



Hong Kong, April 2019

Rethinking Building Design & Delivery with DfMA

Steve Butler, Senior Industry Strategist



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Agenda

Rethinking Building Design & Delivery

- Industry drivers for change: why change, why now?
- Manufacturing buildings: the value of DfMA
- Design for manufacture: design automation for manufacturing
- Platform solutions: using technology today



Drivers for Change



Urbanization



Sustainability

Urbanization



9.7B

People by
2050

6.4B

Living in
cities

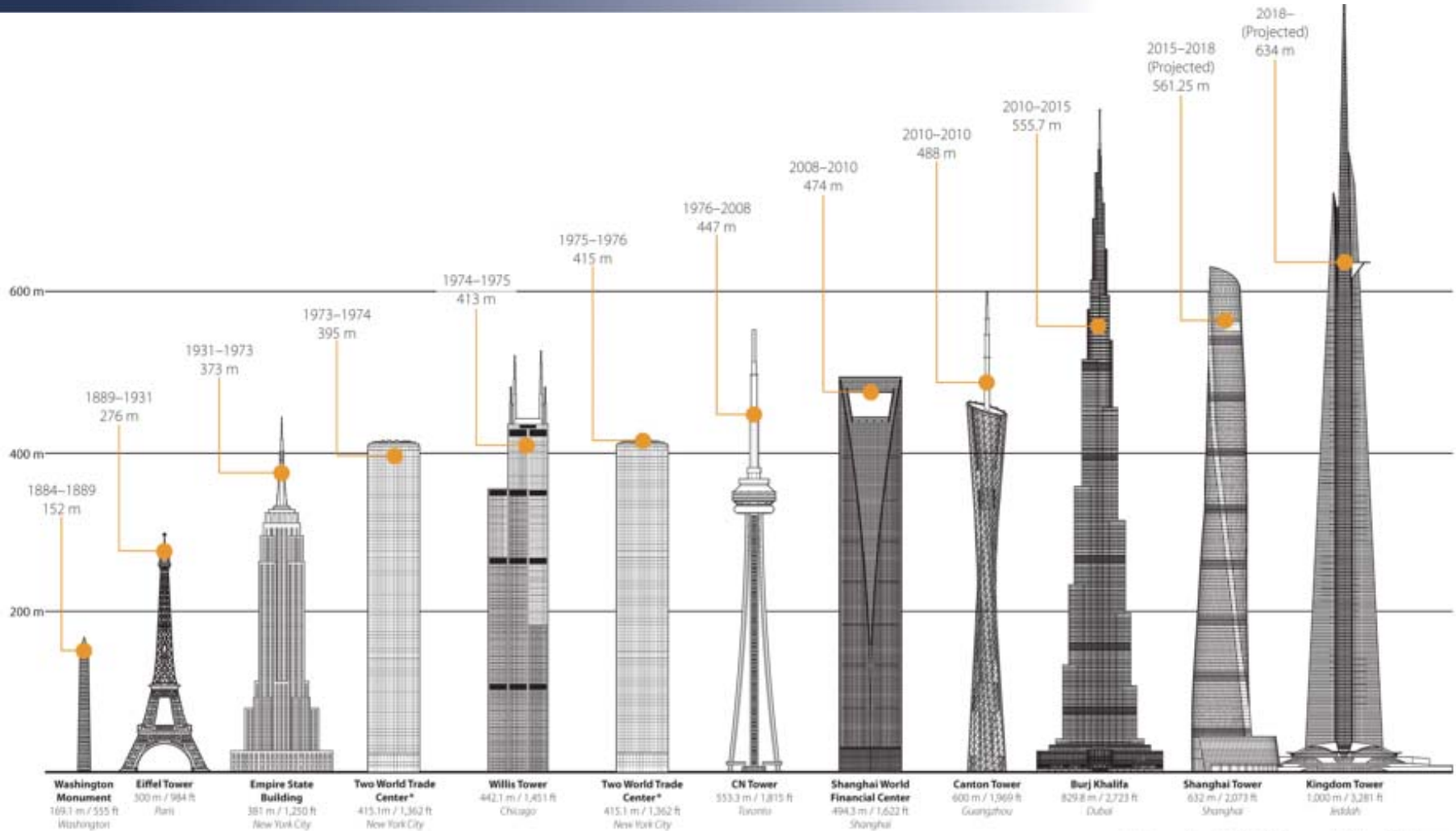
200k

Per day moving
to cities

3,600

Additional
buildings a day

Taller More Complex Buildings



© Council on Tall Buildings and Urban Habitat

Sustainability



40% of global energy,
25% of global water,
30% of GHG emissions

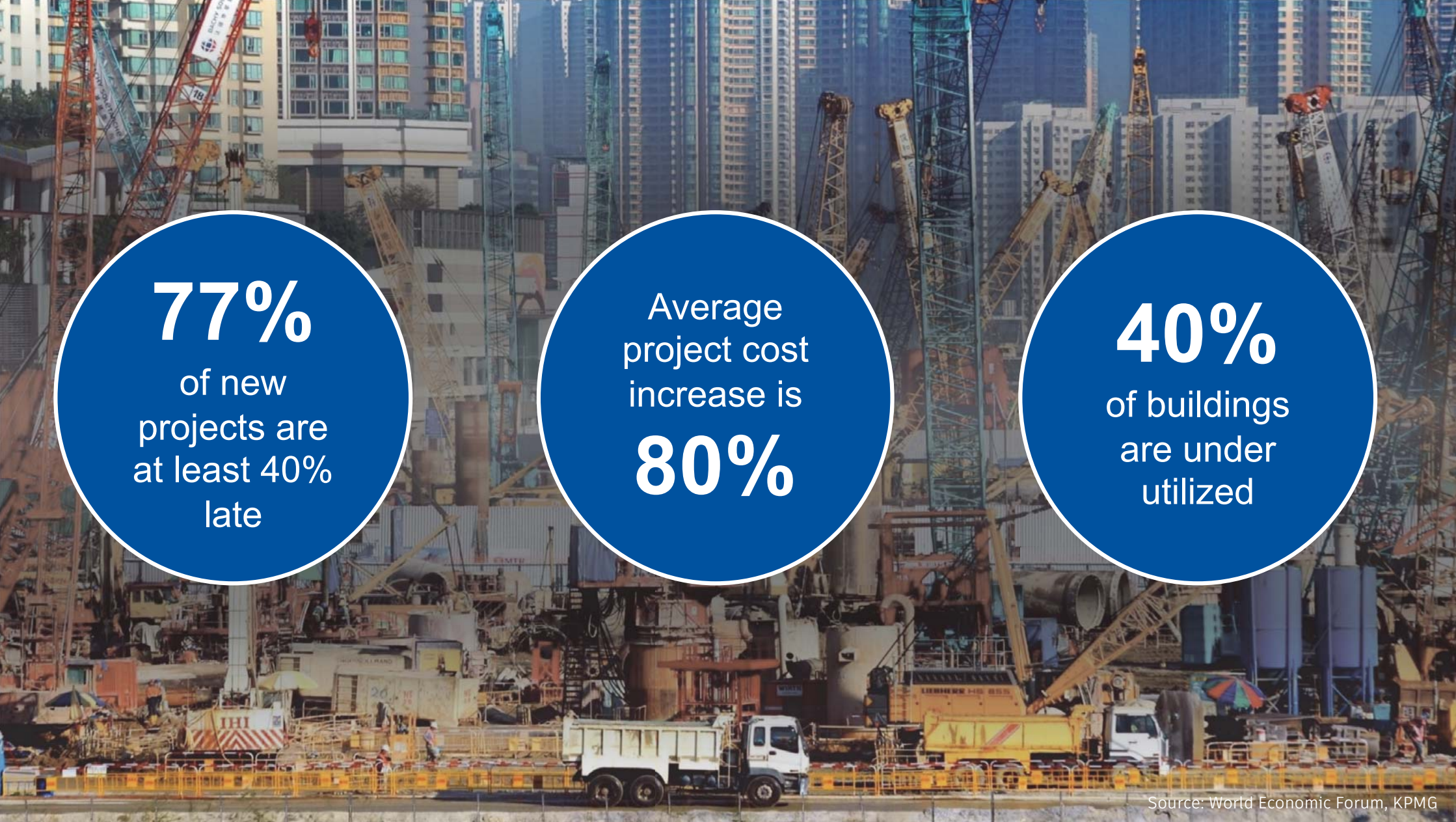
30% of construction is re-work
25% of construction is material waste

1950



2017

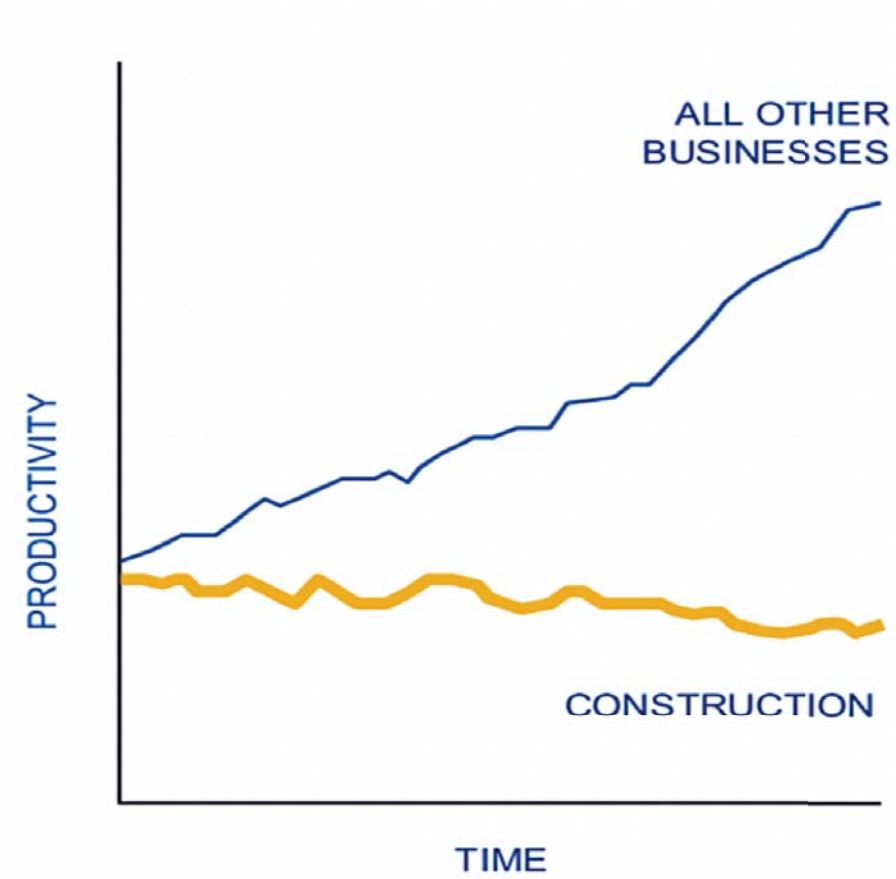


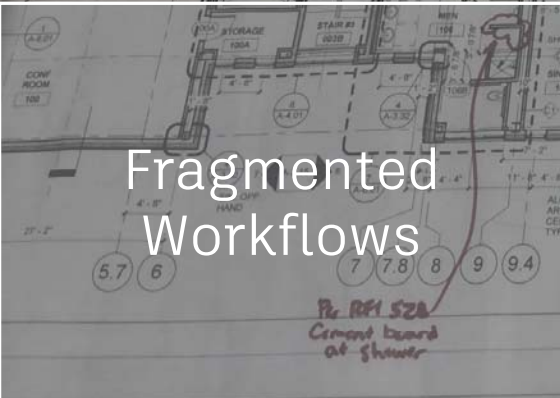
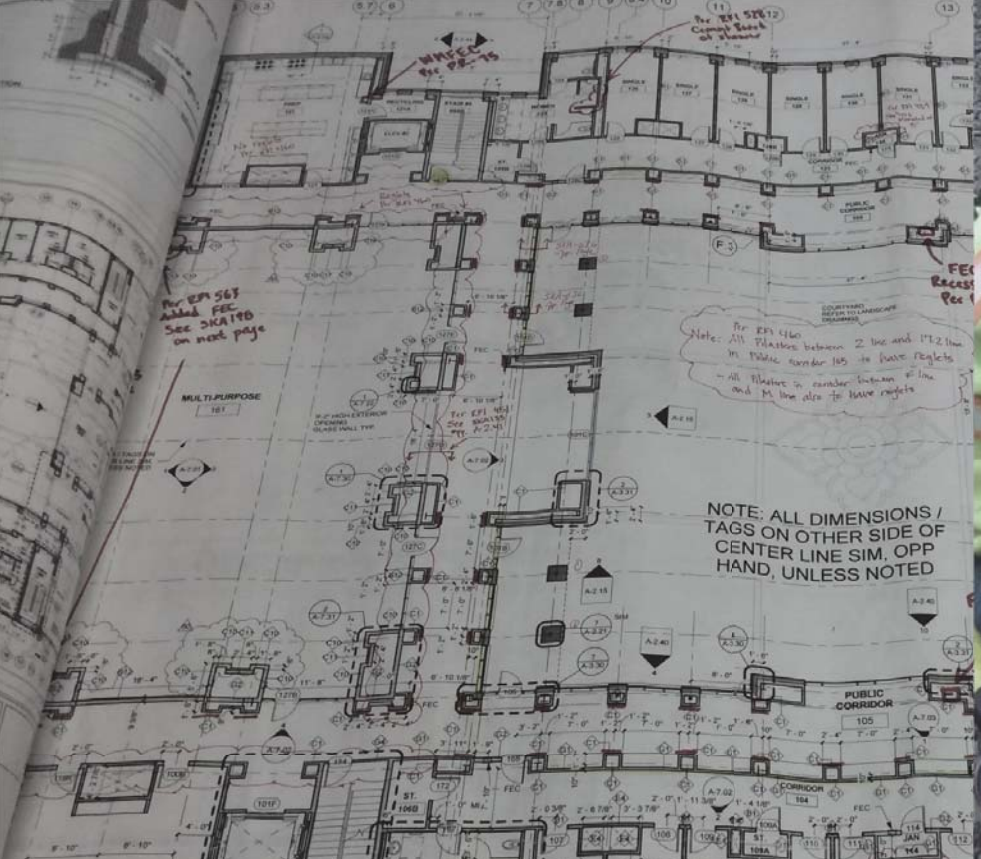


77%
of new
projects are
at least 40%
late

Average
project cost
increase is
80%

40%
of buildings
are under
utilized

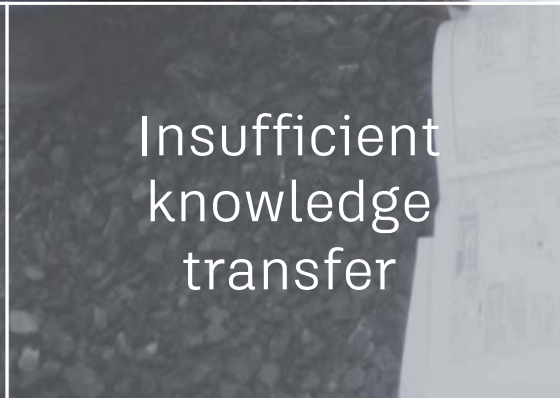




Fragmented Workflows



Inability to attract and develop talent



Insufficient knowledge transfer



Analog-based workflows

The productivity opportunity in construction



Construction matters for the world economy ... but has a long record of poor productivity

Construction-related spending accounts for **13%** of the world's GDP

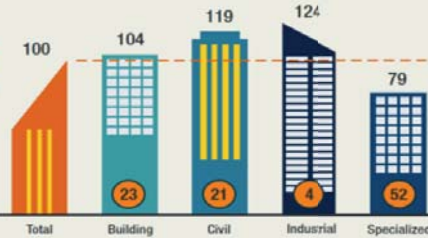
...but the sector's annual productivity growth has only increased **1%** over the past 20 years

\$1.6 trillion of additional value added could be created through higher productivity, meeting half the world's infrastructure need

Construction is a sector of two halves

Fragmented specialized trades drag down the productivity of the sector as a whole

Construction productivity by subsector
Value added per employee, indexed total sector=100, 2013
● % of construction value added



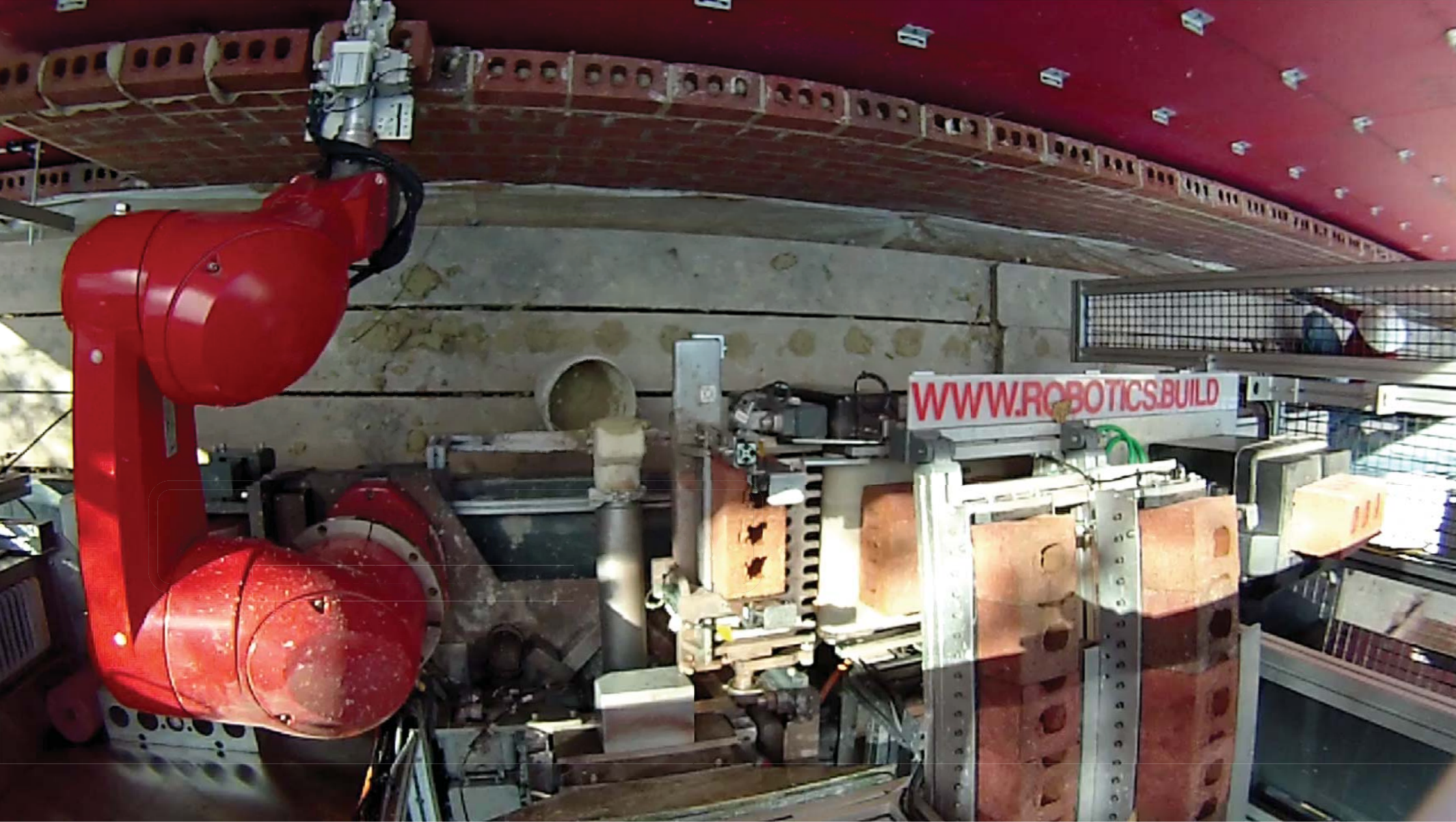
Action in seven areas can boost sector productivity by 50-60%

- Reshape regulation
- Rewire contracts
- Rethink design
- Improve procurement and supply chain
- Improve onsite execution
- Infuse technology and innovation
- Reskill workers

5-10X productivity boost

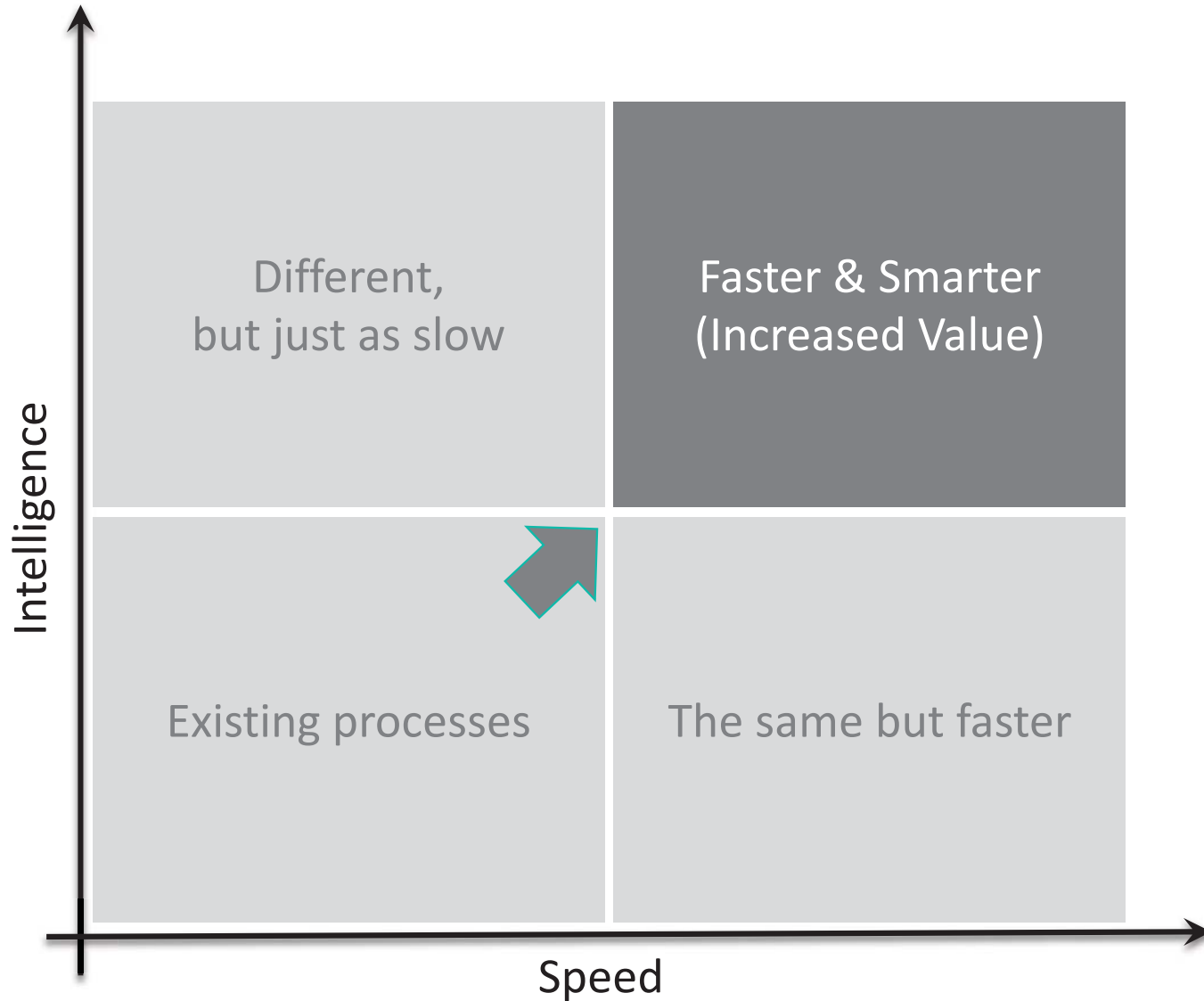
possible for some parts of the industry by moving to a manufacturing-style production system





WWW.ROBOTICS.BUILD







Modular Assembly Methods



Parts



Sub-Assemblies



Assemblies



Modules

PREFABRICATION RESEARCH RESULTS

1.13 BENEFIT-TO-COST RATIO

For every dollar spent on prefab, approximately **13%** of the investment is expected to be returned as a **quantifiable benefit to the project.**



SCHEDULE & COST CERTAINTY

Commit to an aggressive schedule and budget with more confidence.

18% SCHEDULE COMPRESSION ENABLED **29,500** HOURS OF SAVINGS IN LABOR **6%** DIRECT COST PREMIUM



ON-SITE LABOR DENSITY

Improved productivity, flexibility, housekeeping and safety.

\$2.6M JOB PRODUCTIVITY LOSS AVOIDED **150,500** LABOR HOURS DIVERTED OFFSITE



FEWER SAFETY INCIDENTS

Reduced congestion and schedule demands, improved positions and spaces.

7 SAFETY INCIDENTS AVOIDED



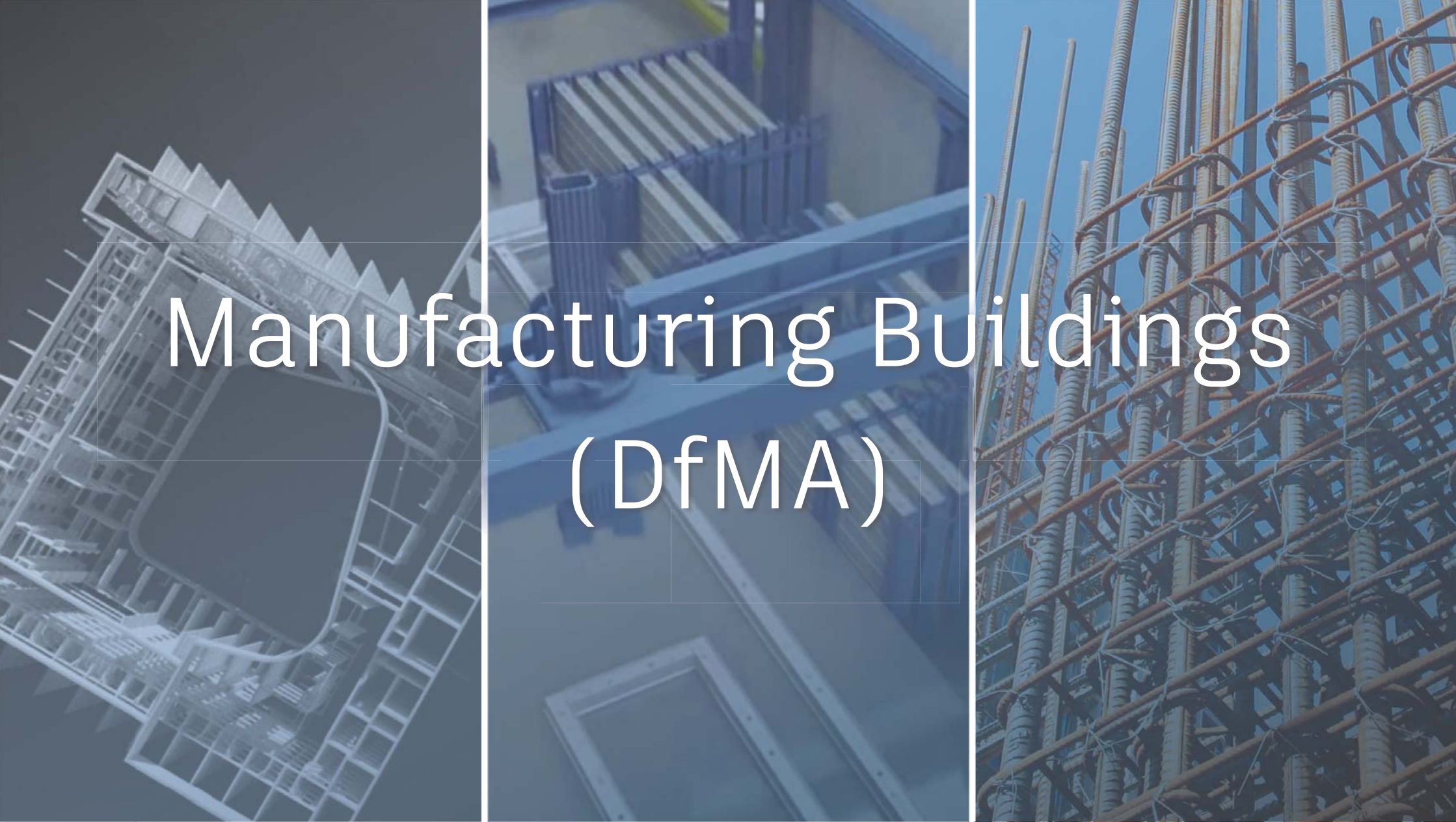
MANPOWER CONSISTENCY

Enhanced efficiency reduces training costs and reinforces cost certainty.

376 HEAD WALLS **346** EXTERIOR WALL PANELS **440** BATHROOM PODS **166** MULTI-TRADE RACKS

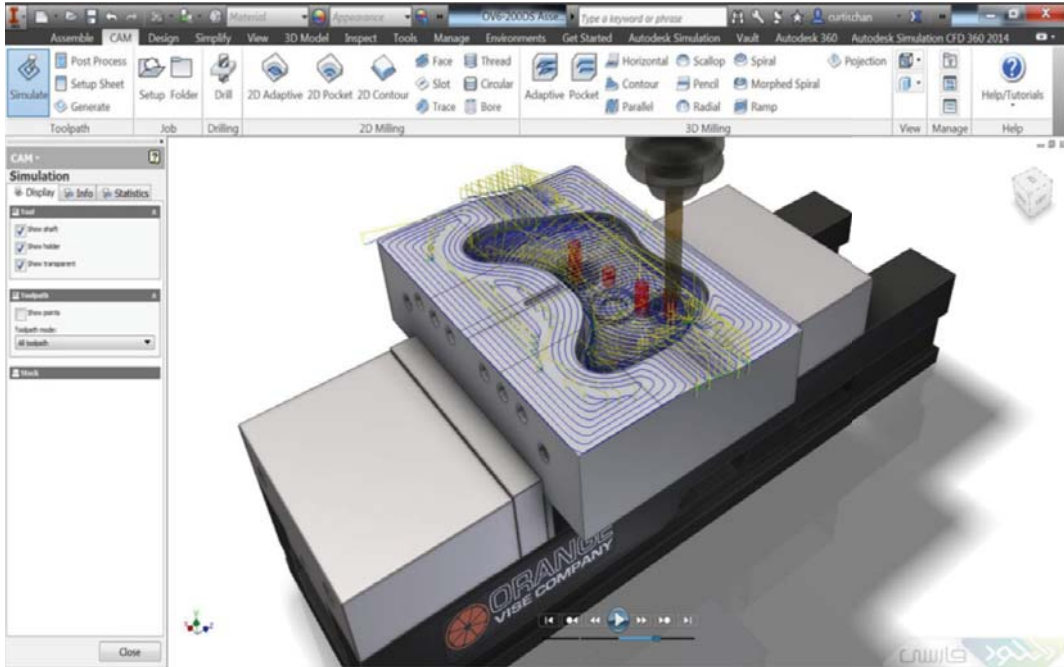
Mortenson Construction





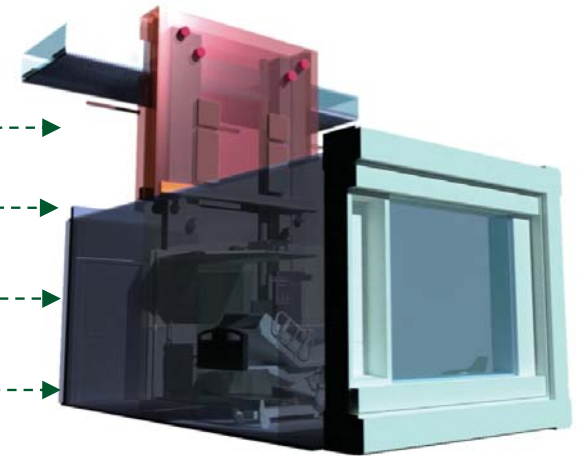
Manufacturing Buildings (DfMA)

Design for Manufacture & Assembly



DfMA for Buildings

Labour	Skilled cost and requirement Highly skilled cost and requirement Supervisor
Information	Training and assembly instruction Standardization and procedures Cost and time
Materials	Existing products Cost and availability JIT instructions
Components	Specialized products Cost and availability JIT instructions



UK Construction 2025



Lower costs

33%

reduction in the initial cost of construction and the whole life cost of built assets

Lower emissions

50%

reduction in greenhouse gas emissions in the built environment

Faster delivery

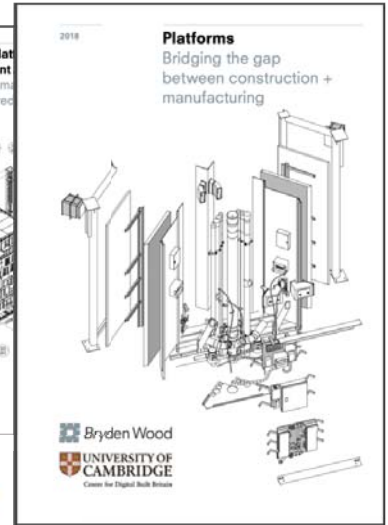
50%

reduction in the overall time, from inception to completion, for newbuild and refurbished assets

Improvement in exports

50%

reduction in the trade gap between total exports and total imports for construction products and materials



Singapore Construction Industry Initiative



Improved Productivity
20%

In construction between 2010 and 2020



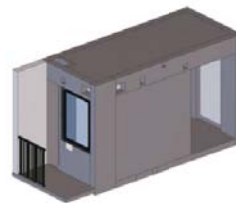
**MODULE A:
LRDIN**
Living and
Dining Room



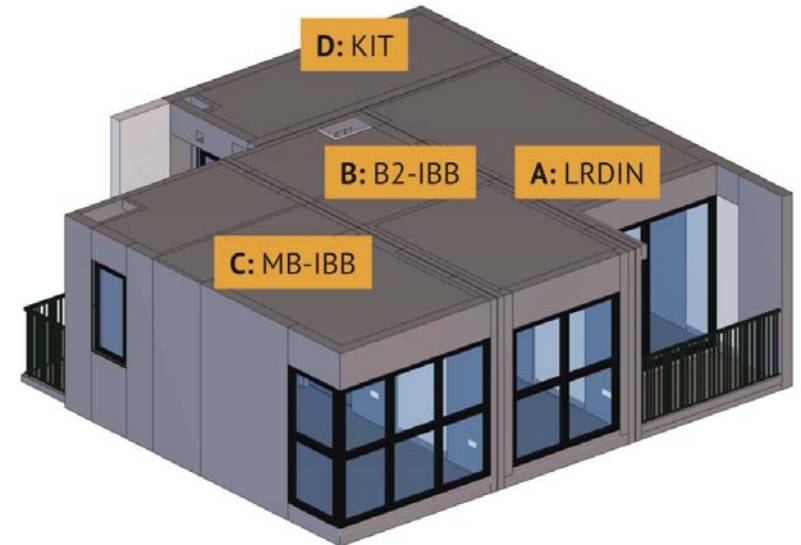
**MODULE B:
B2-IBB**
Bedroom 2
with In-built
Bathroom



**MODULE C:
MB-IBB**
Master
Bedroom
with In-built
Bathroom



**MODULE D:
KIT**
Kitchen

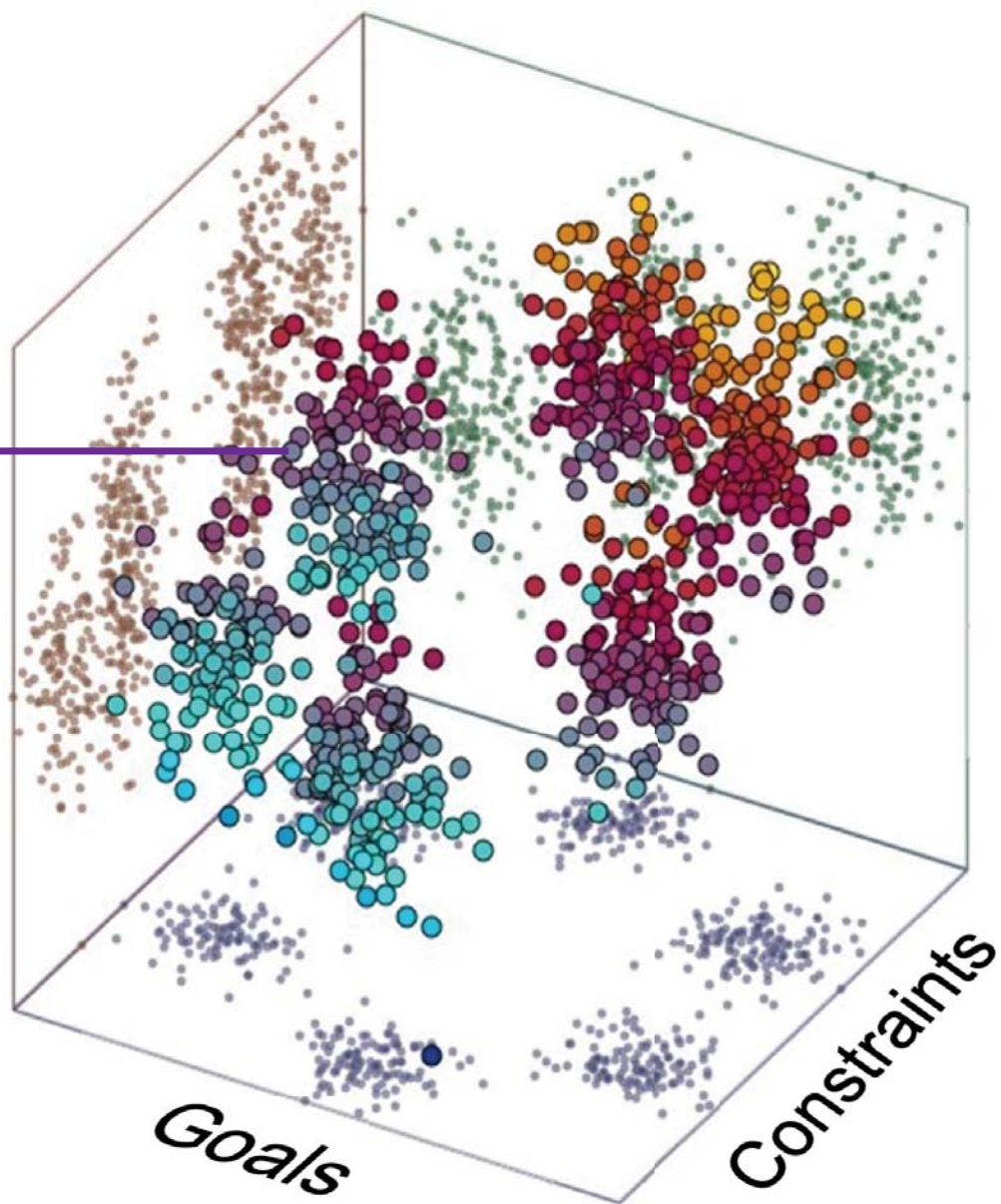




DESIGN for Manufacturing
(Generative Design)



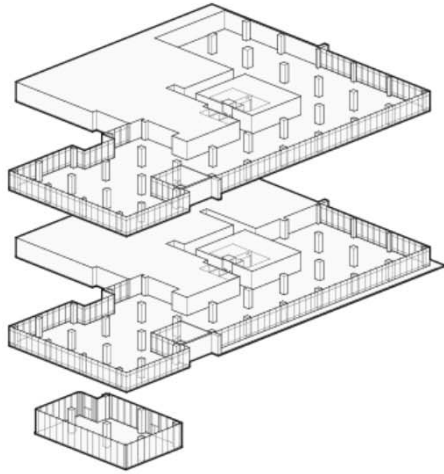
MaRS



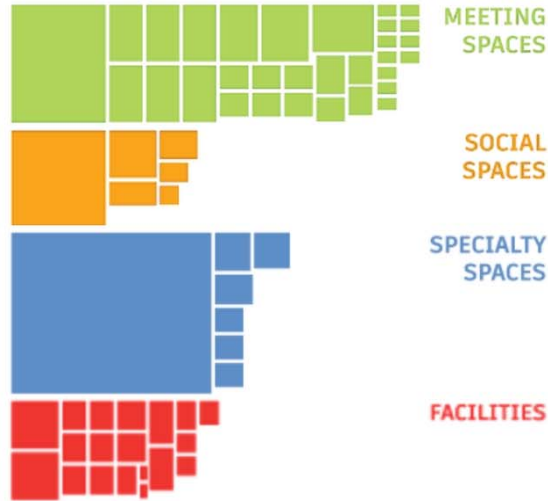
Algorithms

Constraints

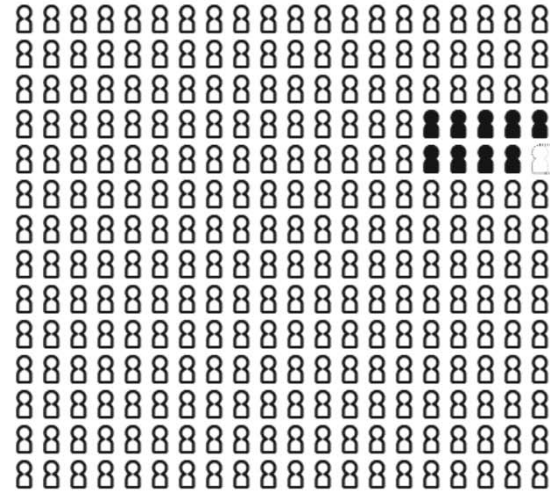
Goals



3 floors
48,000 square feet

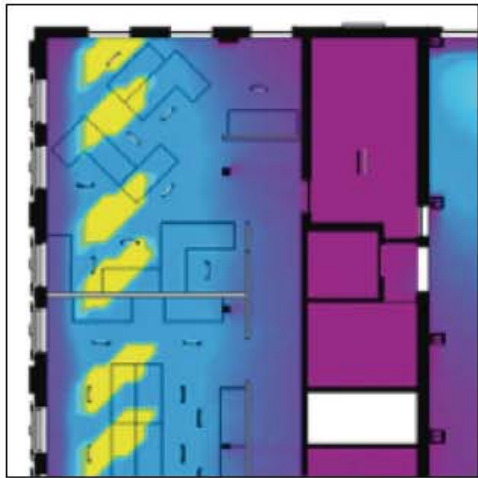


11 meeting rooms
6 multi-purpose rooms
11 phone booths

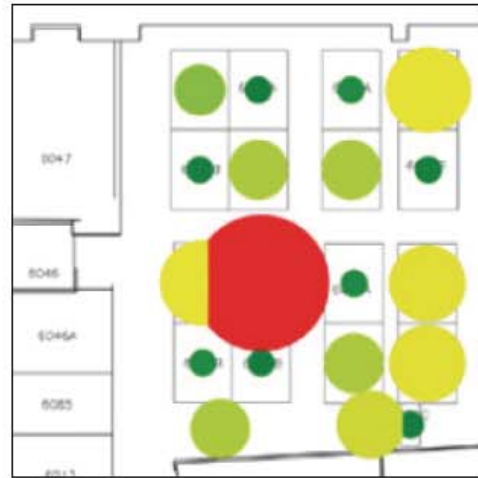


250+ people
25+ teams

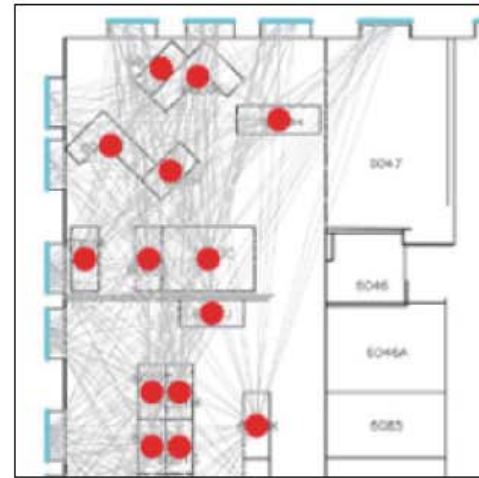
Name:	John Villaggi
TEAM	
Division:	CTO
Manager:	David Lau
Size:	8
Interns:	2
PREFERENCES	
Daylight:	8.0
Acoustic:	4.0
ADJACENCIES	
Teams:	Ray Nagy Dale Locke
Amenity:	Telepresence SCRUM Fabrication Lab AR/VR Lab



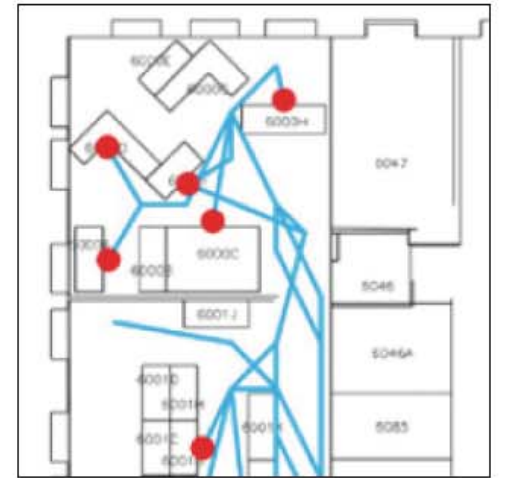
1. Daylight



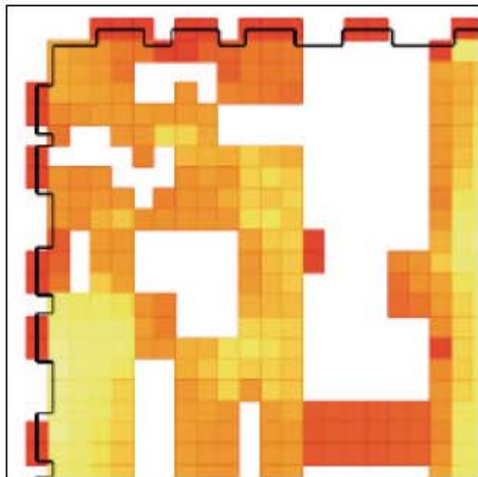
2. Low Visual Distraction



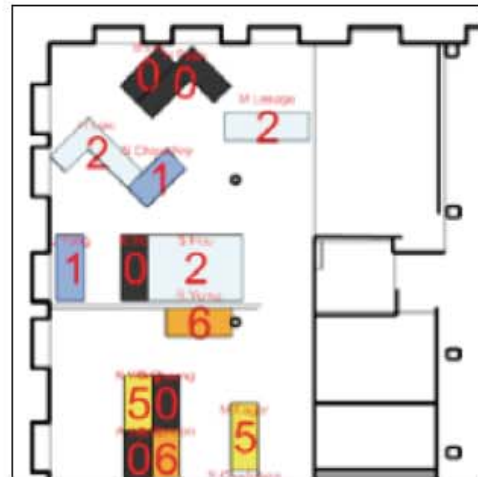
3. Views to Outside



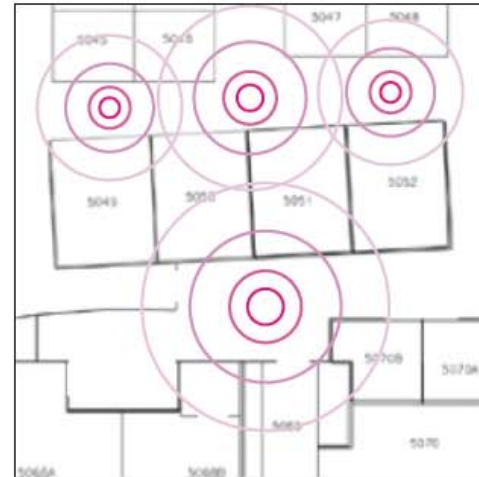
4. Adjacency Preference



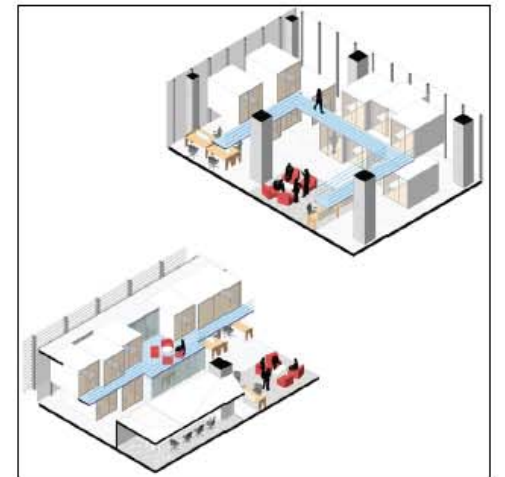
5. Circulation



6. Work Styles



7. Low Acoustic Distraction

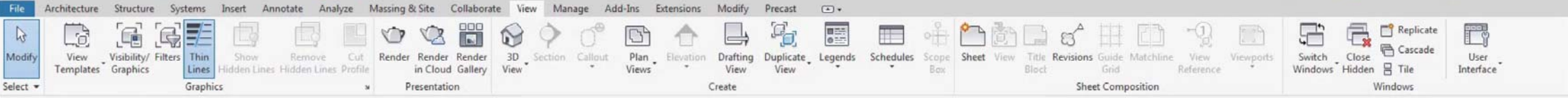


8. Low Density





Platform Solutions



Properties

Walkthrough

Walkthrough: Walkthrough 1

Graphics

Detail Level	Fine
Parts Visibility	Show Original
Visibility/Graphics Ov...	Edit...
Graphic Display Optio...	Edit...
Discipline	Structural
Default Analysis Displ...	None
Sun Path	<input type="checkbox"/>

Extents

Crop View	<input checked="" type="checkbox"/>
Crop Region Visible	<input checked="" type="checkbox"/>
Far Clip Active	<input checked="" type="checkbox"/>
Far Clip Offset	45955.3
Section Box	<input type="checkbox"/>

Camera

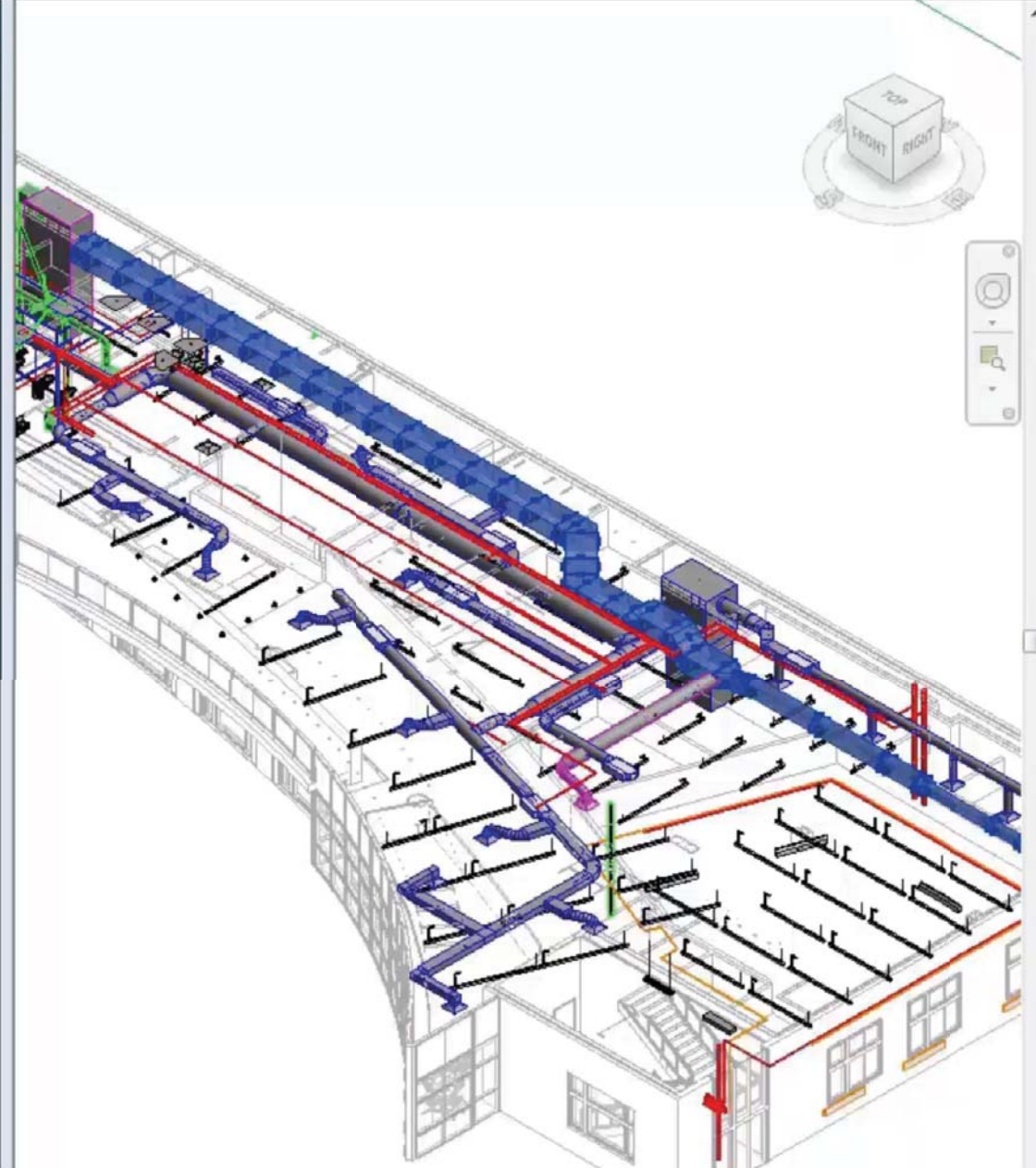
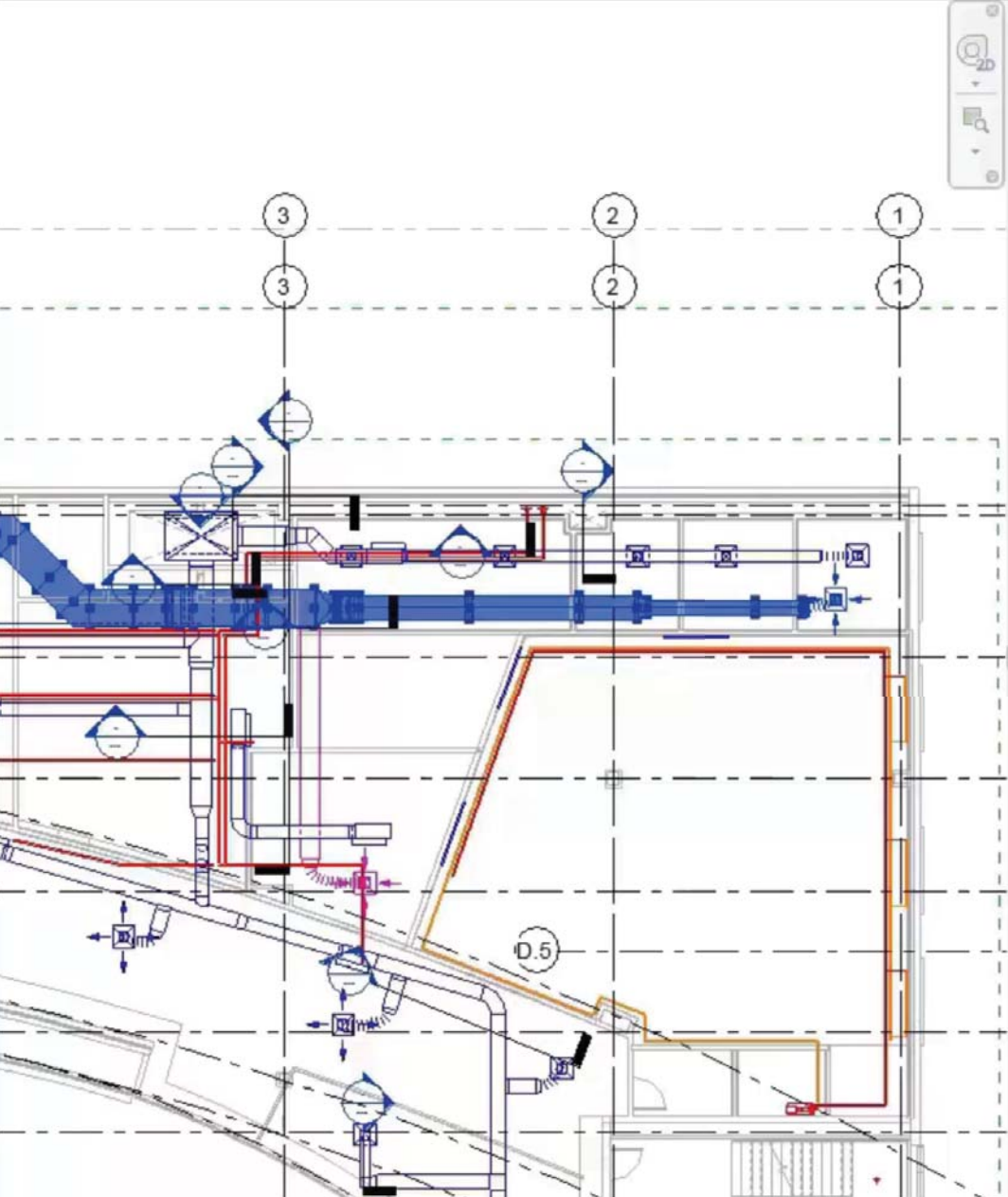
Rendering Settings

Apply

Project Browser - Precast Building.rvt

- Views (all)
 - Structural Plans
 - 3D Views
 - Elevations (Building Elevation)
 - Sections (Cross Section)
 - Walkthroughs
- Legends
- Schedules/Quantities (all)
- Sheets (all)
- Families
- Groups
- Revit Links





Advantages of DfMA for construction

The background image shows a construction site with a large concrete slab being lifted by a crane. The slab is suspended in the air, and the crane's structure is visible on the left. The sky is a clear blue, and the building's framework is visible in the lower part of the image.

Rethinking Building Design & Delivery

- Solves the industry segmentation issues
- Changes the procurement path
- Engages the supply chain earlier
- Reduces risk
- Increases safety and time to market
- True outcome based design and delivery



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Make anything.

Questions?



