

- (1) Digital Design Object Libraries (DOL)
for Architectural Works

- (2) Collaborative Design Processes (CDP) &
Teaming Arrangement

Developing Singapore Standards
for BuildingSMART Singapore

By
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- Dec 2010 Situational Survey
- SS Draft customised for Singapore
 - Proposed Part 1 – DOL for Architectural Works
 - Proposed Part 2 – CDP
 - (Proposed Part 3, 4 etc – Other gaps not within Terms of Reference)
- DOL Pilot Concept reviewed with Vendors
 - Autodesk – Application Agent: Crown Systems
 - Bentley
 - Graphisoft
 - Vectorworks
- CDP Trial Use with Project Users
 - Developer – e.g. Capitaland
 - BIM Ready Consultant – e.g. Arup
 - D&B Contractor – e.g. Woh_Hup
- (What's next?)

- DOL

C2.1 Conduct survey among the industry practitioners for feedback and inputs in terms of current practices and requirements which are needed to be incorporated into the design and development of SS for DOL;

C2.2 Review, identify and propose the information schema, **interfaces, parameters and conditions** that the SS for DOL should comply with in order to be used for local design and construction;

- CDP

D2.1 Conduct survey among local and foreign industry practitioners for feedback and inputs in terms of current practices and requirements that are needed to be incorporated into the collaborative BIM design processes for use in the local context;

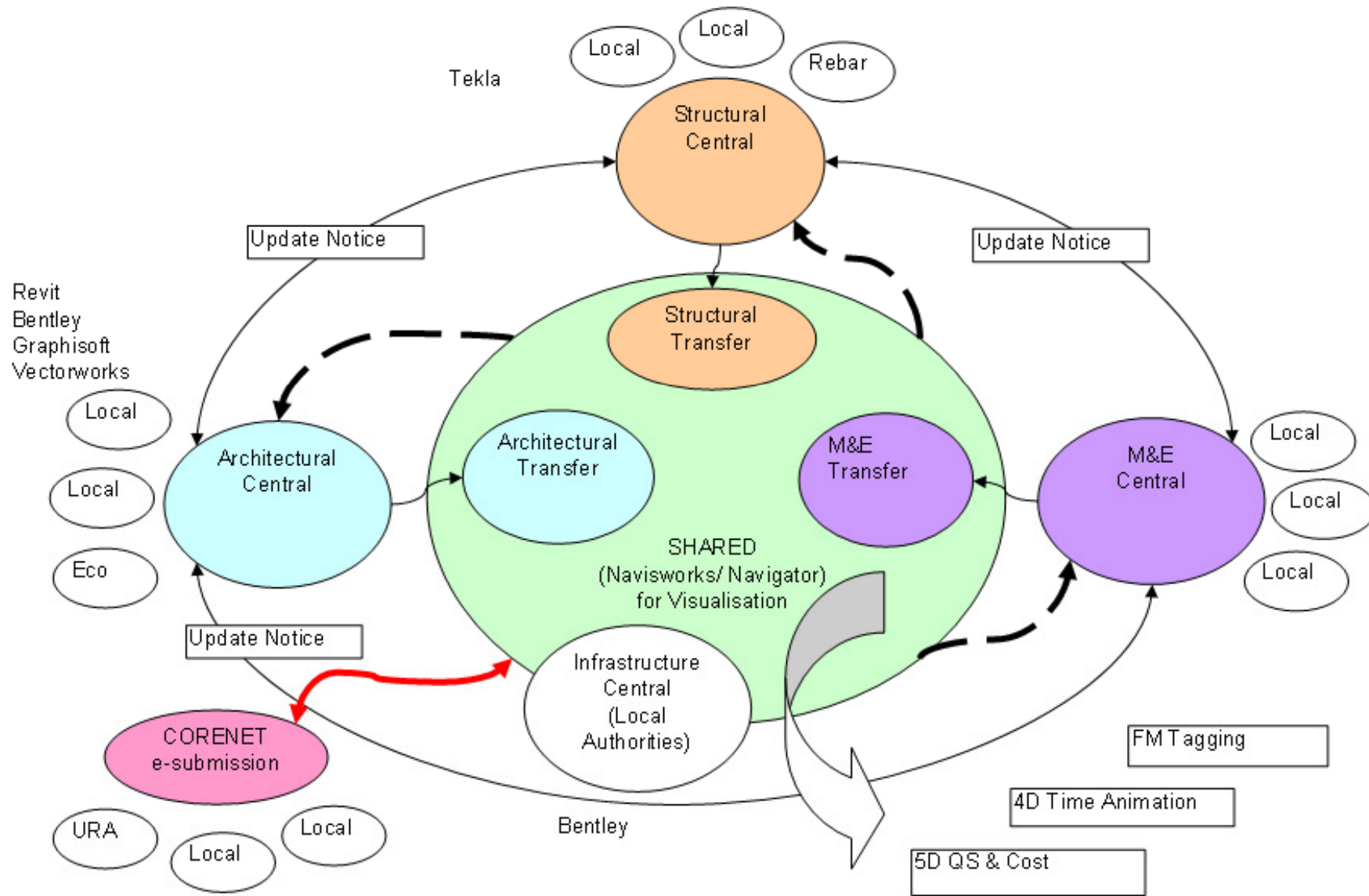
D2.2 Review, identify and propose new collaborative design guidelines for local professionals **in creating BIM design models for building projects**;

- Review available global standards and guides
 - Customisation for Singapore
 - Harmonisation among Vendors /Users
 - Progressive implementation

- The challenges currently noted are:
 - Lack of staff knowledgeable in BIM
 - Lack of supporting consultant knowledgeable in BIM
 - Lack of local technological guides for BIM
 - Lack of locally customised BIM/ digital design object library (DOL)
 - Lack of collaborative design processes(CDP) guide
 - Short of time during pre-tender stage to arrange for or facilitate BIM
- Effective BIM should facilitate Integrated Project Delivery (IPD), which includes:
 - Programme Planning /Construction Animation (4D)
 - Quantification & Costing (5D)
 - Fabrication Design /Site Operation Management
 - Facilities t /Ultimate Tenant-Occupants Management (6D)
 - Developer’s Simulatable Visit
- Design should bring in Fabricator /Installer’s needs in mind earlier for “Constructability”.

- State-of-the-art IAI /buildingSMART IFC
 - allows Graphic/ Data Exchange Interface on common parameters.
- Vendors' agreed IFC compliance allows IPD
 - Inter-operable Architectural CAD, Structural CAD and M&E CAD through “**IFC export**” to a common Visualisation platform e.g. Navisworks /Navigator /Projectwise, an Integrated Project Delivery (IPD) is now possible. (BIM is just another name for IPD)
 - IPD allows all consultant agencies to be brought forward for earlier Value Engineering Review. This includes bringing in contractor's site operational and prefabrication review.
 - AutoCAD, Revit, Bentley, ArchiCAD, Vectorworks are now all IFC compliance.
 - This IPD capability will allow BIM e-submission to be possible.
- What has been lacking
 - **Customisation of construction working Object Classification for use in Singapore (for QTO)**

Component Models in BIM and Visualisation merged /shared in IFC



- **1 ()**
 - The details in this level is sufficient for Outline Planning Permission (OPP) discussions with authorities and sufficient for massing studies.
 - Designers and Developers can use this model to carry out feasibility studies with broad functional areas.
- **2 ()**
 - The details in this level is sufficient for PP and Written Permission (WP) submissions with the authorities.
 - DLS2 is also appropriate for feasibility studies but with more information such as functional room areas, efficiency calculation and the like.
 - This level is ideal for calling full Design and Build (D&B) Tenders and can be considered for Develop and Construct (D&C) tenders.
 - It should be able to support basic Simulation

- **3 (for BP)**
 - DLS3 is appropriate for feasibility studies if the Developer and Designers want to achieve detail illustrations and information in the model.
 - In this level, details such as toilet cubicle areas, sanitary wares and fittings, kitchen appliances and the like are shown but not necessarily specified in detail. DLS3 is more suited for D&C.

- **4**
 - The details in this level is sufficient for Building Plan (BP) submission with the authorities.
 - DLS 4 is appropriate for traditional tenders such as the Lump Sum Contract and Bills of Quantities.
 - In essence, the level of preparation and information should be 80% -90% complete.
 - Most major elements, touch and feel items, Mechanical & Electrical Equipment and System and fittings and fixtures would have been fully specified and tied in with specifications (NPQS) and measurement standards (CEMS) for QTO and for Construction sequence.
 - Depending on the BIM program, this level shall allow simulations to be carried, simulations such as sun path analysis and energy modelling.

- **5**
 - The details in this level would be 100% and to an as-built quality.
 - The BIM model would be ready for Facilities Management and Assets Management use and in some cases, emergency response.

Need Customisation to Singapore

Table 1: Global class standard & naming convention

CLASS NAMING CONVENTION	United States	Europe	United Kingdom	Australia	Singapore
Elemental Classifications	Omniclass,	Finland's OCG's	Uniclass,	-	CP93 (MasterFormat modified)
	Uniformat (ASTM Standard E1557)	-	BCIS Elemental	(BCIS modified)	CP80 Elemental classification (BCIS modified)
Standard method of measurement	-	-	UK SMM	Australia SMM	Singapore SMM, CP97 CEMS
Specification	CSI MasterFormat	-	NBS	NatSpec	NPQS
Dominating architecture 3D CAD Authoring Tools	Bentley, Autodesk	Graphisoft ArchiCAD, Vectorwork	Bentley, Autodesk	-	Autodesk for building, Bentley for infrastructure, Graphisoft
e-plan check	-	Solibri Model Checker	-	-	BCA Guide for BIM in IBP /IBS
BIM standards /Information Delivery Manual (IDM)	GSA BIM guide NBIMS	Senate Properties BIM requirement	BS 1192:2007 BS ISO 29481-1:2010 BIP 2207	National Guidelines for Digital Modelling	-
BIM Level of Development /Detail Level Standards (DLS)	100 Major Group 200 Group E 300 Individual E 400 Sub-E 500	S Group BIM Spatial BIM PBE BE BIM BE BIM BIM As-built		A B C D E	DLS1 DLS2 DLS3 DLS4 DLS5

Customise Detail Development for Singapore Design Phases

Table 1 Detail Level Standard for BIM adopted

Design Phases (based on SIA)	Schematic - Outline Planning Permission (OPP), - Provisional Planning Approval (PP),	Design Development - Written Permission (WP)	Tender Documentation - Building Plan (BP) Approval - NPQS, CP80, e-Tender, SS517	Contract Construction - Analysis, Shop drawing, Fabrication - CP97 CEMS	Final Completion - Temporary Occupation Permit (TOP), - Certificate of Statutory Completion (CSC)
BIM Modelling Phases	Spatial Group BIM	Spatial BIM – Early Design; Detailed Design	Preliminary Building Element BIM	Building Element BIM	A-built Object Model
Information Delivery - Detail Level Standard	DLS1	DLS2	DLS3	DLS4	DLS5
Procurement	Feasibility Study				
	Design & Build /Develop & Construct				
			Traditional with 2D drawings supplemented	Traditional	
					As-built /FM

Design Processes	BIM Phases	
(1) Analysis of Needs & Objectives - Schematic for Outline Planning Permission (OPP),	a. Requirements model	Documentation of requirements
	b. Site BIM	Site use planning
	c. Inventory BIM	Documentation of starting situation for renovation construction
(2) Design of Alternatives - Provisional Planning Approval (PP), Written Permission (WP)	d. (DLS1) Spatial Group BIM	Spatial Group BIM is not necessarily prepared in all projects, but the alternatives are examined at a Spatial BIM level instead.
(3) Early Design - Design Development, Building Plan (BP) Approval	e. (DLS2) Spatial BIM	<ul style="list-style-type: none"> - Stating the extent Architectural BIM portion must produce, accompanied with BIM specification issues for which decisions have already been arrived and those still remain open. - Stating the extent of respective next Component BIM portions must produce, and the extent of expected results to be presented or illustrated to the parties of the project.
	f. (DLS3) Preliminary Building Element (PBE) BIM	Stating ditto and ditto
(4) Detailed Design - Tender Documentation	g. (DLS4) Building Element (BE) BIM	Stating ditto and ditto
(5) Tendering Stage - Contract Documentation	h. BE BIM – quantity take off phase	Must be adaptable into Contract Document for subsequent expansion into Construction development.
(6) Construction & Commissioning - Final Completion, Temporary Occupation Permit (TOP), Certificate of Statutory Completion (CSC)	i. BE BIM – construction phase	Detailed design for prefabrication and production planning
	j. (DLS5) As-built model	Information for maintenance, space occupancy

Federated Model

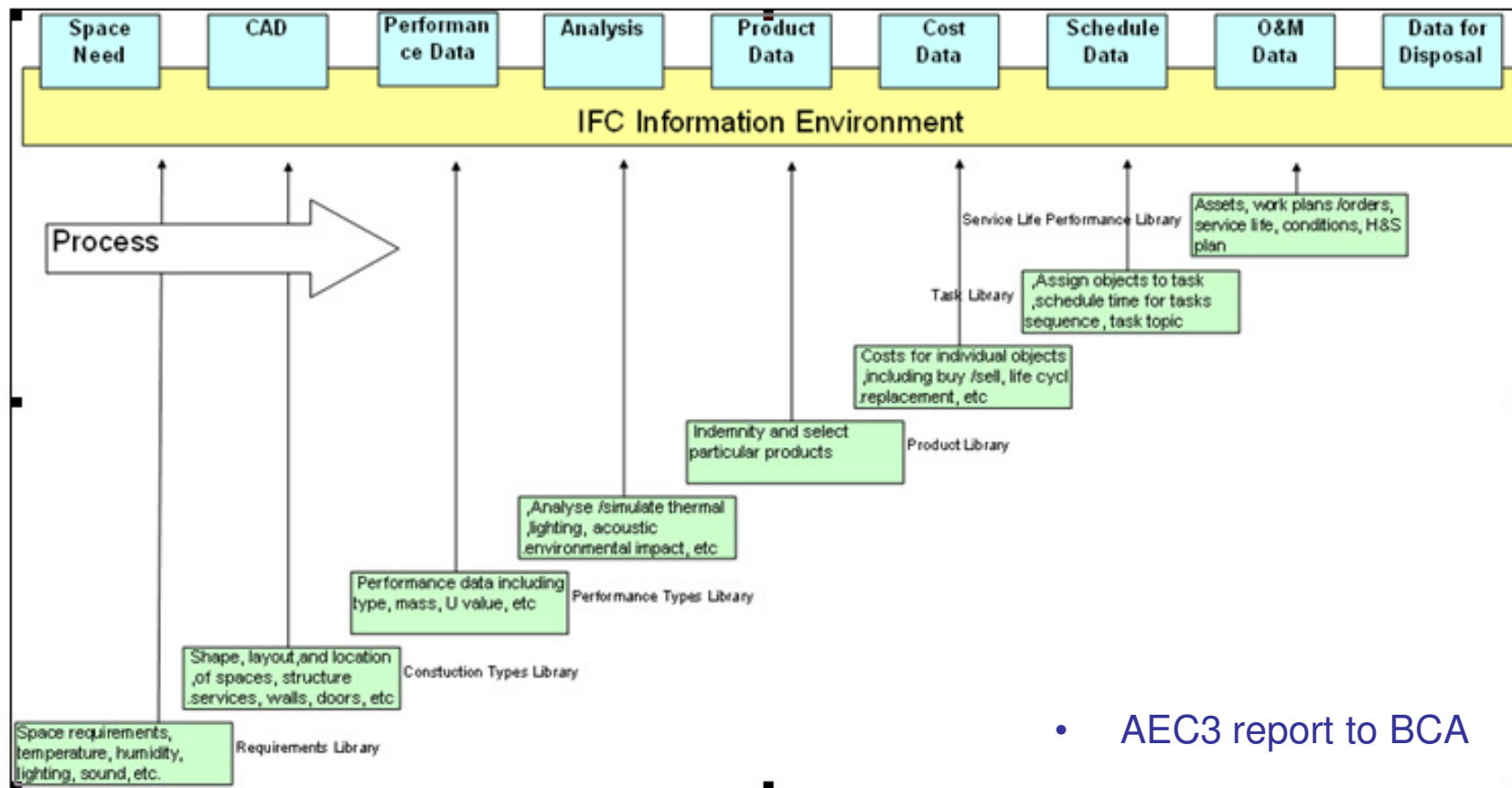
	Schematic DLS1 - Provisional Planning	Design Development DLS2 - Written Permission	Tender Document DLS3 - Building Plan
Initial Modeling Agreement with respective Consultant	Needs and Objectives, Existing Site Info /Building Info Arch Space Massing Structural System Conceptualised M&E System Conceptualised Outline Planning Permission e-submission Budgetary	Arch Concept verified Written Permission e-submission M&E System Verified Energy Review Structural System Verified Facilities Mgt /Walk through Preliminary Construction Animation Authorities Clearances Cost Planning SS CP80 /Programme Planning	Building Plan e-submission Arch Detailed Design M&E Detailed Design Structural Detailed Design Clash Detection Pre-Tender Estimate /Contract Pricing SS CP97
	Contract Construction DLS4	Final Completion DLS5	
	Construction Management /Detailed Activities Programme Planning Document Control System SS 527 Procurement Management - Resources, Labour, Plant, Material Authorities Clearance Progress Monitoring Progress Payment	As-built Verification Assets Tagging Authorities Clearance TOP CSC Handing /Taking Over SS 517 Close out	
		Post Occupant Feedback	

- Each design-partner is responsible to their respective original CAD authoring; and the IFC exported portion in the merged model.

Publication Quality Assurance Checklist

Spatial BIM	Architectural Building Element BIM	Structural Building Element BIM	M&E System BIM	Merged Model
BIM in agreed IFC version	BIM in agreed IFC version	BIM in agreed IFC version	BIM in agreed IFC version	All agreed models available
BIM includes defined stories	BIM includes defined stories	BIM includes defined stories	BIM includes defined stories	
Spaces defined separately in each story	Building elements & spaces modelled separately in each story	Building elements defined separately in each story	Components defined separately in each story	Models are located in the correct coordinate system
Space height defined	Space height defined (including suspended ceilings)			Models represent the same design version
BIM includes gross area objects	BIM includes required building elements	BIM includes required building elements	BIM includes required components	
All spaces have unique IDs	All spaces have unique IDs		System names are defined systematically	
All spatial groups include names and types	All spatial groups include names and types		System colours are defined systematically	
	Building elements include types	Building elements types are as agreed	Components belong to a correct system	
	Building elements modelled using correct objects	Building elements modelled using correct objects	Components modelled using correct objects	
Space names and types are as agreed	Space names and types are as agreed			
Space areas match space program	Space areas match space program			
Spaces match with gross area in each story	BIM includes gross area objects			
	No excess building elements	No excess building elements	No excess components	
	No significant clashes between objects	No significant clashes between objects	No significant clashes between components	No conflicts between different M&E systems
	Spaces do not overlap	No conflicts between structures in arch /structural BIM		No conflicts between vertical shafts and M&E systems
	Spaces, walls and columns match with the gross area	No conflicts between penetrations in arch/structural BIM	No clashes between M&E and architectural BIM	No conflicts between horizontal reservations and M&E
	Shape and size of spaces matches with walls	Columns and beams converge	BIM includes air handling units	No conflicts between suspended ceilings and M&E
Spaces do not overlap	No overlapping or doubled building elements	No overlapping or doubled building elements	No overlapping or doubled components	Penetrations of slabs OK
BIM includes spatial reservations for M&E	BIM includes spatial reservations for M&E	M&E penetrations & reservations includes in structures	Components fit into their spatial reservations	Penetrations of columns and beams OK

DOL	Basic Object	DLS1	DLS2	DLS3	DLS4	DLS5
Generic Object	✓					
Public-shared Object		✓	✓	✓		
Project-shared Object				✓	✓	✓
As-built Object						✓



- AEC3 report to BCA

Customise into Classification for Singapore

The relationship with reference to Singapore is as follows:

<u>IfcRoot</u>	<u>IfcObjectDefinition</u>		
	<u>IfcPropertyDefinition</u>		
		<u>IfcPropertySetDefinition</u>	
		- For UK	NBS
		- For US	CSI
		- For Singapore	NPQS
	<u>IfcRelationship</u>		
		<u>IfcRelAssociates_Library</u>	
		<u>IfcRelAssociates_Document</u>	
		<u>IfcRelAssociates_Classification</u>	
		- For Europe	<u>UniClass</u>
			Finnish class
		- For US	<u>OmniClass (Naming)</u>
			<u>Unifomat (Element, Specification)</u>
			<u>MasterFormat</u>
		- For Singapore	CP83 (CAD Naming /e-submission
			CP80 (Elemental for Cost Planning)
			CP97 (CEMS Bill itemisation)
			CP93 (CRCS)



Type

- Supplier
- Cost
- Spec
- Classification
(See customisation for Singapore)

Type Properties

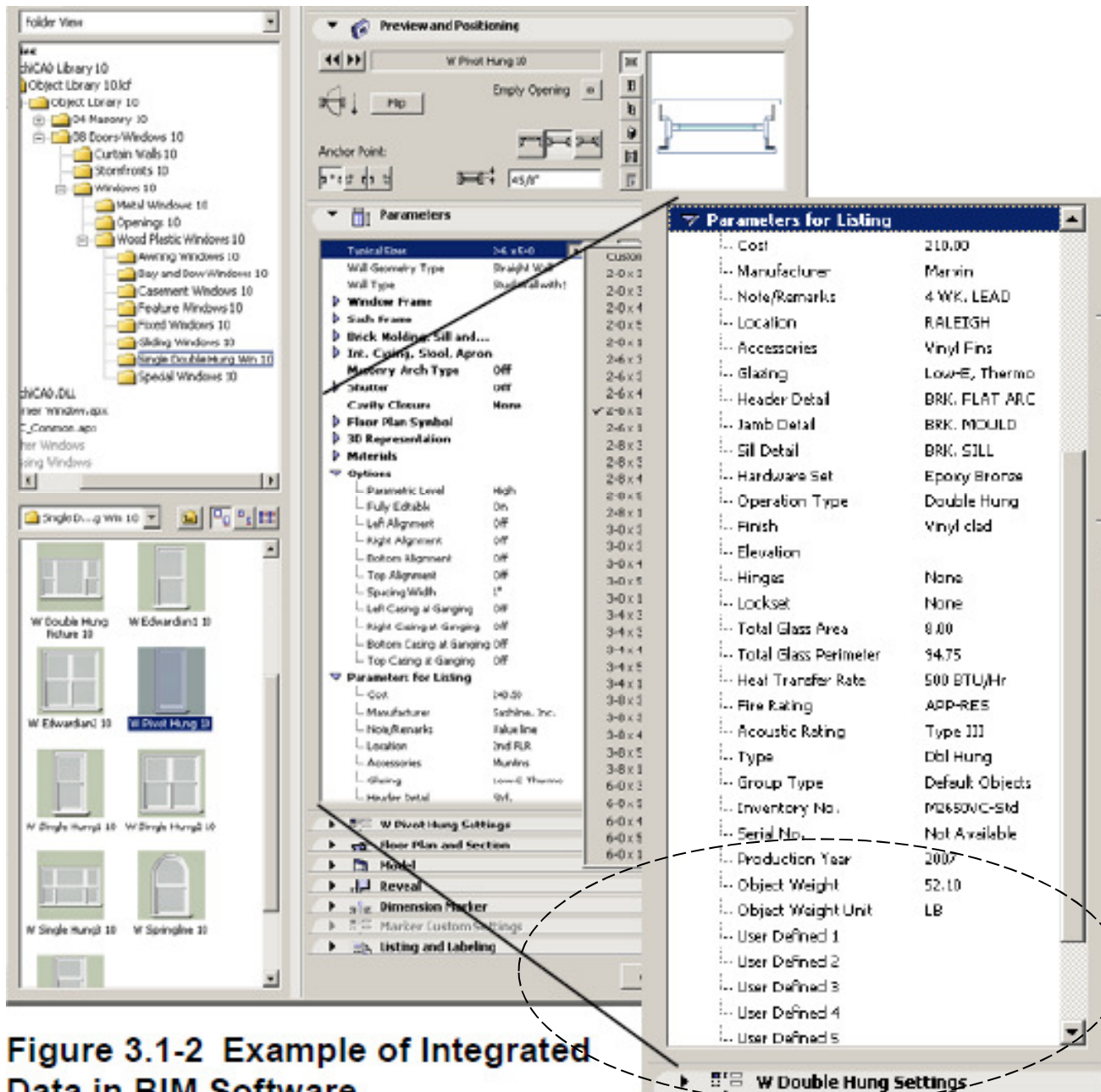
Family: IntSgl (2) Load...

Type: 910 x 2110mm Duplicate... Rename...

Type Parameters

Parameter	Value
Architrave Setback	5.0
Thickness	
Identity Data ^	
Manufacturer	Revit
Keynote	L20
Model	
Type Comments	
URL	
Description	
Assembly Description	
Assembly Code	
Type Mark	36
Fire Rating	
Cost	
OmniClass Number	
OmniClass Title	
IFC Parameters ^	
Operation	SingleSwingRight

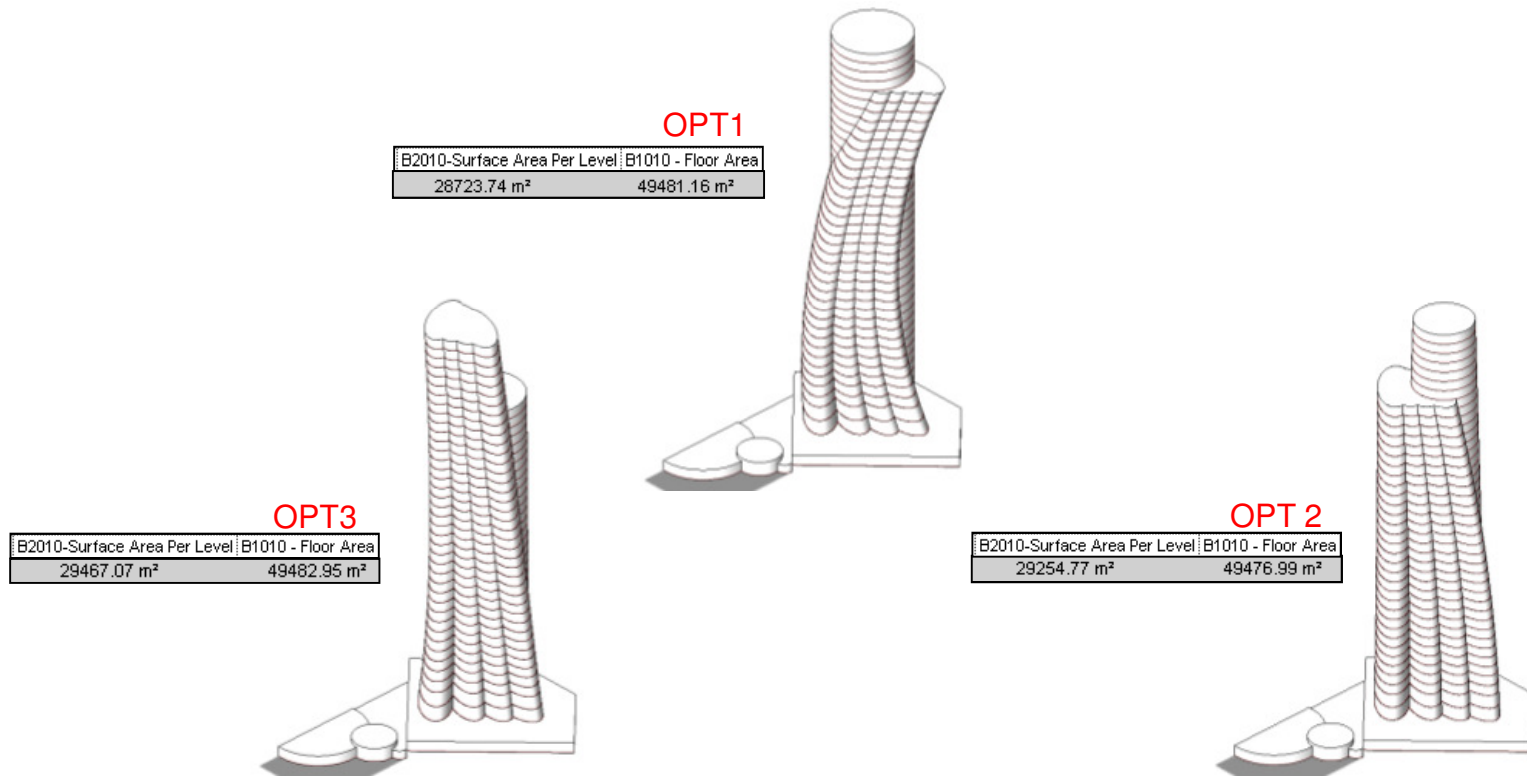
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Additional User Defined Attributes are expandable to meet respective IDM

Figure 3.1-2 Example of Integrated Data in BIM Software

Mass it, Test it, & Evaluate it

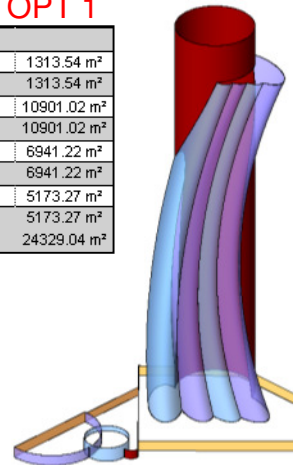


*Surface Area include the Roof Surface

Mass it, Test it, & Evaluate it

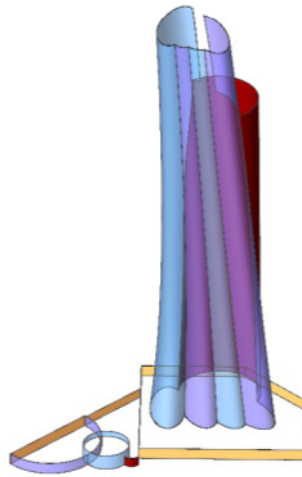
OPT 1

QTO-Exterior - Below	1313.54 m ²
	1313.54 m ²
QTO-Exterior	10901.02 m ²
	10901.02 m ²
QTO-Curtain Wall	6941.22 m ²
	6941.22 m ²
QTO-Curtain Wall 2	5173.27 m ²
	5173.27 m ²
	24329.04 m ²



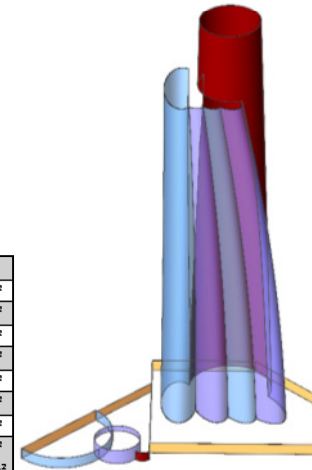
OPT 3

QTO-Exterior - Below	1128.48 m ²
	1128.48 m ²
QTO-Exterior	7146.65 m ²
	7146.65 m ²
QTO-Curtain Wall	8800.10 m ²
	8800.10 m ²
QTO-Curtain Wall 2	7415.93 m ²
	7415.93 m ²
	24491.16 m ²

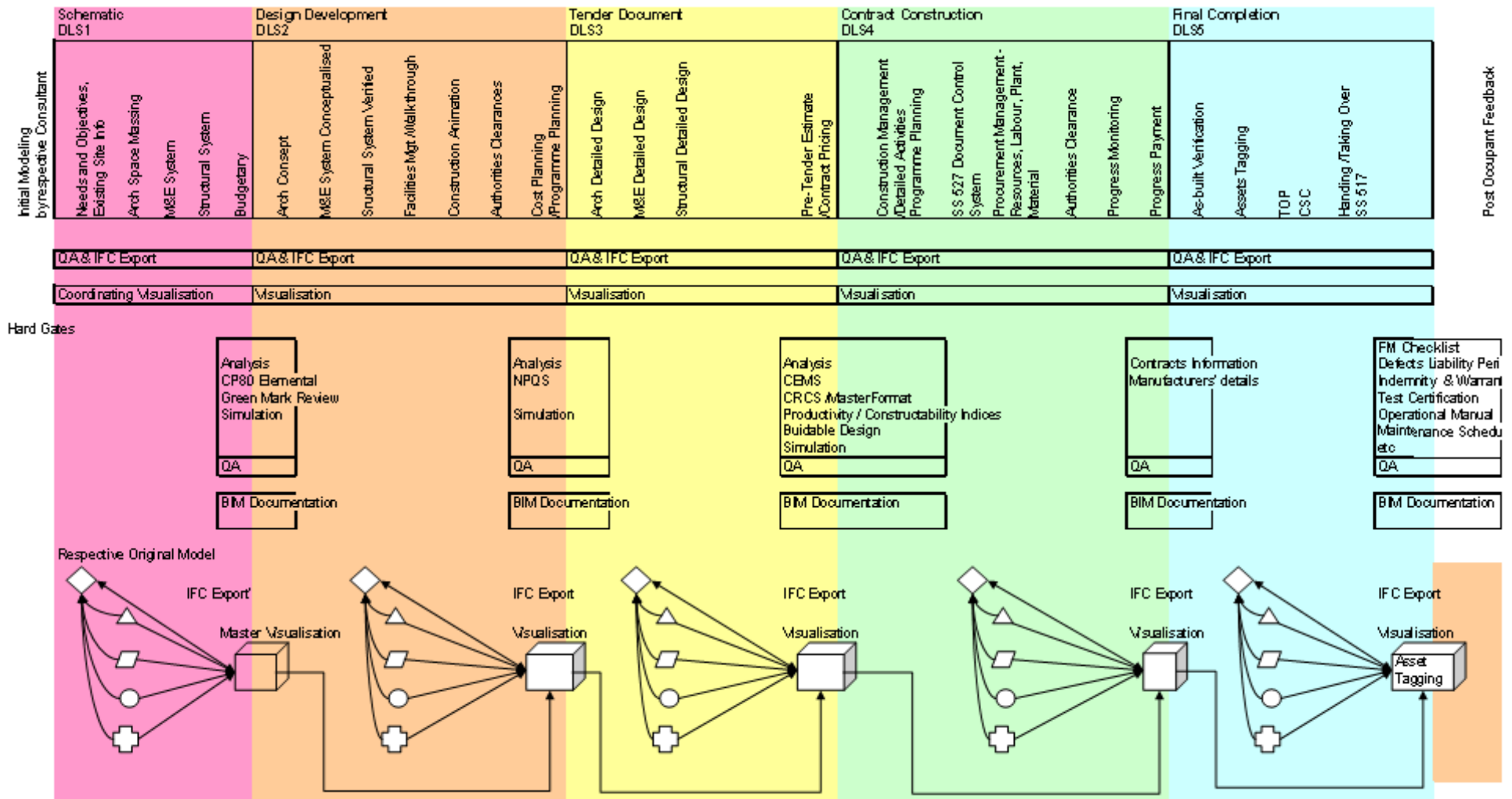


OPT 2

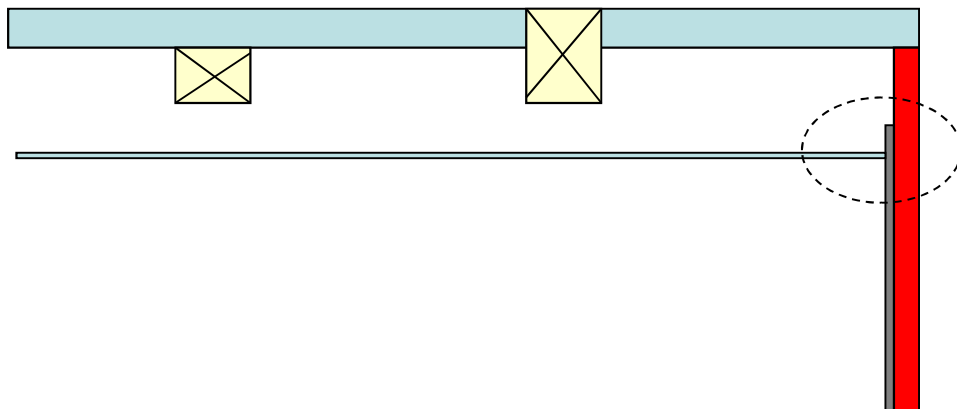
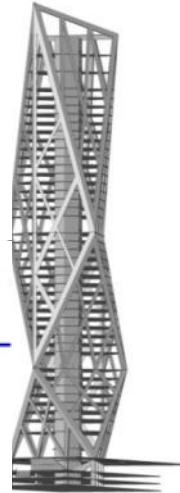
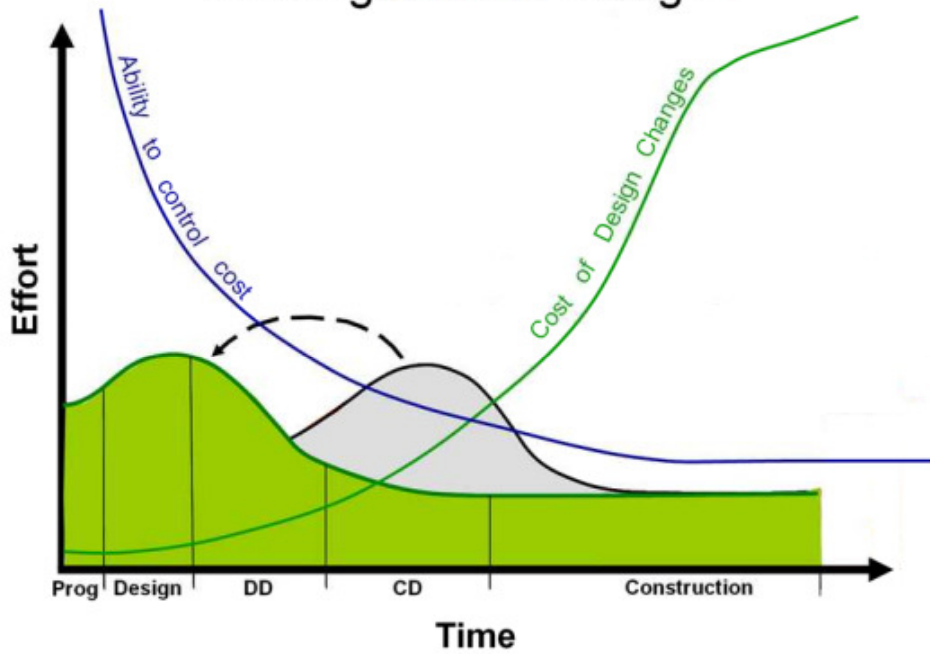
QTO-Exterior - Below	1311.87 m ²
	1311.87 m ²
QTO-Exterior	9424.07 m ²
	9424.07 m ²
QTO-Curtain Wall	8375.30 m ²
	8375.30 m ²
QTO-Curtain Wall 2	5728.35 m ²
	5728.35 m ²
	24839.59 m ²



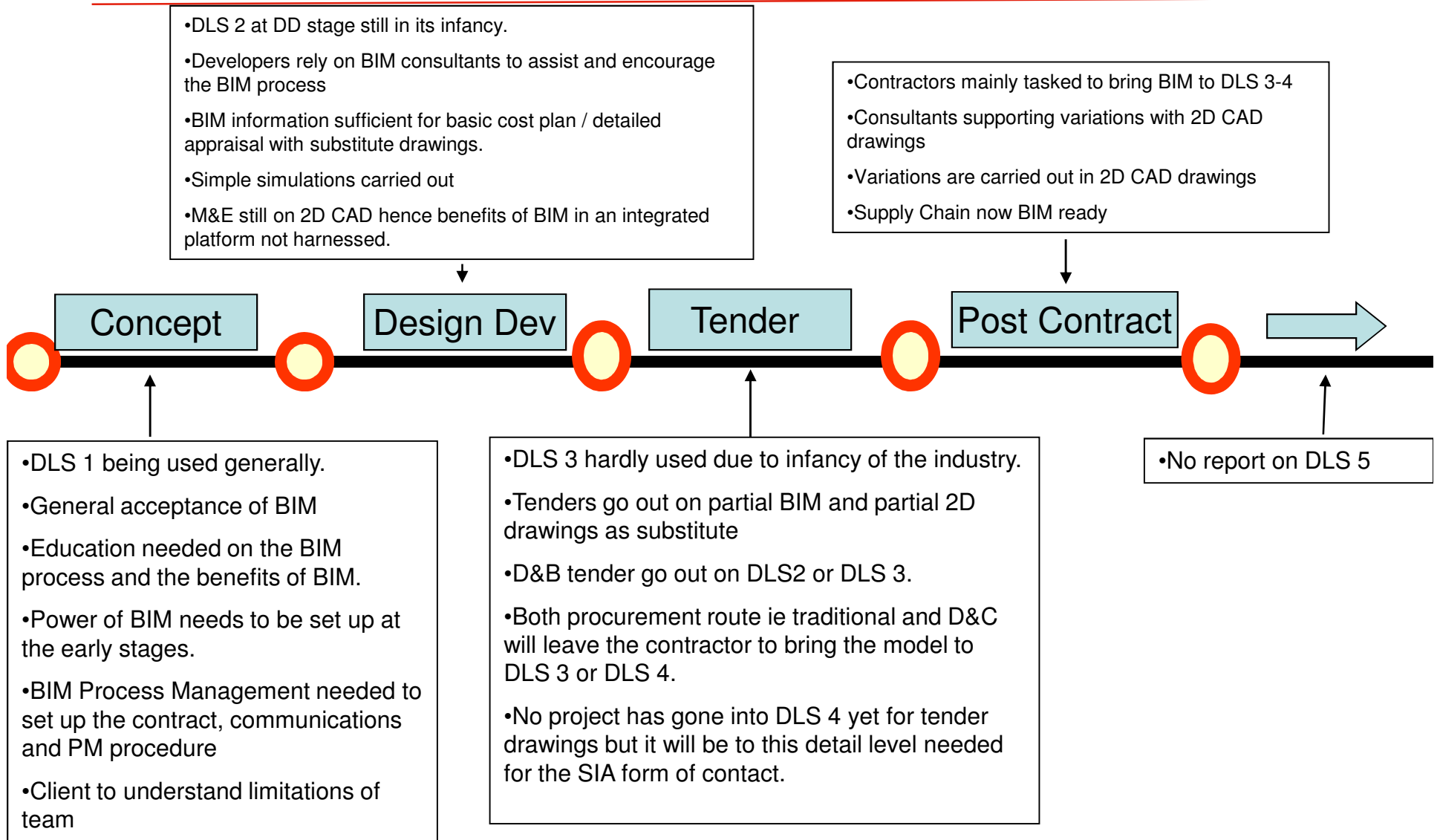
Stage Checking and Documentation



building**SMART** Design



Progressive Delivery with Detail Level Standards (DLSs)





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