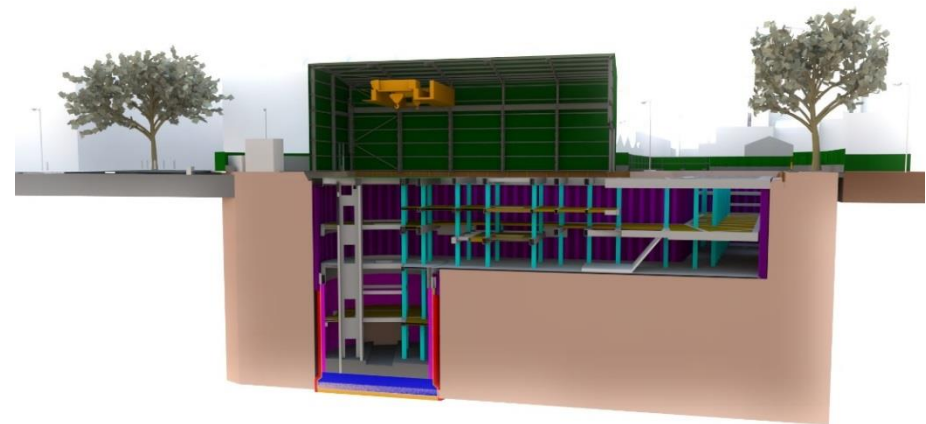
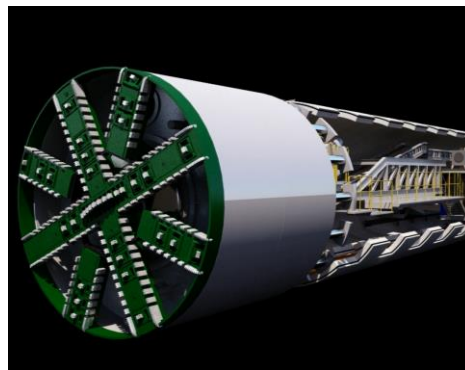


NORTHERN LINE EXTENSION

Innovation and Efficiency through
Digital Engineering

ICE - 26 April 2016



Transport
for London



RAIL & UNDERGROUND NETWORK

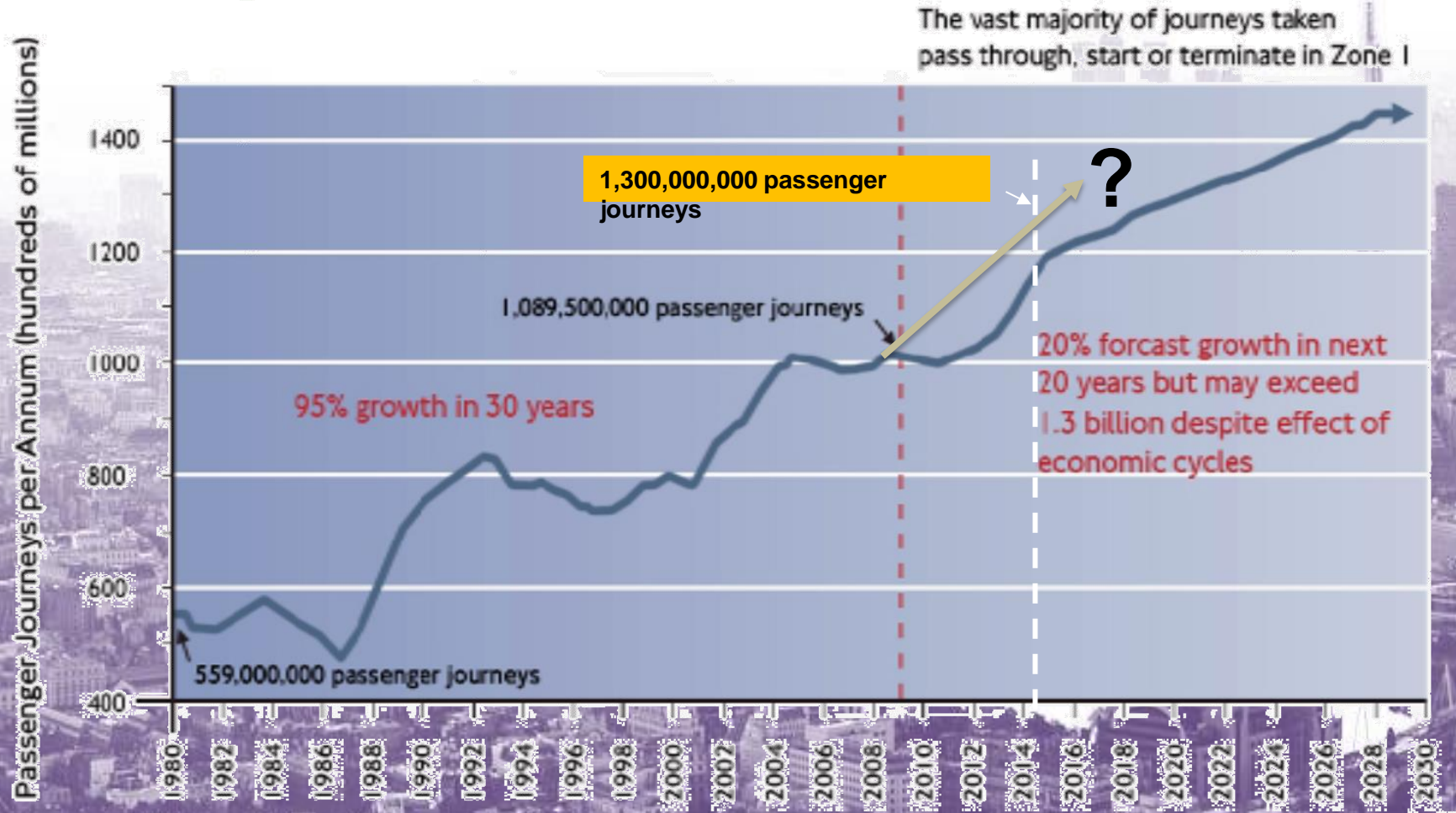


1.3 billion passengers a year



ACCELERATING PASSENGER GROWTH

Passenger Growth



LONDON UNDERGROUND & RAIL PRIORITIES

1. Reliability & Safety

2. Capacity from the *current* network

3. Capacity from *growing* the network

4. Transforming customer service

Underpinned by:

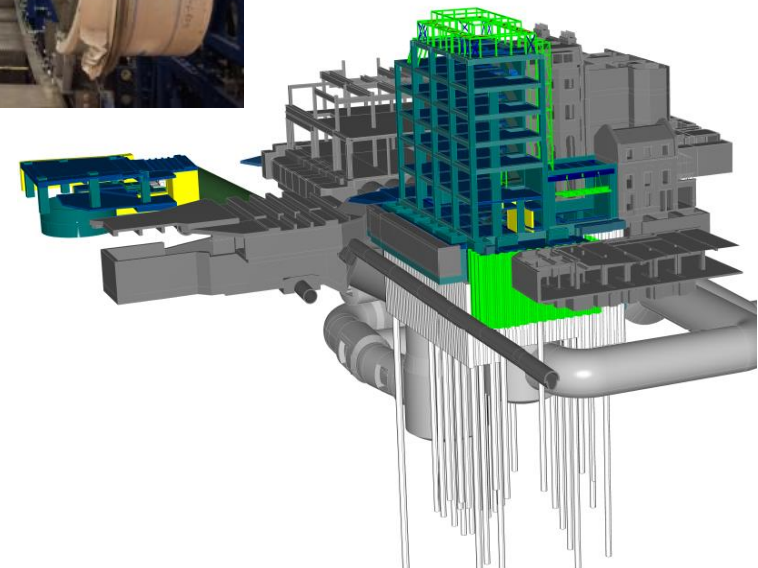
Efficiency

People

Technology

EMBRACING TECHNOLOGY

- LU Design Idiom
 - Common systems, architectural products & finishes
 - Mock Up facility
 - Category Management
- Lower Carbon Solutions
- Digital Engineering (BIM)



***“Construction
to
Configuration”***

NLE PROJECT

Battersea

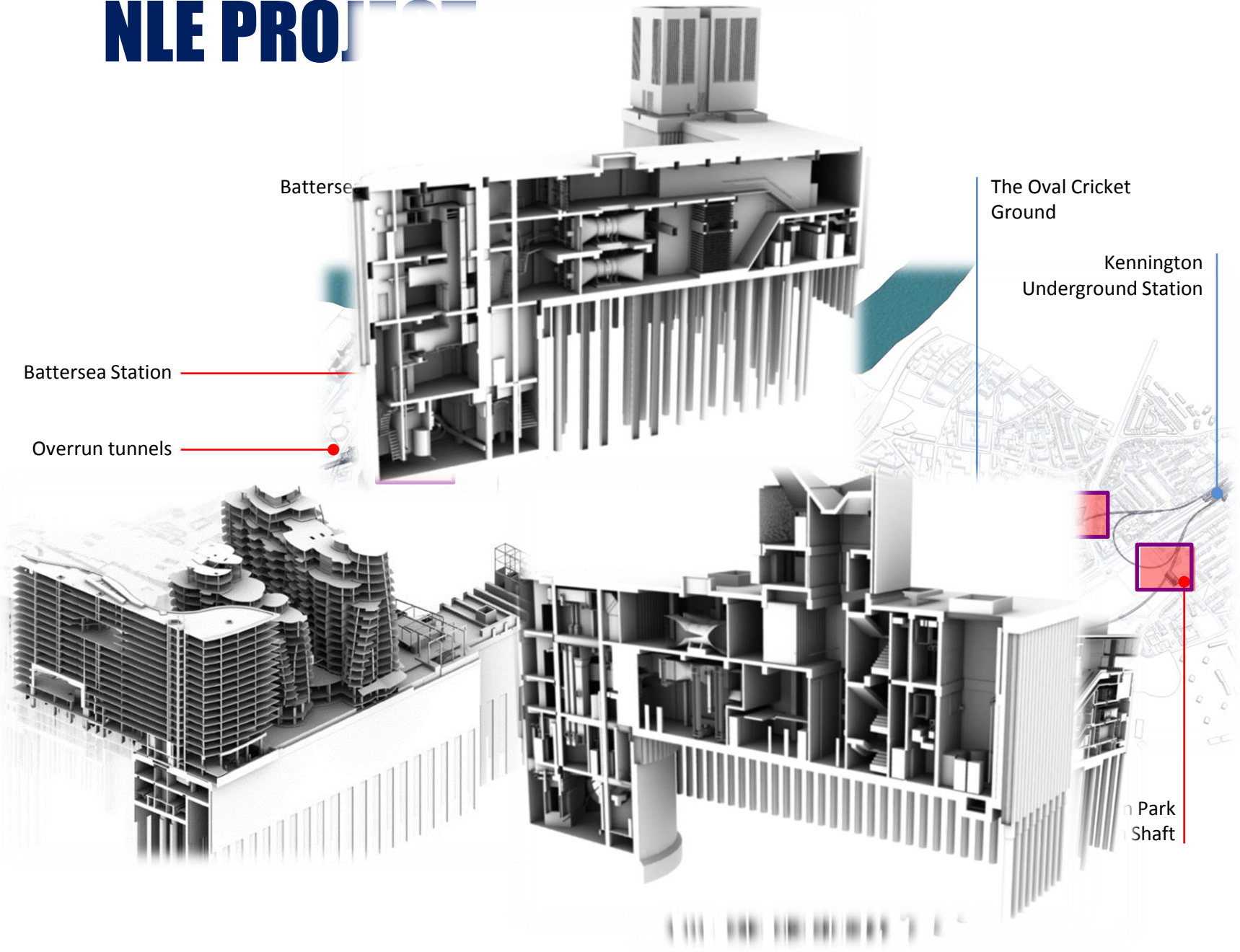
The Oval Cricket Ground

Kennington Underground Station

Battersea Station

Overrun tunnels

Kennington Park Shaft



DIGITAL ENGINEERING ON NLE

CDE - BS1192
Workflows for
whole supply chain

Quantity /
Schedule
Extraction

Design
Analyses

Drawing
Production

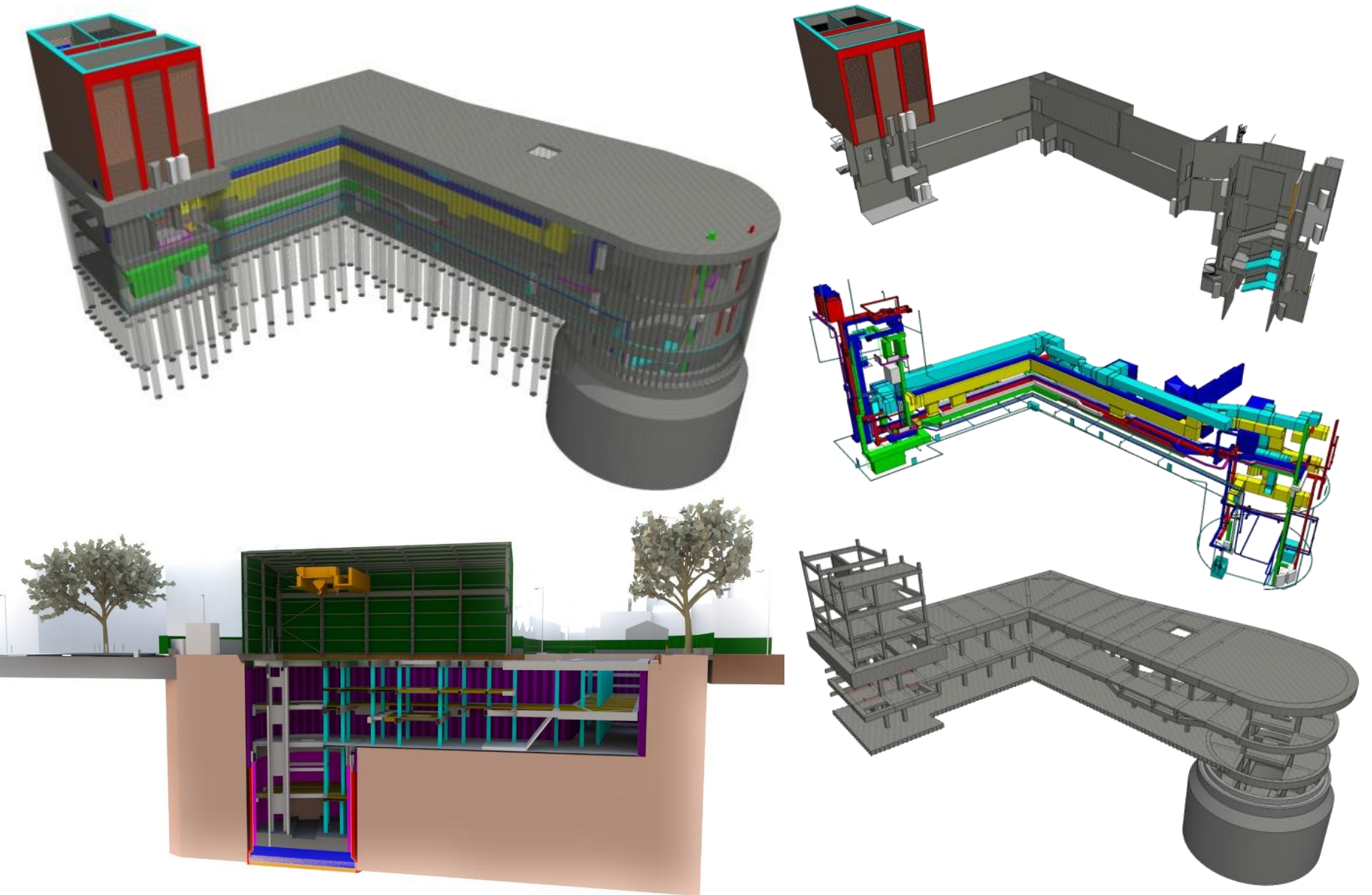
Project
Coordination
& Interfaces

Facilitator for
DFMA

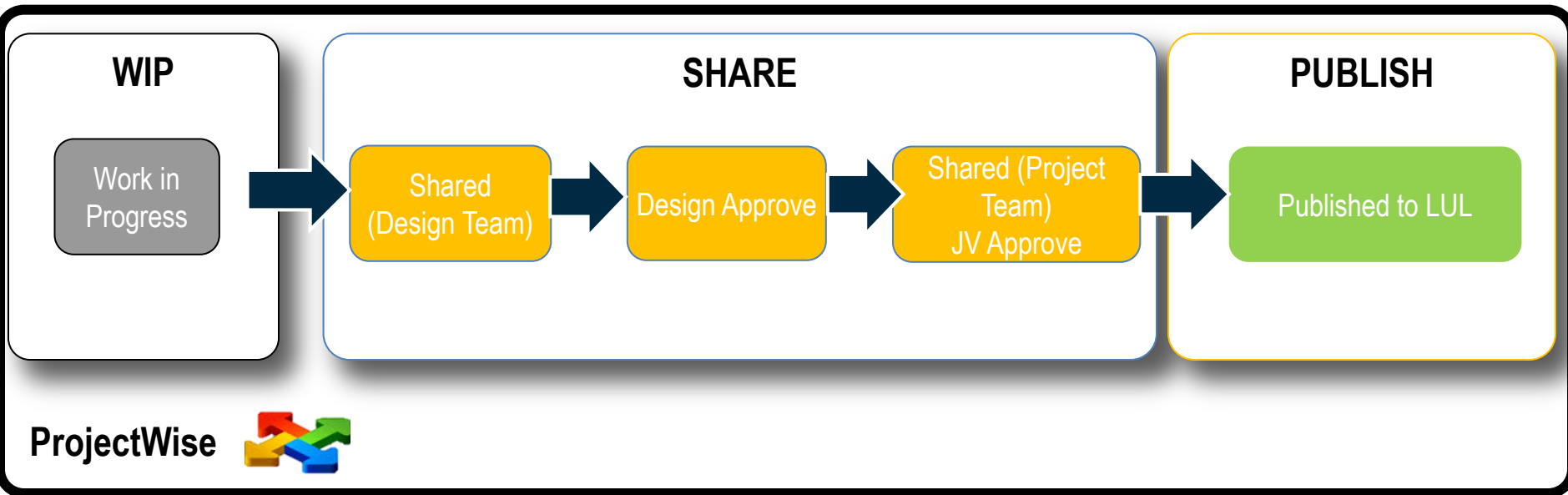
Embedded
Information
“clever objects”

Virtual and
Augmented
Reality
Applications

DESIGN COORDINATION

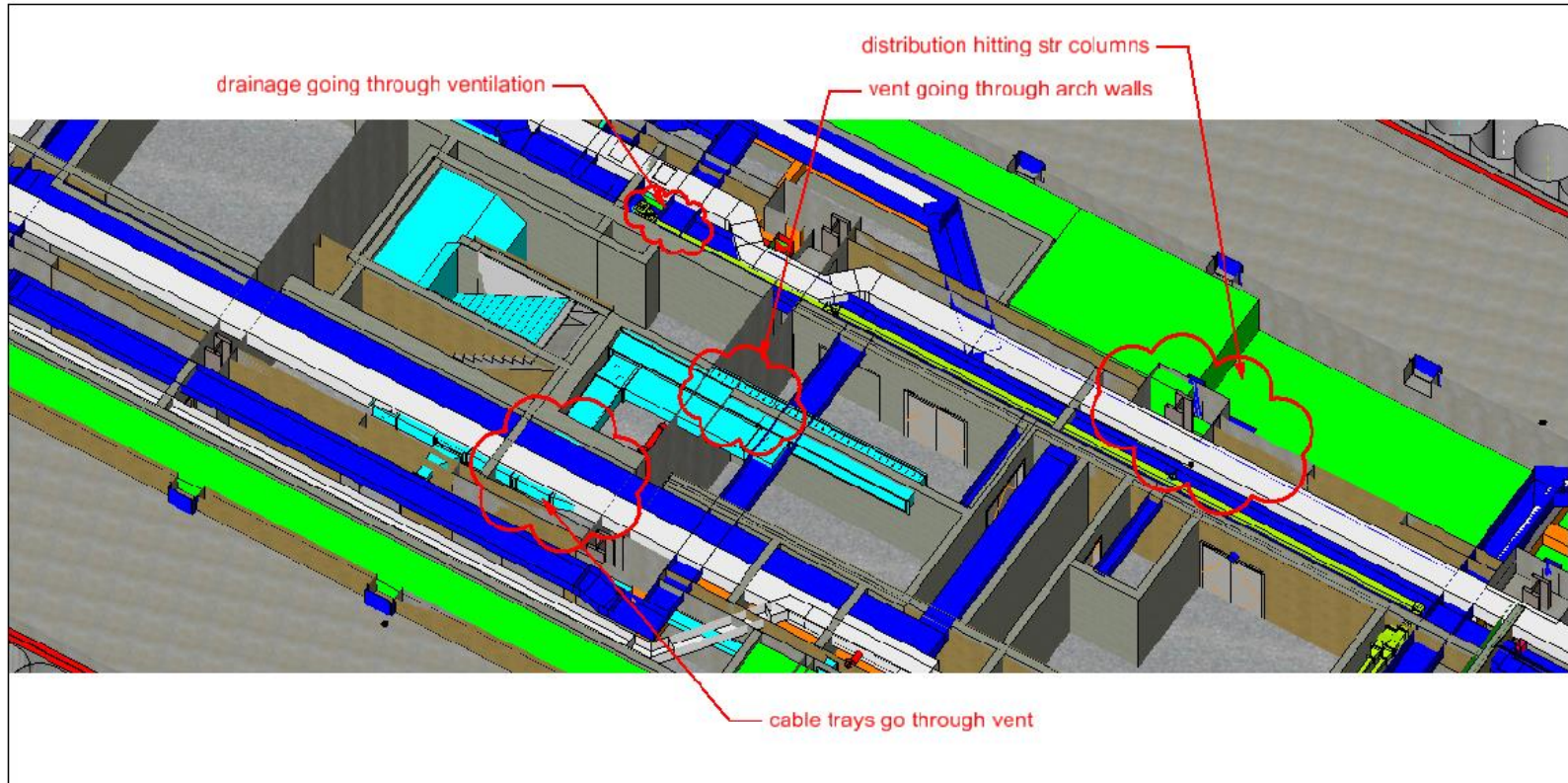


DESIGN: MANAGED CDE



DESIGN ASSURANCE

NORTHERN LINE
EXTENSION PROJECT



Markup: Markup19

Description: cable trays / vent clashes

Creator: gil47982

Date Created: 06/07/2015 13:19:52

Assigned To: MEP

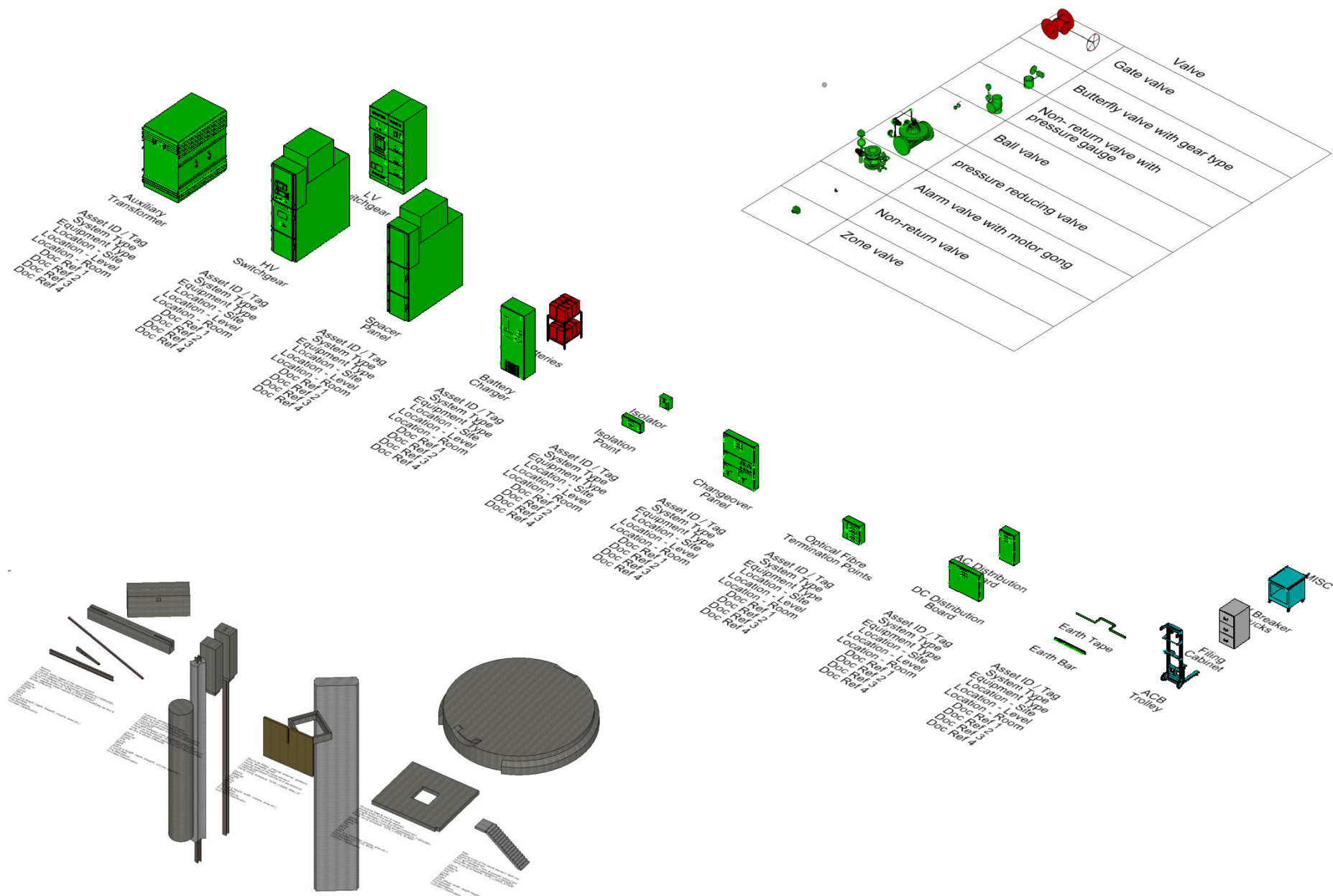
Reviewed By: ear72599

Approved By: ####

Status: In progress



DESIGN – LOD TEMPLATES



DESIGN FOR MANUFACTURE AND ASSEMBLY

Digital Engineering underpinning the end-to-end delivery process

**Greater
Programme
Certainty**

Improved Quality Control

**Reduced time on site –
Improve Health and Safety**

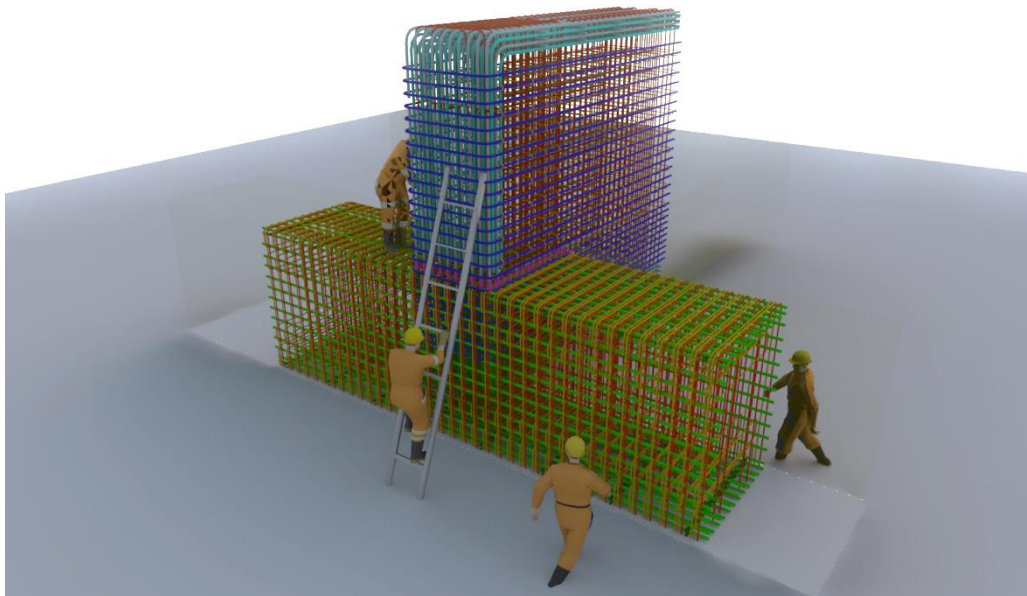
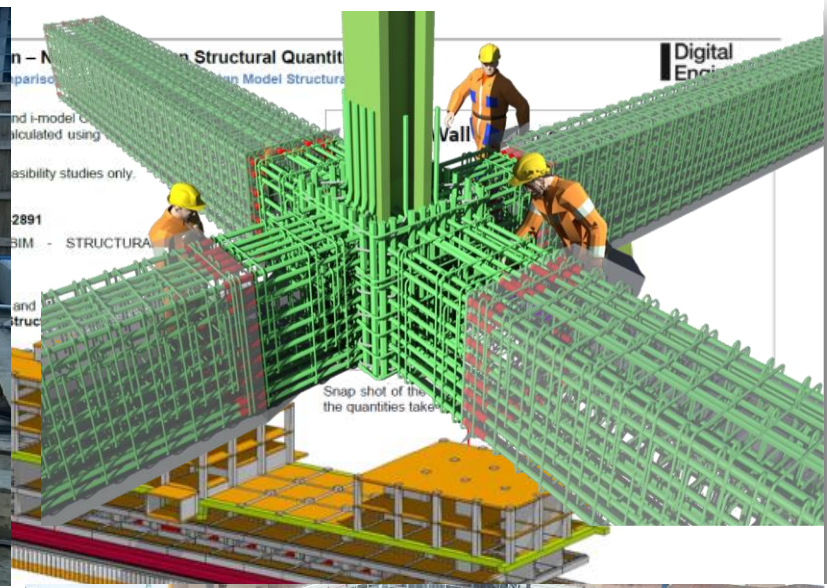
**Greater levels of design
standardisation**

DESIGN FOR MANUFACTURE AND ASSEMBLY



Expertise working collaboratively – Design, Manufacture, Assembly

DESIGN FOR MANUFACTURE AND ASSEMBLY



CONSTRUCTION LOGISTICS PLANNING

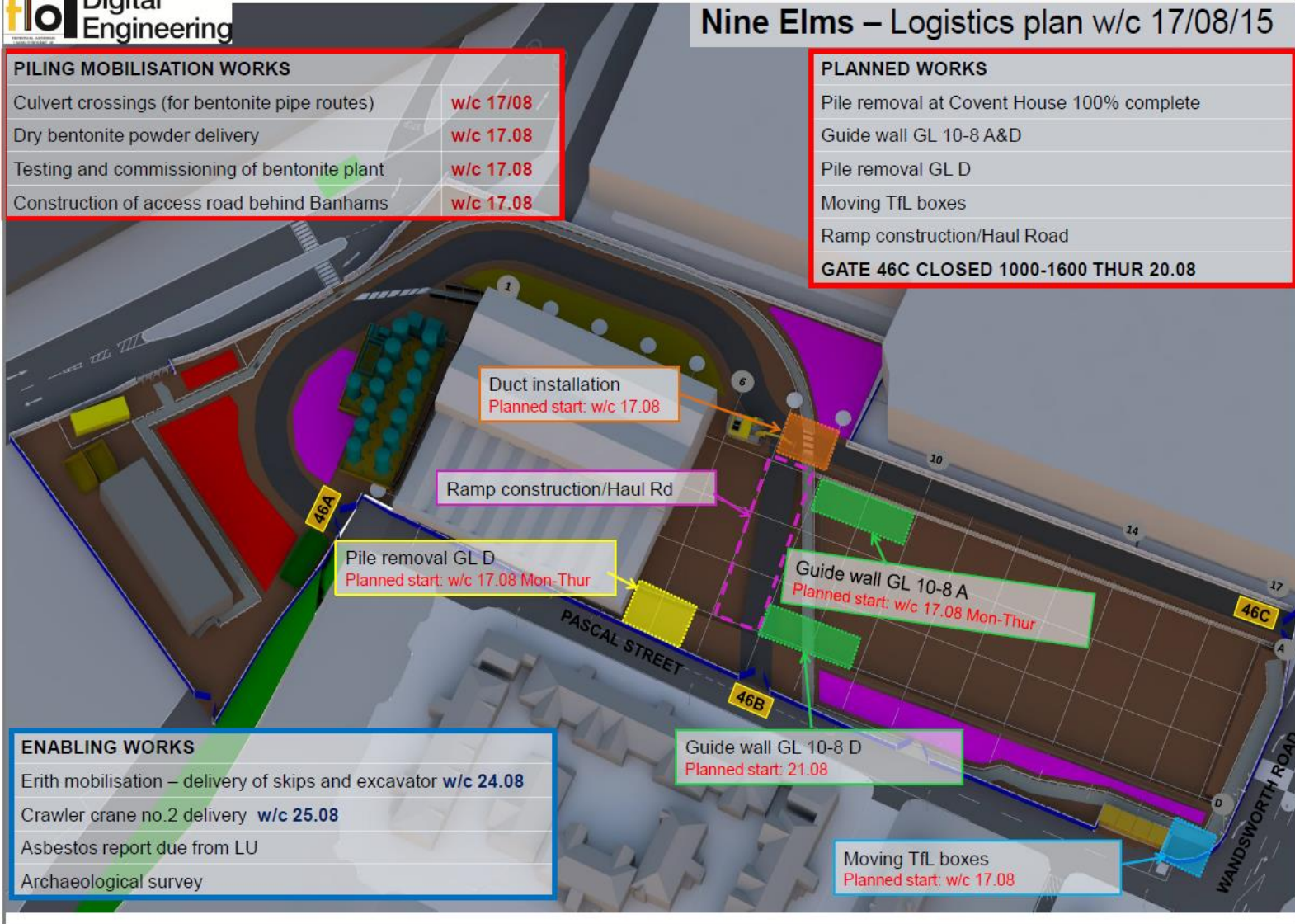
Nine Elms – Logistics plan w/c 17/08/15

PILING MOBILISATION WORKS

Culvert crossings (for bentonite pipe routes)	w/c 17/08
Dry bentonite powder delivery	w/c 17.08
Testing and commissioning of bentonite plant	w/c 17.08
Construction of access road behind Banhams	w/c 17.08

PLANNED WORKS

Pile removal at Covent House 100% complete
Guide wall GL 10-8 A&D
Pile removal GL D
Moving TfL boxes
Ramp construction/Haul Road
GATE 46C CLOSED 1000-1600 THUR 20.08



ENABLING WORKS

Erith mobilisation – delivery of skips and excavator	w/c 24.08
Crawler crane no.2 delivery	w/c 25.08
Asbestos report due from LU	
Archaeological survey	

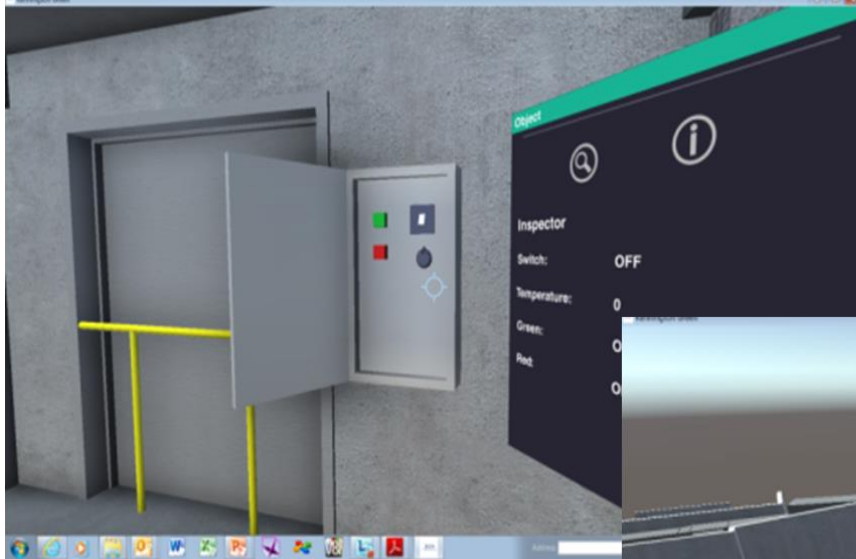
CONSTRUCTION LOGISTICS PLANNING



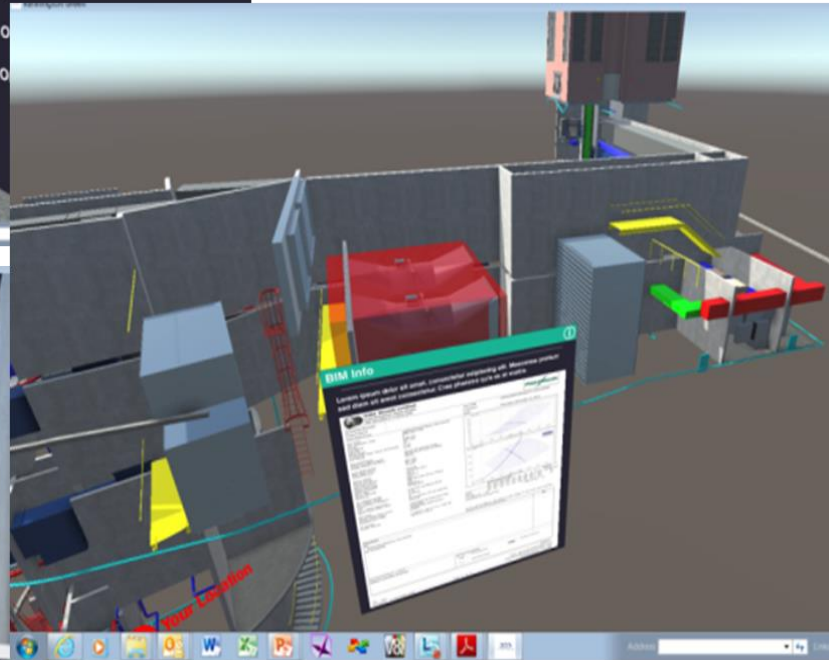
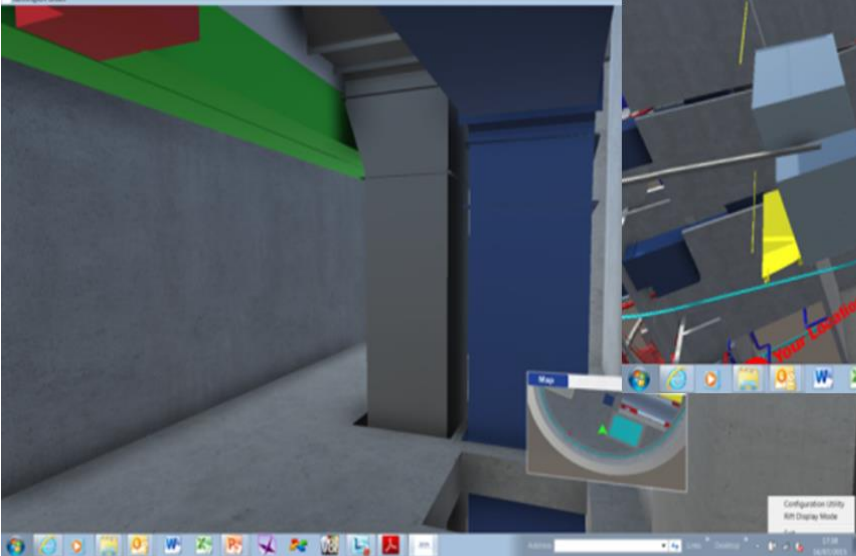
4D Construction Programming using Design Model

Effectively communicate planned works

VIRTUAL REALITY



Virtual Reality Applications



Immersive Experience

Scenario Simulation

VIRTUAL REALITY



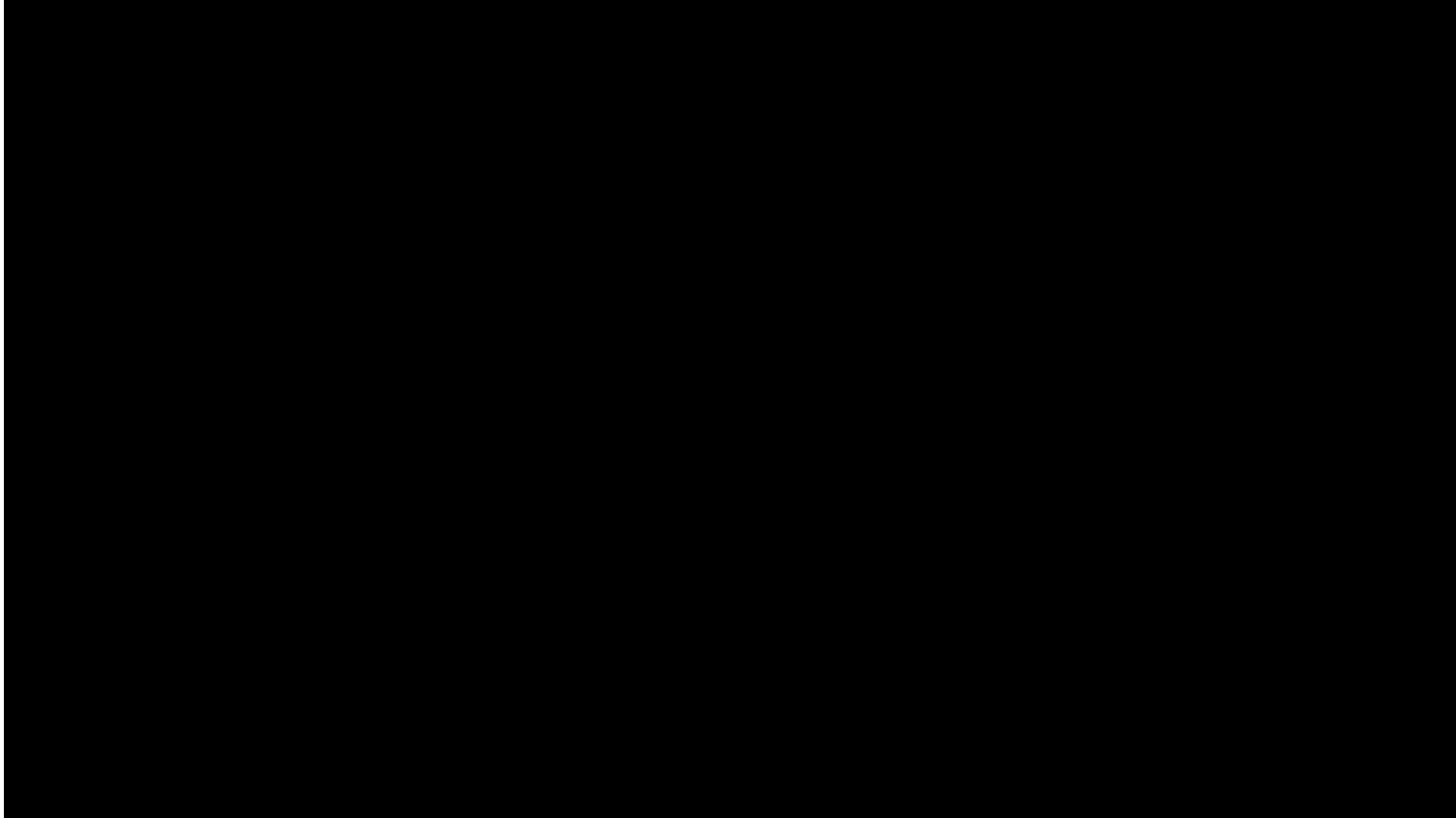
AUGMENTED REALITY



Augmented Reality Applications

Improved Design Accessibility – giving context to 2D drawings

AUGMENTED REALITY



**Augmented Reality
Applications**

Improved Design Accessibility – giving context to 2D drawings

ASSET MANAGEMENT

London Underground Information Requirements

DataGroup Explorer															
New Schedule Modify Refresh Filter Working Units Zoom & Select Place Schedule Export Excel Exchange															
Show Used	Grade	Site	Level	ID Name (Alternate)	ID Type ID	ID Notes	ID Description	ID Keynote	Section Name	Cross Section Area (Modeled)	Net Volume [...]	Length			
Catalog Types	Structural	Columns: Concrete	STR_LOD04_COL_and_PILE	C32/40	NES	NA	S02	A	Zone 1	Long	15000	1.77 Sq m	92.9784 m3	52.615m	
				C12/15	NES	NA	S03	P	Zone 1		15000	1.77 Sq m	31.5207 m3	21.215m	
				C32/40	NES	NA	S04	B	Zone 1	Short	15000	1.77 Sq m	54.1012 m3	30.615m	
				C32/40	NES	NA	S06	A	Zone 1	Long	15000	1.77 Sq m	92.9784 m3	52.615m	
				C32/40	NES	NA	S08	A	Zone 1	Long	15000	1.77 Sq m	92.9784 m3	52.615m	
				C12/15	NES	NA	S01	P	Zone 1		SOP 01	15000	1.77 Sq m	32.6845 m3	21.215m
				C32/40	NES	NA	S294	A	Zone 1	Long	SOP 14	15000	1.77 Sq m	92.9784 m3	52.615m
				C32/40	NES	NA	S292	A	Zone 1	Long	15000	1.77 Sq m	92.9784 m3	52.615m	
				C32/40	NES	NA	S290	A	Zone 1	Long	15000	1.77 Sq m	92.9784 m3	52.615m	
				C32/40	NES	NA	S288	A	Zone 1	Long	15000	1.77 Sq m	92.9784 m3	52.615m	
Multi-Category Schedules	aaa	MEP_LOD_04_TV	Slab Schedule	C32/40	NES	NA	S286	A	Zone 1	Long	15000	1.77 Sq m	92.9784 m3	52.615m	
				C32/40	NES	NA	S136	E	Zone 4	Long	15000	1.77 Sq m	94.6395 m3	53.555m	
				C32/40	NES	NA	S138	M	Zone 4	Long	15000	1.77 Sq m	94.6395 m3	53.555m	
				C32/40	NES	NA	S140	M	Zone 4	Long	15000	1.77 Sq m	94.6395 m3	53.555m	
				C32/40	NES	NA	S142	M	Zone 4	Long	15000	1.77 Sq m	94.6395 m3	53.555m	
				C12/15	NES	NA	S293	P	Zone 1		SOP 13	15000	1.77 Sq m	25.3723 m3	21.215m
				C32/40	NES	NA	S10	B	Zone 1	Short	15000	1.77 Sq m	54.1012 m3	30.615m	
				C32/40	NES	NA	S12	B	Zone 1	Short	15000	1.77 Sq m	54.1012 m3	30.615m	
				C32/40	NES	NA	S14	A	Zone 1	Long	15000	1.77 Sq m	92.9784 m3	52.615m	
				C32/40	NES	NA	S16	A	Zone 8	Long	15000	1.77 Sq m	87.3235 m3	49.415m	
C32/40	NES	NA	S18	B	Zone 8	Short	15000	1.77 Sq m	48.4449 m3	27.415m					
C32/40	NES	NA	S20	B	Zone 8	Short	15000	1.77 Sq m	48.4449 m3	27.415m					
C32/40	NES	NA	S22	A	Zone 1	Long	15000	1.77 Sq m	92.9784 m3	52.615m					
C32/40	NES	NA	S24	A	Zone 1	Long	15000	1.77 Sq m	92.9784 m3	52.615m					
C32/40	NES	NA	S26	B	Zone 1	Short	15000	1.77 Sq m	54.1012 m3	30.615m					
C32/40	NES	NA	S28	B	Zone 1	Short	15000	1.77 Sq m	54.1012 m3	30.615m					
C32/40	NES	NA	S30	A	Zone 1	Long	15000	1.77 Sq m	92.9784 m3	52.615m					
C32/40	NES	NA	S32	A	Zone 8	Long	15000	1.77 Sq m	87.3235 m3	49.415m					
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C32/40	NES	NA	S36	B	Zone 8	Short	15000	1.77 Sq m	48.4463 m3	27.415m					
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C32/40	NES	NA	S46	A	Zone 1	Long	15000	1.77 Sq m	92.9784 m3	52.615m					
C32/40	NES	NA	S47	A	Zone 1	Long	15000	1.77 Sq m	92.9784 m3	52.615m					
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C32/40	NES	NA	S113	A	Zone 1	Long	15000	1.77 Sq m	92.9784 m3	52.615m					
C32/40	NES	NA	S11												

CHALLENGES / LESSONS

Think project lifecycle from day one

Clear end-user data requirements (LOD benchmarking)

Produce data only once and re-use

Digital engineering mindset throughout project team

Think “appropriate” use of DfMA from day one

“Our joint innovative approach in Digital Engineering facilitates Design Manufacture and Assembly, providing greater certainty of high-risk items such as safety, quality, cost and carbon”