELEMENT / ASSEMBLY
As-Built • TOP / CSC • Final	1:100	BIM element is similar in level of detail to the Detailed Design stage, but updated with changes during the Construction stage.  **Comparing the as-built structural model (BIM deliverable, left) with actual site (right) (Source: Hexacon Construction Pte Ltd)**
Facility Management • O & M	1:50	BIM element is modelled as an actual constructed building component or system and is an as-built representation of the actual completed building.  Water storage tank element with attached specification PDF (Source: HDB)

3.3 BIM OBJECTIVE & RESPONSIBILITY MATRIX

The BIM Objective and Responsibility Matrix indicates the basic BIM deliverables (1) required to meet each BIM Project Objective (2). A BIM Project Objective also refers to the use of BIM in a particular stage of the project. It also shows which project members (3) are involved in each objective. Columns can be increased or reduced, depending on the number of users (by discipline) involved in the BIM process of the project (4). The last step of defining the matrix is to indicate whether the selected project member is a **model author** or **model user** for each deliverable. (5) A matrix template can be found in Appendix B.

2 BIM Project Objective	3 Project members involved in fulfilling the objective A – model author; U – model users Arch	Struc	MEP	PM	Cont-ractor
Name of building stage: _____ *General description of BIM in this building stage:* _____ *Example:* ***Detailed Design*** *More detailed version of a generalized building component or system with accurate dimensions, shape, location, orientation and quantity. Non-geometric properties should be provided.*					
BIM Project Objective: _____ BIM deliverable(s) to be achieved through this objective: _____ *Example:* 13. Maintain and update the Structural Model, based on the latest Architectural Model ◦ Design, analysis and detailing ◦ In preparation for regulatory submission ◦ In preparation for tender 1 Suggested Deliverable - Structural Model and Calculation	U	A	U	U	FOR REFER-ENCE ONLY

3.3.1 Model Author

The model author is a party responsible for the creation and maintenance of a specific model to the level of detail prescribed in the BIM Project Objectives & Responsibility Matrix. In creating and maintaining the model, the model author does not convey any ownership right of the model. Any subsequent model author's or model user's right to use, modify and transmit the model is specifically limited to the scope of the project. The Employer may specify for ownership of the model in the Principal Agreement. Before providing the model to model users, it is recommended that the model author should perform quality control checks of their models (Refer to Chapter 4.5, page 23)

3.3.2 Model Users

Model users are parties authorised to use the model on the project. The model can be provided in native or neutral (such as IFC) format for the model users' reference and use related to the project. Although model authors have checked the accuracy and quality of the model before sharing with model users, model users should use the model for reference only, and should also check, verify and otherwise confirm the accuracy of the model. Where inconsistency is found in the model, the model user shall promptly notify the model author for clarification. The model users shall make no claim against the author in connection with the use of the model. The model users shall also indemnify and defend the model author against all claims from or related to subsequent use or modification by the model users.

3.4 COMPENSATION EXPECTATIONS

In general, additional upfront preparation is required for one to use BIM effectively and to build up an information rich BIM model as compared with the current use of 2D for design and construction. This upfront work starts with design consultants working on the BIM model at various design stages, as well as with builders who build a construction model from 2D drawing or design BIM model. It is essential to recognise this upfront effort by all the parties.

The Singapore BIM Steering Committee, recognizing that BIM adoption increases efforts at the design stages, recommends a 5% shift in percentage-based consultancy fee payment, from the Construction to Design stages, as illustrated in Table 4. However, this upstream shift of effort does not necessarily result in increased in the consultancy fees.

Table 4: Example of a Payment Schedule in a BIM Project

Project Stage	% change from non-BIM to BIM payment
Preliminary Design	+2.5
Planning Approval	0
Design Development	+2.5
Tender and Award	0
DESIGN STAGES *	+5
Construction Administration	-5
Post construction	0
CONSTRUCTION STAGES*	-5
Percentage change in total fees	0

* refers to cumulative percentage fees

When releasing design BIM from designers to builders, there may be some cost implications. The Singapore BIM Steering Committee also recommends that this cost should be made known to all builders at the tender stage.

3.5 OTHER ADDITIONAL VALUE-ADDED BIM SERVICES

With BIM, digital analysis may be performed to better understand the performance of the building. These analyses should be considered as additional services. Examples of such services may include the following:

- Environmental simulation and analysis (for Concept Design Purpose only)
- Energy validation to estimate energy usage requirements
- Lighting design validation & visualization
- 4D construction scheduling and sequencing (applicable for Design & Build projects)
- Green Mark, RETV, Buildability and Constructability Scores based on BIM model(s)
- BIM model of existing building(s) for master plan site study and feasibility analysis (A&A)
- Providing Structural and MEP system alternatives based on conceptual massing models
- Project cost estimates based on conceptual massing models
- MEP cost estimates based on MEP BIM model

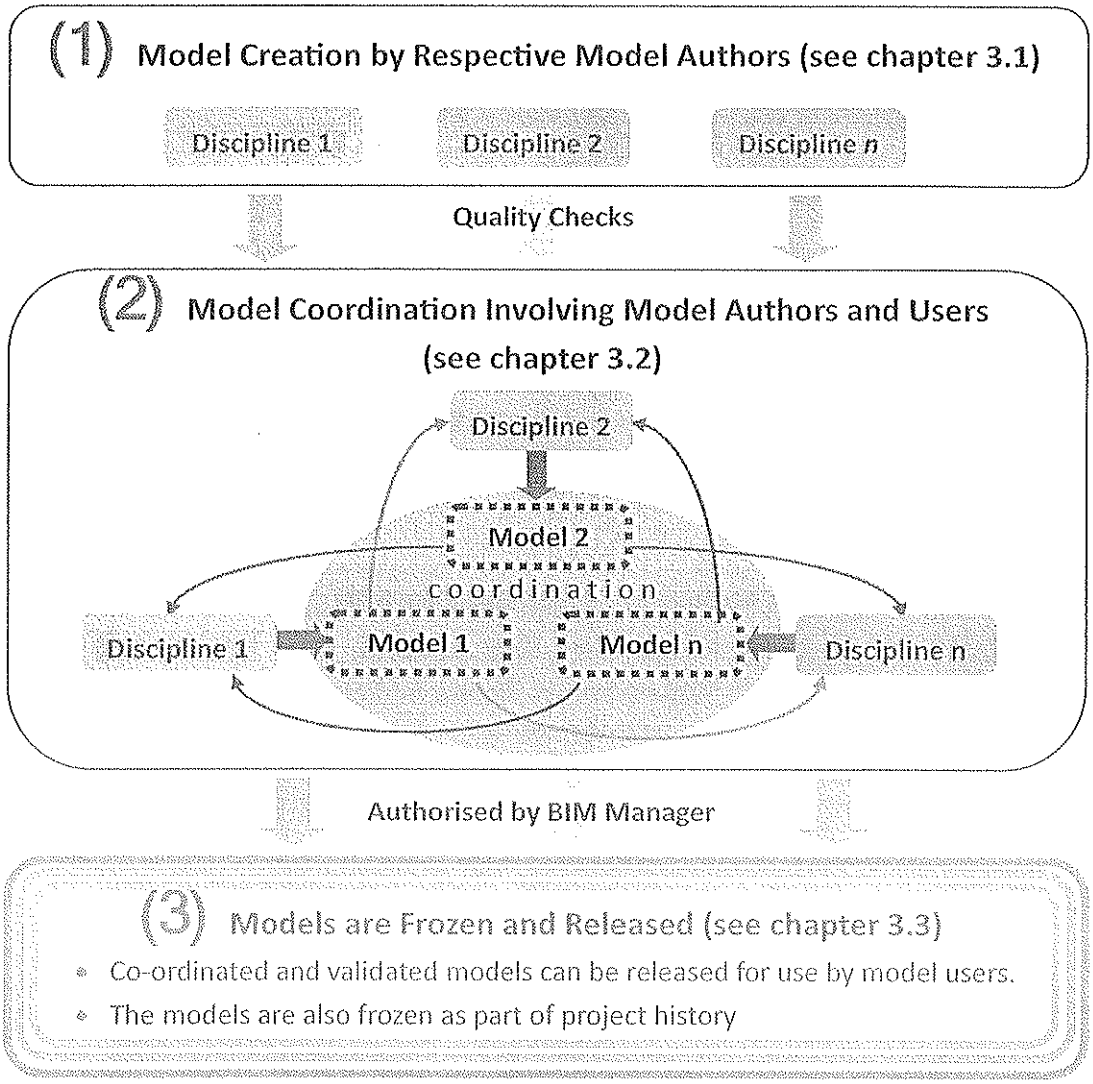
The Employer should understand the potential cost implication for asking such value-added BIM services. It is recommended that additional fees are negotiated among the parties involved.

Furthermore, if BIM services required in the BIM Objective & Responsibility Matrix are agreed to be necessary at an earlier project stage than indicated, these services could also be recognized as additional effort from respective Model Authors. This is because less data is available at an earlier project stage, thus the authors may require additional effort to be able to perform the BIM service.

4. BIM Modelling and Collaboration Procedures

This chapter defines "how" BIM is to be created and shared throughout the project.

A typical BIM process involves model creation (1), model coordination and data exchange (2) involving a team of model authors and users. Upon resolution of identified issues (e.g. coordination clashes) during each project milestone, a version of model can then be frozen and released to the model users (3).



4.1 INDIVIDUAL DISCIPLINE MODELLING

At this stage each model author will create his model according to the agreed deliverables as stated in the BIM Execution Plan. The model is stored in and worked on, by the modelling team of each author and has not yet been checked and verified for use outside of the team.

To ensure modelling quality, Model Authors should set up and follow a minimum standard of modelling requirements during BIM project implementation.

4.1.1 Modelling Guidelines for BIM Elements

A set of modelling guidelines for key BIM elements at different stages of a project can be found in Appendix C of this document. The modelling guidelines are grouped by Architectural, Structural and MEP disciplines in this version of the document.

In general, each element will be modelled according to its size, shape, location, orientation and quantity. At the early stages of the project, element properties are more generic and approximate, but become more specific and increases in accuracy as the project progresses.

4.1.2 Modelling Guidelines for Regulatory Submission

Architectural, Structural and MEP modelling guidelines and templates for Singapore BIM e-submissions for regulatory purpose can be found at
http://www.corenet.gov.sg/integrated_submission/bim/bime_submission.htm

4.1.3 Model Orientation

The origin point of the project should be clearly defined and drawn in the SVY21 coordinate system and with reference to the SLA Vertical Control Point (VCP) plus 100m.

4.1.4 Model Division and Structure

Depending on the size of the building and/or the phasing for the project, it may be necessary to divide the model into separate parts, zones and levels. This should be agreed and documented by the modelling team as early as possible.

4.1.5 Revision Management

The model will evolve rapidly during the project stages. Changes should be tracked and documented, especially when the model creation task is divided into a few smaller packages and handled by different people.

There are various software mechanisms to assist BIM authors and users to manage and monitor design changes. BIM authors and users should work with their respective BIM vendor to familiarise themselves with the use of these software mechanisms so that design changes can be managed more effectively. The BIM coordinator for each discipline could play the role of maintaining a register to record the latest information incorporated in the model. They should work closely with the BIM manager to coordinate the version of model shared or exchanged.

4.2 CROSS-DISCIPLINARY MODEL COORDINATION

Project members should share their models with other project members at regular intervals for reference. At certain milestones, models from different disciplines should be coordinated, allowing involved parties to resolve potential conflicts upfront and avoid costly abortive works and delays at the construction stage. Prior to model coordination, the respective models should be checked, approved and validated as "fit for coordination" (see section 4.5 for more information).

It is recommended for the project team to map out a high level coordination flow, as seen in Table 5 on the next page, which shows the interactions between the Employer and project members.

Table 5: Example of a BIM Project Collaboration Map

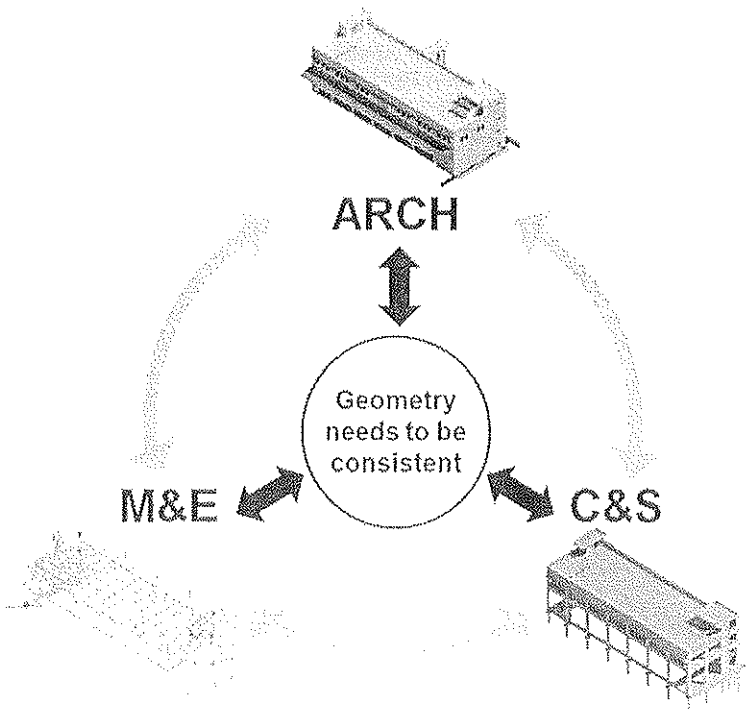
	Employer	Architect	Consulting Engineers	Contractor / Quantity Surveyor
Conceptual Design	Provide requirements related to form, function, cost and schedule	Begin design intent model with massing concepts with site considerations	Provide feedback on initial building performance goals and requirements	Provide feedback on initial building cost, schedule, and constructability *
Schematic Design	Provide design review and to further refine design requirements	Refine Design Model with new input from Employer, Consulting Engineers, and Construction Manager	Provide schematic modelling, analysis and system iterations as Design Model continues to develop	Provide design review and continued feedback on cost, schedule and constructability*
Detailed Design	Design reviews. Final approval of project design and metrics	Continue to refine Design Model. Introduce consultants models and perform model coordination	Create Discipline-specific Design Models and Analyses	Create Construction Model for simulation, coordination, estimates, and schedule*
		Finalize Design model, Tender Documents and Specifications, Regulatory Code Compliance	Finalize Discipline specific Design Models, Tender Documents and Specifications, Code Compliance	Enhance Construction Model and perform final estimate & construction schedule, Manage bid process
Construction	Monitor construction and give input to construction changes and issue	Respond to construction RFI's Perform contract administration, update Design Model with changes	Respond to construction RFI's and update Discipline specific Design Models, field conditions, and commissioning	Manage construction with subcontractors and suppliers, inform changes to Design Model
As-Built		Verify As-built model	Verify As-built model	Prepare As-built model
Facility Management	Engage Architect and Facilities Group for handing over	Coordinate information exchange through model to Facilities Group	Prepare handover documentation	

* Applicable to Design & Build projects where the Main Contractor is appointed at the Conceptual Design stage

The project team could leverage on the available software solutions to perform the coordination effectively. A common (software) platform is recommended, to reduce possibilities of data loss or errors when sharing different models. Issues that arose from the coordination should be documented and followed up.

Discrepancies discovered during the coordination process should be recorded, managed, and communicated to relevant model owners through coordination reports, including any specific location of interferences and suggested resolutions.

It is recommended that a revised version of the model should be frozen and signed-off after the issues identified during the coordination exercise have been resolved. A digital signature can be considered to effect the protection.



Source: RSP

4.2.1 Types of Model Coordination

Successful BIM coordination requires careful planning and a clear understanding of different types of coordination process i.e. design coordination, clash detection or space validation.

In early coordination processes, entire models can be run against other models to determine the scope of interference, i.e. objects, elements and selection criteria, for future testing. However, it is important to recognize that not all conflicts detected are problems. Certain conflicts may have been intentional during the modelling process for the sake of simplifying the modelling process. Proper search sets and clash rules should be set up before running the respective coordination processes, to:

- Reduce time and resources spent on detecting false positives.
- Hide elements that are unnecessary in the coordination process, for example, known issues that are to be resolved in later project stages; elements that do not impact the cost when changed on site, etc
- Group particular elements for a specific type of coordination process, such as forming groups between a ceiling search set and an MEP model only during a clash analysis

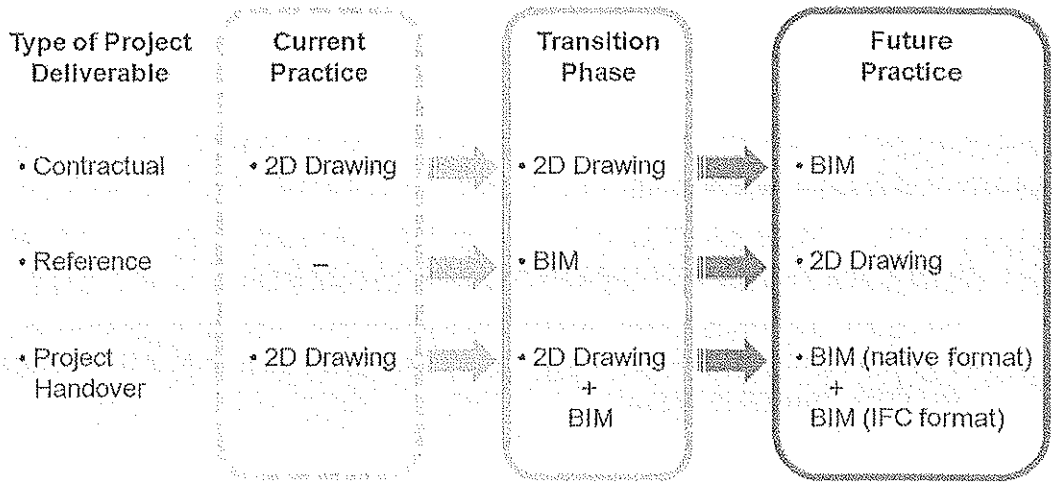
Clash results need to be judged in the context of the elements being analysed, and the type of clash detection software being used. For example, one issue that may occur are duplicate instances of the same clash – for example, a pipe hitting steel could represent 20 clashes when in reality it is only one single issue.

Responsibilities during the coordination process

- Each party owns a discipline-specific model
- During coordination, different models can tap on appropriate software depending on the type of coordination needed
- To resolve clash conflicts, each party carries out agreed changes on their own discipline-specific model
- Liabilities of each discipline-specific model remain the same, before and after the analysis.

4.3 MODEL & DOCUMENTATION PRODUCTION

As of today, the Singapore construction industry is at the "Transition Phase" from the use of 2D drawings to BIM models. In the event of conflict between the contract documents and BIM model, the contract documents shall take precedence over the model.



The changing status of 2D drawings and BIM from current to future practice

4.3.1 Publishing 2D Drawings

Before the industry is ready to accept BIM as part of the contractual documents, there is a need for project members to agree on the standard for 2D drawings that form part of the contract documents. 2D drawings include plans, sections, elevations, details and RFIs, etc.

It is recommended to generate 2D drawings directly from the BIM model, to ensure there are no discrepancies as much as possible. 2D drawings/ details not produced from the BIM models should be clearly labelled.

While the respective disciplines will maintain their own drawing list, drawing numbering and sheet naming systems, the team could determine a common naming convention of views, legends, schedules, sheets and links that could provide a common reference to the corresponding 2D design drawings, tender drawings, working drawings and as-built drawings.

4.3.2 BIM Exchange Formats

Collaboration parties shall also agree on the BIM exchange protocol and submittal format (proprietary or open standard) in the BIM Execution Plan.

To ensure the life-cycle use of building information, information supporting common industry deliverables shall be provided in existing open standards, where available. For those contract deliverables whose open standard formats have not yet been finalised, the deliverable shall be provided in a mutually agreed format which allows the re-use of building information outside the context of the proprietary BIM software. The format could be any of the prevailing open standards, such as the International Foundation Class (IFC) standard, where available. The formats used should be specified in the BIM Execution Plan.

4.3.3 Documentation after Coordination

All output data from BIM models, including published, superseded and 'as-built' data, should be archived in the project folder.

Additionally, at key milestones of the project stages, a complete version of the BIM data and associated deliverables should be copied into an archive location and stored as a record that should not be altered for any reason. It is recommended that the BIM archive consists of two sets of files. The first should be a collection of individual BIM models and associated deliverables as received from the respective Model Authors. The second set of files should consist of the aggregate of those individual BIM models in a format suitable for archiving and viewing.

4.4 DATA SECURITY & SAVING

A data security protocol should be established to prevent any possible data corruption, virus "infections," and data misuse or deliberate damage by project team members, other employees or outside sources. Adequate user access right should be established to prevent data loss or damage during file exchange, maintenance, and archiving. BIM project data residing on network servers should be subjected to regular back-ups.

4.5 QUALITY ASSURANCE AND QUALITY CONTROL

The BIM Manager should establish a quality assurance plan for the BIM models, to ensure appropriate checks on information and data accuracy.

The respective BIM coordinator of each discipline should also establish a quality control procedure to ensure that the discipline model is accurate and correct according to the modelling guidelines.

Each project member should be responsible for performing quality control checks of their design, dataset and model properties before submitting their deliverables.

The following should be considered when determining a quality assurance plan:

- Modelling Guidelines
  - Ensure that the model is created based on the modelling guidelines and CAD standards
- Dataset Validation
  - Ensure that the dataset are populated with correct data.
- Interference Check
  - Detect any clashes between two building components using a Clash Detection software
- Validation of BIM data to be used for Cross-Disciplinary Model Coordination
  - All drawing sheets and extraneous views should be removed from the BIM
  - Each model file should be checked, purged and compressed;
  - File format and naming conventions conform to project Data Exchange protocols.
  - Data segregation conforms to the agreed methods in BIM Execution Plan
  - Model files are up-to-date, containing all users' local modifications
  - Model files are detached from central file
  - Any linked reference files have been removed and any other associated data required to load the model file is made available
  - Model is correctly assembled through visual inspection
  - Any changes since the last issue are communicated to the project team.

More details on Quality Assurance can be found in Appendix C.

4.6 WORKFLOW OF DESIGN-BUILD PROJECTS

The Design-Build project delivery method allows for a single model that is developed to produce the construction documents and fabrication of the building systems.

- Establish a BIM execution plan prior to modelling;
- In schematic design, designers, in collaboration with subcontractors, will create BIM models to meet predefined project requirements.
- Integrate the BIM models into a composite model for coordination and clash detection.
- Interferences will be resolved interactively during coordination meetings;
- Once all conflicts have been resolved, construction documents can be produced
- The Design-Build team will hold installation planning meetings where the coordinated model will be used for review and field installation.
- Allows for accurate digital fabrication of key components off site to be items such as structural steel, precast components, prefabricated units (e.g. facade units).

4.7 WORKFLOW OF DESIGN-BID-BUILD PROJECTS

The traditional Design-Bid-Build project delivery method divides the BIM process into two models - a design model and a construction model. The consultants generate the design model and tender documents. The Main Contractor generates the construction model for construction purposes.

Pre-Tender Stage

- Establish a BIM execution plan prior to modelling;
- Create architectural and system models by design teams;
- Integrate design models for coordination and clash detection;
- Interferences will be resolved interactively during coordination meetings;
- Once all conflicts have been resolved, design and tender documents can be prepared;

Construction Stage

- Models and/or drawings generated from the models will be released to the main contractor for reference only;
- The Main Contractor will develop the model further with construction and fabrication details with fully annotated drawings for/by the sub-contractors

5 BIM Professionals

To facilitate the BIM processes, two new professionals known as BIM Manager for Project, and BIM Coordinators for Consultants and Contractors have been identified in Table 6 below. **These new roles can be undertaken by existing members in the project team**, such as CAD managers, project managers, consultants, contractors, etc.

Besides ensuring that BIM objectives are achieved, the BIM Manager should also ensure that all parties work collaboratively to resolve conflicts in the most efficient way.

The role of the BIM Manager does not include making decisions about design, engineering and construction solutions for the project, nor organizational processes for each discipline.

Table 6: Overview of Responsibilities for New BIM Roles

ROLE	RESPONSIBILITIES IN MODEL MANAGEMENT
Project BIM Manager **(This role can be played by the lead consultant or BIM specialist appointed by the employer or project manager)**	Facilitate the definition and implementation of: • BIM Execution Plan • BIM Goal and Uses • Responsibility Matrix • BIM Deliverables • Delivery Schedules • BIM Modelling Quality Control • BIM Coordination
BIM Coordinator for Consultant	<u>At Design and Construction Stage</u> • Create BIM Design Models and Documentation • Define discipline-specific BIM uses including analysis • Coordinate between BIM modellers, design consultants and cost consultant • Coordinate with contractor and subcontractors • Ensure Modelling Quality Control

ROLE	RESPONSIBILITIES IN MODEL MANAGEMENT
BIM Coordinator for Contractor	At Construction Stage • Coordinate with design consultants and sub-contractors • Study tender documents • Review Design Models and Fabrication Models and Drawings • Use BIM for coordination, sequencing, constructability and cost studies, and field use • Create construction and as built models • Ensure Modelling Quality Control

References

- BCA BIM Submission Guideline for Architectural, Structural and MEP Disciplines
- Finland Sanaatti Properties, BIM Requirements (2007)
- HKIBIM's BIM Project Specification (2011)

Appendix A – Typical BIM Elements by Discipline

Kindly tick and write down the attributes of the selected elements on the table.

(I) ARCHITECTURAL BIM ELEMENTS

	Element	Elements or Parameters needed by each non-Architectural discipline
Site Model	Site infrastructure within site boundary (roads, pavements, car park spaces, access and parking arrangements and surrounding land use)	
	Street fire hydrant (only indication of locations necessary)	
	Surface drainage (only indication of locations necessary)	
	External drainage & underground drainage	
	Hard landscaped areas within site boundary	
	Planter boxes including sub-soil drainage systems	
	Massing of adjacent buildings relevant to project	
Rooms / Spaces	Room spaces, corridors, other spaces, plant and equipment rooms (including designated use)	
Walls and Curtain Walls	Interior / Exterior walls / Non-structural walls / Blockwork walls (*Including finishes to identify if tiled / painted / plastered)*	
	Curtain wall with mullions and transoms with true profile and window glazing units including shading devices	
Doors, Windows and Louvers	Interior / Exterior doors	
	Interior / Exterior windows	
	Louvers	
Basic structure	Beams (based on location and size indicated by the Structural Engineer)	
	Columns (based on location and size indicated by the Structural Engineer)	
Roofs	Roofs with overall thickness (including finishes & insulation)	
Ceilings	Ceilings (without support sub-frames) including module arrangement, material choices and finishes.	
	Hangars and sub-frames for ceilings*	
Floors	Horizontal floors	

	Sloped floors and ramps	
	Floor finishes details including tiling, carpet, screed only	
Vertical Circulation	Steps & stairs including risers, threads and railings including headroom clearance requirements	
	Elevator shafts (without fit-out installations by lift contractor)	
	Access ladders and catwalks	
Architectural Specialties and Casework	Precast / Prefab / GRC / Fibreglass facades	
	Railing & parapets, including mesh & metalwork	
	Fixed Building Maintenance Units in their overall bulk form	
Schedules	Schedules allowing information to be extracted from elements	
Fixtures and Equipment * (with input from interior designers, specialist sub-contractors, etc)	Loose furniture including desks and computer workstations, casework (carpentry), including upper and lower cabinets	
	Appliances such as in kitchen equipment	
	Toilet fixtures, plumbing faucets	

* these elements may cause BIM models to become too big and unmanageable.

(II) STRUCTURAL BIM ELEMENTS

Element	Elements or Parameters needed by each non-Structural discipline
Foundations including piles, pile caps, tie / ground beams & footings	
Diaphragm walls & retaining walls	
Beams	
Columns	
Walls	
Slabs, including slab on grade and floating slab, recesses, curbs, pads and major penetrations	
Other types of transfer structure not mentioned above	
Stairs (steps, risers, threads, landings): all framing members and openings	

Shafts and Pits (and openings)	
Precast & Prestressed concrete systems: all primary and secondary elements	
Temporary structures and platforms	
Concrete reinforcement details (Rebar), imbeds and cast-ins *	
Steel frame structures including bracing systems *	
Base plates, bolts, clip angles, fixings, etc. *	
Connection details of structural steel members *	

* these elements may cause BIM models to become too big and unmanageable.

(III) CIVIL BIM ELEMENTS

	Element	Elements or Parameters needed by each non-Civil discipline
Digital Terrain Model (DTM) ❄	3D surface based on topography that shows site conditions and building locations Include existing walkways, roads, curbs, ramps and parking lots etc	
Geology Report △	Soil investigation report (A BIM Model is not required)	
Utilities Model	All points of connection for existing and new utilities within site boundary	
Rainwater & storm water pipe work	Includes outlets, surface channels, slot channels and manholes	
Underground Public Utilities	For drainage only	
Others	Drains, canals, crossings, retaining walls, and underground harvesting tanks	
	Underground electrical supply cables and sewer lines, IDA (telecom) line and Gas Lines.	

❄ Data of Digital Elevation Model to be provided by registered surveyors

△ Data of Geology Report to be provided by geotechnical engineers

(IV) ACMV BIM ELEMENTS

	Element	Elements or Parameters needed by each non-ACMV discipline
ACMV Equipment	Air Handling unit	
	Chiller unit	
	Variable refrigerant unit	
	Cooling Tower	
	Split-type indoor & outdoor air conditioning units	
	Exhaust or extract air fans	
	Fresh air fans	
	Other fans such as jet fans	
	Heat Exchanges for projects with District Cooling	
ACMV Distribution	Exhaust air ducts (excluding hangars)	
	Fresh air ducts (excluding hangars)	
	Supply air ducts (excluding hangars)	
	Return air ducts (excluding hangars)	
	Transfer air ducts (excluding hangars)	
	Diffusers, air-boots, air grilles, air filters, registers	
	Fire dampers, motorized dampers, volume control dampers, CO_2 sensors, CO sensors	
Mechanical Piping	Chilled water supply pipes including connections, fittings & valves	
	Chilled water return pipes including connections, fittings & valves	
	Condensate drain pipes including connections, fittings & valves	
Others	Switch boards, control, BMS & DDC panels, BMS control & monitoring modules	
	Fan Coil unit	
	Engineering Smoke Extract System (e.g. smoke curtains, ductless fans)	

(V) PLUMBING AND SANITARY BIM ELEMENTS

Element	Elements or Parameters needed by each non-Plumbing and Sanitary discipline
Pipe supports and brackets *	
Pumps	
Control panels, monitoring and control sensors	
Plumbing BIM Elements only	
Fresh water piping, fittings, valves including hot & cold water pipe work with all plumbing equipment, sinks	
Water meters	
Storage, water holding tanks	
Pressure Vessels	
Underground Public Utilities for water supply	
Underground Public Utilities for drainage	
Grey water systems	
Pool filtration equipment	
Sanitary BIM Elements only	
Foul drainage, kitchen waste pipe work including floor drains, open trapped gullies, sealed trapped gullies and clean outs, vents and manholes	
Grease and sand traps	
Sump and sewage pits	

* these elements may cause BIM models to become too big and unmanageable.

(VI) FIRE PROTECTION BIM ELEMENTS

Element	Elements or Parameters needed by each non-Fire Protection discipline
System piping, droppers, fittings, valves and sprinkler heads, sprinkler inlets, sprinkler control valve set, subsidiary valves, flow switches	
Pipe supports and brackets *	
Fire alarm gongs & break glass unit	
Fire sprinkler pumps	
Sprinkler tanks	
Hydrants and hose reels (location of street fire hydrant determined by architects)	
Gas piping for suppression systems	
Heat or smoke detectors, control panels, monitoring and control sensors, pump panels, check meter positions	
Fire extinguishers	
Fire shutters & hoods above	
Smoke Curtains	

* these elements may cause BIM models to become too big and unmanageable.

(VII) ELECTRICAL BIM ELEMENTS

Element	Elements or Parameters needed by each non-Electrical discipline
Cable trays, trunking & cable containment, electrical risers, conduit, bus duct, power feeds	
Outlets, panels, wall switches, circuiting to devices, security devices, card access and "plug moulds" (socket points)	
HV & LV switch boards, switchgear, MCCB boards, MCB boards	
Transformers	
Light fittings & fixtures & housings for light fixtures	

Conduit associated with access, data communication, security systems and electrical equipment	
Telecom equipment and computer racks	
Generators and exhaust flues including acoustic treatments	
Diesel tanks & fuel pipes	
Security system including CCTV camera, smart card system, door monitoring system	
Car park control system, barrier gates	
Equipment and associated installations maintained by public utility companies (including manholes / drawpits for the Power Grid)	
Earthing and lightning protection system	
Lifts, PA systems, BMS equipments including display panels (e.g. power consumption display)	

* these elements may cause BIM models to become too big and unmanageable.

(VIII) GAS BIM ELEMENTS

Element	Elements or Parameters needed by each non-Gas discipline
Gas piping and supply	

Appendix B – BIM Objective & Responsibility Matrix (Basic)

Below is an example of a Basic BIM Objective & Responsibility Matrix, from the Conceptual to the FM Stages. The BIM Manager column is optional.

Abbreviations

Project members indicated in the matrix:

- Architect (Arc)
- Civil or Structural Engineer (Str)
- Mechanical, Electrical & Plumbing Engineer (MEP)
- Quantity Surveyor (QS)
- Registered Surveyor (RS)
- Contractor (CON)
- Facility Manager (FM)

Project members involved in the matrix are not limited to the above six professions. Other representatives can be added to the BIM Project Objectives & Responsibility Matrix, such as:

- Project Manager
- Specialist Consultants
- Landscape Designer
- Sub-Contractor
- Specialist Sub-Contractor

BIM Project Objective	BIM Manager	Project members involved in fulfilling the objective A – model author, U – model users							
		Arc	Str	MEP	QS	Con	RS	FM	Others
Conceptual Design *Building massing studies or other forms of data representation with indicative dimensions, area, volume, location and orientation*									
1. All project members appointed at this stage to agree on needs, objectives, process and outcomes of the project. Suggested Deliverable • BIM Execution Plan agreed and signed by related parties									
2. Create site BIM models for master plan site study and feasibility analysis. - Site Analysis									

BIM Project Objective	BIM Manager	Project members involved in fulfilling the objective A – model author; U – model users							
		Arc	Str	MEP	QS	Con	FS	FM	Others
- Apply an Outline Planning Permission if necessary Suggested Deliverable ◦ Site Model									
3. Create and compare BIM massing models - Space areas and volumes - No. of massing models depend on no. of conceptual design alternatives Suggested Deliverables ◦ BIM Massing Models									
4. Generate, freeze and store final documentation of the authorized BIM model in the Conceptual Design phase before progression into the Schematic / Preliminary Design stage.									
Schematic / Preliminary Design *Generalized building component or system with approximate dimensions, shape, location, orientation, and quantity. Non-geometric properties may be provided.*									
5. Develop, maintain and update one selected BIM massing model - In preparation for regulatory submission (PP, WP) Suggested Deliverable ◦ Architectural Model									
6. Develop, maintain and update structural BIM model based on the Architectural Model - Preliminary structural analysis - In preparation for regulatory submission Suggested Deliverable ◦ Structural Model									
7. Develop, maintain and update MEP BIM model based on the Architectural Model. The MEP Model may consist of Mechanical, Electrical, Plumbing, Water Piping, Fire Protection and Sewerage data. - Preliminary M&E analysis									

BIM Project Objective	BIM Manager	Project members involved in fulfilling the objective A – model author; U – model users							
		Arc	Str	MEP	QS	Con	FS	FM	Others
- In preparation for regulatory submission Suggested Deliverable • MEP Model									
8. Implement design coordination between the Architectural and Structural BIM Models. Suggested Deliverables • Preliminary Design Coordination Report (Architectural and Structural Models only)									
9. Revise project cost estimates based on the Architectural BIM Model Suggested Deliverable • Preliminary Cost Estimate									
10. Apply for and obtain Planning Approval									
11. Generate, freeze, and store final documentation of the authorized BIM model in the Preliminary Design stage before progression into the Detailed Design stage.									
Detailed Design *More detailed version of a generalized building component or system with accurate dimensions, shape, location, orientation and quantity. Non-geometric properties should be provided.*									
12. Maintain and update the Architectural Model - In preparation for regulatory submission - In preparation for tender Suggested Deliverable • Architectural Model									
13. Maintain and update the Structural Model, based on the latest Architectural Model - Design, analysis and detailing - In preparation for regulatory submission - In preparation for tender Suggested Deliverable									

BIM Project Objective	BIM Manager	Project members involved in fulfilling the objective A – model author; U – model users							
		Arc	Str	MEP	QS	Con	RS	FM	Others
• Structural Model and Calculation									
14. Maintain and update the MEP Model, based on the latest Architectural Model - Design, analysis and detailing - In preparation for regulatory submission - In preparation for tender Suggested Deliverable • MEP Model and Analysis									
15. Apply for and obtain Building Plan Approval									
16. Develop MEP cost estimates based on MEP model									
17. Implement design coordination between the Architectural, Structural and MEP Models (before issuing for tender) - Identify element conflicts and interferences - Verify valid headroom and working spaces for building operations and maintenance activities - Penetration conflicts will be addressed Suggested Deliverables • Clash Detection and Resolution Report (Architectural, Structural and MEP Models) • Spatial Validation Report									
18. Produce detailed cost estimation and Bill of Quantities (in accordance with the standard method of measurement) based on BIM models. - In preparation for tender Suggested Deliverables • Detailed Quantity Cost Estimate & BOQ									
19. Generate, freeze and store final documentation of the authorized BIM model in the Detailed Design stage, and update BIM Execution Plan before progression into the Construction stage.									
Construction *BIM element is modelled with complete fabrication and*									

BIM Project Objective	BIM Manager	Project members involved in fulfilling the objective A – model author; U – model users							
		Arc	Str	MEP	QS	Con	FS	FM	Others
assembly details over and above the Detailed Design stage where applicable or useful for construction works; otherwise, details may be represented in 2D CAD drawings to complement the Detailed Design stage level of detail. *Note: The Contractor shall be solely responsible for claims and liability arising from the use of or access to the BIM Model mentioned in items 20 to 25 below as provided under this stage.*									
20. The contractor will start and continuously update the Detailed Design BIM model to an As-Built BIM Model. The Employer will specify the modelling requirements of the As-Built BIM Model.									
21. Produce Construction Models from Architectural, Structural and MEP Models. The models will be produced in stages. Suggested Deliverables • Construction Models with Key Services Coordinated									
22. Produce schedules of materials, areas and quantities from the BIM databases for contractors' reference Suggested Deliverables • Schedules of materials, areas and quantities									
23. Sub-contractors and specialist sub-contractors will generate documents based on the Construction Models Suggested Deliverables • Shopdrawings • Fabrication models and drawings • Combined Services Drawings (CSD) • Single Services Drawings (SSD)									
24. Where an amendment submission is required from the consultants, the contractors should provide the latest record model and drawings to the consultant whenever requested during the Construction stages. Suggested Deliverables • Record model • Record model-generated drawings • Other non-BIM deliverables									

BIM Project Objective	BIM Manager	Project members involved in fulfilling the objective A – model author; U – model users							
		Arc	Str	MEP	QS	Con	RS	FM	Others
25. Generate, freeze and store final documentation of the authorized BIM model in the Construction stage before progression into the Facility Management stage.									
As-Built *BIM element is similar in level of detail to the Detailed Design stage, but updated with changes during Construction stage.*									
26. The contractor will prepare the final As-Built BIM Model to reflect amendments in the Architectural, Structural, MEP BIM models and the completed form of the construction verified before submitting to the consultants. Suggested Deliverables • Final as-built models for each discipline with the necessary third party certifications									
27. Consultants to confirm that the As-Built models are in accordance to the BIM model, corresponding to the final approved amendment plans submitted to the relevant Authorities									
Facility Management *BIM element is modelled as an actual constructed building component or system and is an as-built representation of the actual completed building.*									
28. Incorporate as-built information of major systems and equipment in the BIM model elements for provision to the Facility Manager. Suggested Deliverables • Final as-built models fit for space management, building maintenance and modifications made during occupancy by the FM / Employer									

Appendix C – BIM Modelling Guidelines

The following guidelines recommend how BIM elements should be modelled in different disciplines at different project stages. It does not state who is the Model Author required to model the BIM elements. Modelling guidelines for Facility Management will be addressed in the future version of the Guide.

(i) Overview
(ii) Quality Assurance
(iii) Architectural BIM Modelling Guidelines
(iv) Structural BIM Modelling Guidelines
(v) MEP BIM Modelling Guidelines
    a. ACMV
    b. Plumbing and Sanitary
    c. Fire Protection
    d. Electrical

(I) OVERVIEW

Disciplines / Stages	Architectural Design	Structural Design	MEP Design	Intended Use
Conceptual	Topo, Massing, Site Elements, Site Boundary, Levels, Location, Orientation	*(optional)*	*(optional)*	Site planning, Location of the building(s) on the site, Starting situation for renovation project, Investigation, Visualization, Design options, Investment analysis, Preliminary energy simulation, Alternate spatial designs, Scope management, Investment calculation, Energy simulation, Finalised spatial requirements for structures and MEP systems, Visualisation
Preliminary Design	Building elements with nominal dimensions and details	Load-bearing structures, Proposed structural system & basic structure	MEP Schematics	Definition of building elements, Comparison of building element and structural alternatives, Management of quantity information, Preliminary dimensioning of structures, MEP Analysis, Visualisation
Detailed Design	Building elements with actual dimensions and details	Frame structures, Joints, Foundations, Joining to foundations, Penetrations & Reservations Connections	Service areas of MEP systems, Central units, Ducts, Pipe work, Terminal devices, Switchboards, Cable routes, Lighting fixtures, Penetrations & Reservations	Dimensioning of structures to the precision required for tenders, Definition of MEP systems, Quantity take-off, Penetration & Reservation design, Energy simulation, Visualisation. Combined Services Design
Construction	Model used to extract construction information	Model used to extract construction information	Model used to extract construction information	Detailed Design Information for construction, Prefabricated element design, Production planning
As-Built	Updated detail model as per actual site conditions	Updated detail model as per actual site conditions	Updated detail model as per actual site conditions	Information to be handed over for FM (maintenance & repairs; space & occupancy management)

(II) QUALITY ASSURANCE

Architectural Detailed Design BIM	Structural Detailed Design BIM	MEP Detailed Design BIM	Merged model at Preliminary Design, Detailed Design, Construction and As-Built stages
- BIM in agreed version - BIM includes defined stories - Building elements & spaces modelled separately in each story - BIM includes required building elements - Building elements modelled using correct objects - Building elements include types - No excess building elements - No overlapping or doubled building elements - No significant clashes between objects - No conflicts between structures in architectural and structural BIM - BIM includes GFA spaces objects - Space areas match space program - BIM includes spatial reservations for MEP - Space height defined (including suspended ceilings) - Shape and size of spaces matches with walls - Spaces do not overlap - All spaces have unique IDs	- BIM in agreed version - BIM includes defined stories - Building elements defined separately in each story - BIM includes required building elements - Building elements modelled using correct objects - Building element types are as agreed - No excess building elements - No overlapping or doubled building elements - No significant clashes between objects - No conflicts between structures in architectural and structural BIM - No conflicts between penetrations in architectural and structural BIM - Columns and beams converge - MEP penetrations & reservations included in structures	- BIM in agreed version - BIM includes defined stories - Components defined separately in each story - BIM includes required components - Components modelled using correct objects - Components belong to a correct system - System colours are defined systematically - System colours are defined systematically - No excess components - No overlapping or doubled components - No significant clashes between components - No clashes between MEP disciplines - No clashes between M&E and electrical BIM - Components fit into their spatial reservations - No clashes between M&E, architectural and structural BIM	- All agreed models available - Models represent the same design version - Models are located in the correct coordinate system - No conflicts between vertical shafts and MEP systems - No conflicts between horizontal reservations and MEP - No conflicts between suspended ceilings and MEP - Penetrations of columns OK - Penetrations of beams OK - Penetrations of slabs OK

(III) ARCHITECTURAL BIM MODELLING GUIDELINES

General Architectural Guidelines:

1) Architectural modelling is carried out in the following stages: Conceptual, Preliminary Design, Detailed Design, Construction and As-Built. The types of models produced at each stage depend on the BIM deliverables required.
2) If the design has precast or prefab design then those elements can be placed as Objects.
3) The building elements must be created using the correct tools (Wall tool, Slab tool, etc.). If the features of BIM authoring tool are not sufficient for modelling the element, the required building elements must be created using other appropriate objects. In that case, define the "Type" of the element correctly.
4) 2D can be used to complement the BIM model when the elements are smaller than the agreed size, e.g. Elements smaller than 100mm do not need to be modelled.
5) 2D standard details can be used to complement the BIM model.
6) Building Elements must be modelled separately for each storey.
7) Required Parameters: Type, Material, ID, Size. Type is required for the Quantity Take-off.
8) If more than one tool is used to model certain elements then the elements should be grouped and identified correctly by "Type", e.g. Slabs and Beams can be used to model the Road. The elements must be grouped as one and define the "Type" as a "Road"
9) Structural elements should be modelled based on the information (e.g. Size) from Structural Engineers. The alternative is to link or work in a shared model with the Structural Engineers.

Stages	Elements	Modelling Guidelines	Remarks
Conceptual	Topo (Existing Site)	Existing site's contour and location should be modelled based on the registered surveyor's information (spot levels, northing and easting). Renovation Projects (A&A): If the existing buildings were not in BIM, then 2D drawings of the existing building can be used to complement the BIM model.	Follow BIM e-Submission guidelines for the content and colour code of existing/proposed site. Topographic survey can follow SLA's National Topographic Mapping Standard and Specification (to be released by September 2013)
	Topo (Proposed Site)	Proposed site's cuts and fills of earth should be shown with a proposed site Element	
	Massing (Buildings)	Shape, Location and Orientation of building in site should be modelled using massing element. Name/identify the Mass element clearly, e.g. BLK 1, PODIUM etc. Site elements like Trees, Boundary, Roads, IC, etc can be drawn in 2D.	Output: Concept model that shows site arrangements and building geometries to share with the project members.

Stages	Elements	Modelling Guidelines	Remarks
Preliminary Design Note: Conceptual model is further developed into Preliminary Design model (Massing of the selected design should be converted to real building elements like Wall, Slab, Door, Window, etc...)	General Requirement	If the actual dimension is not available then model using the nominal dimension or expected dimension. Examples - Door opening modelled without considering the fittings. - Walls modelled without considering the different layers thickness. Note: Since the designers has the libraries and templates with element settings, they can model the actual size	Output: Authorities submission (URA). Refer to BCA BIM e-Submission requirement and Guidelines. Use BIM e-Submission Template. Output: Model for co-ordination with Engineers.
	Wall	Model all the Walls (Brick, Dry wall, Glass, Concrete, wood, etc...) from Finish Floor Level to soffit of Slab/Beam above. When the Wall spans across different heights, if the BIM authoring tool permits model as a single Wall with varying height then model as one Wall. Alternative is to model as multiple Walls. Distinguish the internal and external Walls by "Type" parameter.	
	Slab / Floor	Top of Slab = Finished Floor Level When there is a slope in the Slab or the Slab has a special shape and the BIM authoring tool does not have the functionality to create such Slabs, then create the slab geometry using other tools and define the 'Type' as a "slab".	
	Door	Place the Door object with nominal dimensions and parameters required for Preliminary Design.	
	Window	Place the Window object with nominal dimensions and parameters required for Preliminary Design.	
	Column	Model the Columns on the desired locations from Structural Floor Level to Structural Floor Level for the Preliminary Design co-ordination with Structural Engineer. Columns must be modelled by their outer dimensions, taking into consideration the thickness of the finish and structure. Create objects for Columns with special shapes and cross sections.	
	Roof	Model using the Roof or Slab object and define the "Type" as Roof. The supporting structures can be modelled with general objects or beams.	
	Others	If there is a need to model more elements than what	

Stages	Elements	Modelling Guidelines	Remarks
		is specified in the Preliminary Design based on the project, refer to the Detailed Design stage. Model those elements with the information available at this stage.	
	Space group (Zone or Space or Room object)	Note: Similar to individual space/room object Examples - Apartment, Fire Compartment, Departments, GFA Boundary, etc Follow BIM e-Submission guidelines for the details required for the Agencies requirement and display them accordingly in the plans	
	Individual Space (Space or Room object)	Space height = floor height from FFL to the soffit of slab above or the suspended ceiling above. One space may belong to more than one space groups. Area/Volume will be automatically calculated from the space geometry. Follow BIM e-Submission guidelines for the details required by the Agency and display them accordingly in the plans. Give a unique ID that can be used to locate the correct space when there is a need. Name the space based on the function of the room, e.g. Office, Lobby, etc... Follow the BIM e-Submission guidelines for various agencies requirement on the space requirements. Category can be used to group the spaces like Commercial, Residential, etc...	
Detailed Design Note: Preliminary Design model is further developed into Detailed Design model	General Requirement	Model all the elements using the actual/accurate dimension and correct materials.	Output: Authorities submission. Refer to BCA BIM e-Submission requirement and Guidelines. Use BIM e-Submission Template. Output: Model for co-ordination with Engineers. Output: Tender Documents
	Wall	Update the Walls created in the preliminary design with the parameters required for Detailed Design, e.g. Add different Layer thickness, Fire Rating, etc...	
	Load-bearing wall	Load bearing walls includes Core Walls/Shear Walls. Similar to Wall except if the Walls are between Floors then model from Structural Floor Level to Structural Floor Level of Slab below.	
	Slab / Floor	Update the Slabs created in the Preliminary Design with the parameters required for Detailed Design, e.g. Add different Layer thickness, Fire Rating, etc...	
	Door	Update the Doors placed in the Preliminary Design with the parameters required for Detailed Design,	

Stages	Elements	Modelling Guidelines	Remarks
		e.g. Fitting information. It is good to identify the functional difference (Types), e.g. "Fire Door"	
	Window / Louver	Update the Windows placed in the preliminary design with the parameters required for Detailed Design, e.g. Fitting information.	
	Column	Update the Columns created in the Preliminary Design based on the Location and Size information from the Structural Engineer.	
	Beam	Model the Beams based on the Location and Size information from the Structural Engineer. Create objects for Beams with special shapes and cross sections.	
	Staircase / Step / Ramp	Create objects for Staircases, Steps and Ramps with special shapes when it is not available in the BIM authoring tool. If required then the Landings and Stair Platforms can be modelled as Slabs. In that case define their "Type" accordingly.	
	Curtain Wall	Model the Curtain Wall to the full height and not necessary to break it storey by storey. Most BIM Authoring tools enable users to insert Doors and Windows into parts of the Curtain Wall.	
	Balcony Canopy	Model using either as an Objects or use Walls, Floors, Beams and Railings. Check the specific elements for their modelling guideline.	
	Roof	Update the Roofs created in the preliminary design with the parameters required for Detailed Design. E.g. Add different Layer thickness, etc...	
	Skylight Hatch Furniture Balustrade / Railings Project-specific objects	Model using objects and define the "Type" accordingly.	
	Suspended ceiling	If the BIM authoring tool do not have a ceiling tool then modelled using a slab tool or object, and define the "Type" as a Ceiling.	
	Space	Refer to Preliminary Design	
	Civil defence shelter, Service platforms, Structures of	Model using Wall, Floor, Column, Roof, Opening, Objects, Door, Space etc. Check the specific elements for their modelling guideline.	

Stages	Elements	Modelling Guidelines	Remarks
	passageways, Service ducts, Others		
Construction Note: Work together with the contractors and sub contractors to develop the Detailed Design model into Construction model	Refer to Detailed Design model	Model the portions of the buildings that are affected as a result of updates from the Detailed Design models by the other disciplines and variations/RFIs in the design.	Output: Construction model.
As-Built	Refer to Construction model	When the building is complete, the consultant should check the Detailed Design to correspond with the final implementation (As-Built) based on the information from the Contractor.	Output: Model that can be used for space management, building maintenance and modifications made during occupancy by the FM / Employer.

(IV) STRUCTURAL BIM MODELLING GUIDELINES

General Structural Guidelines:

1) The structural consultant produces both an analysis model and a physical model (Structural BIM) with actual member size and position. The model will be used for documentation. These documents cover the Structural BIM only.
2) Structural modelling is carried out in the following stages: Conceptual, Preliminary, Detail, Construction and As-Built. The types of models produced at each stage depend on the BIM deliverables required.
3) If the design has precast or prefab design. The part can be designed and modelled by a specialist and incorporated/linked into the model for reference.
4) Structural BIM covers all load-bearing concrete, wood and steel structures, as well as non-load-bearing concrete structures. The basic building elements used are Wall, Slab, Beam, Column and Lattice. The building elements must be created using the correct tools (Wall tool, Slab tool, etc.). If the features of BIM authoring tool are not sufficient for modelling the element, the required building elements must be created using other appropriate objects. In that case, define the "Type" of the element correctly.
5) The model can be phased and divided for various ST submissions as per the project planning/individual firm's practice.
6) Rebar and Joint details can be done in Detailed Design Stage based on the capability of the BIM authoring tool.

7) 2D or 2D standard details can be used to complement the BIM model when the elements are smaller than the agreed size, e.g. Elements Smaller than 100mm do not need to be modelled.
8) 2D can be used for loading plans.
9) 2D can be used for the column schedule when the BIM authoring tool has limitations. The shape and cutting of each column should be included in the schedule.
10) Building Elements must be modelled separately for each storey
11) Required Parameters: Type, Material, ID, Size. Type is required for the Quantity Take-off.
12) If more than one tool is used to model certain elements then the elements should be grouped and identified correctly by "Type". E.g. Individual beams can be used to model the roof truss the elements must be grouped as one and define the "Type" as a "Truss"

Stages	Elements	Modelling Guidelines	Remarks
Conceptual	Existing Buildings (As-Built Condition) for Addition & Alternations.	The Structural Consultants expertise may required when assessing and modelling existing structures, in particular the load-bearing structural system. The scope of Structural BIM model will be agreed upon on a project-specific basis. If the existing Buildings were not in BIM then 2D drawings of existing building can be used to complement the BIM model.	Output: Structural Model of Existing Building or portions thereof.
	New Buildings	The Structural Consultants expertise may be required in special cases in the assessment of the alternatives massing model from Architect and propose framing systems. Structural BIM model is optional at this stage.	Output: Structural concept alternatives.
Preliminary Design Note: Preliminary Design model will be based on Architectural Conceptual Design model. It will be developed further based on the co-ordination during Preliminary Design stage.	General Requirement	Model the elements using the nominal dimension or expected dimension based on precision available at Preliminary Design stage. Model the elements that are critical and required for Preliminary Design co-ordination (based on projects requirement) Connections/Joints and Members can be detailed in the Detailed Design stage or Construction stage, depending on the project delivery (traditional or D&B).	Input: Geotechnical information/model, Architectural Conceptual Design Model for intended use (for load assumptions) and geometry of the building (to determine the framing system) Note: The location of load bearing elements and the elevation of the floor will be based on the info from the Architect. Output: ST submission. Refer to BCA's BIM e-Submission requirement and Guidelines. Use BIM e-

Stages	Elements	Modelling Guidelines	Remarks
			Submission Template. Output: Model for co-ordination with Architects and MEP Engineers
	Piling (Pile Cap and Pile)	If the BIM authoring tool has relevant objects to represent the foundation elements then place them in the correct level and with the relevant parameter. Alternative is to use Slab, Column and Wall to represent foundation elements. Group them and define the "Type" correctly.	When the design is not confirmed the elements can be modelled as reference to use in the Preliminary Design co-ordination with the Architects and MEP Engineers.
	Diaphragm / Retaining Wall		
	Raft Foundation		
	Pad / Isolated Foundation		
	Strip Foundation		
	Slab / Roof Slab	Top of Slab = Structural Floor Level Multiple Slabs need to be placed if the levels, thickness, span direction and material are different. The soffit of the structural slab should be shown. When there is a slope in the Slab or the Slab with a special shape and the BIM authoring tool does not have the functionality to create such Slabs, then create the slab geometry using other tools and define the 'Type' as a "slab".	
	Beam	Top of Beam = As per design (Up stand Beam or Down hang Beam) Create objects for Beams with special shapes and cross sections, e.g. Tapering and haunch.	
	Truss	Model with multiple elements and group them as a truss. Note: Some BIM authoring tools have a function to automate this process.	
	Column	Model from the Structural Floor level to Structural Floor Level of Slab below. Create objects for Columns with special shapes and cross sections.	
	Wall	All Load bearing Walls and concrete Walls (non-load bearing) need to be modelled, e.g. Core Walls, Shear Walls, Retaining Walls, Diaphragm Walls. If the Walls are between floors then model from Structural Floor Level to Structural Floor Level of Slab below else the Walls need to model to the correct levels. When the Wall spans across different heights, if the	

Stages	Elements	Modelling Guidelines	Remarks
		BIM authoring tool permits model as a single Wall with varying height then model as one Wall. Alternative is to model multiple Walls.	
	Staircase, Step and Ramps	Model only the structure part of the Staircase, Steps and Ramps. Create objects for Staircases, Steps and Ramps with special shapes when it is not available in the BIM authoring tool. If required then the landings and Stair platforms can be modelled as Slabs. In that case define their "Type" accordingly.	
	Opening	Model the structural Opening for the Doors, Windows and Ventilations based on location and size information from the Architects. Model the structural Opening for the MEP elements like Ducts based on the location and size information from the MEP Engineers. Model the Floor openings based on location and Size from the Architects and MEP Engineers.	
	Special Structure Civil defence shelter, Tunnel, Link Way, External structures, Balcony, Canopy, Swimming pool, Temporary structures, Others	Model using Wall, Slab, Column, Beam and Opening or placed as an Object and assign the "Type" accordingly. Check the specific elements for their modelling guideline.	When the design is not confirmed the elements can be modelled as reference to use in the Preliminary Design co-ordination with the Architects and MEP Engineers.
Detailed Design Note: Preliminary Design model is further developed into Detailed Design model	General Requirement	Model all the elements using the actual/accurate dimension. Model all the model elements that are critical and required for the Design co-ordination (based on projects requirement) Detail the Connections/Joints and Members based on the BIM authoring tool's capability. The details can be imported as 2D, which is generated automatically by design tools that can link with BIM authoring tool.	Output: ST Submissions. Refer to BCA's BIM e-Submission requirement and Guidelines. Use BIM e-Submission Template. Output: Tender Drawings. Output: Model for co-ordination with

Stages	Elements	Modelling Guidelines	Remarks
		Divide the project/building as per various ST's or as per agreed Project Plan. Proceed with the modelling according to the schedule.	Architects and MEP Engineers.
	Refer to Preliminary Design	Develop the Preliminary design with more confirmed parameters like Location, Size and Material. Update the correct Type definition that helps detailed quantity take-off.	The detail can be done only for the agreed portion of the building based on the projects need.
Construction Note: Work together with the contractors and sub contractors to develop the Detailed Design model into Construction model	Refer to Detailed Design model	Model the portions of the buildings that are affected as a result of updates from the Detailed Design models by the other disciplines and variations/RFIs in the design. Deepening of structures should be detailed in shopdrawings, if necessary.	Output: Construction model.
As-Built	Refer to Construction model	When the building is complete, the consultant should check the Detailed Design to correspond with the final implementation (As-Built) based on the information from the Contractor.	Output: Model that can be used for operation, building maintenance and modifications made during occupancy by the FM / Employer.

(V) MEP BIM MODELLING GUIDELINES

a. ACMV

Stages	Elements	Modelling Guidelines	Remarks
Conceptual	System distribution lines	Use line diagrams to show the entire system distribution Include equipment symbols in the line diagrams.	Output: Schematic diagrams
	Space objects	Use box objects to represent spaces required for MEP systems Add names and colours to the space objects.	
Preliminary Design	Zone Objects, Air Handling Unit, Chiller Unit Variable refrigerant flow unit,	Zone the spaces that have common design requirements with colour legends on plans. Model each element using the correct BIM generic object	Output: Preliminary Model Shows main distribution

Stages	Elements	Modelling Guidelines	Remarks
	Cooling tower, Exhaust air ducts, Fresh air ducts, Supply air ducts, Return air ducts, Transfer air ducts, Chilled water supply pipes, Chilled water return pipes, Condensate drain pipes	Each element should have an approximate size. Show only the main routes of the systems. All ducts and pipes should be connected to the equipments. Fasteners and hangers are not required. In-line accessories, e.g. valves, fire dampers, volume controls and air filters are not required. Use CP83 symbols.	into different zones Engineers should verify the space allocated by the Architect.
Detailed Design	Main elements of Preliminary Design Fire dampers, Motorized dampers, Volume control dampers Split-type indoor & outdoor air conditioning units Exhaust or extract air fans Fresh air fans Other fans such as jet fans Diffusers, air-boots, air grilles, air filters, registers Fan Coil unit Switch boards, Control, BMS & DDC panels BMS control & monitoring modules	Use CP83 symbols and colour standards Model each element using object correspond to actual component with actual size, material, type code and performance criteria. Include insulation to reflect actual size for coordination purpose. System routing should be connected with fittings. Unavailable BIM objects that are modelled using different objects should be identified accordingly, e.g. use proper names and colours. Downward slopes of the pipes should be modelled realistically. Required fittings allowances, cross-over spaces and maintenance spaces should be considered. Fasteners and hangers are not necessary. Commercial product libraries can be used to the extent allowed by the modelling software. Fire rating should be included in the fire damper objects. Pipe Accessories should follow the CP83 symbols in plan views. For design coordination, documents such as coordinated services plans, sections, elevations, etc. should be derived from the	Output: Detailed model for e-Submission and Tender For BIM e-Submission, please also refer to submission guidelines Services should be coordinated with architecture model Proposed position of mechanical components base on calculation or analysis e.g. air terminals, FCU should be approved by the architect.

Stages	Elements	Modelling Guidelines	Remarks
		model.	
Construction	The elements are the same as Detailed Design stage.	Model the portions of the building that need more attention. All changes made by contractor & approved by consultants should be clearly indicated. Objects not found in BIM tool can be represented by a box with proper identification and attributes such as equipment name, capacity, etc. Levels of the elements comprising the system from finish floor line or at the certain reference in the model should be clearly annotated. For construction coordination, documents such as coordinated services plans, sections, elevations, etc. should be derived from the model. Fasteners can be modelled if necessary.	Output: Model with construction details Contractor to develop the detailed Design BIM into Construction BIM.
As-Built	The elements are the same as Construction phase.	When the building is complete, the consultant should check the Detailed Design to correspond with the final implementation (As-Built) based on the information from the Contractor.	Output: Model that can be used for space management, building maintenance and modifications made during occupancy by the FM / Employer.

b. Plumbing & Sanitary

Stages	Elements	Modelling Guidelines	Remarks
Conceptual	System distribution lines	Use line diagrams to show the entire system distribution Include equipment symbols in the line diagrams.	Output: Schematic diagram
	Space objects	Use box objects to represent spaces required for MEP systems Add names and colours to the space objects.	
Preliminary Design	Zone objects, Plumbing equipments	Zone the spaces that have common design requirements with colour legends on plans.	Output: Preliminary Model

Stages	Elements	Modelling Guidelines	Remarks
	Plumbing fixtures Sump and sewage pits Storage, water holding tanks, pressure vessels Water meters chambers Manholes, outlets, surface and slot channels	Model each element using the correct BIM generic object Each element should have an approximate size. Show only the main routes of the systems. All main pipes should be connected to the equipments. Fasteners and hangers are not required. In-line accessories e.g. valves, filters, water meters are not required. Use CP83 symbols.	Shows main distribution into different zones Engineers should verify the space allocated by the Architect.
Detailed Design	Main elements of Preliminary Design Fresh water piping, Fittings, Valves, including hot and cold water pipes Rainwater and storm water pipes Foul drainage and kitchen waste pipe work including Floor drains, Open trapped gullies, Sealed trapped gullies, Clean outs, Vents Control panels, Monitoring and control sensors Underground public utilities for water supply Underground public utilities for drainage	Use CP83 symbols and colour standards Model each element using object correspond to actual component with actual size, material, type code and performance criteria. Include insulation to reflect actual size for coordination purpose. System routing should be connected with fittings. Unavailable BIM objects that are modelled using different objects should be identified accordingly, e.g. use proper names and colours. Downward slopes of the pipes should be modelled realistically. Required fittings allowances, cross-over spaces and maintenance spaces should be considered. Fasteners and hangers are not necessary. Commercial product libraries can be used to the extent allowed by the modelling software. Pipe Accessories should follow the CP83 symbols in plan views. For design coordination, documents such as coordinated services plans, sections, elevations, etc. should be derived from the model.	Output: Detailed model for e-Submission and Tender For BIM e-Submission, please also refer to submission guidelines Services should be coordinated with architecture model

Stages	Elements	Modelling Guidelines	Remarks
Construction	The elements are the same as Detailed Design stage.	Model the portions of the building that need more attention. All changes made by contractor & approved by consultants should be clearly indicated. Objects not found in BIM tool can be represented by a box with proper identification and attributes such as equipment name, capacity, etc. Levels of the elements comprising the system from finish floor line or at the certain reference in the model should be clearly annotated. For construction coordination, documents such as coordinated services plans, sections, elevations, etc. should be derived from the model. Fasteners can be modelled if necessary.	Output: Model with construction details Contractor to develop the detailed Design BIM into Construction BIM.
As-Built	The elements are the same as Construction phase.	When the building is complete, the consultant should check the Detailed Design to correspond with the final implementation (As-Built) based on the information from the Contractor.	Output: Model that can be used for space management, building maintenance and modifications made during occupancy by the FM / Employer.

c. *Fire Protection*

Stages	Elements	Modelling Guidelines	Remarks
Conceptual	System distribution lines	Use line diagrams to show the entire system distribution Include equipment symbols in the line diagrams.	Output: Schematic diagrams
	Space objects	Use box objects to represent spaces required for MEP systems Add names and colours to the space objects.	
Preliminary Design	Zone Objects	Zone the spaces that have common design requirements with colour legends on plans.	Output: Preliminary Model

Stages	Elements	Modelling Guidelines	Remarks
			Shows main distribution into different zones
Detailed Design	Main elements of Preliminary Design Sprinkler pipework Fire sprinkler pumps Sprinkler heads SIB (Sub-Indicator Board) Sprinkler control valve sets (Main stop valve, Subsidiary valve with indicator, Alarm valve, Water motor alarm/gong, Test and drain valve, Pressure gauges and Direct read water flow meter.) Hydrants and hose reels, including street fire hydrant system Fire alarm gongs, Break glass unit Fire shutters and hoods above Gas piping for suppression systems Heat or smoke detectors, Control panels, Monitoring and control sensors, Pump panels, Check meter positions Breeching inlet Breeching inlet cabinet Fire extinguishers	Use CP83 symbols and colour standards Model each element using object correspond to actual component with actual size, material, type code and performance criteria. Include insulation to reflect actual size for coordination purpose. The types, finish, temperature rating and orifice sizes should be indicated. Unavailable BIM objects that are modelled using different objects should be identified accordingly, e.g. use proper names and colours. System routing should be connected with fittings. Required fittings allowances, cross-over spaces and maintenance spaces should be considered. Fasteners and hangers are not necessary. Commercial product libraries can be used to the extent allowed by the modelling software. Pipe Accessories should follow the CP83 symbols in plan views. Size of breeching inlet cabinet For design coordination, documents such as coordinated services plans, sections, elevations, etc. should be derived from the model.	Output: Detailed model for e-Submission and Tender For BIM e-Submission, please also refer to submission guidelines Services should be coordinated with architecture model Engineers should verify the space allocated by the Architect.
Construction	The elements are the same as Detailed Design stage.	Model the portions of the building that need more attention.	Output: Model with

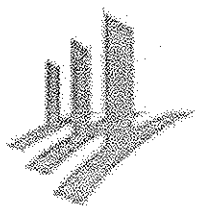
Stages	Elements	Modelling Guidelines	Remarks
		All changes made by contractor & approved by consultants should be clearly indicated. Objects not found in BIM tool can be represented by a box with proper identification and attributes such as equipment name, capacity, etc. Levels of the elements comprising the system from finish floor line or at the certain reference in the model should be clearly annotated. For construction coordination, documents such as coordinated services plans, sections, elevations, etc. should be derived from the model. Fasteners can be modelled if necessary.	construction details Contractor to develop the detailed Design BIM into Construction BIM.
As-Built	The elements are the same as Construction phase.	When the building is complete, the consultant should check the Detailed Design to correspond with the final implementation (As-Built) based on the information from the Contractor.	Output: Model that can be used for space management, building maintenance and modifications made during occupancy by the FM / Employer.

d. Electrical

Stages	Elements	Modelling Guidelines	Remarks
Conceptual	System distribution lines	Use line diagrams to show the entire system distribution Include equipment symbols in the line diagrams.	Output: Schematic diagrams
	Space objects	Use box objects to represent spaces required for MEP systems Add names and colours to the space objects.	
Preliminary	Zone Objects,	Zone the spaces that have common design requirements with colour legends on plans.	Output: Preliminary

Stages	Elements	Modelling Guidelines	Remarks
Design	Transformers HV & LV switch boards, Switchgear, MCCB boards, MCB boards Cable trays, Trunking & cable containment Electrical risers Generators and exhaust flues, including acoustic treatments Diesel tanks & fuel pipes Telecom equipment and computer racks	Model each element using the correct BIM generic object Each element should have an approximate size. Show only the main routes of the systems. All cable trays, conduits and trunkings should be connected to the equipments. Wires, fasteners and hangers are not required. In-line accessories e.g. Valves, fire dampers, volume controls and air filters are not required. Use CP83 symbols.	Model Shows main distribution into different zones
Detailed Design	Main elements of Preliminary Design Light fittings, Fixtures, Housings for light fixtures Conduit, Bus duct, Power feeds Concealed and cast-in-place conduits Outlets, Panels Wall switches, Circuiting to devices, Security devices, Card access, "Plug moulds" (socket points) Conduit associated with access, data communication, security systems and electrical equipment Security system including CCTV camera, smart card	Use CP83 symbols and colour standards Model each element using object correspond to actual component with actual size, material, type code and performance criteria. Include insulation to reflect actual size for coordination purpose. System routing should be connected with fittings. Unavailable BIM objects that modelled using different objects should be identified accordingly, e.g., use proper names and colours. Required fittings allowances, cross-over spaces and maintenance spaces should be considered. Fasteners and hangers are not necessary. Commercial product libraries can be used to the extent allowed by the modelling software. Electrical devices e.g. switches, power outlets, telephone and TV outlets should follow the CP83 symbols in plan views. For design coordination, documents such as coordinated services plans, sections,	Output: Detailed model for e-Submission and Tender For BIM e-Submission, please also refer to submission guidelines Services should be coordinated with architecture model Engineers should verify the space allocated by the architect

Stages	Elements	Modelling Guidelines	Remarks
	system, door monitoring system Car park control system, Barrier gates Equipment and associated installations maintained by public utility companies	elevations, etc. should be derived from the model.	
Construction	The elements are the same as Detailed Design stage.	Model the portions of the building that need more attention. All changes made by contractor & approved by consultants should be clearly indicated. Objects not found in BIM tool can be represented by a box with proper identification and attributes such as equipment name, capacity, etc. Levels of the elements comprising the system from finish floor line or at the certain reference in the model should be clearly annotated. For construction coordination, documents such as coordinated services plans, sections, elevations, etc. should be derived from the model. Fasteners can be modelled if necessary.	Output: Model with construction details Contractor to develop the detailed Design BIM into Construction BIM.
As-Built	The elements are the same as Construction phase.	When the building is complete, the consultant should check the Detailed Design to correspond with the final implementation (As-Built) based on the information from the Contractor.	Output: Model that can be used for space management, building maintenance and modifications made during occupancy by the FM / Employer.



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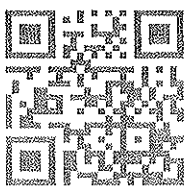
For more information and feedback on the Singapore BIM Guide, please visit the following blog:
bimsg.wordpress.com



BIM Particular Conditions Version 1.0

The BIM Particular Conditions Version 1.0 on the following pages may be attached to the Principal Agreement when incorporating the use of BIM into the project, as part of the scope of services under the Principal Agreement.

Please read the Notes below before using the BIM Particular Conditions.

Notes:

A. This document is for use in construction projects where Building Information Modelling (BIM) is used and shall be called the BIM Particular Conditions. All parties in such projects shall incorporate the BIM Particular Conditions as a contract document in their respective agreements for services, supply and/or construction for the project.

B. The BIM Steering Committee (BIMSC) appointed by the Building and Construction Authority (BCA) developed this document. The BIMSC consists of representatives from a wide cross-section of the construction industry. The BIM Particular Conditions was developed by consensus of opinion of the members of the BIMSC.

C. The BIM Particular Conditions can be used for all methods of procurement. However, this document does not cover all issues in the use of BIM; especially those that may be specific to any particular user. The BIMSC therefore encourages users to review and adapt the BIM Particular Conditions for specific use. Users should obtain appropriate professional/legal advice before making any changes to the BIM Particular Conditions.

D. Please refer to the Notes to Users at the end of this document for further information.

PARTICULAR CONDITIONS FOR BUILDING INFORMATION MODELLING

1. DEFINITIONS

1.1. **BIM** means building information modelling and is the process and technology used to create a Model.

1.2. **BIM Guide** means the guide to the use of BIM published by the Building and Construction Authority for the time being in force (the Singapore BIM Guide) or such other guide to the use of BIM as may be expressly provided in the Principal Agreements.

1.3. **BIM Particular Conditions** means these particular conditions for BIM.

1.4. **BIM Execution Plan** means the plan referred to in Clause 4 of this BIM Particular Conditions.

1.5. **BIM Manager** means the person, firm or corporation appointed by the Employer as BIM Manager pursuant to Clause 3 and includes any person, firm or corporation appointed by the Employer to replace an existing BIM Manager.

1.6. **Construction Documents** means all drawings, calculations, computer software programmes, samples, patterns, models and other information of a similar nature prepared by the Designer for the Project but not a Model.

1.7. **Contribution** means the expression, design, data or information that a party to the Project (a) creates or prepares, and (b) incorporates, distributes, transmits, communicates or otherwise shares with other parties to the Project for use in or in connection with a Model for the Project.

1.8. **Designer** refers to the party or parties in the Project who are responsible for the design of the whole or some part of the Project under the relevant Principal Agreement(s).

1.9. **Drawings** means (a) those two-dimensional plans, sketches or other drawings that are contract documents in the Principal Agreement and are created separately from, and are not derived from, a Model and (b) those two-dimensional projections derived from a Model supplemented with independent graphics and annotations specified by the parties to be contract documents in the Principal Agreement.

1.10. **Employer** means the owner of the Project including any government or statutory body.

1.11. **Model** means a digital representation of the physical and functional characteristics of the Project, that is, a three-dimensional representation in electronic format of building elements representing solid objects with true-to-scale spatial relationships and dimensions. A Model may include additional information or data. A Model may be used to describe a **Model Element** (that is, a portion of the Model representing a component, system or assembly within the Project or Project site), a single Model or

multiple Models used in aggregate or in federation. BIM is the process and technology used to create the Model.

1.12. **Final Design Model** means a Model of those aspects of the Project that are (a) to be modelled as specified in the BIM Execution Plan and (b) have reached the stage of completion that would customarily be expressed in two-dimensional construction documents. This shall not include analytical evaluations, preliminary designs, studies, or renderings. A Model prepared by a Designer that has not reached the stage of completion specified in this definition is referred to as a Model.

1.13. **Model Author** means the party responsible for developing the content of a specific Model Element to the level of detail required for a particular phase of the Project. **Model Authors** are identified in the Model Element Table in the BIM Execution Plan.

1.14. **Model User** means any individual or entity authorised to use the Model on the Project, such as for analysis, estimating or scheduling.

1.15. **Principal Agreement** in relation to any party in the Project means the agreement for services, supply and/or construction which that party has entered into for the Project.

1.16. **Project** means the project in which the parties will be carrying out BIM pursuant to their respective Principal Agreements.

2. GENERAL PRINCIPLES

2.1. The parties to a Project shall incorporate the BIM Particular Conditions into all agreements for services, supply and/or construction where at least one party shall be required to be involved in carrying out BIM. This BIM Particular Conditions shall be passed downstream to subconsultants, suppliers and subcontractors, as applicable.

2.2. The BIM Particular Conditions does not change any contractual relationships or shifts any risks of the parties in a Project as provided in the Principal Agreements. In particular:

2.2.1. Nothing in this BIM Particular Conditions shall relieve a Designer from its obligation, nor diminish the role of the Designer, as the person responsible for and in charge of the design of the Project or any part of the Project.

2.2.2. Where under applicable law or in contract, the Employer warrants to any party the adequacy and/or sufficiency of design, nothing in this BIM Particular Conditions shall diminish the extent to which the Employer warrants to any party the adequacy and/or sufficiency of design.

2.2.3. Participation of a contractor or its subcontractors and suppliers in carrying out BIM shall not constitute performance of design services unless in the Project, the contractor or its subcontractors and suppliers had assumed design responsibility under their respective Principal Agreements.

2.2.4. In the event of any inconsistency between a Model and any Drawings, the Drawings shall prevail.

2.3. In the event of any inconsistency between the BIM Particular Conditions and the applicable Principal Agreement, the BIM Particular Conditions shall prevail.

2.4. As regards the Models produced in BIM:

2.4.1. A Final Design Model is not intended to provide the level of detail needed in order to extract precise materials or object quantities, unless the parties agree in the BIM Execution Plan otherwise.

2.4.2. The dimensional tolerances provided in the Principal Agreement shall apply to the dimensions in a Model, unless the parties agree in the BIM Execution Plan otherwise.

2.4.3. If there is a conflict between a Final Design Model and any other Model, the Final Design Model shall prevail.

2.4.4. If any party to the Project becomes aware of a discrepancy between a Model and either another Model or any contract document in the Principal Agreement, that party shall immediately notify all the other parties to the Principal Agreement and the BIM Manager.

3. BIM MANAGEMENT

3.1. The Employer shall appoint one or more BIM Managers for the Project. All compensation and related costs for the BIM Manager shall be paid by the Employer unless otherwise agreed between the parties to the Project. The Employer may appoint any one or more of the parties in a Project as BIM Manager in addition to the duties and obligations of that party under the Principal Agreement.

3.2. The role and responsibility of the BIM Manager shall be as provided in the BIM Guide unless expressly agreed otherwise in the BIM Execution Plan.

4. BIM EXECUTION PLAN

4.1. As soon as practicable and from time to time as required, the BIM Manager shall call all parties to the Project involved in the execution of BIM to meet, confer and use their best efforts to agree upon the terms of or modifications to a BIM Execution Plan.

4.2. The BIM Execution Plan and the Model shall be developed in accordance with the BIM Guide.

4.3. As soon as practicable and from time to time as required, the BIM Manager shall call all parties to the Project involved in the execution of BIM to identify and agree on the Final Design Model.

4.4. The BIM Manager shall schedule and chair all meetings. In the event of any disagreement on the terms or modifications to the BIM Execution Plan, the BIM

Manager's decision shall be final and conclusive. In the event that more than one BIM Manager has been appointed in accordance with Clause 3, then the decision shall be the joint decision of the BIM Managers.

4.5. If under the BIM Execution Plan for the time being in force, any party is required to perform or carry out any work which is beyond its scope of work under the Principal Agreement; such work shall be treated as additional works or variations under the Principal Agreement.

5. RISK ALLOCATION

5.1. Each Model Author's Contribution is intended to be shared with subsequent Model Authors and Model Users throughout the course of the Project.

5.2. In contributing content to the Model, the Model Author does not convey any ownership right in the content provided or in the software used to generate the content. Unless otherwise granted in a separate licence, any subsequent Model Author's and Model User's right to use, modify, or further transmit the Model is specifically limited to the design and construction of the Project, and nothing contained in this BIM Particular Conditions conveys any other right to use the Model for another purpose.

5.3. It is understood that while the content of a specific Model Element may include data that exceeds the required level of detail specified in the BIM Execution Plan, Model Users and subsequent Model Authors may rely on the accuracy and completeness of a Model Element consistent only with the content required for the level of detail identified in the BIM Execution Plan.

5.4. Any use of, or reliance on, a Model Element inconsistent with the level of detail indicated in the BIM Execution Plan by subsequent Model Authors or Model Users shall be at their own sole risk and without liability to the Model Author. Subsequent Model Authors and Model Users shall indemnify and defend the Model Author from and against all claims arising from or related to the subsequent Model Author's or Model User's unauthorised modification to, or use of, the Model Author's content.

5.5. To the extent that any or all Final Design Models are included as contract documents, parties may rely upon the accuracy of information in those Final Design Models (including dimensional accuracy) unless otherwise specified in the BIM Execution Plan.

5.6. The standard of care applicable to each party regarding any Contribution shall be in accordance with the Principal Agreement or if none is specified, in accordance to applicable law.

5.7. Each party shall use its best efforts to minimize the risk of claims and liability arising from the use of or access to its Model or the Final Design Model. Such efforts shall include promptly reporting to the relevant party and the BIM Manager any errors, inconsistencies or omissions it discovers in its Model or the Final Design Model. However, this section shall not relieve any party of liability for any of its Contribution.

5.8. No party involved in creating a Model shall be responsible for costs, expenses, liabilities, or damages which may result from use of its Model beyond the uses stated in the BIM Execution Plan.

6. INTELLECTUAL PROPERTY RIGHTS

6.1. Each party warrants to the other parties to the Principal Agreement that either (a) that party is the owner of all copyrights in all of that party's Contributions, or (b) that party is licensed or otherwise authorised by the holders of copyrights of expression contained in the Contribution to make such Contribution under the terms of this BIM Particular Conditions. Each party agrees to indemnify and hold such other parties harmless against claims of third parties arising out of or relating to, claims or demands relating to infringement or alleged infringement of expression contained in that party's Contribution. Nothing in this BIM Particular Conditions is intended to limit, transfer, or otherwise affect any of the intellectual property rights that a party may have with respect to any Contribution, except for licences or permissions expressly granted by this BIM Particular Conditions or the Principal Agreement.

6.2. Subject to the provisions of Clause 6.1, each party grants to the other party or parties to the Principal Agreement for the sole purpose of the other party or parties carrying out their respective duties and obligations relating to the Project:

6.2.1. A limited, non-exclusive licence to produce, distribute, display, or otherwise use that party's Contribution for purposes of this Project only.

6.2.2. A limited, non-exclusive sub-licence to reproduce, distribute, display, or otherwise use, for the purposes of this Project only, the Contributions of those other parties to the Project who have granted that party an identical licence or sub-licence;

6.2.3. The right to grant an identical sublicence to any other party to the Project with which the licensee has a contract in which this BIM Particular Conditions is incorporated by reference; and

6.2.4. A limited, non-exclusive licence to reproduce, distribute, display, or otherwise use any Model containing such Contributions, or any other Model with which the Model containing such Contributions is federated or otherwise related.

The limited licence granted in this Clause shall include any archival purposes permitted in this BIM Particular Conditions or in the Principal Agreement.

6.3. If a party to a Principal Agreement is the holder of copyrights in the Contribution of another party to the Project or is the grantee of an exclusive licence with respect to such Contribution, then such holder or exclusive licensee hereby grants to the other party or parties to the Principal Agreement the right to grant to other parties to the Project with which that other party has or those parties have a contract in which this BIM Particular Conditions is incorporated, a limited licence in the terms set forth in Clause 6.2.

6.4. The Employer's entitlement to use any Final Design Model after completion of the Project shall be governed by the Principal Agreement(s) between the Employer and the Designer(s).

6.5. Unless otherwise limited herein or by express licence-limiting terms in the Principal Agreement, the non-exclusive licence granted in this BIM Particular Conditions shall remain in effect as permitted by law. In addition, after final completion of the Project, the non-exclusive licence shall be limited to keeping an archival copy of Project-related Contributions.

6.6. In the absence of express language to the contrary in the Principal Agreement or in this BIM Particular Conditions, nothing in this BIM Particular Conditions, and no act by any party in the Project in furtherance of this BIM Particular Conditions, shall be deemed or construed to deprive or dispossess any party in the Project of copyrights or licence rights held by that party in its respective underlying Contribution to any Model. Other parties, persons or entities that provide Contributions to a Model shall not be deemed to be co-authors in the Contributions of other parties to the Project.

Notes to Users:

1. Clause 1.2 defines the BIM Guide as either the Singapore BIM Guide published by BCA or such other guide as may be expressly provided in the Principal Agreements. If the user intends to use any other guide for a project, then it is absolutely critical that this be stated in the Principal Agreements (see next paragraph for a suggestion on how this can be done).

2. For the BIM Particular Conditions to apply in a project, the parties must ensure that the BIM Particular Conditions is incorporated as a contract document in the Principal Agreements. This can be done in a variety of ways. Suggestions for the more common local standard forms of contract are set out below.

   a. REDAS Design and Build Conditions of Contract

   To insert as one of the documents in Appendix 4:

   Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force.

   For the purposes of Clause 1.2, if it is intended that another guide for BIM be used, then, to insert as one of the documents in Appendix 4:

   Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force. For the purpose of Clause 1.2 of the BIM Particular Conditions, the BIM Guide shall be [name of the guide].

   b. SCAL Conditions of Sub-Contract

   To amend Clause 4 by adding a new Clause 4(j) as follows:

   (j) Schedule 10: Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force.

   For the purposes of Clause 1.2, if it is intended that another guide for BIM be used, then, to amend Clause 4 by adding a new Clause 4(j) as follows:

   (j) Schedule 10: Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force. For the purpose of Clause 1.2 of the BIM Particular Conditions, the BIM Guide shall be [name of the guide].

   c. SCAL Standard Agreement for Appointment of Consultants

   To insert as one of the documents in Appendix C:

   The Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force shall apply for use of building information modelling.

   For the purposes of Clause 1.2, if it is intended that another guide for BIM be used, then, to insert as one of the documents in Part 1 of the Schedule:

   The Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force shall apply for use of building information modelling. For the purpose of Clause 1.2 of the BIM Particular Conditions, the BIM Guide shall be [name of the guide].

   d. SIA Contract

   To amend Article 6 of the Articles of Contract by adding a new Article 6(g) as follows:

   (g) Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force.

   For the purposes of Clause 1.2, if it is intended that another guide for BIM be used, then, to amend Article 6 by adding a new Article Clause 6(g) as follows:

   (g) Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force. For the purpose of Clause 1.2 of the BIM Particular Conditions, the BIM Guide shall be [name of the guide].

   e. SIA Sub-Contract

   To insert as one of the documents in Part I of the Schedule:

   Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force.

For the purposes of Clause 1.2, if it is intended that another guide for BIM be used, then, to insert as one of the documents in Part I of the Schedule:

Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force. For the purpose of Clause 1.2 of the BIM Particular Conditions, the BIM Guide shall be [name of the guide].

f. SIA Conditions of Appointment (for Architect)

To amend the Conditions of Appointment by adding a new Clause 1.1(11) as follows:

(11) Building Information Modelling

The Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force shall apply for use of building information modelling.

For the purposes of Clause 1.2, if it is intended that another guide for BIM be used, then, to amend the Conditions of Appointment by adding a new Clause 1.1(11) as follows:

(11) Building Information Modelling

The Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force shall apply for use of building information modelling. For the purpose of Clause 1.2 of the BIM Particular Conditions, the BIM Guide shall be [name of the guide].

g. Association of Consulting Engineers Singapore Agreement

To insert at Clause 1.1.1(i) of the Specific Provisions:

Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force.

For the purposes of Clause 1.2, if it is intended that another guide for BIM be used, then, to insert at Clause 1.1.1(i) of the Specific Provisions:

Particular Conditions For Building Information Modelling ("BIM Particular Conditions") published by the Building and Construction Authority for the time being in force. For the purpose of Clause 1.2 of the BIM Particular Conditions, the BIM Guide shall be [name of the guide].

BIM Deployment Plan

The template aims to assist organisation in setting up a BIM Deployment Plan to guide its BIM implementation.

BIM Fund applicants who apply for the "**Expenditure of Manpower**" component of the Fund can use this template to develop and implement the organisation's BIM Deployment Plan to be submitted as part of the claim process.

1. Leadership and Planning

1.1 Organisational BIM Vision

List your organization's vision statement and specify how the implementation of BIM technologies and processes enhances that vision. An example is given in *italic* below.

Organization Vision Statement
e.g. To be the premier architecture firm for complex building projects, in which meeting challenges through technology sets us apart from our competition.
BIM Enhances Vision
e.g. BIM enhance our company's technology offering and help us provide superior service to our clients. We plan to implement BIM for all our projects by 2015

1.2 Goals for BIM

List your organisation's goals and objectives for using BIM technologies and processes below. For each goal and objective, please indicate how the achievement is measured and targeted timeframes. An example is given in *italic* below.

BIM Goal	Measureable Objective	Achieved If (measurable KPI)	Projected Timeframe
Improve transparency of design for all stakeholders	*Produce architecture BIM model for DC and BP submission*	*The model is approved by the regulatory officers*	*March - April 2013*

1.3 BIM Committee

List your organisation's BIM Committee that spearheads its BIM implementation. Fill in members of the BIM Committee, their name and their roles in the organisation in the following table. Examples are given in *italic* below.

BIM Committee Personnel	Name	Current Designation	Roles
BIM Leader	*Jane Doe*	*Project Director*	*Championing BIM implementation in the firm*
BIM Team member	*John Doe* *June Doe* *Jean Doe*	*Principal Architect* *CAD Manager* *Modeller*	*Assisting BIM Leader:* • *Setting up company BIM Standard* • *Overseeing BIM training implementation* • *etc*

2. Information, Process and Environment

2.1 Models, Content and Authoring Tools

List the BIM models and their content to be delivered by your organisation at different stages of a project. List also the model authoring tool to be used for each. For models not created by your organization, leave the row blank; add rows to include models not already found below but likely to be delivered by your organisation. Examples are given in *italic* below.

Model Name	Model Content	Project Stage	Authoring Tool
Architectural Massing Model	*Building massing studies with indicative dimensions, area, volume, location, and orientation.*	*Conceptual Design*	*Autodesk® Revit® Architecture Rhino*
Architectural Model	*As per Singapore BIM Guide Appendix B.*	*Preliminary Design and Detailed Design*	*Autodesk® Revit® Architecture*
Coordination Model	*Architectural, structural, and MEP components of main building.*	*Detailed Design*	*Autodesk® Navisworks® Manage*
Civil Model			
Structural Model			
MEP Model			
Construction Model			
As-Built Model			

2.2. Analysis Services and Tools

List the types of analysis services that your organization can or plans to offer. List also the analysis tool to be used for each. For analysis not offered by your organization, leave the row blank; add rows to include analysis not already found below but likely to be offered by your organisation. Examples are given in *italic* below.

Analysis Services	Analysis Reports	Project Stages	Analysis Tool
Energy	*Total Energy Use and Carbon Emissions*	*Preliminary Design*	*Autodesk® Ecotect® Analysis*
Visualization			
Structural			
Clash Detection			
Quantity Takeoff			
Scheduling/4D			
Cost Analysis/5D			
Daylight/Lighting			

2.3. Quality Control Checklist

List the types of quality control checks performed by your organisation in ensuring the model quality.

The following should be considered when determining a quality assurance plan:

- Modelling Guidelines
  - Ensure that the model is created based on the modelling guidelines and CAD standards
- Dataset Validation
  - Ensure that the dataset are populated with correct data.
- Interference Check
  - Detect any clashes between two building components using a Clash Detection software
- Validation of BIM data to be used for Cross-Disciplinary Model Coordination
  - Ensure that the model is in accordance to the exchange protocol as established in the project execution plan

2.4. Company BIM Standard

The company BIM standard can be attached as an annexe to this document.

2.5 Current Computer Hardware and Propose Upgrade

In the table below, list the current computer hardware and propose computer hardware upgrade. Examples are given in *italic* below.

Current Hardware	Propose Hardware Upgrade
2 computers with: • *Intel Core i5* • *64 bit, 4GB RAM, 500GB HD*	*Intel core i7* *8 – 16 GB RAM*
4 computers with: • *Intel Core i5* • *32 bit, 2GB RAM, 200GB HD*	*Intel core i7* *64 bit, 8 GB RAM, 500 GB HD*

3. People and Capability

3.1 Current BIM Skills

Indicate your organization's current BIM skills by listing personnel type, number of employees of each type, and average skill level in the following table. Examples are given in *italic* below.

Personnel Type	No. of Staff	Average BIM Skill / Knowledge Level
Project Director	*1*	*None*
Principal Architect	*2*	*Novice*
CAD Manager	*2*	*None*
Draft persons	*1* *5* *10*	*Expert in Revit Architecture* *Intermediate in Revit Architecture* *None*
Project Manager	*5*	*Novice*

3.2. Training Plan

List the training programmes to be provided to staff, the intended personnel, number of people to be trained, timeframe, and training provider in the following table. Examples are given in *italic* below.

Training Programme	Personnel Type	No. to be Trained	Timeframe	Training Provider
BIM Workshop for Senior Management	*Project Director*	*1*	*Jan 2013*	*BCA Academy*
BIM Management	*Principal Architect* *Cad Manager*	*1* *2*	*Feb 2013* *Feb 2013*	*BCA Academy* *In-house*
BIM Modelling (Autodesk® Revit Architecture)	*Draft persons*	*5* *10*	*Feb - Apr 2013* *Feb - Jun 2013*	*In-house/OJT* *Software Vendor / BCA Academy*
BIM Management (BIM for PM)	*Project Manager*	*5*	*Mar 2013*	*BCA Academy*

Note: You may be required to submit document prove to show your *in-house* or *on-the-job training (OJT)* programme as part of the BIM fund claim process.

BIM MANUAL

SAMPLE

1. Introduction

a. *Introduction*

The main objective of this manual is to document the standard and procedures in performing drawing documentation at [*your firm*]. The document will be used as the basis for minimum standard work performance.

[*Additional information, i.e. software your are using?, why you need this manual, is it a living document?, who own this document?, etc.*]

b. *Standard Conformance*

All project teams shall comply with the standards and procedures outlined in this manual...

[*Additional information, i.e. if you are a leading consultant, will you require the sub-consultants to follow the standards and procedures? If yes, are you going to issue a printed copy of the manual?*]

[*Any exemptions? i.e. projects with client driven standards or projects in progress*]

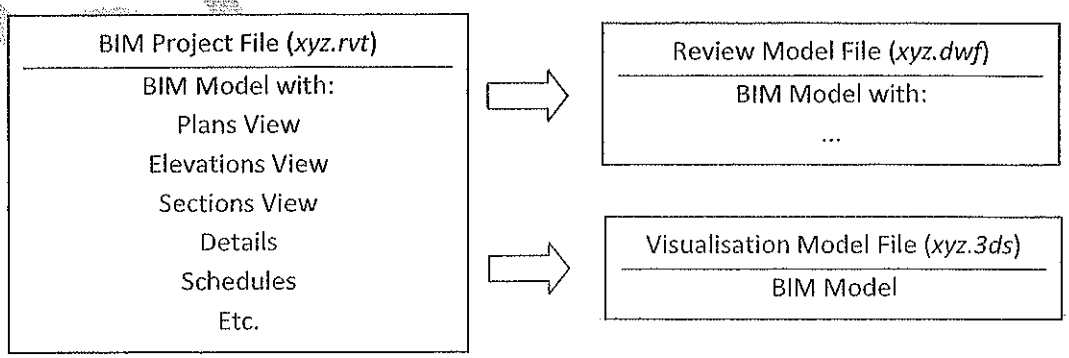
c. *BIM Committee (or Department)*

[*who are they or what are they doing?*]

2. Document Management

a. *General*

b. *Small-scale Project*



c. *Large-scale Project*

You might consider following example from Hong Kong Housing Authority on the model hierarchy (http://bimsg.wordpress.com/2012/02/01/model-hierarchy-hkha/).

SAMPLE

You might also want to have 2 BIM Project File: Visualisation Model and Documentation Model. Reason is from Australian Case Study "*1 Bligh Street*" (http://www.construction-innovation.info/images/pdfs/BIM_CaseStudies_Book_191109_lores.pdf).

d. Project Folder Structure

You might want to consider the folder structure from UK Standard (http://aecuk.wordpress.com/2010/06/25/aec-uk-bim-standard-for-revit/)

e. File Naming Convention

You might want to consider the naming convention from BIM e-submission guideline (http://www.corenet.gov.sg/integrated_submission/bim/BIMe_submission.htm)

f. Object Library

[*How/where to get/load the company standard library,* procedure in creating new object library for specific project – typical detail]

You might want to follow library creation guide from HKHA (http://www.housingauthority.gov.hk/en/business-partnerships/resources/building-information-modelling/index.html)

3. Standard Project Template

You might want to consider the BIM e-submission template (http://www.corenet.gov.sg/integrated_submission/bim/BIMe_submission.htm)

[*Explanation about your company project template: how to get, how to set up new project, etc.*]

You might want to have a look at the BIM User guide from HKHA (http://www.housingauthority.gov.hk/en/business-partnerships/resources/building-information-modelling/index.html)

[*Location and Orientation, Browser Organisation, Default Families and Types, Object Styles, Annotations, Annotation Object Styles, Text Styles, Dimensions, Tags, Legends, Filters, Keyboard Shortcuts, Line Patterns, Styles and Weights, Hatch Patterns, Materials, Schedules, Titleblocks, View Templates, etc.*]

4. Procedure of producing 2D Drawings

You might want to have a look at the BIM User guide from HKHA (http://www.housingauthority.gov.hk/en/business-partnerships/resources/building-information-modelling/index.html)

5. Data Exchange (Import and Export)

You might want to have a look at the BIM User guide from HKHA (http://www.housingauthority.gov.hk/en/business-partnerships/resources/building-information-modelling/index.html)

a. ***Revit to Design Review (DWF)***

b. ***Revit to 3ds Max***

c. ***Revit to ... (DWG, DXF, IFC, etc)***

d. ***2D CAD to Revit***

e. ***Land Survey Data to Revit***

f. ***(IFC, images, etc) ... to Revit***

6. Best Practice

You might want to have a look at the UK BIM guide (http://aecuk.wordpress.com/2010/06/25/aec-uk-bim-standard-for-revit/)

And Building Information Modeling (BIM) Roadmap, Volume 3 – BIM Implementation Plan for Military Construction Projects, Autodesk Platform

(http://kelarpacific.com/Resources/Documents/BIM-USARMY.pdf)

SAMPLE