BIM uses and processes: BIM workflow & strategy

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May 2019

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- BIM work flow

- Office organization
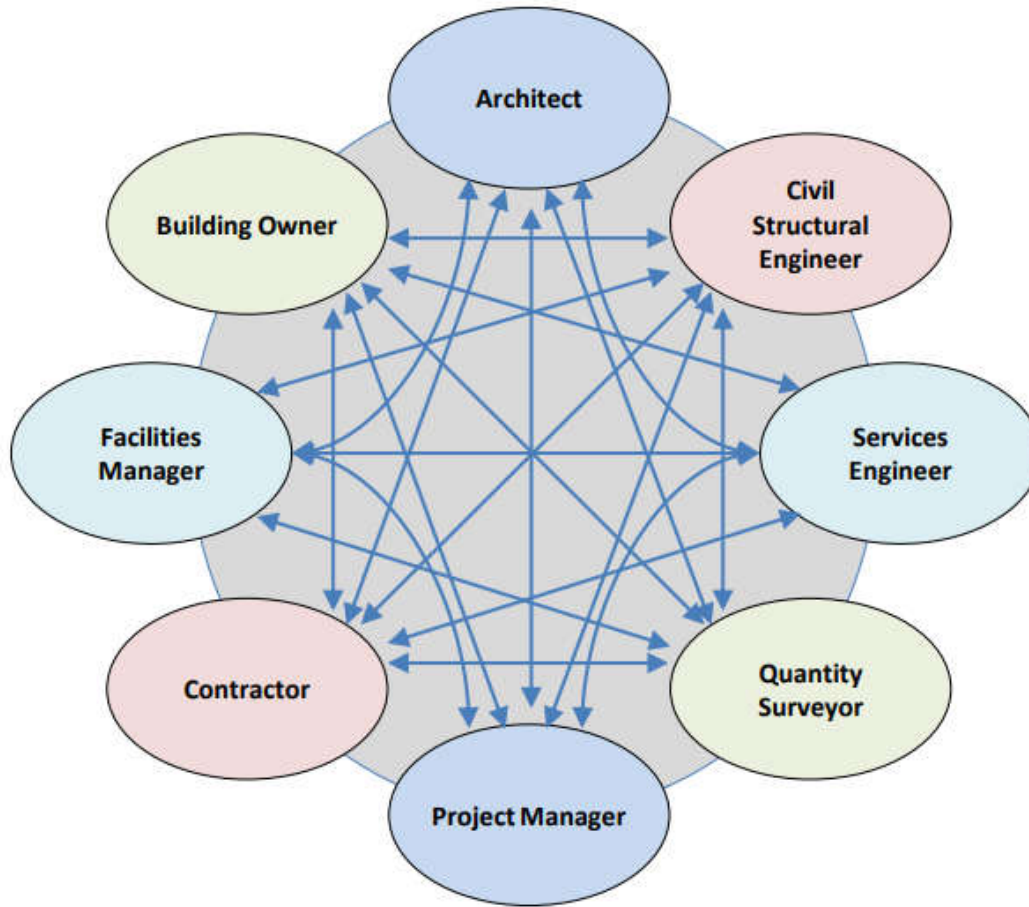
- BIM maturity levels

- Level of development (LOD)

Current team working in the building industry

BIM can streamline fragmented work processes in construction – "silos"

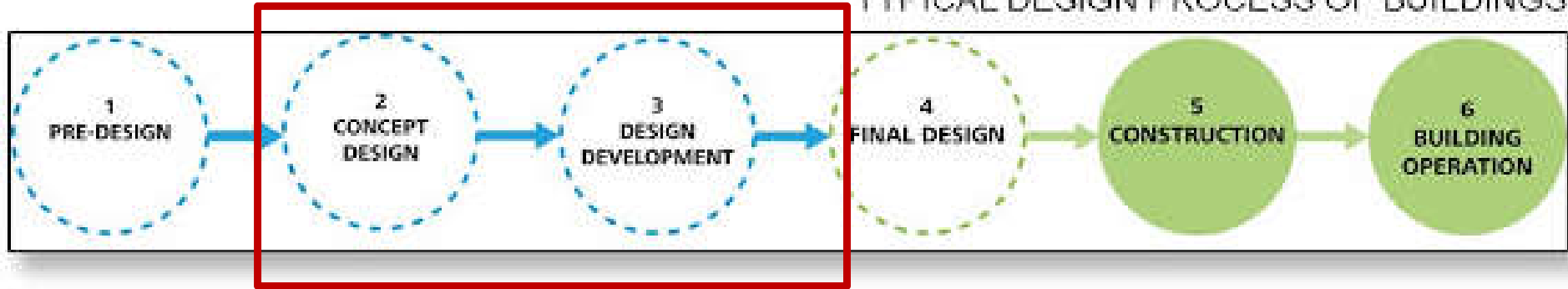

Information "Chaos"
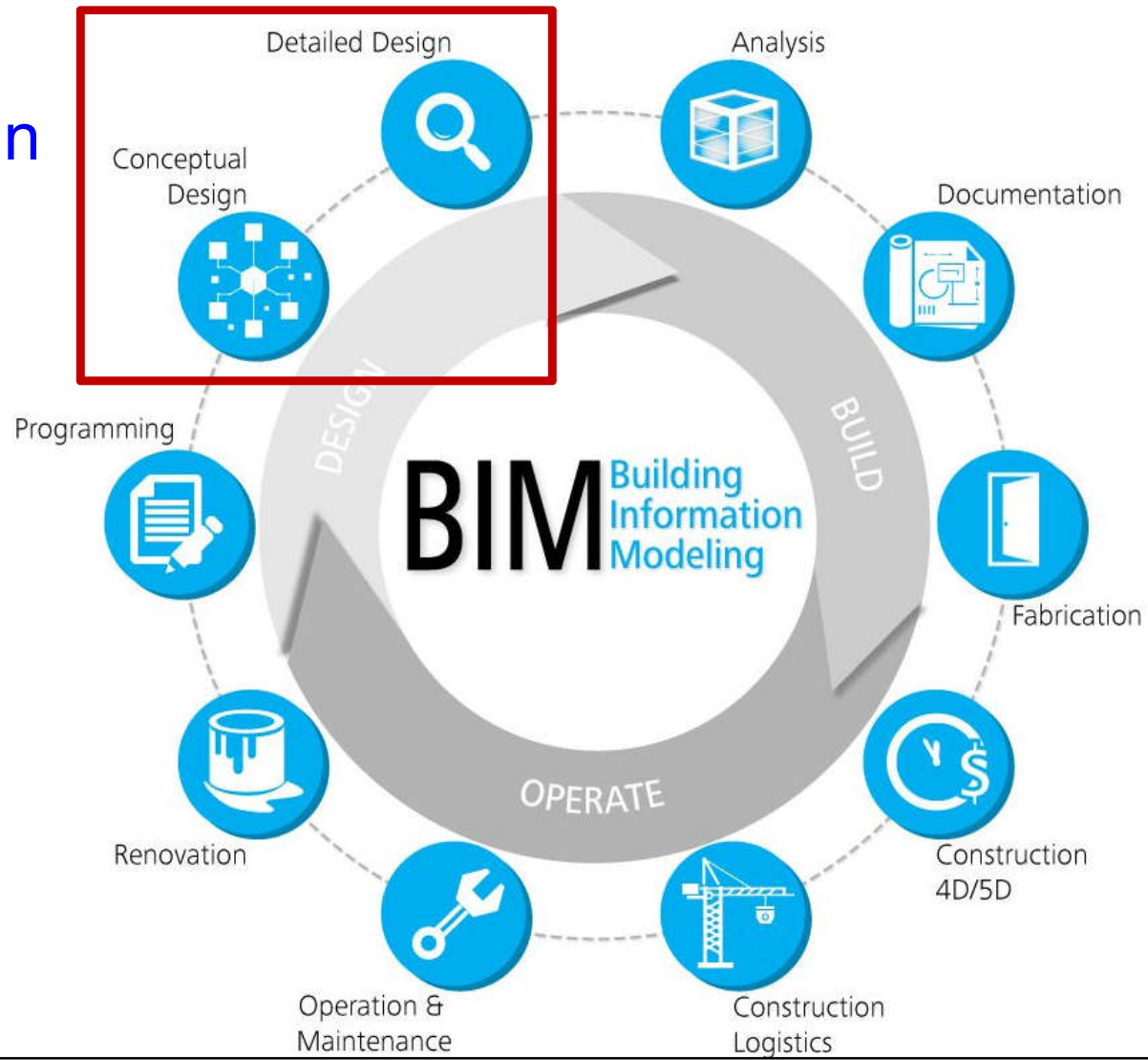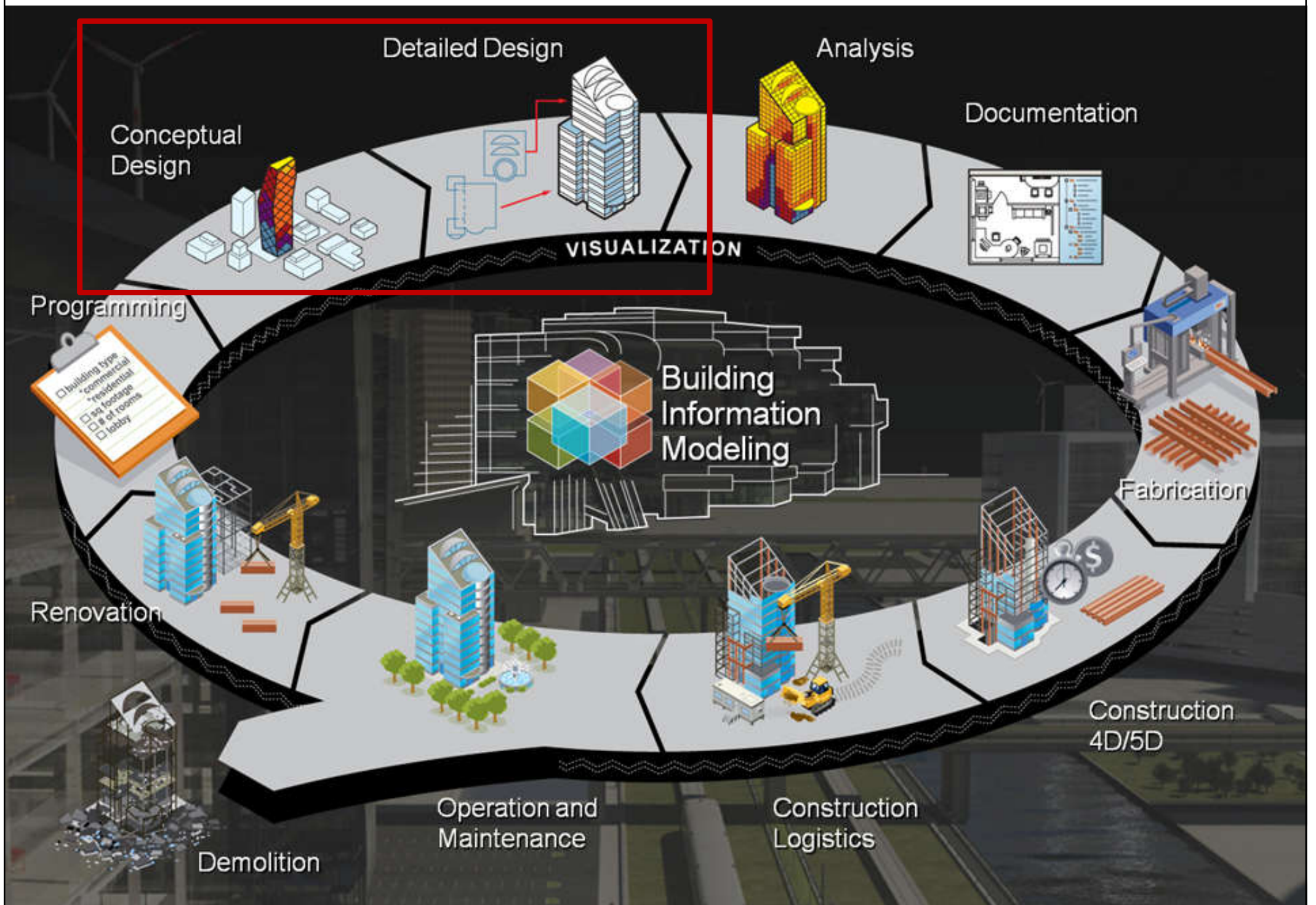
Shared Project Model

BIM simulates new project management style & culture for all disciplines to collaborate on building projects.

TYPICAL DESIGN PROCESS OF BUILDINGS

1 PRE-DESIGN → 2 CONCEPT DESIGN → 3 DESIGN DEVELOPMENT → 4 FINAL DESIGN → 5 CONSTRUCTION → 6 BUILDING OPERATION

· Conceptual design
· Detailed design

BIM Building Information Modeling

DESIGN
- Detailed Design
- Conceptual Design
- Programming

BUILD
- Analysis
- Documentation
- Fabrication
- Construction 4D/5D
- Construction Logistics

OPERATE
- Operation & Maintenance
- Renovation

Conceptual Design

Detailed Design

Analysis

Documentation

Programming

VISUALIZATION

Building Information Modeling

Fabrication

Renovation

Construction 4D/5D

Demolition

Operation and Maintenance

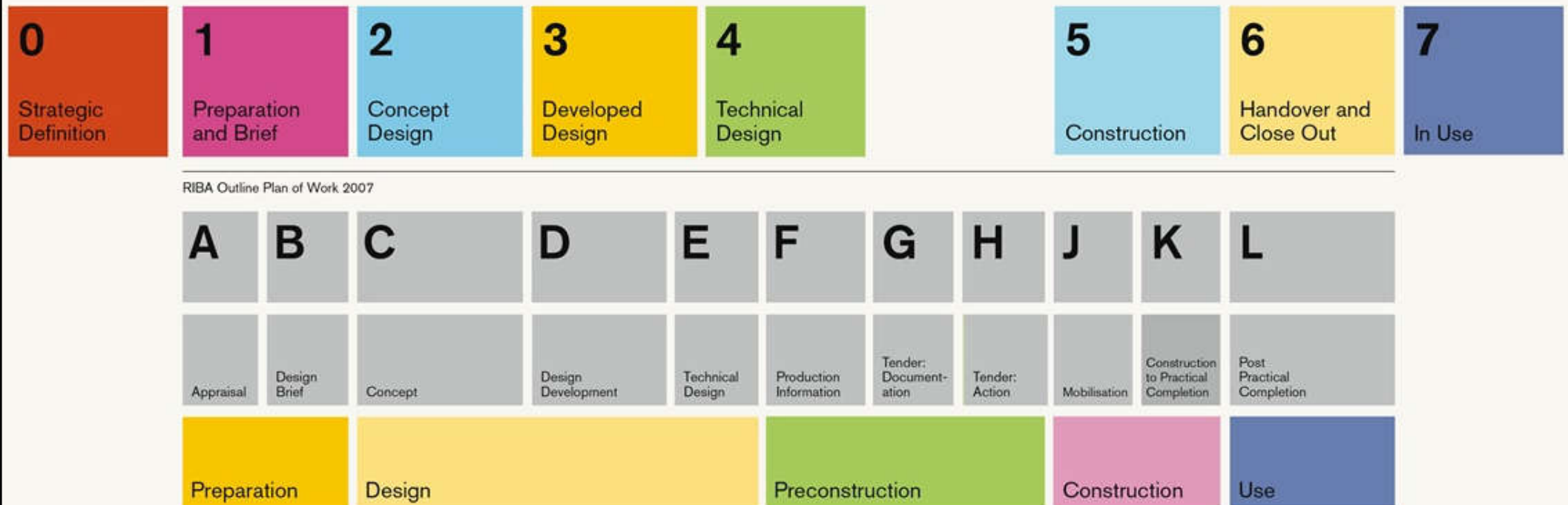Construction Logistics

(Source: Autodesk https://www.autodesk.com/)

RIBA Outline Plan of Work 2013*

Stage 0. Strategic definition
Stage 1. Preparation and brief
Stage 2. Concept design
Stage 3. Developed design
Stage 4. Technical design
Stage 5. Construction
Stage 6. Handover and close out
Stage 7. In use

* The 2013 version reflects increasing requirements for sustainability and Building Information Modelling (BIM).

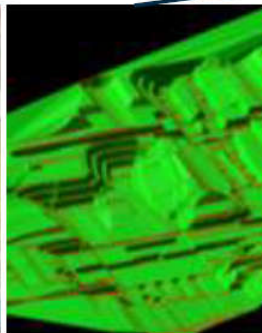(Source: https://www.architecture.com/knowledge-and-resources/resources-landing-page/riba-plan-of-work)

RIBA Plan of Work 2013 compared with RIBA Outline Plan of Work 2007

0 Strategic Definition	1 Preparation and Brief	2 Concept Design	3 Developed Design	4 Technical Design	5 Construction	6 Handover and Close Out	7 In Use

RIBA Outline Plan of Work 2007

A	B	C	D	E	F	G	H	J	K	L
Appraisal	Design Brief	Concept	Design Development	Technical Design	Production Information	Tender: Document-ation	Tender: Action	Mobilisation	Construction to Practical Completion	Post Practical Completion

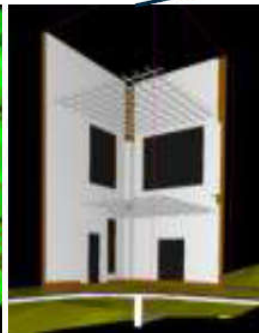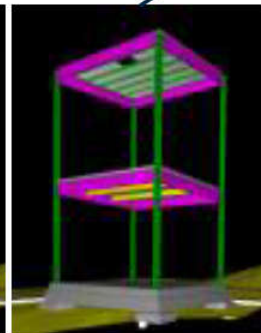| Preparation	Design	Preconstruction	Construction	Use

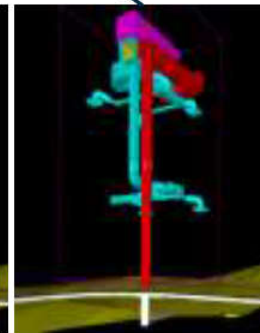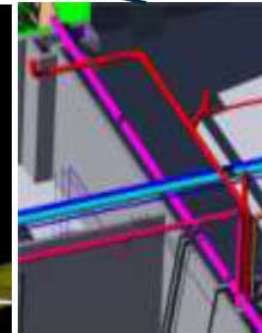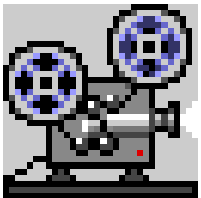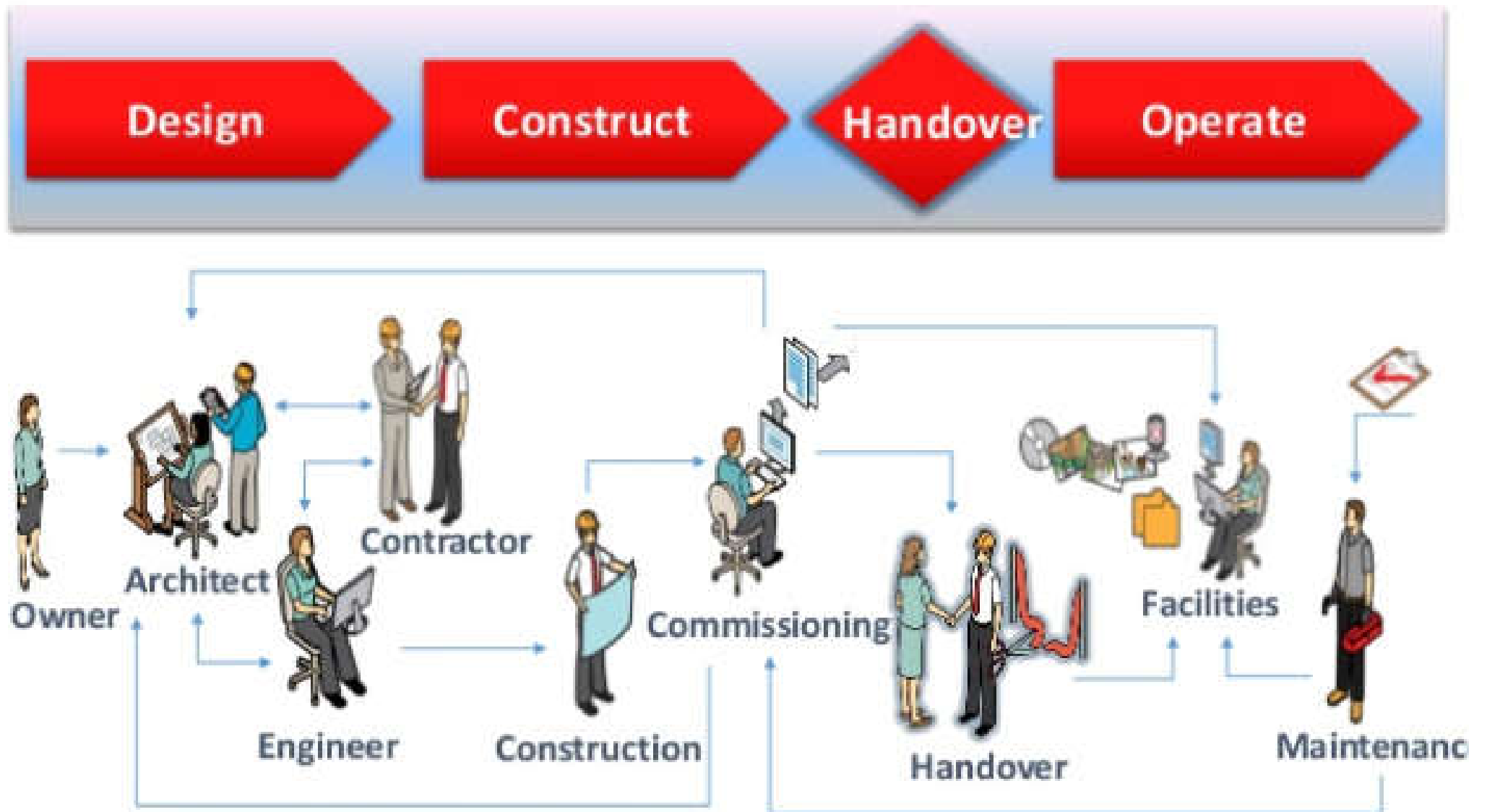# Using BIM across various disciplines in building, construction and infrastructure

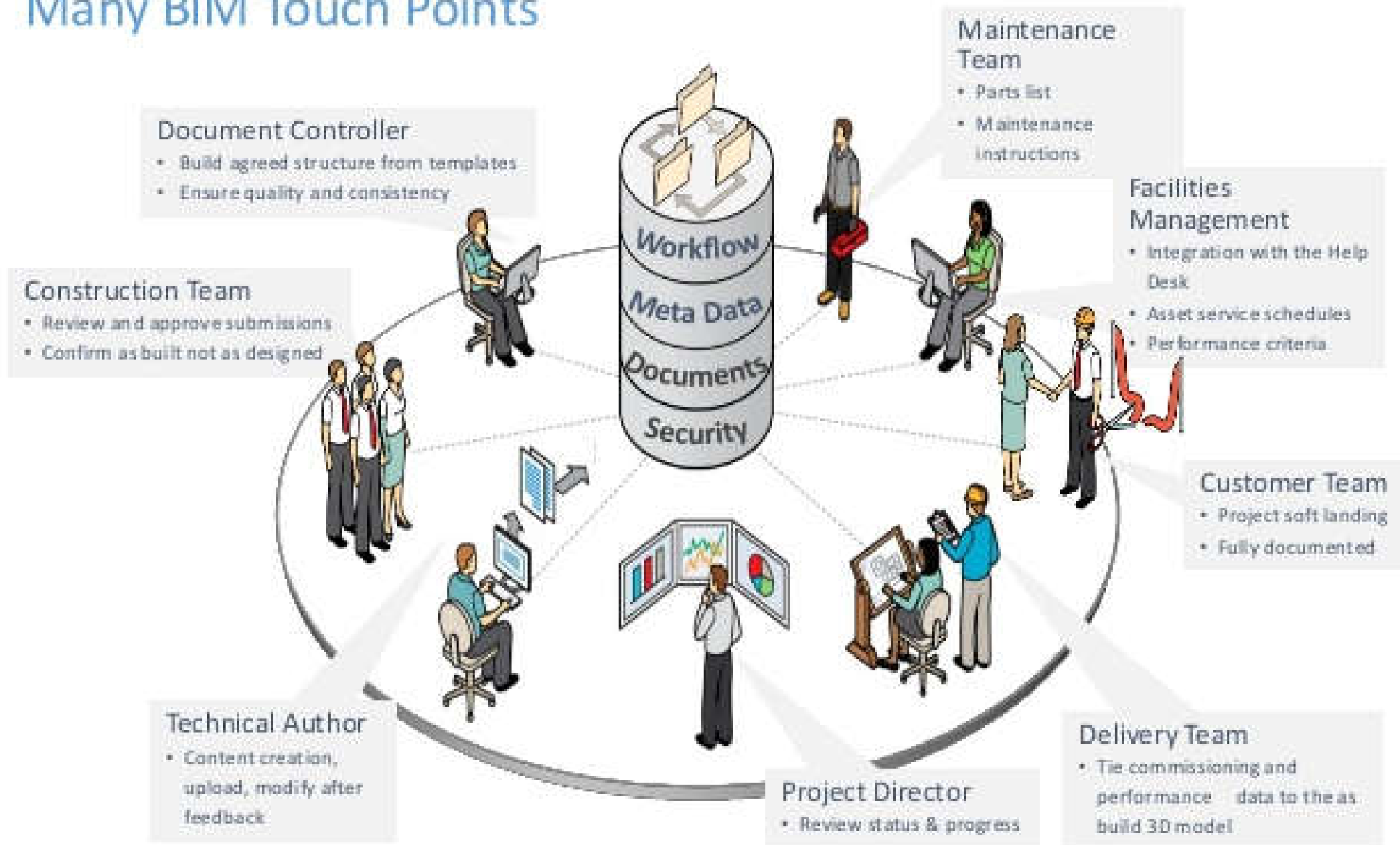

GEO CIVIL ARCH STRUCT MECH PLUMB ELEC FM

BIM - The Sky is the Limit

Video: BIM - The Sky is the Limit (6:12) https://youtu.be/cTX9mQbOjuY

Complex information flow in building and construction

Key Stakeholders
Many BIM Touch Points

Document Controller
- Build agreed structure from templates
- Ensure quality and consistency

Construction Team
- Review and approve submissions
- Confirm as built not as designed

Maintenance Team
- Parts list
- Maintenance instructions

Facilities Management
- Integration with the Help Desk
- Asset service schedules
- Performance criteria

Customer Team
- Project soft landing
- Fully documented

Technical Author
- Content creation, upload, modify after feedback

Project Director
- Review status & progress

Delivery Team
- Tie commissioning and performance data to the as build 3D model

Workflow
Meta Data
Documents
Security

The question is **NOT** about the technology!
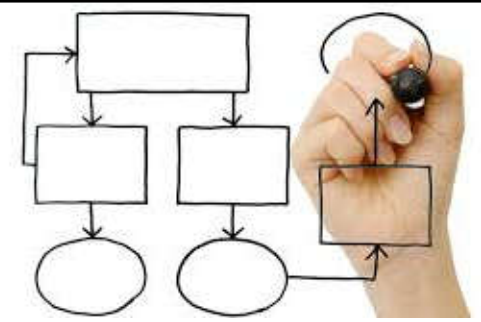
Success BIM =
Organisation (People)
+
Process
+
Technology
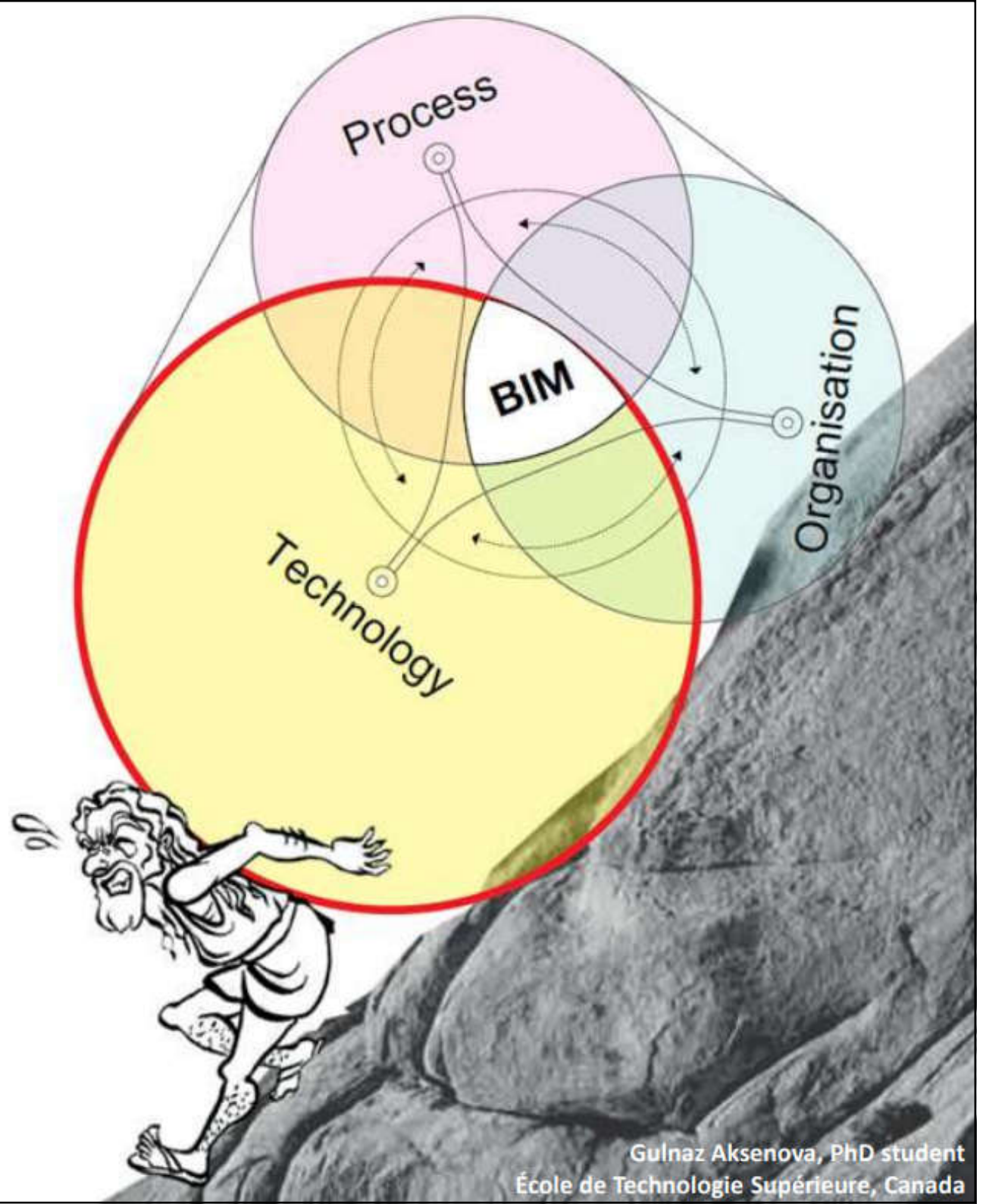
If you want the winning team, do you select the cheapest players or do you select players with the right skills for every position?
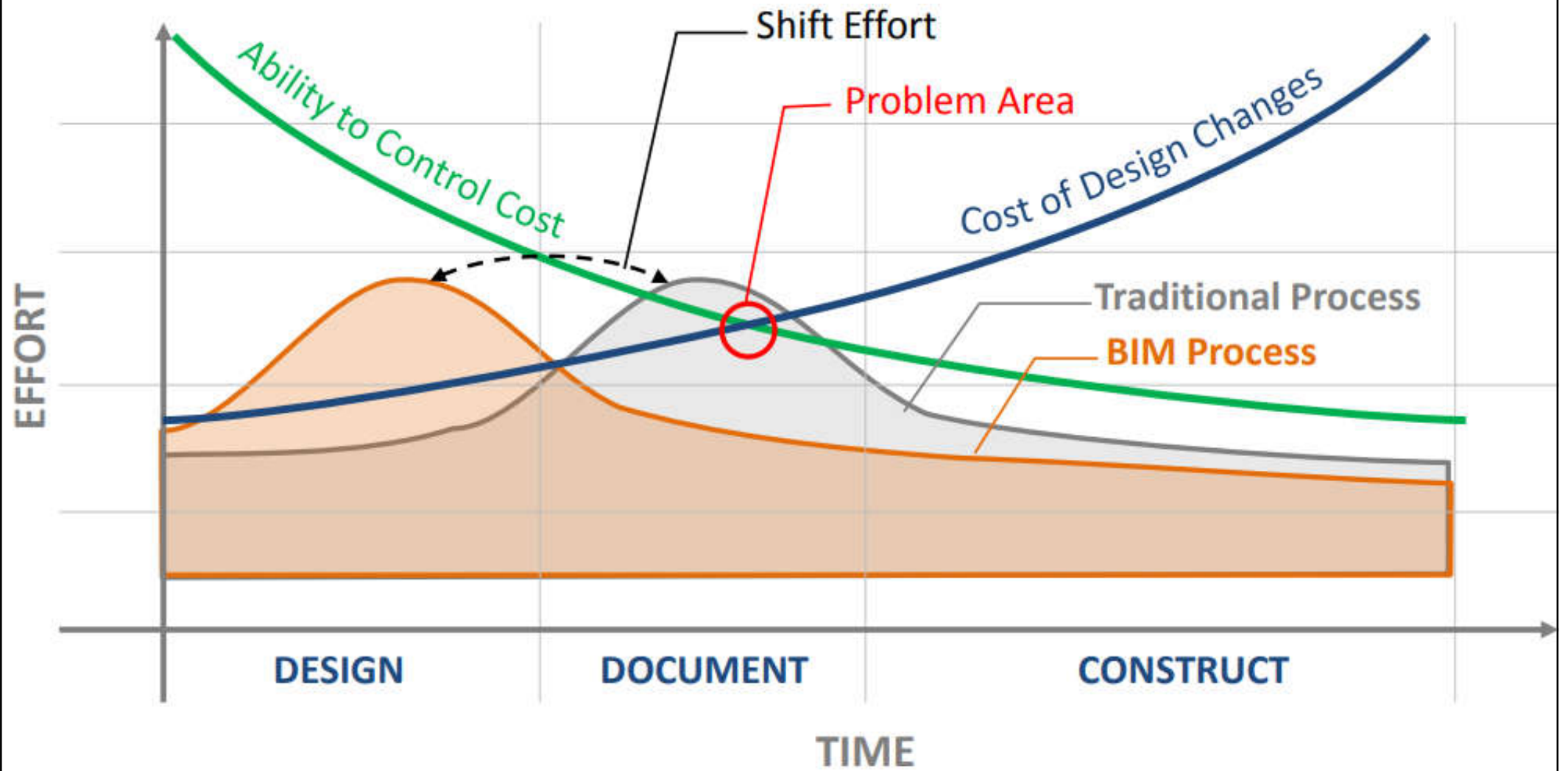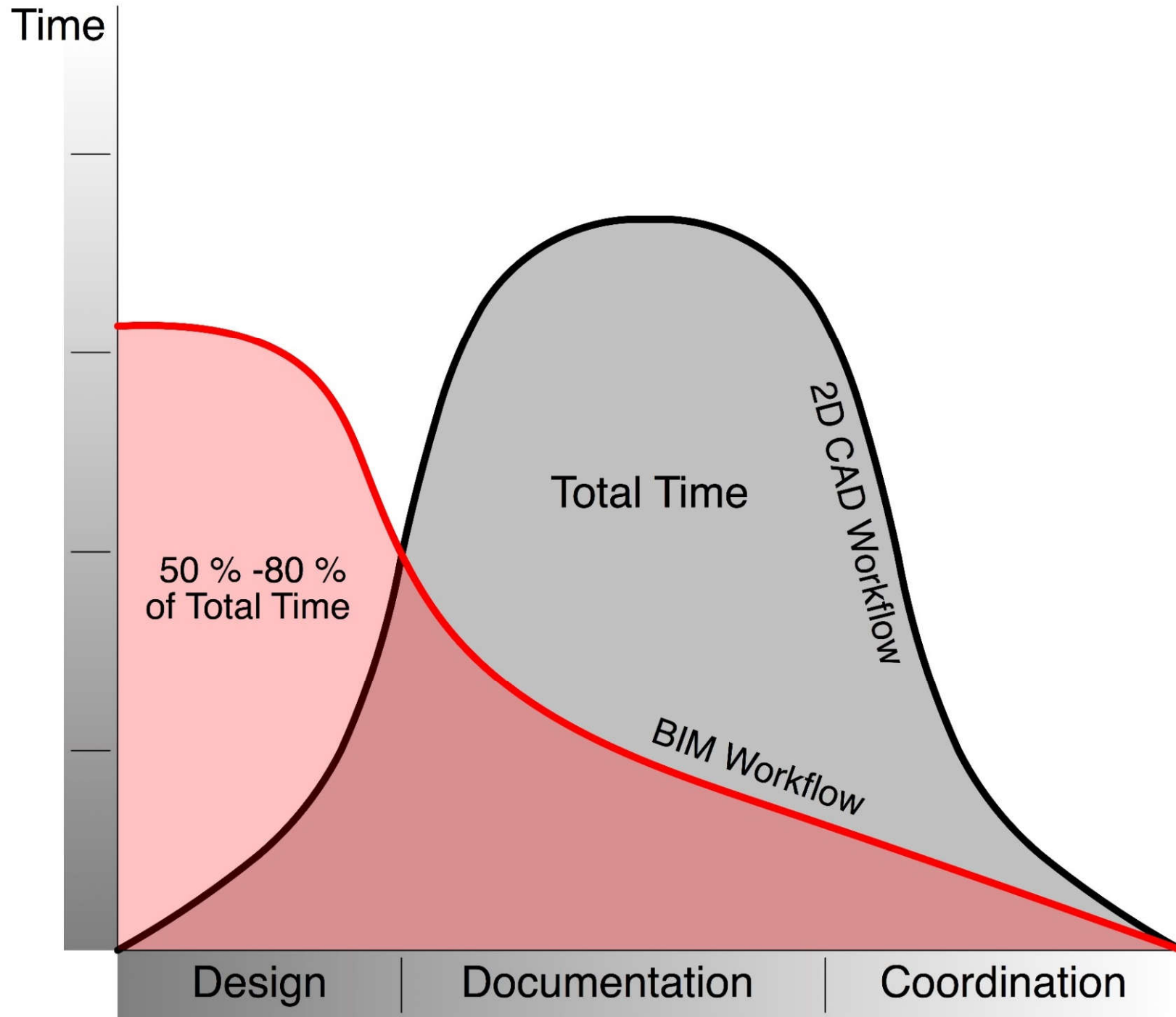
Teamwork

BIM work flow

- BIM is a paradigm shift
  - From 2D linear thinking/geometrical method to 3D visual modelling
  - From drawing to digital information
  - From static to dynamic
  - From isolated parts to contextual relationships
- Change in culture and work flow
  - Work is divided up by major building elements in lieu of by drawing sheets
  - Decisions are made earlier as to materials, specifications and quantities

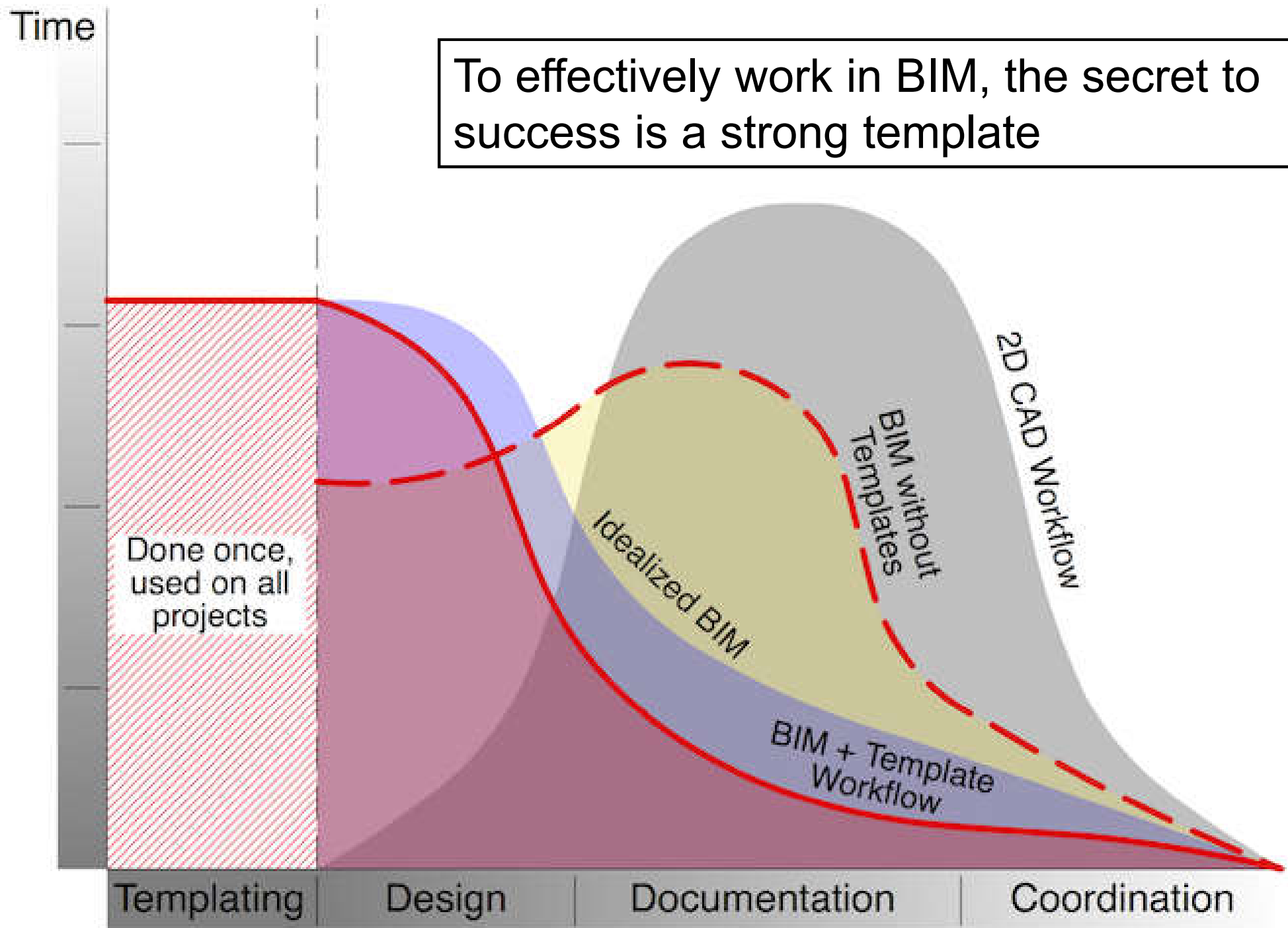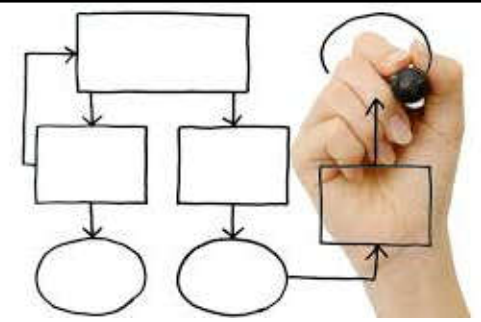# BIM process can shift efforts to reduce problems

(Source: Patrick MacLeamy – HOK)

Workflow of BIM and 2D CAD

Time

50 % -80 %
of Total Time

Total Time

2D CAD Workflow

BIM Workflow

Design | Documentation | Coordination

Actual workflow of BIM with and without templates

To effectively work in BIM, the secret to success is a strong template

Time

Done once, used on all projects

2D CAD Workflow

BIM without Templates

Idealized BIM

BIM + Template Workflow

Templating | Design | Documentation | Coordination

BIM work flow

- Behaviour change towards collaboration
  - <u>Co-ordination</u>
    - Avoid gaps and overlap in team members work
  - <u>Co-operation</u>
    - Obtain mutual benefit by sharing work
  - <u>Collaboration</u>
    - Achieve results which could not be accomplished alone
- Integrated multi-disciplinary collaborative solutions for the construction industry
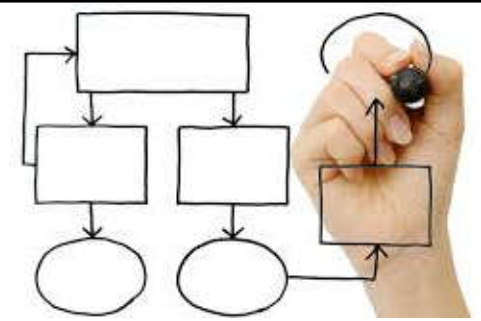
BIM work flow

- Key points
  - Get senior management involved to ensure leadership support
  - Dedicate someone to the effort – BIM Champion
  - Prepare a BIM plan – keep it simple and specific
- Learning curve
  - There is an initial cost and loss of productivity while obtaining the necessary resources as firms go through the initial learning curve (6-18 months)

BIM work flow
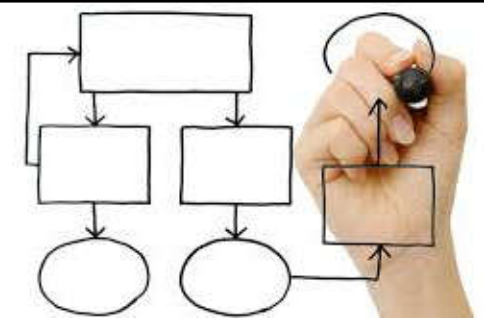
- The Periodic Table of BIM
  - https://www.thenbs.com/periodic-table-of-bim
  - Guide to ensure a successful BIM implementation

■ Strategy		■ Technology	
■ Foundations		■ Standards	
■ Collaboration		■ Enabling Tools	
■ Process		■ Resources	
■ People		■ Digital Plan of Work	

The Periodic Table of BIM

Legend:
- Strategy
- Foundations
- Collaboration
- Process
- People
- Technology
- Standards
- Enabling Tools
- Resources

#	Symbol	Name
1	Bs	BIM Strategy
2	Su	Surveys and Reports
3	Fr	Framework
4	Cu	Culture and behaviour
5	Bt	BIM Toolkit
6	Lod	Level of detail
7	Loi	Level of Information
8	Vi	Videos
9	Co	Common methods
10	Po	Process
11	As	Assesment and need
12	Eir	Employers info requirements
13	Cm	Communication
14	In	Investment
15	Sf	Software
16	Cd	Capital delivery phase
17	Cl	Collaborative business relationships
18	Li	Library objects
19	Cs	Classification
20	An	Analysis tools
21	Ev	Events
22	Pr	Procurement route
23	Fo	Forms of procurement
24	Ex	Execution
25	Bep	BIM execution plan
26	So	Soft skills
27	Ch	Change process
28	Ha	Hardware
29	Op	Operational phase
30	Pt	Protocol
31	Pe	Prequalification questionnaires
32	Cafm	Computer-Aided Facilities Management
33	Ct	Cost tools
34	Fu	Forums and user groups
35	Ca	Capability and capacity
36	Di	Digital tools
37	De	Delivery
38	Midp	Master information delivery plan
39	Cp	Cooperation
40	Sh	Share success
41	Tr	Training
42	Fm	Facilities management
43	Qu	Quality management systems
44	Bsdd	buildingSMART data dictionary
45	Pg	Programme tools
46	Ad	Administration tools
47	Sc	Social media
48	St	Standardisation and Interoperability
49	Ma	Maintenance and use
50	Cde	Common data environment
51	Ci	Champion
52	Av	Availability
53	Fi	File storage
54	Dg	Digital security
55	Ds	Design managment systems
56	Ifc	Industry foundation classes
57	Au	Authoring tools
58	Mo	Model viewers and checkers
59	Bl	Blog posts
60	Dpow	Digital Plan of Work
61	If	Information exchange
62	Sp	Support
63	En	Engage
64	Ir	Infrastructure
65	Br	Briefing
66	Am	Asset management
67	Idm	Information delivery manual
68	Sp	Specification tools
69	Fl	File sharing and collaboration
70	Bo	Books

Digital Plan of Work stages

#	Symbol	Name
71	Sr	Strategy
72	Bi	Brief
73	Df	Definition
74	Dn	Design
75	Bu	Build and commission
76	Hn	Handover and closeout
77	Oe	Operation
78	Ed	End of life

Find support on your BIM journey at **theNBS.com/BIM**

(Source: The Periodic Table of BIM https://www.thenbs.com/periodic-table-of-bim)

BIM work flow

- Step-by-step guide to using BIM on projects
  - https://www.designingbuildings.co.uk/wiki/Step-by-step_guide_to_using_BIM_on_projects
    - To identify the decisions that will need to be made throughout the life of a built asset and the information deliverables required at each stage of the project to support those decisions
    - Information deliverables include model files, documents and structured data files containing information about the facility, floors, spaces, systems and components (*digital replica* of the built asset)

Step-by-step guide to using BIM on projects: following the RIBA plan of work stages

Stage 0: Strategic definition
- 0a: Business justification
- 0b: Strategic brief

Stage 1: Preparation and brief
- 1a: Appraisals
- 1b: Brief and information requirements
- 1c: Supplier appointments

Stage 2: Concept design

Stage 3: Developed design

Stage 4: Technical design

Stage 5: Construction

Stage 6: Handover and close out

Stage 7: In use

* The end of each stage is marked by an employer's decision point at which the employer needs specific information to help them decide whether the project has developed satisfactorily and whether it should continue to the next stage.

Step-by-step instructions showing how to plan a project in compliance with BIM

- Structure the project and the data
- Create the building model
- Assign parameters and attributes; attach additional information
- Export the BIM model and give it to all those involved
- Check the model data and the components
- Revise and adjust the model; external planning partners add their data
- Import the external data into the project
- Compare the models and their components
- Add the changes to the original model
- Export the updated BIM model again and give it to all those involved
- ……

BIM process overview

Design | Procure | Construction | Operation

Concept

Design Model

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

Construction Model

QS Takeoff

Fabrication 3D

Site

Federated Model

Drawings

Schedules

Analysis

Visualise

As Built Model

3D model & data is handed down the line

FM

Concept model → **Design model** → **Construction model** → **As-built model**
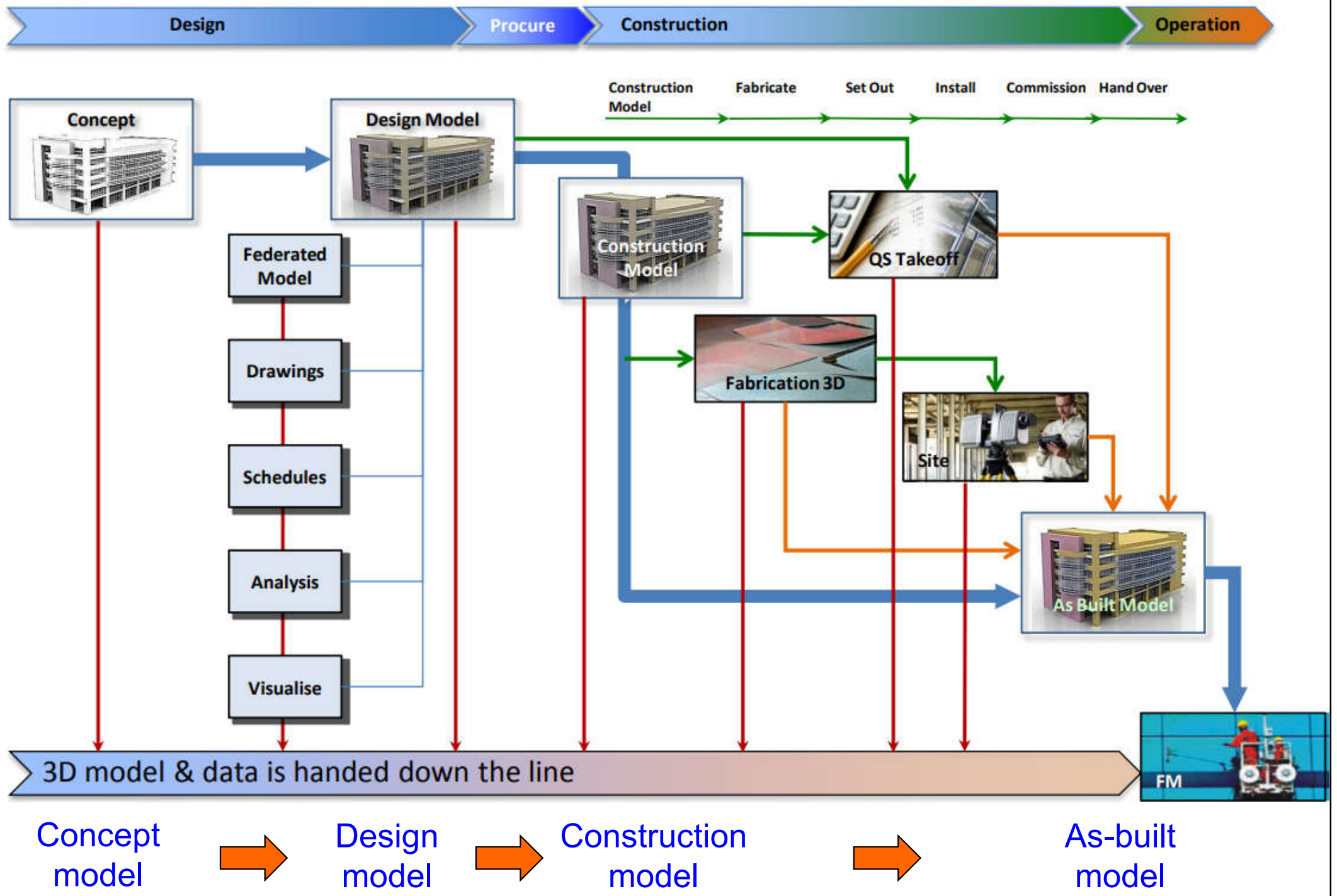
Collaboration in the Office

- Sharing and coordinating the work between the project team members is one of the most important tasks of the project leader and the CAD manager.

-

- Project sharing method should be adequate for the project team size and the office organization.

- Advanced BIM programs provide effective solutions for this problem.

Office Organization: Small Office

Organization:

- Two independent project teams
- Two projects run at the same time
- One project team contains 4-5 people
- Small to medium scale projects
- No full time CAD manager

Problems:

- No dedicated person to establish and maintain office CAD and IT standards
- Lack of professional design and visualization teams

Principal(s)

Project Leader 1
(Part Time CAD Manager)

Project Leader 2

Office Administration

Project Architect 1
Project Architect 2
Draftsman 1
Draftsman 2

Project Architect 1
Project Architect 2
Draftsman 1
Draftsman 2
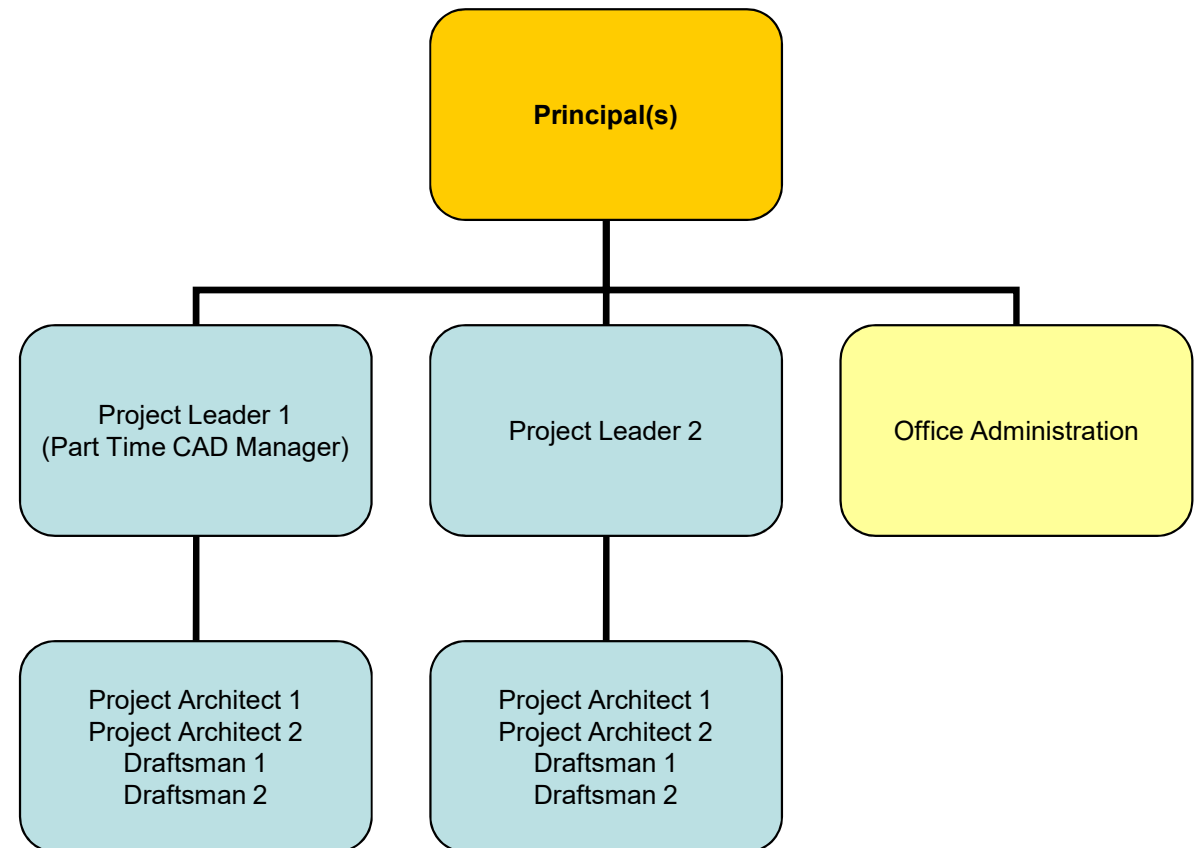
Office Organization: Large Office

Organization:

- 4 project Teams
- Three projects run parallel (one big project)
- Two project teams are working on a big project under the supervision of a project director
- One project team contains 5-10 people
- Full time CAD and IT managers
- Independent design and Visualization Team supports the project architects

Principal(s)

Project Director | Project Leader | Project Leader | Design Team | Visualization Team | IT Manager | CAD Manager | Office Administration

Project Leader — Architects Draftsmen — Architects Draftsmen

Project Leader — Architects Draftsmen

Project Leader — Architects Draftsmen
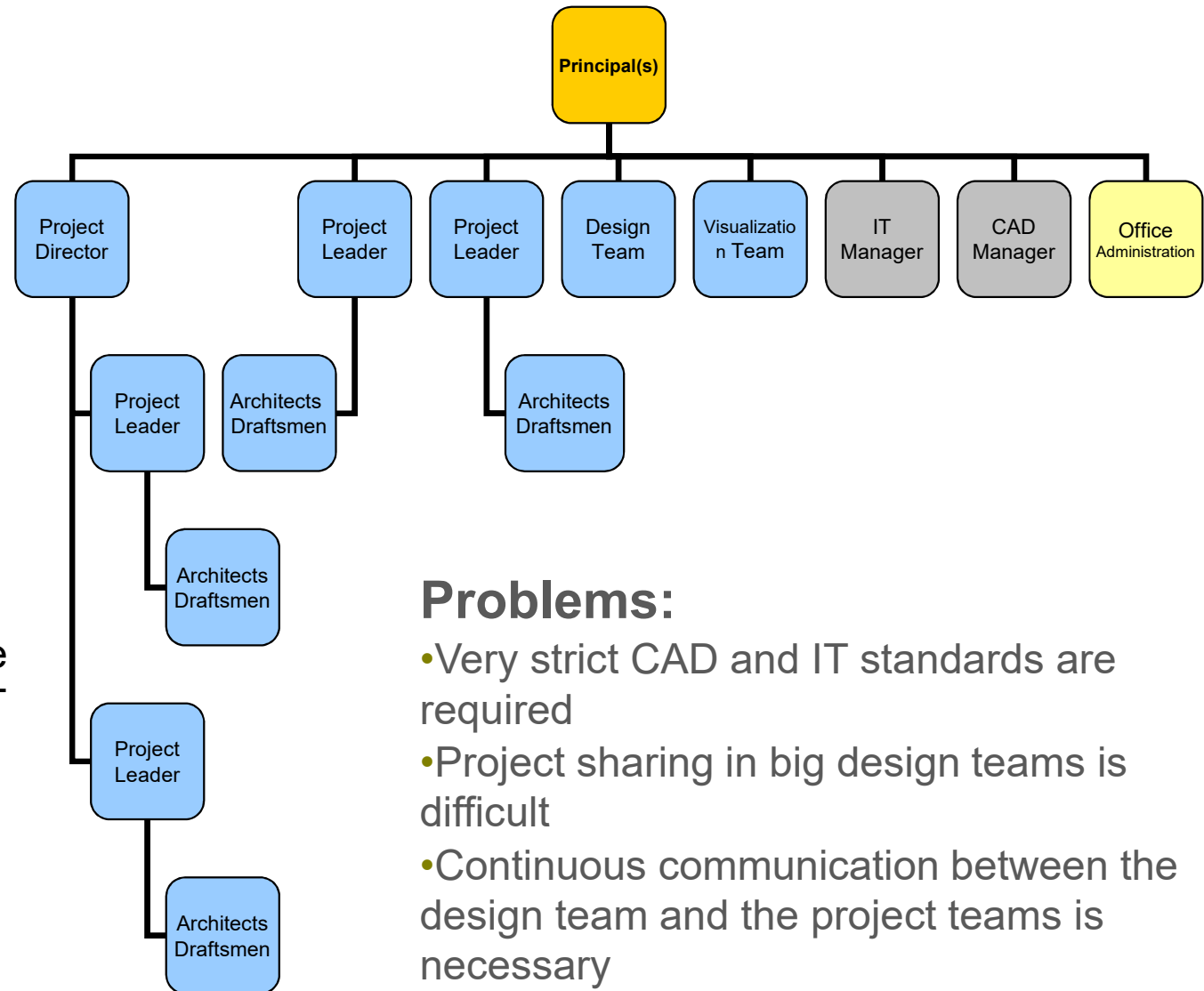
Problems:

- Very strict CAD and IT standards are required
- Project sharing in big design teams is difficult
- Continuous communication between the design team and the project teams is necessary

Centralized BIM support team

QTO

Cost planning

Planning

Safety

PROJECT 1

PROJECT 2

PROJECT 3

BIM
Centralized BIM support team

CENTRALIZED BIM KEY FUNCTIONS

Training
- In house training
- Individual training plans
- Knowledge sharing

Resources
- BIM content libraries
- BIM Templates

Guidelines
- Implementation guidelines
- Corporate standards
- Audit checklists
- BIM modelling guides

Support
- Technical support
- Handholding
- Set-up

Research and Innovation
- Technological solutions

(Source: Singapore VDC Guide https://www.corenet.gov.sg/media/2094675/singapore-vdc-guide_version1_oct2017.pdf)

An example of organization structure of a BIM company/department

The BIM Manager

Project Developer

BIM Manager

PM/CM

Designer | Consultant | Contractor

Designer | other Specialist
CM/PM | Cost Estimator
Developer | BIM | Con-structor
Owner | coordination | Facility Manager
BIM Manager

PROJECT LIFECYCLE

BIM Manager

People | Technology

BIM

Process | Policy

Collaboration and communication
Knowledge and experience
Roles and responsibilities
Trust and commitment
Culture

Data security and user management
Certified hardware and software
Data formats and structure
Data versioning
Internet

Cost estimation
Quantity take-off
Change management
Operation & maintenance
Design creation and coordination
Scheduling and Progress Monitoring

Building standards
Risks and insurance
Ownership of deliverables
Project guidelines and contracts

Typical tasks of a BIM Manager

- Receive and manage multiple subcontractor models
- Coordinate all BIM Logistics (contracts, emails, file sharing, etc.)
- Create, maintain and analyze federated model mainly for coordination purposes
- Review and document design and coordination conflicts
- Run and analyze clash detection on federated model
- Prepare and distribute clash reports to facilitate the coordination process
- Schedule and facilitate coordination meetings along with project manager and/or superintendent
- Write meeting minutes
- Site inspection and liaising with trade contractors
- Meet with designers/owners as required to facilitate review of models as needed
- Compile contract BIM close out documentation

BIM role classification
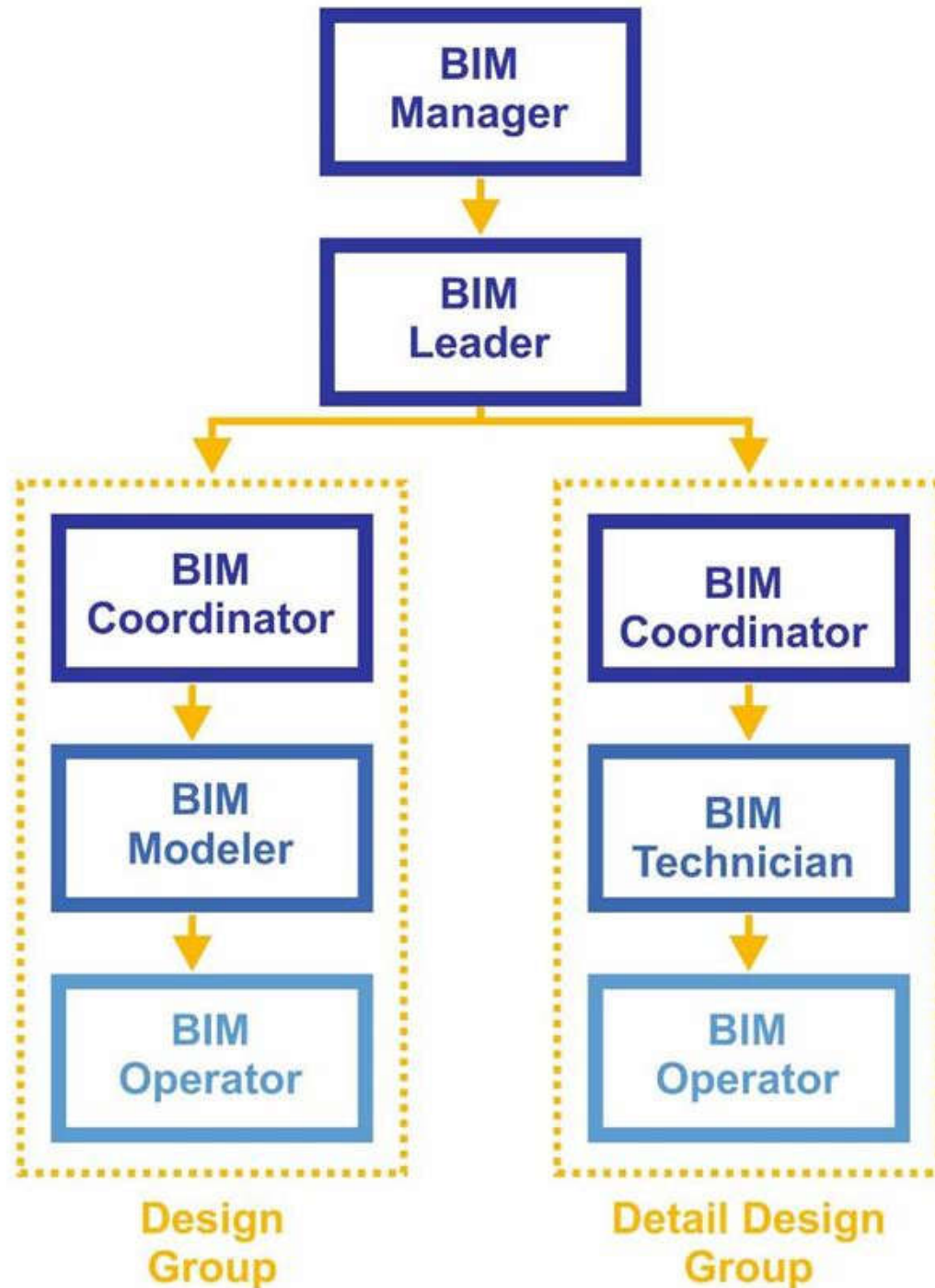
4 key areas of BIM management:
- Model & drawing management
- Information management
- Design & construction management
- Stakeholder management

Office organization

- Effective BIM management
  - It's everyone's responsibility
- 6 types of BIM Manager:
  - Project BIM Managers
  - BIM Coordinators
  - Information Manager
  - Technical BIM Manager
  - Construction BIM Manager
  - Internal BIM Managers (within an organization)
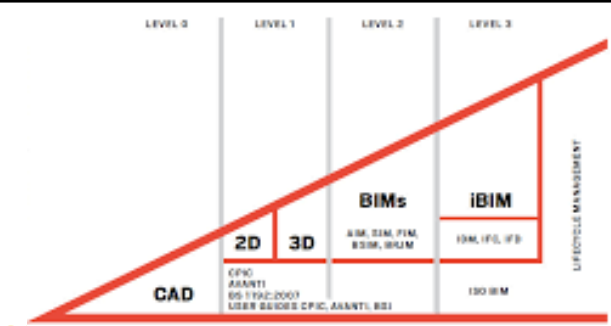
BIM management structure
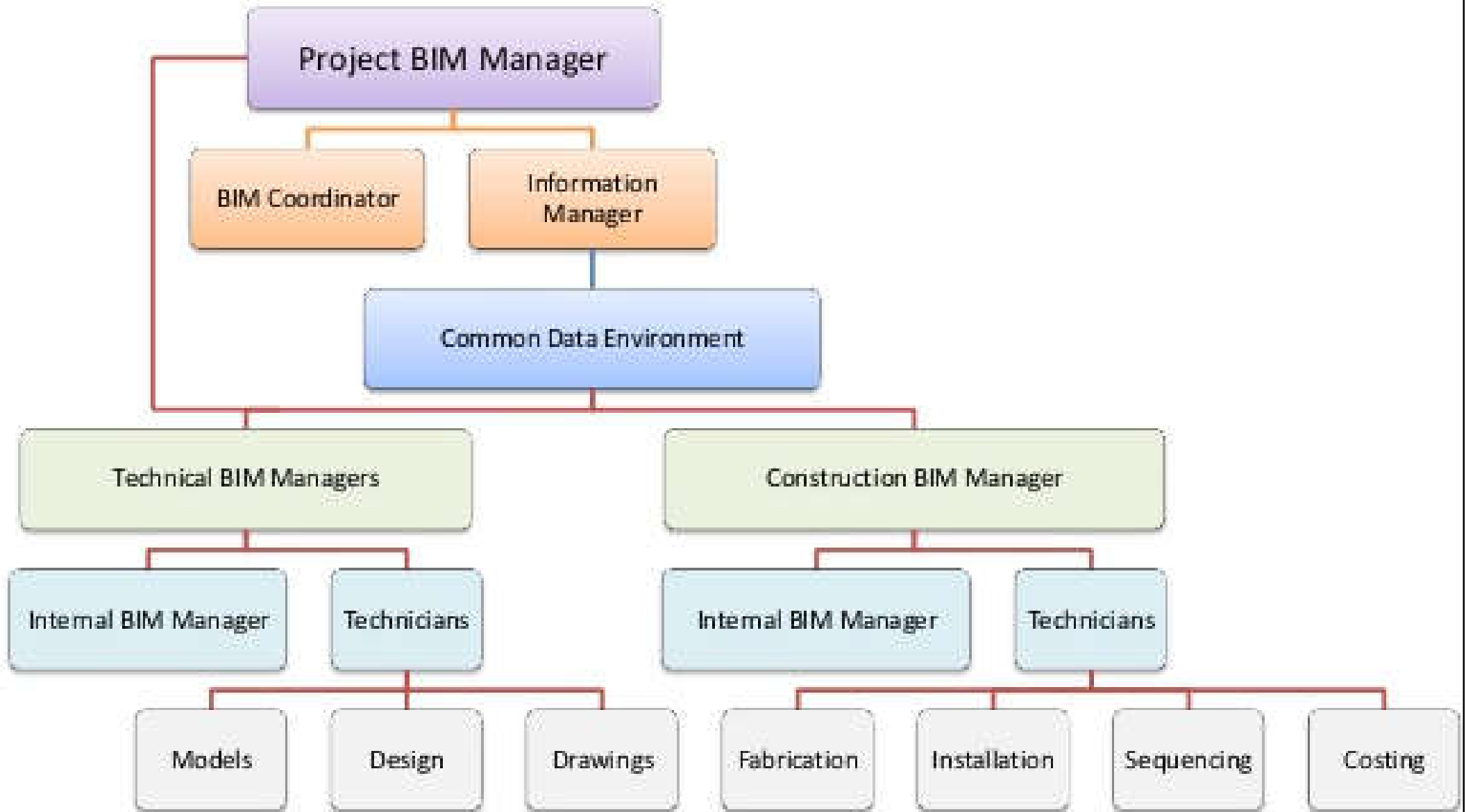
BIM maturity levels
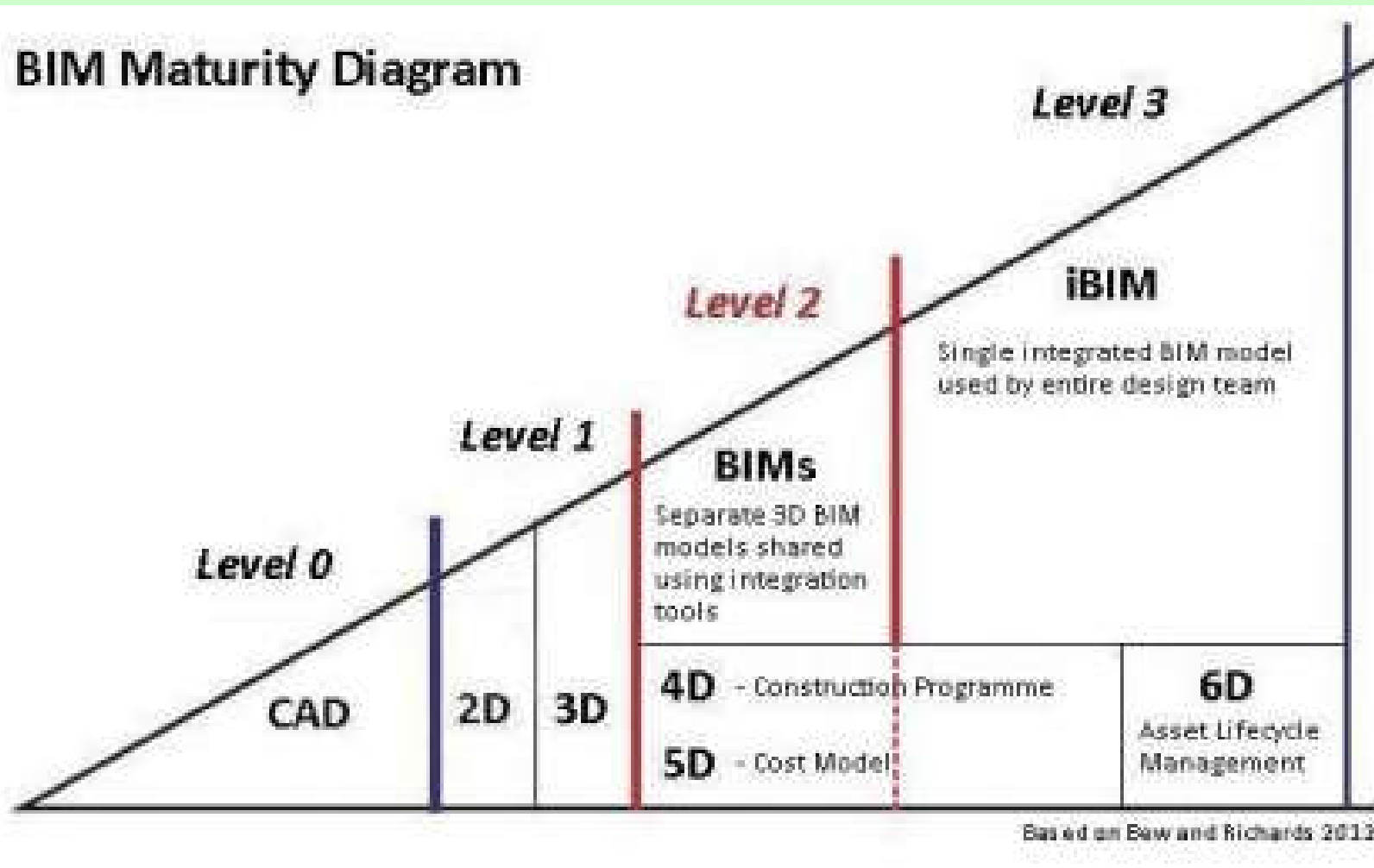
BIM maturity levels

- The range of BIM maturity levels:
  - [Level 0](): Unmanaged CAD (Computer Aided Design)
  - [Level 1](): Managed CAD in 2D or 3D
  - [Level 2](): Managed 3D environment with data attached, but created in separate discipline models
  - [Level 3](): Single, online, project model with construction sequencing, cost and life-cycle management information

BIM maturity levels
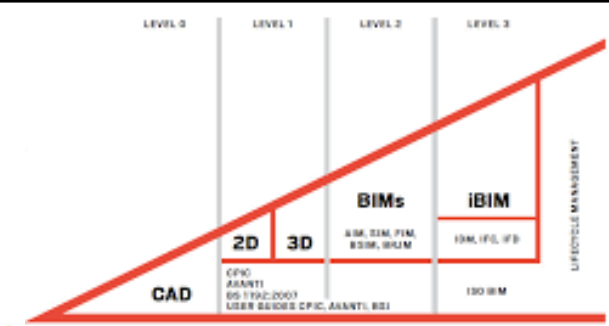
- BIM Levels explained
    - [Level 0](#):
        - No collaboration; 2D CAD drafting only
        - Output and distribution is via paper or electronic prints, or a mixture of both
    - [Level 1](#):
        - A mixture of 3D CAD for concept work, and 2D for drafting of statutory approval documentation and production information
        - Models are not shared between project team members

BIM maturity levels
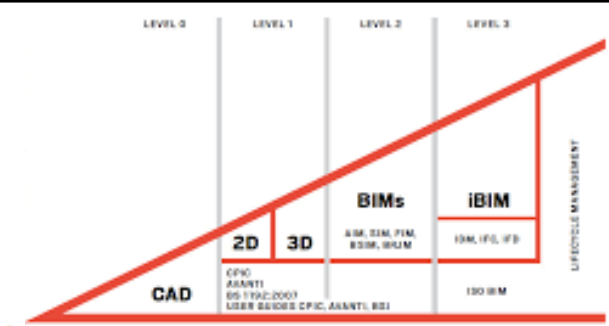
- BIM Levels explained (cont'd)
    - Level 2:
        - Collaborative working – all parties use their own 3D CAD models, but not necessarily working on a single, shared model
        - Design information is shared and exchanged through a common file format
    - Level 3: **OPEN BIM™**
        - Full collaboration between all disciplines by means of using a single, shared project model which is held in a centralized repository (also known as "Open BIM")

BIM maturity levels
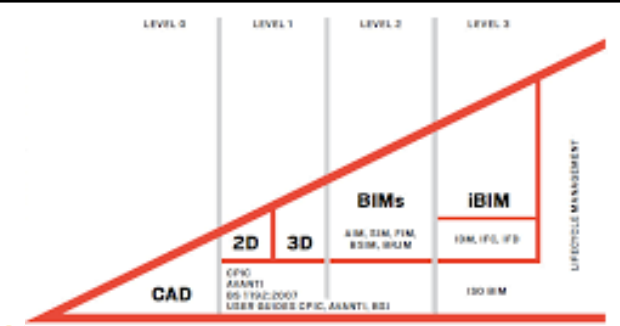
- Video: Wienerberger - What is BIM? (5:23)
  - https://youtu.be/ZYvQk78WlTc
  - An brief introduction to BIM and Geo-BIM, through a short animation. The video highlights what BIM Level 2 and Level 3 entail and how these are directly influencing construction in the UK.
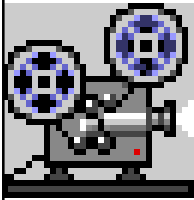
BIM maturity levels
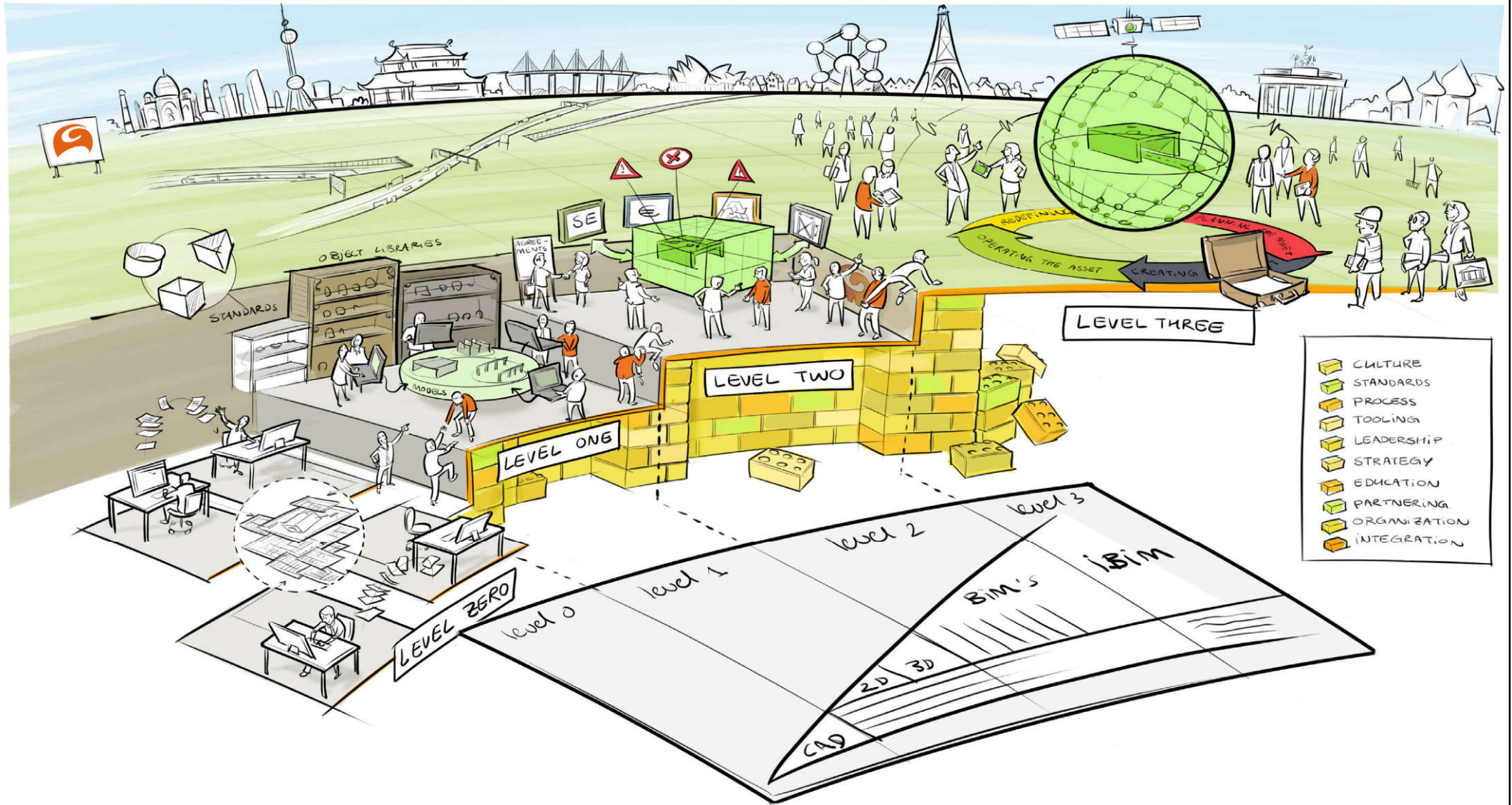
BIM maturity levels and development path in UK
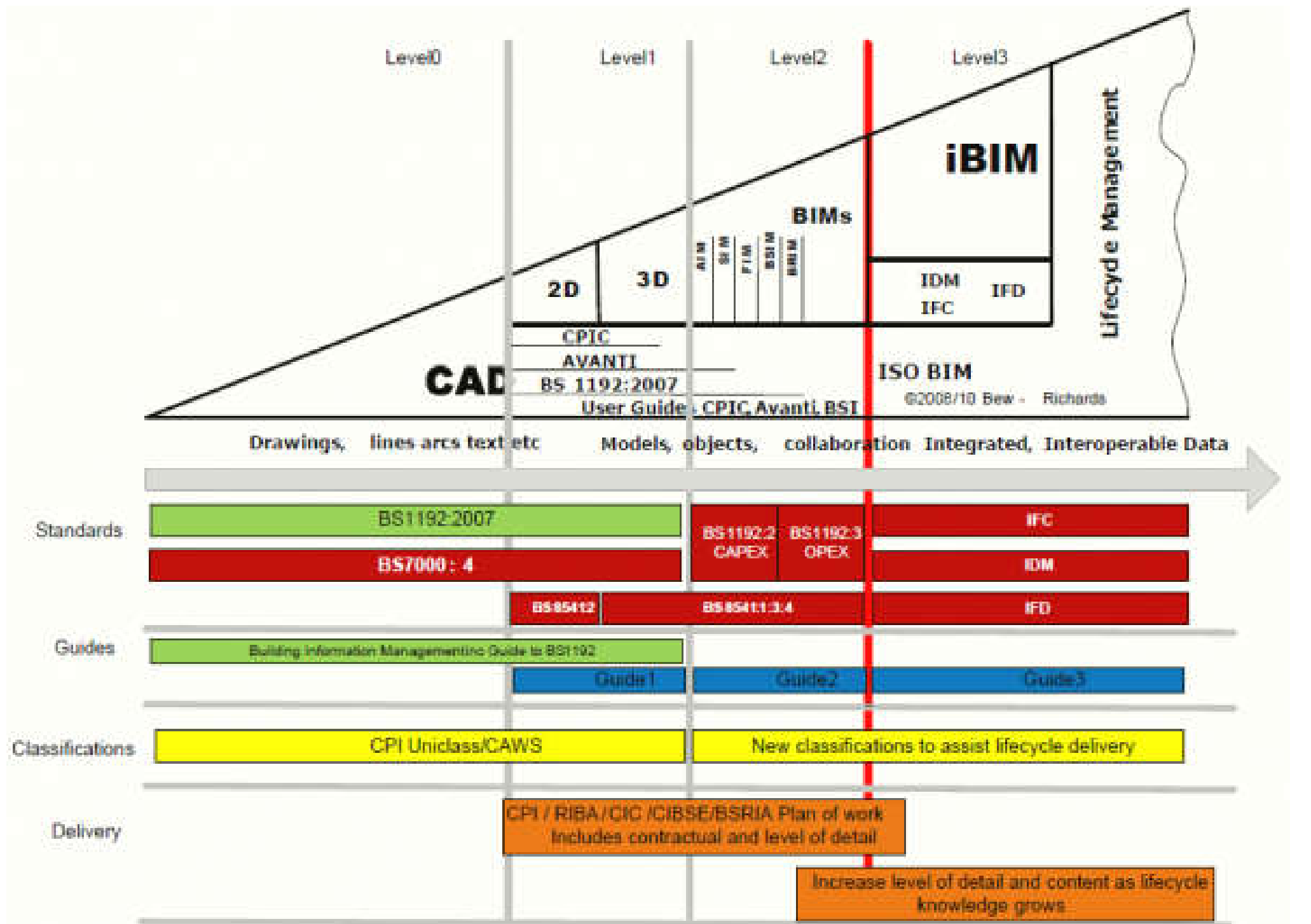
BIM maturity levels
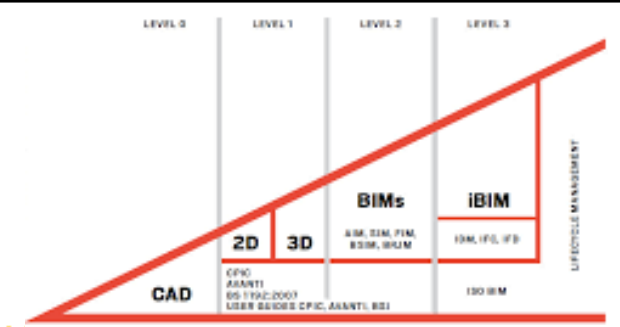
- Maturity of organisations regarding BIM:
  - <u>Company level</u>: object-based modelling
  - <u>Project level</u>: information exchange processes based on models (for collaboration)
  - <u>Sectorial level</u>: a global view, linked to public (procurement) policies, e.g. mandatory BIM
- Integrated Project Delivery (IPD): the long-term goal of BIM implementation

Integrated Project Delivery

*"Integrated Project Delivery (IPD) is a project delivery approach that **integrates people, systems, business structures and practices** into a process that collaboratively harnesses the talents and insights of all participants to **reduce waste** and **optimize efficiency** through all phases of design, fabrication and construction."*

AIA
CALIFORNIA COUNCIL
The American Institute of Architects

Traditional		IPD
Segmented	**Teams**	Integrated, collaborative
Linear, distinct, segregated	**Process**	Concurrent, multi-level, integrated
Individually managed	**Risk**	Collectively managed
Individual success, minimum effort for maximum return	**Reward**	Value-based, team success
Paper based, 2D, analog	**Technology**	Digitally based, BIM, 4D
Minimize or transfer risk, don't share	**Agreements**	Open sharing, collaboration, full integration
Individually focused	**Education**	Team-based , integrated, collaborative

BIM maturity levels

- Integrated Project Delivery (IPD) 集成項目交付
  - Involve all team members in design meetings
  - Identify key objectives up front
  - Open collaboration at all stages of a project
  - BIM is utilized
  - Minimize paper based processes and collaborate digitally
  - Check for & manage interferences with 3D clash detection
  - Set up contract mechanisms that enable and reward achievement of key objectives
  - Create a culture of trust and information sharing (win-win-win)

Level of development (LOD)
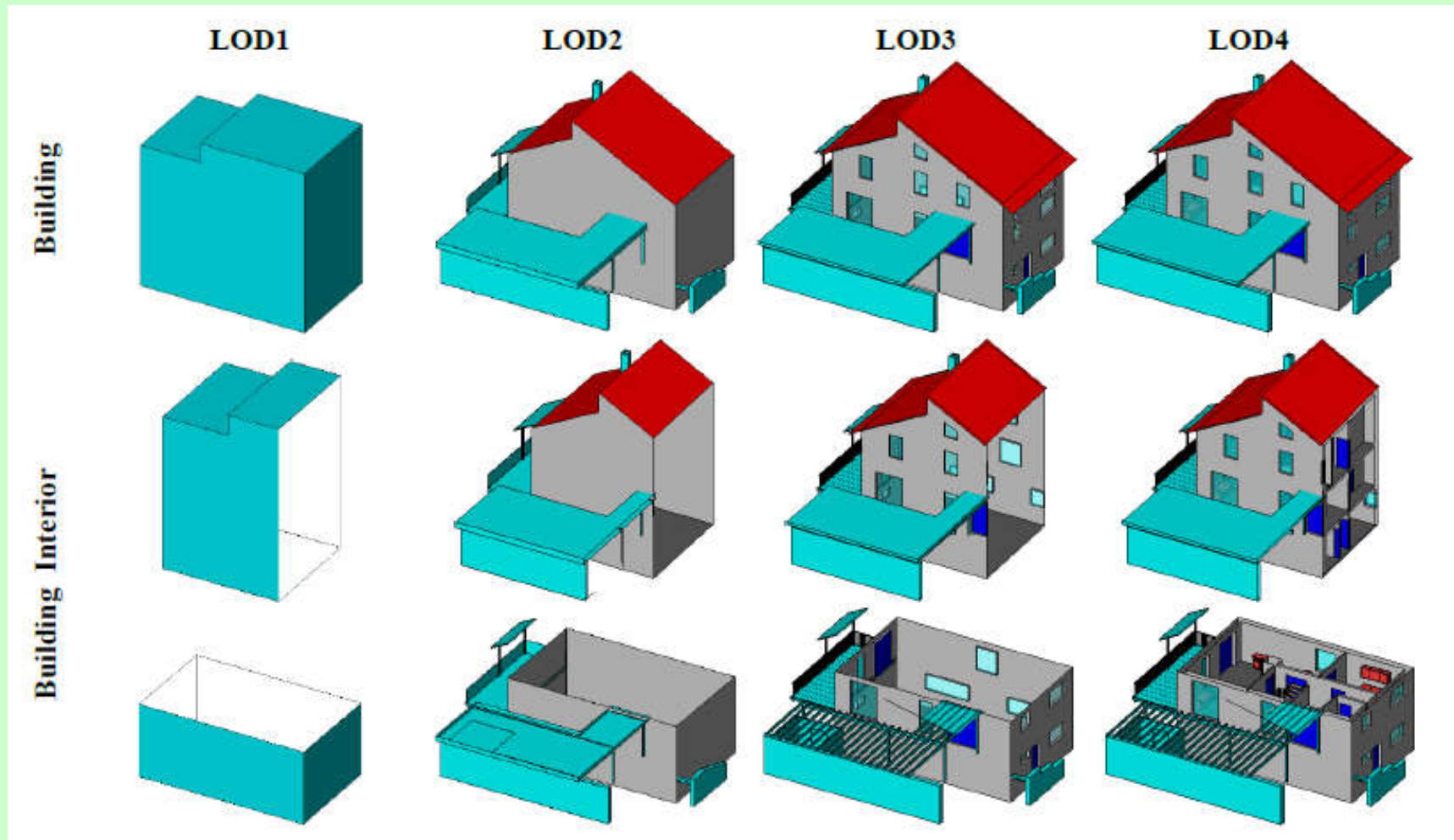
Level of development (LOD)
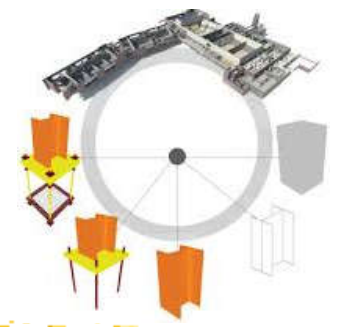
- LOD is commonly used to represent the level of precision of model content

  - This is the degree to which an element's geometry and its attached information have been thought through – the degree to which project team members may rely on the information when using the model

  - The expected LOD by element/category/building system at each stage of the project has to be determined and documented

Level of development (LOD)
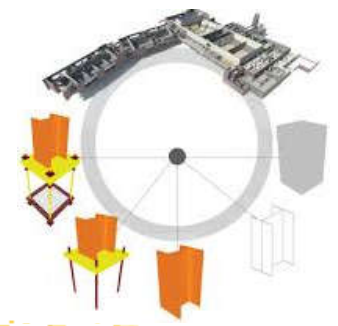
- Level of Development (LOD) specifications:
    - LOD 100: Conceptual design
    - LOD 200: Design Development
    - LOD 300: General Construction documents
    - LOD 350: The compromise
    - LOD 400: Fabrication information
    - LOD 500: As-built model

(Source: LOD | BIMForum http://bimforum.org/lod/)

LOD

400

350

300

200

100
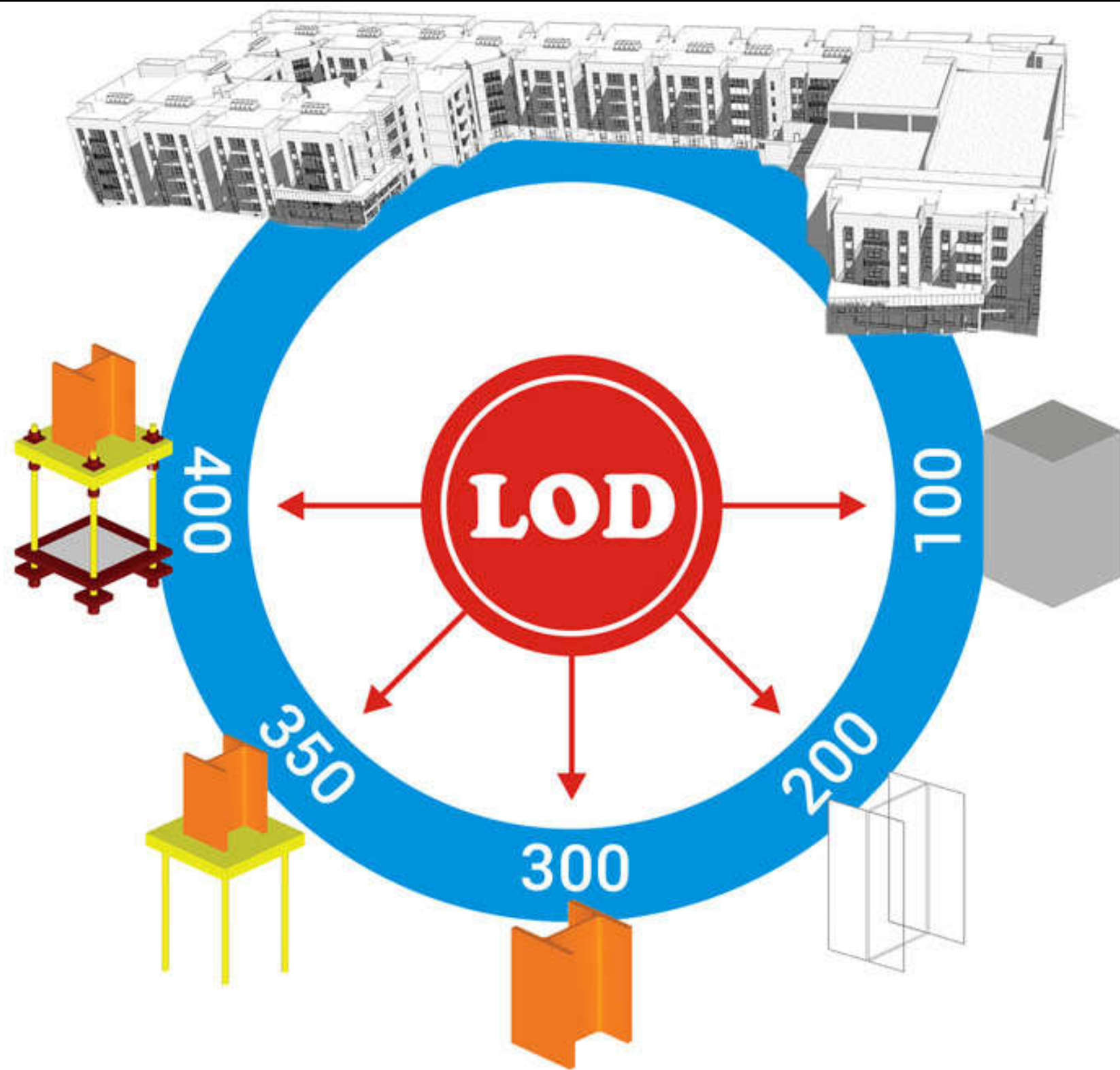
Level of development (LOD)
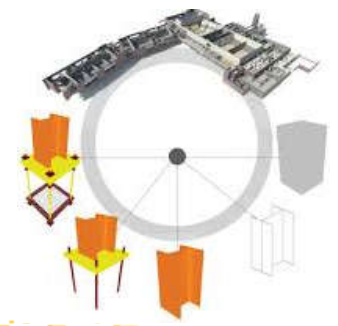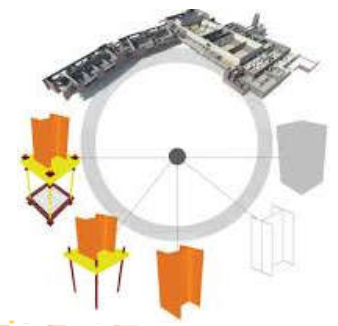
- LOD 100 elements:
  - Are not geometric presentations (may be symbols or other generic representations)
  - Any information derived from them must be considered approximate

- LOD 200 elements:
  - Are represented graphically but are generic placeholders, e.g., volume, quantity, location, or orientation (they must be considered approximate)

Level of development (LOD)

- <u>LOD 300 elements</u>:
  - Are graphically represented as specific systems, objects, or assemblies from which quantity, shape, size, location, and orientation can be measured directly, without having to refer to non-modeled information such as notes or dimension call-outs

- <u>LOD 350 elements</u>:
  - Are enhanced beyond LOD 300 by the addition of information regarding interfaces with other building systems

Level of development (LOD)
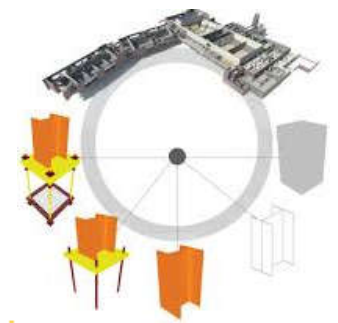
- LOD 400 elements:
  - Are modeled at sufficient detail and accuracy for fabrication of the represented component

- LOD 500 element:*
  - It is a field verified representation in terms of size, shape, location, quantity, and orientation
  - Non-graphic information may also be attached
  - * The Specification does not define or illustrate it

A piping project at various LOD levels

LOD 200
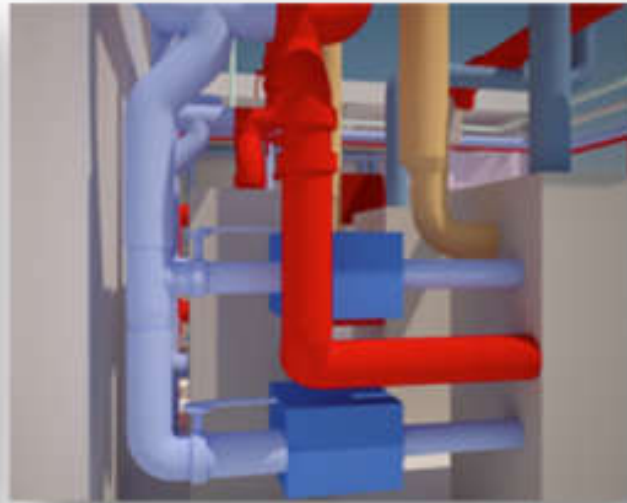
LOD 300

LOD 350

LOD 400

LOD 500

(Source: LOD – Development or Detail & Why it Matters http://lanmarservices.com/2014/05/14/lod-in-scan-to-bim/)
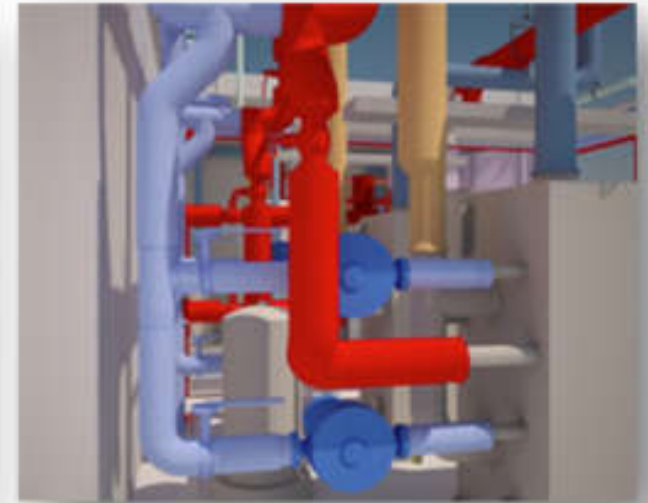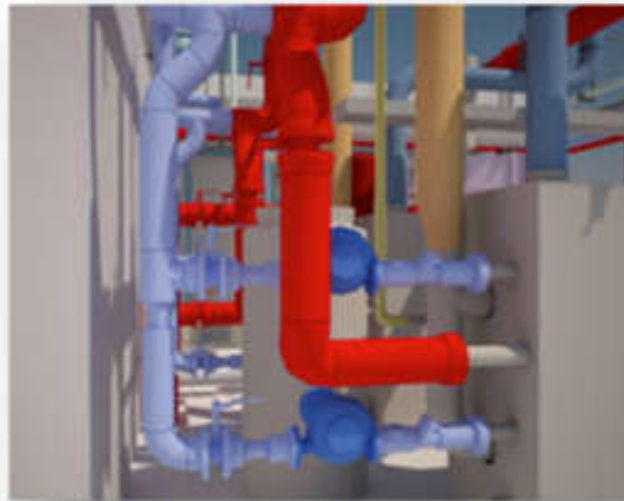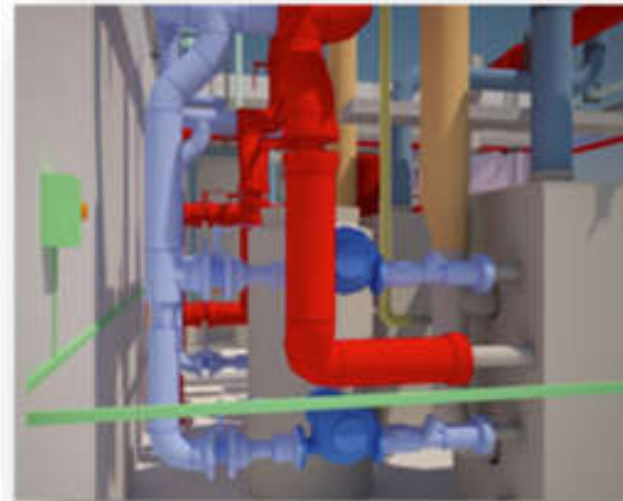
Level of Development (LOD): examples

LOD 100	LOD 200	LOD 300	LOD 400	LOD 500
	Remicon Glass	Ready-Mixed on Steel Glass Paint Insulation Concrete Product	Ready-Mixed on Rebar Glass Paint Insulation Concrete Product Steel	Ready-Mixed on Rebar Glass Paint Insulation Concrete Product Steel
0%	52%	95%	100%	100%
N/A	Simplicity Assetment	Detailed Assetment	Detailed Assetment	Detailed Assetment

Conceptualization → Criteria Design → Detailed Design → Implementation Documents → Construction

(*BIM Level of Development(LOD) 100, 200, 300, 400 & 500 http://www.srinsofttech.com/bim-level-of-development-lod-300-400-500.html)
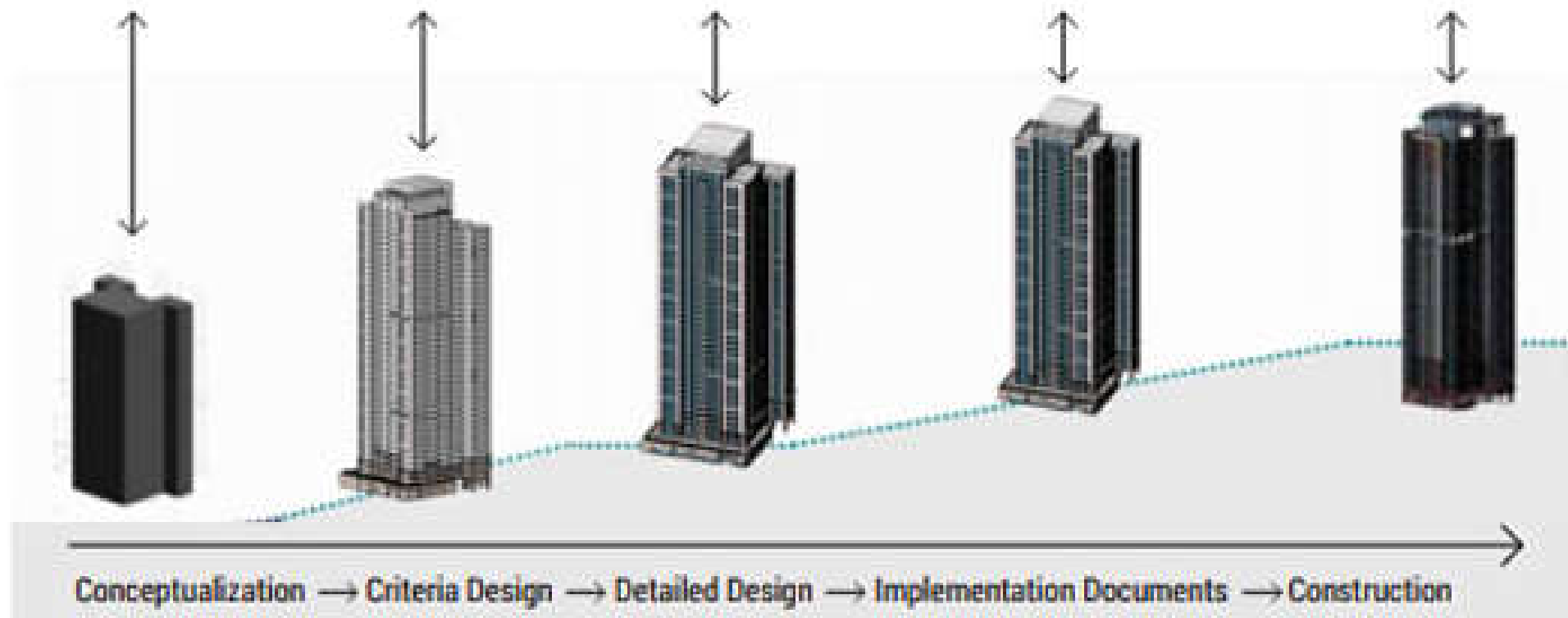
LEVEL of DEVELOPMENT

LOD 100	LOD 200	LOD 300	LOD 400	LOD 500
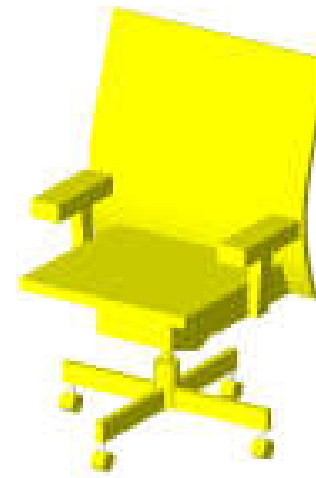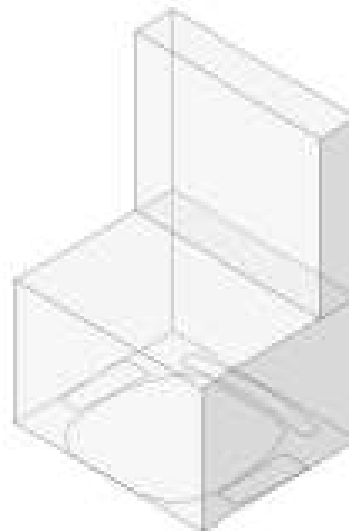
Concept (Presentation)	Design Development	Documentation	Construction	Facilities Management
DESCRIPTION: **Office Chair** Arms, Wheels WIDTH: DEPTH: HEIGHT: MANUFACTURER: Herman Miller, Inc. MODEL: Mirra LOD: **100**	DESCRIPTION: **Office Chair** Arms, Wheels WIDTH: **700** DEPTH: **450** HEIGHT: **1100** MANUFACTURER: Herman Miller, Inc. MODEL: Mirra LOD: **200**	DESCRIPTION: **Office Chair** **Arms, Wheels** WIDTH: **700** DEPTH: **450** HEIGHT: **1100** MANUFACTURER: Herman Miller, Inc. MODEL: Mirra LOD: **300**	DESCRIPTION: **Office Chair** **Arms, Wheels** WIDTH: **685** DEPTH: **430** HEIGHT: **1085** MANUFACTURER: **Herman Miller, Inc** MODEL: **Mirra** LOD: **400**	DESCRIPTION: **Office Chair** **Arms, Wheels** WIDTH: **685** DEPTH: **430** HEIGHT: **1085** MANUFACTURER: **Herman Miller, Inc** MODEL: **Mirra** PURCHASE DATE: **01/02/2013**

(Only data in red is useable)

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Level of development (LOD)
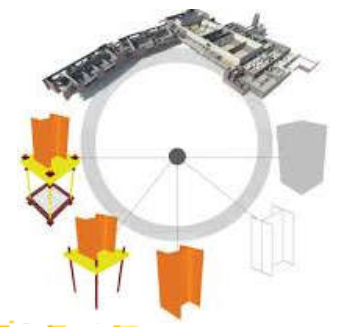
- Level of Development vs. Level of Detail
  - Level of Detail (LoD) is essentially how much detail is included in the model element
  - Level of Development (LOD) is the degree to which the element's geometry and attached information has been thought through
    - Level of Detail can be thought of as input to the element, while Level of Development is reliable output
  - Levels of (model) information (LOI), which relates to the non-graphical content of models

(Source: LOD | BIMForum http://bimforum.org/lod/)

Level of Development (LOD) vs. Level of Detail (LoD)
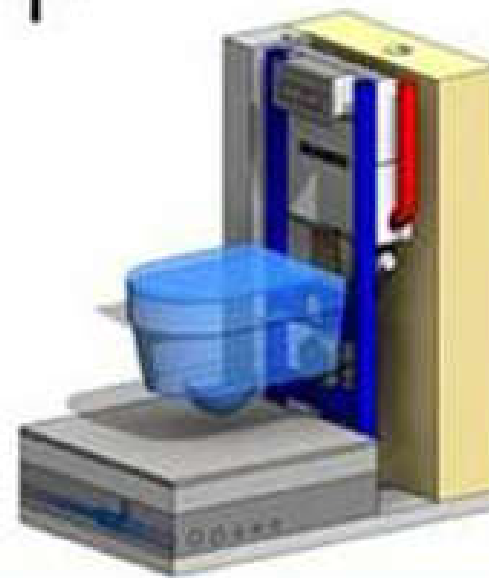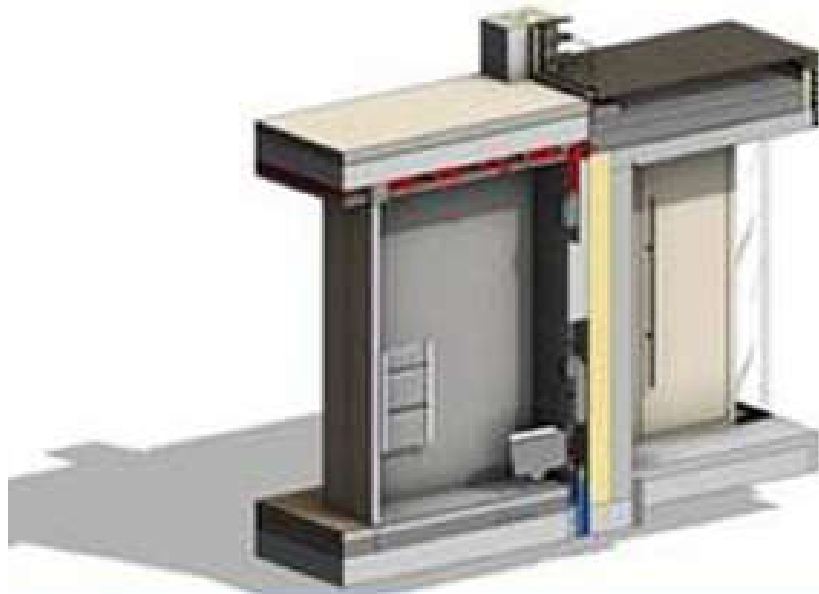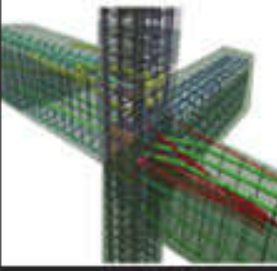
Level of Development (LOD) and building development process
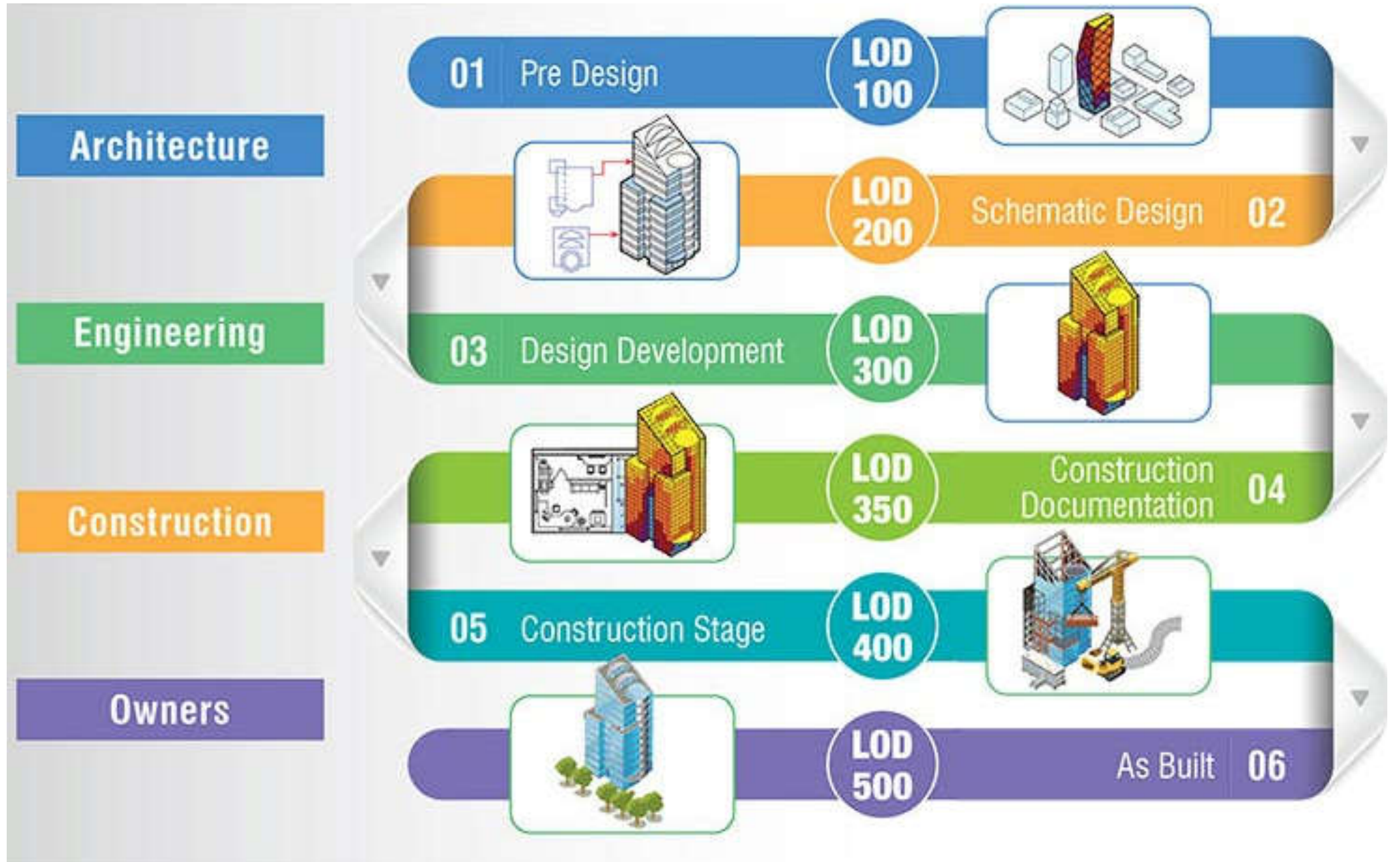
Level of development (LOD)

- LOD in the design and construction process:
  - 1. Element-oriented modelling
    - As-Built (LOD 500)
    - Fabrication and assembly (LOD 400)
  - 2. System/Component oriented modelling
    - Detailed design (LOD 300)
    - Basic design (LOD 200)
  - 3. Conceptual information model
    - Conceptual design (LOD 100)
    - Client requirements (Pre-modelling)

Element-Oriented Modeling	As-Built	LOD 500		Operation Budget Occupancy Capacity Location LEED Class
	Fabrication and Asembly	LOD 400		Shape Areas Volumes Number of Levels Structural System Mechanical Systems Electrical Systems
System \ Component Oriented Modeling	Detailed Design	LOD 300		Component 1 Basement Space: Geometry G1 G2 — ; Position P1 P2 — ; Specification S1 S2 — Component Attributes
	Basic Design	LOD 200		Comp. 1.1 Basement Wall: Geo. G1 —; Pos. P1 —; Spc. S1 — Comp. 1.2 Basement Floor Slab: Geo. G1 —; Pos. P1 —; Spc. S1 — Inter-model Dependency
Conceptual Information Model	Conceptual Design	LOD 100		C. 1.1.1 Wall Formwork: G. —; P. —; S. — C. 1.1.2 Wall Rein. Bar: G. —; P. —; S. —
	Client Requirements	Pre-Modeling		Intra-modal Dependency C. 1.2.2 Floor Slab Reinf. Bar: G. —; P. —; S. — C. 1.2.1 Floor Slab Formwork: G. —; P. —; S. —

(*BIM Level of Development(LOD) 100, 200, 300, 400 & 500 http://www.srinsofttech.com/bim-level-of-development-lod-300-400-500.html)

Further reading

- Step-by-step guide to using BIM on projects
  - https://www.designingbuildings.co.uk/wiki/Step-by-step_guide_to_using_BIM_on_projects

- The Periodic Table of BIM
  - https://www.thenbs.com/periodic-table-of-bim

- Level of Development - LOD - as a Lifecycle BIM tool
  - http://blog.areo.io/level-of-development/

- Project Phases & Level of Development
  - https://sustainabilityworkshop.autodesk.com/buildings/project-phases-level-development