



Construction coordination



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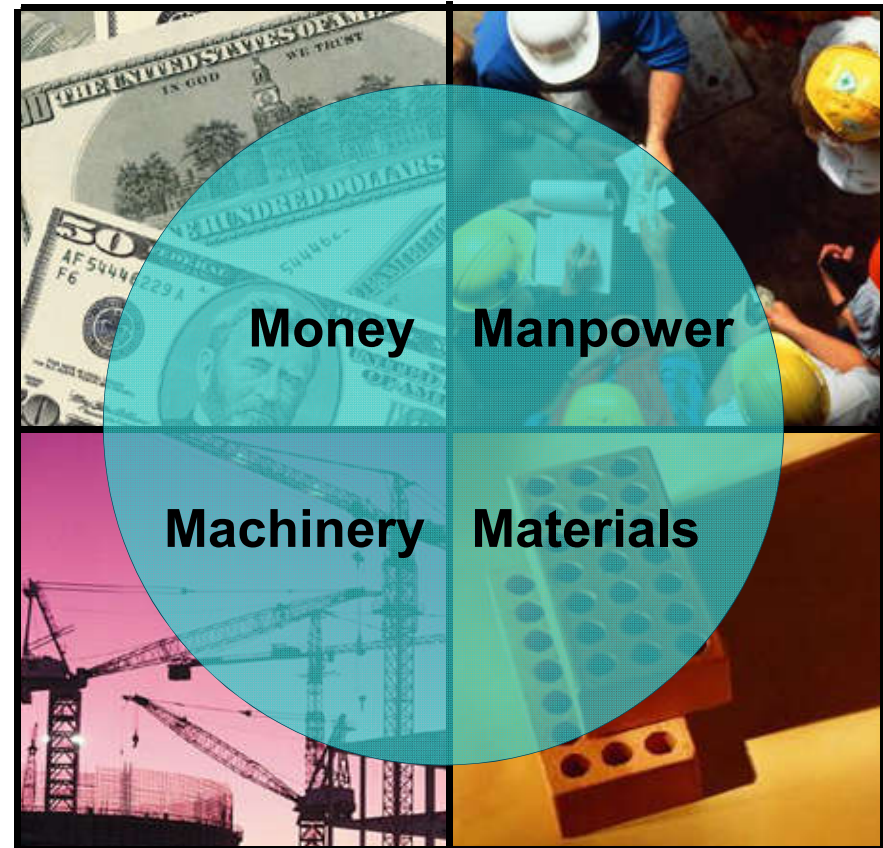
- Construction planning
- Virtual construction model
- Potential benefits
- BIM-based coordination
- Examples of coordination issues

Problem Definition

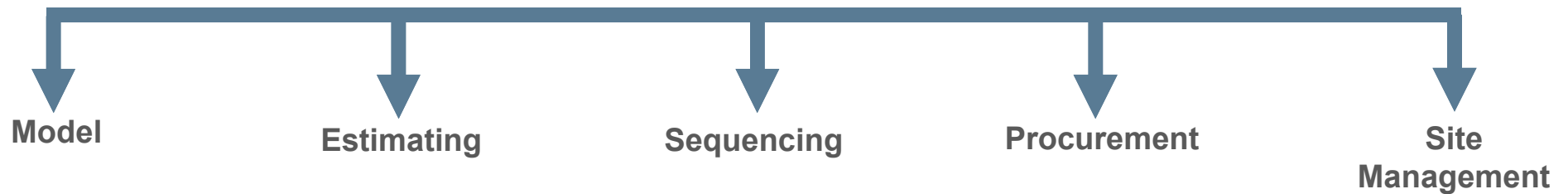
- Design
 - No direct cost feedback on design decisions
 - Coordination of trades
- Sub Contractor Cost
 - Missing / Incorrect Design Information
 - Inability for reusing data for shop drawings
 - Field rework required for prefabricated components
 - Padding to compensate risks
 - Poor subcontractor work flow – “Starts and Stops”
 - Inadequate quantity information for planning
- Construction
 - Lack of owner trust – difficulties in communicating cost and schedule issues
 - Production control is based on subjective information
 - Frequent starts and stops
 - Estimating is time consuming and occasionally inaccurate
- Facility Management
 - Insufficient as-built project documentation
 - Renovation, addition and demolition planning is time consuming

Objectives

- Winning the bid
 - Fast design feedback loop
 - Fast & accurate estimates
 - Value engineering
 - Constructability analysis
- Managing the 4 Ms
 - Money
 - Manpower
 - Machinery
 - Materials



Construction Planing



- Constructability Analysis
- Drives Estimating
- Provides Locations
- Zone Planning
- Design to Build / Build to Design



- Fast & Accurate
- Easy Updates – Linked
- Drives Sequencing



- Schedule Analysis
- Line of Balance
- Integrated Monte Carlo
- 4D Simulation
- Drives Procurement

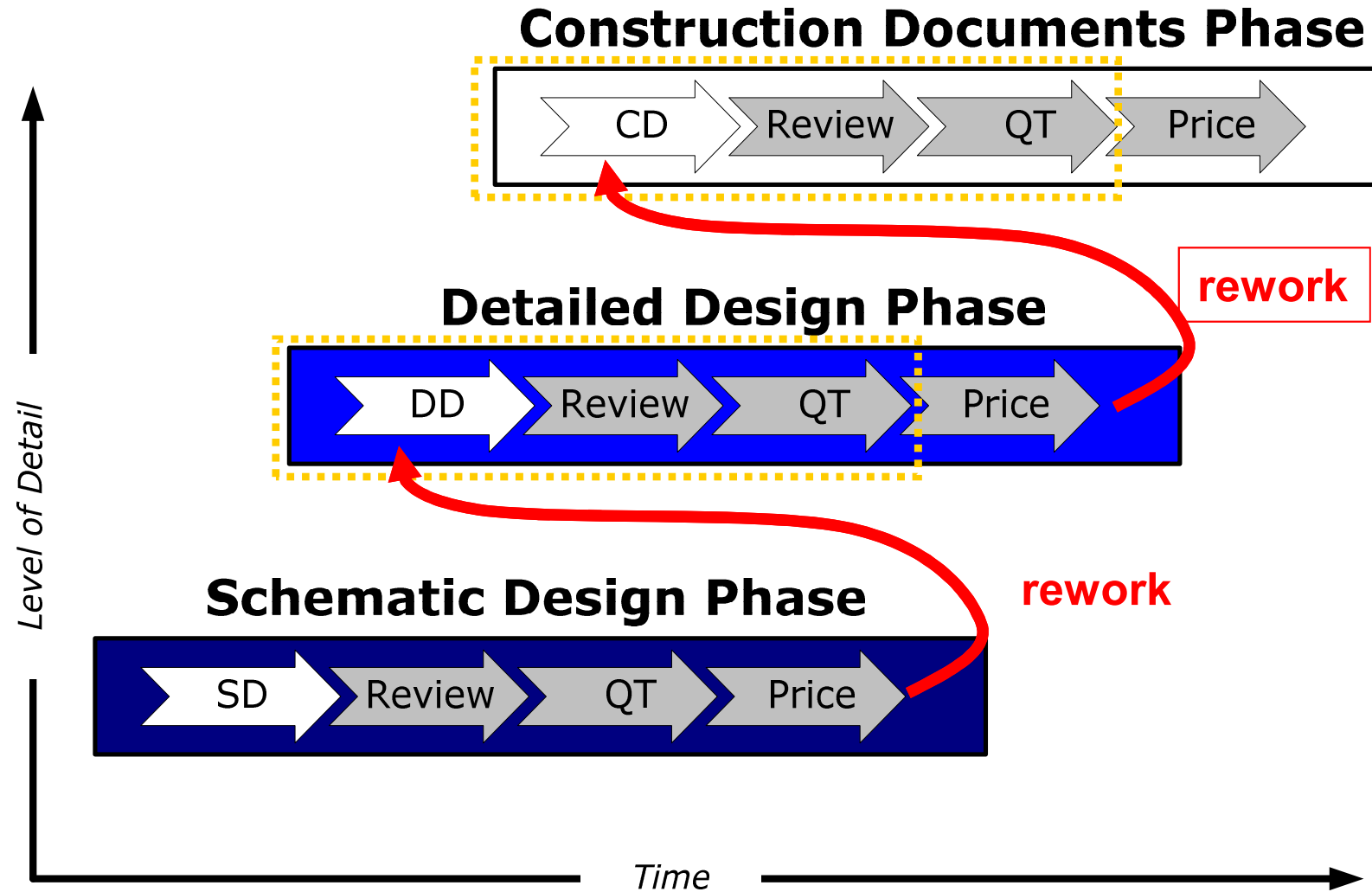


- Data Mining for Supplier Negotiations
- Tracking of High Risk, Long Lead Items
- Integrated with the Project Schedule
- Drives Site Management Process

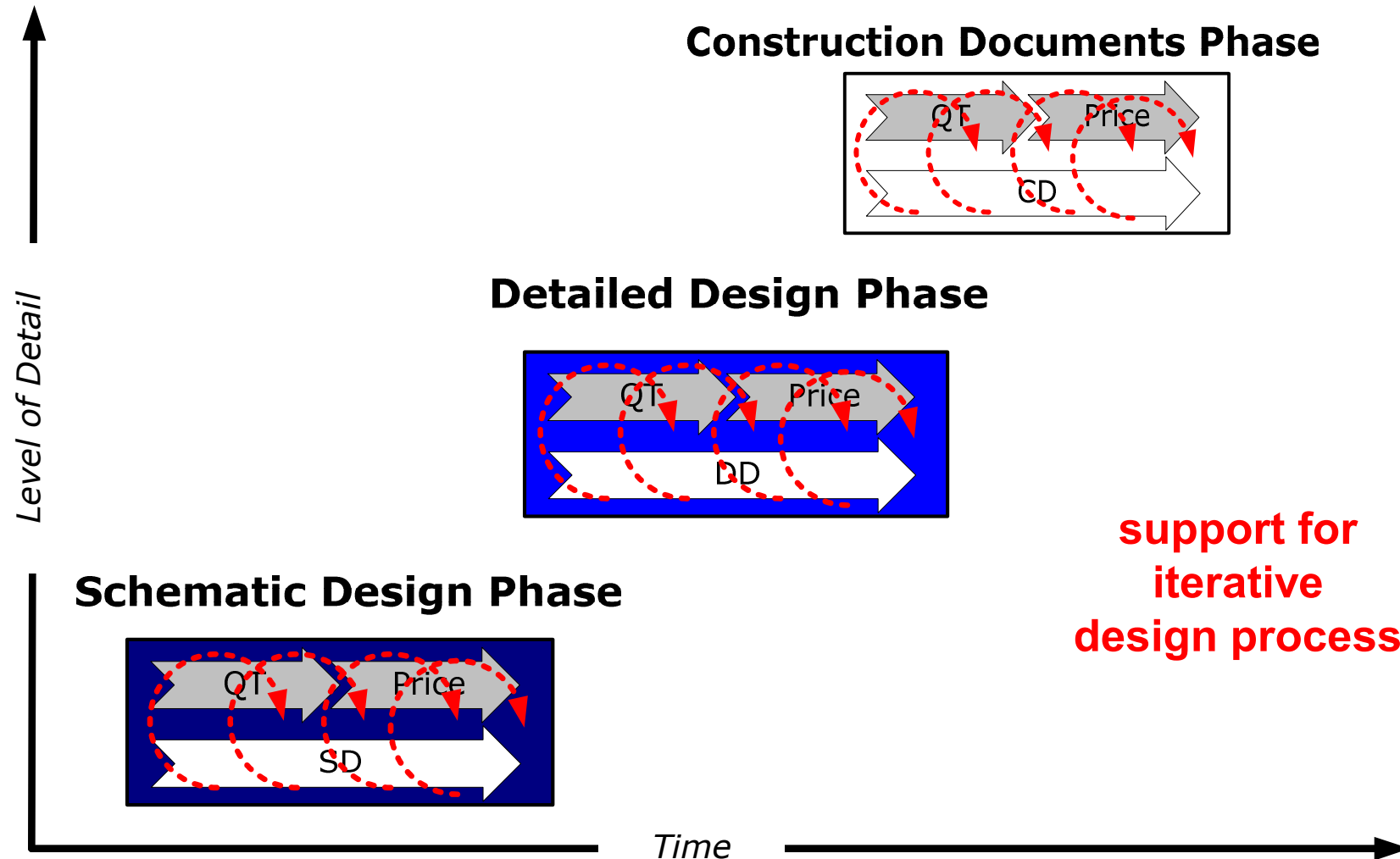


- Short Lead Procurement
- Site Planning for Materials, Equipment & Locations

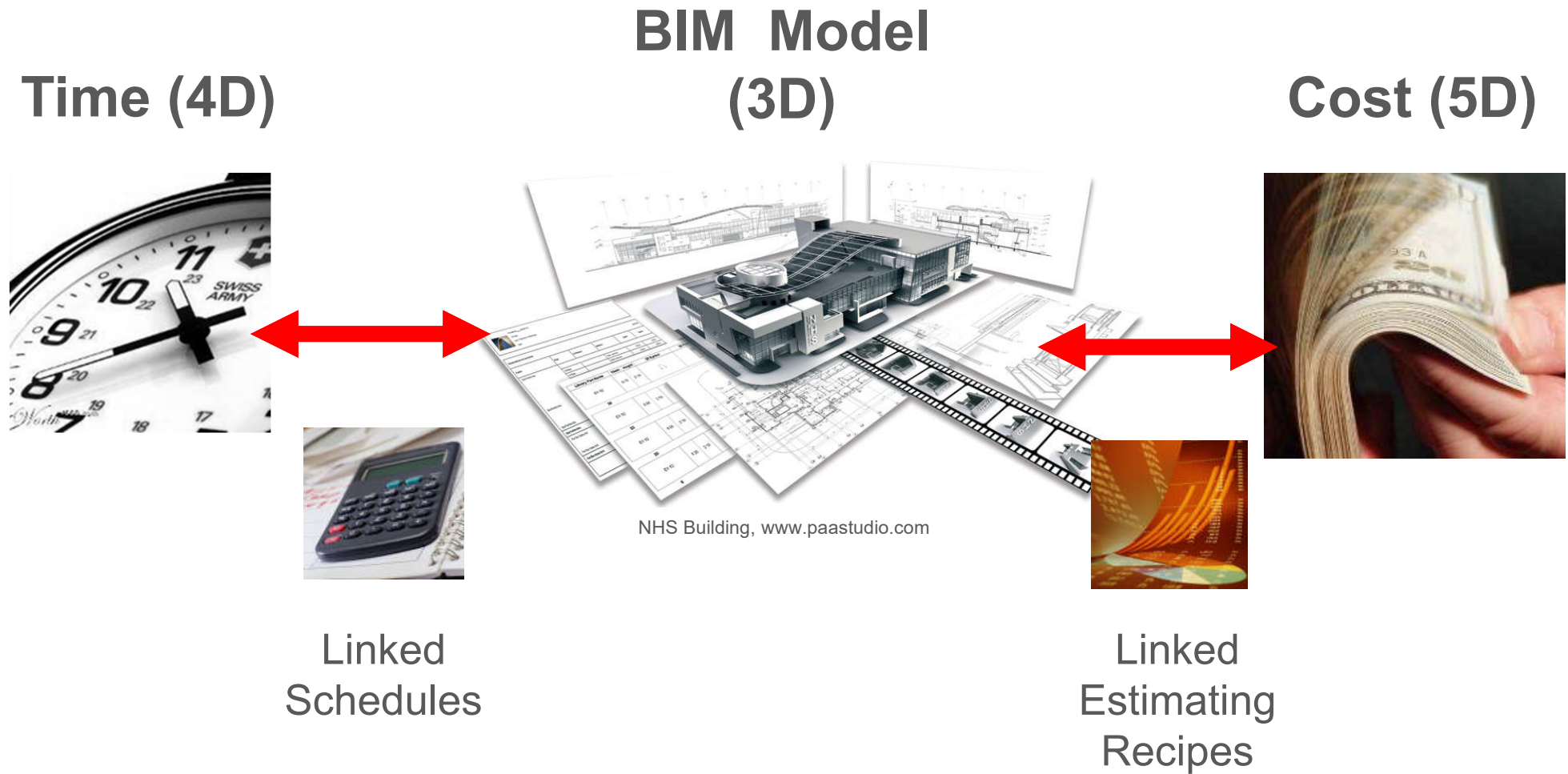
Traditional Design Process



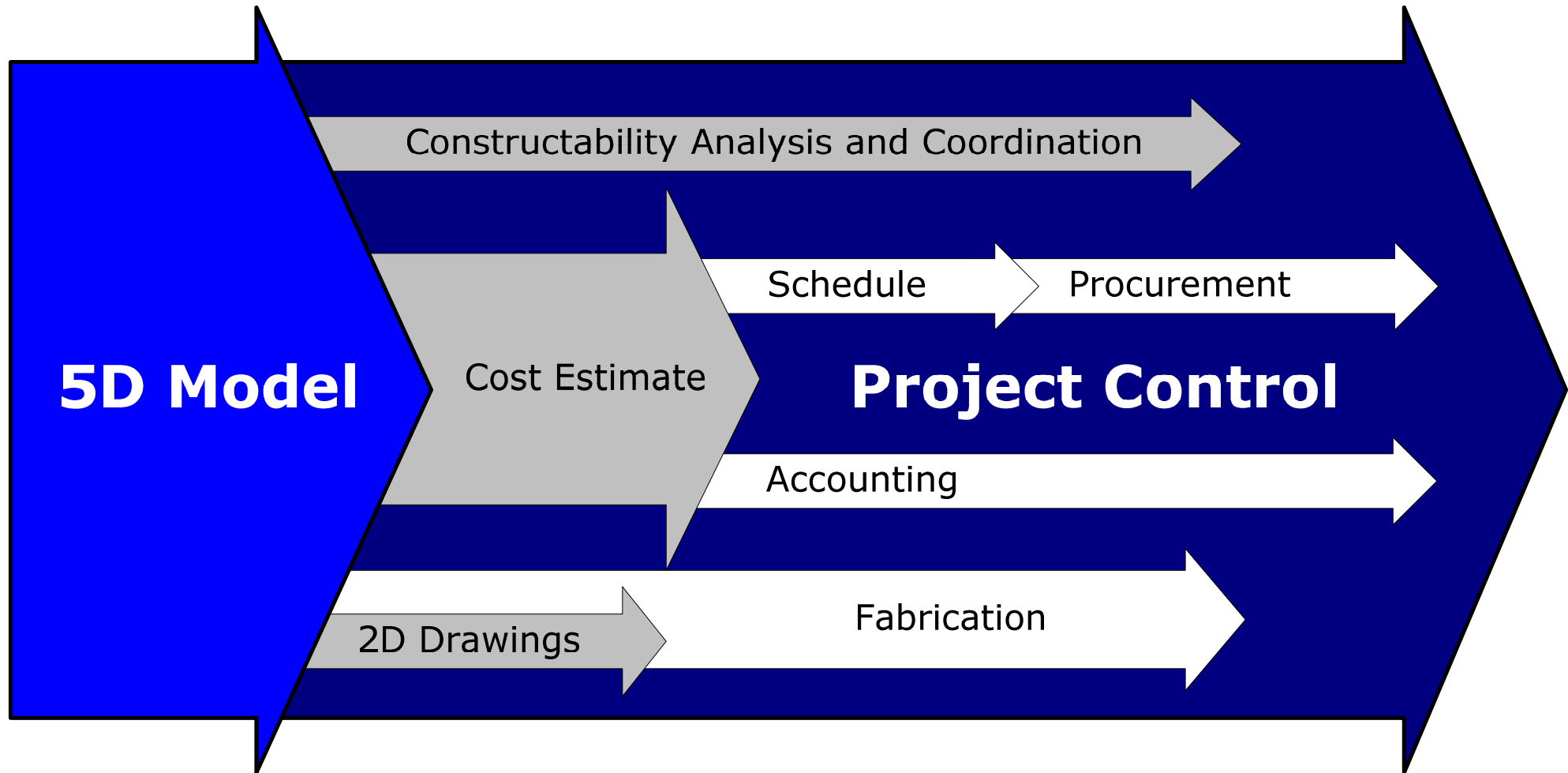
New Design Process



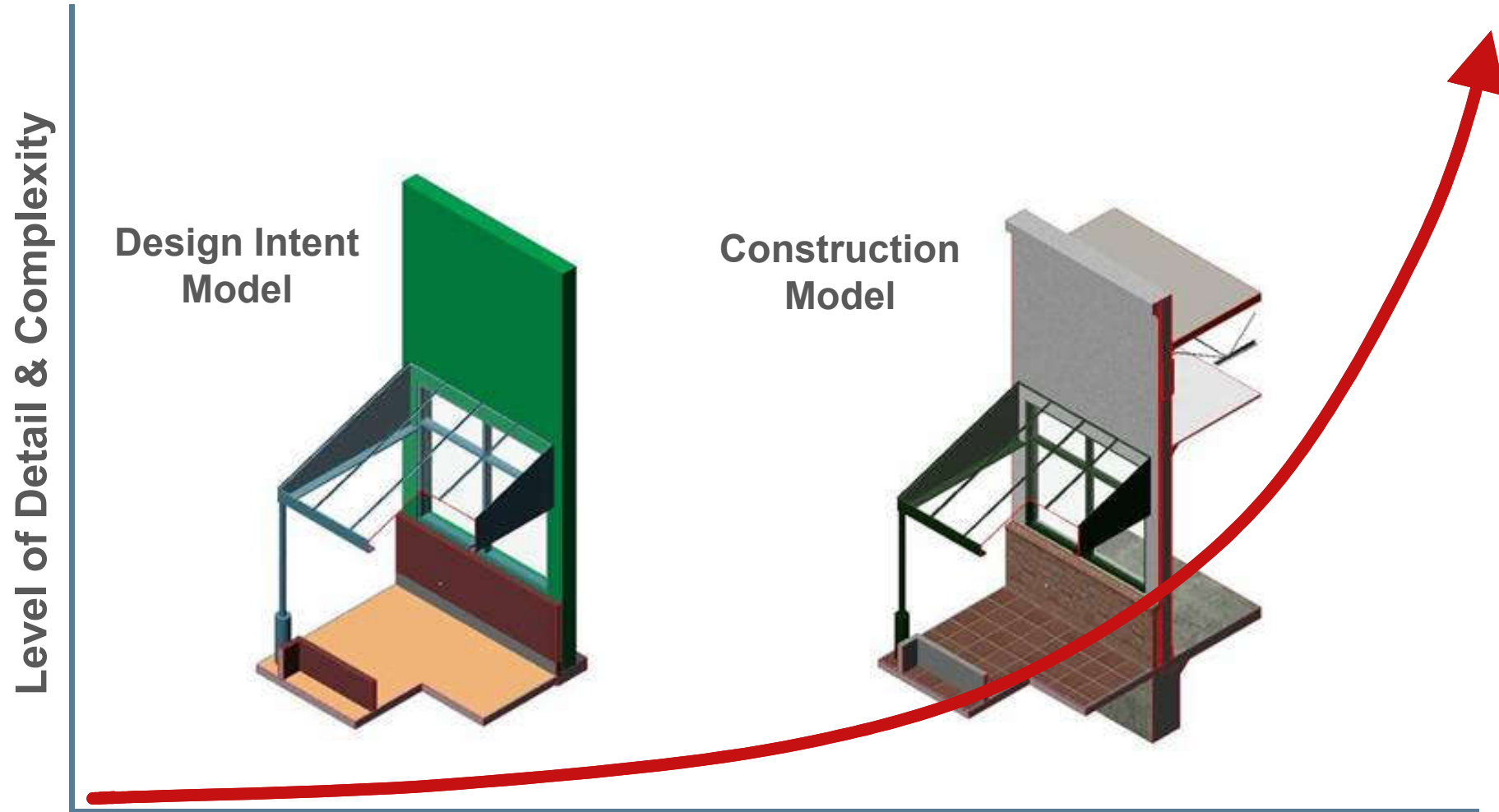
The Virtual Construction Model (5D)



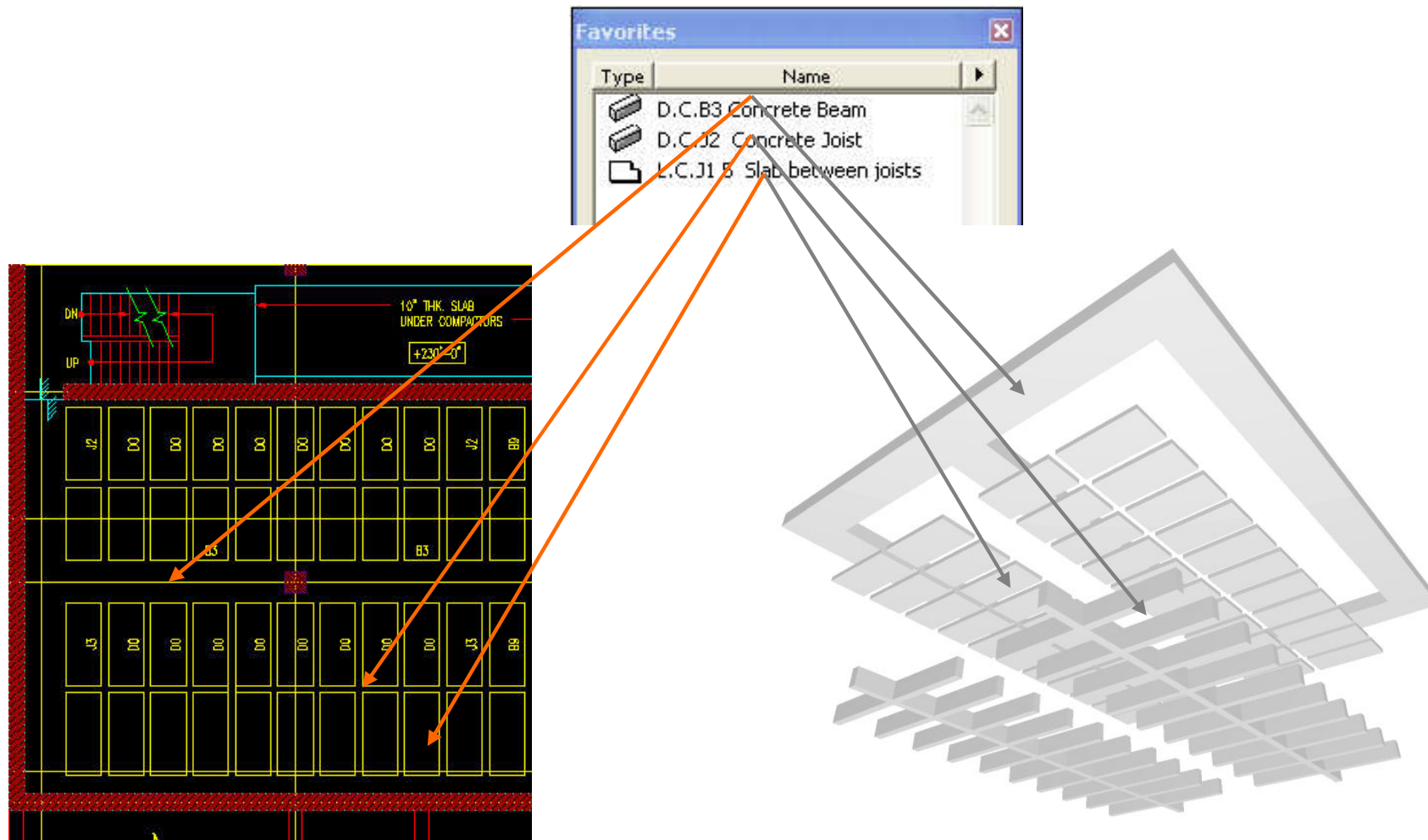
Work Flow



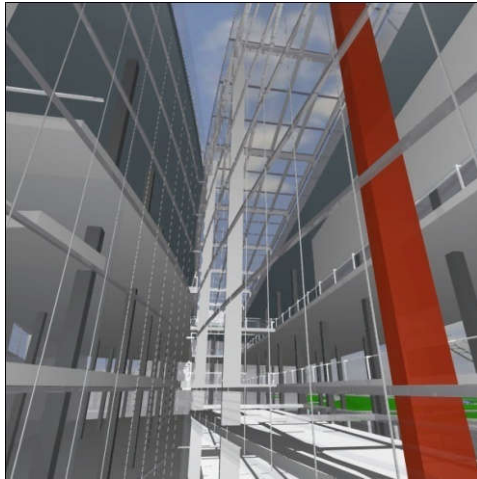
Construction Modelling



Construction Modelling



Recipe

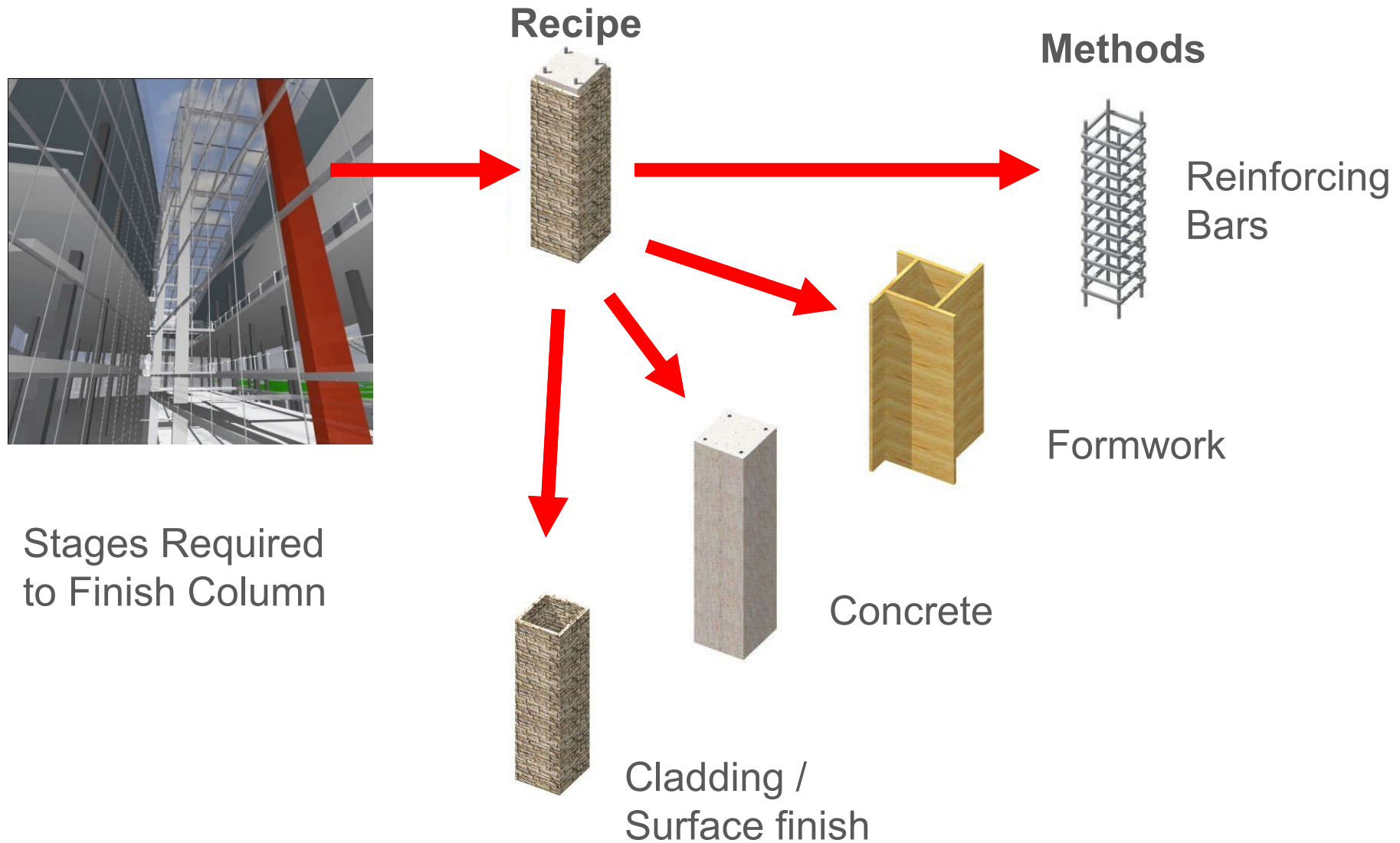


Recipe

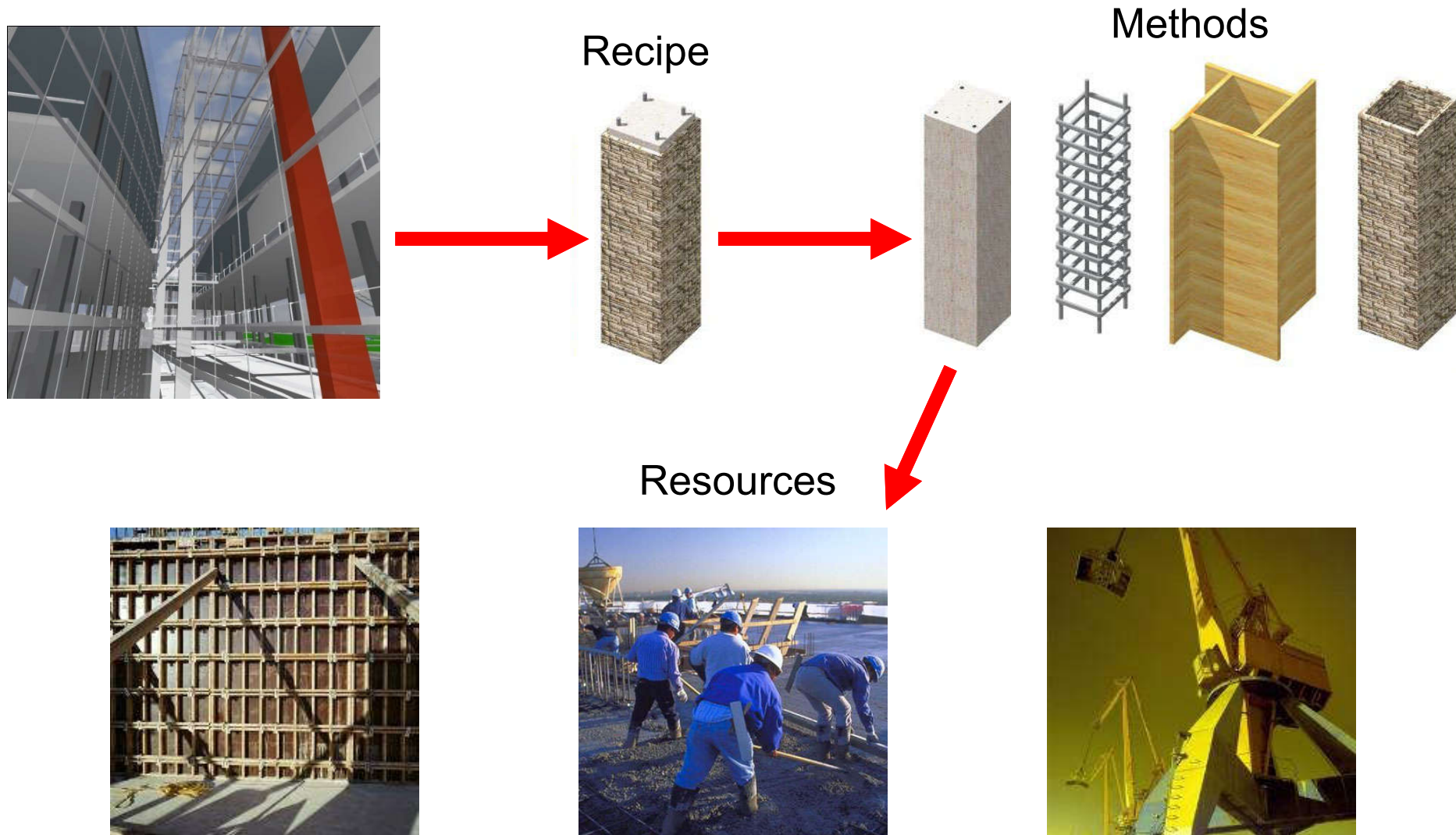


**Completed
Column**

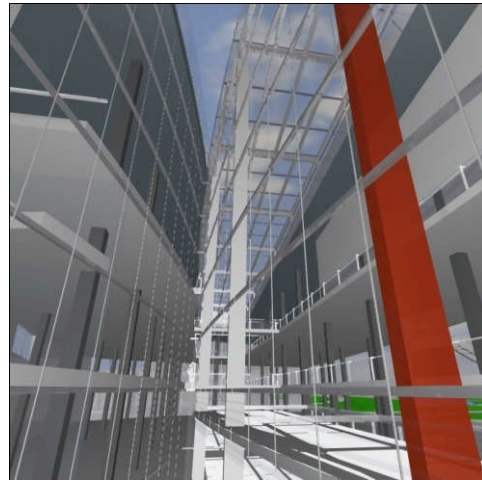
Methods



Resources



5D



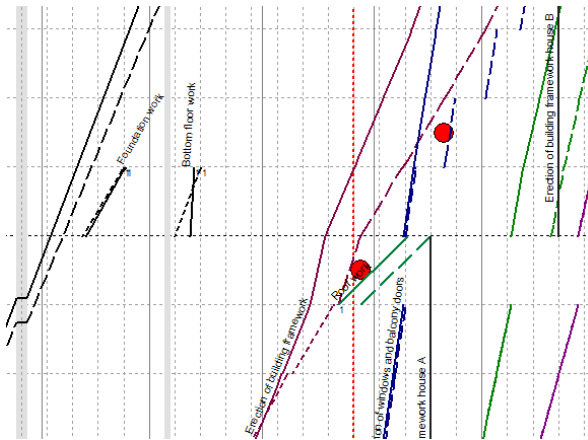
Recipe

Methods

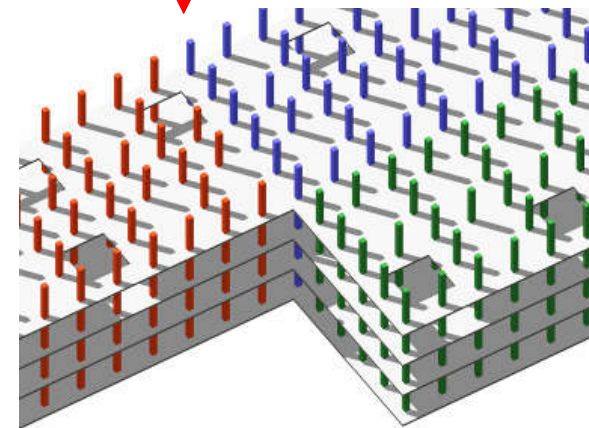
Resources



Zones/Floors

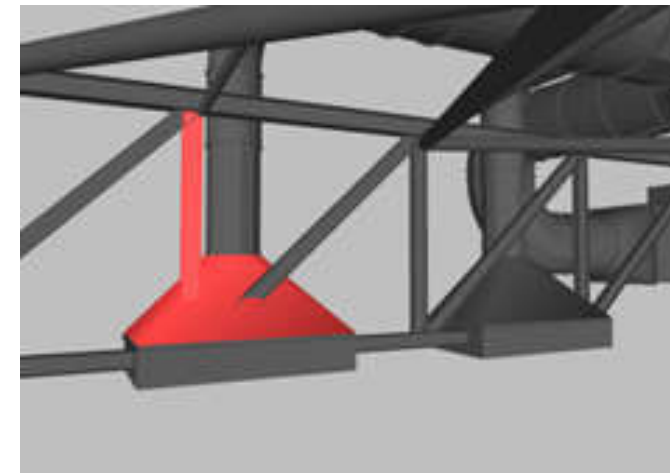
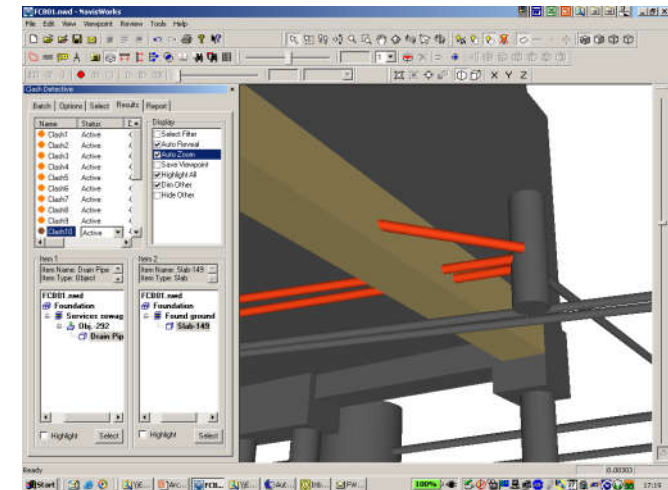


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Benefits: Clash Detection

- Conventional methods of coordination are extremely time consuming and error-prone.
- Using internal or external clash detection software helps to identify the construction errors in the BIM model
- Construction risks and costs can be reduced significantly



(See also: Coordination and Clash Detection <http://www.vicosoftware.com/coordination-and-clash-detection>)

(Source: Graphisoft BIM Curriculum <http://www.graphisoft.com/learning/bim-curriculum/>)

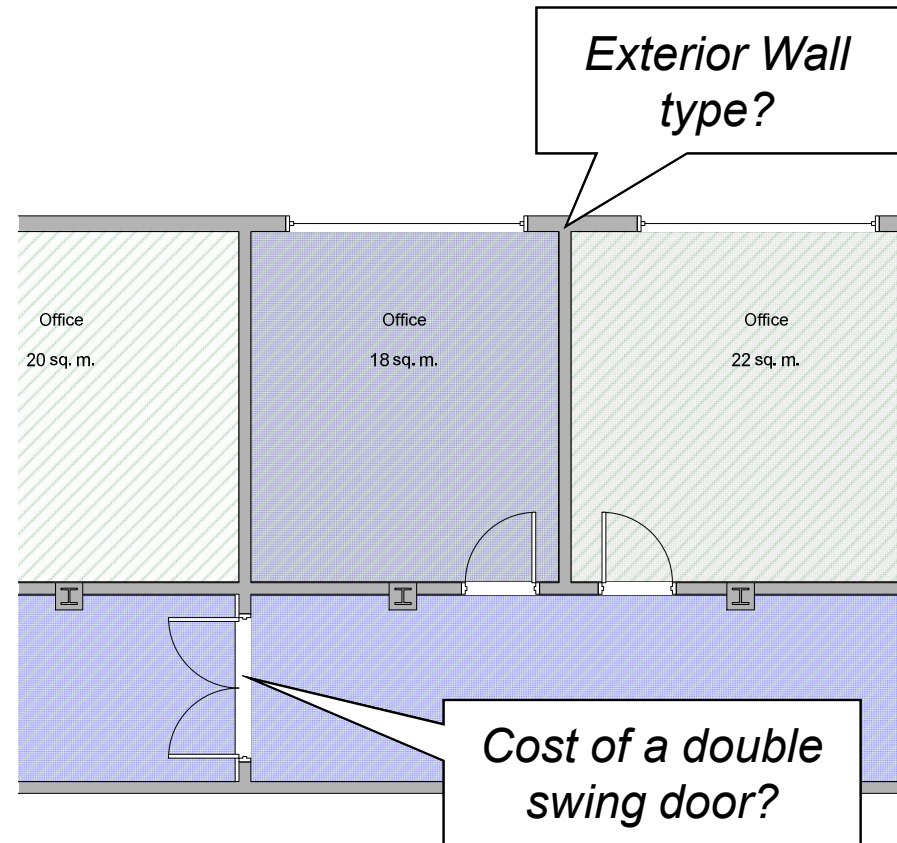
Benefits: Model-based Estimating

Early Design phases:

- Which materials?
- Price of materials?

Solution:

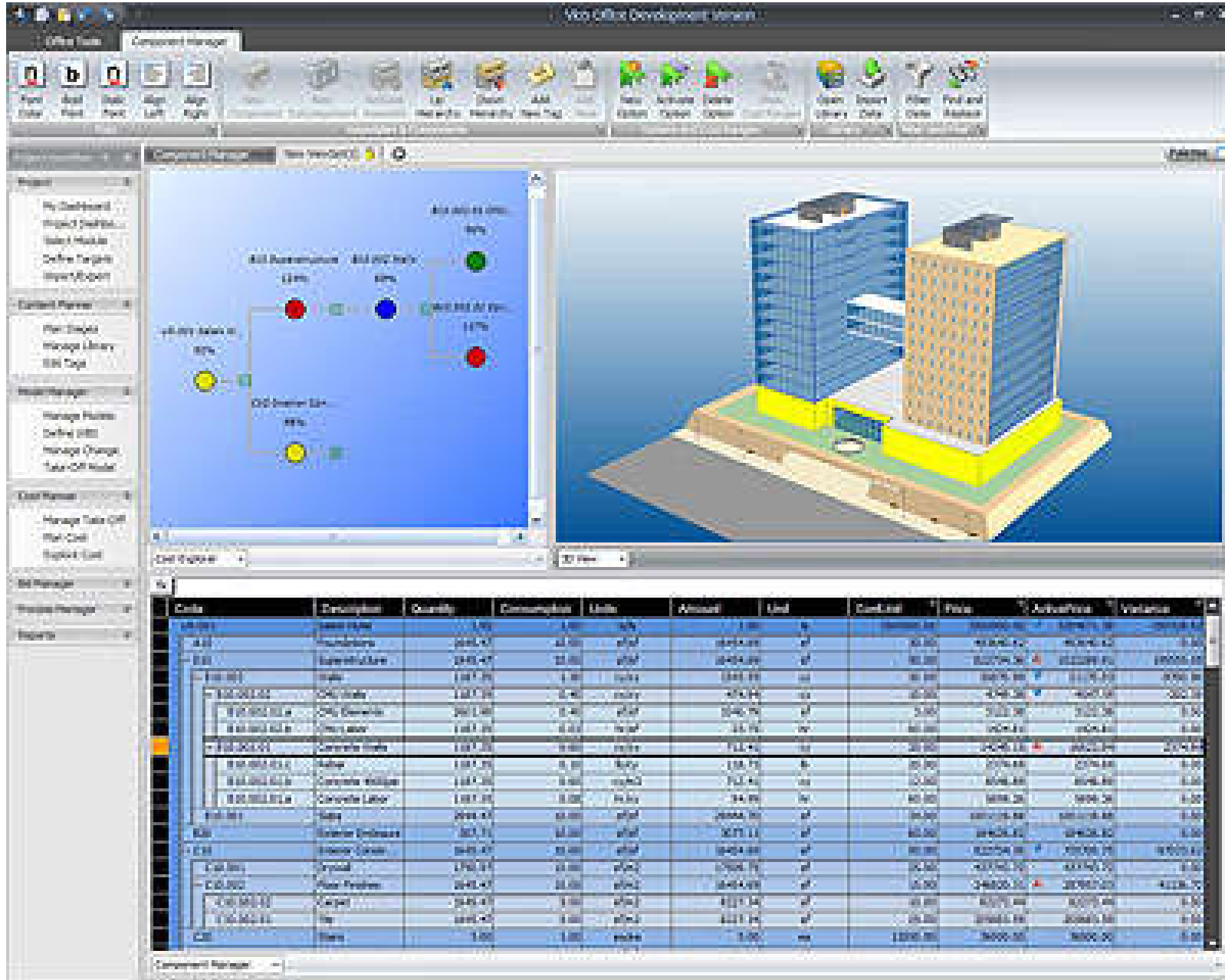
- Calculate cost ranges instead of fixed prices



(See also: Model-Based Estimating <http://www.vicosoftware.com/model-based-estimating>)

(Source: Graphisoft BIM Curriculum <http://www.graphisoft.com/learning/bim-curriculum/>)

Benefits: Vico Cost Planner



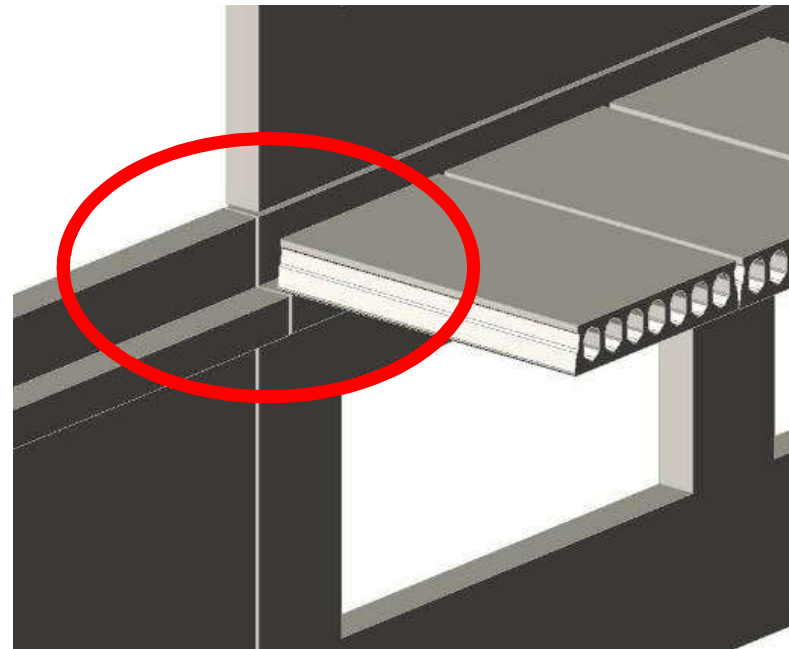
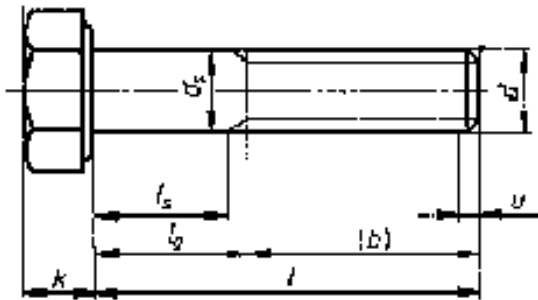
(See also: Cost Planning vs Estimating <http://www.vicosoftware.com/cost-planning-versus-estimating>)

(Source: Graphisoft BIM Curriculum <http://www.graphisoft.com/learning/bim-curriculum/>)

Benefits: Design to Build

Design follows construction methodology:

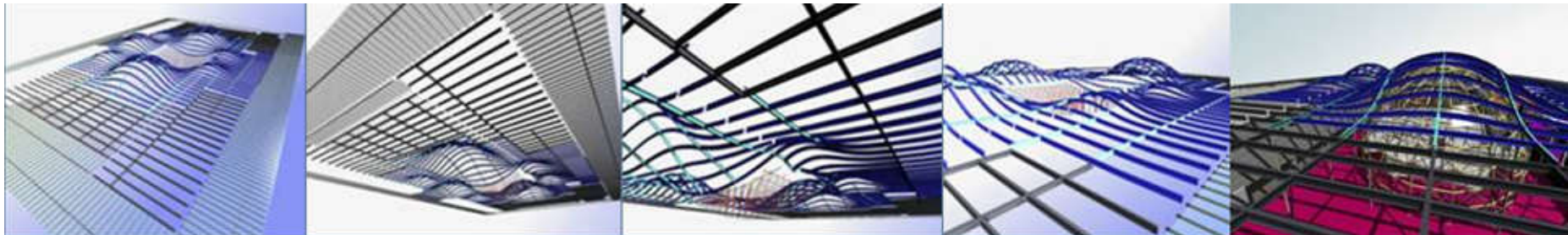
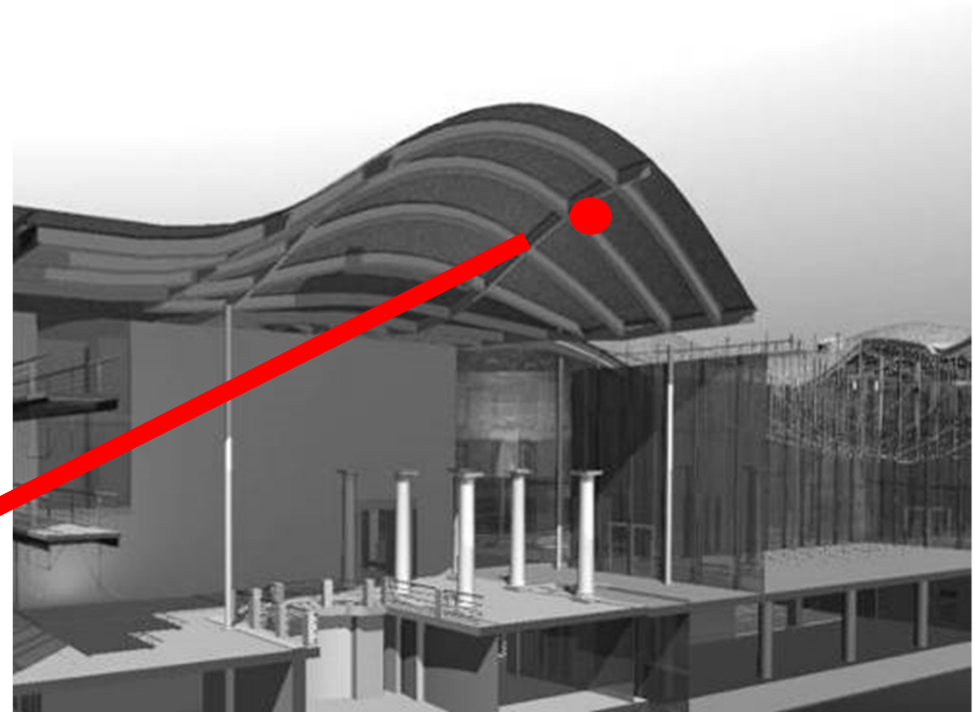
- Acceptable Tolerance
- Coordination of Trades
- Quality Check



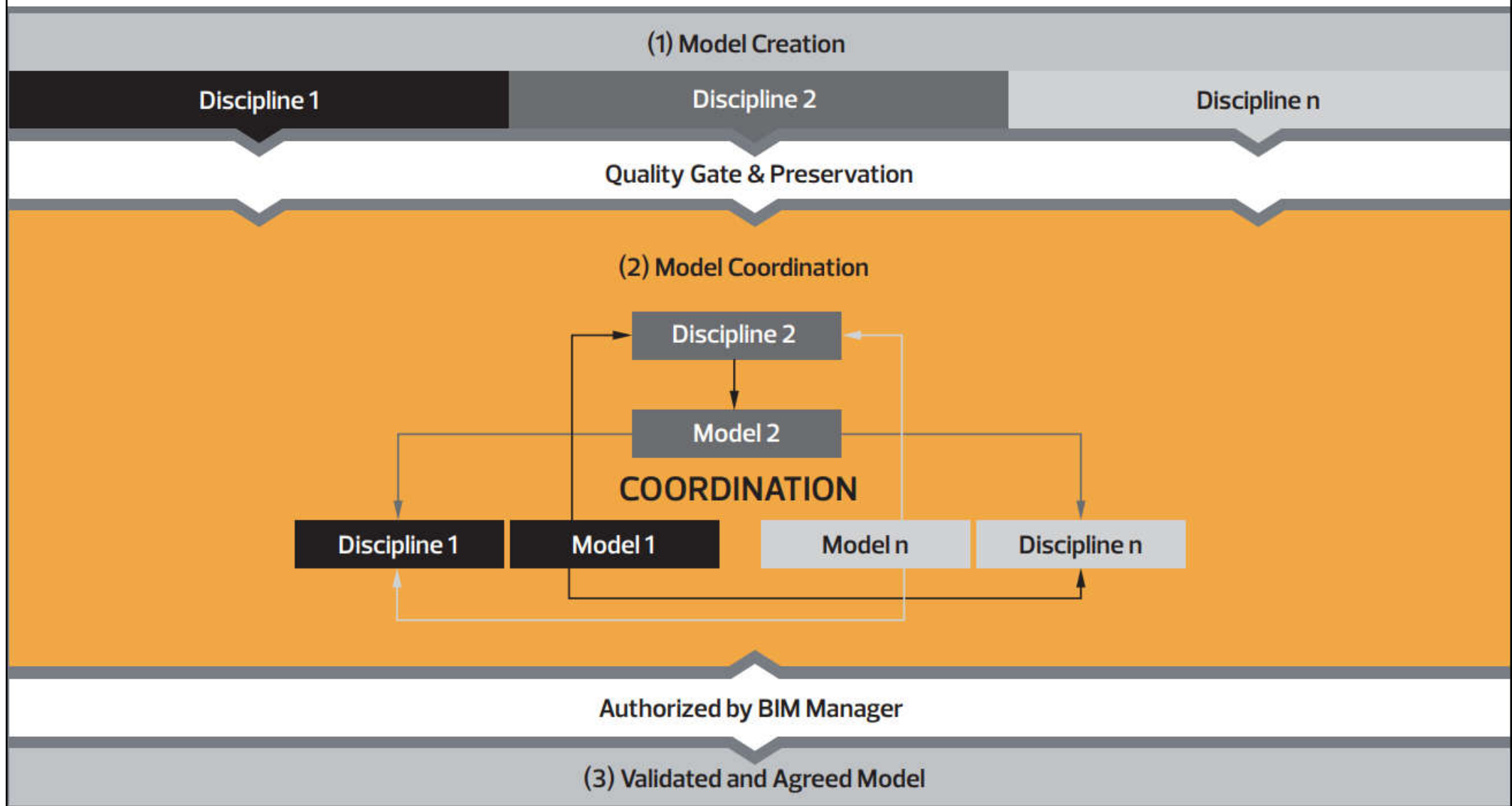
Benefits: Build to Design

- Measure points
- Check Onsite
- Guarantee Fit

X, Y, Z



Schematic BIM-based creation, coordination, and collaboration process

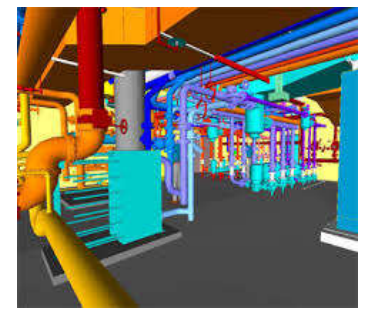


BIM-based coordination



- Model-based collaboration
 - With digital, structured building models
 - Discipline-oriented or Federation model approach
 - Every author, in accordance with their discipline, is responsible for their own digital model and shall have access for this model content only
 - Discipline model, submodel or technical model
 - With clear allocation of authors to individual discipline models, the components and changes can be organized clearly

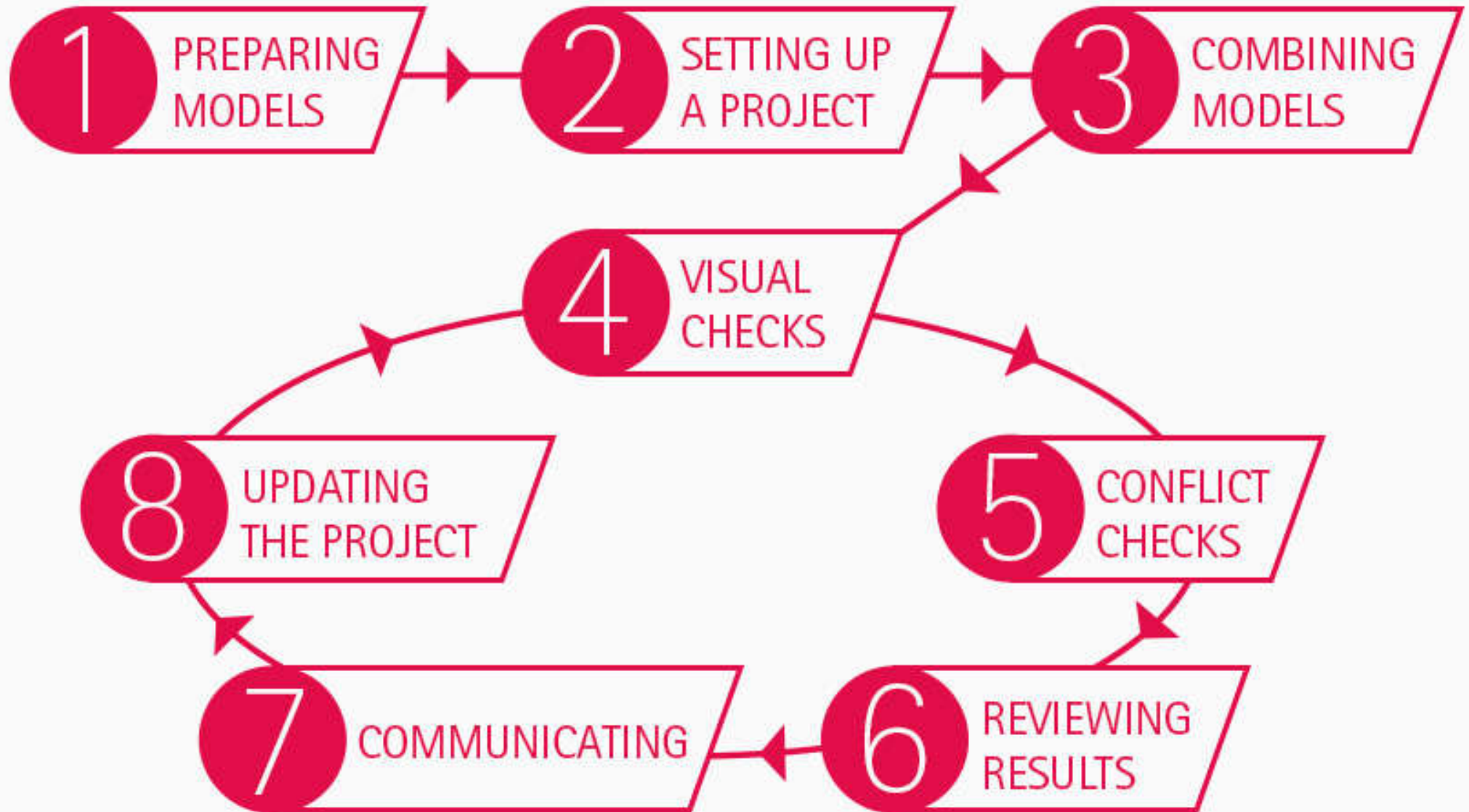
BIM-based coordination



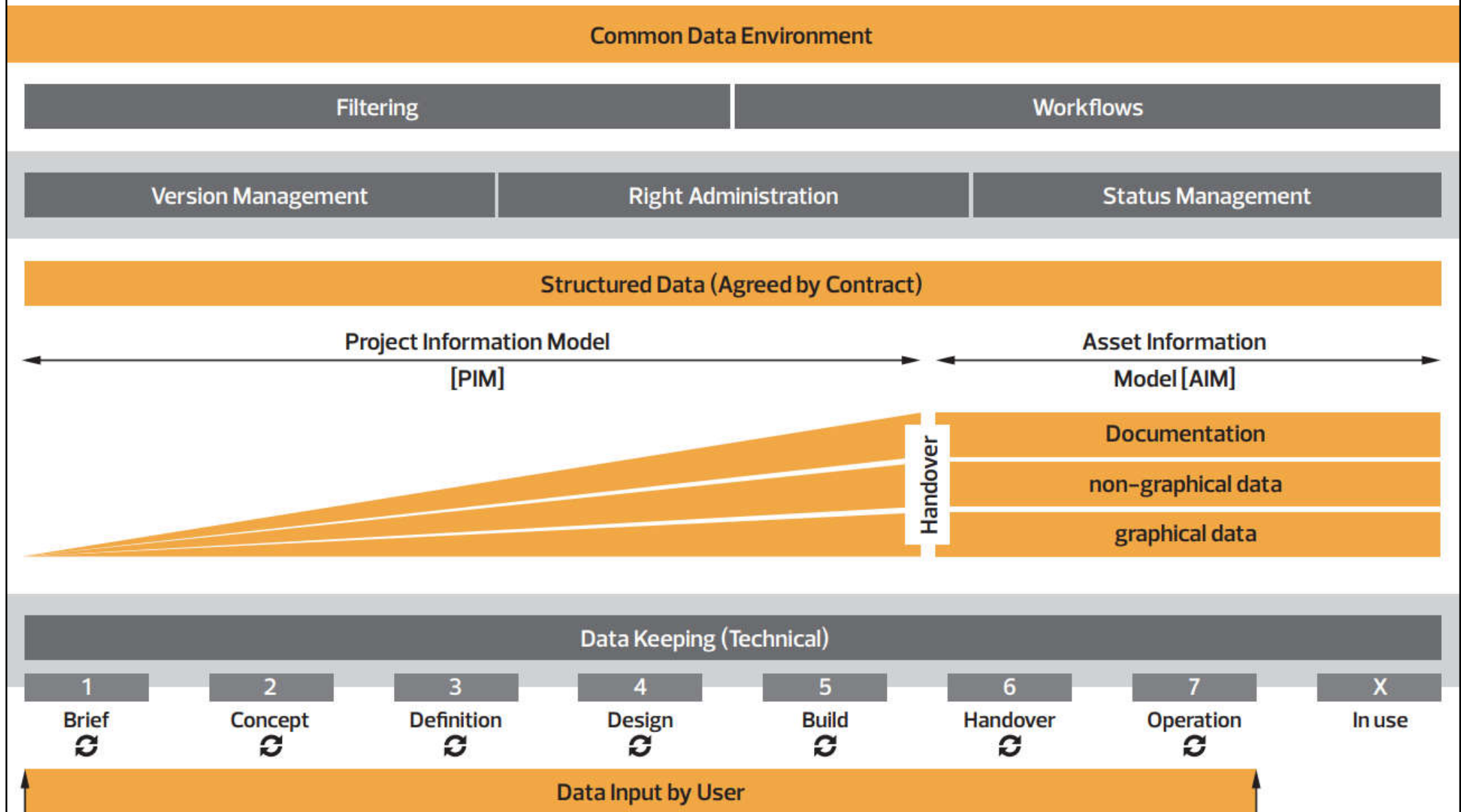
- Model-based collaboration (cont'd)
 - To safeguard the integrity and consistency of the entire model, the technical models must be checked at regular intervals by the BIM manager in a coordination environment
 - The organization and management of digital information and associated processes is the principle task during the entire BIM-based construction project, under a Common Data Environment (CDE)

Design coordination in BIM

Design Coordination Guide



Example of Common Data Environment (CDE)



BIM-based coordination



- Common Data Environment (CDE)
 - An information management strategy generally using a piece of software or a paper process
 - Create a single source of truth (SSOT) for any given project (or asset)
 - To collect manage and disseminate all relevant approved project documents for multi-disciplinary design teams members (architects, engineers, MEP) in a managed process

BIM-based coordination



- Common Data Environment (CDE) (cont'd)
 - The centralization of the stored data within the CDE reduces the risk of redundancies and simultaneously ensure that all data is up-to-date
 - The CDE results in a higher reuse rate, simplifies the aggregation of model information and at the same time serves as the central platform for archiving and documentation

(See also: Common data environment CDE https://www.designingbuildings.co.uk/wiki/Common_data_environment_CDE)

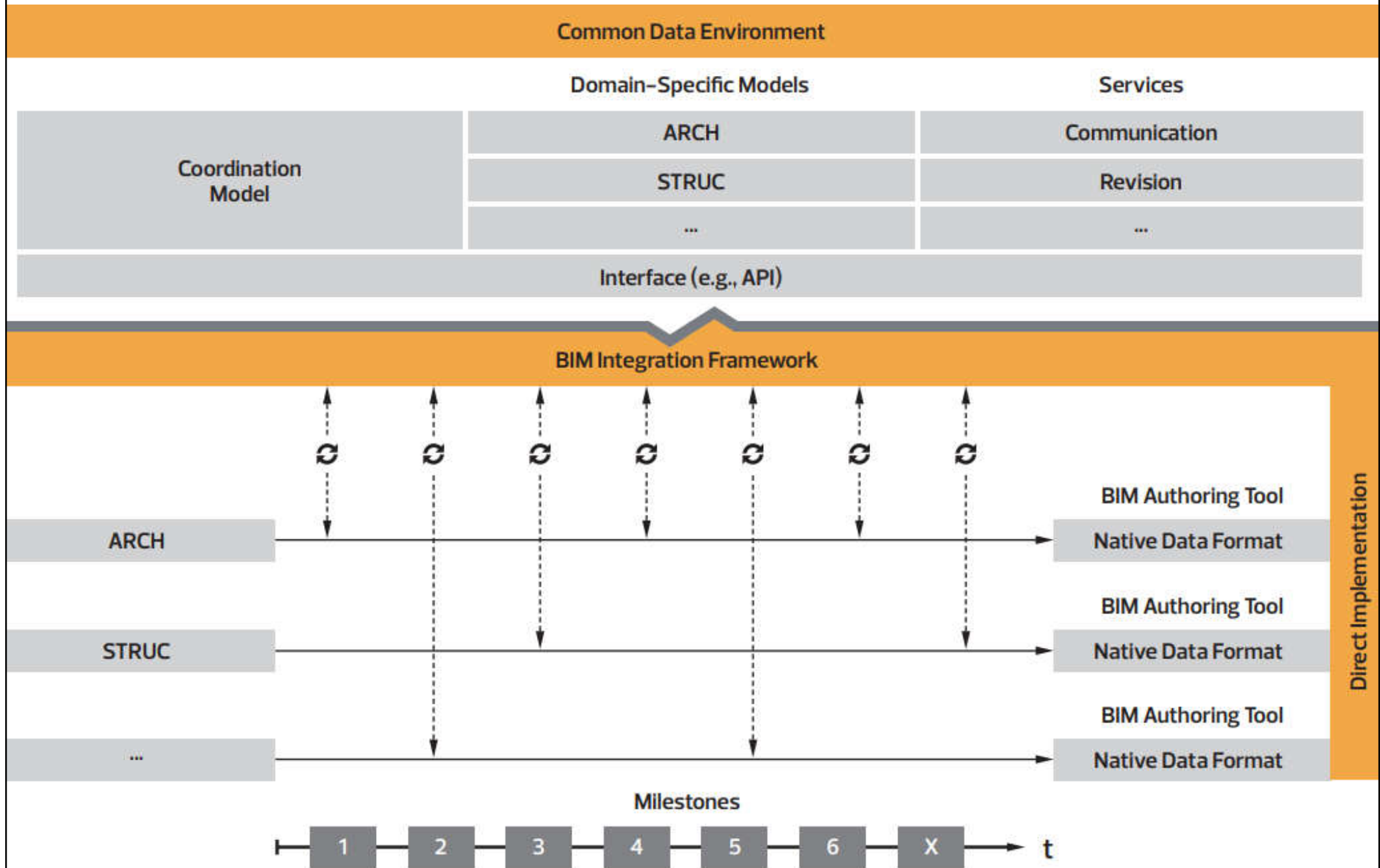
(Source: https://info.allplan.com/hubfs/07_Guides/Whitepaper_BIM_Integration_Framework_EN.pdf)

BIM-based coordination



- BIM Integration Framework (BIF)
 - It represents a software concept which can establish the link from any BIM tool to a CDE
 - Provide seamless integration of access
 - BIF assembles all functions of the interface
 - Functions are simultaneously standardized regardless of the BIM tool used, in order to enable smooth collaboration (e.g. information exchange, process management or communication)

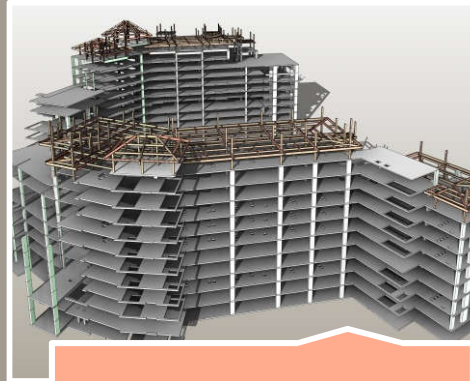
Collaboration processes based on the BIM Integration Framework



Examples of BIM use in building, construction and infrastructure



Architectural



Structural



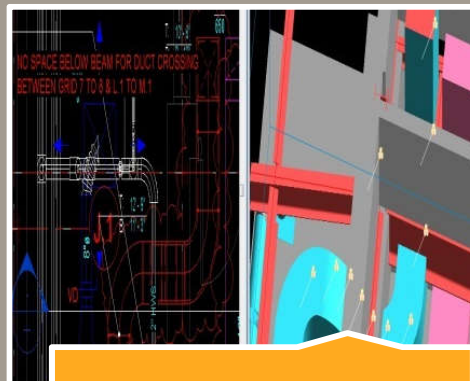
MEP



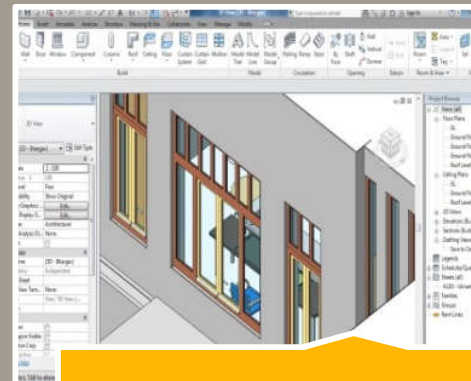
Co-ordination

| Wall Schedule | | | | | |
|----------------|----------|-----------------|-------------|------------------|--------|
| Wall Us | Function | Acoustic Rating | Fire Rating | Compartmentation | Area |
| aring Exterior | | | | | 16346 |
| aring Exterior | | | | | 128854 |
| aring Exterior | 40 | E160 | | | 11044 |
| aring Interior | 40 | E160 | | | 20879 |
| aring Interior | 40 | E160 | | | 10600 |
| aring Interior | 40 | E160 | | | 21729 |
| aring Interior | 40 | | | | 8631 |
| aring Exterior | | | | | 841 |
| aring Interior | | | | | 17520 |
| aring Interior | 40 | E160 | | | 33148 |
| aring Interior | 40 | E160 | | | 20674 |
| | | | | | 38587 |
| aring Exterior | | | | | 15079 |
| aring Exterior | | | | | 777 |

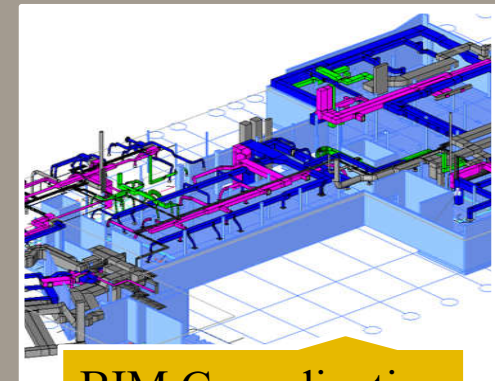
Scheduling



Clash Detection

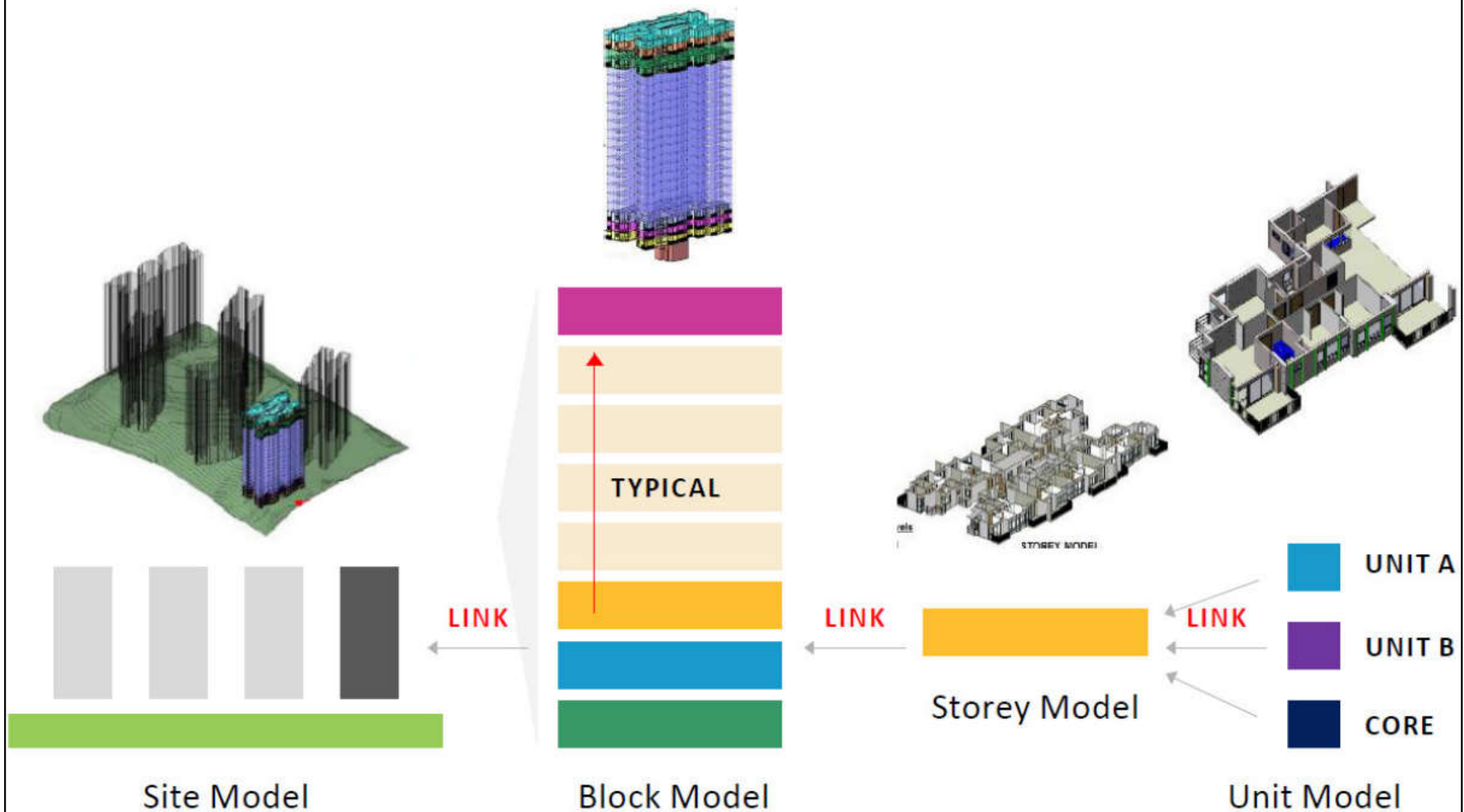


Family Creation

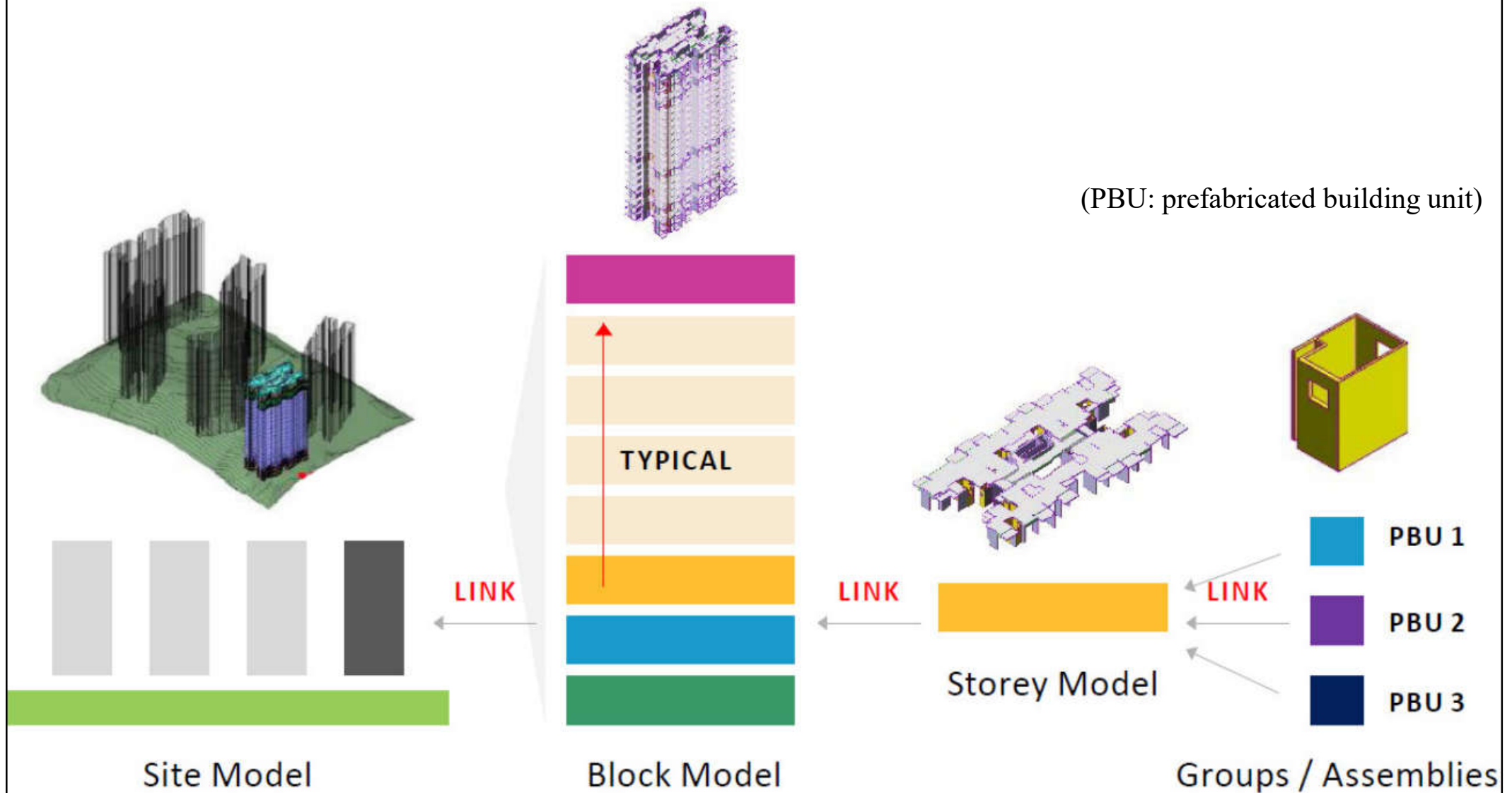


BIM Co-ordination Model

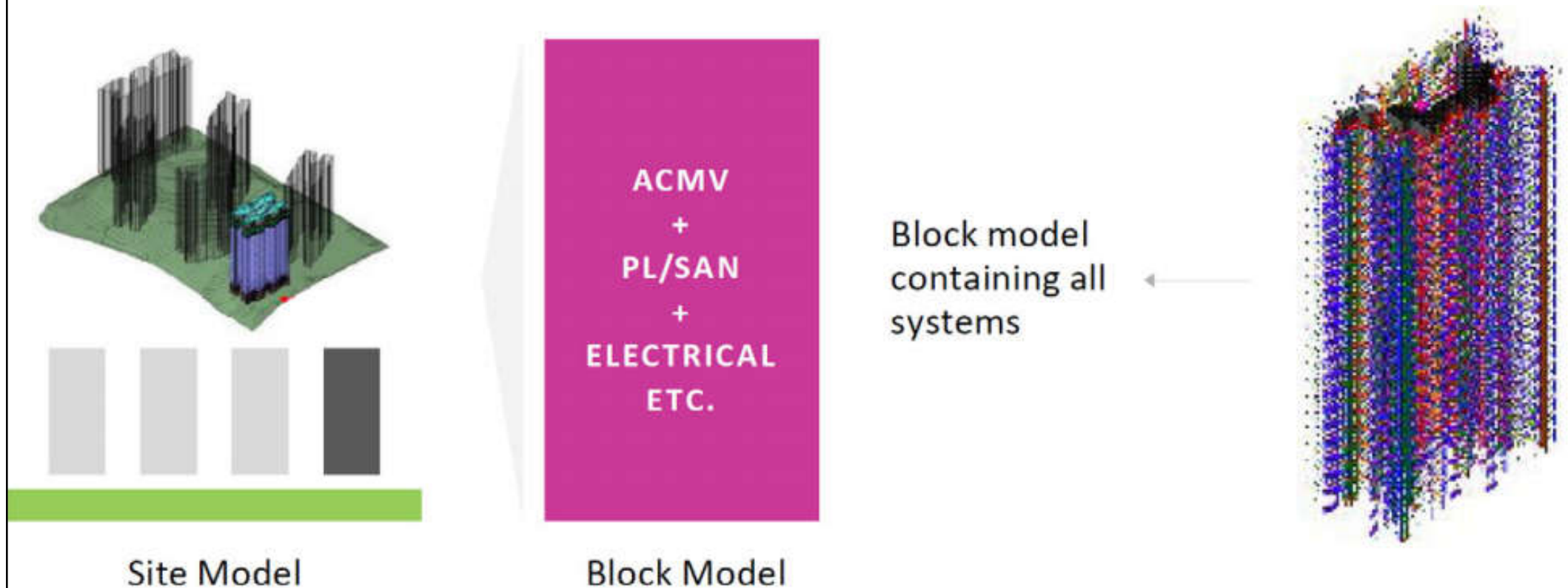
A sample model and linking structure for the Architectural discipline



A sample model and linking structure for the Structural discipline



A sample model for the MEP (Building Services) discipline



All systems within one zone/block as one file.
Depending on model size, one system of one zone/block in one file (This makes it easier to handover files to different MEP subcontractors for their further development and use), where each system may be further split up into floors if needed.

(ACMV: air-conditioning & mechanical ventilation; PL/SAN: plumbing/sanitation)

Typical coordination issues that are critical to construction

| | |
|--|--|
| Architectural – Structural Coordination <ul style="list-style-type: none">• Column setting out and alignment between Architectural and Structural models• Ceiling to structural framing coordination• Staircase and ramp coordination | Structural – MEP Coordination <ul style="list-style-type: none">• Critical penetrations especially of large pipes and MEP services into structural framing• MEP openings into structural walls• Underground MEP services to structural foundation |
| Architectural – MEP Coordination <ul style="list-style-type: none">• Service shaft coordination• Ceiling to concealed MEP services coordination | Arch-Structure-MEP <ul style="list-style-type: none">• Toilet setting out, including coordination of tile layout, floor drains, and fixtures• Façade coordination |

Main responsibilities of the **BIM co-ordinator**

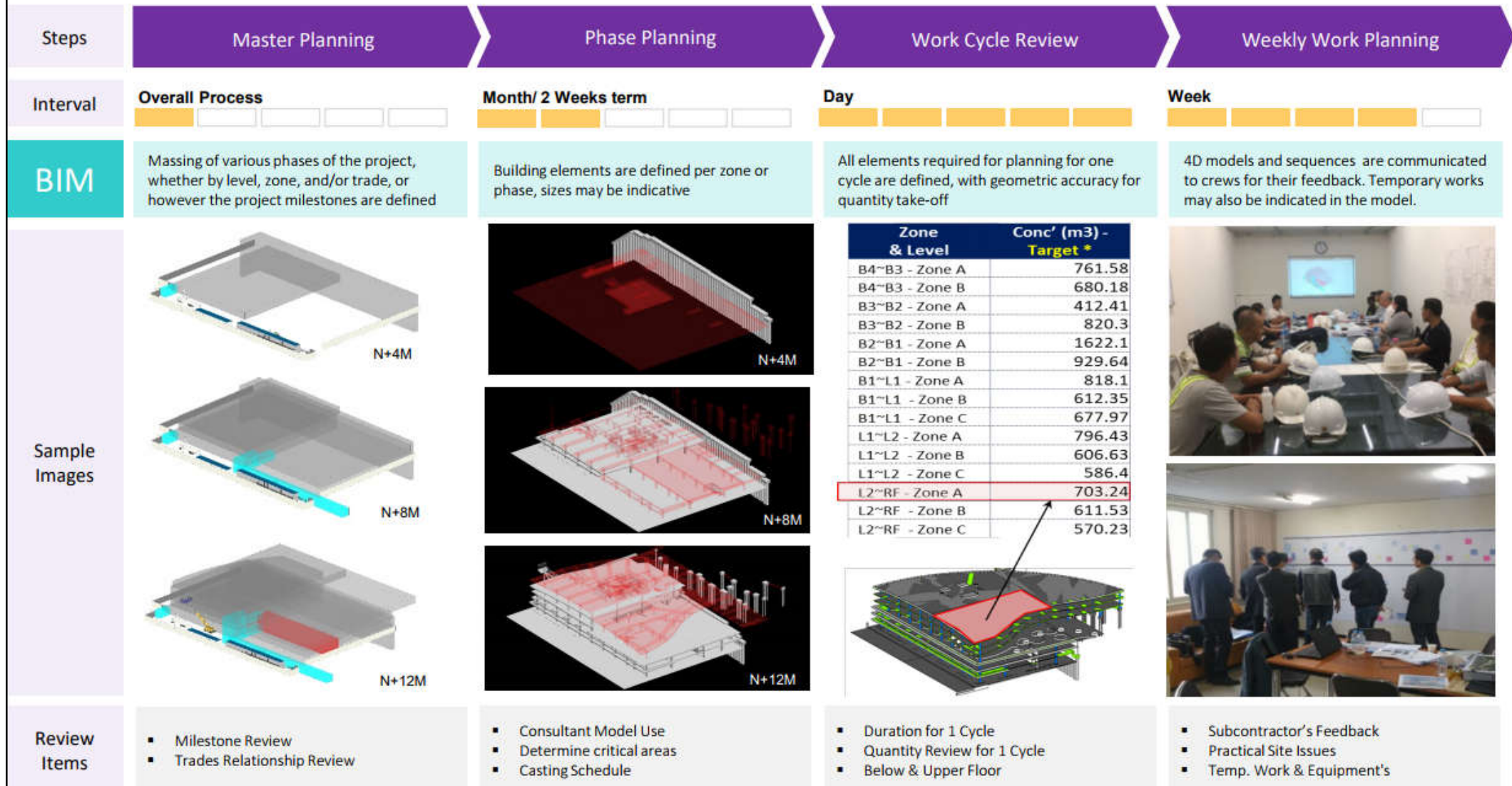
- Developing and maintaining the project's BIM Protocol
- Following the mandated BIM collaboration format (BCF)
- Co-ordinating stakeholders in terms of their role within the BIM process
- Ensuring the accuracy of models and datasets by establishing quality control procedures
- Using clash detection software to identify clashes
- Where there are shared data and inter-model relationships, e.g. shared project coordinates, floor levels, etc., making sure these are recorded and monitored
- Co-ordinating data modelling and management
- Liaising with the design team and client

BIM coordination tasks:

- Clash detection & resolution
- Interactive walk-through & fly-by animations
- Virtual mock-up & review





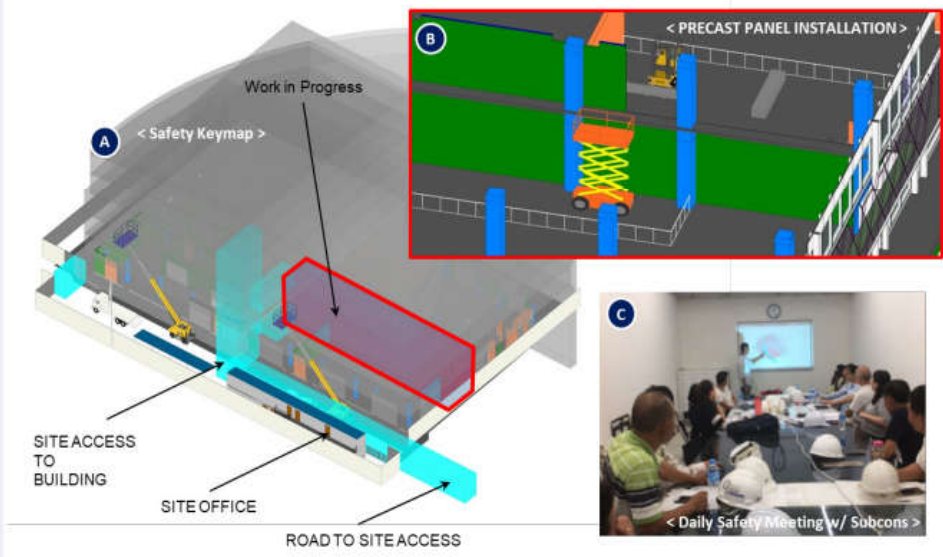
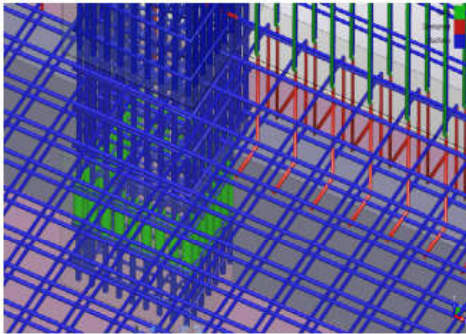
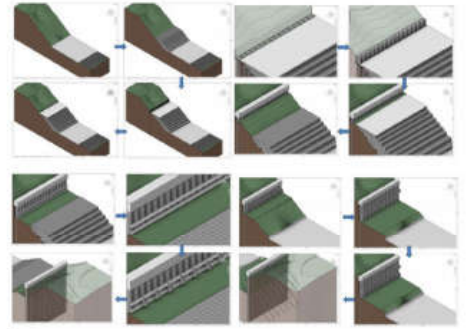
Integration of BIM & production planning / scheduling:

From master planning to weekly work planning



Integration of BIM & production planning / scheduling:

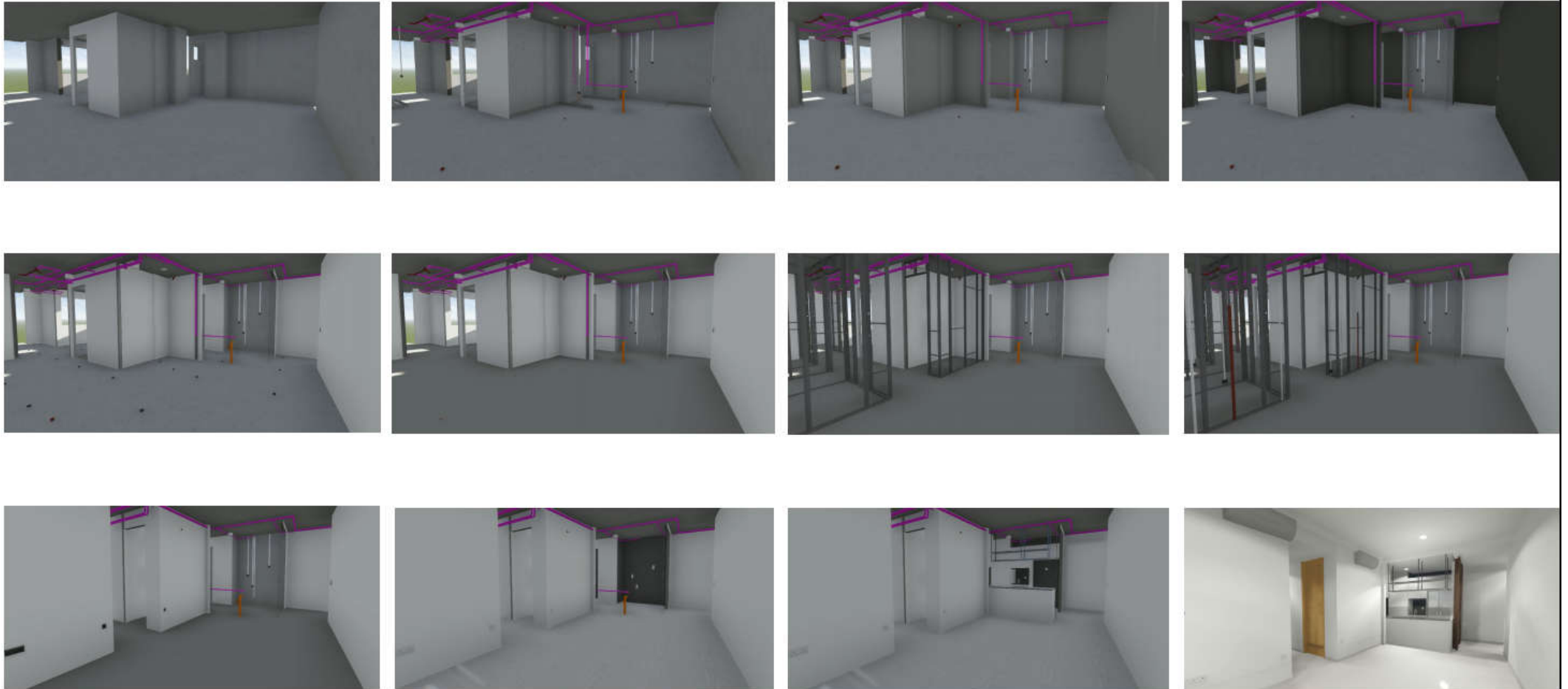
Weekly and daily coordination, review and tracking

| Steps | Method Confirmation | | Site Meetings | Review of Process Mapping | Documentation (Sign-off master schedule) |
|---------------|---|--|--|---|--|
| Frequency | Week  | | Day  | Day  | Daily Tracking Sheet  |
| BIM | Model all components of the proposed methodology to an appropriate level of detail required for planning and reviews. | | Elements that are used as basis for resource planning and materials take-off are modelled to data extraction. | | In certain areas or activities, the model may be sequenced to show daily (or within a day's) work. |
| Sample Images |  | |  | |  |
| Review Items | <ul style="list-style-type: none"> Temp Work such as Scaffolding & Support, Access, T/C M/C | | <ul style="list-style-type: none"> Daily Work Coordination Set up Full Process Mapping | | <ul style="list-style-type: none"> Detailed Review and Update Schedule Documentation & sign off Update (if necessary) |

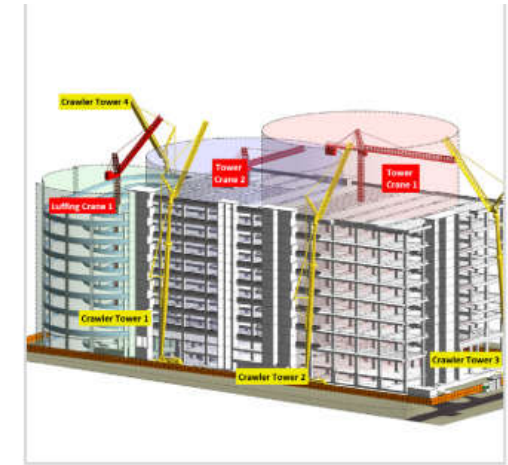
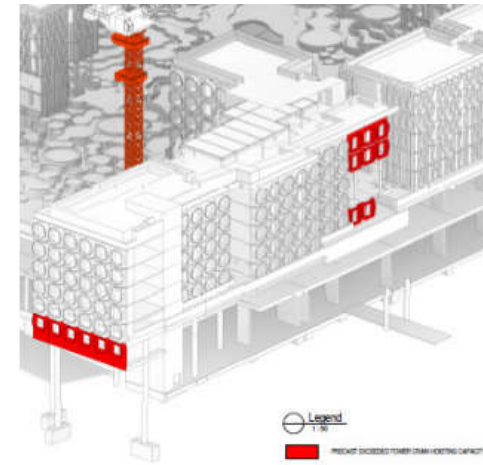
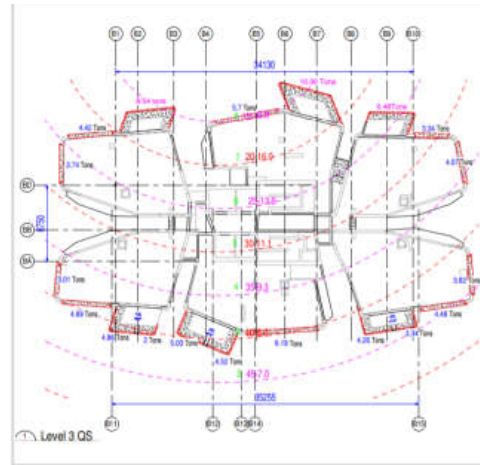
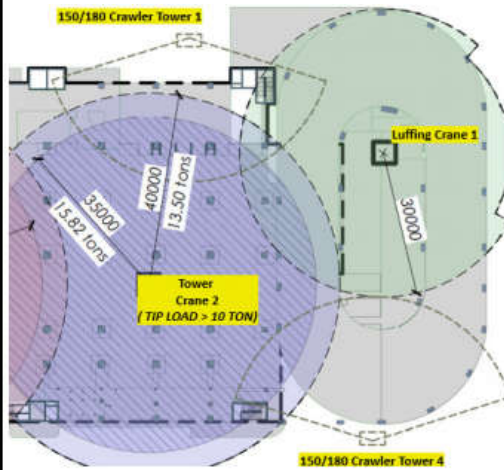
An example of coordination matrix

| | ARCHITECTURAL | | | | | STRUCTURAL | | | | | | MEP | | | | | | | | |
|-------------------------------|---------------|-------------|--------|----------|-------------|-----------------------|-------------------|--------------------|-----------------|------|------------------|---------------------|-------------------|----------------------|---------------------|-----------------|----------------------|-------------------------------|-------------------------------|---------------------|
| | Ceiling | Rated Walls | Floors | Casework | Furnishings | Structural Foundation | Structural Column | Structural Framing | Structural Wall | Slab | Steel & Pre-Cast | Mechanical Ductwork | Mechanical Piping | Mechanical Equipment | Mechanical Fixtures | Plumbing Piping | Electrical Equipment | Electrical Fixtures & Devices | All equipment with clearances | Specialty Equipment |
| Mechanical Ductwork | 1 | 2 | | | | | 3 | 3 | 3 | 3 | 3 | | | | | | | | | |
| Mechanical Piping | 1 | 2 | | | | | 3 | 3 | 3 | 3 | 3 | | | | | | | | | |
| Mechanical Equipment | | | | | | | | | | | | 13 | | | | | | | | |
| Mechanical Fixtures | | | | | | | | | | | | 13 | | | | | | | | |
| Plumbing Piping | | | | | | | | | | | | | | | | | | | | |
| Electrical Equipment | | | | | | | | | | | 10 | 11 | 11 | 6 | 6 | 12 | | | | |
| Electrical Fixtures & Devices | | | | 7 | 8 | | | | | | 10 | 11 | 11 | 6 | 6 | 12 | | | | |
| All equipment with clearances | | 4 | | | | | 5 | 5 | 5 | | 5 | | | | | | | | | |
| Specialty Equipment | | | | | | | | | | | 9 | | | | | | | | | |

Sample virtual sequencing for residential unit mock-up



Crane capacity planning



STEP 1

Model in Tower Cranes / crane to exact planned location

- Build in reach radii into object

STEP 2

Identify and prep all items to be hoisted in the model

- Modelled to exact location
- Modelled to exact overall size, dimensions, details as per fabrication
- Apply formula or scripting to calculate weight from each object OR manually key in

STEP 3

MANUAL METHOD:

- Tag weight for each items so that this annotation shows up in the model
- Visually check if every component weight is within load capacity for that reach radius

AUTOMATIC METHOD:

- Apply scripting to auto-detect and highlight items that are over weight

STEP 4

Adjust tower crane plan (add in more tower cranes) until all items (esp. heaviest or critical items) are within hoisting weight and reach



Further reading

- Video: Amazingly detailed 4D Animation with Fuzor VDC! (4:44) <https://youtu.be/sZ1XxGXFZrk>
- Common data environment CDE
 - https://www.designingbuildings.co.uk/wiki/Common_data_environment_CDE
- BIM co-ordinator
 - https://www.designingbuildings.co.uk/wiki/BIM_co-ordinator
- CS122402: BIM Implementation in the Construction of a Complex Intersection of Utility Tunnels (Duration 43:52) (a real-life project in Shanghai)
 - <http://au.autodesk.com/au-online/classes-on-demand/class-catalog/classes/year-2017/bim-360-glue/cs122402>