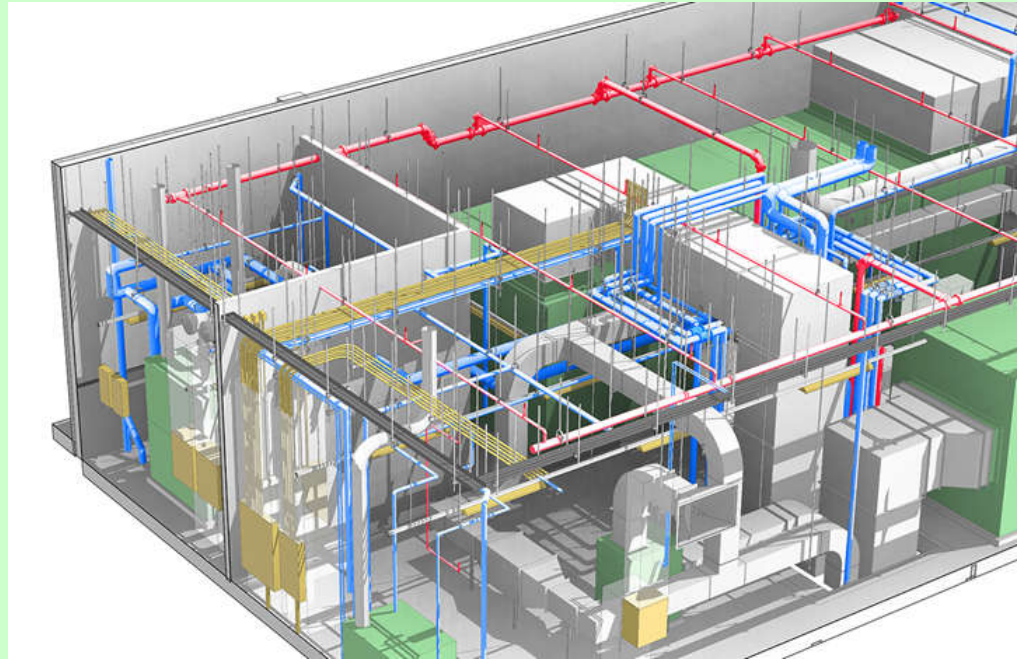


SBM5106 BIM for MEP & Sustainable Building

<http://ibse.hk/SBM5106/>



MEP Design Management



Faculty of Science and Technology

Technological and Higher Education Institute of Hong Kong

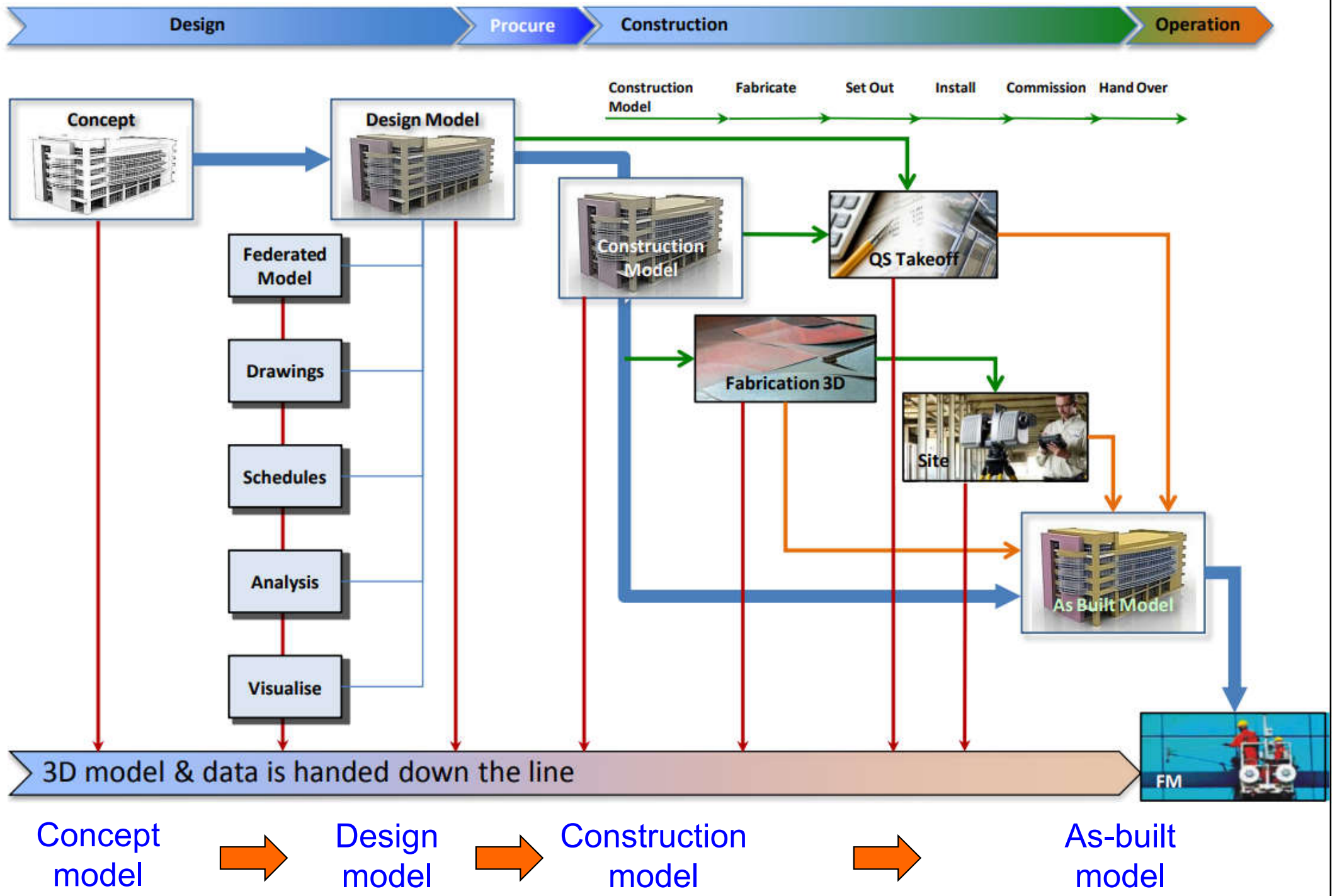
May 2019

Contents



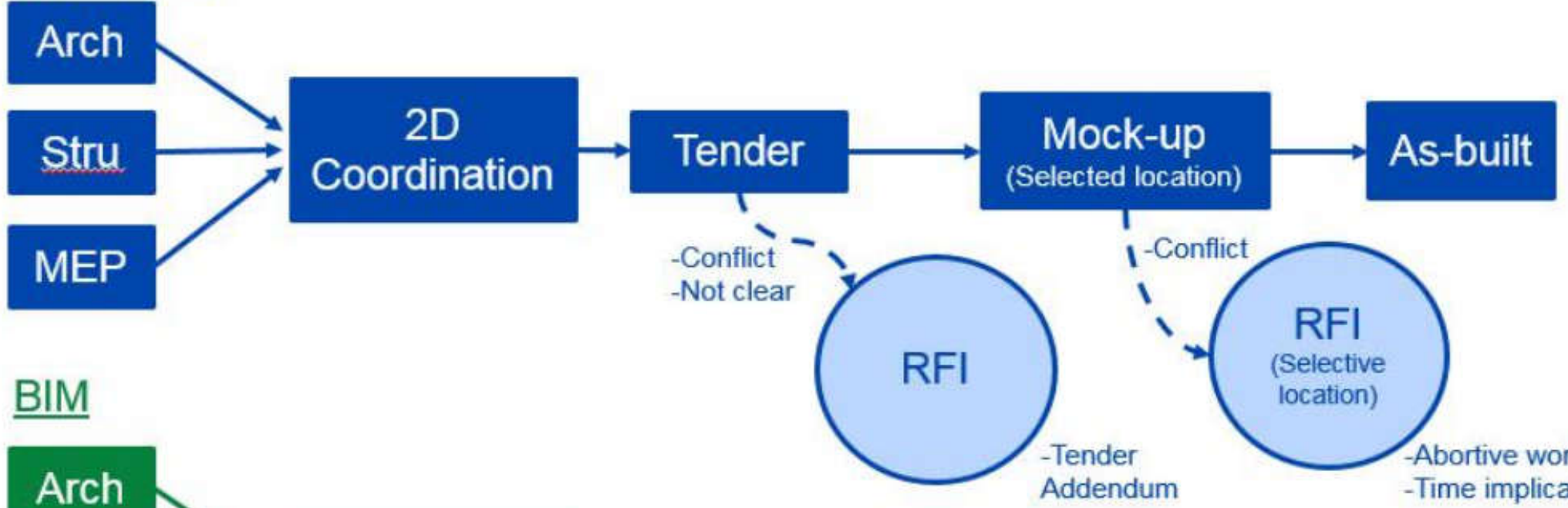
- BIM process
- Project Execution Plan (PXP)
- Modelling methodology
- Level of development (LOD)
- BIM adoption strategy

BIM process overview

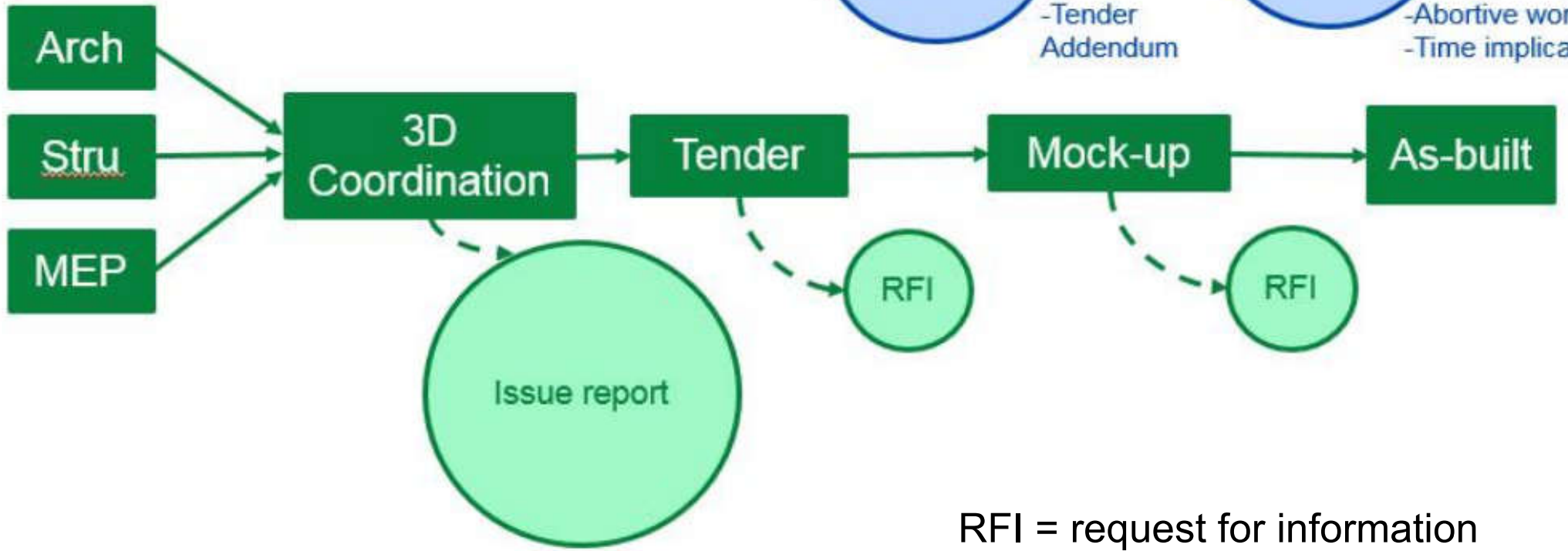


Comparison of traditional and BIM workflows

Traditional

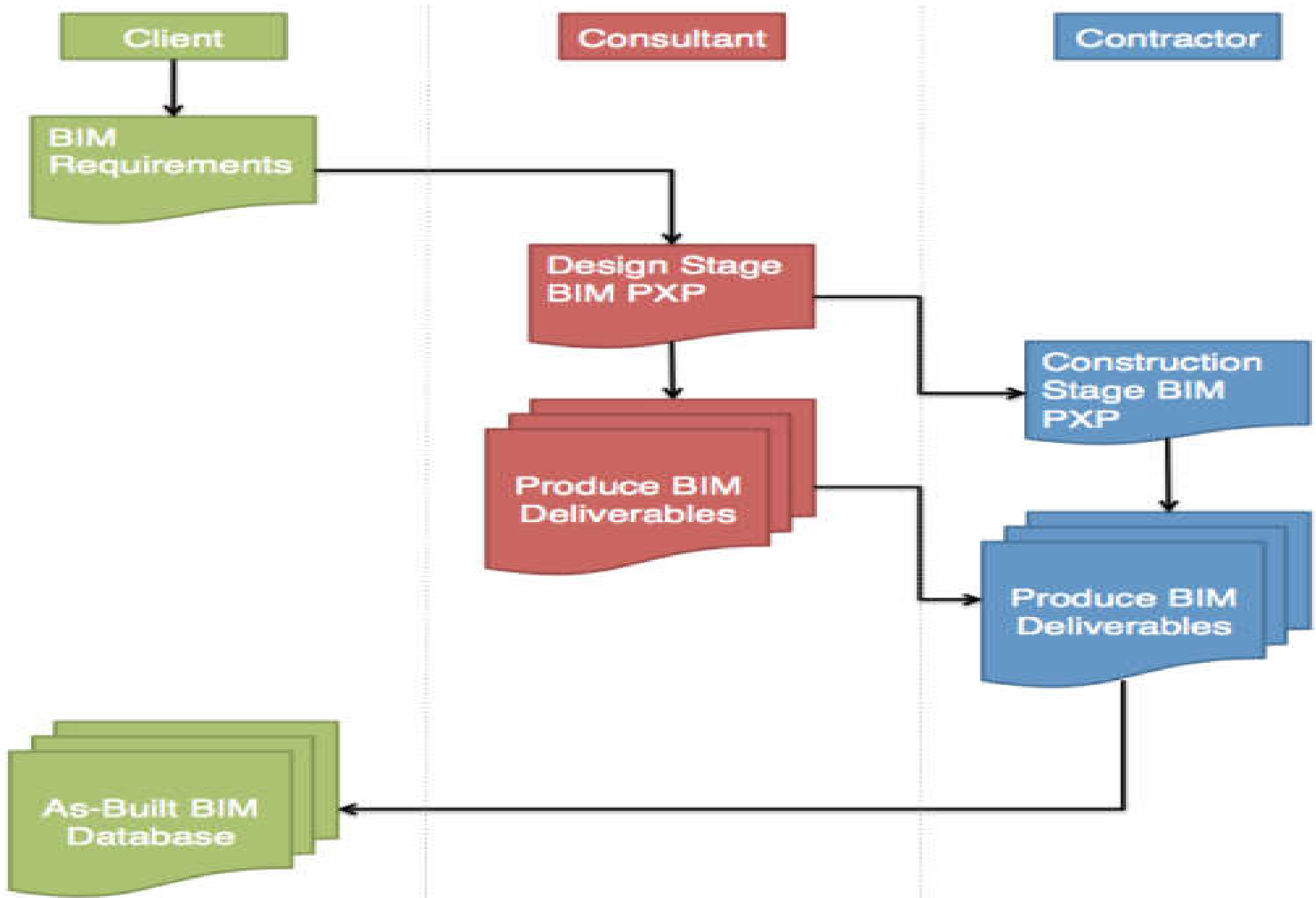


BIM



RFI = request for information

Typical BIM design management process



(Source: CIC, 2015. *CIC Building Information Modelling Standards (Phase One)*, Construction Industry Council (CIC), Hong Kong.

http://www.cic.hk/files/page/51/CIC%20BIM%20Standards_FINAL_ENG_v1.pdf)



BIM process

- Every BIM project shall have a clearly defined outcome
- The purpose of the BIM process should be set out and agreed by the client
- The successful delivery requires careful planning, detailed BIM specifications and a defined set of procedures and methodologies for the BIM implementation
- Usually a professional **BIM Manager** will lead and support the BIM process



BIM process

- Define the scope of work for a BIM process
- Major issues:*
 - BIM Project Execution Plan (PXP) or BIM Execution Plan (BEP or BXP)
 - Modelling methodology
 - Level of development (LOD)
 - Component presentation style and data organisation

Project Execution Plan (PXP)



- BIM PXP

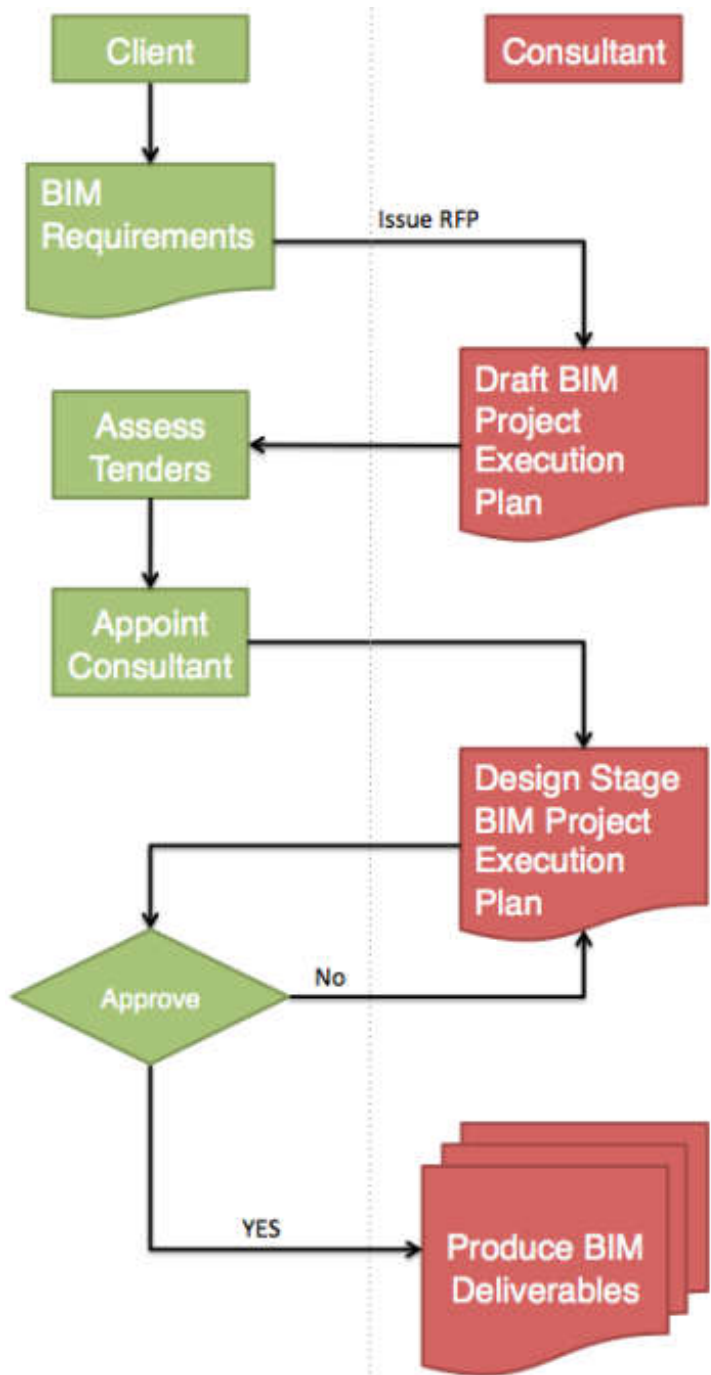
- Created at the start and updated throughout the project period
- Developed by the client, or with support from the lead consultant (architect or engineer)
- Should outline the overall vision for the project and provide implementation details
- Include the agreed BIM deliverables & processes for a project; specifies the roles & responsibilities of project members

Project Execution Plan (PXP)

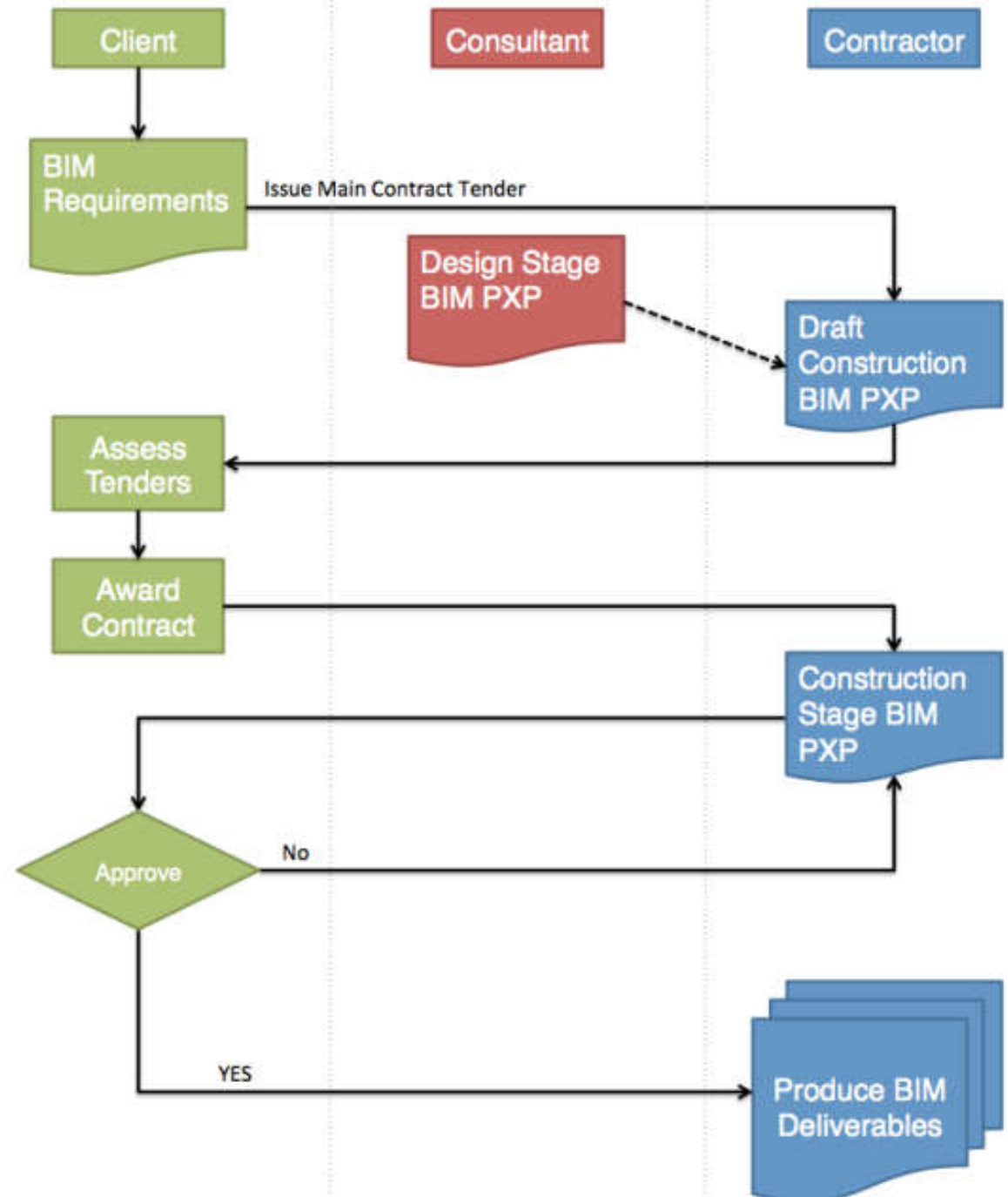


- Types of BIM PXP:
 - Design stage (prepared by the lead consultant BIM Manager)
 - Conceptual design, schematic/preliminary design, detailed design
 - Tender stage (contractors update & amend the design stage PXP)
 - Construction stage (prepared by the contractor's BIM Manager)
 - As-built stage (prepared by the facility manager)

Design stage BIM PXP



Tender & construction stage BIM PXP



Project Execution Plan (PXP)



- Typical contents of a BIM PXP:
 - Project information
 - Name, address, reference number, members, milestones
 - Client BIM requirements
 - BIM goals, uses & deliverables
 - BIM management
 - Roles, responsibility & authority
 - BIM team resources, competency & training
 - BIM deliverable schedule (programme)
 - Approval of BIM deliverables

Project Execution Plan (PXP)

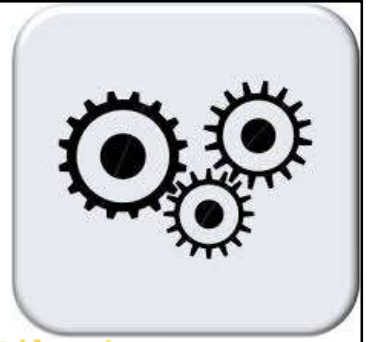


- Typical contents of a BIM PXP: (cont'd)
 - BIM process
 - Individual discipline modelling
 - Revision management
 - Collaboration & model sharing
 - BIM coordination & clash detection
 - Drawing production
 - Model archive
 - Quality control

Project Execution Plan (PXP)



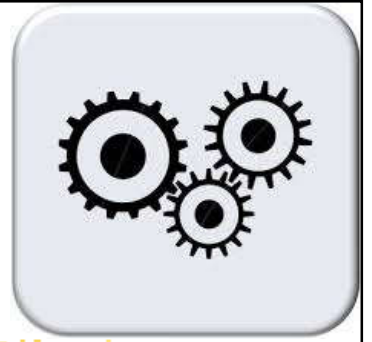
- Typical contents of a BIM PXP: (cont'd)
 - BIM procedures
 - BIM origin point & orientation (e.g. HK1980 Grid)
 - Model division, model units
 - File & layer naming convention
 - Drawing sheet templates
 - Annotations, dimensions, abbreviations & symbols
 - IT hardware & software solutions
 - Software versions, exchange formats, data security & back-up, hardware specifications, IT upgrades



Modelling methodology

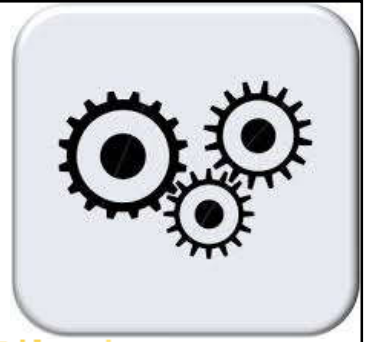
- How to enable model development & build-up which will facilitate the efficient use or re-use of BIM data and models
- For feasibility & scheme design stages, a model for simple drawings & visualisations may be acceptable
- For detailed design, construction and as-built models, an accurate BIM is required
- The **BIM Coordinators** shall create & manage separate models for each design discipline and allow thorough coordination checks

Modelling methodology



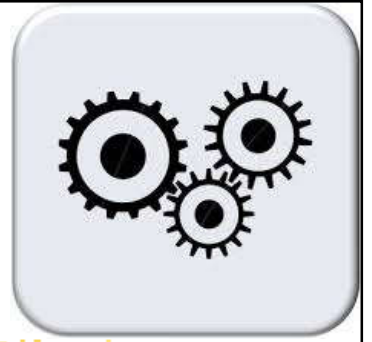
- Discipline modelling guidelines:
 - 1. Site modelling
 - Topography, land uses, site formation, geology, massing models of surrounding buildings, roads, infrastructure
 - 2. Architectural modelling
 - Building or feature elements for walls, slabs, doors, windows, etc.

Modelling methodology



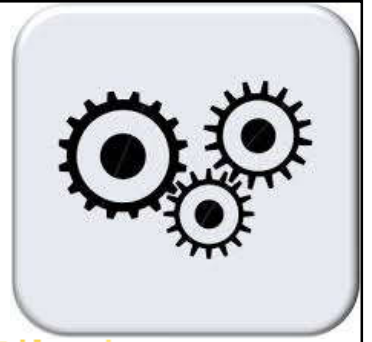
- Discipline modelling guidelines: (cont'd)
 - 3. Structural modelling
 - Analysis and physical models, load-bearing or non-load-bearing structures
 - 4. Building services (MEP) modelling
 - Ductwork, pipework, schematic diagrams, etc.
 - 5. Utilities modelling
 - Cables, pipework, drainage, gas, etc.

Modelling methodology



- Model set-up requirements:
 - BIM model zones
 - For separate areas or levels
 - To reduce BIM file size
 - BIM project coordinates
 - Match true world coordinates
 - e.g. HK 1980 Grid
 - Project origin point & principal datum

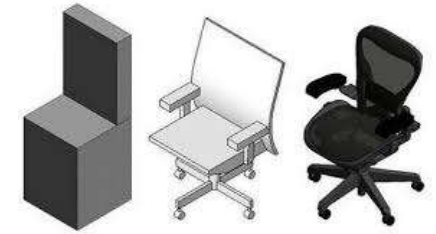
Modelling methodology



- Collaboration procedures:
 - Collaboration standards
 - For information management
 - Federated model creation*
 - BIM Manager to manage linked models
 - Facilitating BIM coordination
 - e.g. face-to-face meetings, web conferencing, BIM coordination room



Level of development (LOD)



- Clearly specify the content of models at each stage of a project
 - LOD definitions
 - LOD responsibility matrix (e.g. model author)
 - LOD specification
- Must understand the usability & limitations of the model elements
- Building systems are developed at different rates through the design process

Level of development (LOD) for MEP design process

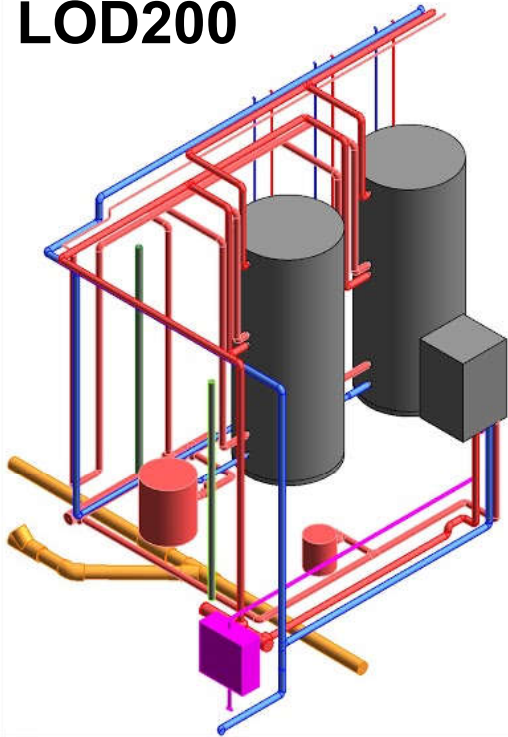
LOD	Concept Phase	Traditions Phase	Example
100	Conceptualization	Schematic design	
200	Criteria design	Design development	
300	Detailed design	Construction documentation	Valve mechanism Valve operation Size Material
350	Beyond detailed design	Pre-construction	
400	Fabrication details	Construction administration	Percentage open Flow coefficient Measured flow rate Measured pressure drop
500	Facility management (FM)	Hand over	FM: Brand FM: Model FM: Serial number FM: Acquisition date FM: Warranty period FM: Warranty content

Examples of level of development (LOD) for MEP

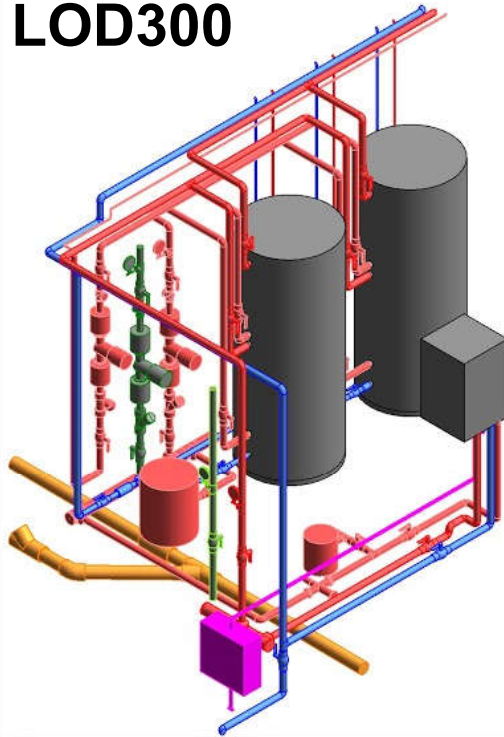
Level Of Development (LOD)

= Level of Graphical Detail (LoD) + Level of Information Included (LOI)

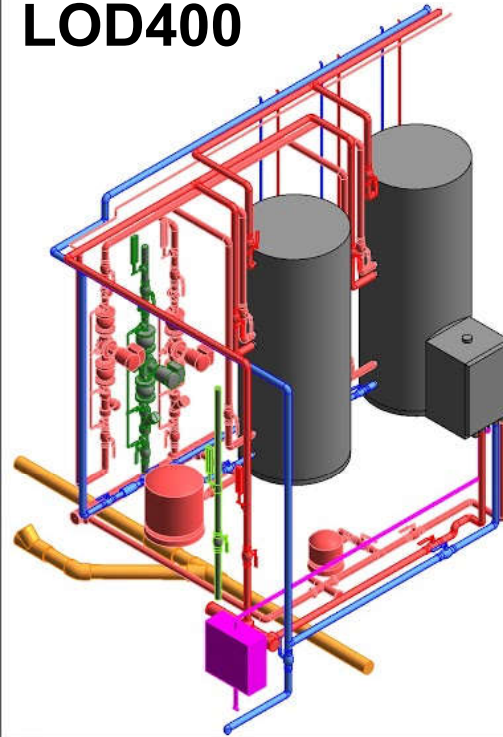
LOD200



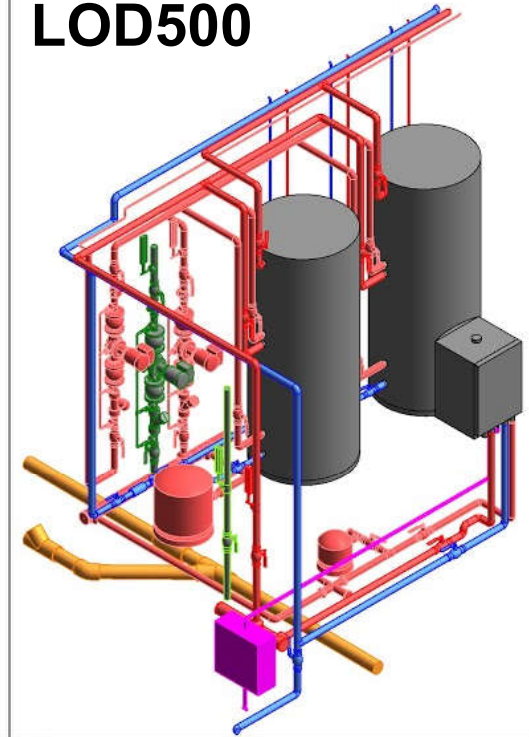
LOD300



LOD400



LOD500



LOD 200

LOD 300

LOD 400

LOD 500



MEP_0420_Valve-ball

Valve Mechanism
Valve Operation
Size
Material



MEP_0420_Valve-ball

Valve Mechanism
Valve Operation
Size
Material
Percentage open
Flow Coefficient
Measured Flow Rate
Measured Pressure Drop



MEP_0420_Valve-ball

Valve Mechanism
Valve Operation
Size
Material
Percentage open
Flow Coefficient
Measured Flow Rate
Measured Pressure Drop
FM_Brand
FM_Model
FM_Serial Number
FM_Acquisition Date
FM_Warranty Period
FM_Warranty Content

(*See also: Level Of Development <https://www.modelical.com/en/gdocs/level-of-development/>)

(Source: Revit MEP Best Practice <https://www.modelical.com/en/gdocs/mep-best-practices/>)

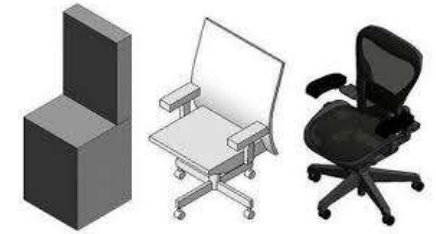
Adequate model LOD for a specific scope

Model Use	LOD 200	LOD 300	LOD 400	LOD 500
Coordination review and clash detection	Adequate	Optimal if also done LOD 200	Adequate if also done in LOD 300	Unnecessary
4D Sequence	Adequate	Adequate if also done in LOD 200	Adequate but intensive labour	Unnecessary
Quantity take-off and review	Not adequate	Adequate	Optimal	Adequate
Site planning	Adequate	Unnecessary	Highly unnecessary	Unnecessary

Bottom-line:

- Model sparingly to meet the needed model development so it can serve the intended uses of the model.
- Intended uses of the model should be clear in advance, so that the project and model development can be programmed accordingly.
- There is no point in defining whole models LODs. It is better to focus on element LODs.

Level of development (LOD)

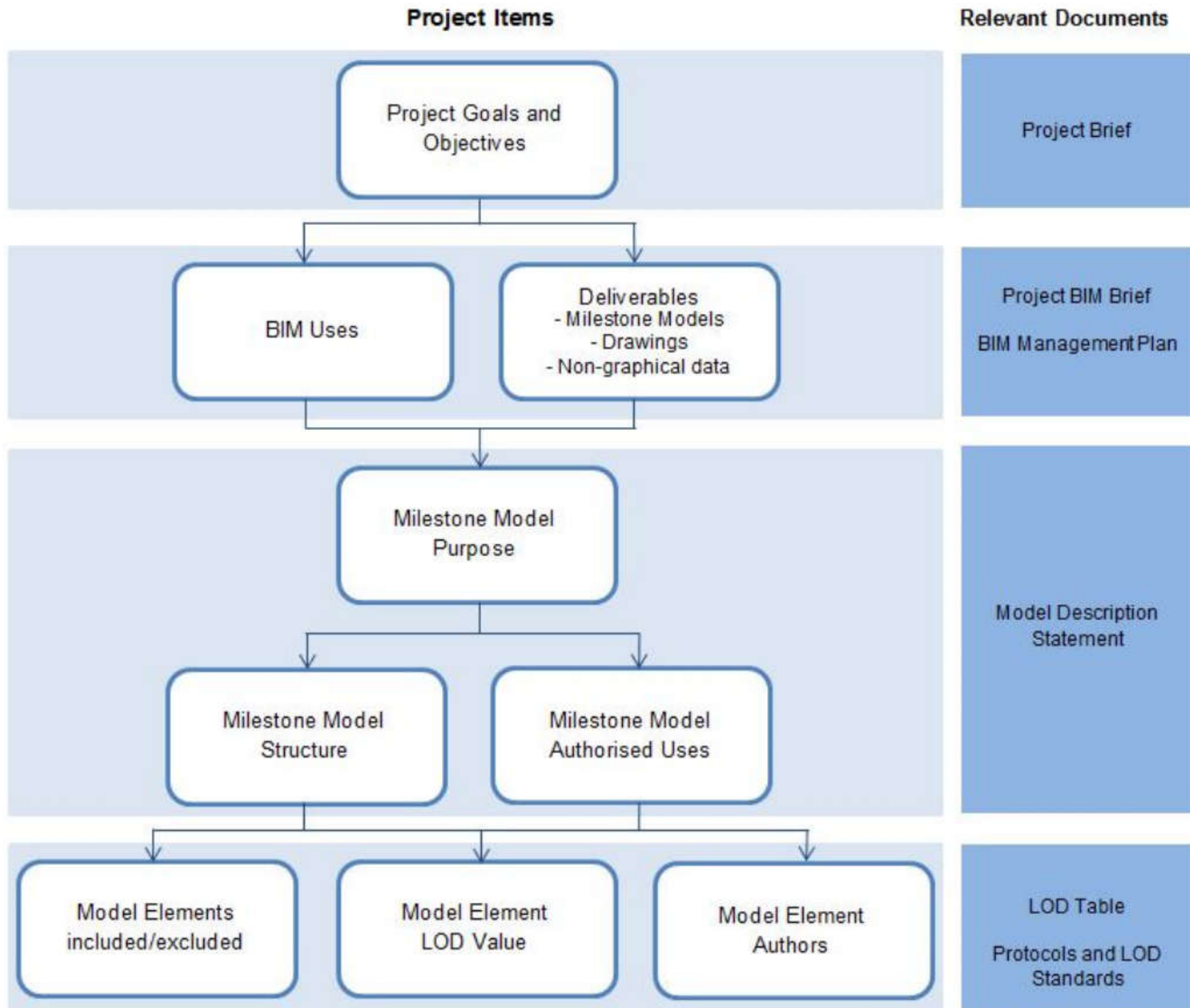


- A **BIM use** is a concrete action developed within the BIM Model
- A model should be developed at each stage to the point that it includes the information that is useful for the intended use and the project status
- The modelling effort should be limited to what is useful at each project milestone

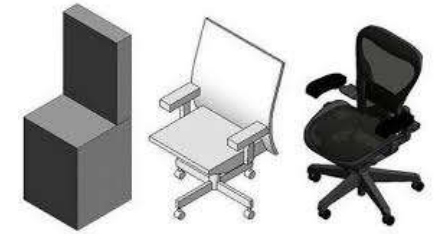
Examples of BIM content per discipline (LOD 300 is used)

Model Use	Architecture	Structure	MEP
Coordination review and clash detection	<ul style="list-style-type: none"> •Interior partitions. •Openings, windows and doors •Staircases and ramps •Elevators 	<ul style="list-style-type: none"> •Walls, columns and retaining walls •Slabs and mat slabs •Framing, beams, openings 	<ul style="list-style-type: none"> •Ducts and mechanical equipment •Sanitary downpipes and branches •Water supply system •Fire fighting system •Shafts and shunts •Lighting fixtures and panels
4D Sequence	<ul style="list-style-type: none"> •Construction joints •Concrete pouring joints •Facade assemblies 	<ul style="list-style-type: none"> •Earthworks •Structure assemblies •Formwork •Cranes and machinery 	<ul style="list-style-type: none"> •Only major elements
Quantity take-off and review	<ul style="list-style-type: none"> •Partitions and facade elements with specifications •Windows and openings •Staircases and ramps •Elevators •Finishes •Furniture 	<ul style="list-style-type: none"> •Walls, columns and retaining walls •Slabs and mat slabs •Framing, beams, openings •Foundations •Materials and coding •Reinforcement general quantities 	<ul style="list-style-type: none"> •Ducts and mechanical equipment •Sanitary downpipes and branches •Water supply system •Fire fighting system •Shafts and shunts •Valves and pumps •Lighting fixtures and panels
Site planning	<ul style="list-style-type: none"> •Site facilities, fencing •Cranes and machinery •Formwork and centering 		

LOD tables as a project management tool



Level of development (LOD)



- Define LOD by reference to standards
 - Geometry (graphical information)
 - Defined by reference to BIMForum LOD Specification
 - Data (non-graphical information)
 - Defined by reference to NATSPEC BIM Object Element Matrix
- Use a standard LOD table to document the LOD of individual model elements
 - Document agreed standards & any variations in Project BIM Brief or BIM Management Plan

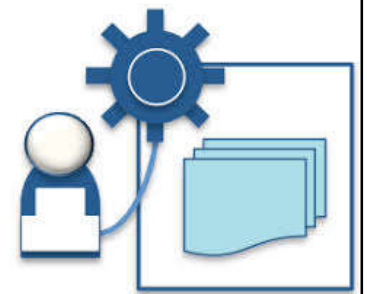
BIM adoption strategy

- BIM adoption plan in an organisation should be endorsed by the senior management and be reviewed and refined regularly
- Essential items to consider:
 - Leadership and planning
 - Information and process
 - People and capability
 - Customer engagement
 - Results



BIM adoption strategy

- Leadership and planning
 - Senior Leaders & BIM Committee
 - BIM vision & goals, essential themes
 - Change management (cultural)
 - BIM environment (hardware & software)
- Information and process
 - BIM standards, quality assurance, information management
 - BIM process for project & deliverables



Examples of quality control checks

Modelling Validation (visual check)

- Ensure that the model is created accordingly to the modelling guidelines in the BIM standard

Dataset Validation (adopt standard objects)

- Ensure that the dataset are populated with correct data

Interference Validation (computer-assisted)

- Detect any clash between building component using a clash detection software
- Detect sufficient space clearance between building components for installation and maintenance purposes

Exchange Validation (visual check)

- Ensure that model is published/received based on the exchange protocol as defined in the project execution plan

BIM adoption strategy

- BIM information management
 - An example of BIM folders:
 - BIM Execution Plan
 - BIM Progression by Stages
 - Conceptual, Schematic, Design Development, Regulatory Submission, Tender, Construction, As-built, Facility Management
 - BIM Coordination Meetings
 - Reports & resolutions
 - BIM Object Library (discipline objects)
 - Contractual (addendum, RFI, change orders)



BIM process and MEP deliverables

Stage	BIM MEP deliverables
1. Preparation & Conceptual Design	<ul style="list-style-type: none"> a. Understand Project Brief (client's requirements) b. Define BIM Execution Plan c. Set up BIM Project Template, coordinate system, grids, level height
2. Schematic Design	<ul style="list-style-type: none"> a. Preliminary Model based on architectural massing, structural and site models (identify ceiling height, opening, load bearing structures, services connections on site) b. Determine design criteria, key service connections, services routes and plant room. c. Preliminary MEP model layout d. Preliminary MEP services calculation report e. Schematic drawings f. Alternate design
3. Detailed Design	<ul style="list-style-type: none"> a. Understand & validate Architectural and Structural Models b. Define zones, spaces, services routes and plant room c. MEP services calculation reports (load & sizing) d. MEP services model layout and detailed BOQ by trade e. Clash detection & resolution report among different MEP trades (ACMV, plumbing, sanitary, fire protection and electrical) f. Clash detection & resolution report w.r.t. Architectural & Structural models g. Regulatory submissions h. Tender documents

(Source: BCA, 2013. *BIM Essential Guide for BIM Adoption in an Organization*, Building and Construction Authority (BCA), Singapore.

<https://www.corenet.gov.sg/media/586143/Essential-Guide-Adoption.pdf>

BIM process and MEP deliverables (cont'd)

Stage	BIM MEP deliverables
4. Construction	a. Design validation report b. RFI (request for information) resolution c. Shop & working drawings d. Single services drawings (SSD) & combined services drawings (CSD) e. Detailed schedule of materials & quantities
5. As Built	a. As constructed model & drawings b. Operation & Maintenance Manual (OMM) c. Commission reports
6. Facility Management	a. As built model

BIM adoption strategy



- People and capability
 - BIM competency & skills
 - Training to staff
 - BIM related roles (e.g. BIM Managers, BIM Coordinators)
- Customer engagement
 - Define BIM Execution Plan & contract conditions
- Results
 - Monitored regularly, KPI, corrective actions



BIM adoption strategy

- Useful references on BIM execution*:
 - Appendix A: BIM Use Case Template
 - Conceptual design
 - Schematic / Preliminary design
 - Detailed design
 - Construction
 - As-built
 - Appendix B: Typical BIM Elements by Discipline
 - Architectural, structural, civil, ACMV, plumbing & sanitary, fire protection, electrical, gas

BIM adoption strategy

- Useful references on BIM execution: (cont'd)
 - Appendix C: BIM Modelling Guidelines
 - Overview
 - Quality assurance
 - Architectural BIM modelling guidelines
 - Structural BIM modelling guidelines
 - MEP BIM modelling guidelines
 - ACMV
 - Plumbing and sanitary
 - Fire protection
 - Electrical



Further reading

- BCA, 2013. *BIM Essential Guide for BIM Adoption in an Organization*, Building and Construction Authority (BCA), Singapore.
 - <https://www.corenet.gov.sg/media/586143/Essential-Guide-Adoption.pdf>
- BCA, 2013. *BIM Essential Guide for BIM Execution Plan*, Building and Construction Authority (BCA), Singapore.
 - <https://www.corenet.gov.sg/media/586149/Essential-Guide-BEP.pdf>
- BCA, 2013. *BIM Essential Guide for MEP Consultants*, Building and Construction Authority (BCA), Singapore.
 - <https://www.corenet.gov.sg/media/586155/Essential-Guide-MEP.pdf>
- CIC, 2015. *CIC Building Information Modelling Standards (Phase One)*, Construction Industry Council (CIC), Hong Kong.
 - http://www.cic.hk/files/page/51/CIC%20BIM%20Standards_FINAL_ENG_v1.pdf