UNIVERSITY OF CAMBRIDGE

LAING O'ROURKE CENTRE *for* CONSTRUCTION ENGINEERING *and* TECHNOLOGY

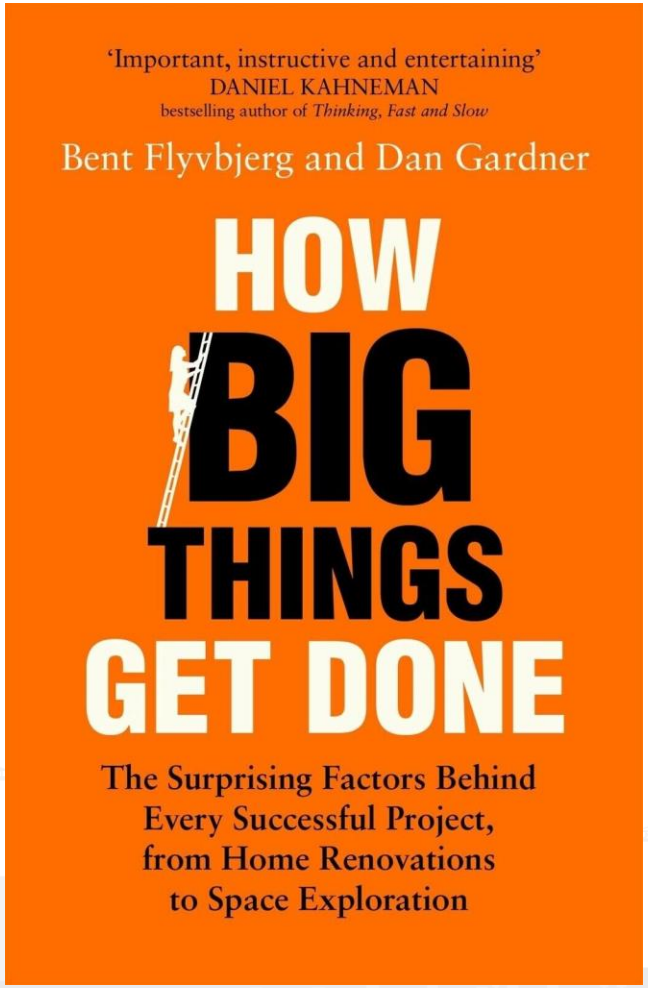
TRANSFORMING CONSTRUCTION

Data is the new ~~oil~~ gold

Campbell Middleton
Laing O'Rourke Professor of Construction Engineering
University of Cambridge

28th January 2025

The construction industry today …



On budget (or better)
48.0%

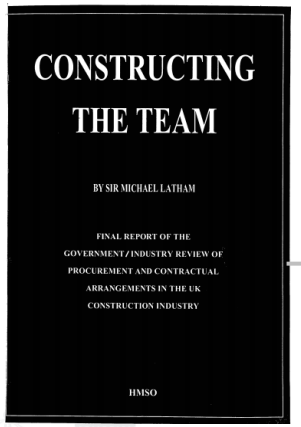
From graph on page 8

Based on database of 16,000 projects in 136 countries

Iron Law of Project Management:

"Over Budget, Over Time, Under Benefits, Over and Over Again"

Strategic reports on the construction sector



Latham Report
1994

1998

2002

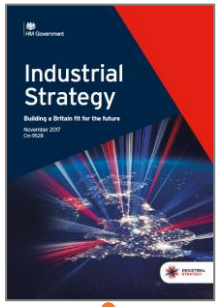
2009

2011

2013

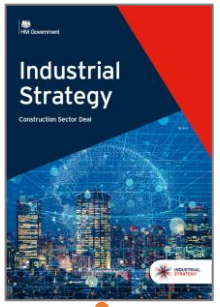
2016

2016



2017

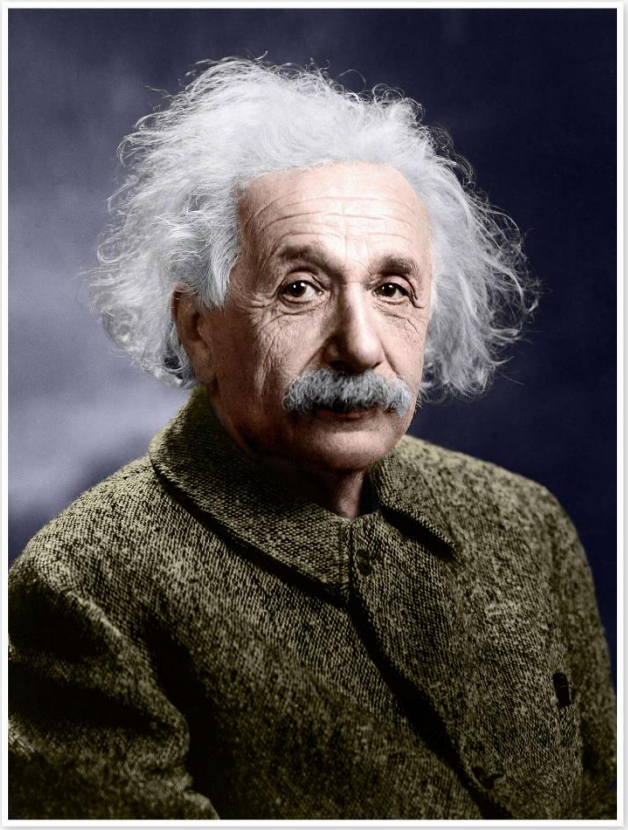
2017



2018

Strategic reports on the construction sector

Transforming construction…….

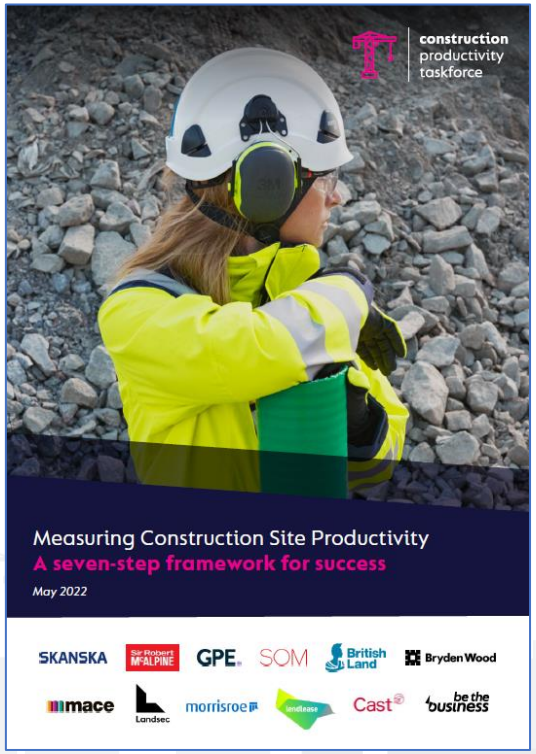


“Insanity is doing the same thing over and over again and expecting different results”

Albert Einstein

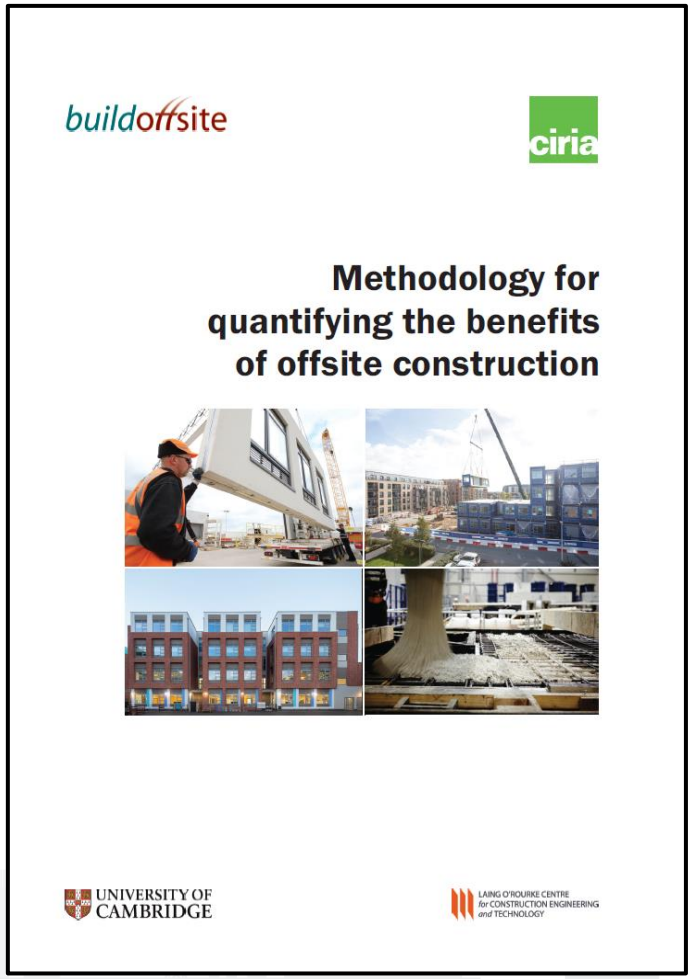
Construction Productivity Taskforce (CPT)

CPT's proposed 5 "high level" productivity metrics



1. Productivity (£/hr)
2. Waste (m^3/£100k)
3. Pre-manufactured value (%)
4. Right first time (%)
5. Tool time (%)

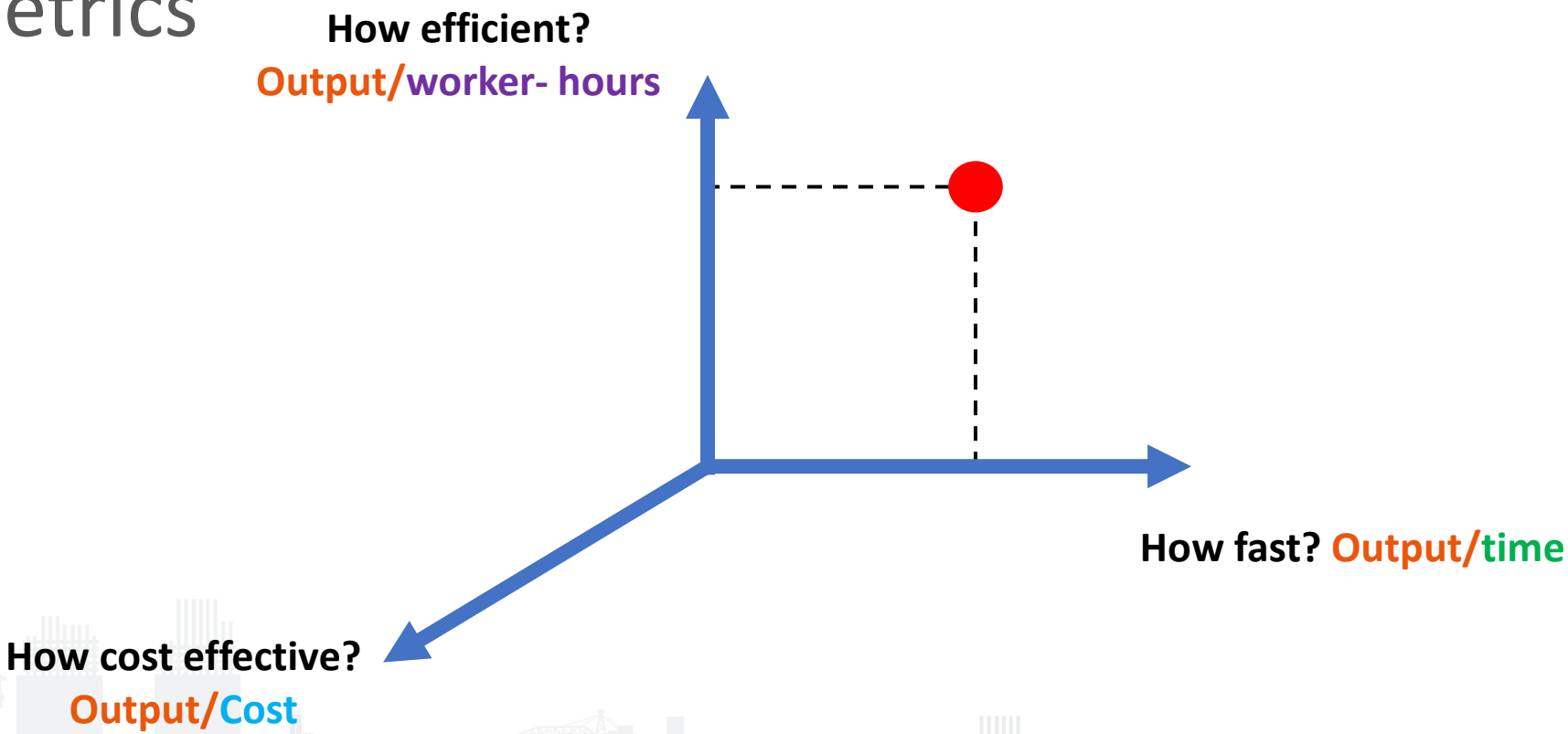
Manufacturing (MMC / offsite) – Jansen report (2020)



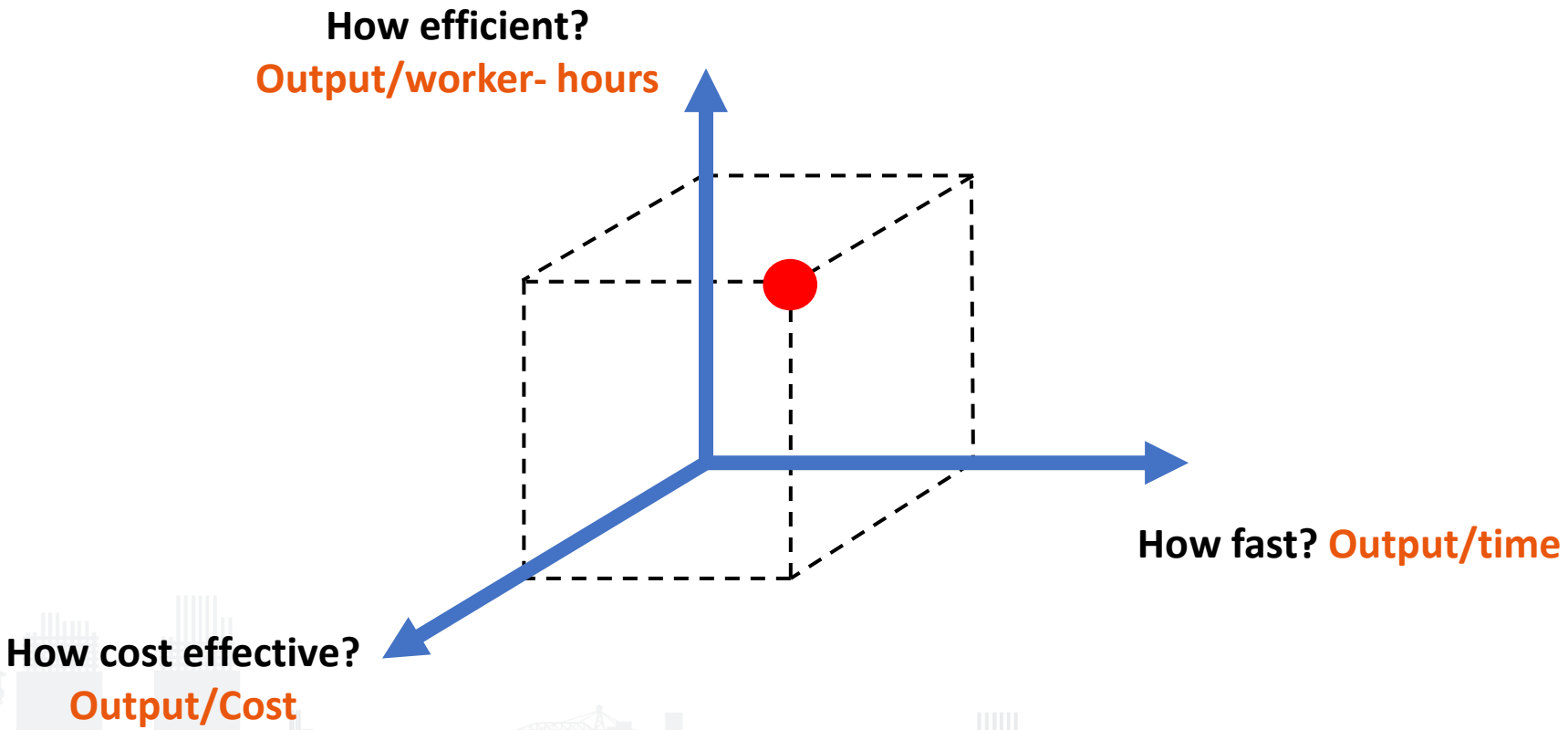
CIRIA Report C792 - "Jansen Report" - 2020

Our proposed framework for measuring productivity

3 key metrics

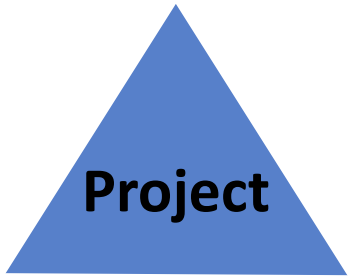


Three metrics to measure productivity



Applied to multiple levels

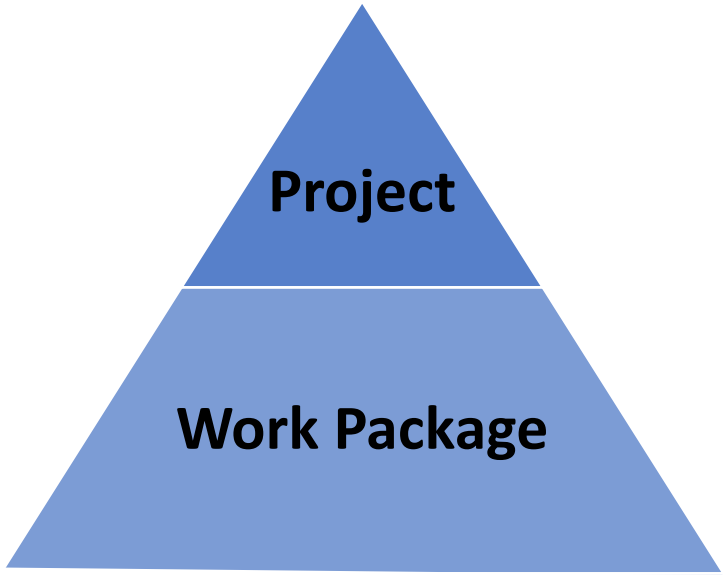
Applied to multiple levels



Building A

Building B

Applied to multiple levels



Building A

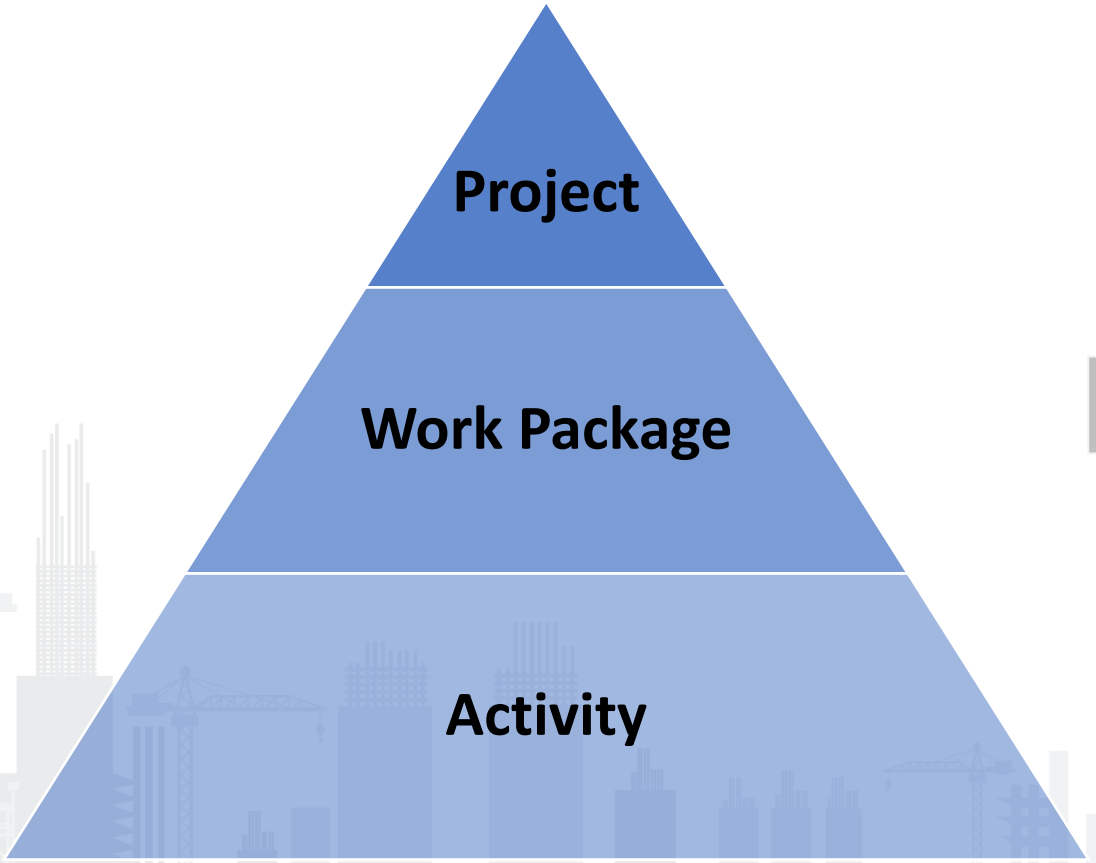
Building B

Superstructure

Envelope

M&E

Applied to multiple levels



Building A

Building B

Superstructure

Facade

M&E

Steel fixing

Formwork

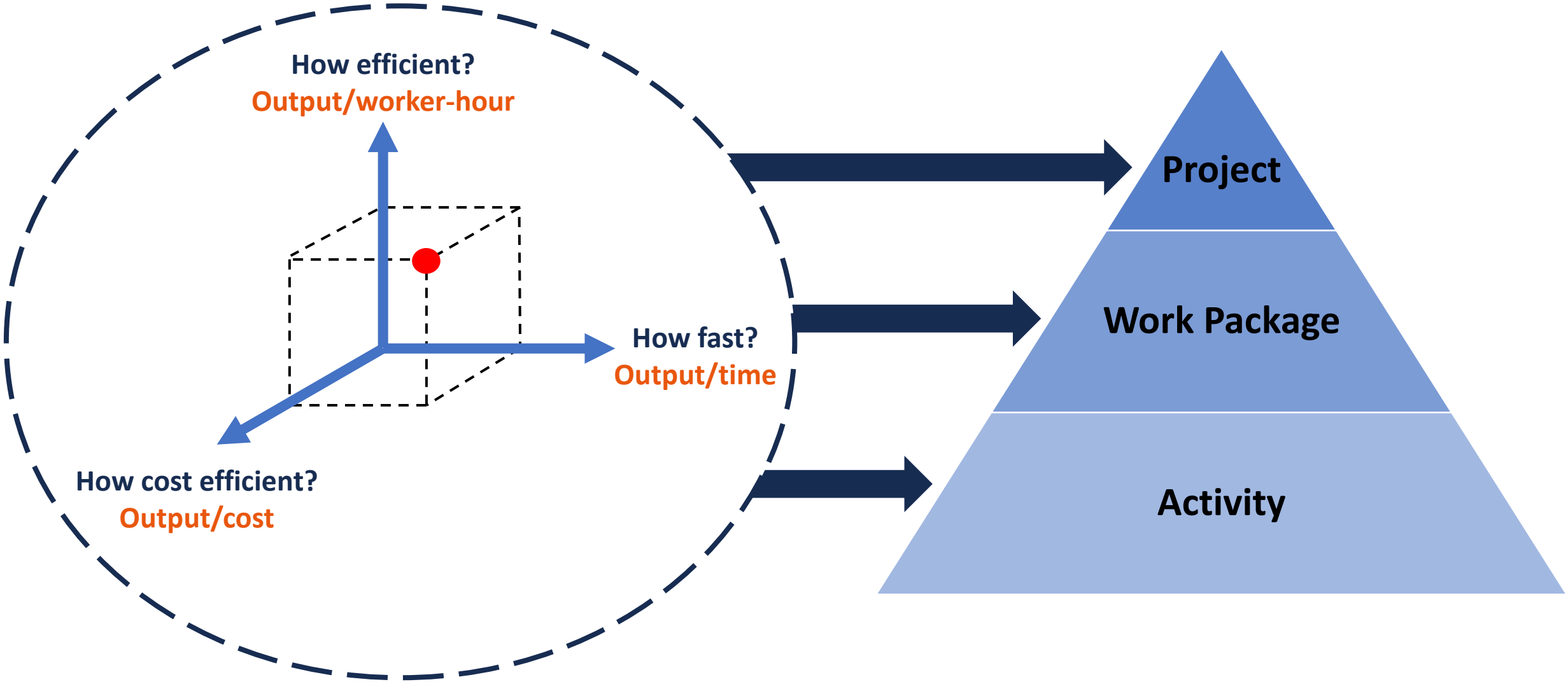
Concrete

Panels

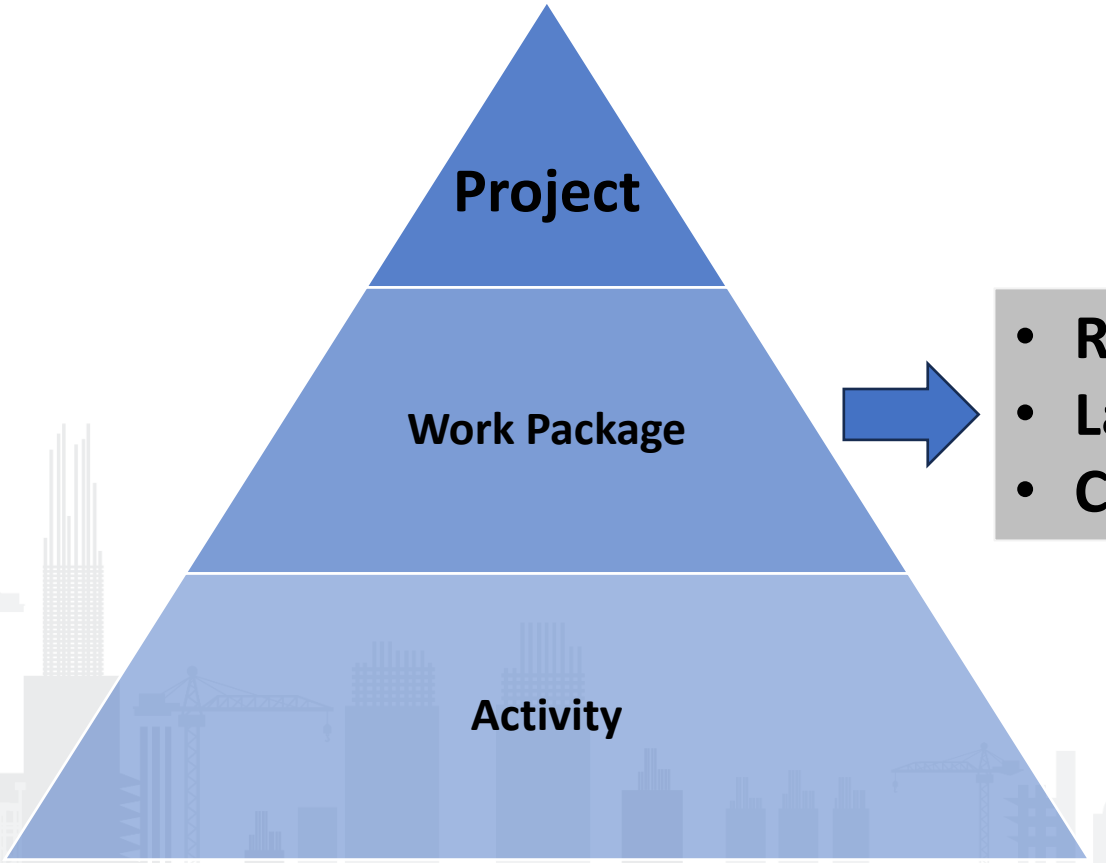
Fan coil units

Ducts

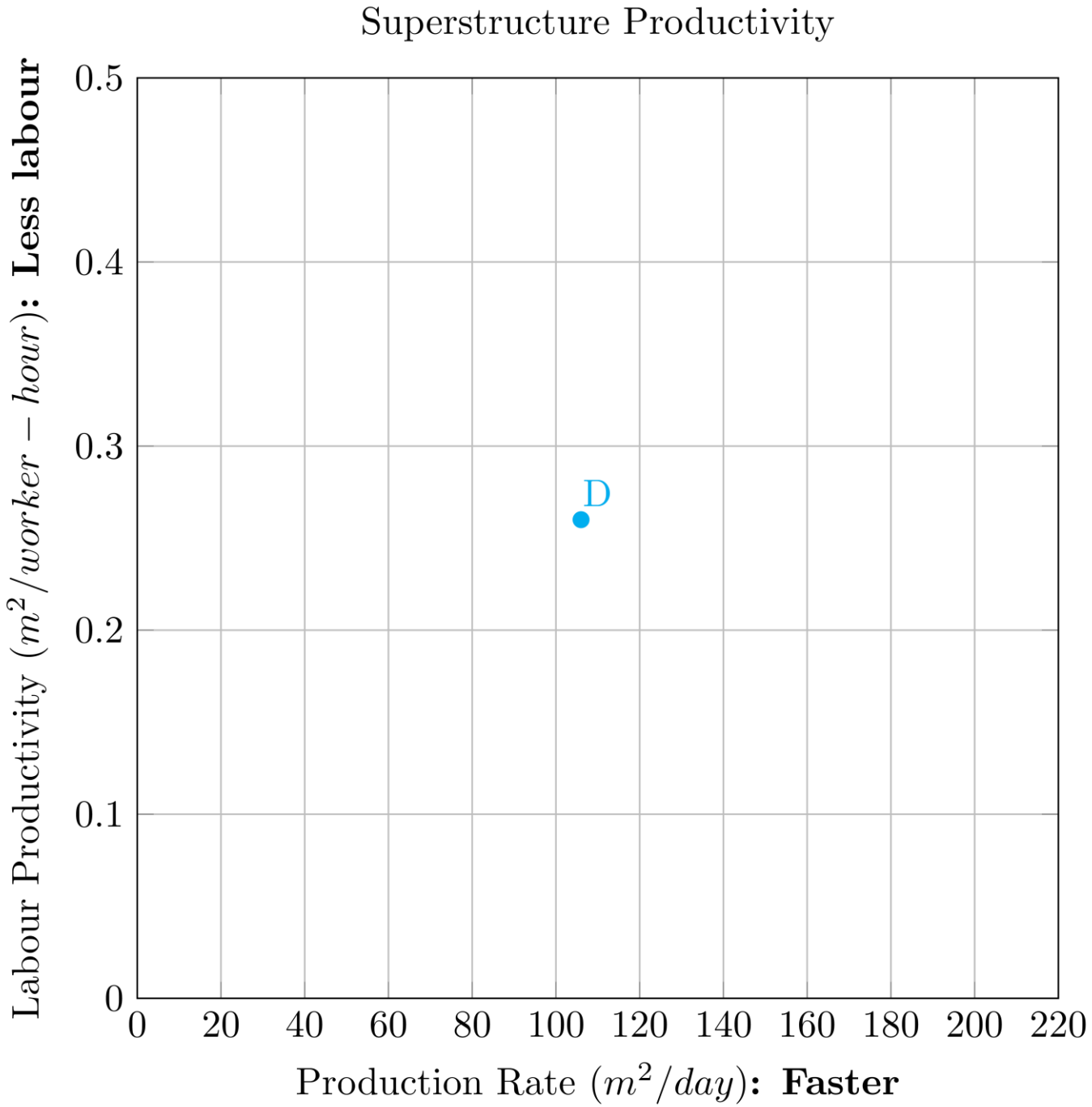
Pipework

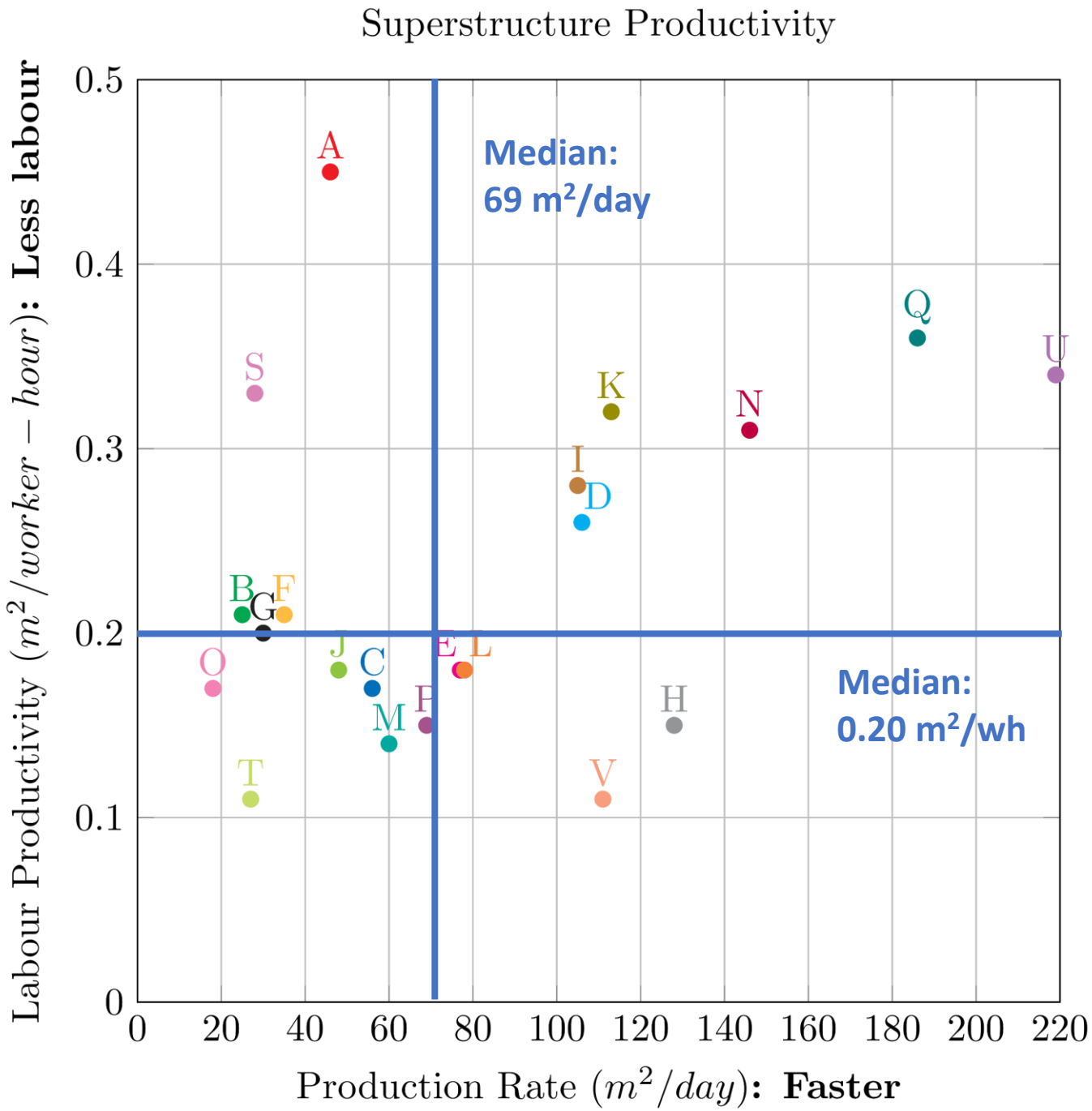

How efficient?
Output/worker-hour
How fast?
Output/time
How cost efficient?
Output/cost
Project
Work Package
Activity

Example: Work package level metrics for a building frame

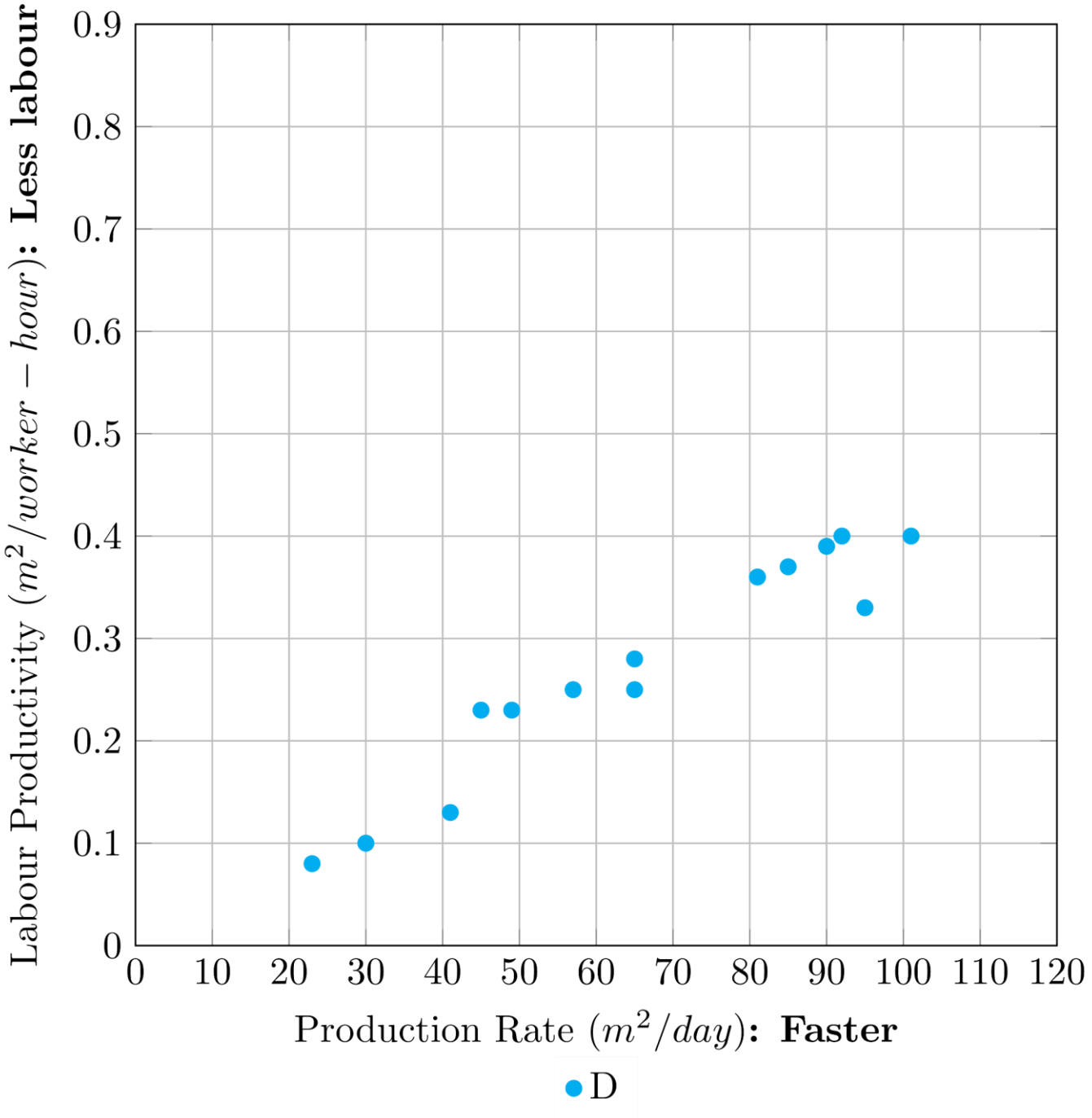


- **Rate of work** (m^2 of floor slab/week)
- **Labour Productivity** (m^2 of floor slab/worker-hour)
- **Cost efficiency** (m^2 of floor slab/total cost)

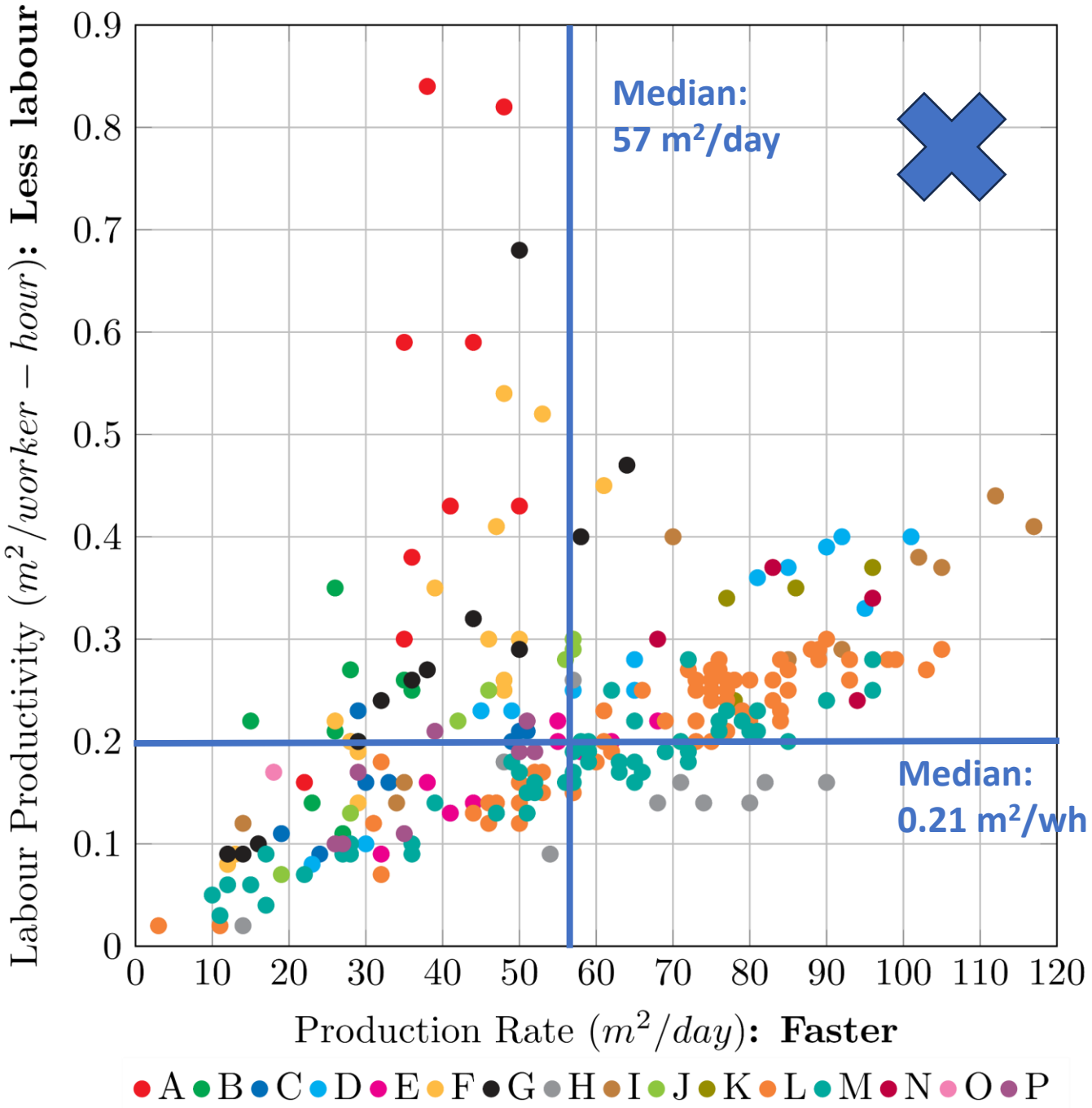

Superstructure Productivity
Labour Productivity ($m^2/worker - hour$): **Less labour**
0.5
0.4
0.3
0.2
0.1
0
D
0
20
40
60
80
100
120
140
160
180
200
220
Production Rate (m^2/day): **Faster**



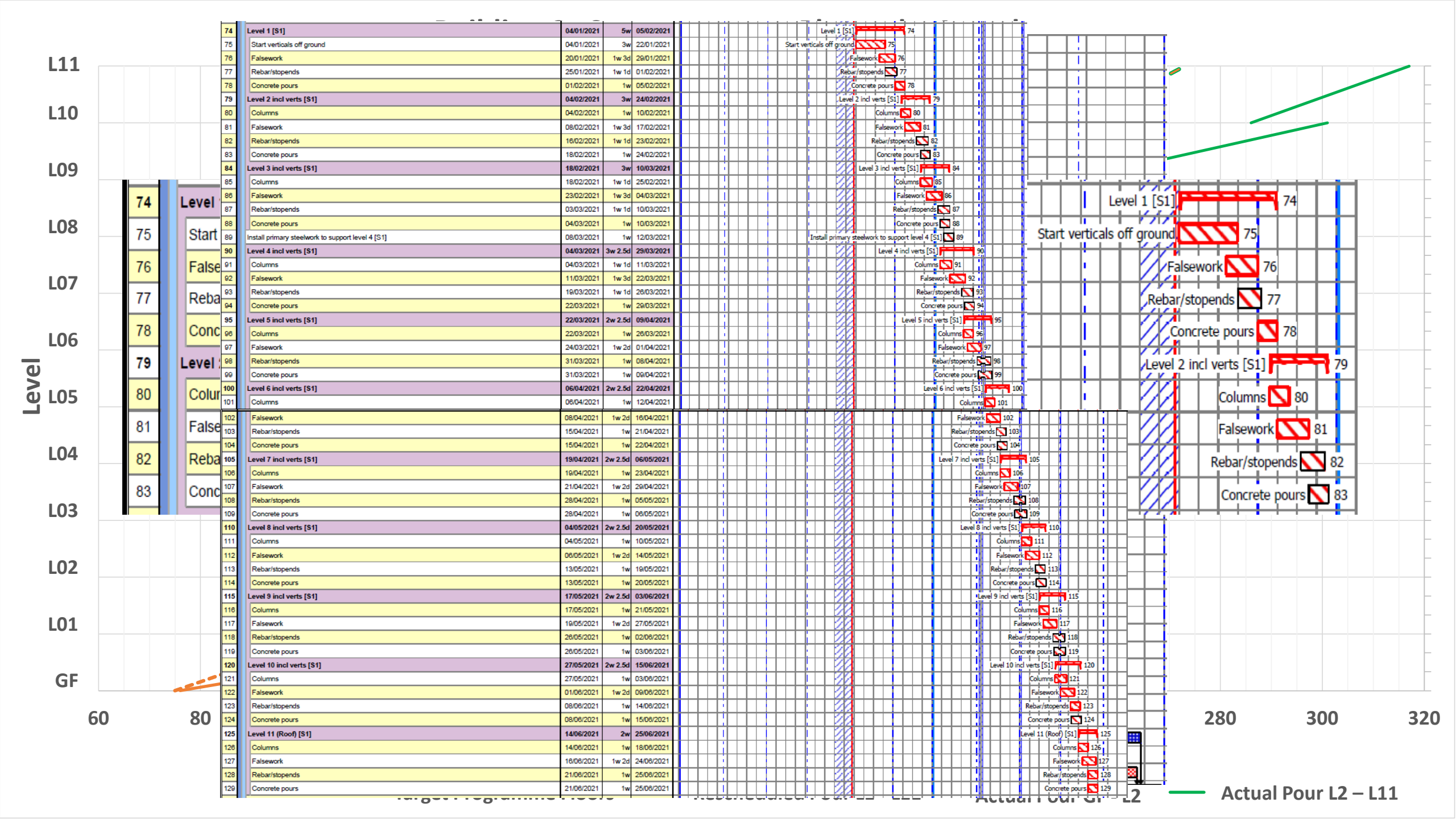
Each dot represents a building



Each dot represents the productivity of a single level of a multi-level building

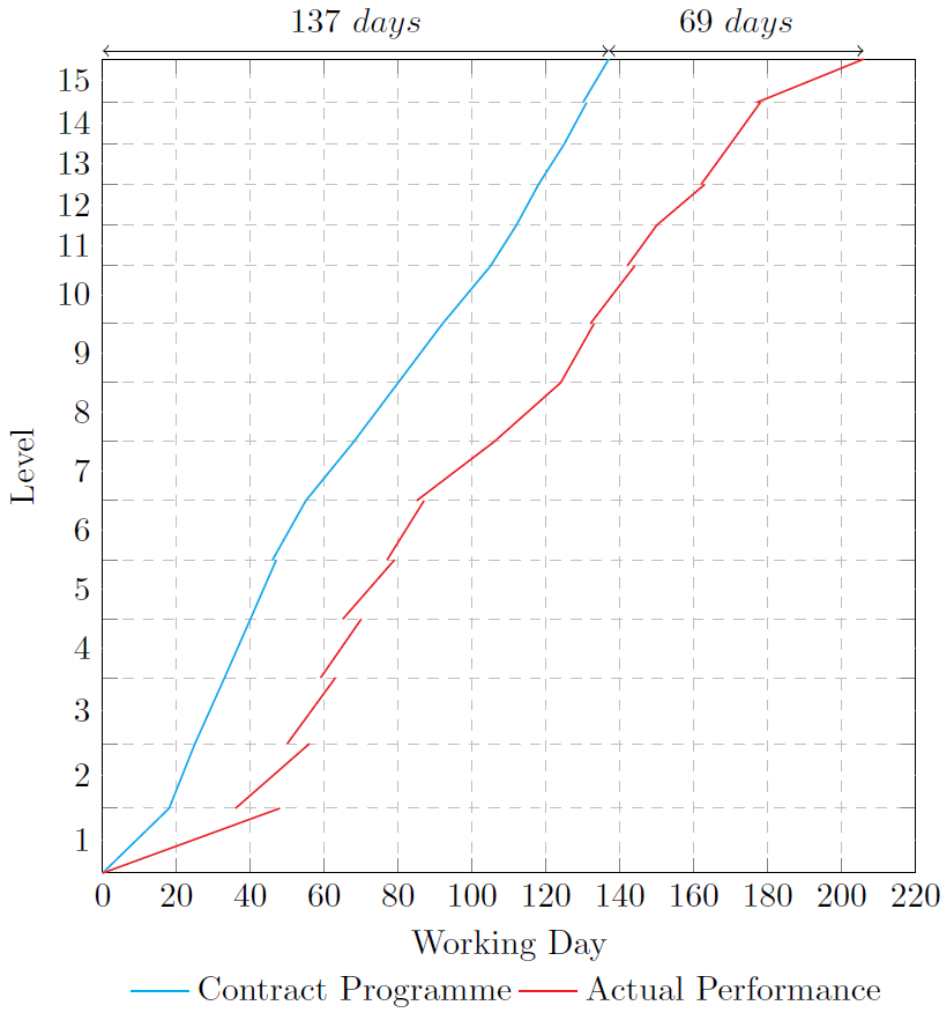


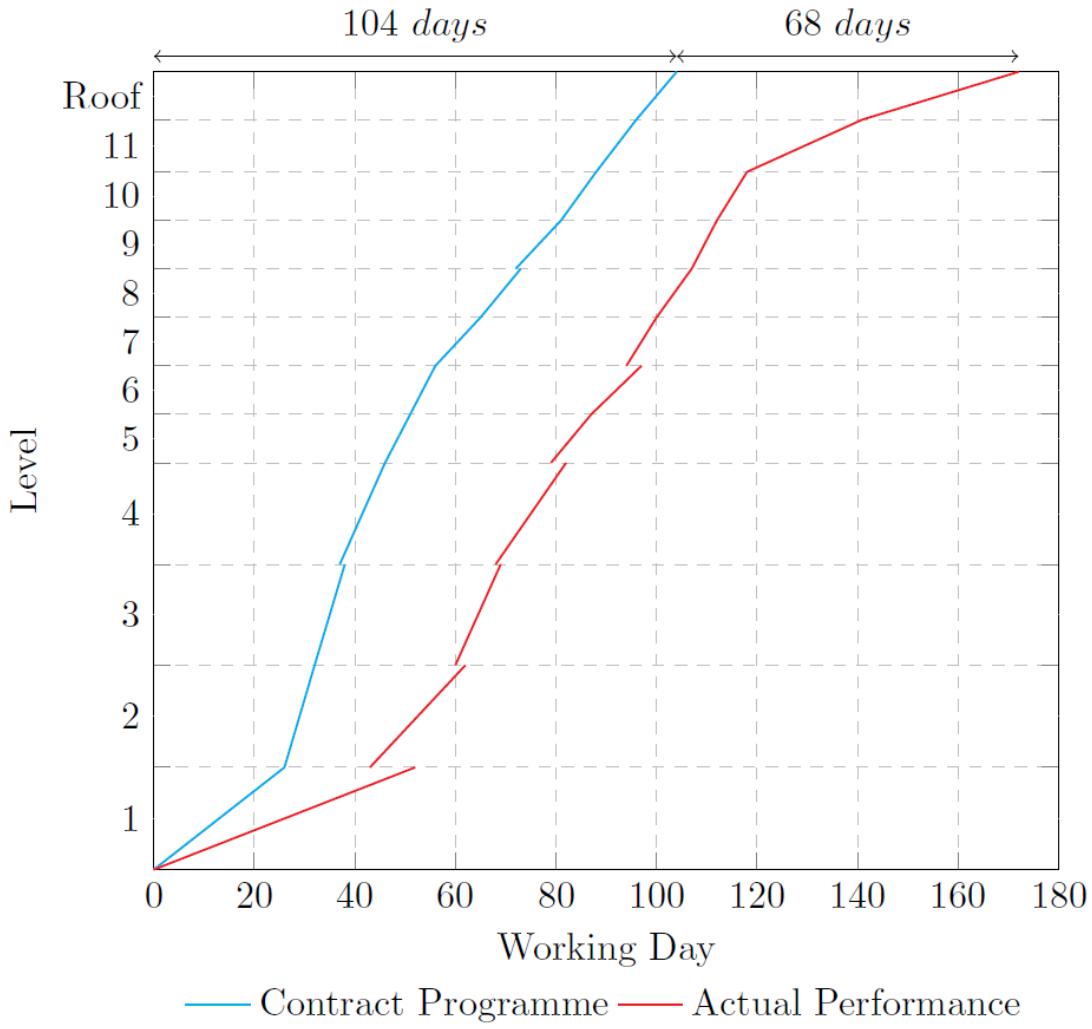
Each dot of the same colour represents the productivity of a single level of a multi-level building



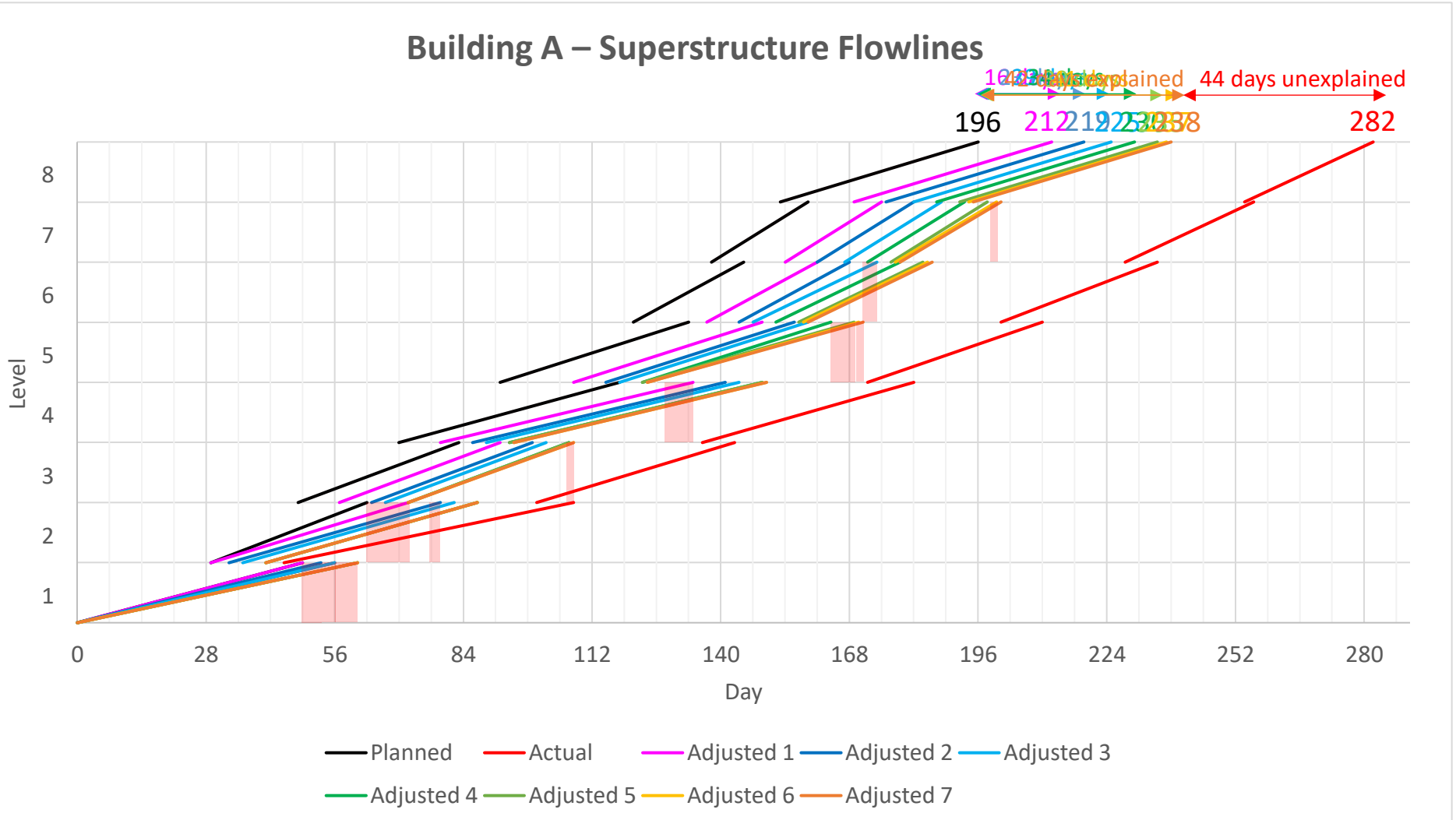
74	Level 1 [S1]	04/01/2021	5w	05/02/2021
75	Start verticals off ground	04/01/2021	3w	22/01/2021
76	Falsework	20/01/2021	1w 3d	29/01/2021
77	Rebar/stopends	25/01/2021	1w 1d	01/02/2021
78	Concrete pours	01/02/2021	1w	05/02/2021
79	Level 2 incl verts [S1]	04/02/2021	3w	24/02/2021
80	Columns	04/02/2021	1w	10/02/2021
81	Falsework	08/02/2021	1w 3d	17/02/2021
82	Rebar/stopends	16/02/2021	1w 1d	23/02/2021
83	Concrete pours	18/02/2021	1w	24/02/2021
84	Level 3 incl verts [S1]	18/02/2021	3w	10/03/2021
85	Columns	18/02/2021	1w 1d	25/02/2021
86	Falsework	23/02/2021	1w 3d	04/03/2021
87	Rebar/stopends	03/03/2021	1w 1d	10/03/2021
88	Concrete pours	04/03/2021	1w	10/03/2021
89	Install primary steelwork to support level 4 [S1]	08/03/2021	1w	12/03/2021
90	Level 4 incl verts [S1]	04/03/2021	3w 2.5d	29/03/2021
91	Columns	04/03/2021	1w 1d	11/03/2021
92	Falsework	11/03/2021	1w 3d	22/03/2021
93	Rebar/stopends	19/03/2021	1w 1d	26/03/2021
94	Concrete pours	22/03/2021	1w	29/03/2021
95	Level 5 incl verts [S1]	22/03/2021	2w 2.5d	09/04/2021
96	Columns	22/03/2021	1w	26/03/2021
97	Falsework	24/03/2021	1w 2d	01/04/2021
98	Rebar/stopends	31/03/2021	1w	08/04/2021
99	Concrete pours	31/03/2021	1w	09/04/2021
100	Level 6 incl verts [S1]	06/04/2021	2w 2.5d	22/04/2021
101	Columns	06/04/2021	1w	12/04/2021
102	Falsework	08/04/2021	1w 2d	16/04/2021
103	Rebar/stopends	15/04/2021	1w	21/04/2021
104	Concrete pours	15/04/2021	1w	22/04/2021
105	Level 7 incl verts [S1]	19/04/2021	2w 2.5d	06/05/2021
106	Columns	19/04/2021	1w	23/04/2021
107	Falsework	21/04/2021	1w 2d	29/04/2021
108	Rebar/stopends	28/04/2021	1w	05/05/2021
109	Concrete pours	28/04/2021	1w	06/05/2021
110	Level 8 incl verts [S1]	04/05/2021	2w 2.5d	20/05/2021
111	Columns	04/05/2021	1w	10/05/2021
112	Falsework	06/05/2021	1w 2d	14/05/2021
113	Rebar/stopends	13/05/2021	1w	19/05/2021
114	Concrete pours	13/05/2021	1w	20/05/2021
115	Level 9 incl verts [S1]	17/05/2021	2w 2.5d	03/06/2021
116	Columns	17/05/2021	1w	21/05/2021
117	Falsework	19/05/2021	1w 2d	27/05/2021
118	Rebar/stopends	26/05/2021	1w	02/06/2021
119	Concrete pours	26/05/2021	1w	03/06/2021
120	Level 10 incl verts [S1]	27/05/2021	2w 2.5d	15/06/2021
121	Columns	27/05/2021	1w	03/06/2021
122	Falsework	01/06/2021	1w 2d	09/06/2021
123	Rebar/stopends	08/06/2021	1w	14/06/2021
124	Concrete pours	08/06/2021	1w	15/06/2021
125	Level 11 (Roof) [S1]	14/06/2021	2w	25/06/2021
126	Columns	14/06/2021	1w	18/06/2021
127	Falsework	16/06/2021	1w 2d	24/06/2021
128	Rebar/stopends	21/06/2021	1w	25/06/2021
129	Concrete pours	21/06/2021	1w	25/06/2021

Planned v Actual Flowlines – Multistorey frame buildings





Using data to explain variability between plans and actuals



Medium Level Factors Affecting Productivity

1. Equipment failure (scaffolding, hoist failure) (16 days)
2. Weather (winding) (7 days)
3. Material unavailability (delays, incorrect deliveries) (6 days)
4. Design changes (5 days)
5. Labour issues (5 days)
6. Rework (2 days)
7. Safety standdown (1 day)

Total = 42 days

- Is data missing?
- Are the plans unfeasible?

Productivity Measurement Framework

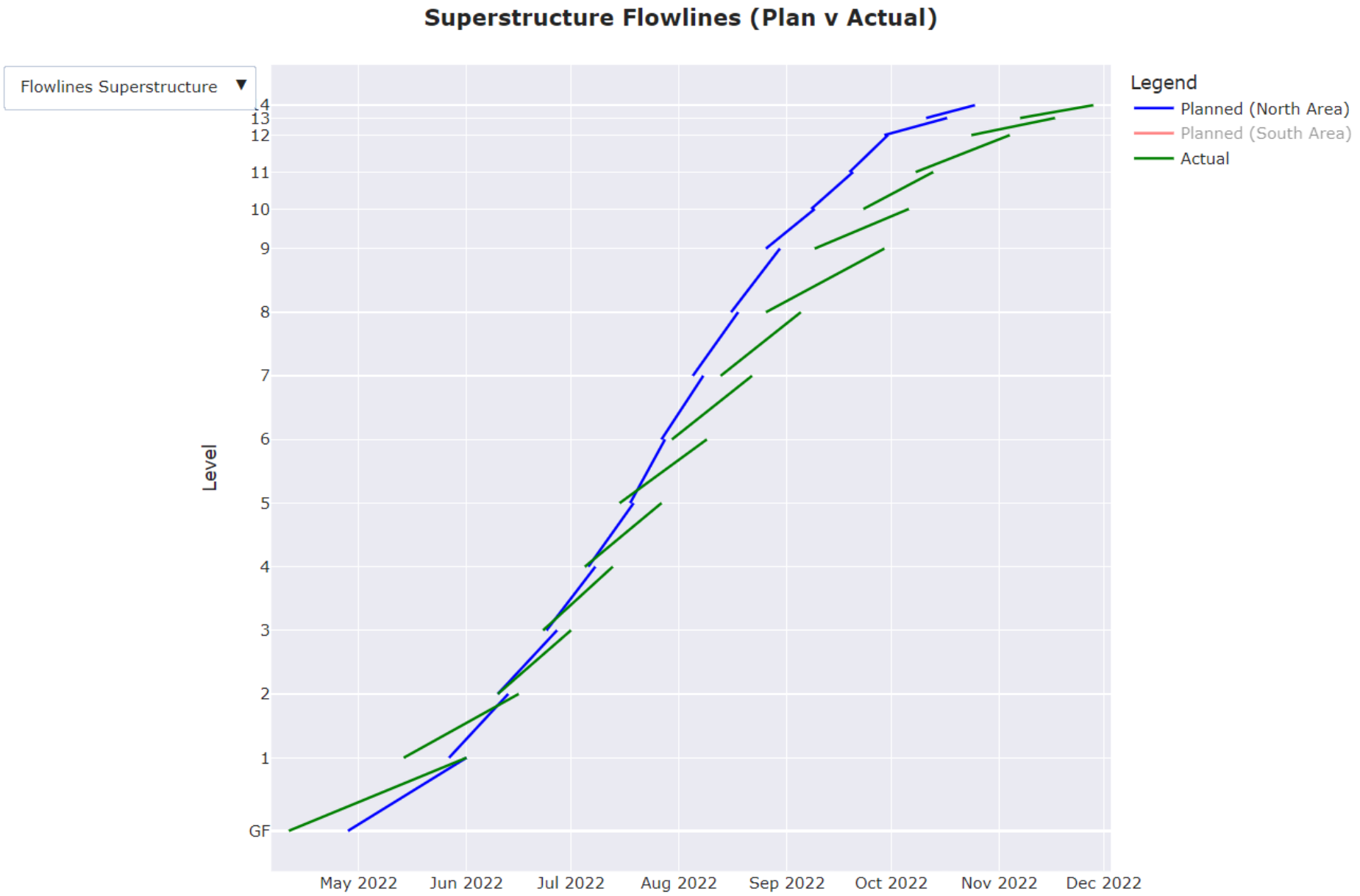
- Framework
- Data templates
- Visualisation dashboard
- Examples

Menu

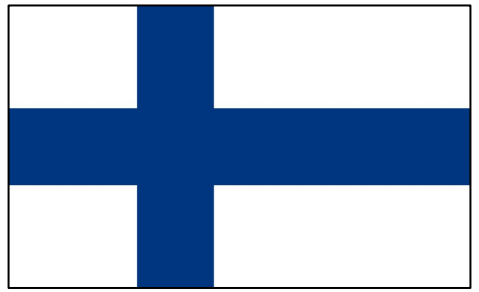
Project

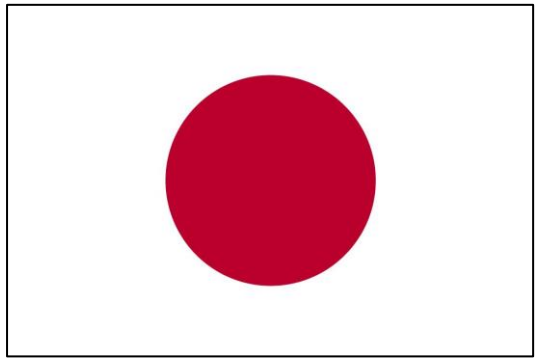
Superstructure

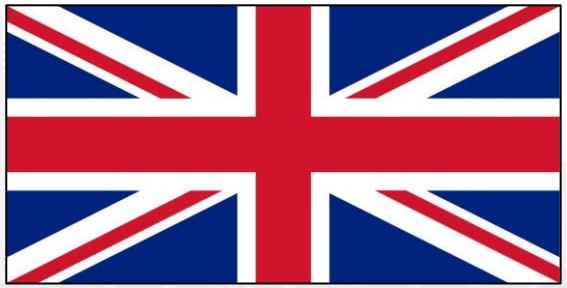
Cladding

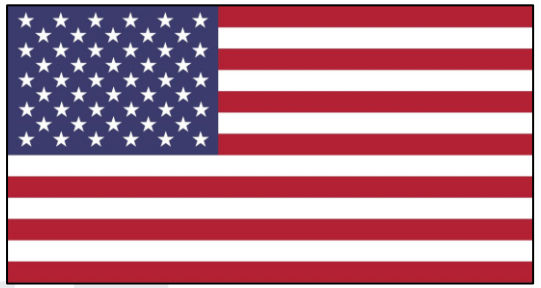


WCLF – World Construction Leadership Forum

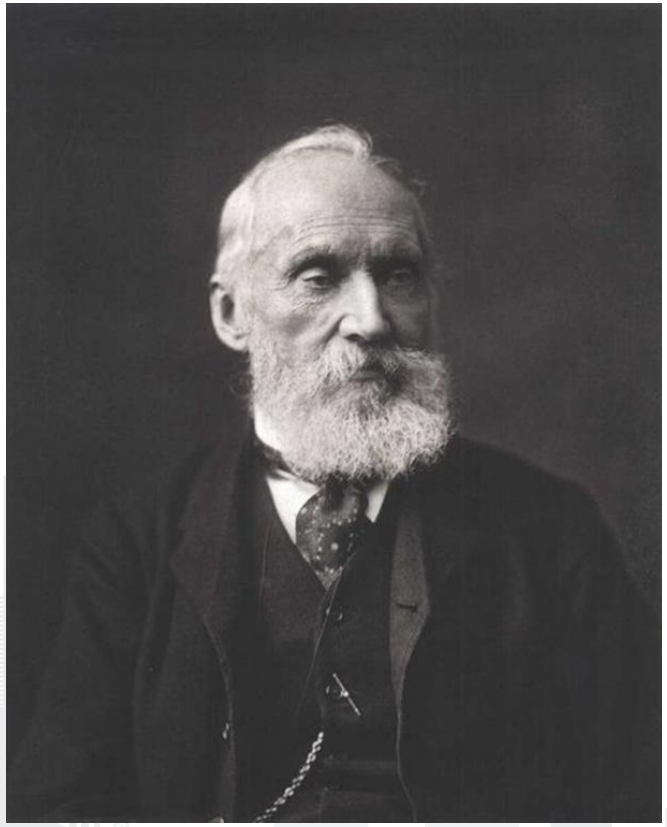








Transforming construction……



"If you cannot measure it, you cannot improve it"*

*shortened attribution derived from quote by **Lord Kelvin**

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  - Tercia Jansen van Vuuren

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Image courtesy of Grimshaw Architects