4.3 MEP Design Management
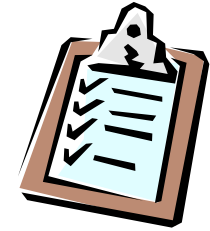
Ir Dr. Sam C. M. Hui
Department of Mechanical Engineering
The University of Hong Kong
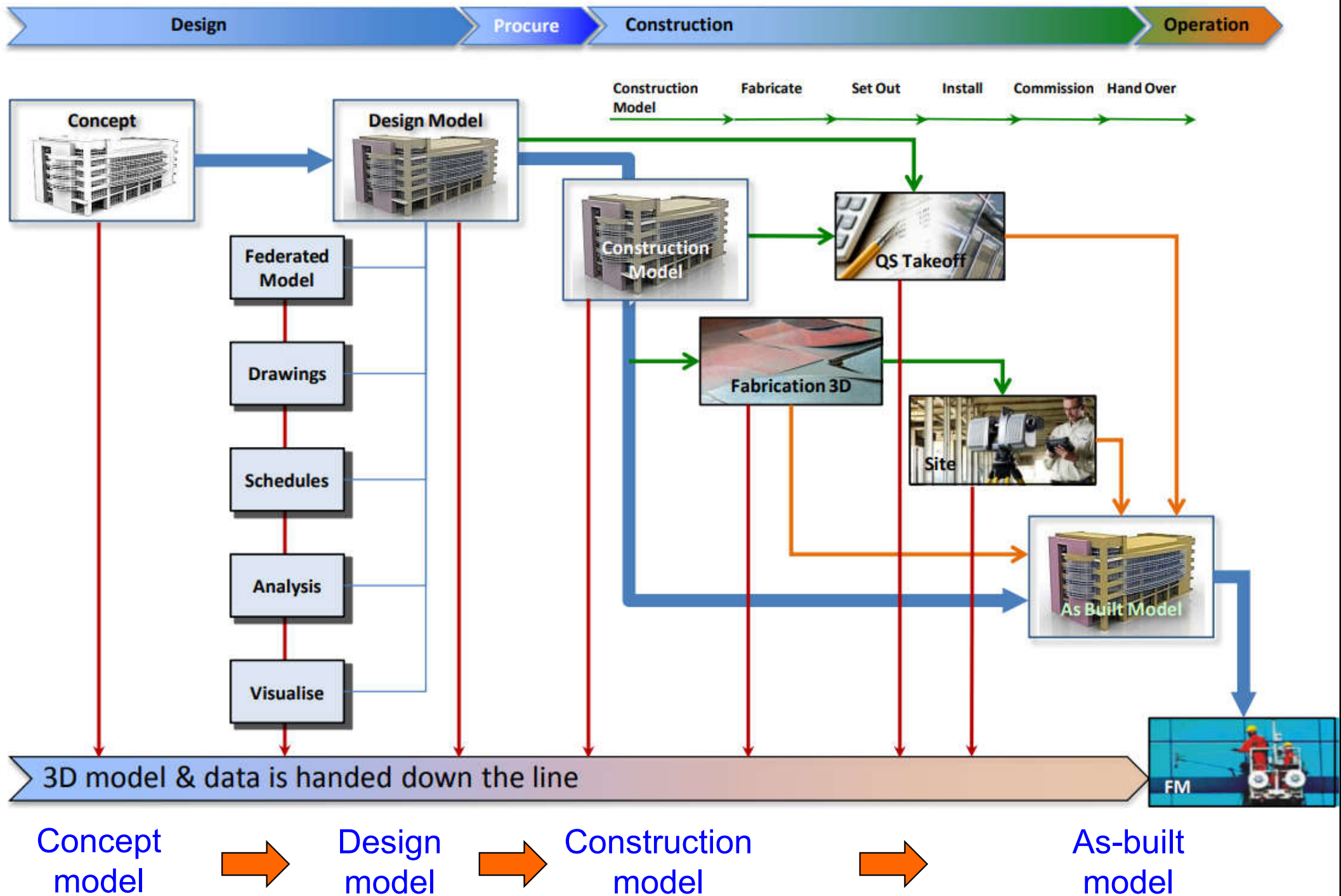E-mail: cmhui@hku.hk

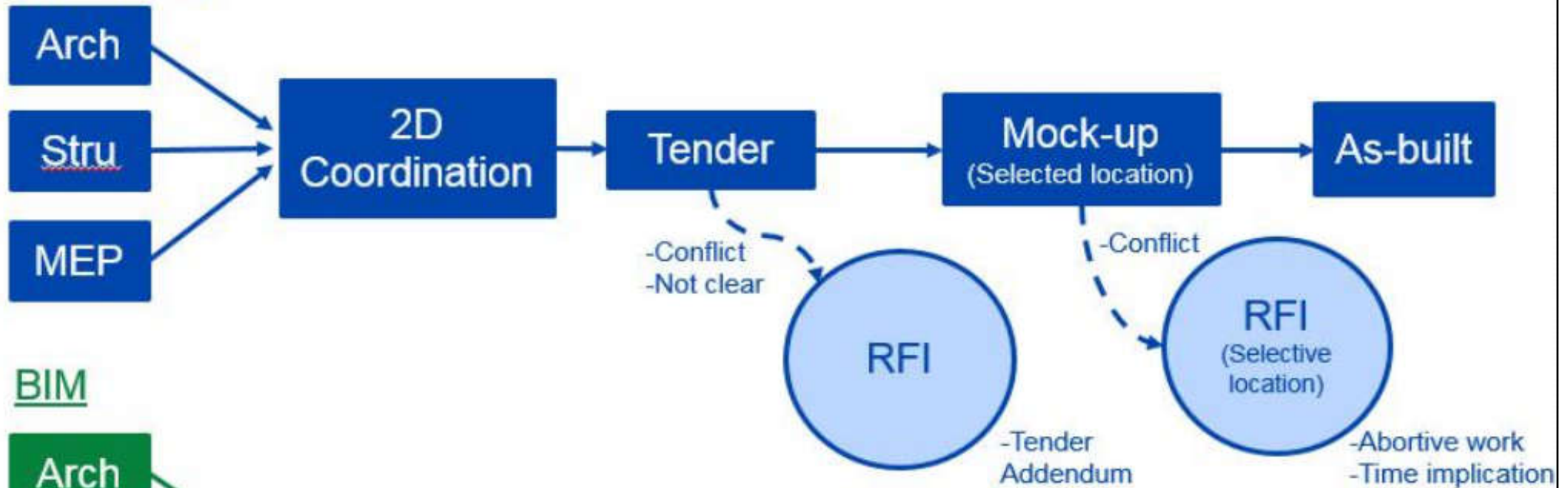Jun 2025

Contents

- BIM process

- Project Execution Plan (PXP)

- Modelling methodology

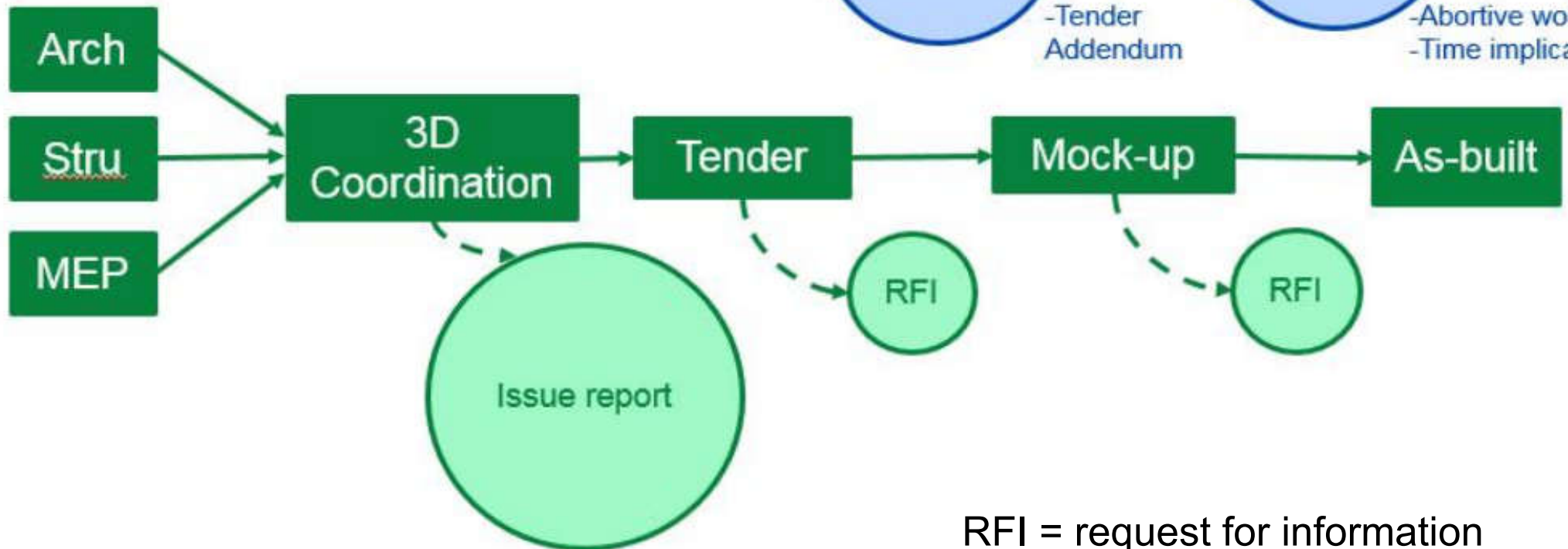- Level of development (LOD)

- MEP coordination

BIM process overview

Design → Procure → Construction → Operation

Construction Model → Fabricate → Set Out → Install → Commission → Hand Over

Concept → Design Model → Construction Model → QS Takeoff → Fabrication 3D → Site → As Built Model → FM

Federated Model → Drawings → Schedules → Analysis → Visualise

3D model & data is handed down the line

Concept model → Design model → Construction model → As-built model

Comparison of traditional and BIM workflows

RFI = request for information

Typical BIM design management process
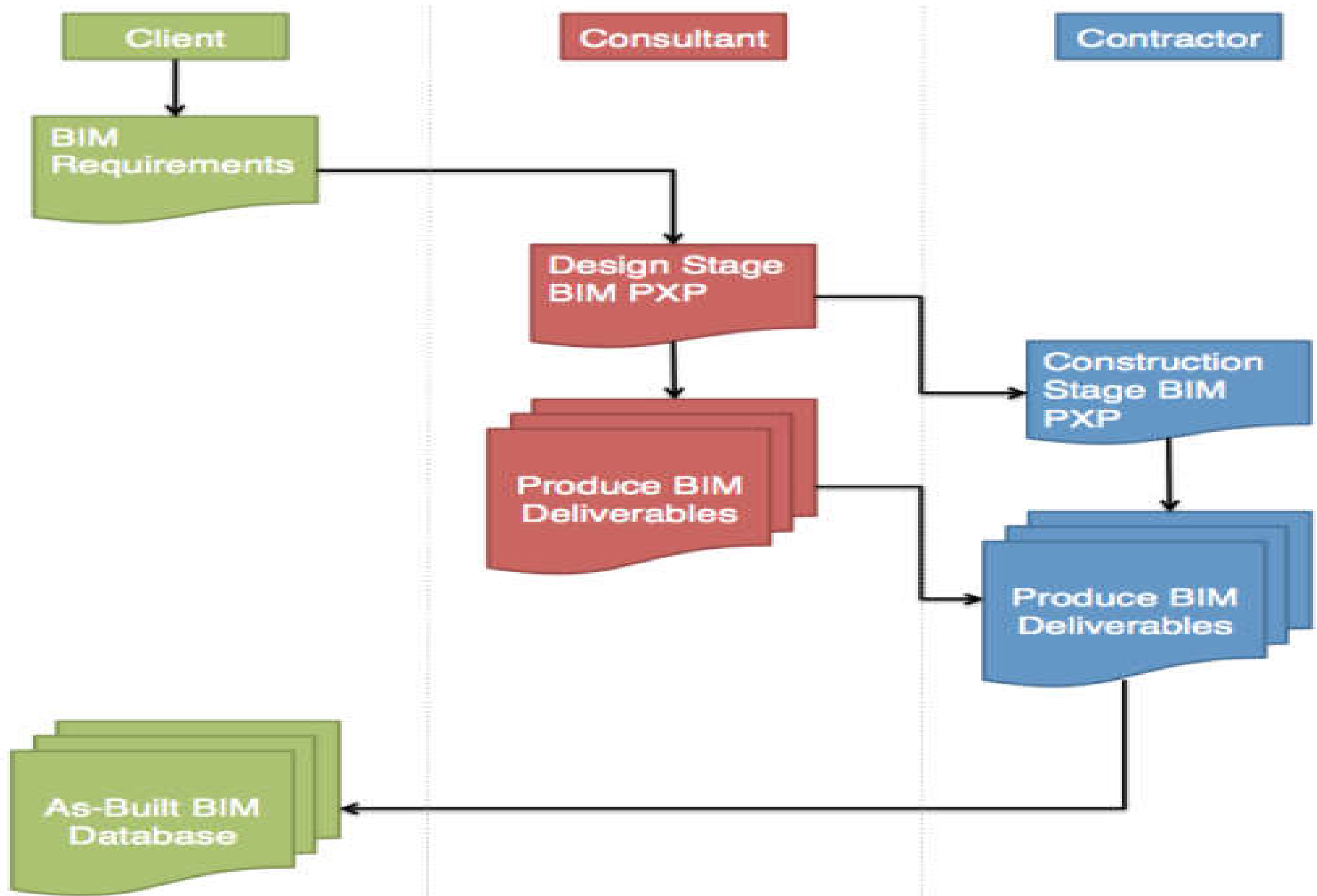
BIM process

- 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

(See also: 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)
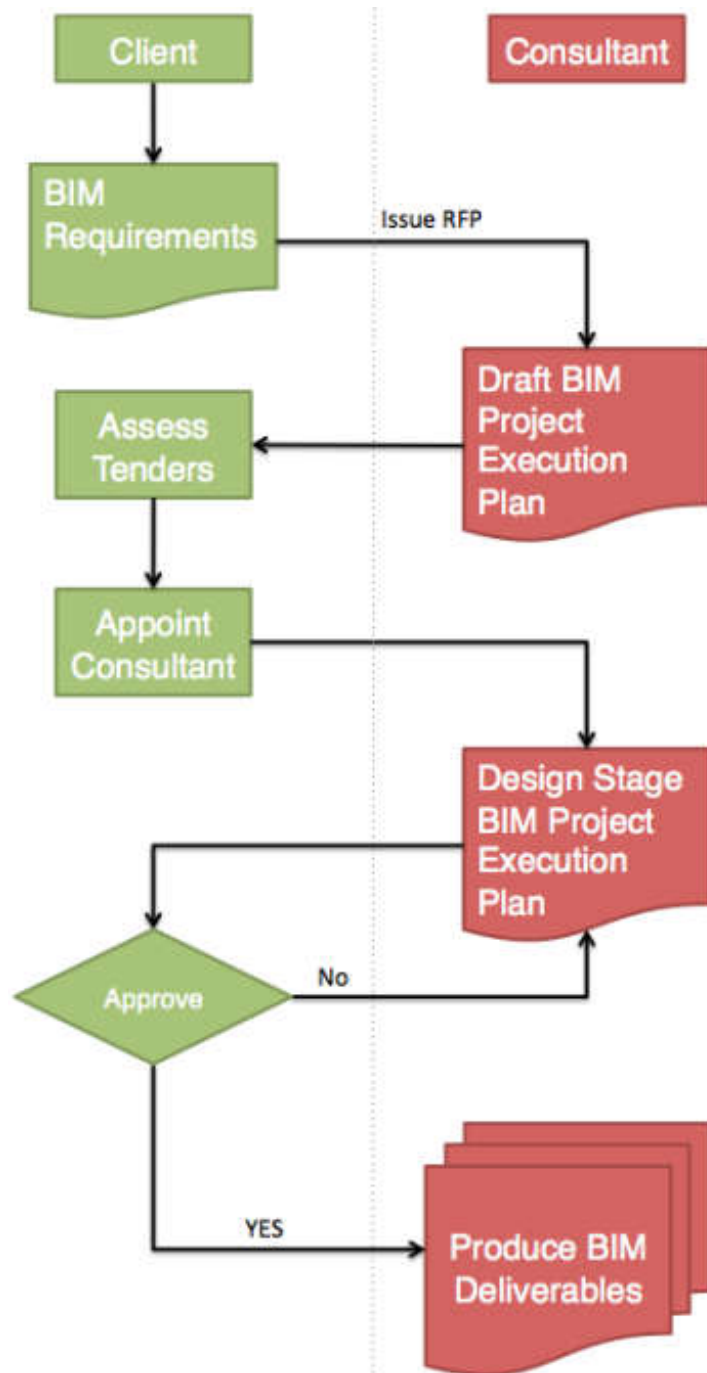
Project Execution Plan (PXP)

- 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
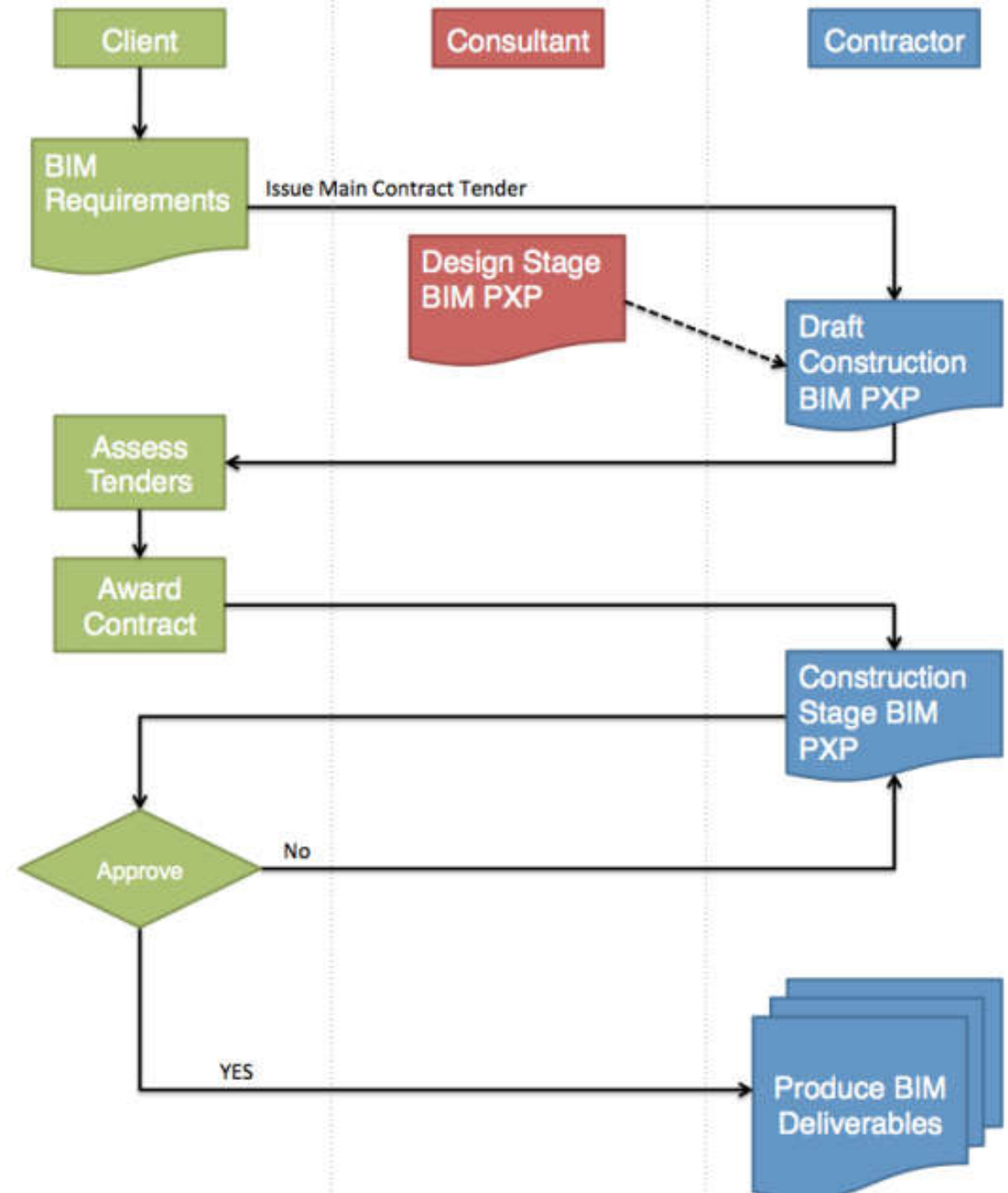
Project Execution Plan (PXP)

- 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

(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)

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
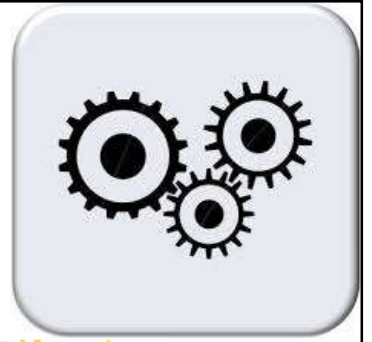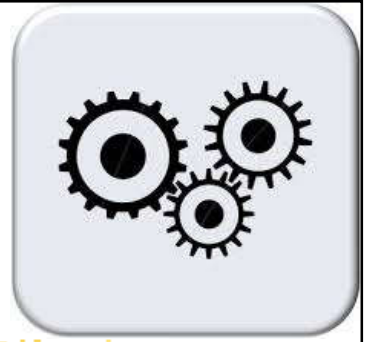
Modelling methodology

- 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
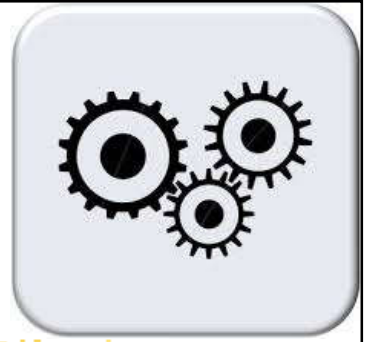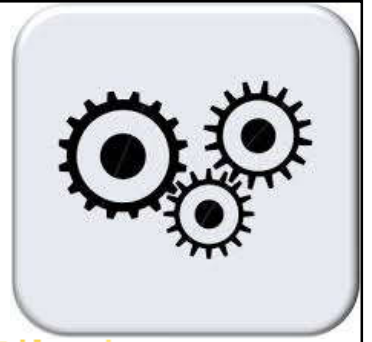
Modelling methodology

- 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. <u>Structural modelling</u>
    - Analysis and physical models, load-bearing or non-load-bearing structures
  - 4. <u>Building services (MEP) modelling</u>
    - Ductwork, pipework, schematic diagrams, etc.
  - 5. <u>Utilities modelling</u>
    - 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
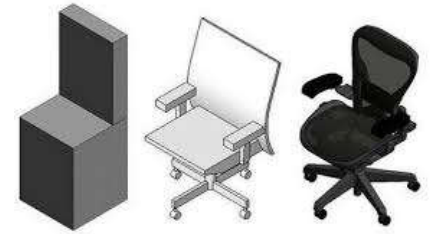   - Project origin point & principal datum

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

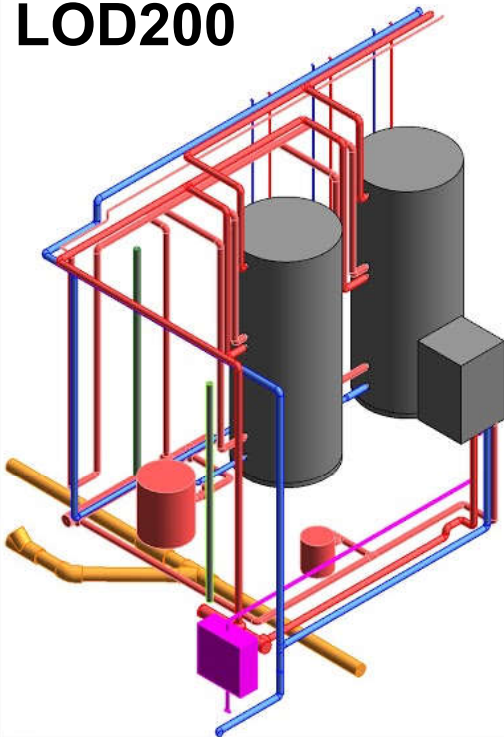## Level of development (LOD) for MEP design process

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

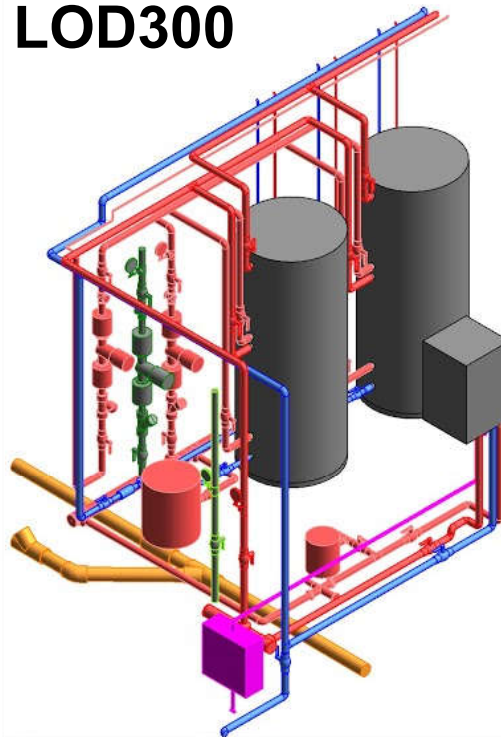# Examples of level of development (LOD) for MEP

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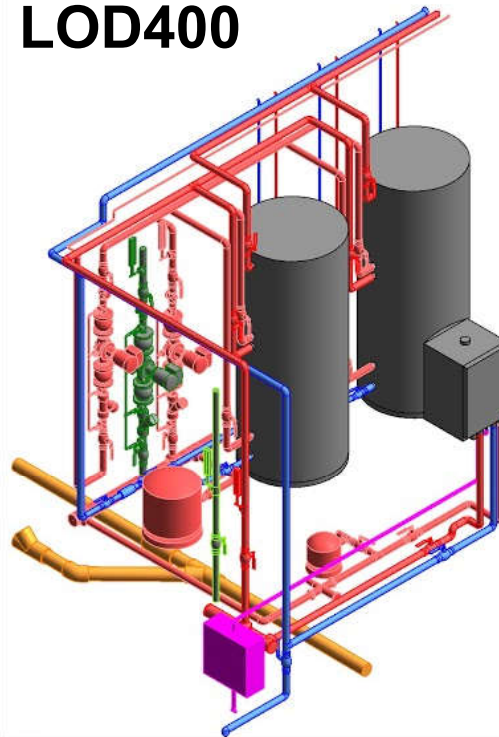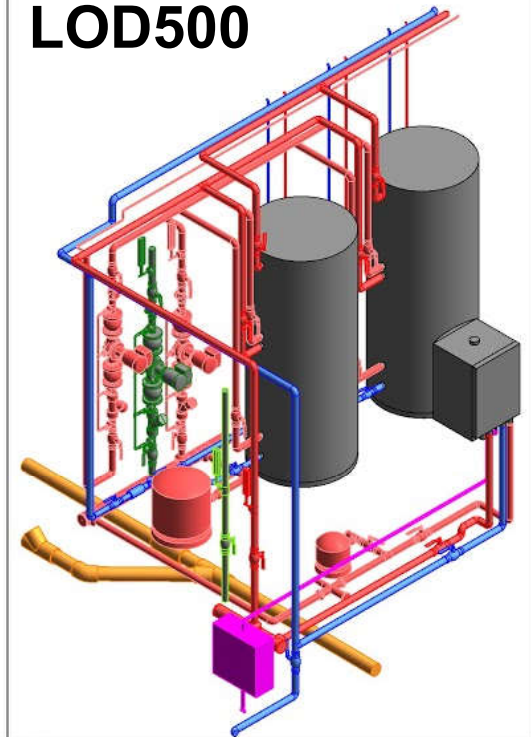= Level of Graphical Detail (LoD) + Level of Information Included (LOI)

(*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.

(Source: Level Of Development https://www.modelical.com/en/gdocs/level-of-development/)
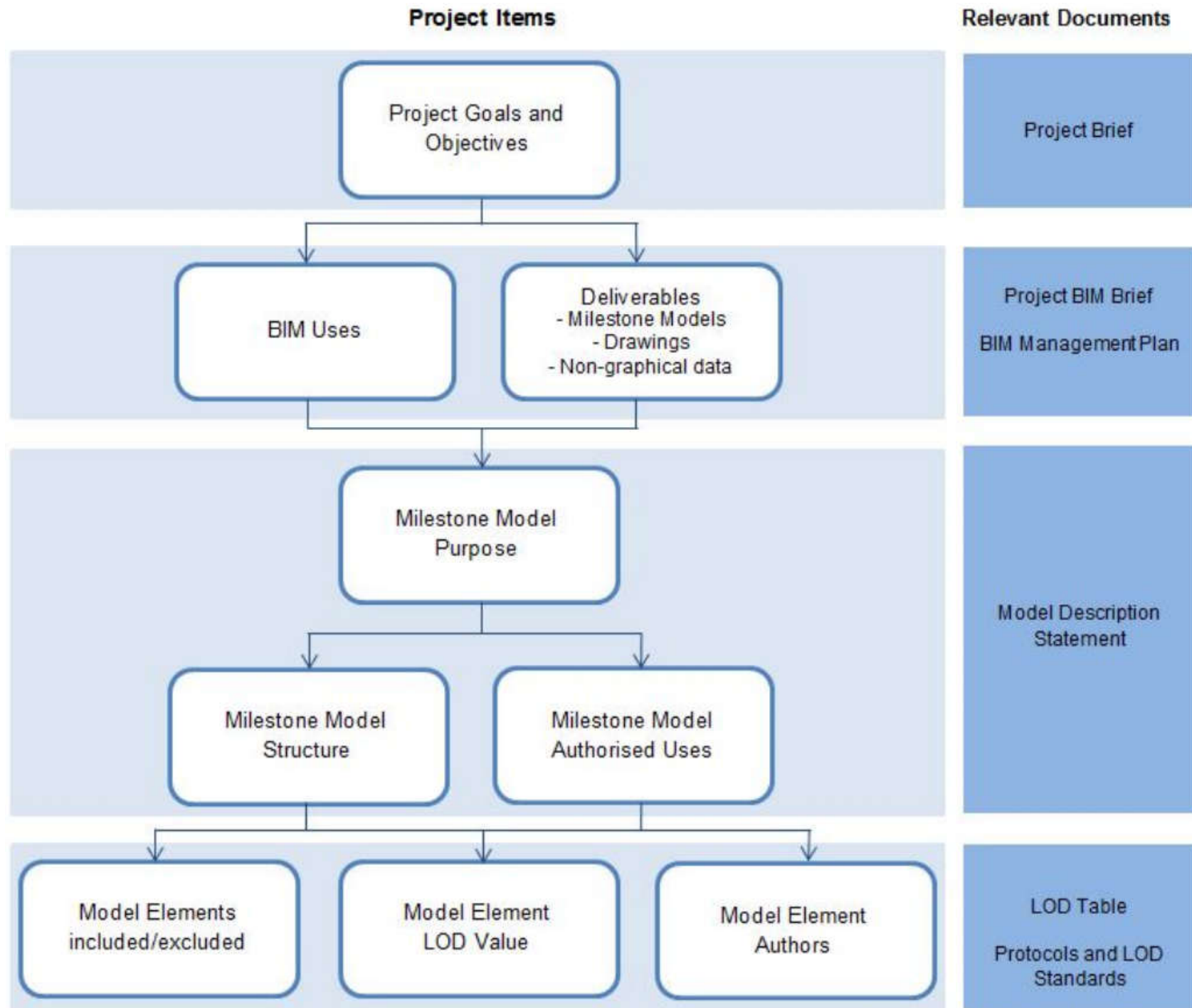
Level of development (LOD)
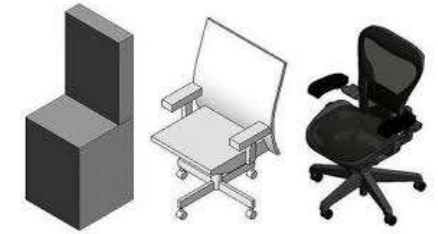
- A BIM use is a concrete action developed within the BIM Model

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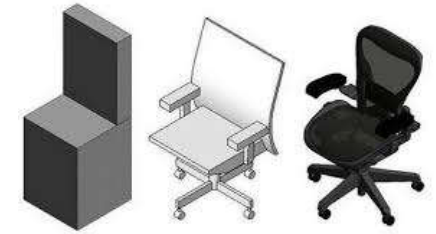
Examples of BIM content per discipline (LOD 300 is used)

Model Use	Architecture	Structure	MEP
Coordination review and clash detection	•Interior partitions. •Openings, windows and doors •Staircases and ramps • Elevators	•Walls, columns and retaining walls •Slabs and mat slabs •Framing, beams, openings	•Ducts and mechanical equipment •Sanitary downpipes and branches •Water supply system •Fire fighting system •Shafts and shunts •Lighting fixtures and panels
4D Sequence	•Construction joints •Concrete pouring joints •Facade assemblies	•Earthworks •Structure assemblies •Formwork •Cranes and machinery	•Only major elements
Quantity take-off and review	•Partitions and facade elements with specifications •Windows and openings •Staircases and ramps •Elevators •Finishes •Furniture	•Walls, columns and retaining walls •Slabs and mat slabs •Framing, beams, openings •Foundations •Materials and coding •Reinforcement general quantities	•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	•Site facilities, fencing •Cranes and machinery •Formwork and centering		

(Source: Level Of Development https://www.modelical.com/en/gdocs/level-of-development/)

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 mode elements
  - Document agreed standards & any variations in Project BIM Brief or BIM Management Plan

BIM process and MEP deliverables

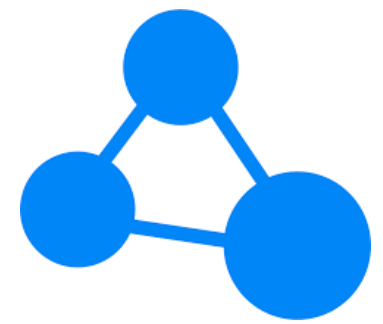| Stage	BIM MEP deliverables
1. Preparation & Conceptual Design	a. Understand Project Brief (client's requirements) b. Define BIM Execution Plan c. Set up BIM Project Template, coordinate system, grids, level height
2. Schematic Design	a. Preliminary Model based on architectural massing, structural and 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	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

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

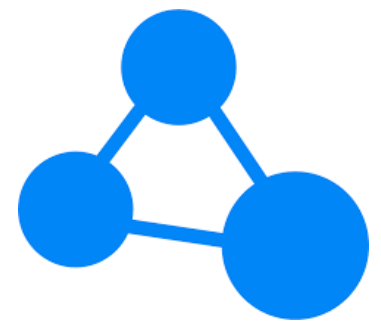# MEP coordination

- [MEP coordination](#) refers to the spatial coordination of all building services (HVAC, pipework, plumbing & electrical systems) with other disciplines making up the building structure, architectural elements, fabric & external envelope (steel, concrete, false ceilings, etc.)

  - Acts as a link between the architectural design, the engineering system & the construction process
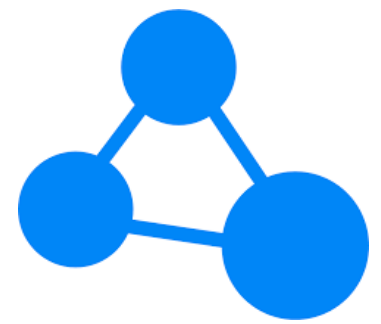
An example of MEP coordination
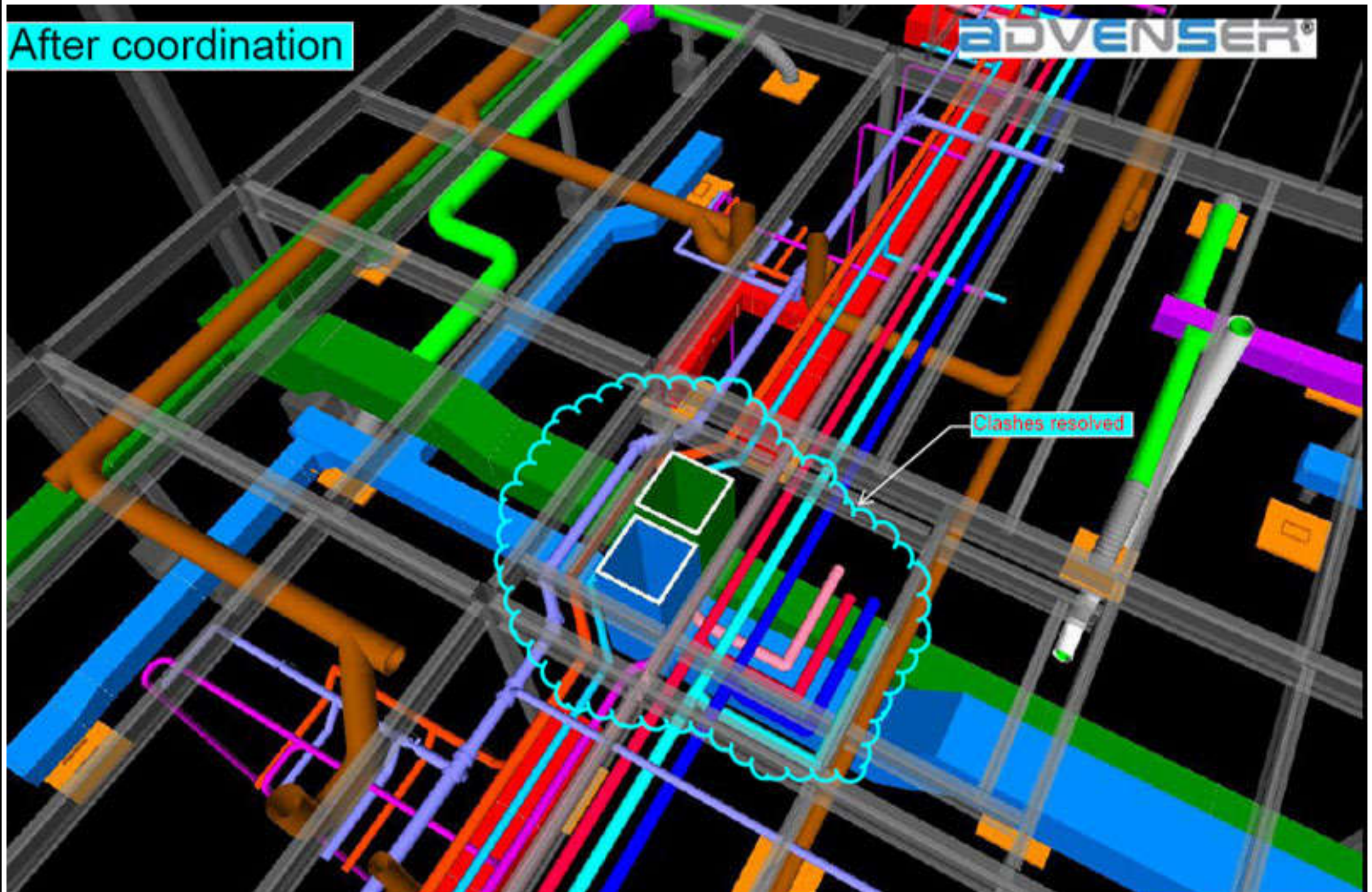
MEP coordination

- Typical stages involved in MEP coordination:
  - http://www.xscad.com/blog/typical-stages-involved-in-mep-coordination/
  - 1. Review of consultant design drawings & architectural/structural plans
  - 2. 3D model creation
  - 3. Clash detection & resolution
  - 4. Create coordinated drawings & sections
  - 5. Create detailed service drawings
  - 6. Create fabrication drawings, spool and hangar drawings
  - 7. Create as-built drawings which include all site-based changes, modifications & differences

MEP coordination

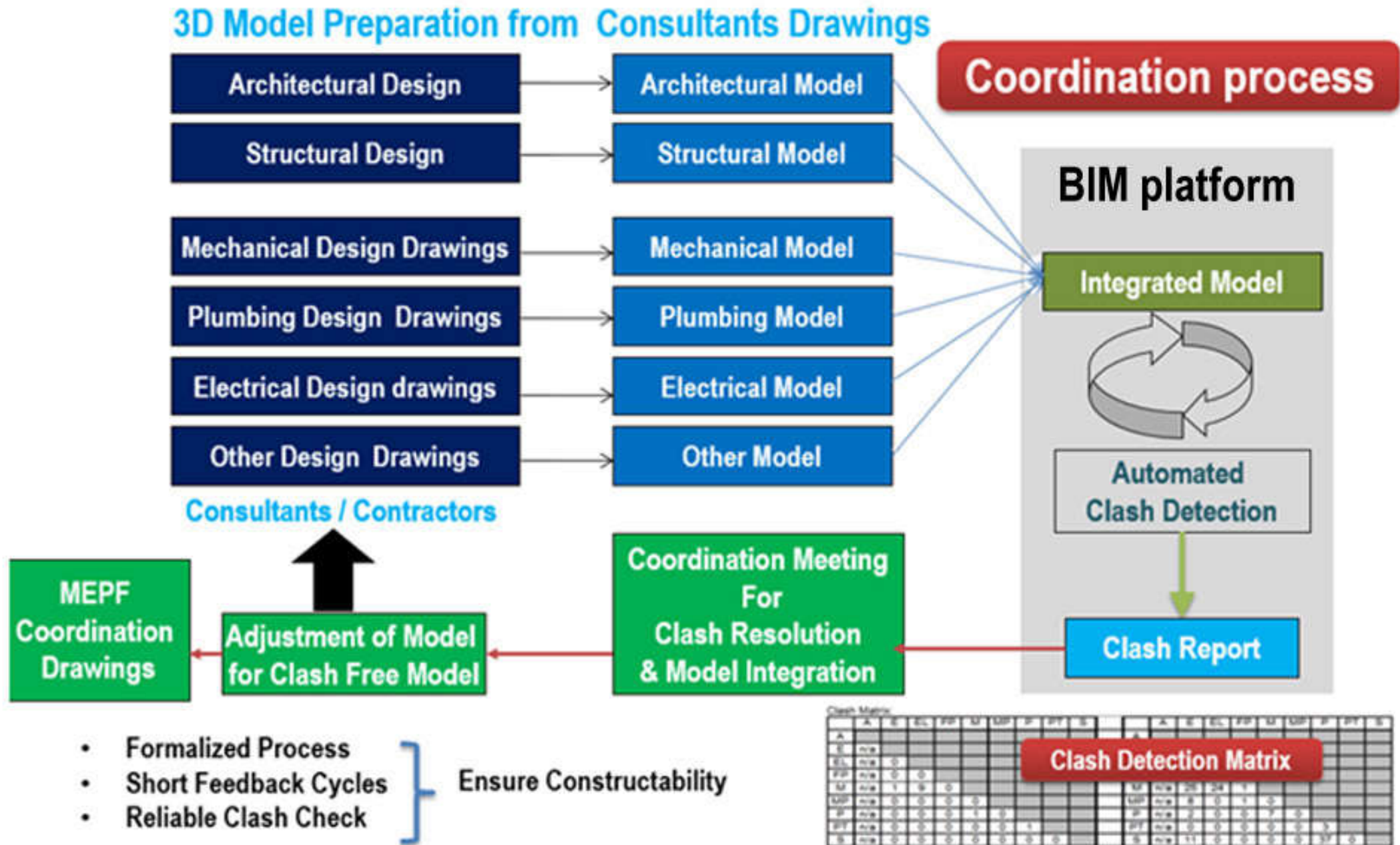- Benefits of MEP coordination using BIM:
  - Improve the spatial coordination process with a 3D approach
  - Better avoidance of clashes
  - Reduce conflicts & reworks in the field
  - Enhance prefabrication of MEP Systems
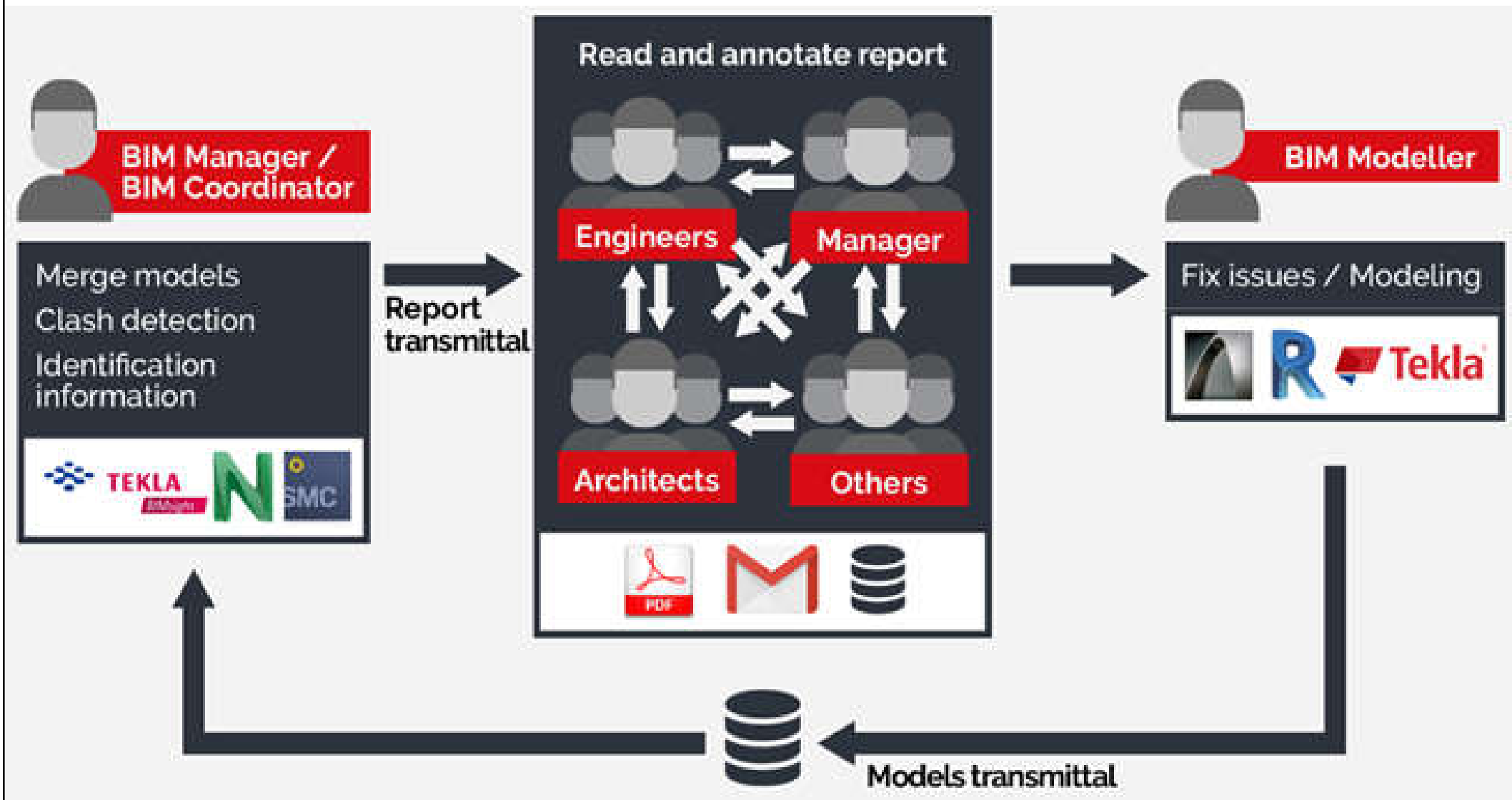 - Promote analytical capabilities using BIM coordination (e.g. knowledge based reasoning)

BIM coordination process

(Source: http://bimstar.co.in/)

Examples of clash detection
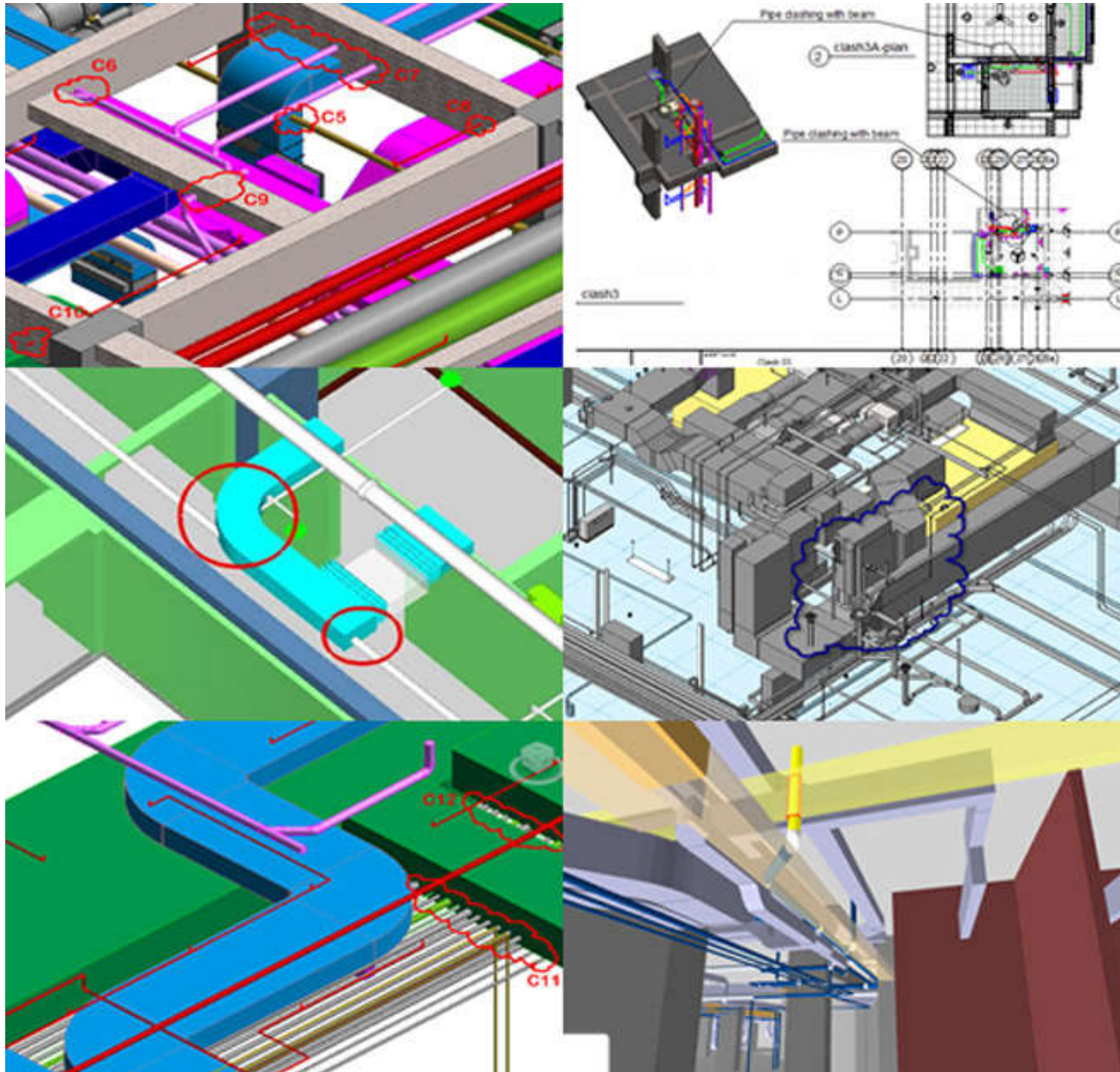
Typical BIM model coordination workflow

Examples of clash report (from Navisworks)

Autodesk Navisworks — Clash Report

AR vs MEP	Tolerance	Clashes	New	Active	Reviewed	Approved	Resolved	Type	Status
	0.000m	301	2	296	1	1	1	Hard	OK

Image	Clash Name	Status	Distance	Grid Location	Description	Date Found	Date Approved	Approved By	Clash Point	Item 1 Item ID	Item 1 Layer	Item 1 Item Name	Item 1 Item Type	Item 2 Item ID	Item 2 Layer	Item 2 Item Name	Item 2 Item Type
	Clash1	New	-0.128	C-2 : 01-First Floor		Hard	2017/1/19 09:14.07			x:7.857, y:6.112, z:5.950	Element ID: 271189	01-First Floor	Default Wall	Solid	Element ID: 790871	02-Second Floor	PVC-C	Line
	Clash2	Reviewed	-0.125	C-2 : 02-Second Floor		Hard	2017/1/19 09:14.07			x:6.913, y:6.112, z:6.245	Element ID: 306133	02-Second Floor	Default Wall	Solid	Element ID: 790633	02-Second Floor	PVC-C	Line
	Clash3	Active	-0.125	H-2 : 01-First Floor		Hard	2017/1/19 09:14.07			x:27.809, y:6.112, z:3.197	Element ID: 300480	01-First Floor	Default Wall	Solid	Element ID: 797230	Level 1	PVC-C	Line
	Clash4	Active	-0.125	C-2 : 01-First Floor		Hard	2017/1/19 09:14.07			x:6.913, y:6.112, z:3.197	Element ID: 271189	01-First Floor	Default Wall	Solid	Element ID: 791663	Level 1	PVC-C	Line

Name — Basement Clashes
Distance* — -0.10m
Status* — Active
Clash Point* — -52.83m, 4.11m, 7.72m

Item 1*

Element ID — 292404
Layer — 2ND FLOOR
Item Name* — W14X159
Item Type* — Solid

Item 2*

Element ID — 870736
Layer — <No level>
Item Name* — Galvanized
Item Type* — Solid
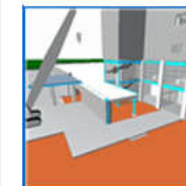
Name — Clash1
Distance — -0.10m
Clash Group — Basement Clashes
Description — Hard
Status — Active
Clash Point — -52.83m, 4.11m, 7.72m
Date Created — 2011/12/12 10:30:42

Item 1

Element ID — 292404
Layer — 2ND FLOOR
Item Name — W14X159
Item Type — Solid

Item 2

Element ID — 870736
Layer — <No level>
Item Name — Galvanized
Item Type — Solid

(Source: https://knowledge.autodesk.com/)