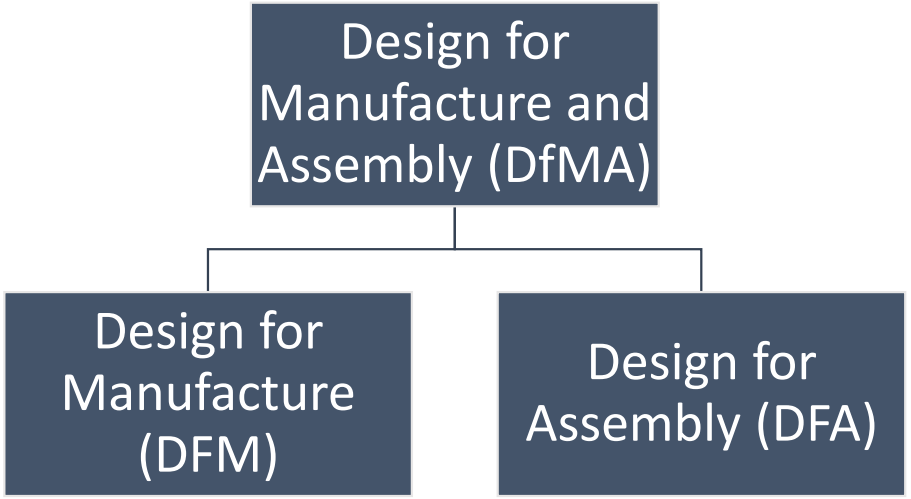
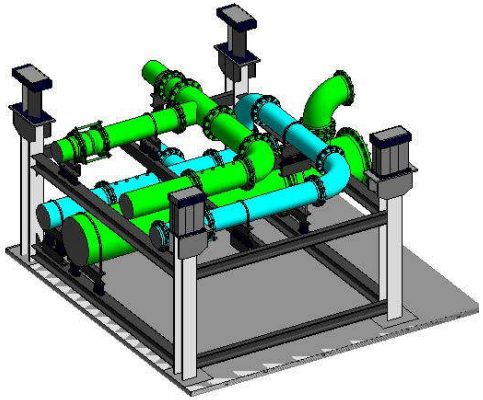
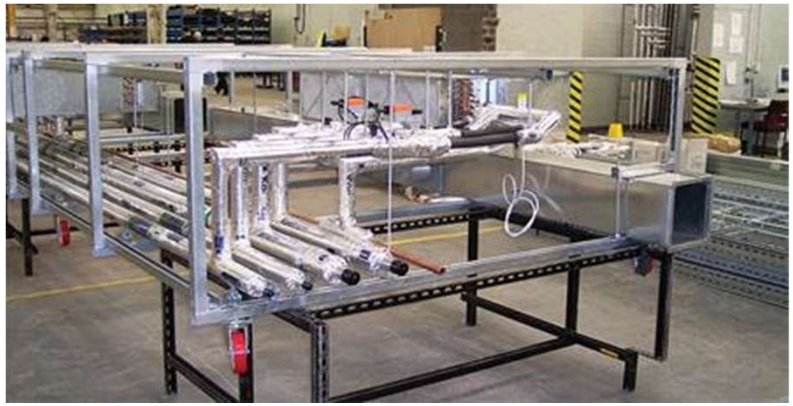
Wider Adoption of DfMA in MEP Works

- DfMA
- DfMA for Construction
- DfMA for MEP
- DfMA for Hong Kong







Design for manufacture and assembly (DfMA)

- A set of principles for enabling a design process that facilitates the optimization of all manufacture & assembly functions and contributes to the minimization of cost & delivery time and the maximization of quality & customer satisfaction
- Originate from production industries
- A potential approach for the construction industry to enhance productivity & quality

(See also: https://www.designingbuildings.co.uk/wiki/Design_for_Manufacture_and_Assembly_(DfMA))

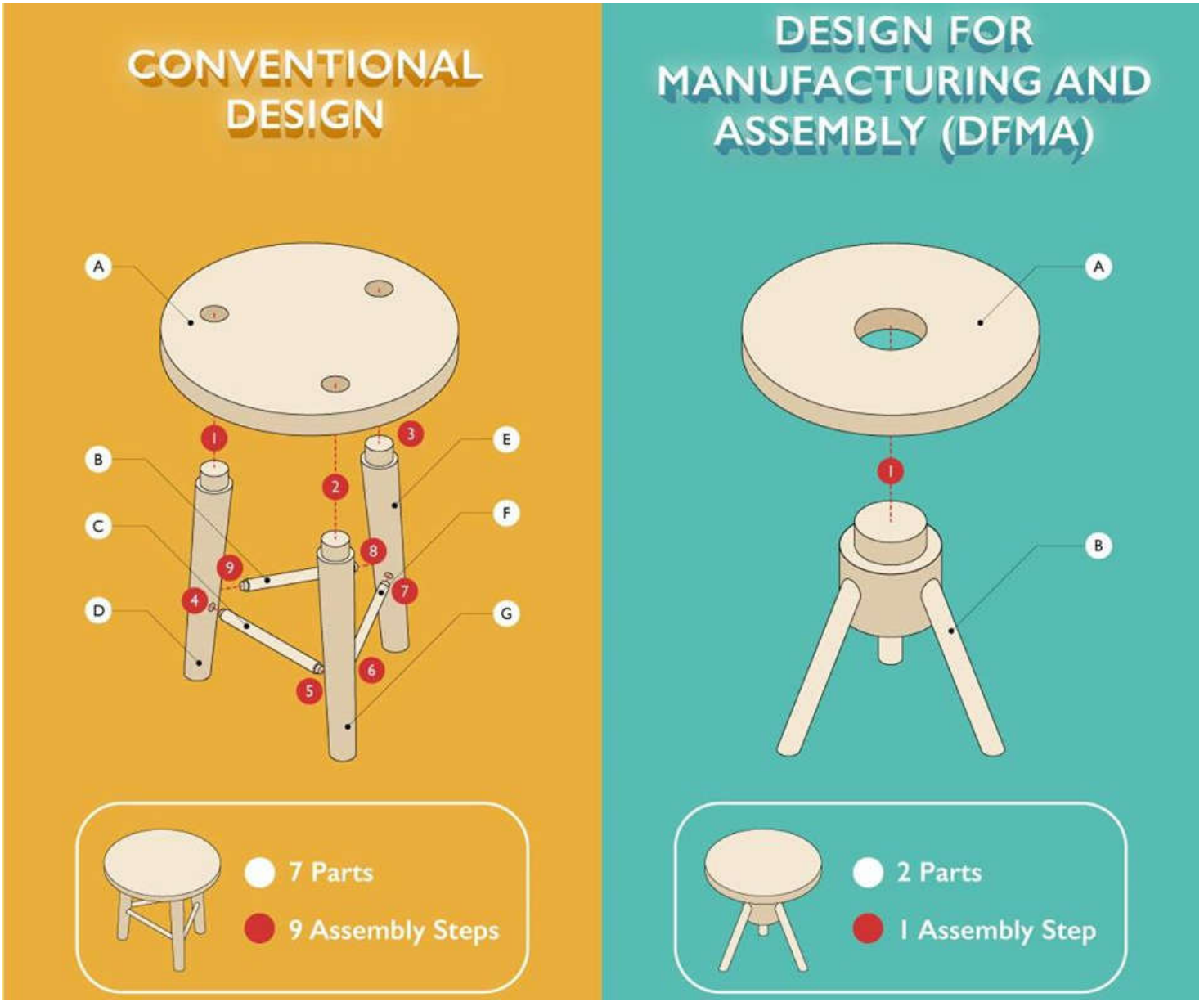
DfMA process

Design for Assembly (DFA)

- Minimize the number of parts
- Optimize for assembly

Design for Manufacture (DFM)

- Best process
- Best materials
- Tolerances
- Optimize process



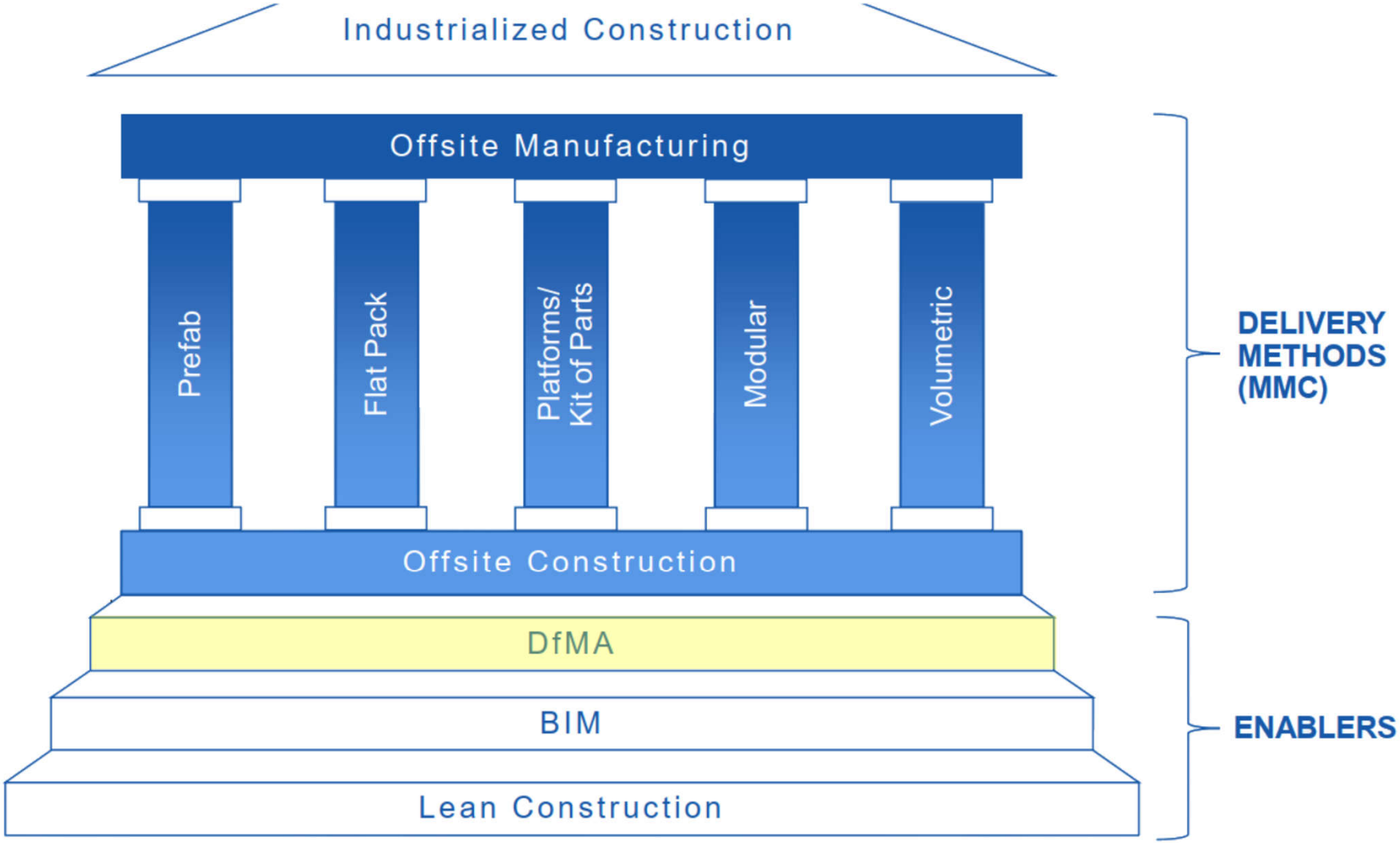
(Image source: CPG Corporation https://www.cpgcorp.com.sg/)

DfMA for Construction

- (a) Holistic & systematic design with DfMA principles
- (b) Work with virtual design & construction (VDC) to assess the efficiency of manufacturing & assembly
- (c) Philosophy to support prefabrication & modular construction technologies
- Facilitated by building information modelling (BIM) & lean construction to enable industrialized construction (IC)

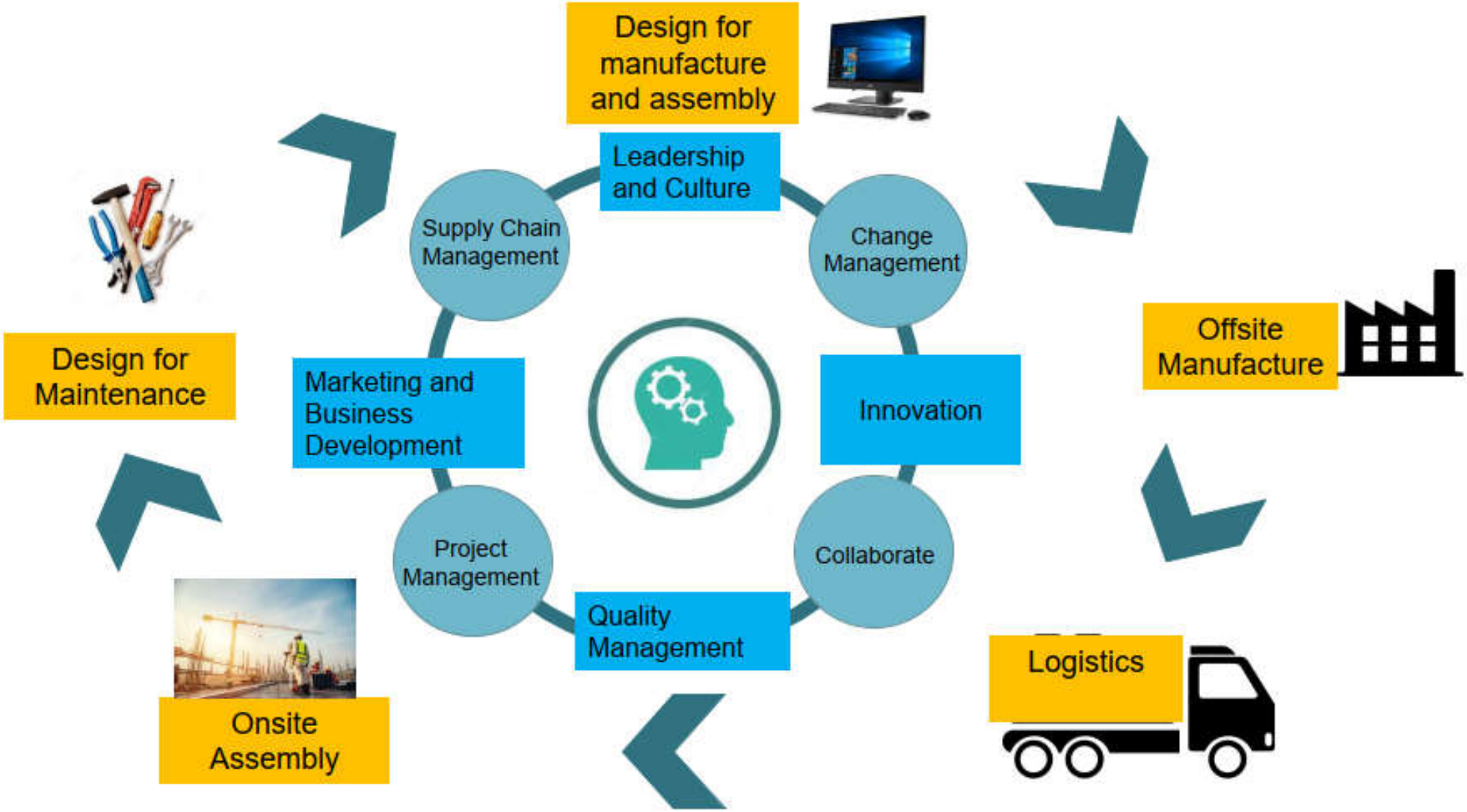
(Ref: Gao S., Jin R. & Lu W., 2020. Design for manufacture and assembly in construction: a review, *Building Research & Information*, 48 (5) 538-550.)

DfMA & Industrialized Construction



(Image source: https://www.autodesk.com/autodesk-university/class/DFMA-and-Industrialization-Construction-2019)

DfMA mindset for construction industry



(Adapted from: RIBA, 2016. *RIBA Plan of Work 2013: Designing for Manufacture and Assembly*, RIBA Publishing, Newcastle upon Tyne, UK.

DfMA for MEP

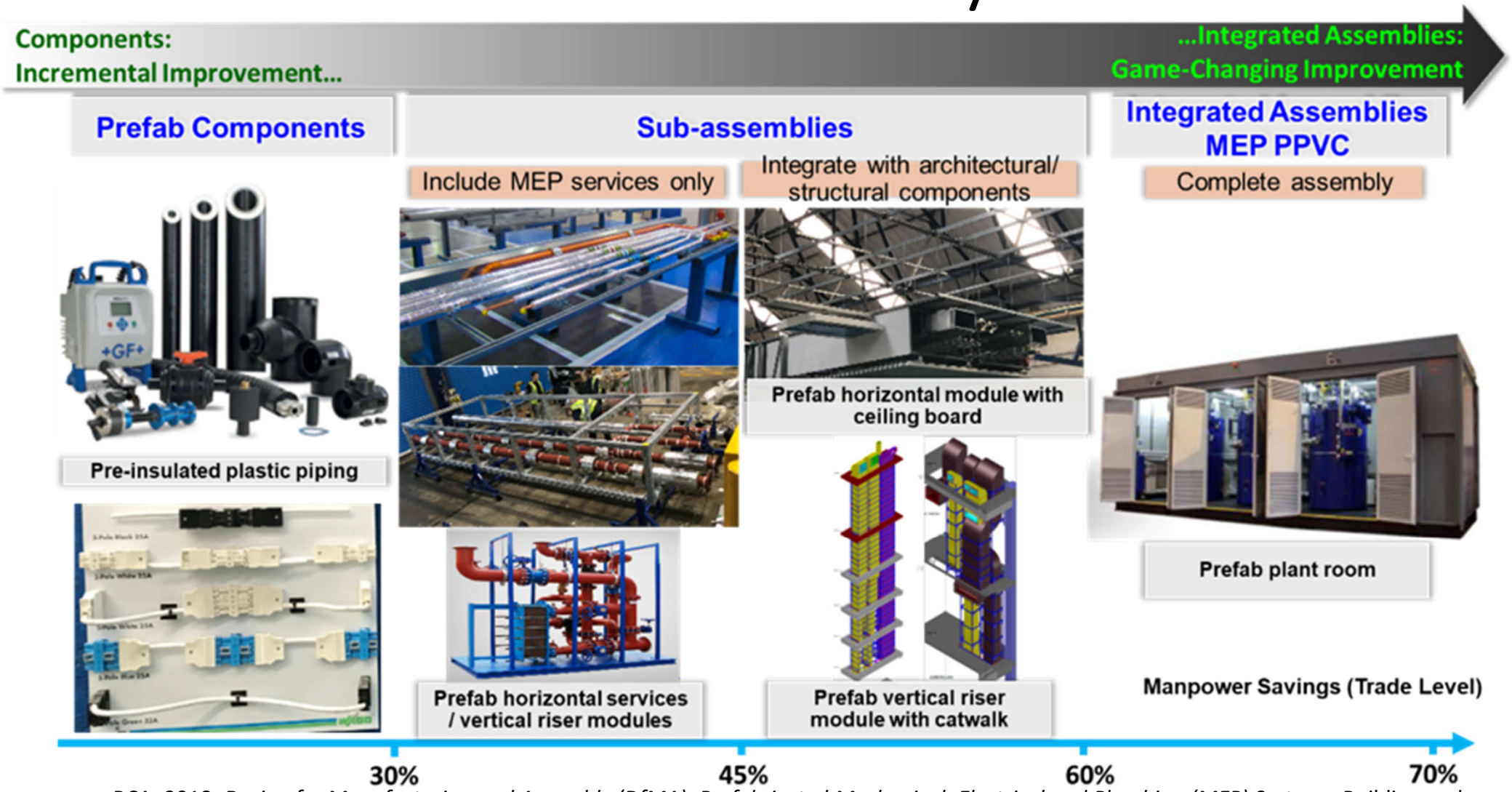
- DfMA & prefabrication to support offsite construction (OSC) of building services (MEP) elements
- Degree of DfMA adoption
  - Lower level: site assembly + standardization + some prefab elements
  - Higher level: highly standardized + prefab components/assemblies
  - Highest level: prefab components /assemblies + high modularization & integration + highest standardization

Major MEP elements suitable for prefabrication

Building services systems	Major elements
Mechanical ventilation & air conditioning	- Air duct system - Water pipework & fitting - Refrigerant pipework & fitting - Air conditioning equipment (e.g. air handling unit)
Fire services	- Water pipework & fitting - Pump sets & fittings
Plumbing & drainage	- Water supply pipework & fitting - Drainage pipework & fitting - Pump sets & fittings - Bathroom & toilet sanitary fittings
Electrical services	- Cable & busbar trunkings - Conduits & wiring - Power outlets & telecommunication - Electrical switchgear

(Ref: Hui S. C. M. & Or G. K. C., 2005. Study of prefabricated building services components for residential buildings in Hong Kong, In *Proceedings of the Hubei-Hong Kong Joint Symposium 2005*, 1-2 July 2005, Wuhan, China, pp. 88-97. http://ibse.hk/cmhui/hubei2005.pdf)

Prefabricated MEP systems



(Image source: BCA, 2018. *Design for Manufacturing and Assembly (DfMA): Prefabricated Mechanical, Electrical and Plumbing (MEP) Systems*, Building and Construction Authority (BCA), Singapore.)

DfMA and levels of offsite

Level	Category	Definition
1	Component manufacture & subassembly	Items always made in a factory and never considered for on-site production
2	Non- volumetric preassembly	Pre-assembled units which do not enclose usable space (e.g. timber roof trusses, flat panel units, panelised systems)
3	Volumetric preassembly	Pre-assembled units which enclose usable space and are typically fully factory finished internally, but do not form the buildings structure (e.g. toilet and bathroom pods)
4	Modular systems or buildings	Pre-assembled volumetric units which also form the actual structure and fabric of the building (e.g. prison cell units or hotel/ motel rooms)
5	Hybrid system	Consists of a combination of any two or more volumetric or nonvolumetric systems (extensively used in commercial and residential buildings)

(Ref: Arif M., Bendi D., Sawhney A. & Iyer K. C., 2012. State of offsite construction in India-Drivers and barriers, *Journal of Physics: Conference Series*, 364: 12109.)

DfMA for Hong Kong

- Precast concrete & prefabrication for housing projects
- Construction 2.0 & key initiatives to enhance productivity & sustainable/green building (BEAM Plus)
- Prefab components & DfMA approach for infrastructure & building projects
- Promotion of modular integrated construction (MiC)
- Wider adopton of DfMA approach & thinking

Key challenges & initiatives in Hong Kong

Key challenges	Key initiatives
• **Significant future construction volumes** • **High costs** • **Unsatisfactory site safety performance** • **Declining productivity** • **Lack of creativity and innovation**	• Offsite construction (DfMA and MiC) • Building Information Modelling • Smart infrastructure • Uplifting project governance and leadership • Professional development • Attracting and nurturing young talents • Project Management Information Systems • Digitalization of site management

(Ref: DevB, 2018. *Construction 2.0: Time to Change*, Development Bureau (DevB), Hong Kong. https://www.psgo.gov.hk/assets/pdf/Construction-2-0-en.pdf)

DfMA development in Hong Kong & other places

Hong Kong & Greater Bay Area – factories & logistics

Strategies to drive DfMA adoption in Hong Kong