

*BIM
Based
Prefab*

BIM BASED PREFABRICATION

BIM – The Next Step into the Future
Leibniz University, Hannover, Germany
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ENVISIONING THE FUTURE FOR CONSTRUCTION

Construction Productivity Improvement Research Roadmap Study

GLOBAL SCANNING OF POTENTIAL TECHNOLOGIES

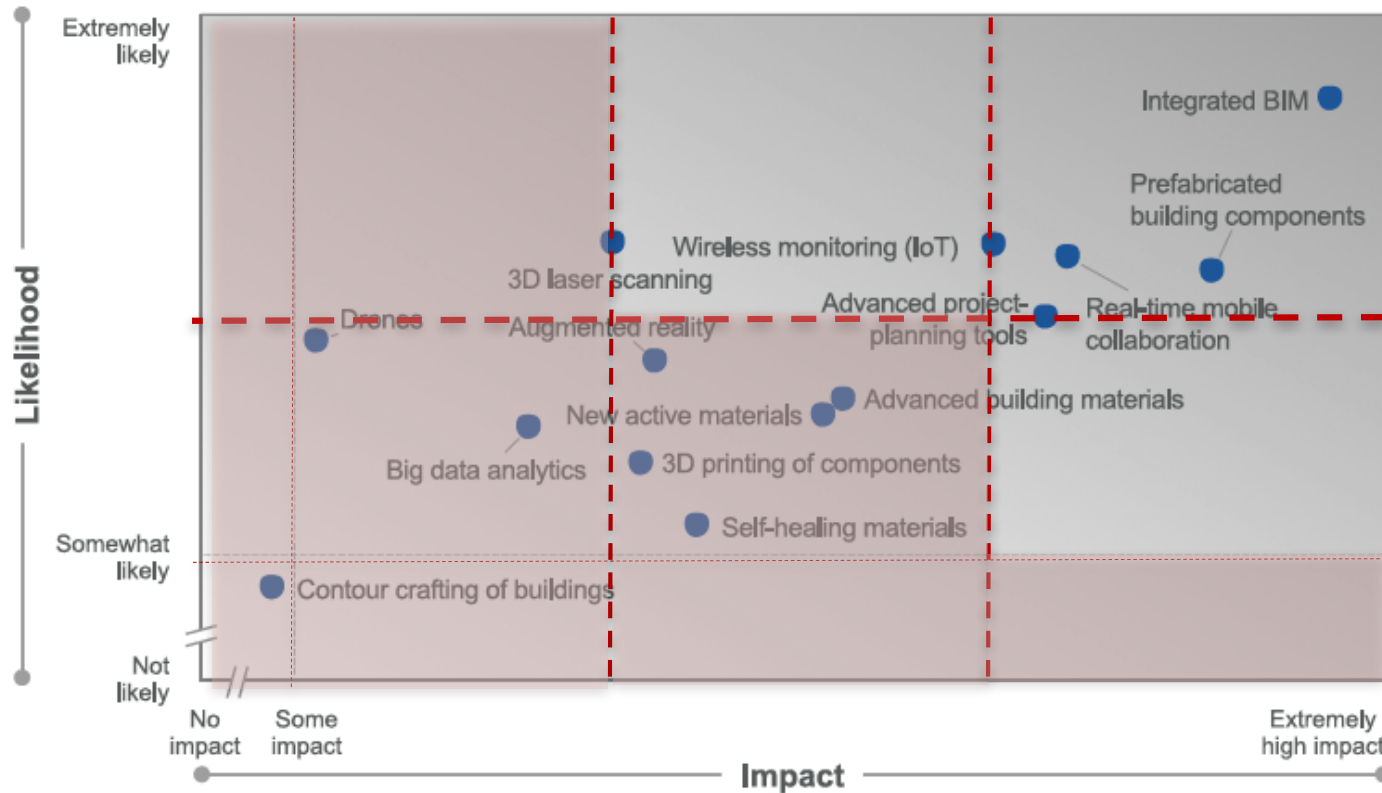
Through secondary research, trend analysis and workshop discussions, a long list of **150 technologies/applications** were identified.

Over 150 Technologies/
Applications Identified Through Our Initial Scan

Topic	Application
3D Printing	Low Volume, Highly Customised Components
3D Printing	Combining robots and 3-D printing (e.g. Tiling)
3D Printing	Robotics Site inspection robots (collaborative)
3D Printing	Robotics Assistive robots to lift heavy parts/equipment
3D Printing	Robotics Intelligent inventory management system
3D Printing	Robotics BIM BIM for As-Built Verification
3D Printing	Robotics ICT BIM Predictive BIM modeling
3D Printing	Robotics ICT BIM Interoperability of BIM (pre-con)
3D Printing	Robotics ICT BIM Competency of workers e.g. master craftsmen, guides
3D Printing	Robotics ICT BIM Making sure that model has been used exp MOH (post construction)
3D Printing	Robotics ICT BIM Construction Coordination
3D Printing	Robotics ICT BIM For assembly of precast elements
3D Printing	Robotics ICT BIM Safety Inspections
3D Printing	Robotics ICT BIM Marketing Tools
PPVC	Robotics ICT BIM AR/VR Category
PPVC	Robotics ICT BIM AR/VR Application
PPVC	Robotics ICT BIM AR/VR Advanced Materials Materials for 3D printing (molds)
PPVC	Robotics ICT BIM AR/VR Advanced Materials Self-cleaning materials (TiO2, photo catalytic)
PPVC	Robotics ICT BIM AR/VR Advanced Materials Concrete Increase porosity
PPVC	Robotics ICT BIM AR/VR Advanced Materials Concrete Air-entrained concrete
PPVC	Robotics ICT BIM AR/VR Advanced Materials Concrete Fly ash concrete
PPVC	Smart ICT BIM AR/VR Advanced Materials Concrete Recycled material for self-compacting concrete
PPVC	Smart ICT BIM AR/VR Advanced Materials Concrete Optimization of mix design of self-compacting concrete
PPVC	Smart ICT BIM AR/VR Advanced Materials Concrete Timber Hybrid/Composite use
PPVC	Smart ICT BIM AR/VR Advanced Materials Concrete Timber Schools function halls
PPVC	Smart ICT BIM AR/VR Advanced Materials Concrete Timber Roofing structure - light & heat insulation using CLT
PPVC	Smart ICT BIM AR/VR Advanced Materials Concrete Timber Composite/hybrid construction
PPVC	Smart ICT BIM AR/VR Advanced Materials Concrete Timber Integrated cassette floor system
PPVC	Smart ICT BIM AR/VR Advanced Materials Concrete Timber Using wood panel for acoustic insulation
PPVC	Smart ICT BIM AR/VR Advanced Materials Concrete Timber Building envelope - roof + façade
PPVC	Smart ICT BIM AR/VR Advanced Materials Concrete Timber Curtain wall
PPVC	Smart ICT BIM AR/VR Advanced Materials Concrete Timber Upgrade existing buildings with timber components
PPVC	Smart ICT BIM AR/VR Advanced Materials Concrete Timber Hybrid structure of concrete + CLT in floors
PPVC	Smart ICT BIM AR/VR Advanced Materials Concrete Timber Wall and ceiling claddings
PPVC	Smart ICT BIM AR/VR Advanced Materials Concrete Timber Bus/car shelter link ways
PPVC	Smart ICT BIM AR/VR Advanced Materials Concrete Timber Open building "shelter"
PPVC	Smart ICT BIM AR/VR Advanced Materials Concrete Timber Timber bridges
PPVC	Smart ICT BIM AR/VR Advanced Materials Concrete Steel Ultra-high strength steel
PPVC	Smart ICT BIM AR/VR Advanced Materials Concrete Steel Sound proofing - thin/insulate damping film
PPVC	Smart ICT BIM AR/VR Advanced Materials Concrete Steel Galvanizing
PPVC	Smart ICT BIM AR/VR Advanced Materials Concrete Steel Spray-on fireproofing
PPVC	Smart ICT BIM AR/VR Advanced Materials Concrete Steel Update construction methods to integrate steel works
PPVC	Smart ICT BIM AR/VR Advanced Materials Concrete Steel Self-healing steel - memory alloy for impact areas
PPVC	Smart ICT BIM AR/VR Advanced Materials Concrete Steel Green mark
PPVC	Smart ICT BIM AR/VR Advanced Materials Concrete Steel Steel-frame PPVC modules

NEW TECHNOLOGIES IN PERSPECTIVE

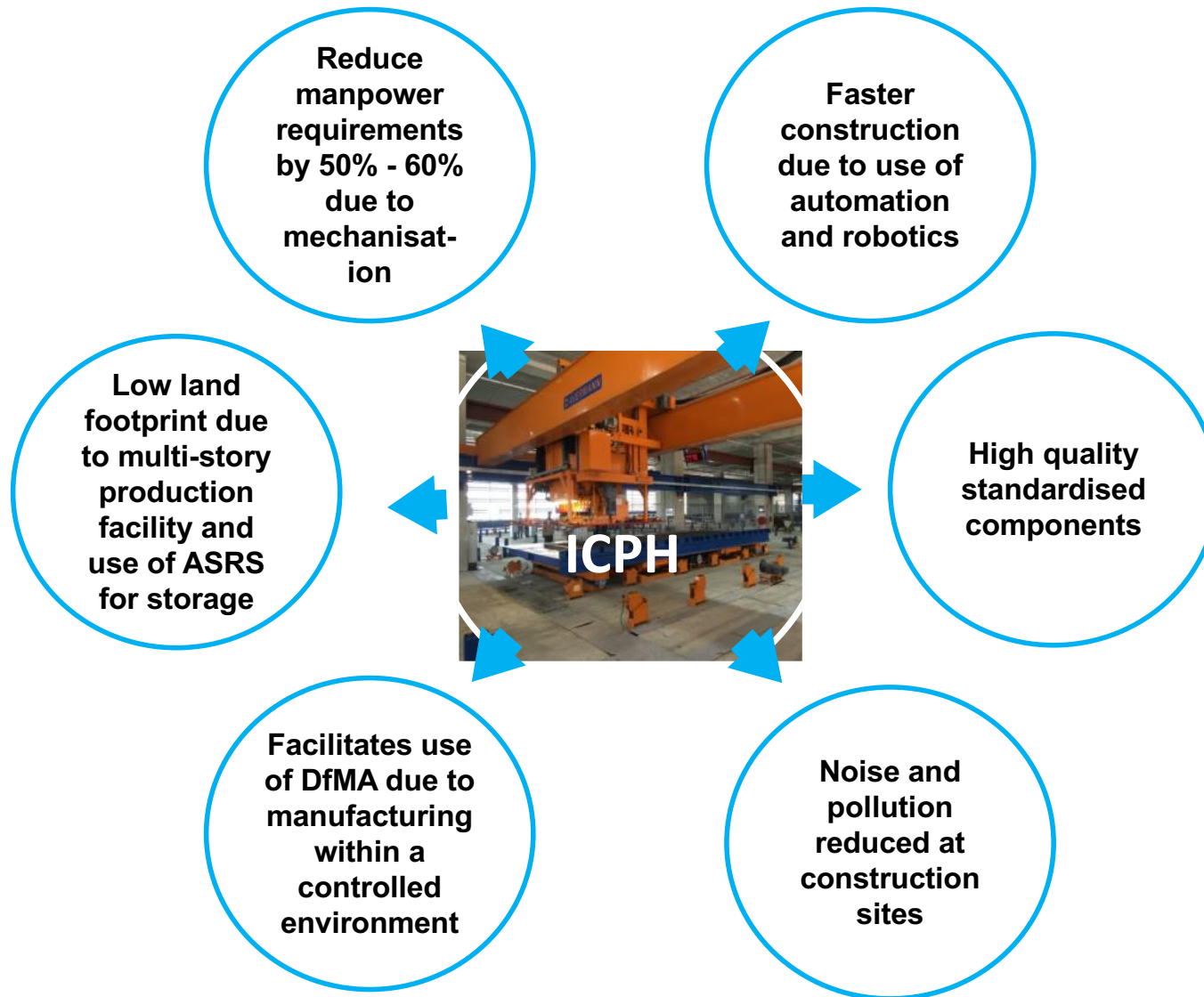
Impact-likelihood matrix of new technologies



Source: Future of Construction Survey Taken from Report by BCG, Shaping the Future of Construction

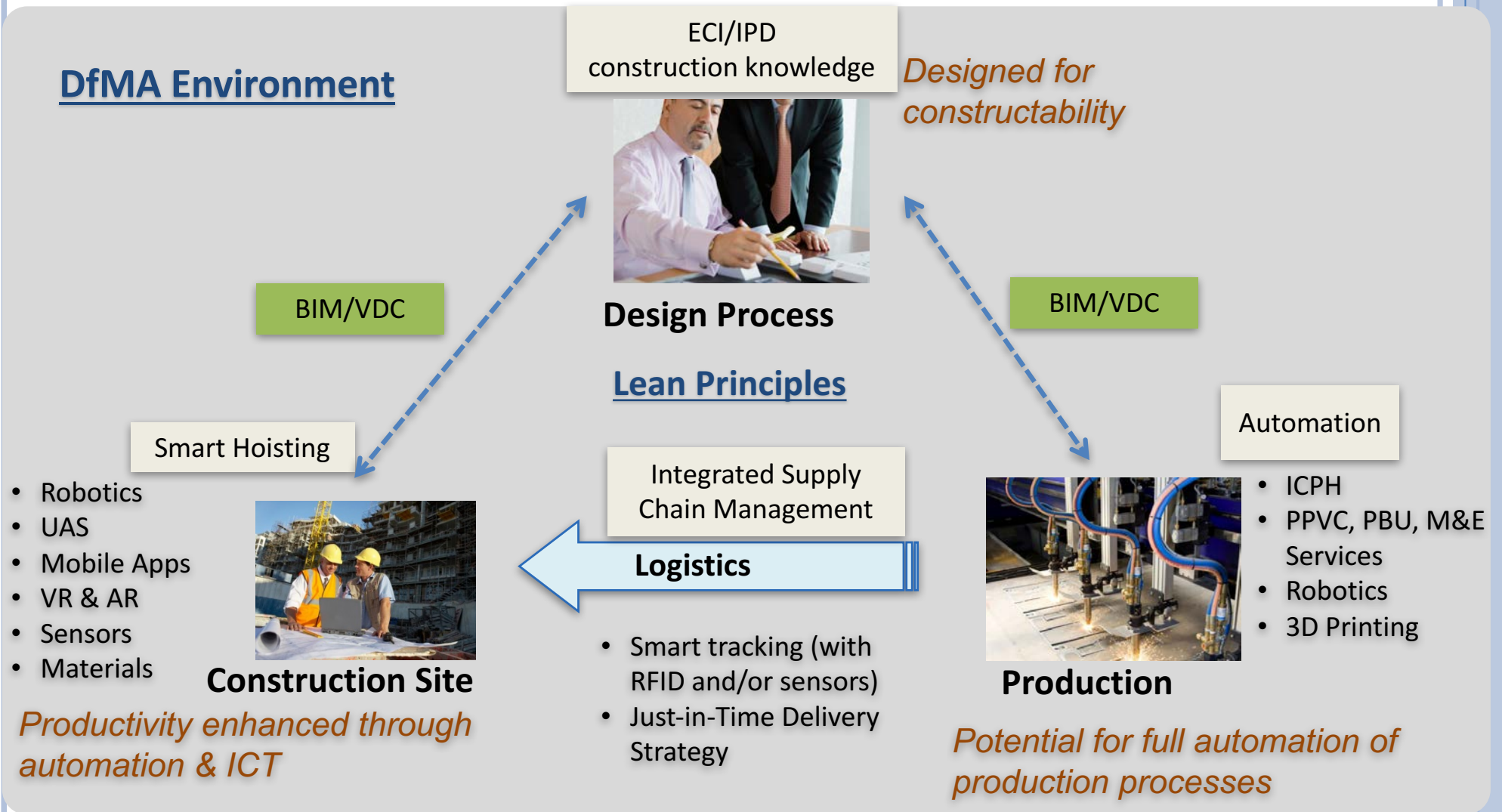
CONSTRUCTION IN FUTURE – ICPH AS AN ENABLER

The ICPH will be a key enabler of Singapore’s strategy, providing an off-site environment where construction can be automated, mechanised and standardised.



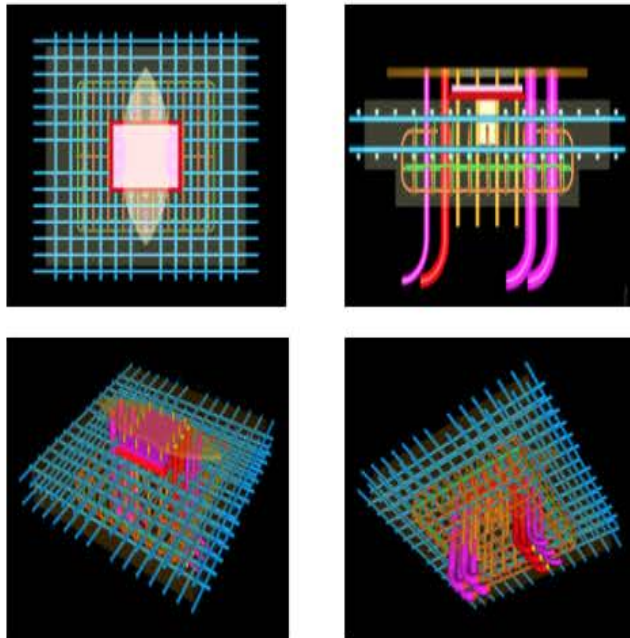
CONSTRUCTION OF THE FUTURE

Design and Construction tightly integrated in a DfMA environment enabled by BIM in a VDC process that is undergirded by lean principles implementation



DFMA SOLUTION FOR A SITE PROBLEM

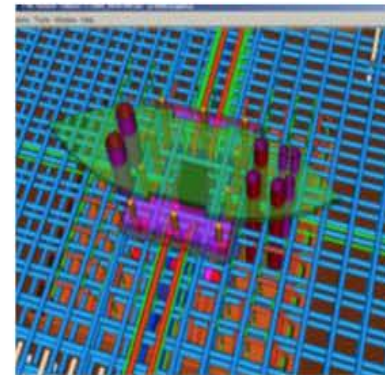
West Deck Re-design



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West Deck Results



A **buildable** solution in the model



The **built** solution in the field

Reported savings of \$170,000 just on PIP installations

©2014

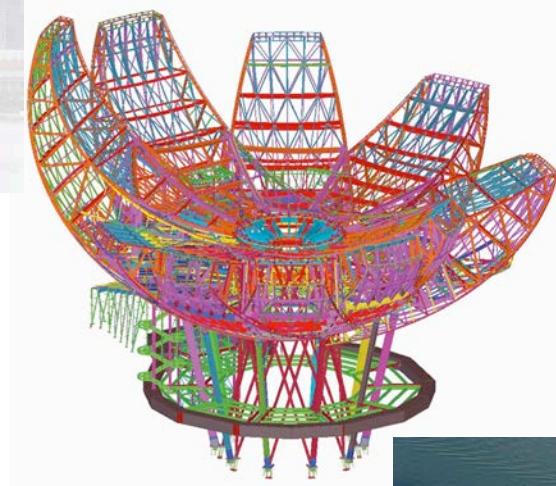
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PREFABRICATED STEEL STRUCTURES



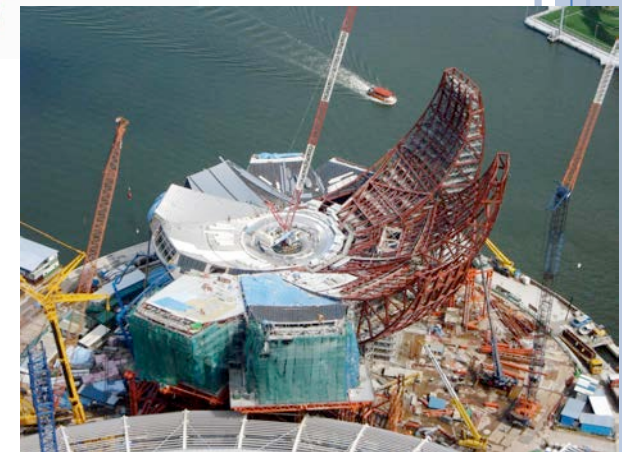
ArtScience Museum at Marina Bay

Unique steel structure measures 165m in height and resembles an open lotus.
Total steel tonnage: 5,000 tonnes



With BIM, Yongnam was able to

- Identify the complexity of the fabrication
- Generate key data for the fabrication
- Reconcile cladding skin of the structure
- Detail complex jointing system



PREFINISHED, PREFABRICATED AND VOLUMETRIC CONSTRUCTION

Crowne Plaza Changi Airport Hotel Extension

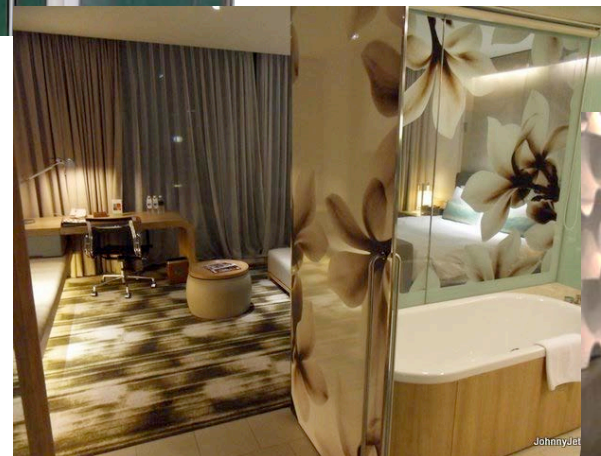
Moving to manufacturing and assembly



Add another 243 rooms to the existing 320

Pre-fabricated interiors

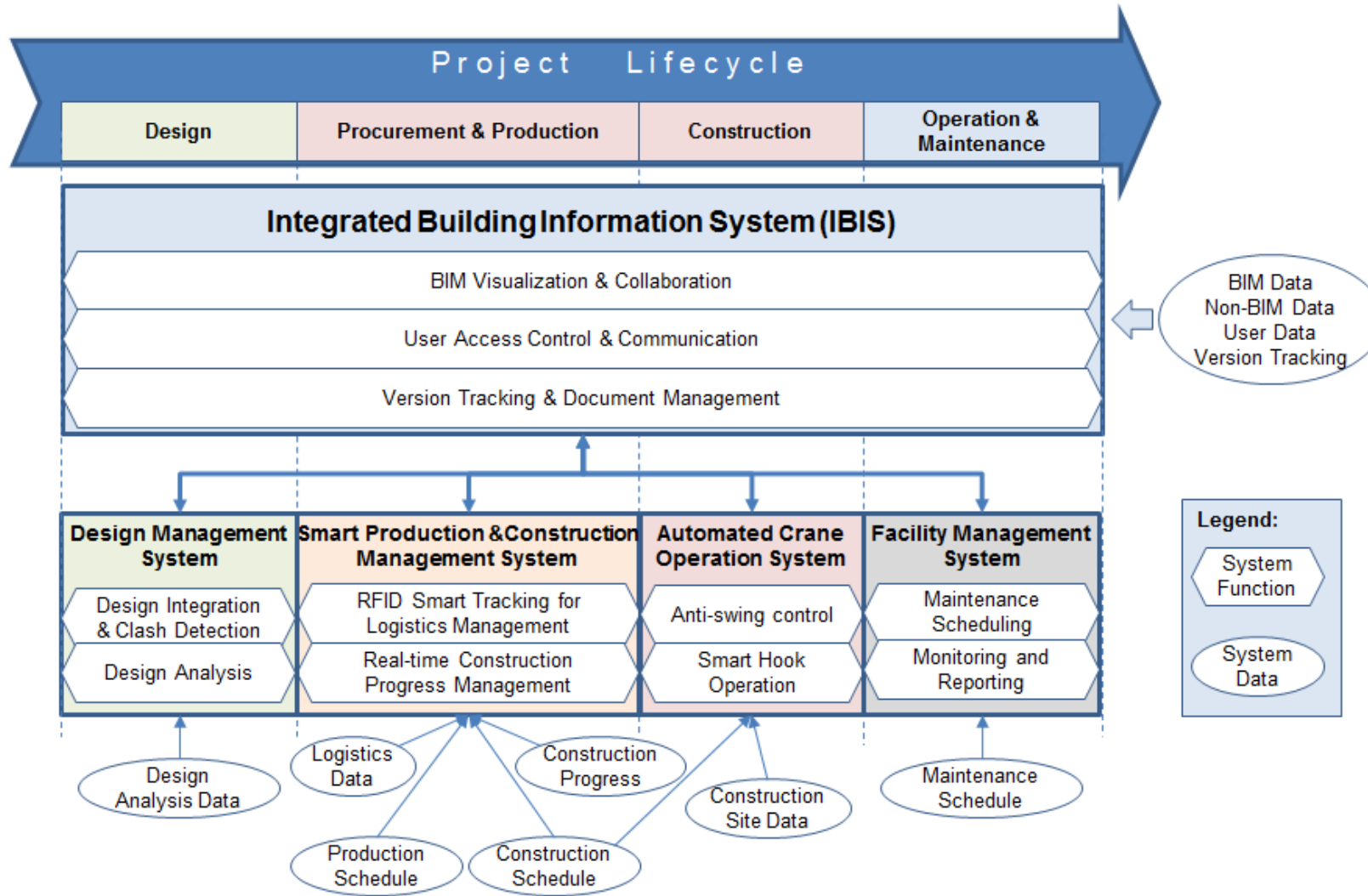
- Complete launching in 26 days
- 45% reduction in manpower on site
- 17% reduction in construction time
- 40% manpower savings overall



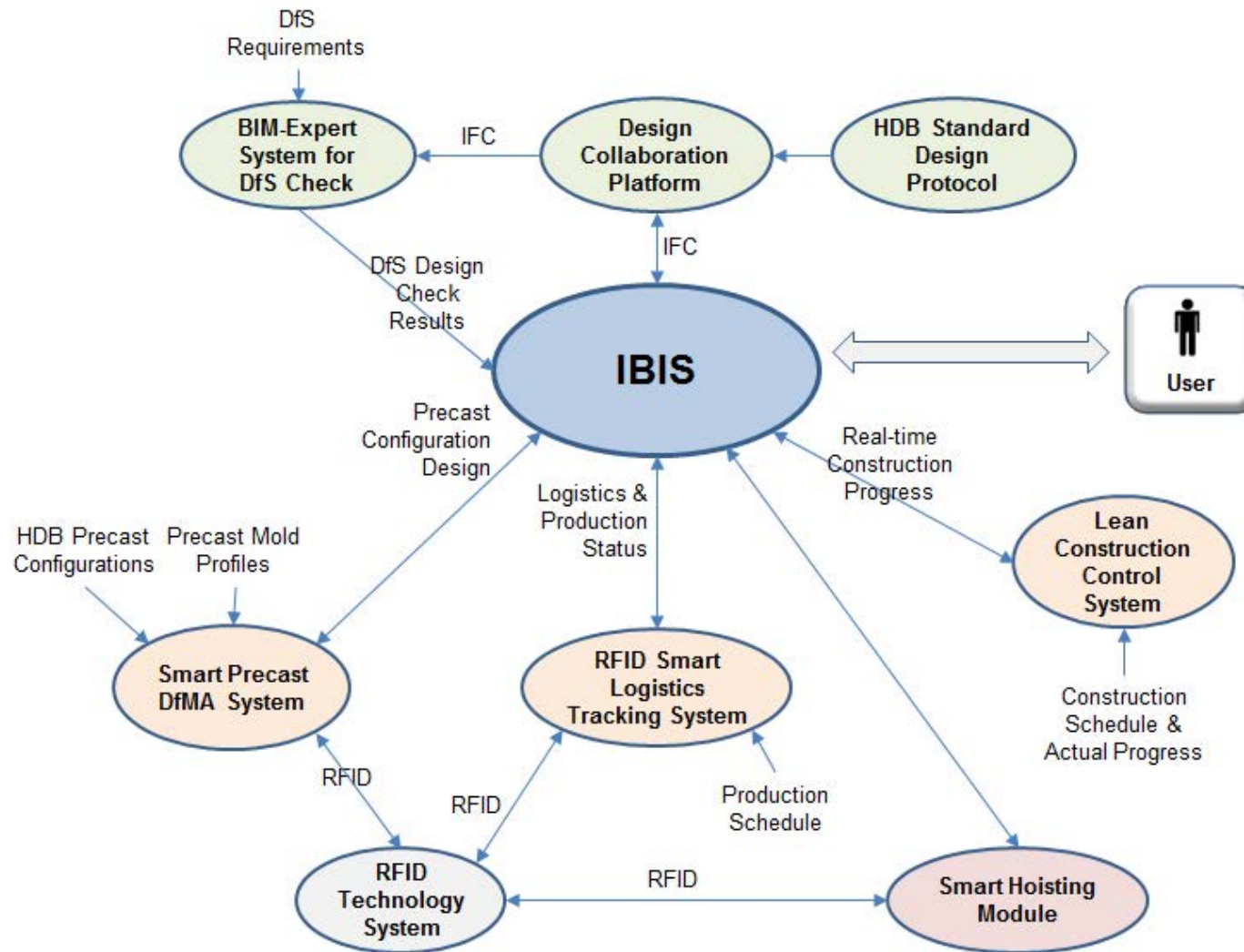
SYSTEM FOR ENABLING DFMA CONSTRUCTION

Based on a proposal

INTEGRATED BUILDING INFORMATION SYSTEM



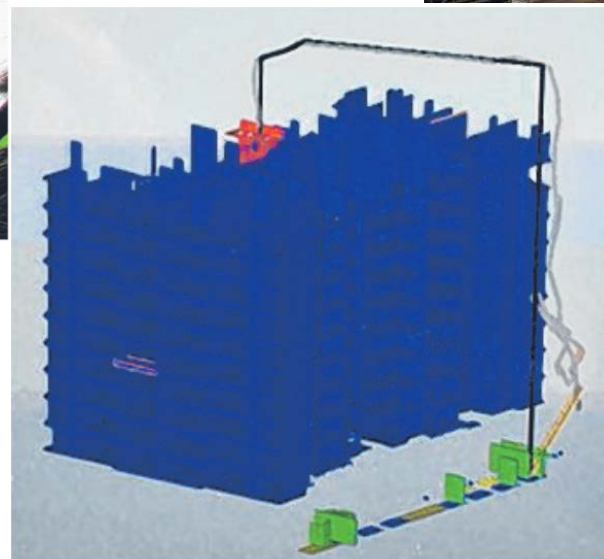
PROPOSED SYSTEM INTEGRATION



SMART HOISTING



Instead of handwritten labels, each precast component has its own RFID tag – enables supply chain tracking system.



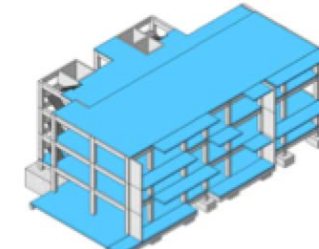
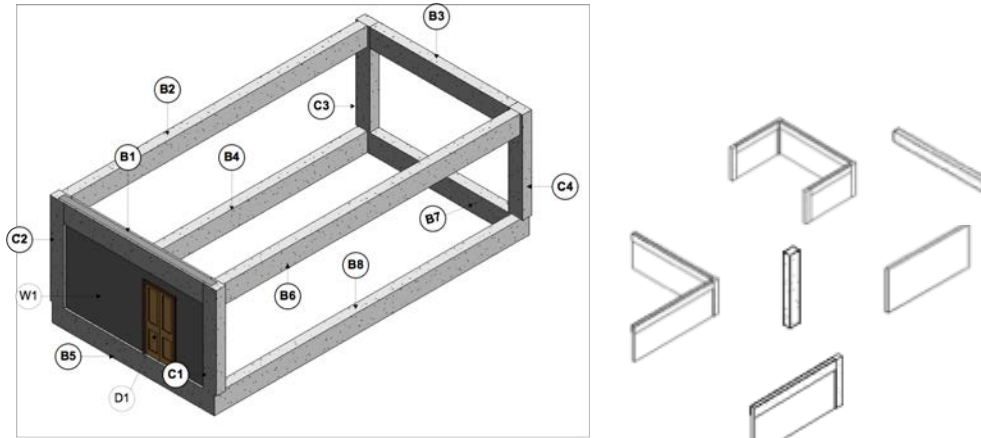
Smart path - determines ideal lifting path

Integrated Building Information System – design collaboration, smart production, smart hoisting

RESEARCH COMPONENTS OF THE SYSTEM

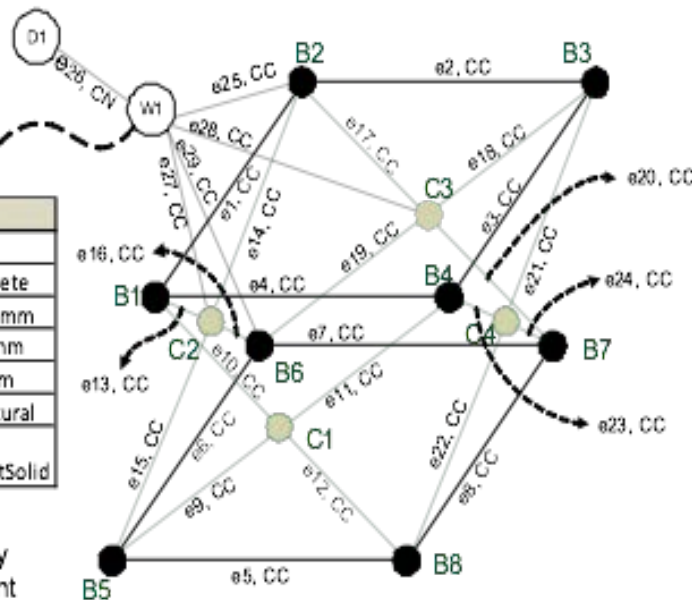
Completed and On-going work

SMART PRECAST DFMA SYSTEM



NodeID: W1	
Type	Wall
Material	Concrete
Length	1000mm
Height	3000mm
Thickness	300mm
Functionality	Structural
Geo-Representati	SweptSolid

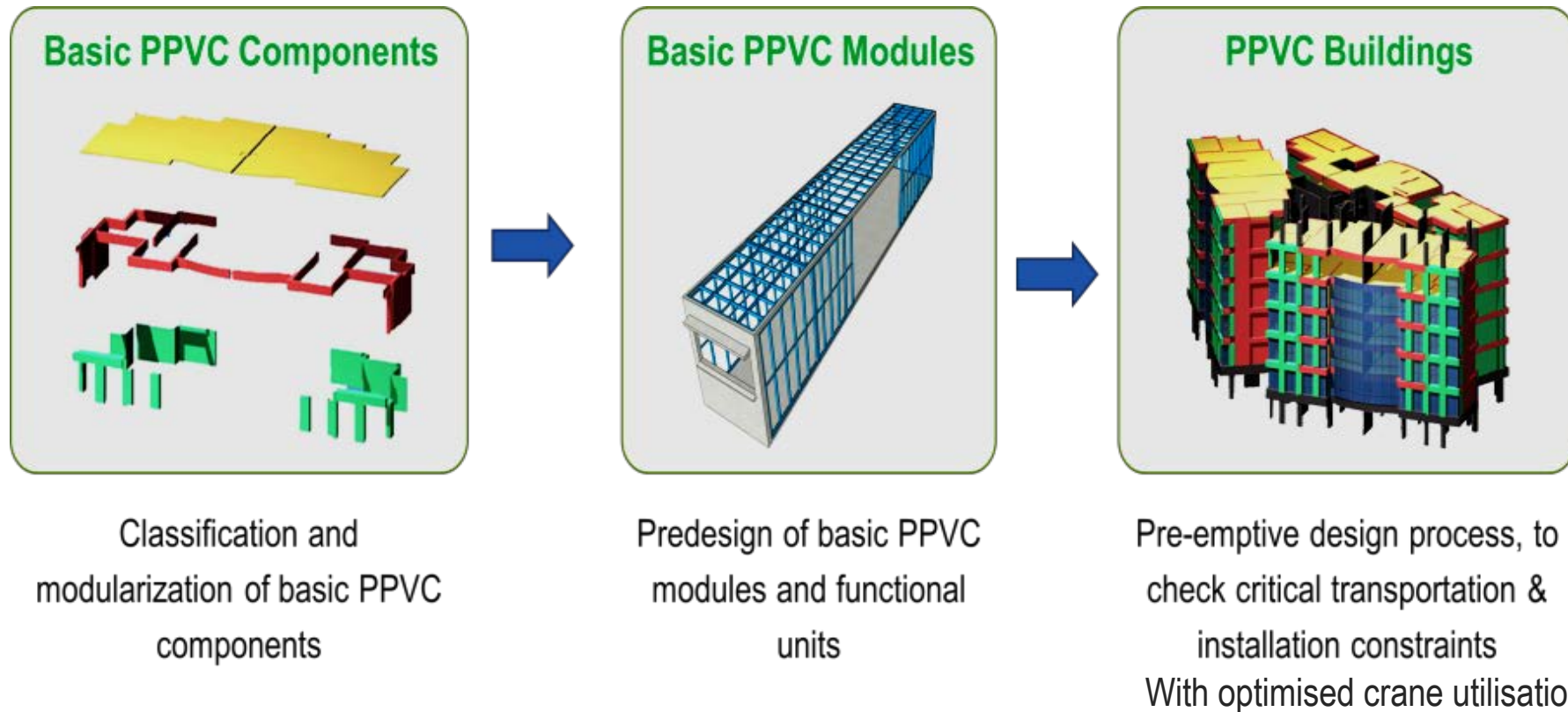
Legend:
 CC: Connectivity
 CN: Containment



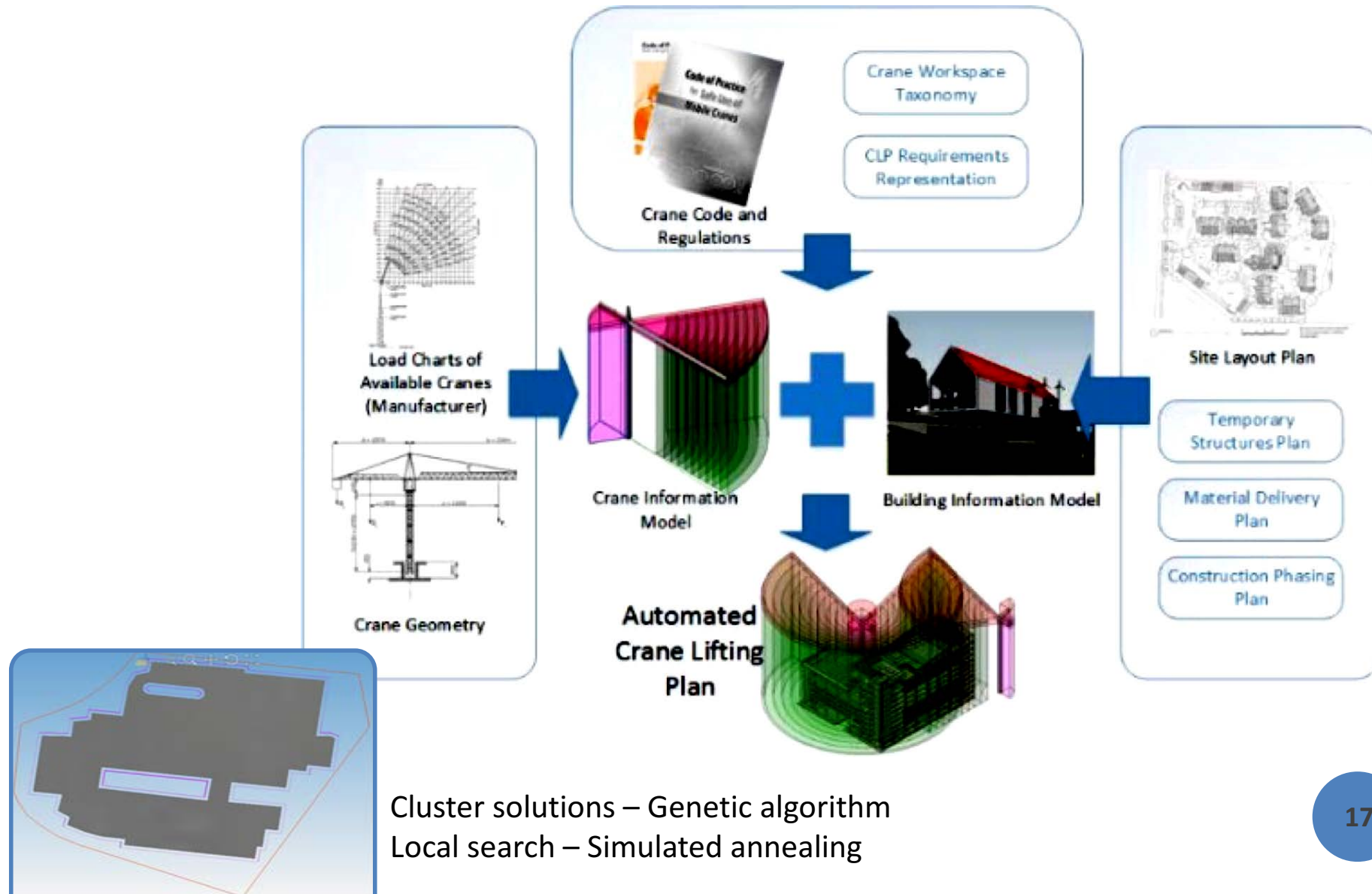
Graph Data Model and Topological Relationships

GA with tabu-search and isomorphism algorithms for optimal mould numbers based on desired installation cycle

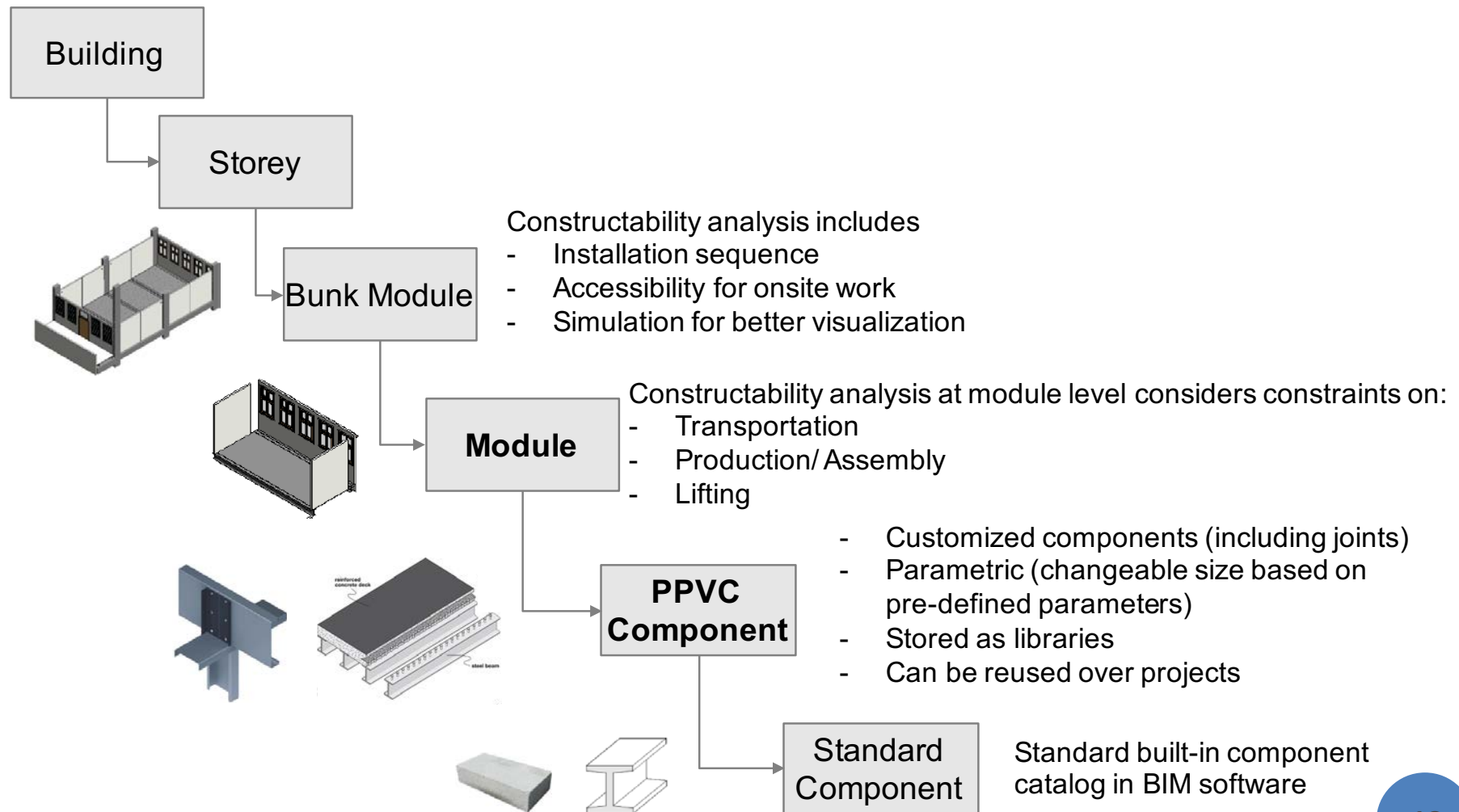
BIM PLATFORM FOR PPVC DESIGN



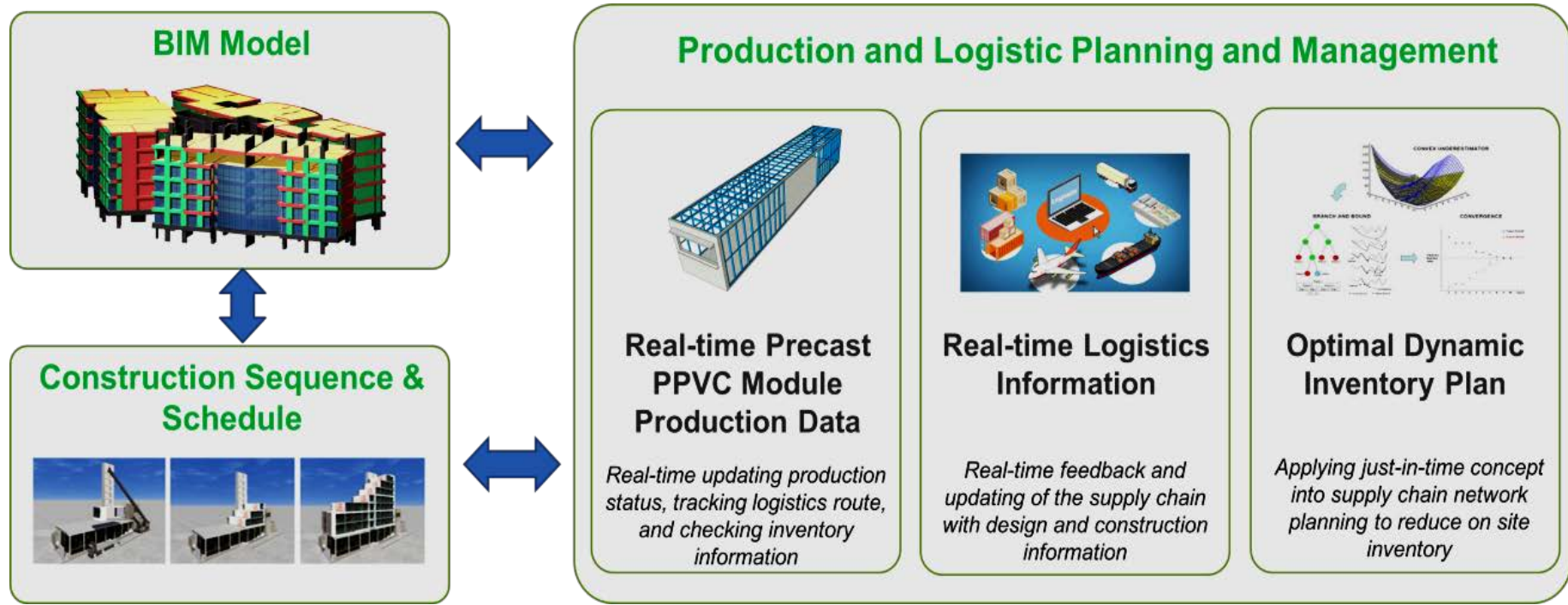
CRANE LIFTING IN BIM ENVIRONMENT



PROPOSED PPVC COMPONENT HIERARCHY FOR CONSTRUCTABILITY ANALYSIS



BIM CLOUD-BASED SUPPLY CHAIN MANAGEMENT OF PRECAST ELEMENTS



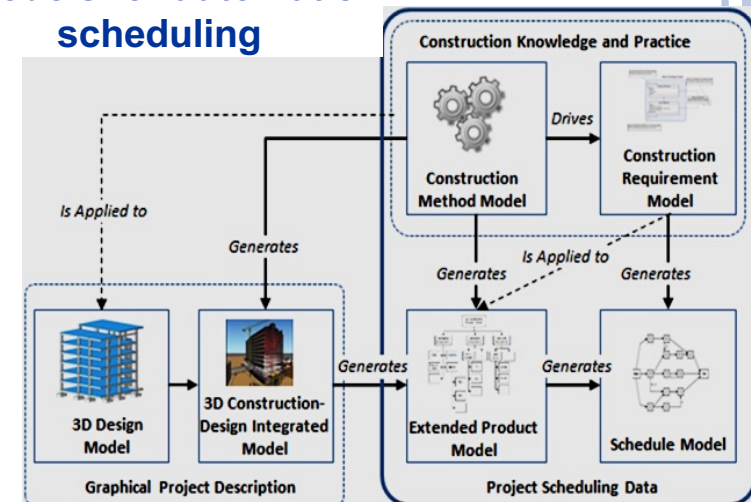
AUTOMATIC SCHEDULING BASED ON CONSTRUCTION KNOWLEDGE

Developing Methodology for BIM-based Automatic Scheduling

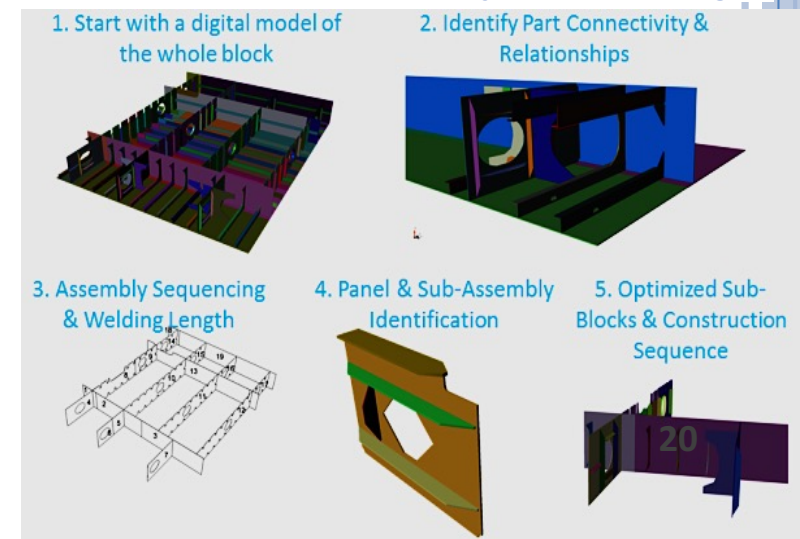
- Construction Requirement Model: Capturing and representing complex construction knowledge for automatic sequencing
- Automatic Scheduling Framework: Provide generalized approach to generate alternative construction schedules
- AI Algorithms for Automatic Sequencing and Production Planning for Shipyard construction

2nd and 3rd International Conference on Engineering, Project, and Production Management, for papers entitled “A Simulation Model for Look-ahead Spatial Scheduling of Dynamic Block Assembly in Shipbuilding” and “Criticality of Schedule Constraints – Classification and Identification”

Core knowledge models for automatic scheduling



Automatic Sub-Assembly Sequencing

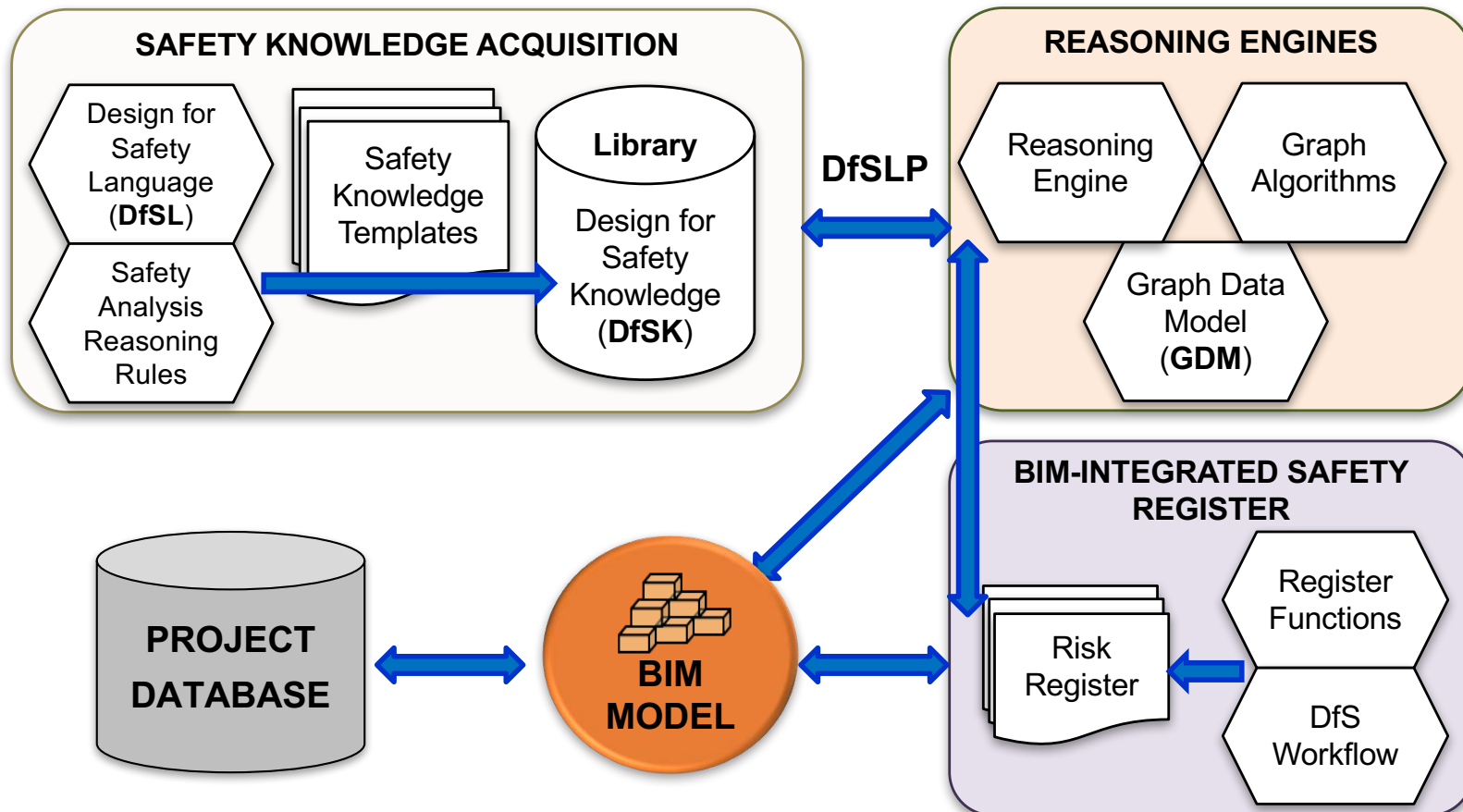


DfS WITH EMBEDDED KNOWLEDGE IN BIM

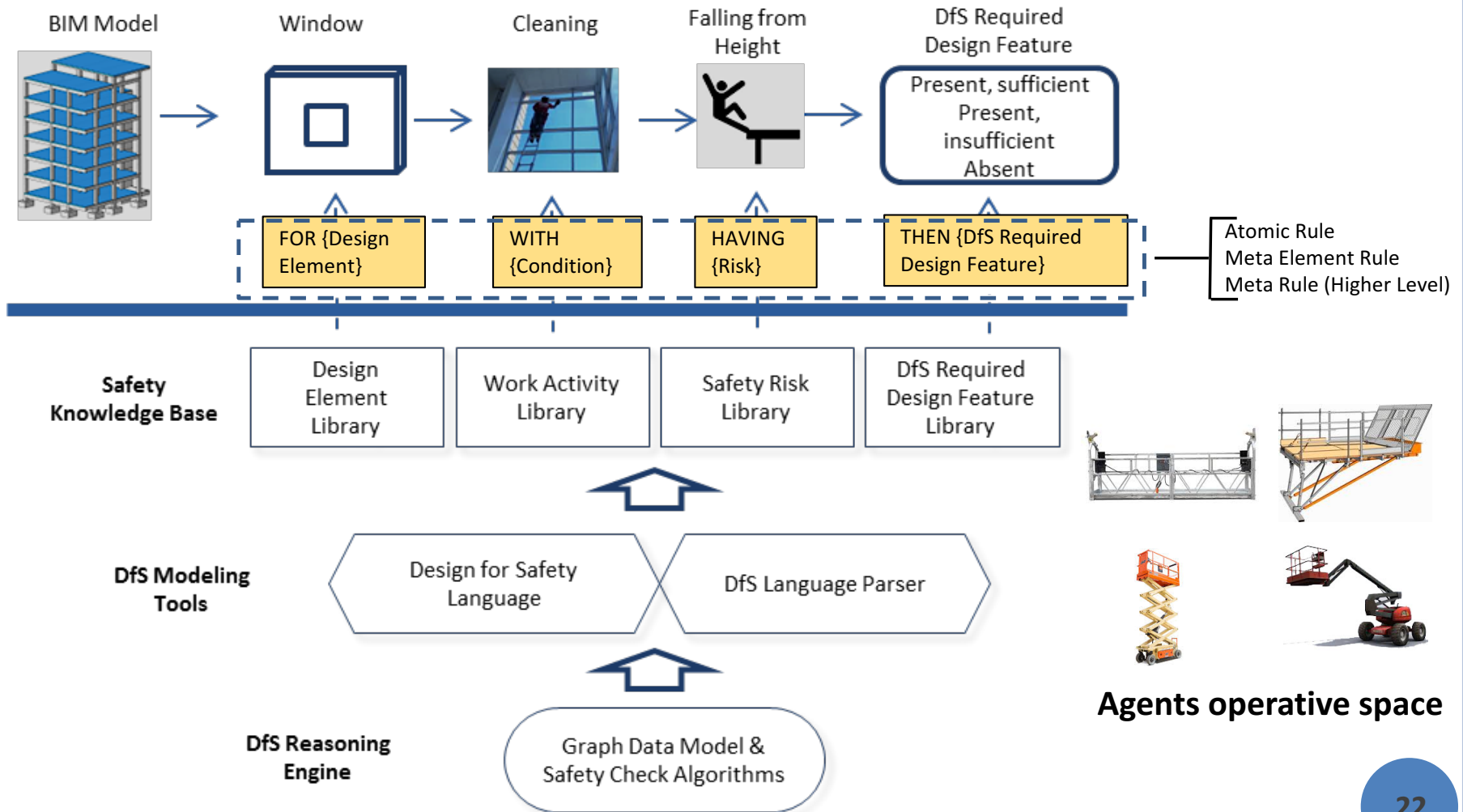
BIM-based Design for Safety Check

Objective: Developing a BIM system for checking Design for Safety issues during the design phase

Provide industry with basic implementation of DfS requirements



FRAMEWORK FOR INTELLIGENT BIM-BASED REVIEW OF DFS



CONCLUSION

- The future of construction points to prefabrication with integrated BIM and lean construction assisted by real-time mobile collaboration
- BIM forms the core of an Integrated Building Information System that will facilitate design, production, logistics and construction collaboration
- BIM is the enabler for automation for precast production (at ICPH) and assembly (at site)
- Intelligent BIM facilitates design and process optimisation e.g. prefabrication configuration, automated scheduler, crane lifting, constructability analysis for DfMA

ACKNOWLEDGEMENT

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