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A brief introduction to Building Information Modelling (BIM)



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WHAT IS BUILDING INFORMATION MODELING - BIM?

- It is a process of creating and managing building data during its development.
- It is a three-dimensional, real-time and dynamic building model.
- It is a reliable digital representation of the building available for design decision-making, high-quality production of construction document, construction planning, performance predictions and cost estimates.



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2D DRAFTING VERSUS BIM

2D DRAFTING	BIM
Lower cost for software & hardware	Higher cost for software & hardware
Lesser design/smart features	Equipped with design/smart features
Easy head-start/Simple interface	Inputs required even for simple elements
Each element drawn is just a 2D entity	Each element drawn is a 3D object with its own parameters
Only 2D plan is created	From a 2D plan, a 3D model will be generated
Sectional views, elevations, etc. are drawn from scratch	Sectional views, elevations, etc. are generated automatically
Can ‘cheat’ drawing	Can’t ‘cheat’ drawing/design as the element has properties
Smaller cadfile size	Huge cadfile size
Rework may require total drawing	Easier manipulation of changes without total re-drawing

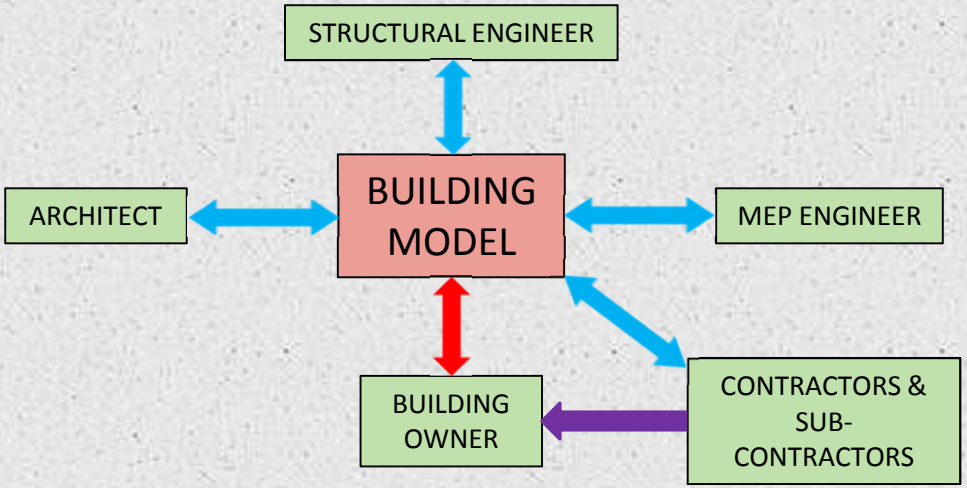
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ADVANTAGES OF BIM

- Each element is a 3D object with parameters that can be modified to develop the entity.
- The entire model is a single database with all elements interrelated - when you make any changes in one location, all affected elements will dynamically update. Able to keep up-to-date information.
- By creating 2D plans, you will automatically generate 3D models. Sections, elevations, callouts, etc. will be done automatically.
- Automatically provides you with a schedule based on the category of your choice by extracting data from the elements. Documentation is no longer manual. The information is already there - just extract it.
- Work-sharing: you can work on the same project and synchronize information to a central file located on a server while everyone is separately working on their own computers.
- Ability to track architectural changes to ensure the MEP design is updated as per the architectural changes.
- Increase productivity throughout building design and construction. Identify problems earlier in the building process.
- Gives architects, engineers, builders and owners a clear overall vision of the project, more data sharing as well as the ability to make informed decisions faster.
- Can be used to demonstrate the entire building life cycle, including the processes of construction and facility operation.
- Information loss associated with handing a project from the design team, to the construction team and to building owner/operator can be eliminated/minimise.
- In short, it saves time and money.

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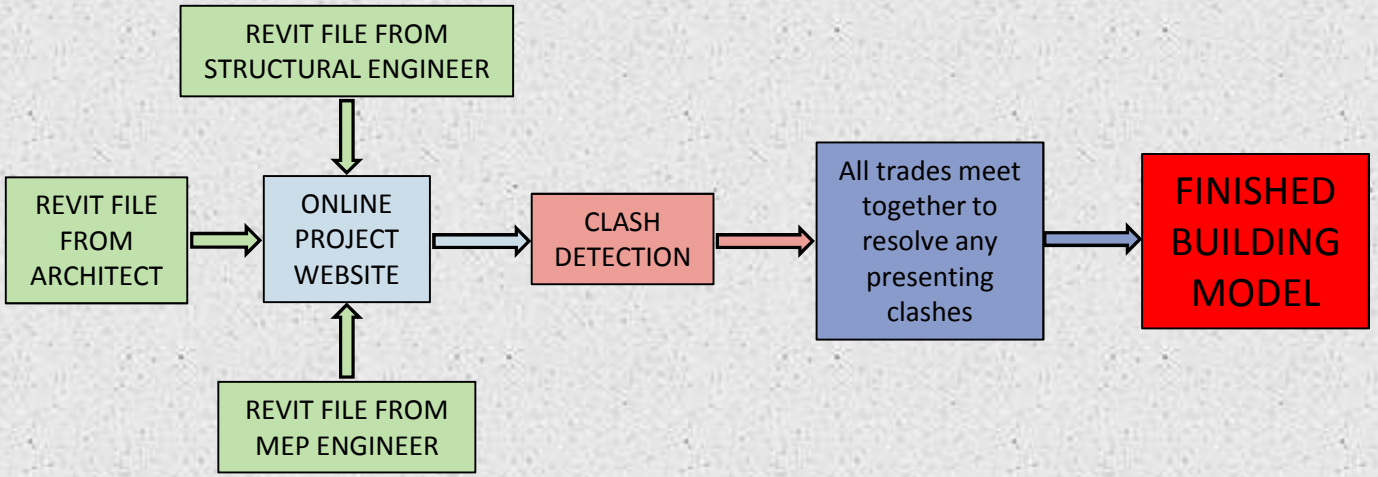
BUILDING INFORMATION MODEL



Building model is a compilation of information received from the building owner, architect, structural engineer, mechanical, electrical & plumbing (MEP) engineers and contractors.

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BIM COORDINATION PROCESS FLOW CHART

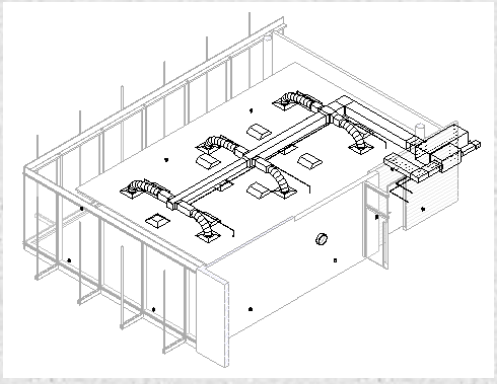


1. All trades are responsible for creating and uploading their own models to an online project website.
2. Numerous document types are combined into one model.
3. Clash Detection process is run to remove any trade clashes that may occur during preconstruction services.
4. All trades meet together to resolve any presenting clashes.
5. Once clashes are resolved, the result is a finished BIM product.

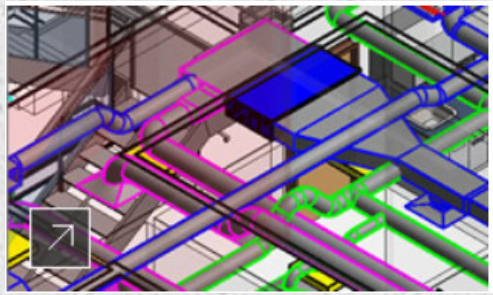
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VALUE OF BIM FOR MEP ENGINEERS

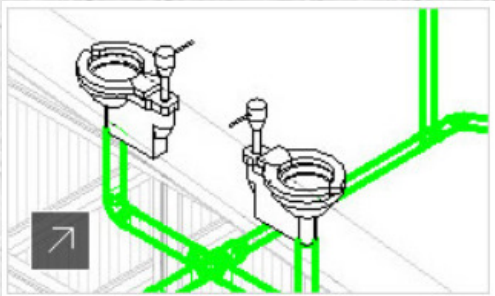
- Generate 3D model of pipes, vents, etc. which can be used to perform basic clash detection and even basic analysis.
- Check for potential headroom issues as per Architect's and Authorities' 'clear' height requirement.
- Do energy and thermal analysis, as well as reporting of pressure drops and physical properties.
- Continuous update to model as the real project is being worked on, allows every trade the option of detailed cut and fit of materials prior to going on site.
- Ability to update BIM model to "As-built" conditions following each trade on the project - an immense cost and time saver.
- Primary design program will ensure everything can be installed in the real world and even does all the necessary analysis needed for sizing and control.



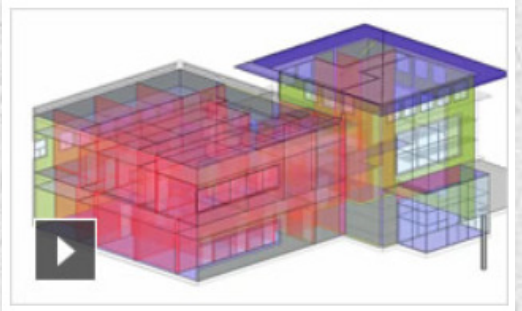
3D MODEL



CLASH DETECTION



3D MODEL



ENERGY & THERMAL ANALYSIS

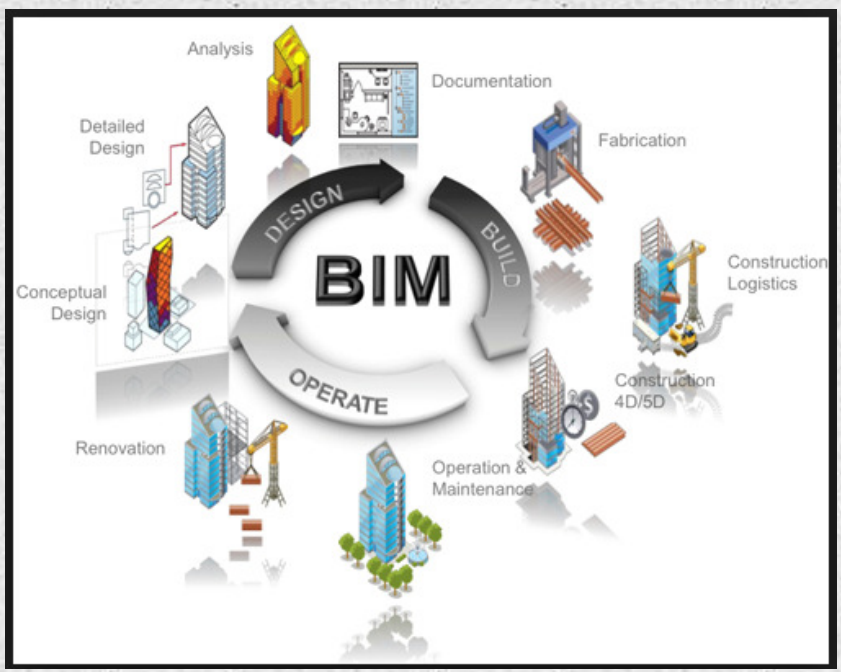
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TYPICAL BIM USAGE

- Design stage
- Modelling
- Design analysis or simulation
- Coordination
- Documentation
- presentation

- Construction
- Site planning
- Constructability review
- Construction details
- Coordination
- Formwork optimisation
- Drywall fabrication
- Construction sequence
- Model-based cost estimation

- Operations and Maintenance
- Space planning
- Asset management
- Building operation



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BIM TOOLS

1) Authoring tools

- Creating the actual model.
- Populate the model with data.
- Used in schematics, design phase to construction documentation.

Example of Authoring tools:

For architectural, structural & MEP:

Revit
BIM tools for architectural design, MEP, and structural engineering.

Bentley

For architectural & MEP:

GRAPHISOFT ARCHICAD

GRAPHISOFT MEP MODELER
a Virtual Building Solution

For structural:

TEKLA Structures

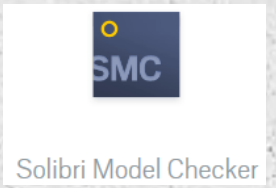
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BIM TOOLS

2) Analysis tools

- Annalise and predict model behaviour.
- Validate model compliance with standard/codes.
- Used in all phases.

Example of Analysis tools:















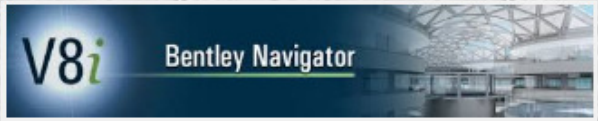
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BIM TOOLS

3) Coordination tools

- Perform clash detection analysis.
- Visualise assembly of building based on inputs.
- Used in design phase to construction phase.

Example of Authoring tools:



AUTODESK
NAVISWORKS

TEKLA
BIMsight

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BIM TOOLS

4) Model Review tools

- Evaluate model content.
- Validate model compliance with standard/codes.
- Used in schematics, design phase to construction phase.

Example of Analysis tools:

Bentley View V8i

Autodesk
Design Review

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BIM TOOLS

5) Model Quantity Take-off tools

- Extract quantities automatically from model file.
- Used in design phase to construction phase.

Example of Authoring tools:







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BIM TOOLS

6) File Sharing tools

- Archive files, view or review files.
- Model transfer.
- Used in all phase.

Example of Analysis tools:









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BIM TOOLS

7) Facility Management tools

- Space management, strategic planning, asset management, facility maintenance, etc.
- Used after construction phase.

Example of Analysis tools:

FM:Systems

ARCHIBUS

IBM maximo

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BIM FILE FORMATS

Type of formats

- Open file format:
  IFC (Industry Foundation Classes)
  The Industry Foundation Classes (IFC) data model is intended to describe building and construction industry data. It is a platform neutral, open file format specification that is not controlled by a single vendor or group of vendors.

- Proprietary file formats:
  RVT (using Autodesk Revit)
  DGN (using Bently Microstation)
  PLN (using Archicad)

- Lineweight file formats:
  DWF (Design Web Format)
  3D PDF
  Pre-defined line thickness.

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BIM E-SUBMISSION

1) E-Submission guidelines :

	Gross Floor Area of New Developments		
	More than 20,000 m^2	**More than 5,000 m^2**	**Less than or equal to 5,000m^2**
Architecture	Require BIM e-submission if the first application for Planning Permission is made on or after 1 Jul 2013	Require BIM e-submission if the first application for Planning Permission is made on or after 1 Jul 2015	BIM e-submission is optional.
M&E Engineering	Require BIM e-submission if the first application for Planning Permission is made on or after 1 Jul 2014		
C&S Engineering			

New developments include:

a) New building and infrastructure projects; and

b) A&A projects involving reconstruction or addition of any new building or infrastructure.

Reference: BCA's BIM e-Submission Guideline: Mechanical, Electrical, Plumbing

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BIM E-SUBMISSION

2) Regulatory Agencies:

- BCA
- CBPU
- PUB(WRN)
- PUB(WSN)
- FSSD
- IDA-TFCC
- Citygas

3) Accepted file format:

- DWF
- PDF

Note:

a) Submission through Corenet is limited to 100MB per file, per submission. If the file size is larger than 100MB, it shall be delivered in CD-ROM to the respective agency.

b) To separate DWF/PDF file for “sheets” & “3D views”.

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DWF VERSUS PDF

DWF (Drawing Web Format)	PDF
A compressed DWG format	PDF is basically a snapshot image of the original drawing
Good quality while minimizing the file size – ease of transferring files over the internet	Some loss of quality will be evident in the conversion process
Built-in software	Creating PDF from AutoCAD, requires the purchase of additional software.
Wider range of available resolution and yet maintaining a smaller file size	File size increases with higher resolution
In order to access DWF, it is necessary to download and install the Express Viewer	99% of computers already have the software necessary to view PDF's in Adobe Reader
Publish multiple layouts at one time. If you have a drawing containing multiple layouts, the Publish command allows you to embed all those layouts, as well as a model space view, into one DWF file	With PDF, you have to create a separate PDF for each layout.

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BIM GUIDELINES - SINGAPORE

- BCA's Singapore BIM Guide Version 2
- BCA's Essential Guide for Arch, CS, MEP & Contractors
- BCA's Essential Guide for BIM Execution Plan
- BCA's Essential Guide for BIM Adoption in an Organisation

Note:
To learn more, please go to this link:
S:\Drawing\BIM\BIM Guides\BCA

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LEVEL OF DEVELOPMENT (LOD)

The Level Of Development (LOD) is a reference to define, standardise and determine the attributes for each BIM element so as to avoid over specifying.

- LOD assists Team Members in getting a clear picture of what will be included in a BIM deliverable.
- LOD assists Design Managers to explain to their Team Members the information and detail that needs to be provided at various points in the design process.
- LOD provides a standard that can be referenced by contracts and BIM execution plans.
- LODs are agreed upon by the Team Members at the start of the project.

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LEVEL OF DEVELOPMENT SPECIFICATION (LOD)

References can be made from:



- Level of Development (LOD) Specification by BIMFORUM (US)

  https://bimforum.org/lod

  Note:

  1) A copy of BIMFORUM LOD Version 2013 can be found in our server, S:\Drawing\BIM\BIM Guides\LOD.

  2) BIMFORUM LOD Version 2015 is still in progress and there is no Version 2014.

  3) LOD is sometimes interpreted as Level of Detail rather than Level of Development. This Specification uses the concept of Levels of Development. There are important differences:
  Level of Detail is essentially how much detail is included in the model element.
  Level of Development is the degree to which the element's geometry and attached information has been thought through – the degree to which project team members may rely on the information when using the model. In essence, Level of Detail can be thought of as input to the element, while Level of Development is reliable output.

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LEVEL OF DEVELOPMENT SPECIFICATION (LOD)

4) Fundamental LOD Definitions:

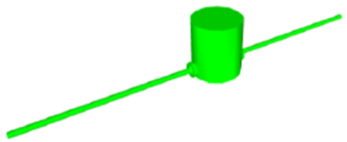
LOD 100: The Model Element may be graphically represented in the Model with a symbol or other generic representation.

example:

100	Diagrammatic or schematic model elements; conceptual and/or schematic layout/flow diagram; design performance parameters as defined in the BIMXP to be associated with model elements as non-graphic information.	

LOD 200: The Model Element is graphically represented within the Model as a generic system, object or assembly with approximate quantities, size, shape, location, and orientation.

example:

200	Schematic layout with approximate size, shape, and location of equipment; approximate access/code clearance requirements modeled; design performance parameters as defined in the BIMXP to be associated with model elements as non-graphic information.	

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LEVEL OF DEVELOPMENT SPECIFICATION (LOD)

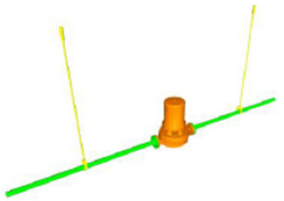
LOD 300: The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of quantity, size, shape, location, and orientation

example:

300	Modeled as design-specified size, shape, spacing, and location of equipment; approximate allowances for spacing and clearances required for all specified anchors, supports, vibration and seismic control that are utilized in the layout of equipment; actual access/code clearance requirements modeled.	

LOD 350: The Model Element is graphically represented within the Model as a specific system, object or assembly in terms of quantity, size, shape, orientation, and interfaces with other building systems.

example:

350	Modeled as actual construction elements size, shape, spacing, and location/connections of equipment; actual size, shape, spacing, and clearances required for all specified anchors, supports, vibration and seismic control that are utilized in the layout of equipment.	

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LEVEL OF DEVELOPMENT SPECIFICATION (LOD)

References can be made from:



- Singapore BIM Guide Version 2

  See Chapter 3 – BIM Deliverables.
  The guide only describes the general concept and does not contain specifications to explain the LOD framework and standards.

- VA Object/Element Matrix (US)

  www.cfm.va.gov/til/bim/BIMGuide/downloads/oemf.xls

  1) Created by the US Dept. of Veterans Affairs – Office of Construction and Facilities Management .
  2) The Object Element Matrix in an attempt to provide standards for information necessary to include in BIM models at creation and at various stages of development.
  3) The BIM Object Element Matrix is a Spreadsheet/WORKSHEET to be used for identifying and tracking BIM information during the project. It depicts Building Information Typologies/Types, when they are relevant, and to what level of development (LOD) throughout a building lifecycle.
  4) A copy of the excel file, oemf.xls, can be found in our server, S:\Drawing\BIM\BIM Guides\VA ObjectElement Matrix (US)

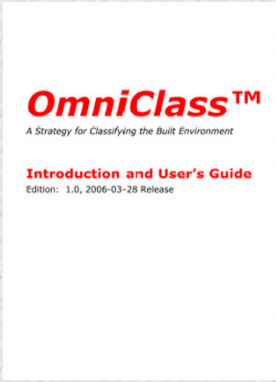
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OTHER STANDARDS

- OmniClass

  http://www.omniclass.org

1) Designed to provide a standardised basis for classifying information created and used by the architectural, engineering and construction industry, throughout the full facility life cycle.
2) Used in oraganising and preparing many different forms of information, electronic & hardcopy.
3) A copy of OmniClass document can be found in our server, S:\Drawing\BIM\BIM Guides\OMNICLASS



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OTHER STANDARDS

- CoBie (Construction Operations Building information exchange)

1) COBie was devised by the United States Army Corps of Engineers.

2) In September 2014, a code of practice regarding COBie was issued as a British Standard: "BS 1192-4:2014 Collaborative production of information Part 4: Fulfilling employer's information exchange requirements using COBie – Code of practice".

3) COBie provides common structure for the exchange of information about new and existing Facilities, including both buildings and infrastructure.

4) The use of COBie ensures that information can be prepared and used without the need for knowledge of the sending and receiving applications or databases.

5) It ensures that the information exchange can be reviewed and validated for compliance, continuity and completeness.

