HKIE Electrical Division & Building Services Division Technical Talk
23 May 2019 (Thu), Room FJ301, PolyU

The Good, The Bad and The Future of BIM

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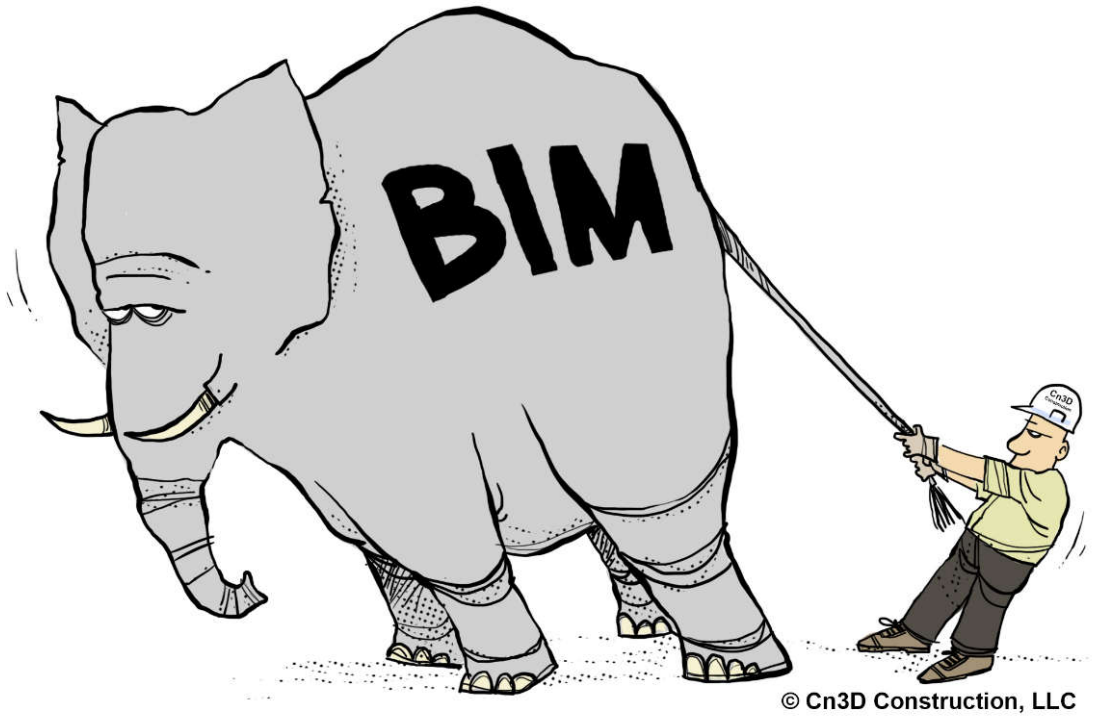
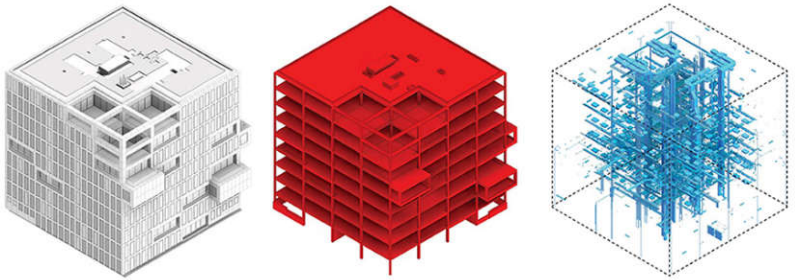


Introduction

- Recent BIM development in Hong Kong
  - Promoting BIM in government departments
    - e.g. Housing Authority, ArchSD, DSD, EMSD
  - Mandatory adoption for capital works projects (2018) & growing interests in private sector
  - BIM initiatives by Construction Industry Council
    - e.g. roadmap for BIM, promotion & training, BIM Year 2019, Certification of BIM Manager/Professionals, BIM competitions
  - Development of BIM standards & guidelines

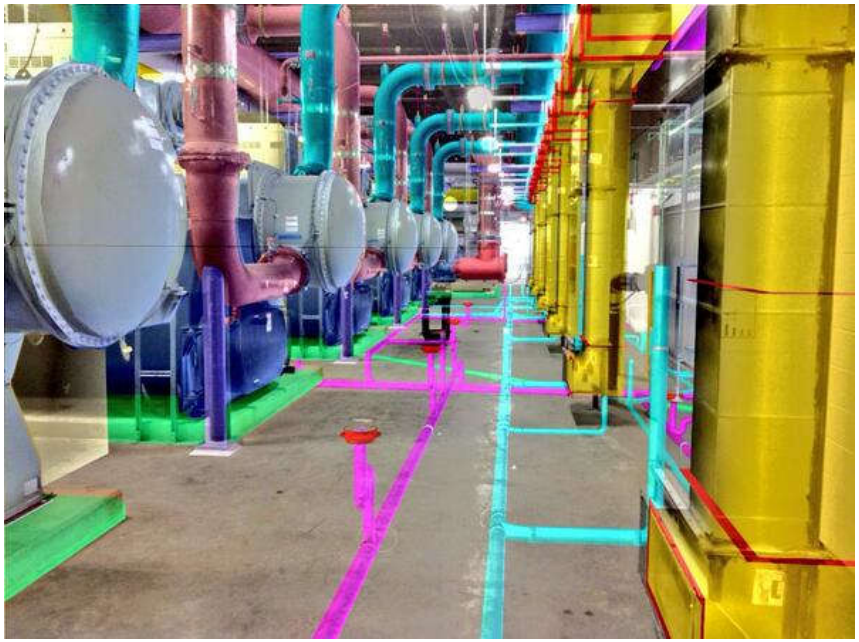
Introduction

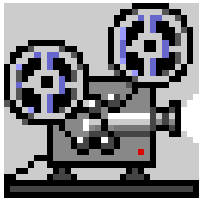
- **Building Information Modelling (BIM)**
  - A collaborative working process
  - 3D design + Information



- BIM definitions:
  - Process of creating & using digital models for design, construction, and/or operations of projects
  - Simulate the construction project in a virtual environment, to identify any potential design, construction, or operational issues

BIM is an intelligent 3D model-based process





Video:
- What is BIM (Building Information Modeling)? (3:00) https://youtu.be/suNadRnHy-U

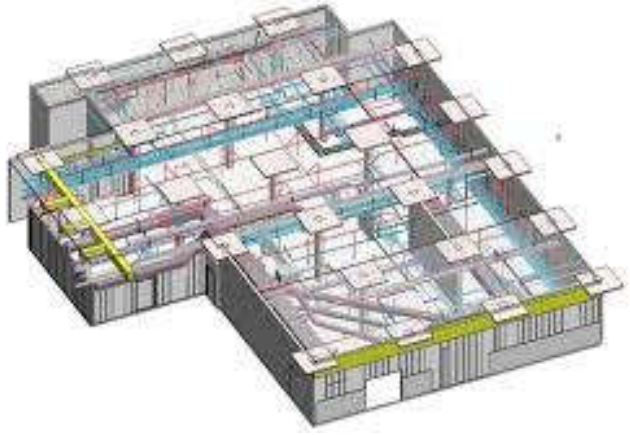
CAD versus BIM

Computer Aided Design (CAD)

- Primarily 2D
- Dumb graphics (lines, arcs, circles, polylines)
- Electronic drafting
- Basic measuring
- AutoCAD

Building Information Modelling (BIM)

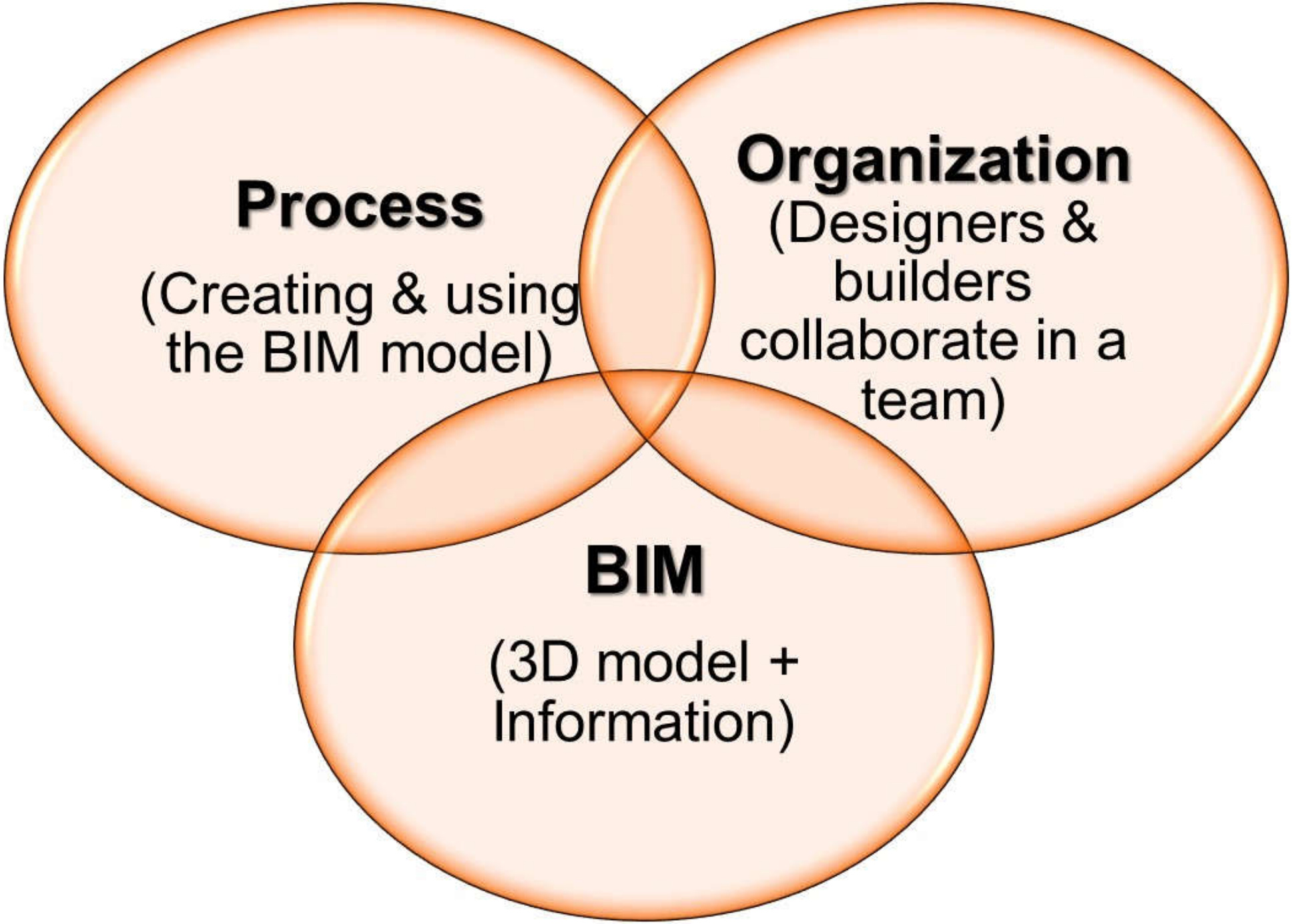
- 3D, 4D, 5D, 6D, 7D, …
- Intelligent objects (walls, floors, doors, windows, columns)
- Virtual construction
- ‘One-click’ bill of quantities
- Revit, ArchiCAD



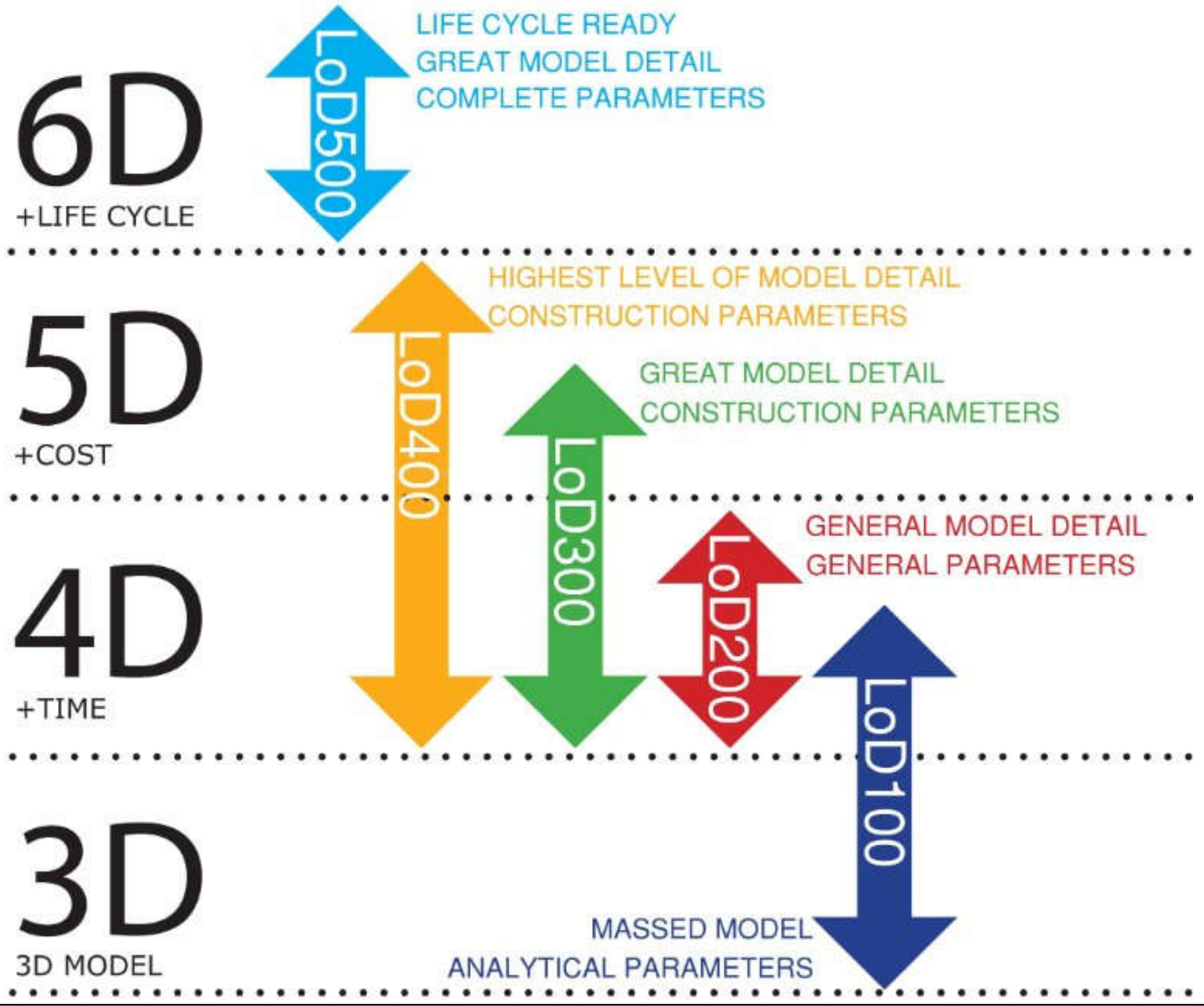
Introduction

- **V**irtual **D**esign & **C**onstruction (VDC)
  - It is the management of integrated multi-disciplinary performance models of design-construction projects
  - Five elements that enable VDC:
    - 1. BIM model
    - 2. Level of development (LOD)
    - 3. Advanced digital tools
    - 4. Collaboration space
    - 5. Collaborative mindset

Virtual design and construction (VDC) process

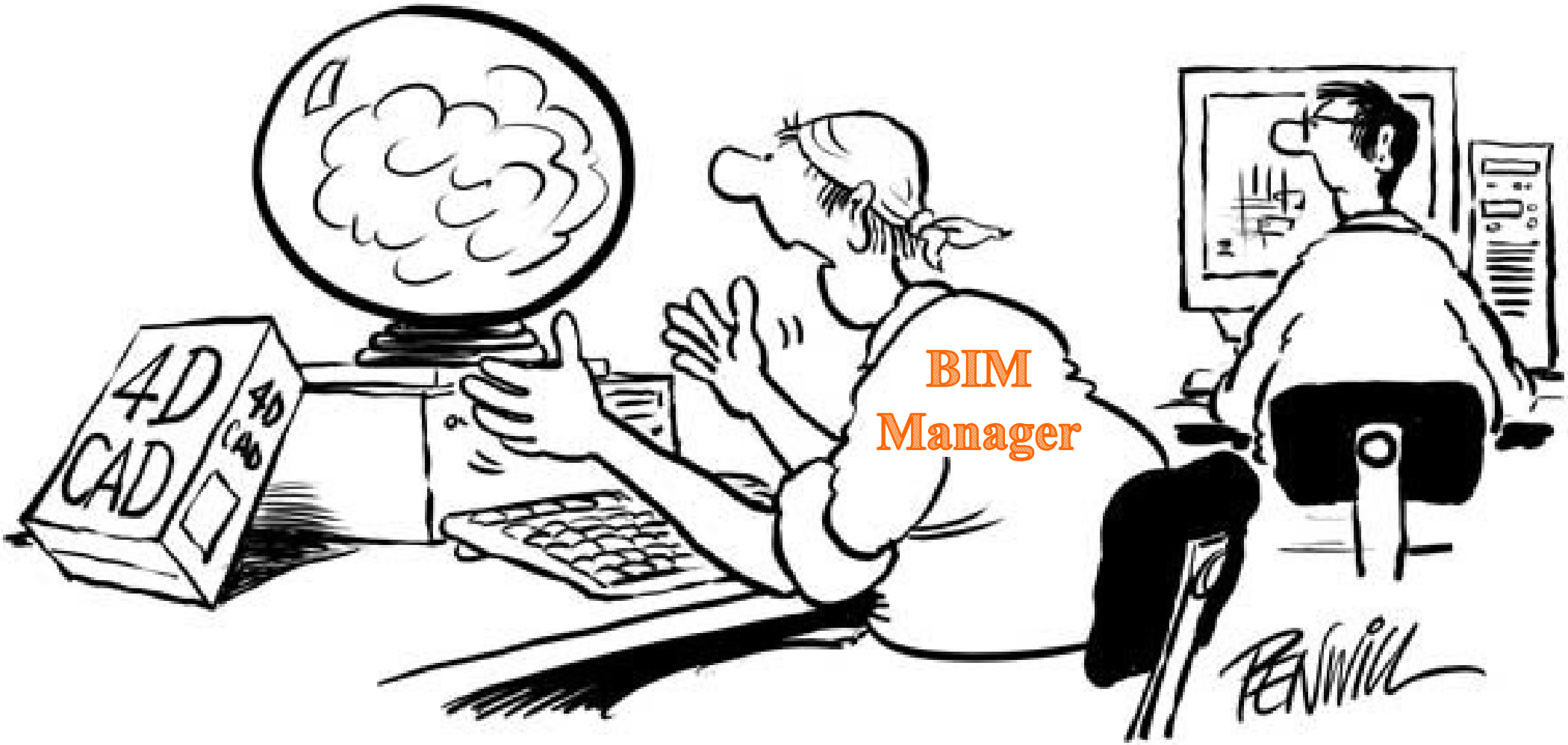


BIM dimensions



The Good of BIM

- BIM opportunities:
  - Visualisation, intelligent 3D-modelling
  - 4D-scheduling, logistics, clash detection
  - Energy simulation, safety planning, fire, etc.
  - Quantity take-off (QTO), estimating/costing
  - Life cycle assessment (LCA) & life cycle costing
  - Supply chain management & procurement
  - Facilities management, operation & maintenance
  - Prefabrication, modular construction

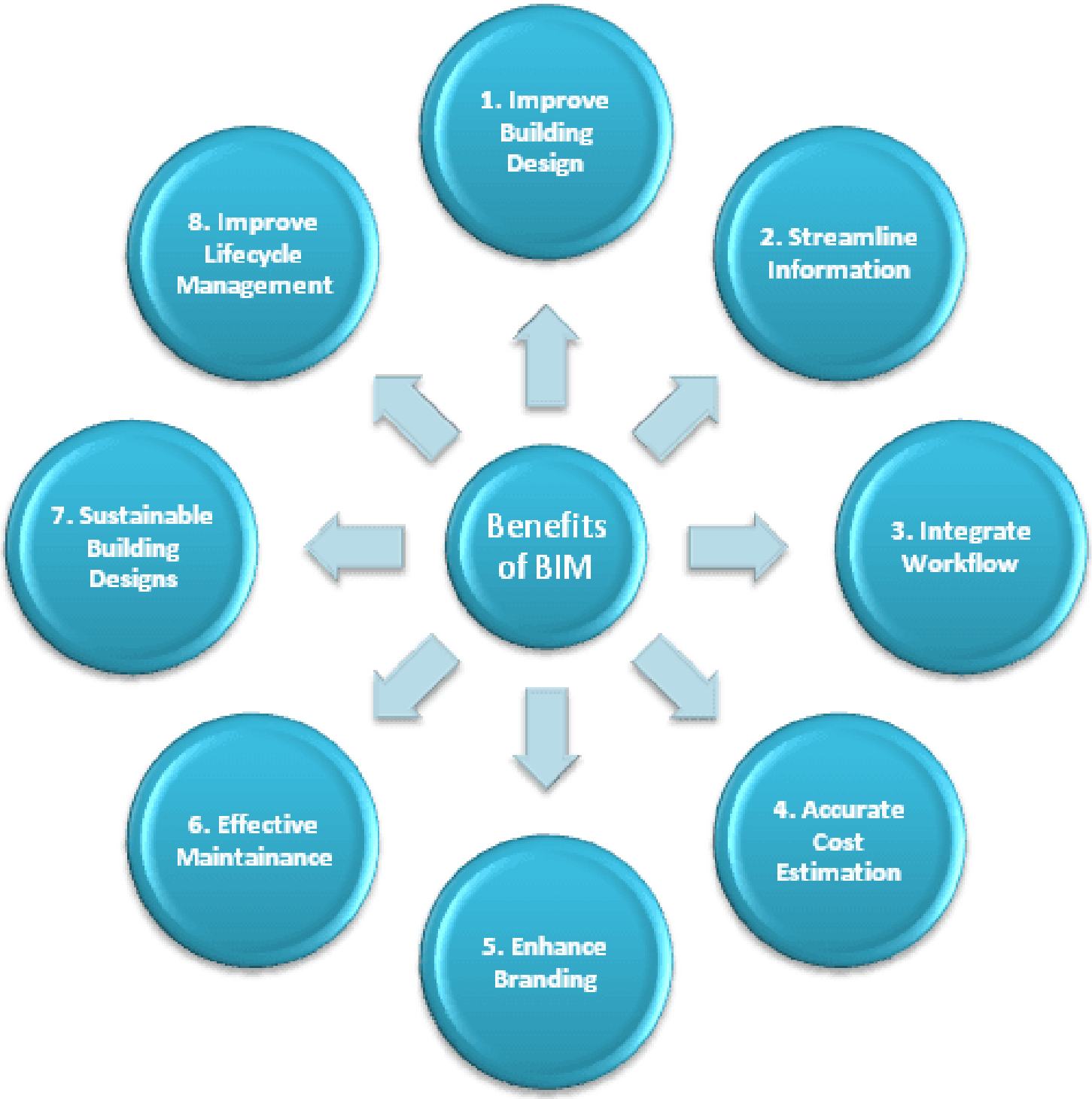


(Image source: https://www.augi.com/articles/detail/cool-a-point-cloud...-now-what)

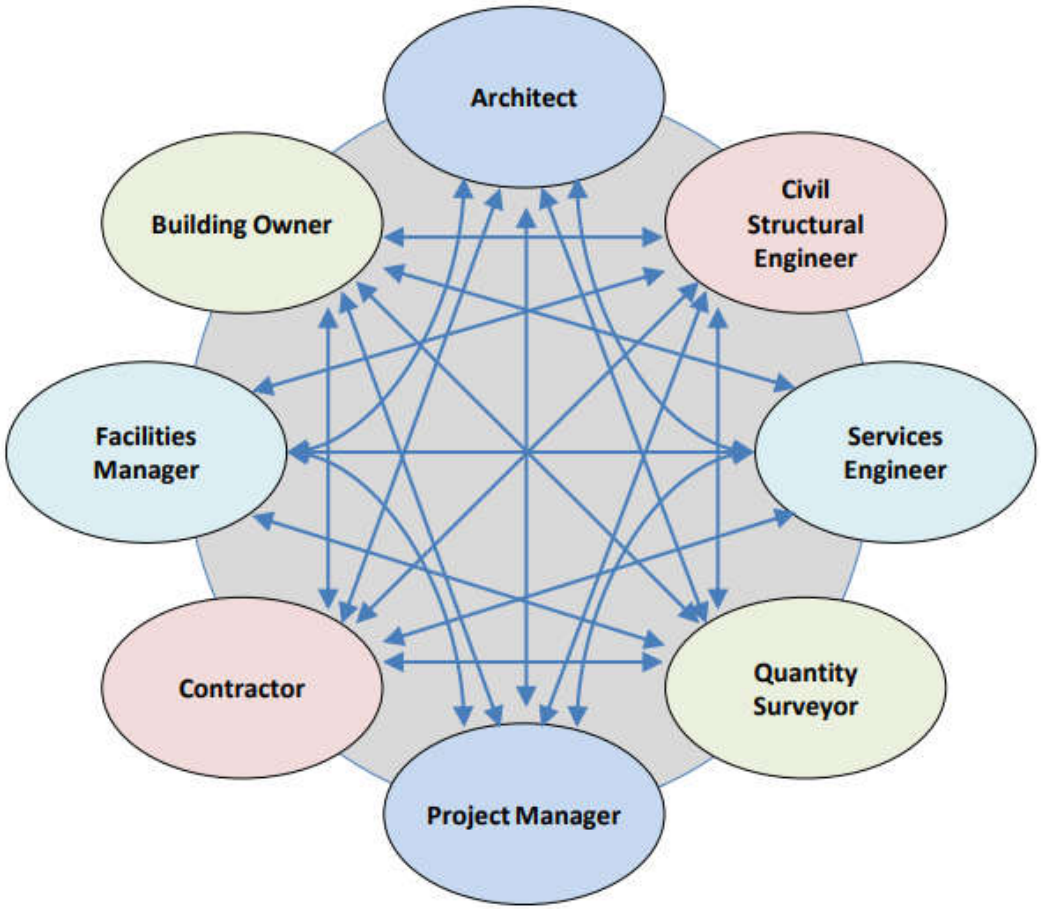
The Good of BIM

- Benefits of BIM
  - Promises better decision making
  - Accurate geometrical representation
  - Enhanced efficiency & lowered overall risk
  - Improved project sustainability
  - Decreased project cost
  - Increased productivity & quality
  - Reduced project delivery time
  - Enhanced communication & collaboration

Benefits of BIM process



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



Information "Chaos"

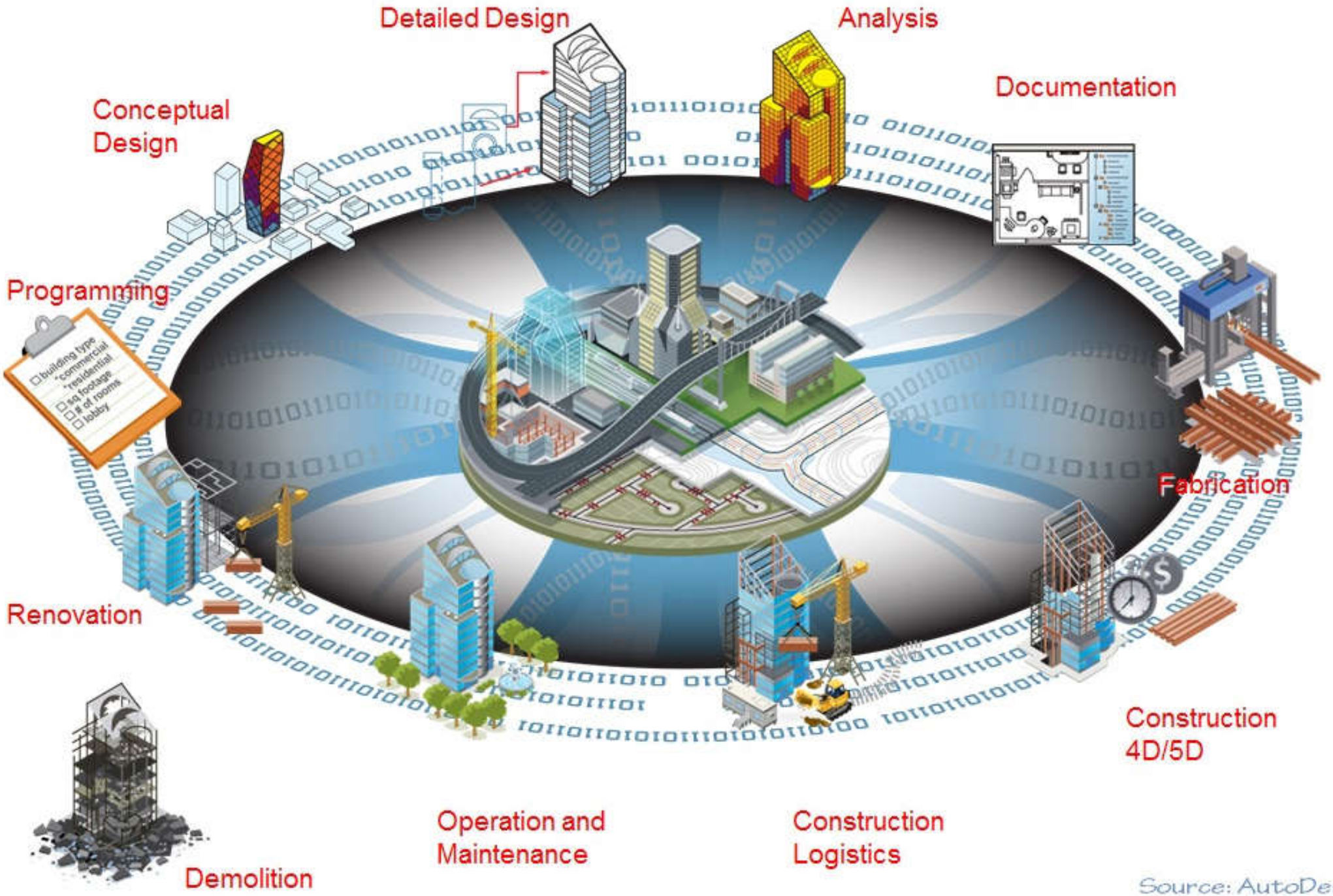
Shared Project Model

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

BIM is changing the way we build, collaborate and operate (Avatars in the virtual BIM environment)

(Image source: https://new.siemens.com/global/en/products/buildings/digitalization/bim.html; https://www.kensetsunews.com/web-kan/73531)

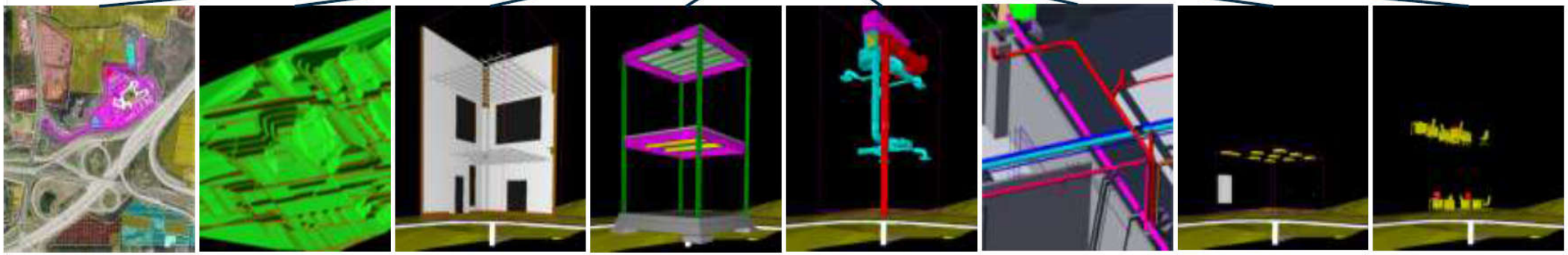
BIM process throughout building life cycle



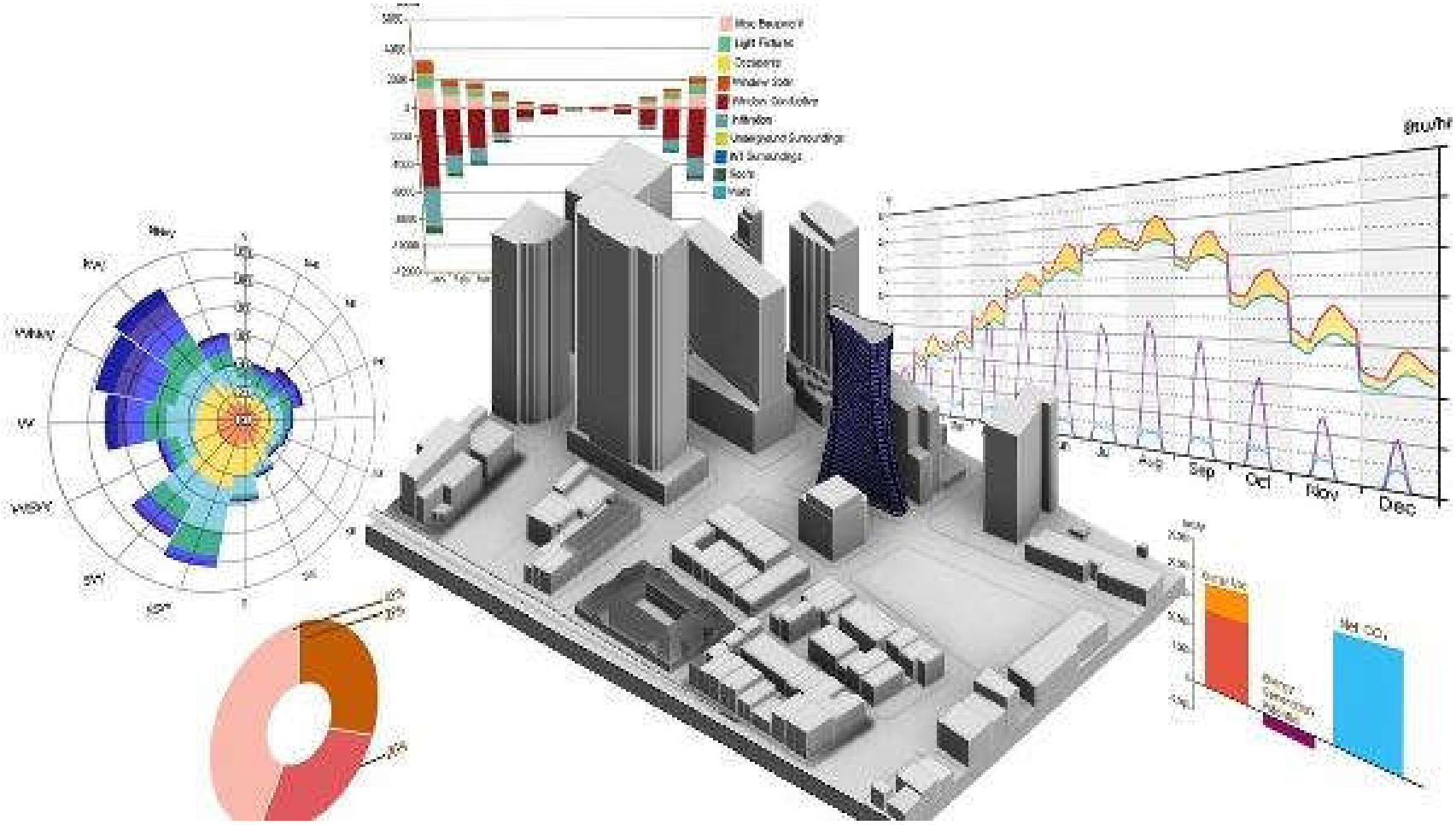
BIM for building, construction and infrastructure

Design meeting

Construction meeting



BIM Process + Analysis Tools = Power of BIM



Energy, green building and structural analyses

3D Scanning

Unmanned Aircraft System (UAS) / Drone

The Good of BIM in construction

BIM for Contractors:

Avoid Rework: Detect and resolve conflicts between systems before construction begins

Test New Procedures: Visualize untested or complex processes to predict problems before they happen

Improve Safety: Reduce risks created by inadequate perimeter protection and unsafe site layouts

Save on Materials: Know upfront what materials you'll need to take advantage of economies of scale and just-in-time ordering, resulting in lower costs and less waste

Manage Logistics: Avoid project delays by making sure everybody has the equipment, materials, plans, and instructions they need, when they need them

Give Input on Designs: Collaborate with designers to ensure constructability and potentially cut costs

BIM for Manufacturers:

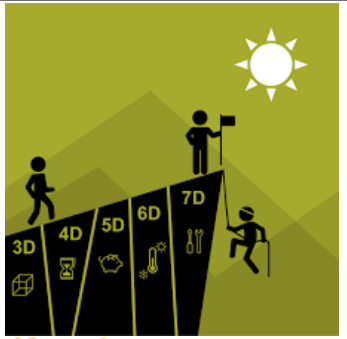
- Develop BIM Objects for your products
- Use BIM to fabricate custom products

(Source: BIM in Construction: Part 1 – The Good https://www.isqft.com/start/blog-bim-in-construction-part-1/)

Is the Good of BIM a fairy tale?
Any bad or precaution?

(Image source: https://xinaps.com/bim/fairy-tale-told-bim/)

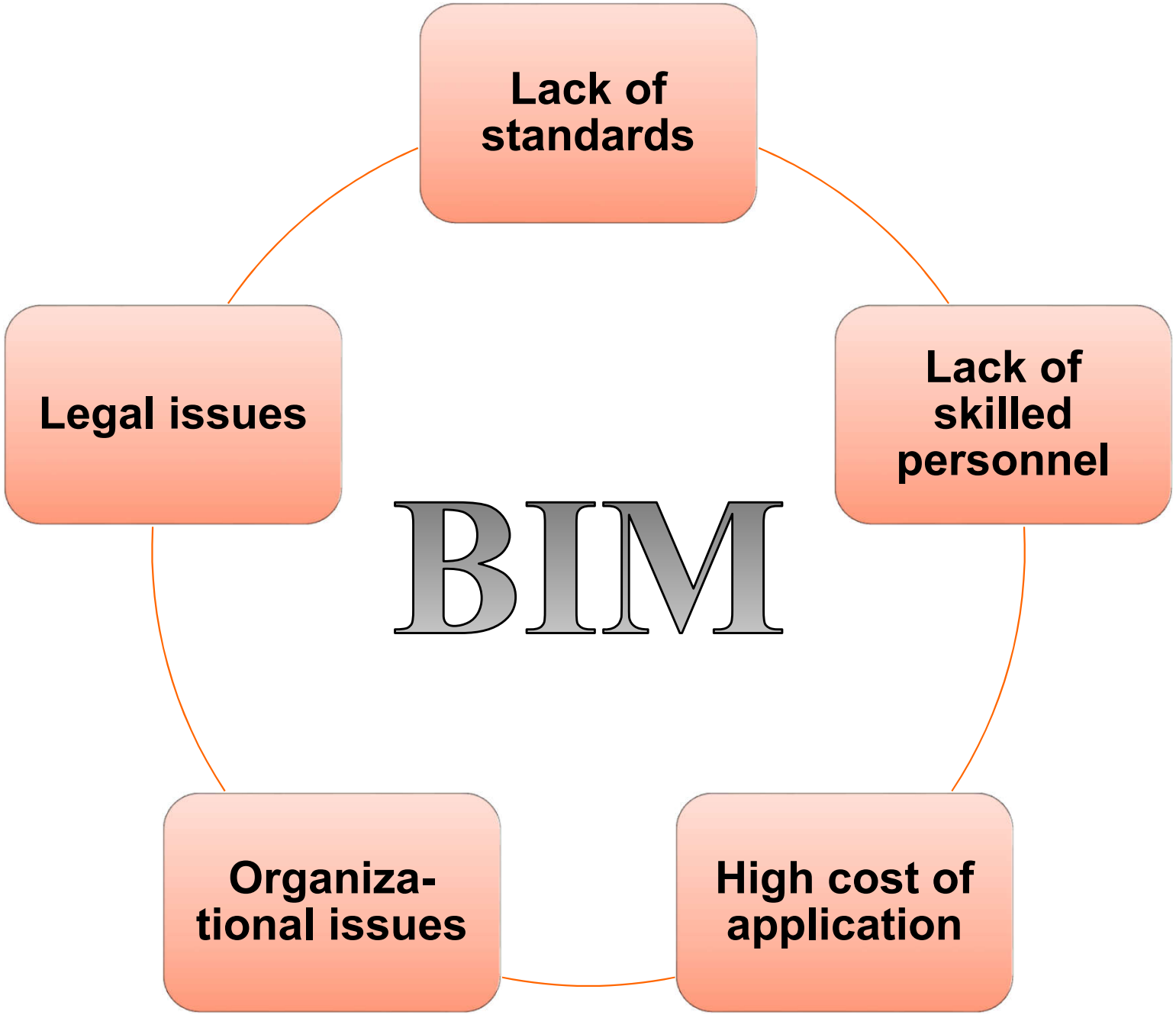
The Bad of BIM



- BIM is extremely powerful but can also be overwhelming and complex
- Major barriers to BIM adoption:
  - Social-organizational (e.g. resistance to change, lack of understanding & motivation)
  - Technical (e.g. interoperability issues)
  - Financial (e.g. adoption/start-up costs)
  - Contractual (e.g. BIM contract issues)
  - Legal (e.g. BIM model ownership & liability)

(Ref.: Alreshidi E., Mourshed M. and Rezgui Y., 2017. Factors for effective BIM governance, *Journal of Building Engineering*, 10: 89-101.)

Critical barriers to BIM implementation



(Adapted from: Liu S, Xie B, Tivendal L & Liu C, 2015. Critical barriers to BIM implementation in the AEC industry, *International Journal of Marketing Studies*, 7 (6): 162-171.)

The Bad of BIM in construction

The Downsides of BIM:

Added Costs: BIM costs money (software, hardware upgrades, training, and technical support)
Skills Shortage: finding new employees with the right skills is even more difficult
"BIM-less" Partners: BIM works best if everyone on the project is using it (problems with a partner who is unwilling or unable to use BIM)
Incompatible Software: To translate from one platform to another, companies often end up recreating early conceptual design models and re-entering data - losing some of the big benefits of BIM
Legal Risks: legal implication and intellectual property right issues associated with BIM

The Root Causes of Bad BIM Process & Problems:

- Lack of technical capability & capacity
- Lack of commitment to information management and collaboration
- Poorly defined BIM information requirements & level of development/details
- Poor BIM planning & execution plan

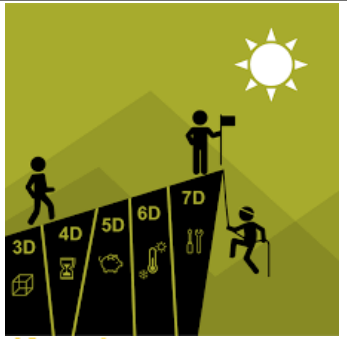
(Refs: BIM in Construction: Part 2 – The Bad https://www.isqft.com/start/blog-bim-in-construction-part-2/; Are you experiencing bad BIM?: Rescuing difficult BIM projects http://www.dpw-group.com/are-you-experiencing-bad-bim-rescuing-difficult-bim-projects/)

Legal risks of BIM

Employer & Consultant: Duty of care Ownership Insurance	**Consultants & Contractors:** Information & reliance Types of information Responsibility for inputs
Consultants & Sub-Consultants: Professional terms of engagement Information and reliance Different BIM models Duplication and the risk of ambiguity	**Employer & Contractors:** Design responsibility Standard of care Information & reliance Coordination & amendment of the BIM

(Source: Mr. Vincent Connor of Pinsent Masons LLP
https://cic.hk/cic_data/pdf/about_cic/news_and_update/past_event/chi/2013_11_29%20%20Mr_%20Vincent%20CONNOR.pdf)

The Bad of BIM



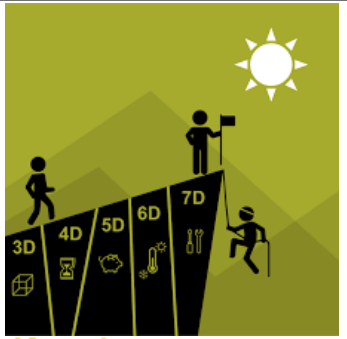
- Complexity of BIM software
  - BIM modeling software
  - BIM execution planning software
  - BIM content management software
  - Generative design software / algorithmic BIM software
  - BIM performance / BIM analysis software
  - BIM collaboration software
  - BIM validation / BIM checking software
  - Preconstruction BIM 4D/5D software
  - Construction BIM software
  - Facilities management BIM software

BIM software (so many of them … ☹)

Problems: a steep learning curve, complicated operability, a lack of technical support/training, and significant up-front investment in hardware

(Source: BIM Software guide https://www.buildingincloud.net/en/bim-software-guide/)

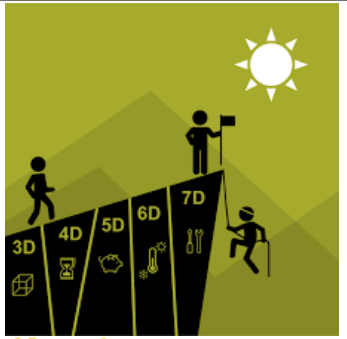
The Bad of BIM



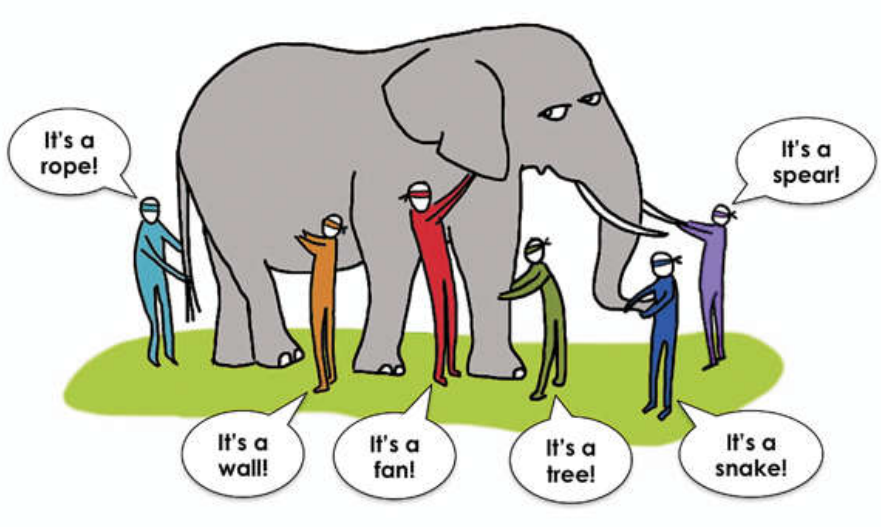
- Top 10 "Evil BIM" List
  - 1. Owners Just Requesting "BIM"
  - 2. Not Enough BIM
  - 3. Too Much BIM
  - 4. Unclear Model Element Authors
  - 5. Unnecessary Clashes
  - 6. Evil Scope Agreements
  - 7. Poor Quality Modeling
  - 8. BIM Spreadsheet Contracts
  - 9. "LOD 500 + COBie" Requests
  - 10. Contracting To 2D

(Source: https://www.linkedin.com/pulse/top-10-evil-bim-list-clive-jordan-smartleanbim-/)

The Bad of BIM



- Challenges with BIM implementation
  - Training of employees
  - Lack of standards for BIM
  - Management of data
  - Interoperability of software
- Critical success factors
  - Team collaboration of stakeholders
  - Organization during construction projects



(Ref.: Langar S. and Criminale A., 2017. Challenges with BIM implementation: a review of literature, In *Proceedings of the 53rd Associated Schools of Construction (ASC) Annual International Conference 2017*, pp. 329-335.)


Teamwork

Facility Manager

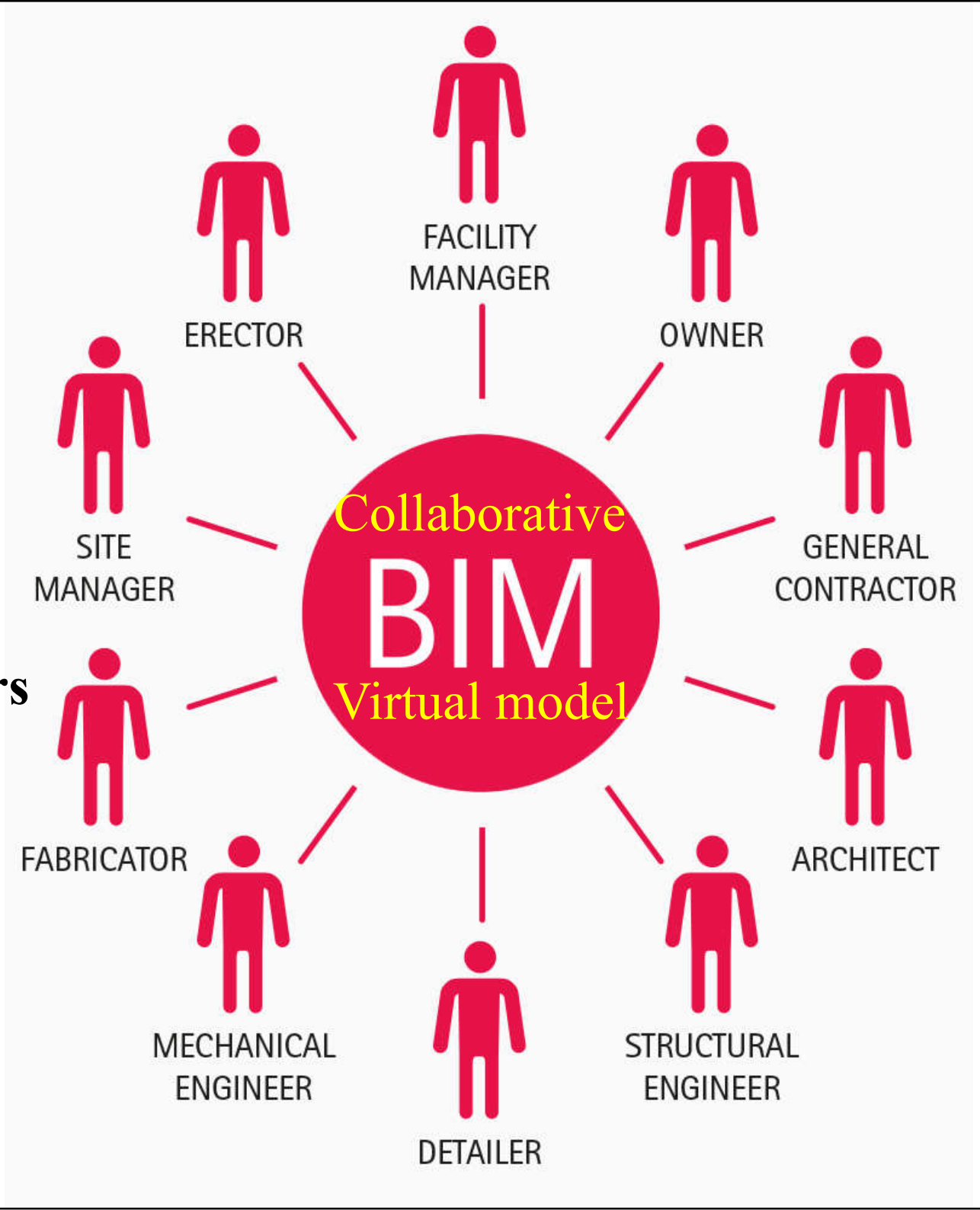
Building Owner

Contractors

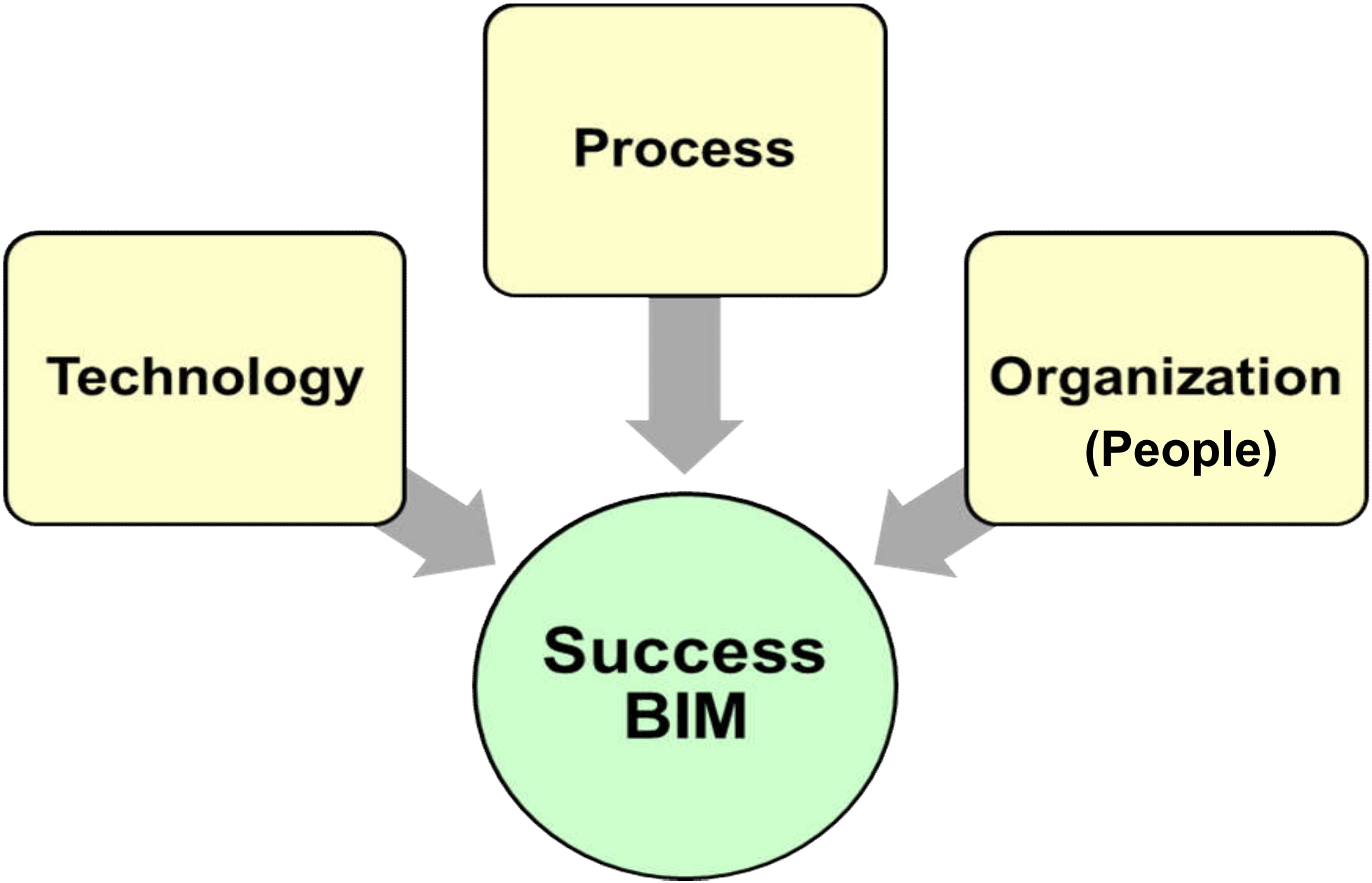
Suppliers/ Manufacturers

Architect

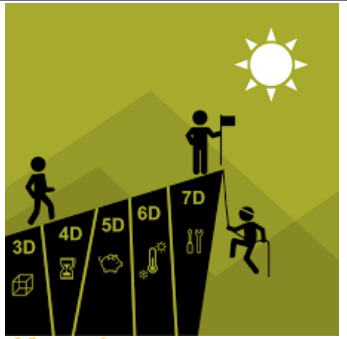
Engineers



Three key aspects for successful BIM implementation

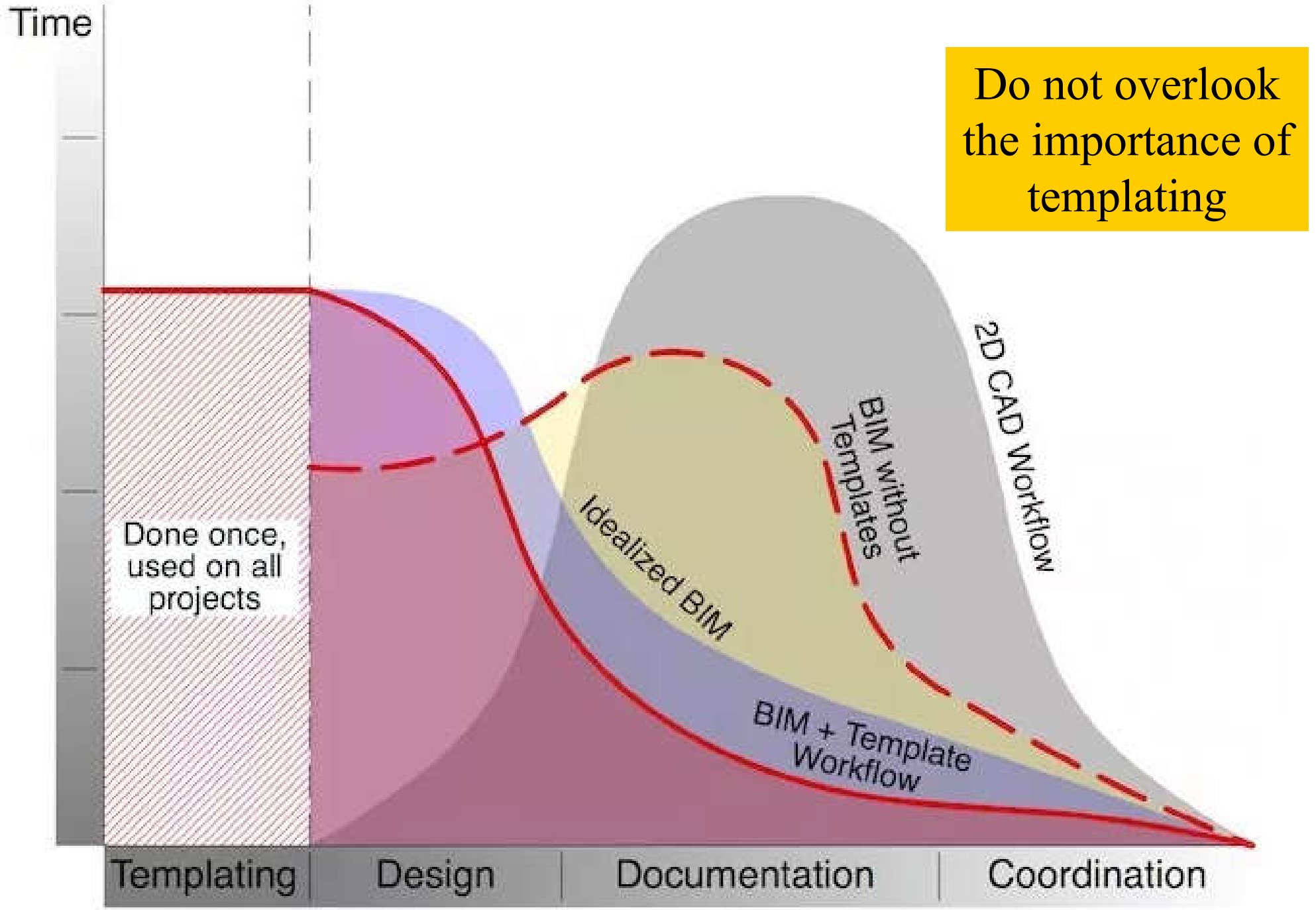


The Bad of BIM



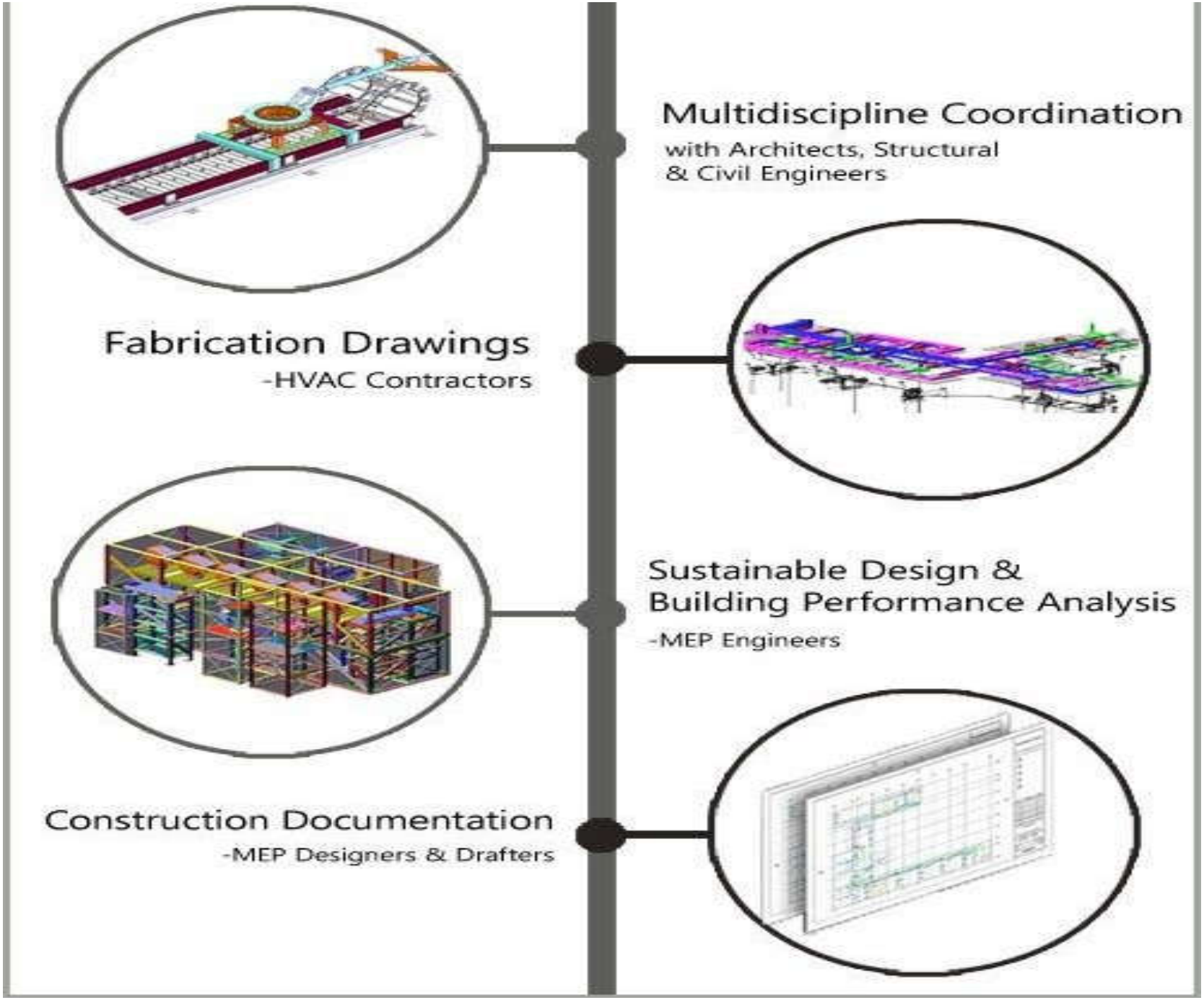
- Why MEP (mechanical, electrical & plumbing) engineers are lagging behind in BIM?
  - MEP for BIM comprises more technical and industrial components & connections
  - Lack of BIM data from MEP manufacturers
  - Effective MEP calculation & design tools are not available in current BIM software
    - e.g. design calculations of lighting, power and cable routing systems, panel board design and balancing
  - Weak BIM learning in current MEP education

Why BIM is Still Bankrupting Your Firm



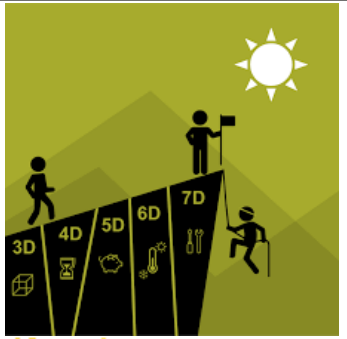
(Source: http://www.shoegnome.com/2015/12/09/bim-still-bankrupting-firm/)

How BIM can help MEP engineers?

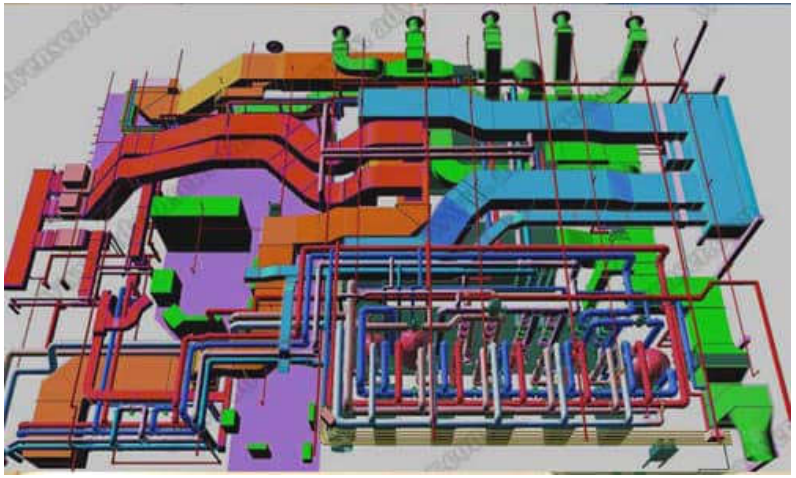


(Source: Is BIM (building information modeling) actually useful for MEP projects? https://www.quora.com/Is-BIM-building-information-modeling-actually-useful-for-MEP-projects)

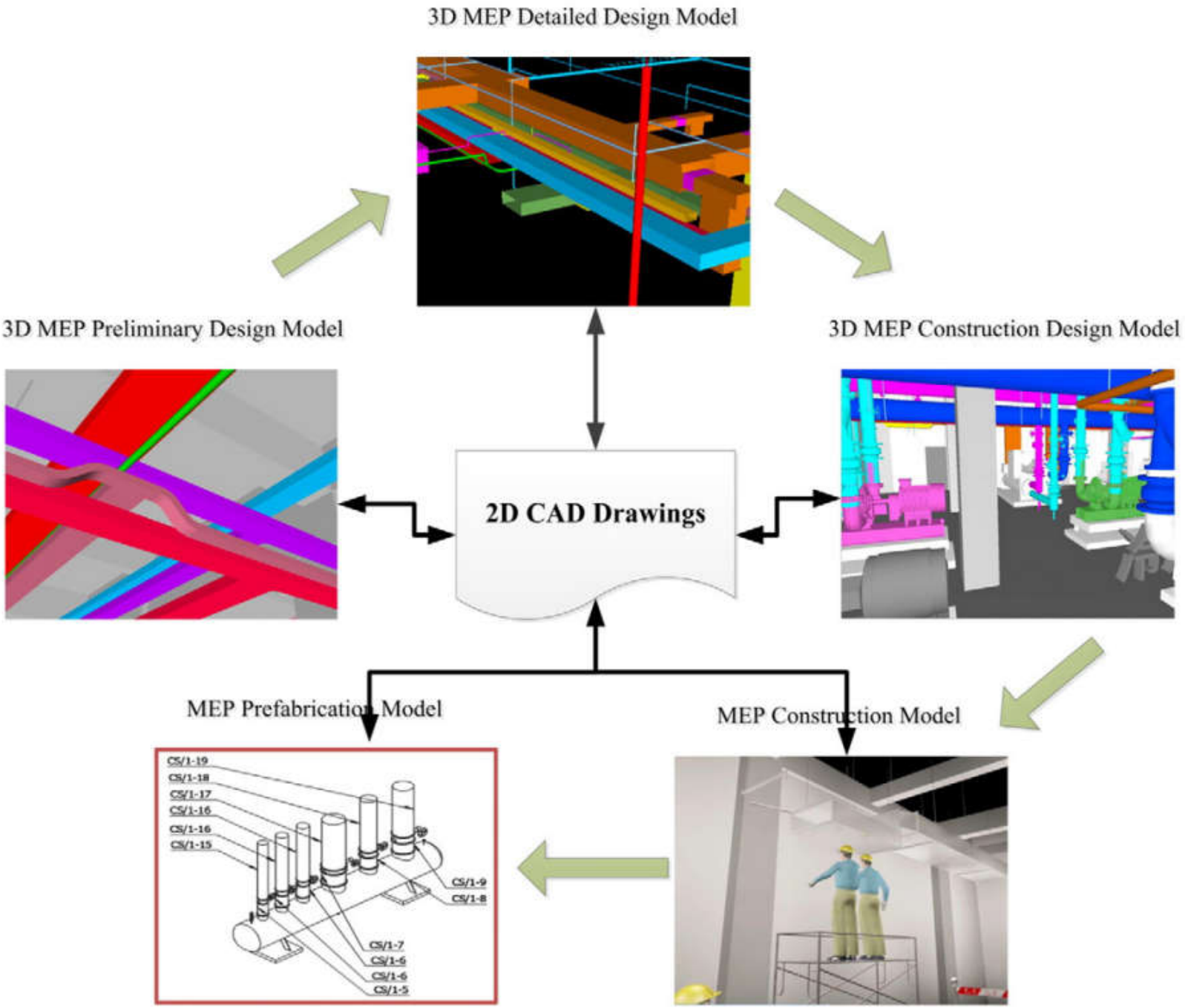
The Bad of BIM



- Examples of MEP engineering services using BIM
  - https://www.advenser.com/mep-engineering/
  - MEP BIM coordination
  - MEP shop drawings
  - MEP 3D modelling
  - Mechanical room modelling
  - Builders work drawing
  - As-built drafting
  - Piping spooling drawing (pipe assembly)
  - MEP quantity take off



MEP model development process

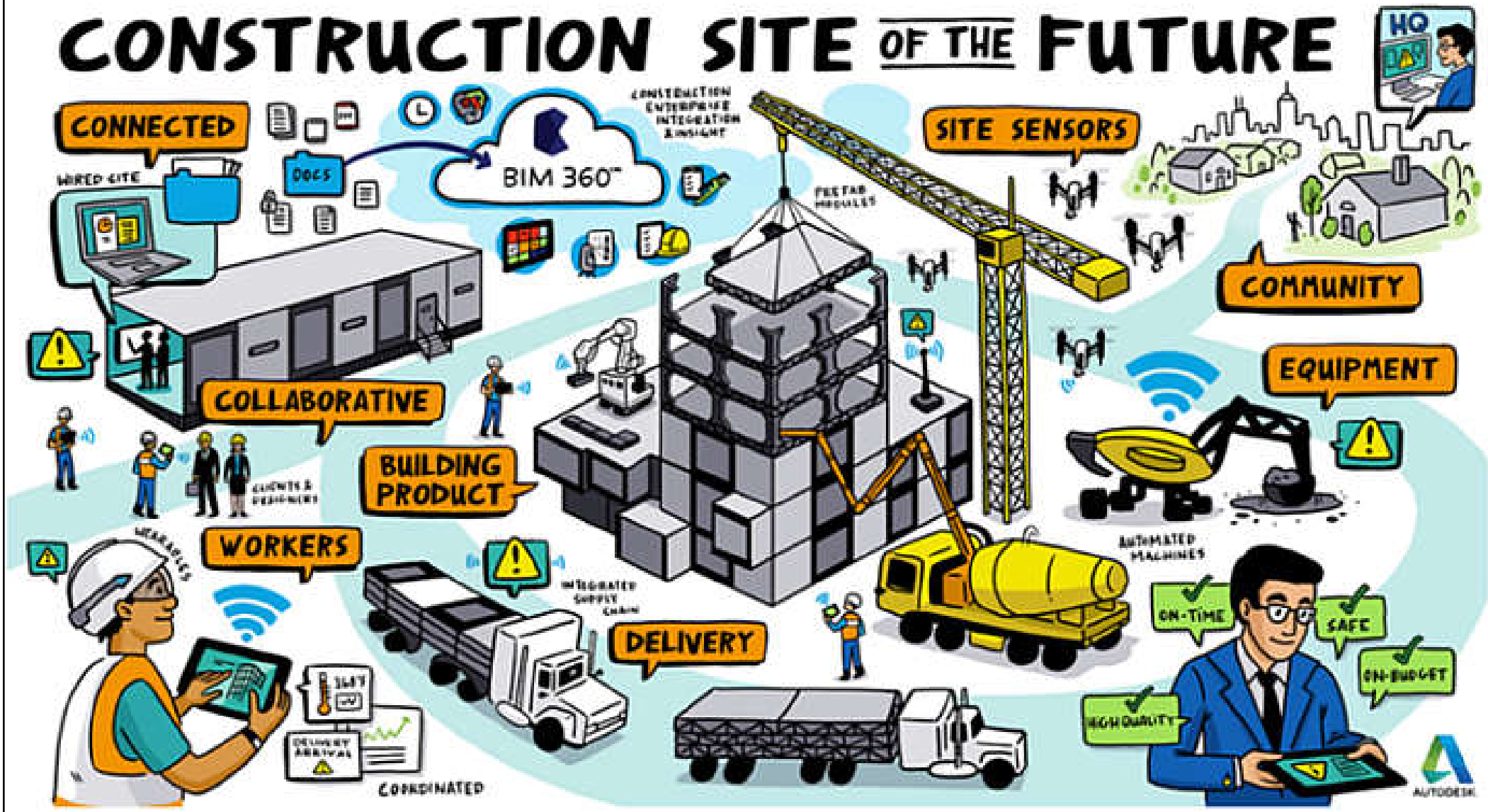


(Source: Wang J, Wang X, Shou W, Chong H.-Y. and Guo J., 2016. Building information modeling-based integration of MEP layout designs and constructability, *Automation in Construction*, 61 (2016): 134-146.)

The Future of BIM

- BIM is an enabling technology
  - Common data environment (CDE): enhance collaboration & integration
  - Everything is connected: improve project/issue management, design/construction coordination
  - Virtual design & construction (VDC): increase efficiency, productivity & quality
  - Off-site construction: using manufacturing approach, modular construction & automation

The future of BIM collaboration and construction site



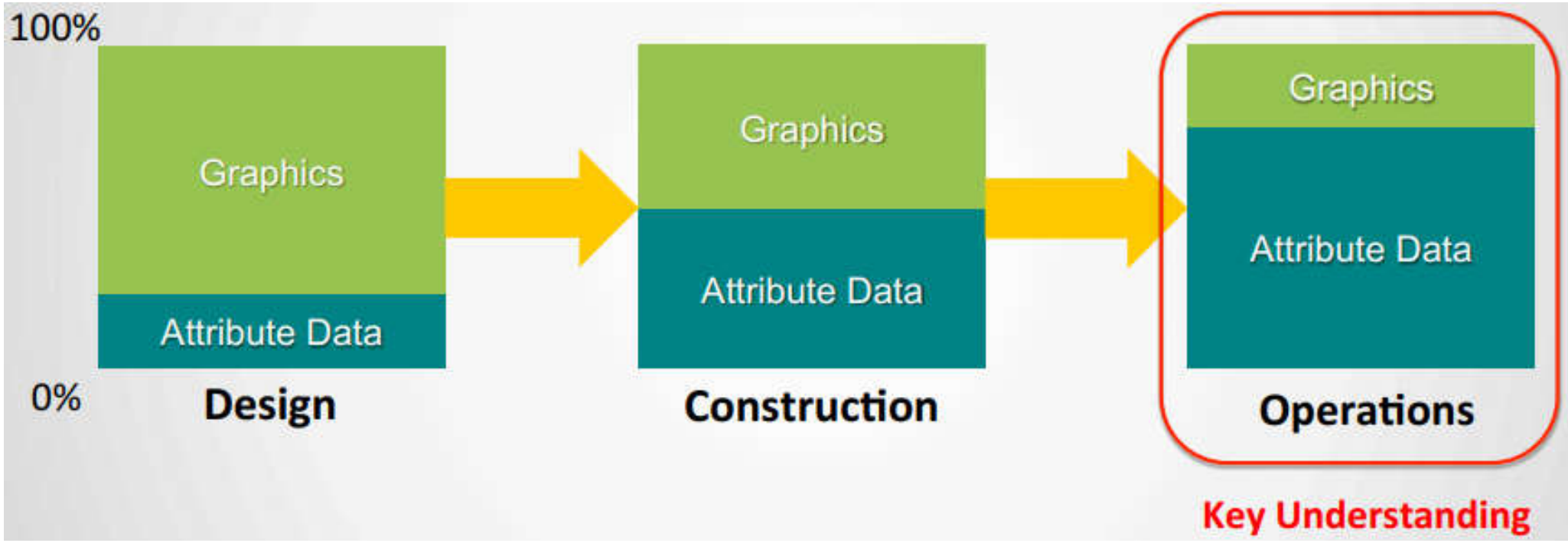
(Image source: Autodesk)

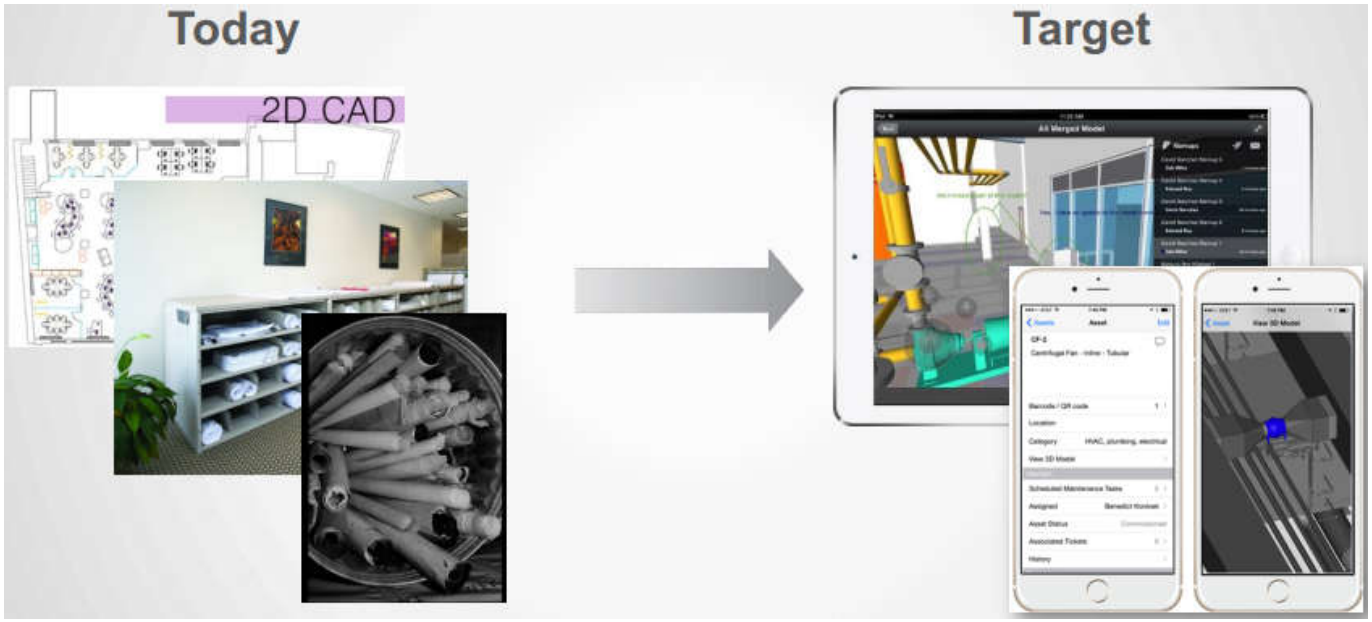
The future of BIM will not be BIM and it's coming faster than you think

With advancements in generative design, software algorithms, and robotic construction, our current processes are going to be changing quite a bit over the next three to ten years. We will see more and more done by computers and machines than we have ever seen. Rather than Building Information Modeling (BIM), we are going to see Building Information Optimization.

(Source: https://www.autodesk.com/autodesk-university/article/Future-BIM-Will-Not-Be-BIM-and-Its-Coming-Faster-You-Think-2017)

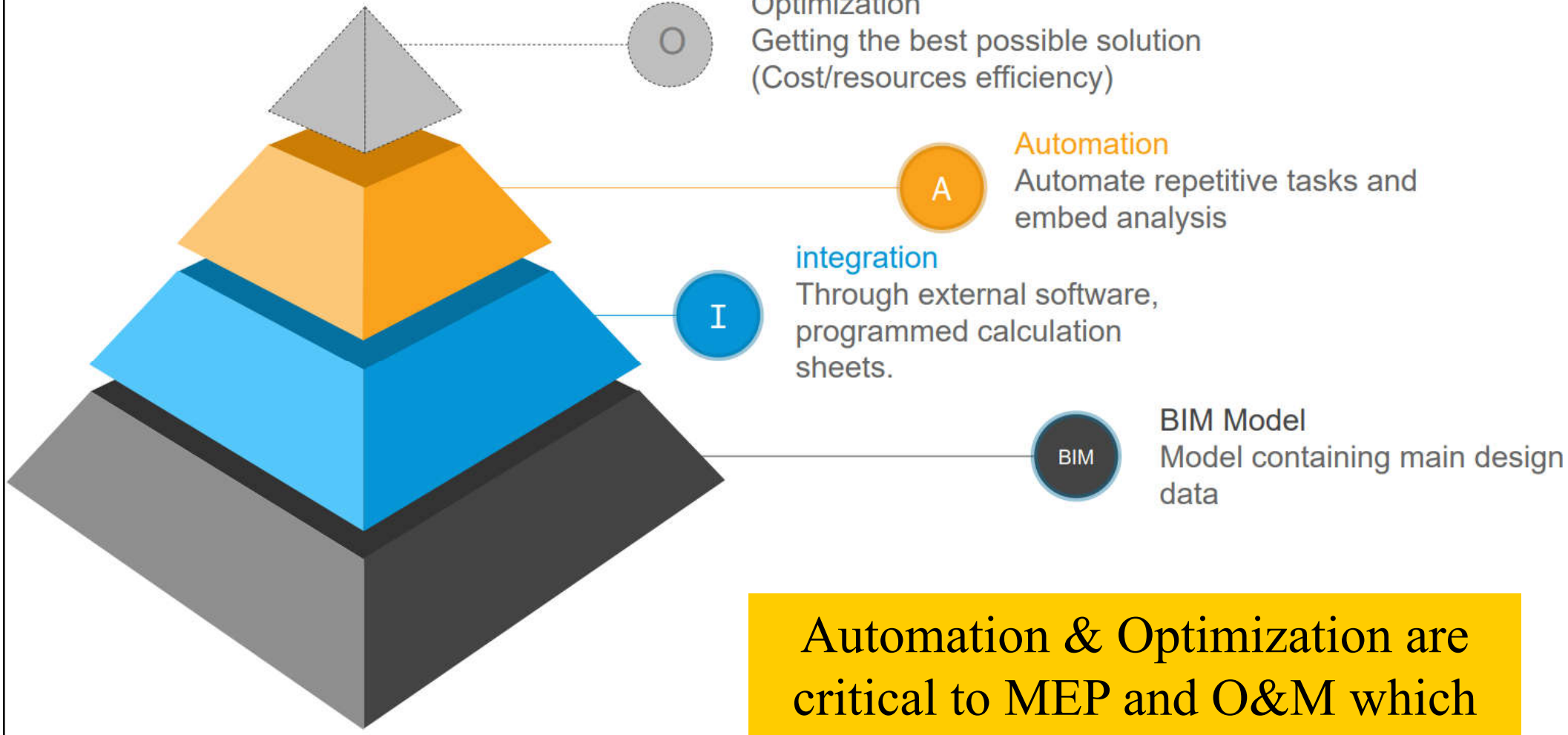
Extend BIM values from design & construction to operation & maintenance (O&M)





(Source: https://www.autodesk.com/autodesk-university/class/Present-and-Future-Making-BIM-Useful-Owners-2015)

BIM future map:
BIM Model >> Integration >> Automation >> Optimization

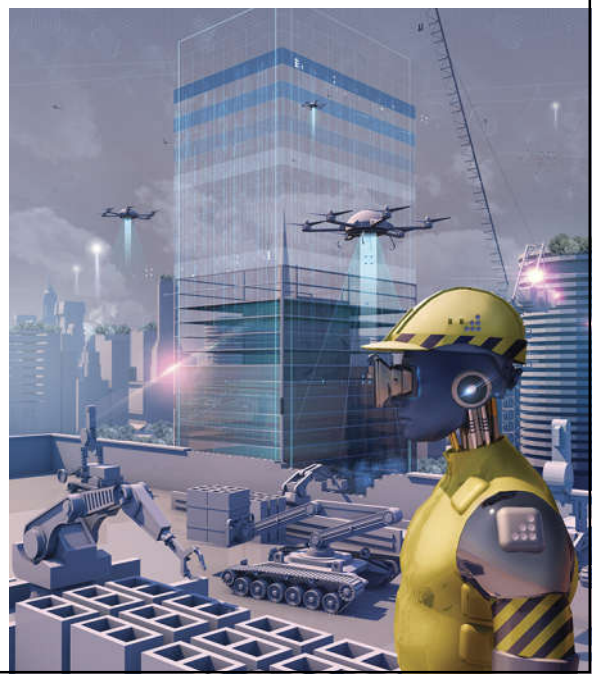


Automation & Optimization are critical to MEP and O&M which can use the BIM data/information to enhance efficiency/effectiveness

(Image source: https://www.autodesk.com/autodesk-university/class/Next-Level-BIM-Electrical-Embedded-Analysis-Using-Revit-API-2018)

The Future of BIM

- BIM related construction technologies:
  - Design for Manufacturing and Assembly (DfMA)
  - Modular Integrated Construction (MiC)
  - Prefabricated Prefinished Volumetric Construction (PPVC)
  - Construction Robotics (CR)
  - Construction 3D Printing (c3Dp)
  - Lean Construction (LC)
  - Digital Twin (DT)



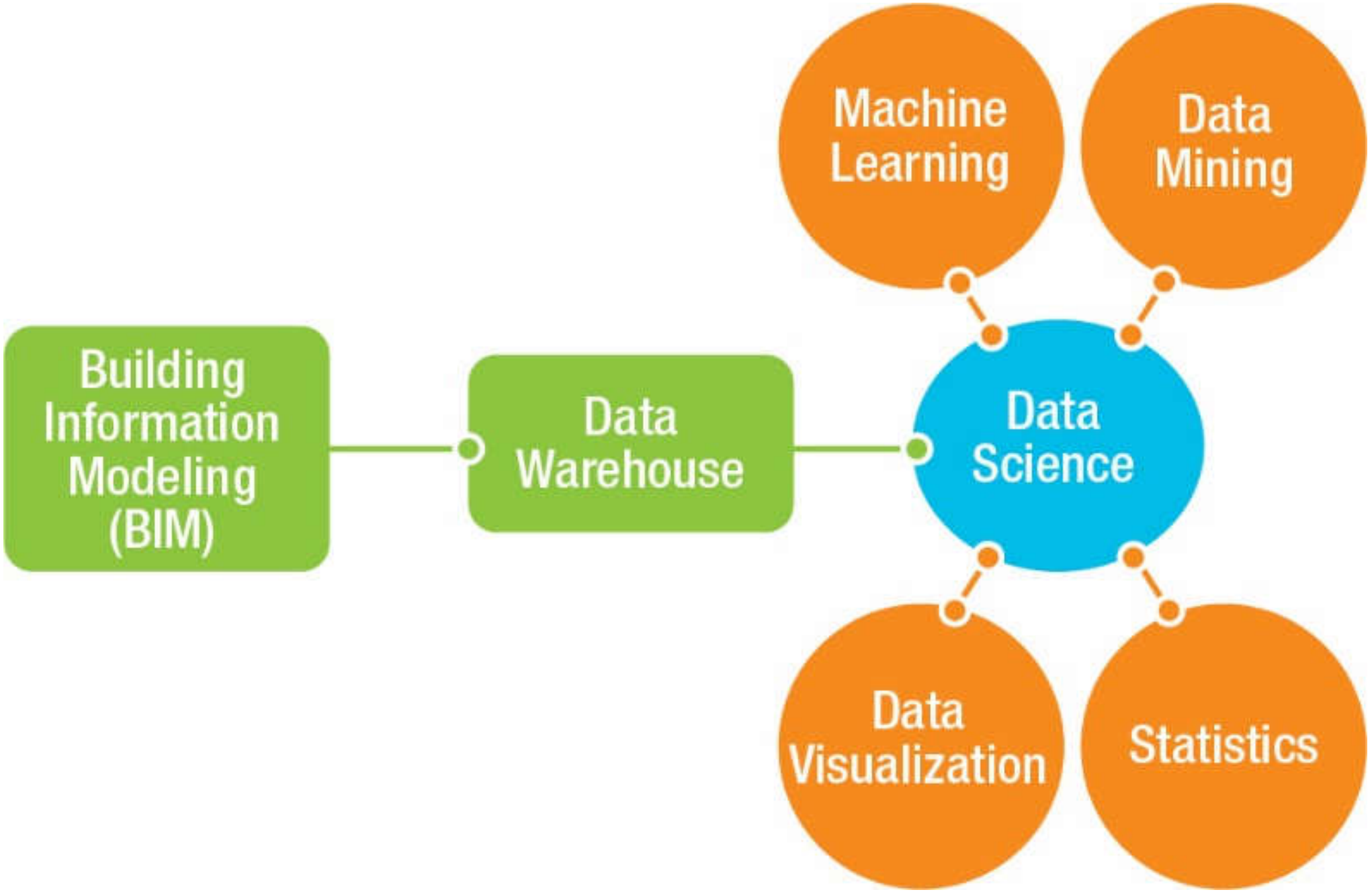
The Future of BIM

- Other technologies with significant impacts:
  - Augmented Reality (AR)/Virtual Reality (VR)
  - Cloud computing & analysis
  - Mobile technology & wearable devices
  - Global Positioning System (GPS)
  - 3D laser scanning & drones
  - Internet of Things (IoT) & intelligent sensors
  - Big data & data science
  - Artificial intelligence (AI)

The Future of BIM

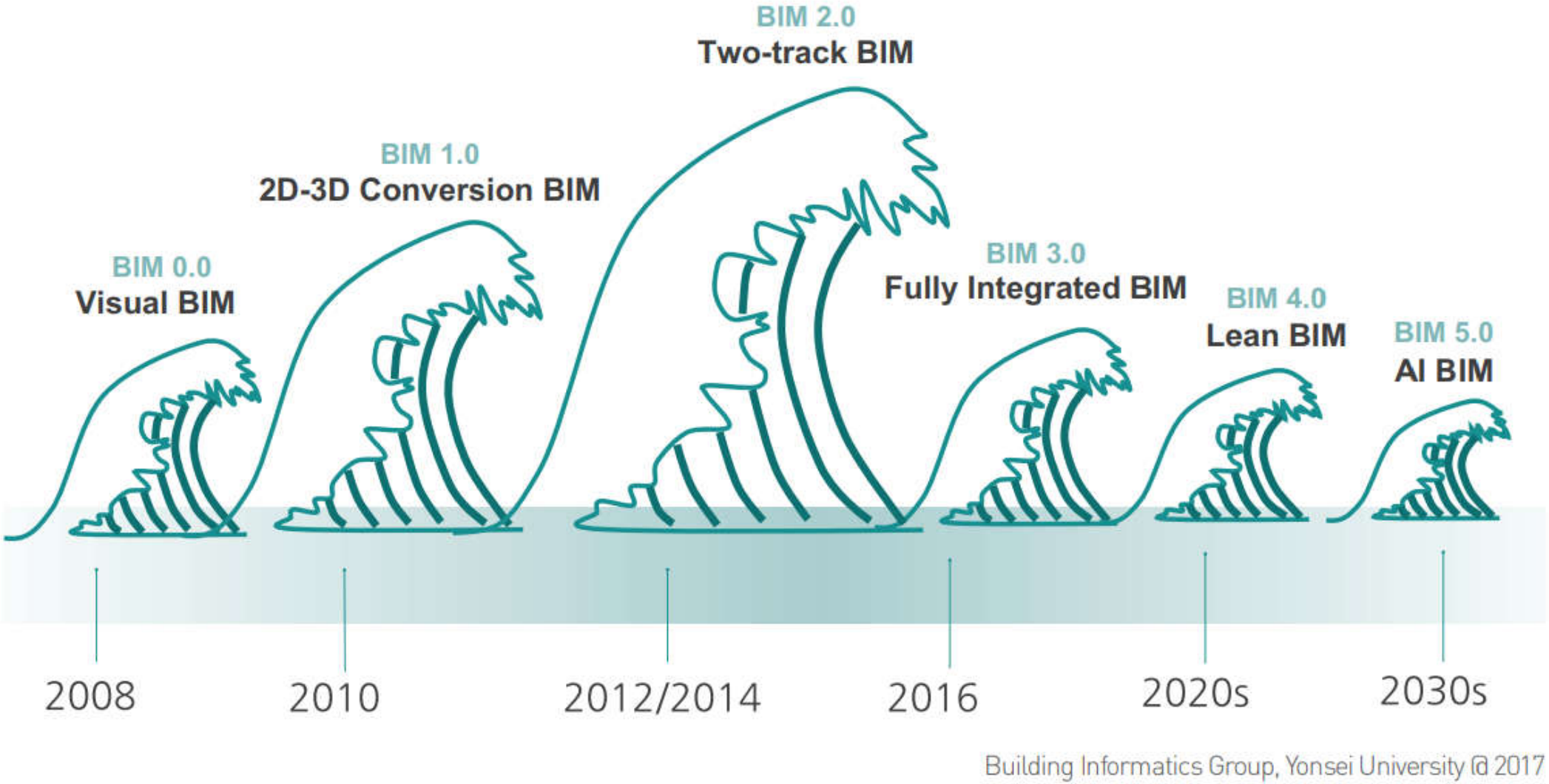
- BIM => More data/information => Big Data
  - Big data of building/construction/lifecycle
- BIM and Artificial Intelligence (AI)
  - Machine Learning (ML)
  - Deep Learning (DL)
  - Image/visual/speech recognition
  - Problem/safety detection
  - Predictive modelling/analytics
  - Task automation & robotics

BIM and Data Science



(Source: http://www.aecbytes.com/feature/2018/BIM-DataScience.html)

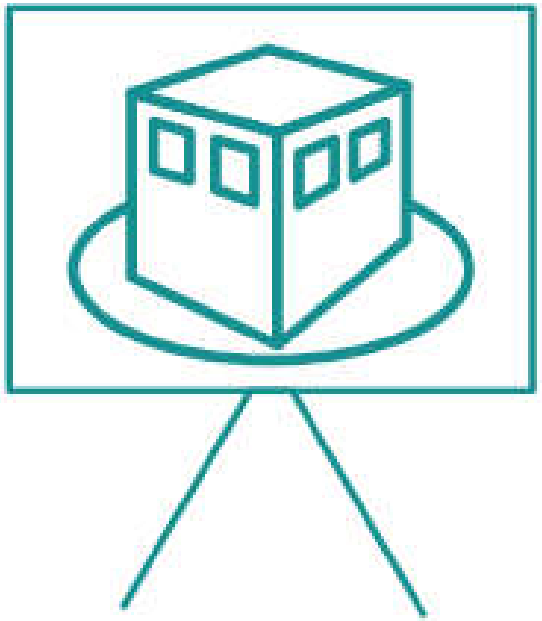
The six waves of BIM



(Source: Rail BIM 2030 roadmap http://big.yonsei.ac.kr/railbim/)

BIM 0.0 Visual BIM | BIM 1.0 2D-3D Conversion BIM

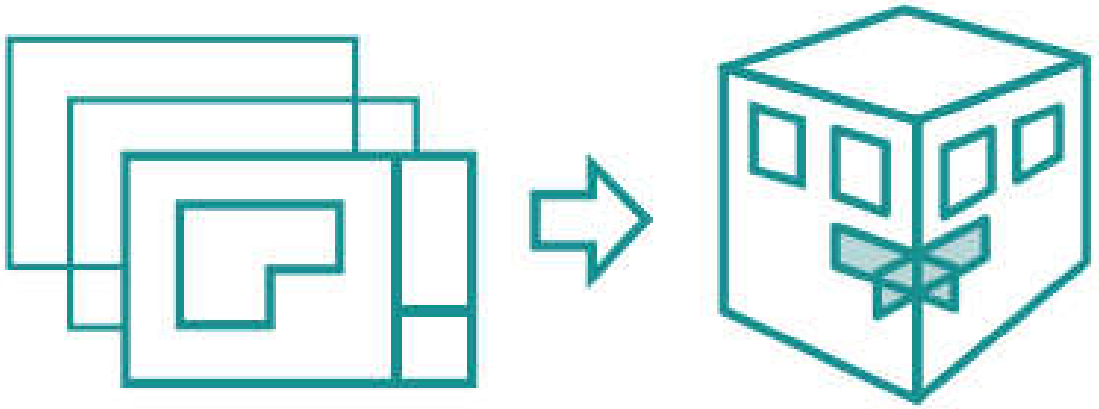
BIM 0.0 Visual BIM



Visualization

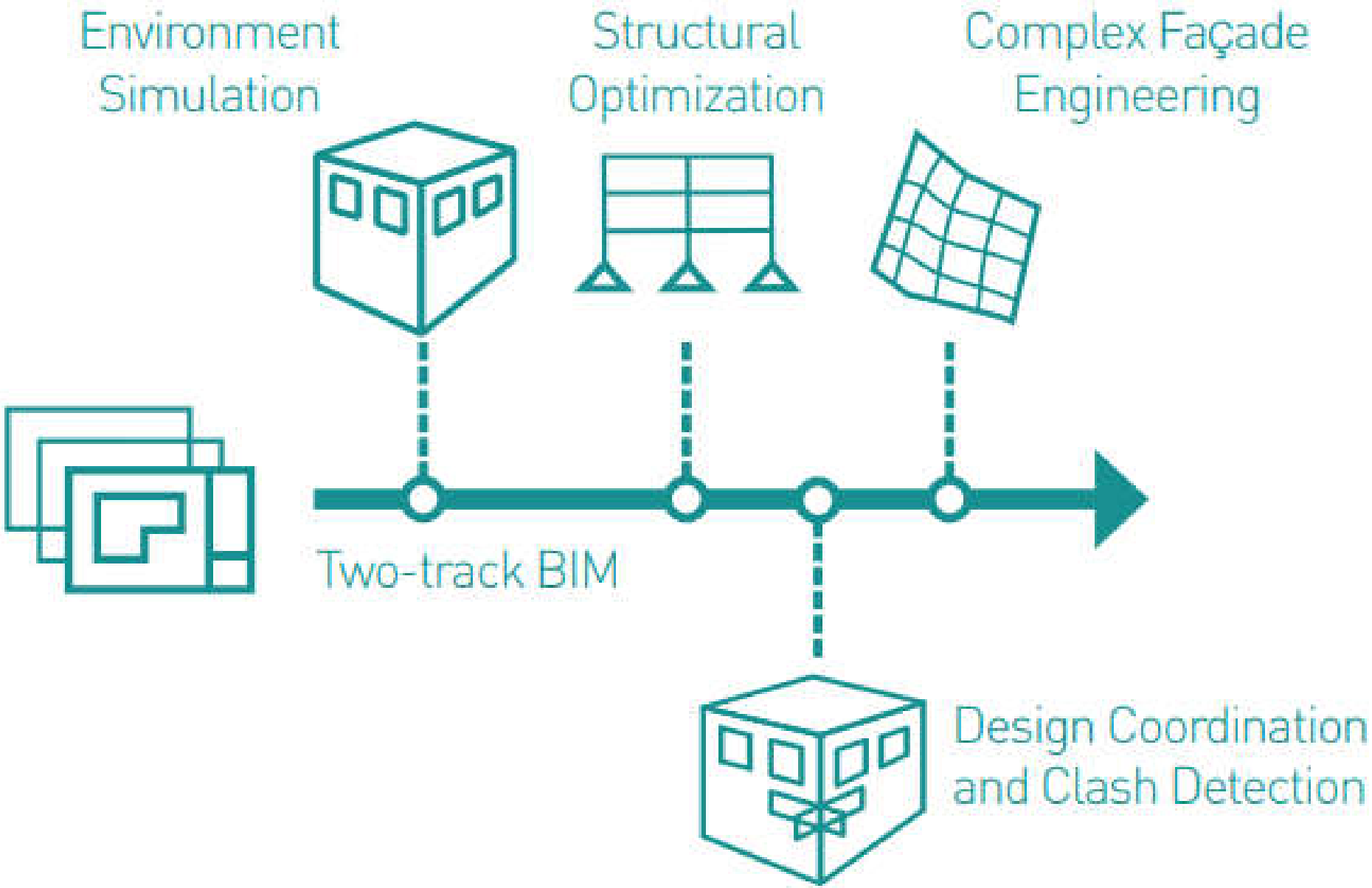
BIM 1.0 2D-3D Conversion BIM

Design Coordination and Clash Detection



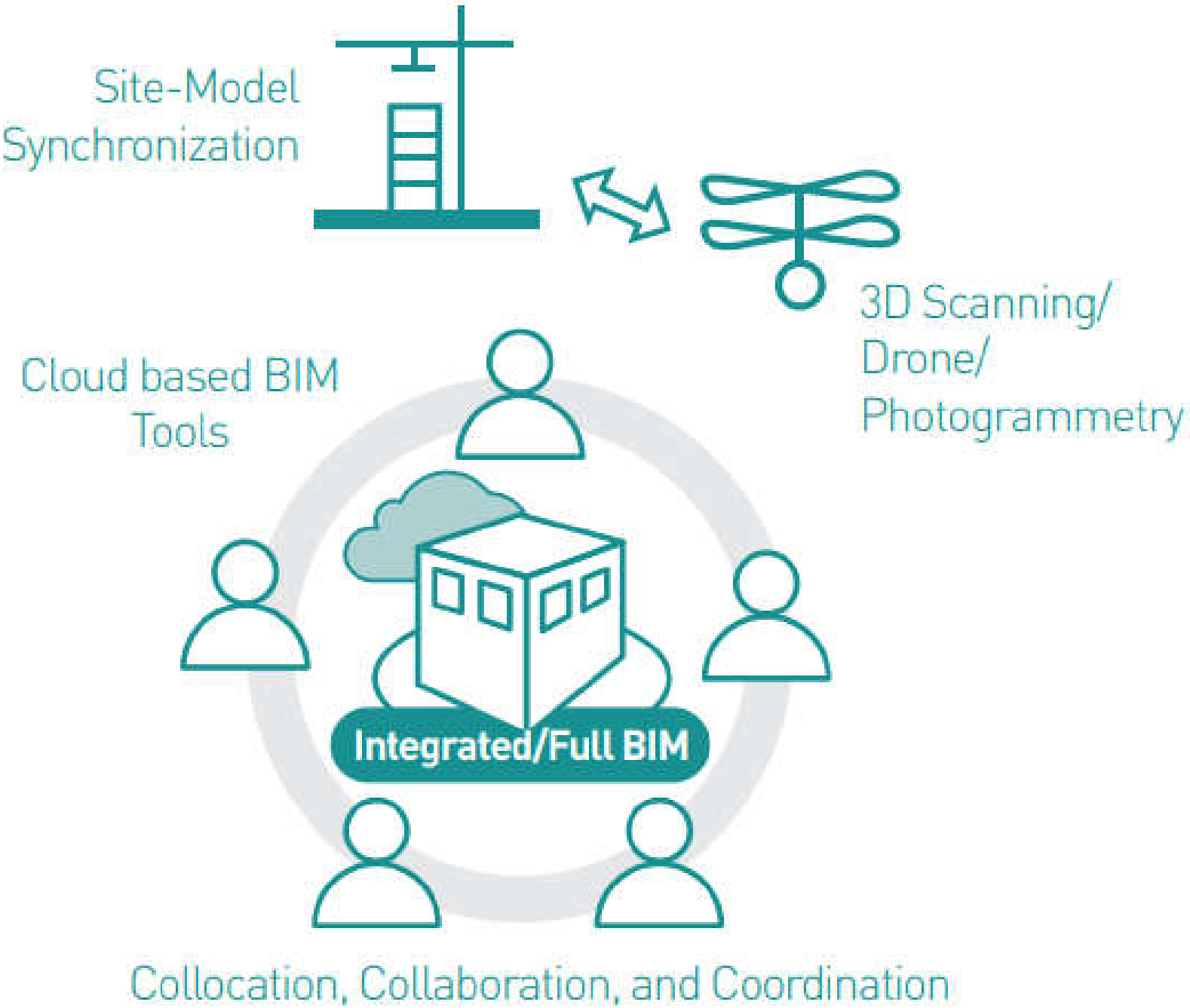
(Source: Rail BIM 2030 roadmap http://big.yonsei.ac.kr/railbim/)

BIM 2.0 Two-track BIM



(Source: Rail BIM 2030 roadmap http://big.yonsei.ac.kr/railbim/)

BIM 3.0 Fully Integrated BIM



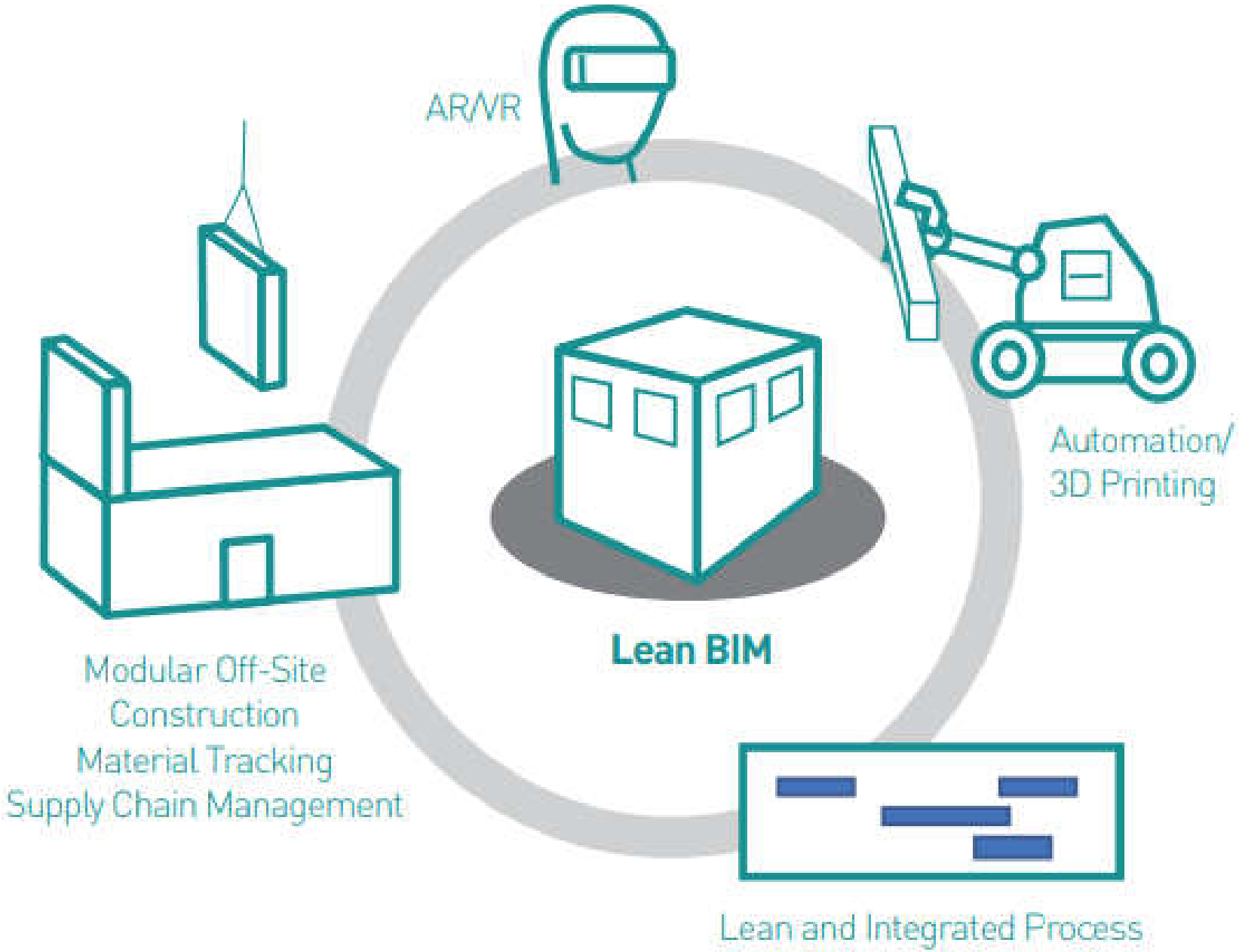
(Source: Rail BIM 2030 roadmap http://big.yonsei.ac.kr/railbim/)

The Future of BIM

- The future generations of BIM:
  - BIM 4.0 -- Lean BIM: Construction projects are carried out using the manufacturing approach, e.g. modular construction, lean construction, off-site construction, and construction automation
  - BIM 5.0 -- Intelligent BIM: Projects are carried out based on informed decision-making using big data and artificial intelligence (a.k.a. connected BIM or linked BIM)

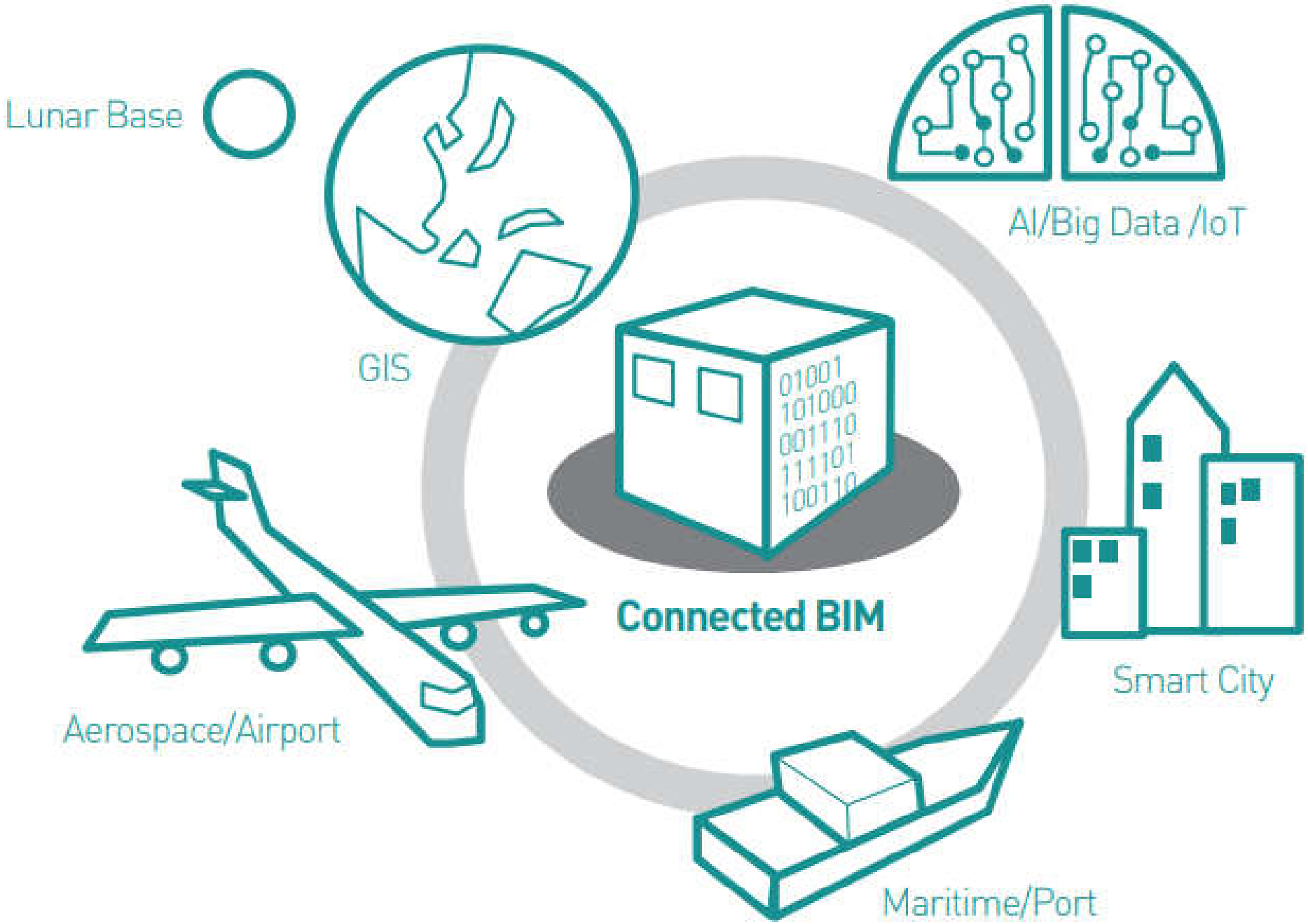
(Source: Rail BIM 2030 roadmap http://big.yonsei.ac.kr/railbim/)

BIM 4.0 Lean BIM



(Source: Rail BIM 2030 roadmap http://big.yonsei.ac.kr/railbim/)

BIM 5.0 Intelligent BIM



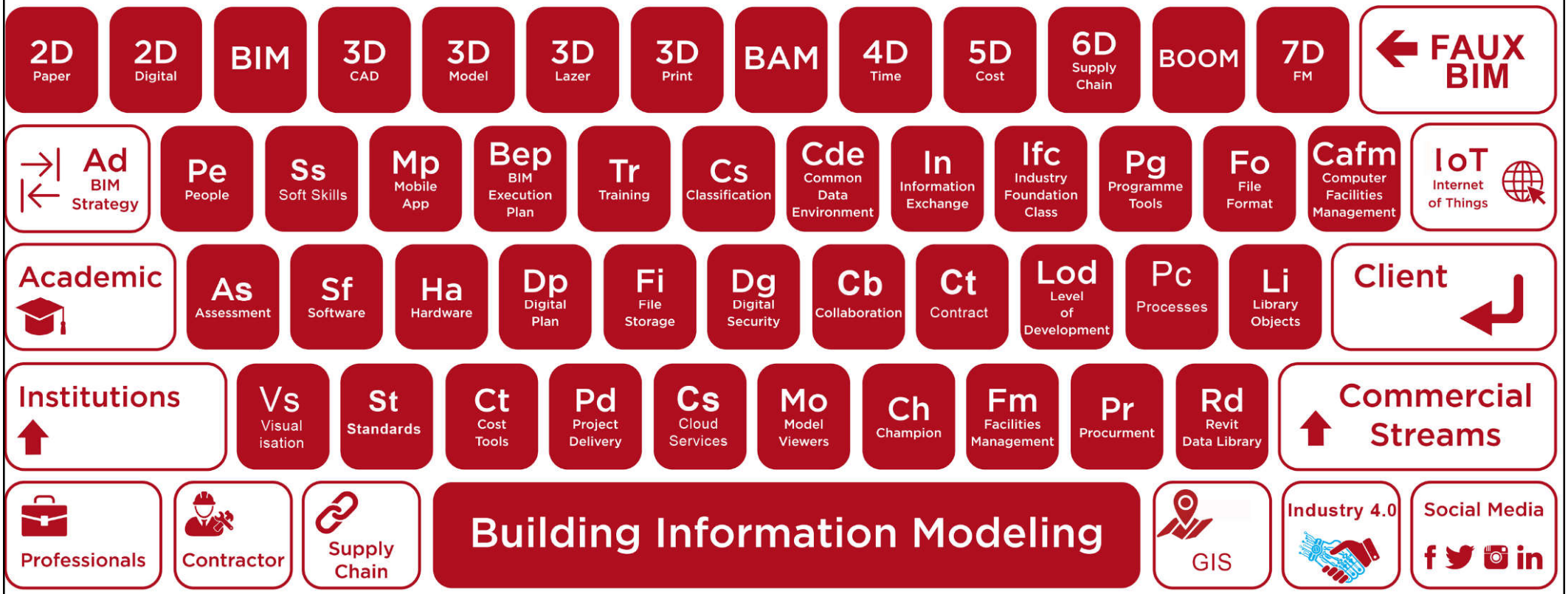
(Source: Rail BIM 2030 roadmap http://big.yonsei.ac.kr/railbim/)

Conclusion

- BIM is the buzzword people are using, but it doesn't tell the whole story
- The Good and the Bad of BIM should be understood & evaluated carefully
- BIM brings significant changes to design, construction and operation of building and construction projects
- The future of BIM depends on innovation and your "Imagination"

THANK YOU 謝謝 !!

The BIM Keyboard



(Source: BIM Keys Explained (BIM Institute) https://navigator.biminstitute.org.za/bim-keys-explained/)