Digital Engineering – (BIM)

Contractors Viewpoint

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03/10/2013

LAING O'ROURKE

Cannon Place, London, UK


An engineering
enterprise
LAING O'ROURKE

Sectors and businesses

With a presence in all of the major building and infrastructure sectors, our internationally integrated delivery model serves clients in all phases of the project. We recognise that every project is unique and tailor our service offering to provide custom solutions to the highest standards of quality – on time and on budget.

Our sectors

Business
- Commercial offices
- Data centres
- Industrial
- Science and research

Lifestyle
- Hotels
- Residential
- Retail
- Sport and leisure

Social infrastructure
- Defence
- Education
- Healthcare
- Law and order

Transport
- Aviation
- Highways
- Marine
- Rail

Power
- Generation
- Maintenance
- New nuclear
- Renewables

Utilities and waste
- Sewage
- Utility networks
- Waste
- Water treatment

Mining and natural resources
- Coal and mineral processing
- Labour accommodation
- Material transport
- Minerals handling

Oil and gas
- LNG terminals
- Pipelines and pump stations
- Processing plants
- Storage

Our businesses

Investment and Development

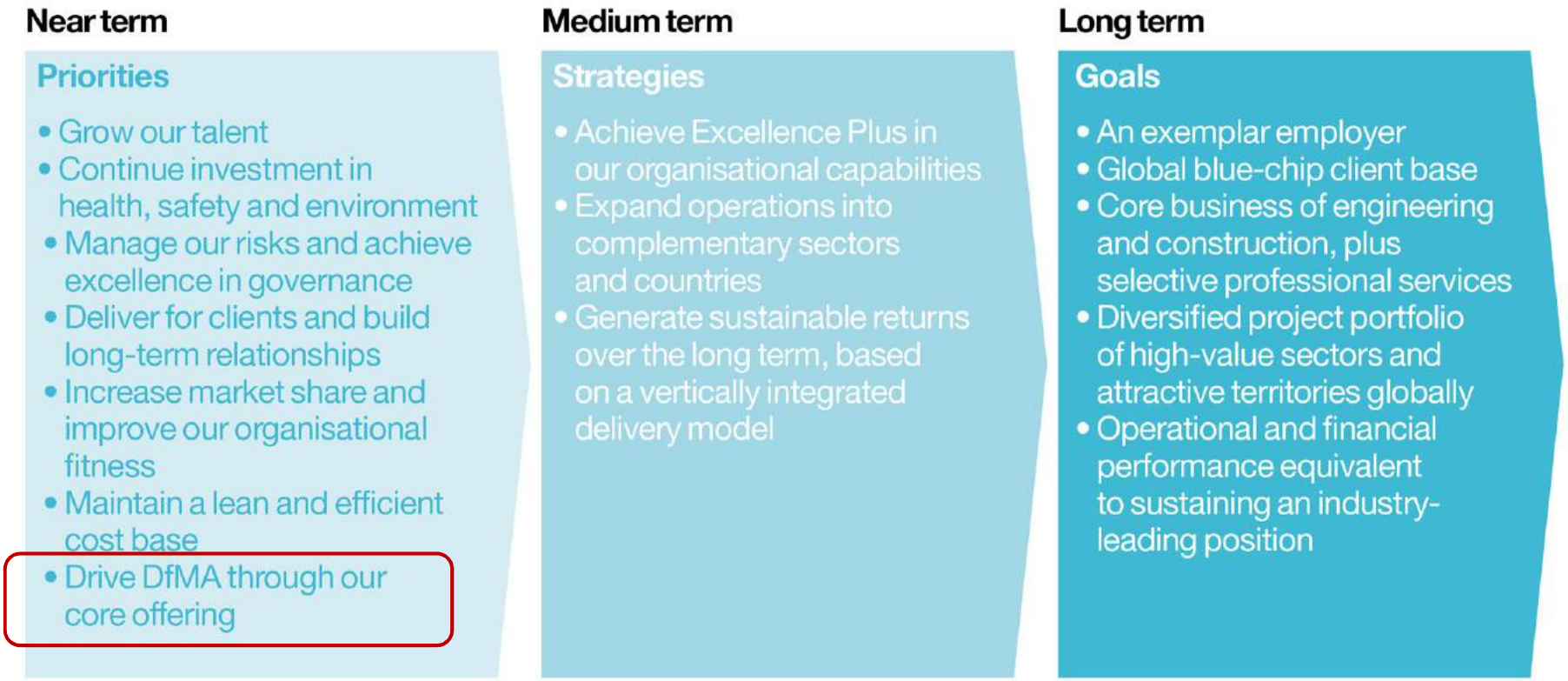
Manufacturing

Construction and Building Services

Infrastructure Services

Support Services

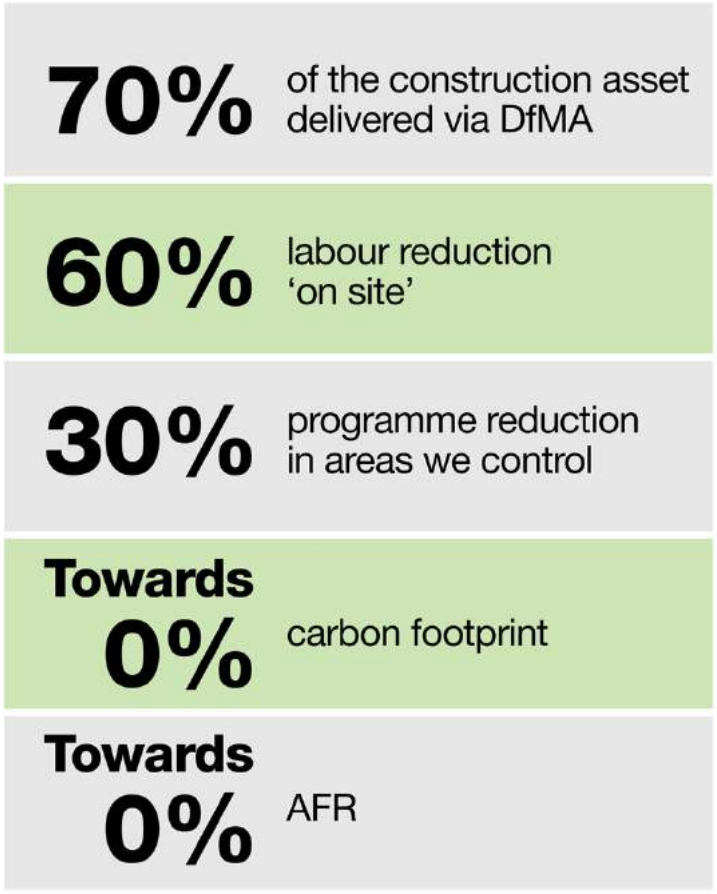
Vision and strategy



DfMA Strategy is to deliver 70/60/30->0->0

DE is an enabler to DfMA

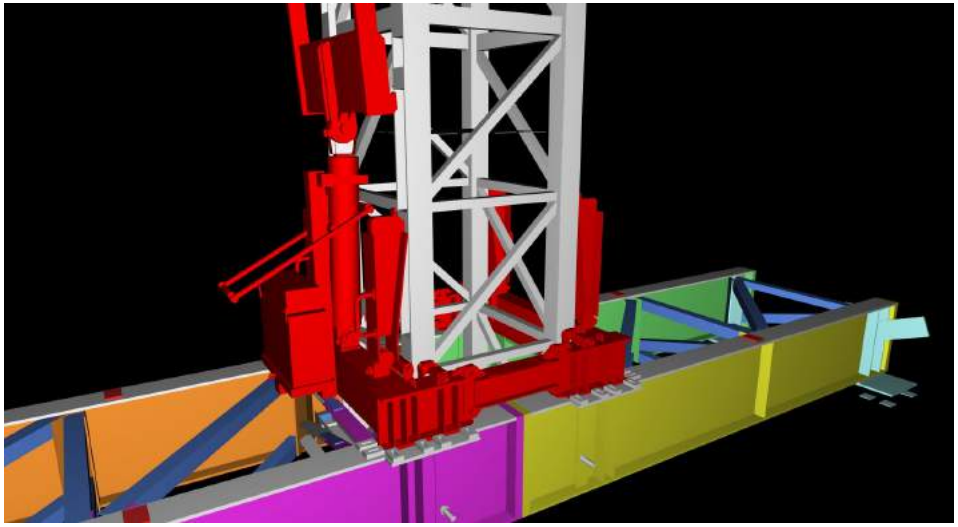
DfMA and DE are mandated within Laing O'Rourke on all new projects

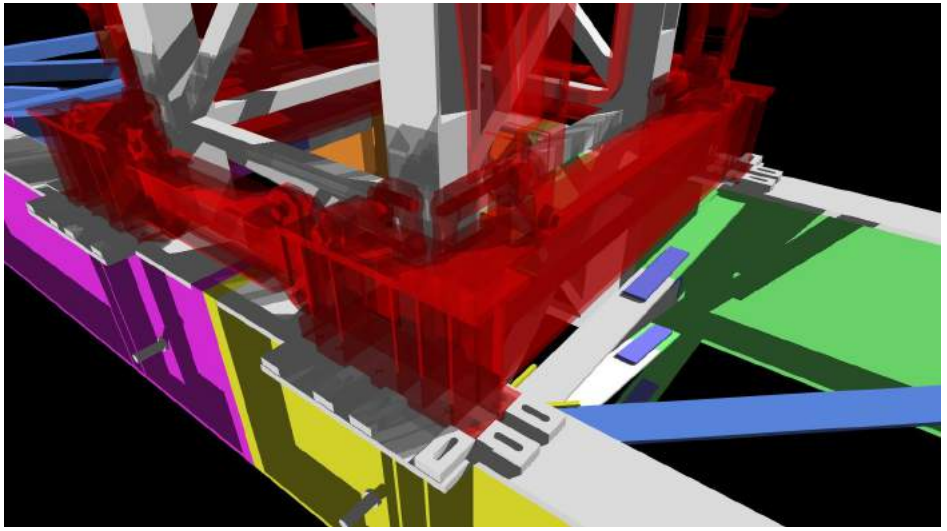


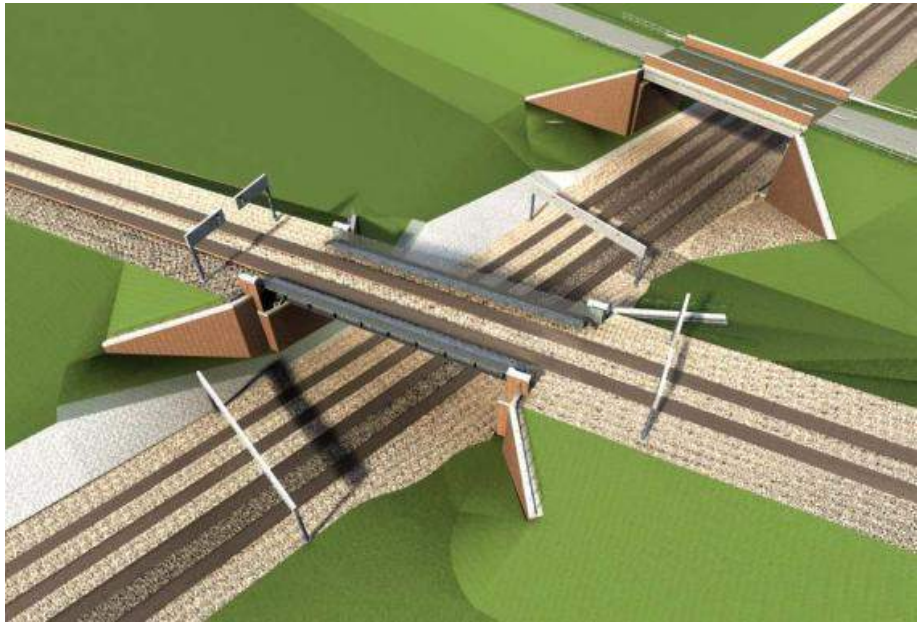
Our stated DfMA objectives = your personal objectives

Digital Engineering

Work Winning and Post Win







Frame

Concrete framesDefinition: Concrete columns and beams.

Sub element unit quantity: Concrete frames

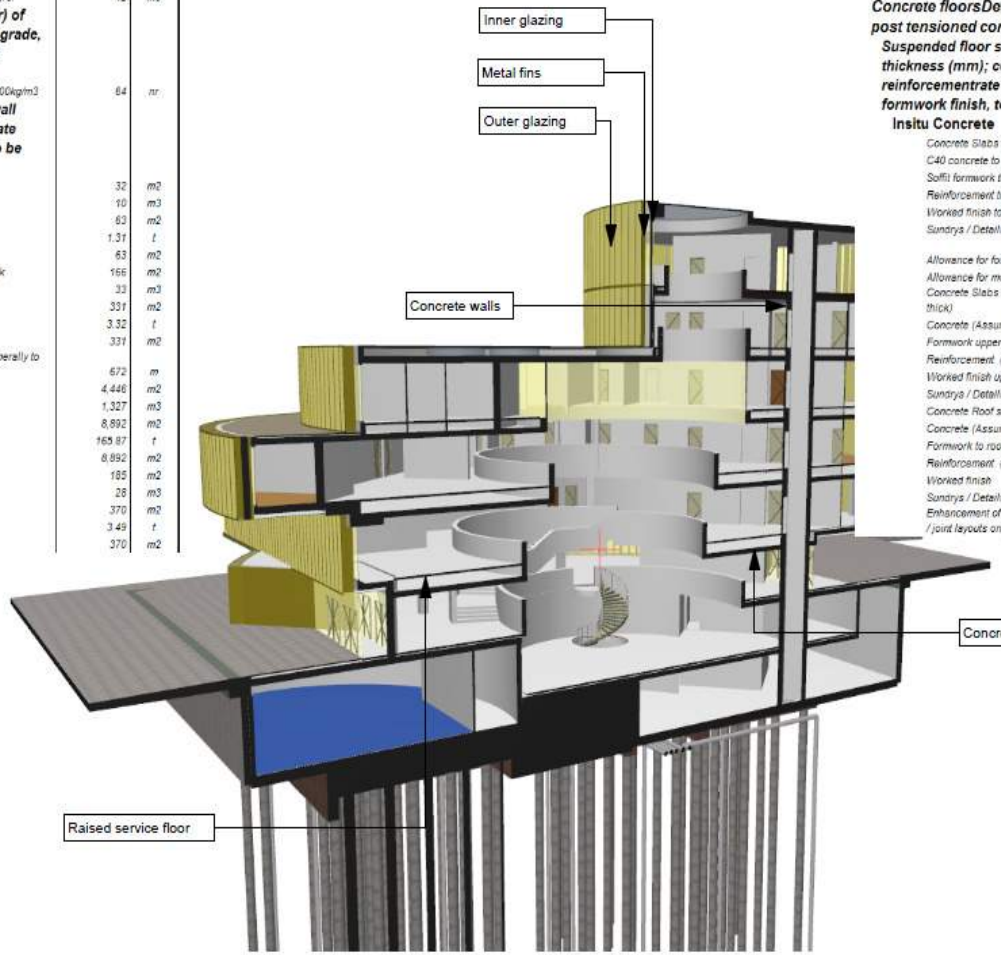
Total Concrete in columns. Reference measure.	42	m3

Columns: details,including number (nr) of columns, column size (mm), concrete grade, reinforcement rate (kg/m³) and type of formwork finish, to be stated.

Other columns - includes reinforcement @ 300kg/m3	84	nr

Walls:Details, including thickness of wall (mm), concrete grade,reinforcement rate (kg/m³) and type of formwork finish, to be stated.

Concrete load bearing walls, 350mm thick:	32	m2
C50 concrete in 350mm walls	10	m3
Formwork to 350mm walls	63	m2
Reinforcement to 350mm walls 125gk/m3	1.31	t
Enhancement of finish to 350mm walls	63	m2
Concrete non load bearing walls 200mm thick:	166	m2
C50 concrete in 200mm walls	33	m3
Formwork to 200mm walls	331	m2
Reinforcement to 200mm walls 100gk/m3	3.32	t
Enhancement of finish to 200mm walls	331	m2
350mm x 350mm Upstands / Downstands generally to level perimeter including roof	672	m
Concrete load bearing walls, 300mm thick:	4,446	m2
C50 concrete in 300mm walls	1,327	m3
Formwork to 300mm walls	8,892	m2
Reinforcement to 300mm walls 125gk/m3	165.87	t
Enhancement of finish to 300mm walls	8,892	m2
Concrete load bearing walls, 150mm thick:	185	m2
C50 concrete in 150mm walls	28	m3
Formwork to 150mm walls	370	m2
Reinforcement to 150mm walls 125gk/m3	3.49	t
Enhancement of finish to 150mm walls	370	m2



Upper floors

Element unit quantity: Upper floors

Total area of upper floors measured as for GIFA	7,285	m2
The area measured is the area of the floors related to theframe. - elemental cost	7,285	m2

Concrete floorsDefinition: Reinforced and post tensioned concrete suspended floors

Suspended floor slabsDetails, including thickness (mm); concrete strength (N/mm²), reinforcementrate (kg/m³) and type of formwork finish, to be stated

Insitu Concrete

Concrete Slabs to Lower Ground Floor (300mm thick)	1,054	m2
C40 concrete to lower ground slab	316	m3
Soffit formwork to lower ground slab	1,054	m2
Reinforcement to lower ground slab (145kg/m3)	108.54	t
Worked finish to lower ground	1,054	m2
Sundrys / Detailing to lower ground	1,054	m2
Allowance for forming ramps between gridlines 4 and 9	5	item
Allowance for movement joints / crease lines	4	item
Concrete Slabs to remaining upper floors (300mm thick)	6,230	m2
Concrete (Assumes C40 Mix) upper floors	1,992	m3
Formwork upper floors	6,276	m2
Reinforcement (145kg/m3) upper floors	288.78	t
Worked finish upper floors	6,230	m2
Sundrys / Detailing	6,230	m2
Concrete Roof slab (300mm thick)	49	m2
Concrete (Assumes C40 Mix) to roof slab	92	m3
Formwork to roof slab	49	m2
Reinforcement (145kg/m3) to roof slab	13.41	t
Worked finish	49	m2
Sundrys / Detailing	49	m2
Enhancement of finish to Soffits to all Net Areas - Board / joint layouts only	7,282	m2

CPE312 BLAVATNIK SCHOOL OF GOVERNMENT - Stage D

A.01 Stage D (25%) Quantification

A.01.2 General Quantification sheet 2

Core 4 – Bid Production Support

- ☑ Inception
- ☑ Concept / optioneering
- ☑ Scheme design
- ☑ Detailed design

Responsible:
Construction process engineer

Consulted:
Bid production

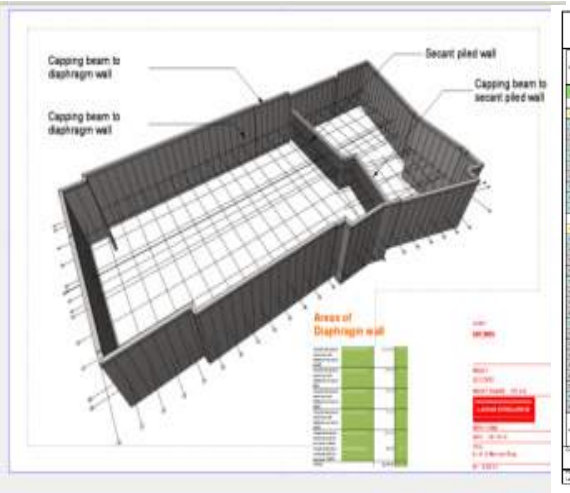
- Visuals from the model to support bid production
- Authoring of BIM sections of the bid to ensure consistency and full demonstration of our capabilities
- Presentational material can be produced based on model views

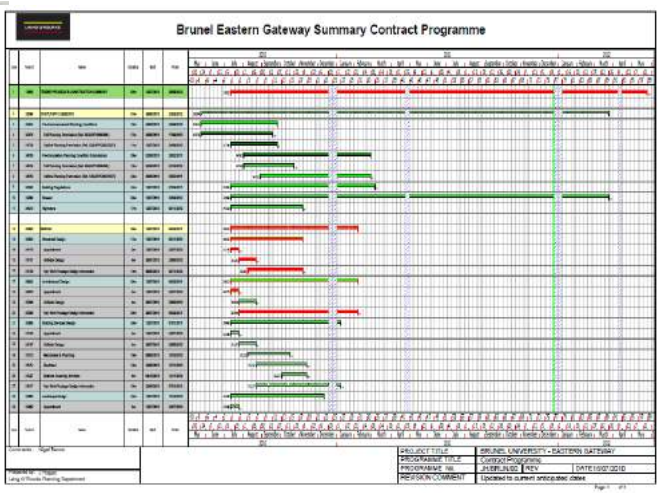
1

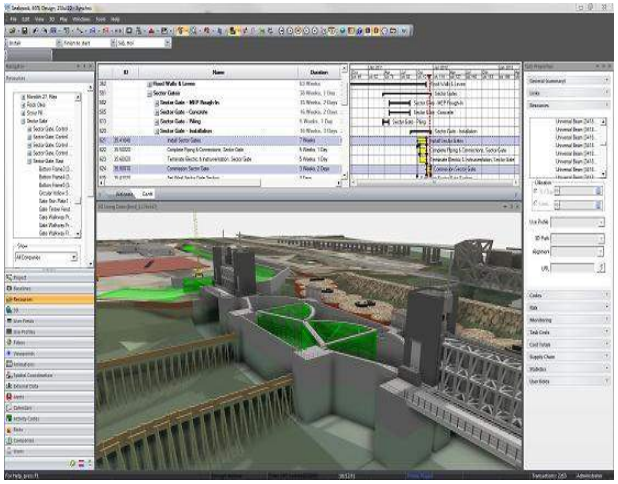
1. Example of annotated output used to demonstrate building properties within submission document

Digital Engineering in Work Winning - where are we now?

Into 4D – the model is exported to the project planner for application of programme.

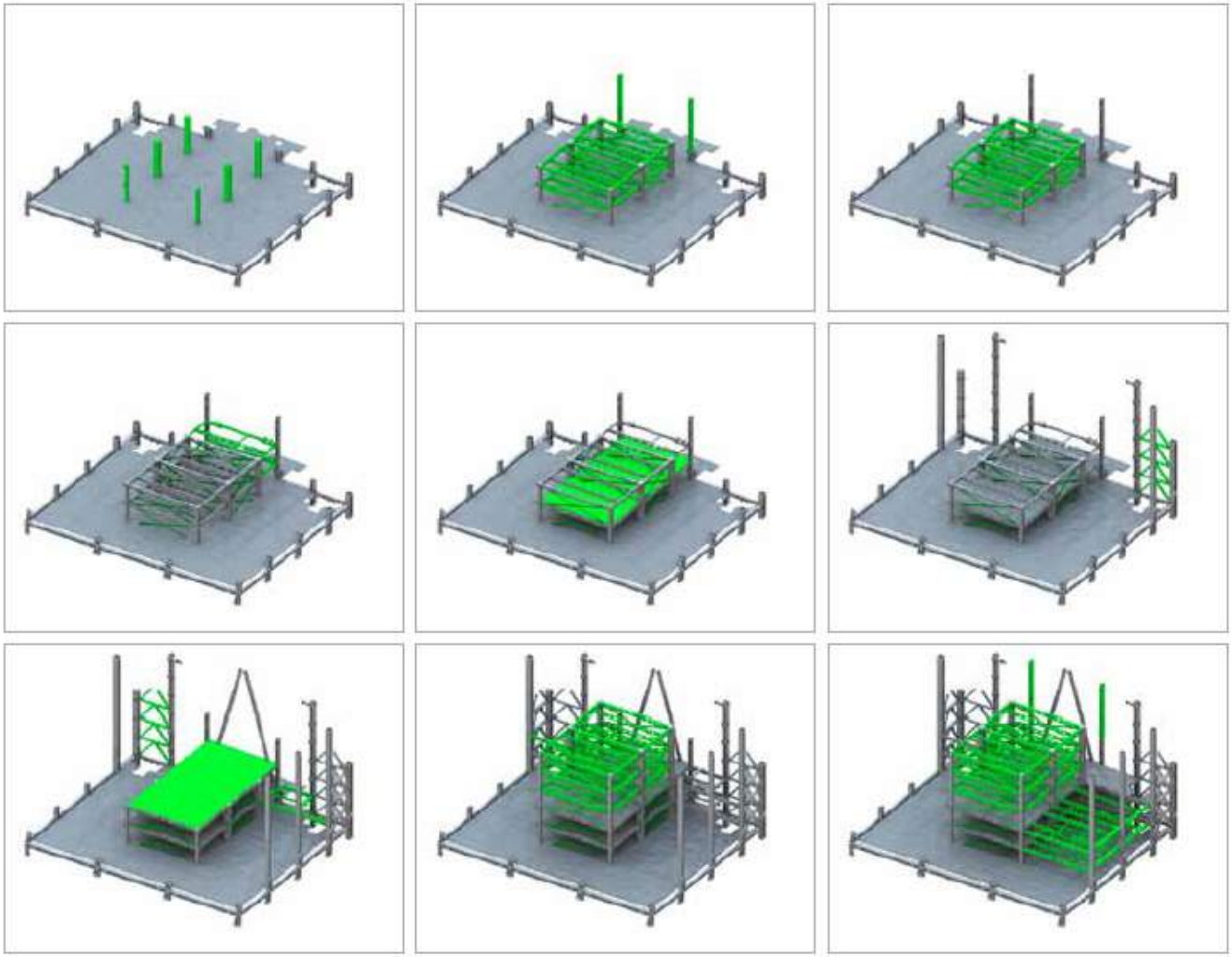






3D Model + Programme = 4D Programme

Core 6 – Model Developed to Enable Planning Team 4D



- ☑ Inception
- ☑ Concept / optioneering
- ☑ Scheme design
- ☑ Detailed design

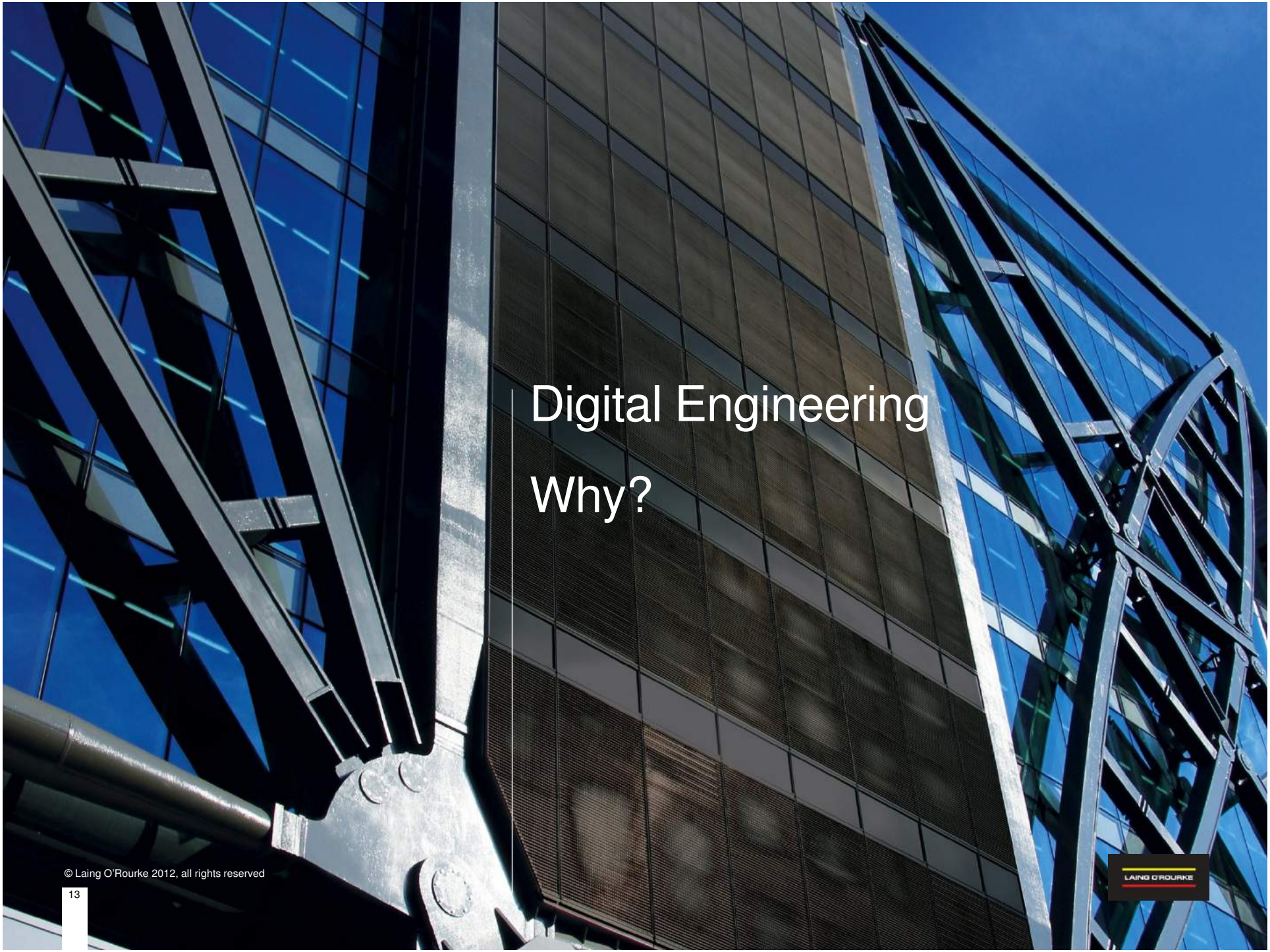
Responsible:
Planning lead

Consulted:
Construction process engineer

- The planning team can develop the programme in 4D to interrogate and validate the programme sequence and methodology, plus logistics
- The model will be linked to the schedule to an agreed level of detail to facilitate the above
- The bid team can then produce 4D stills and animations from this to support bid presentations and documentation
- Visualise occupational phasing

1	2	3
4	5	6
7	8	9

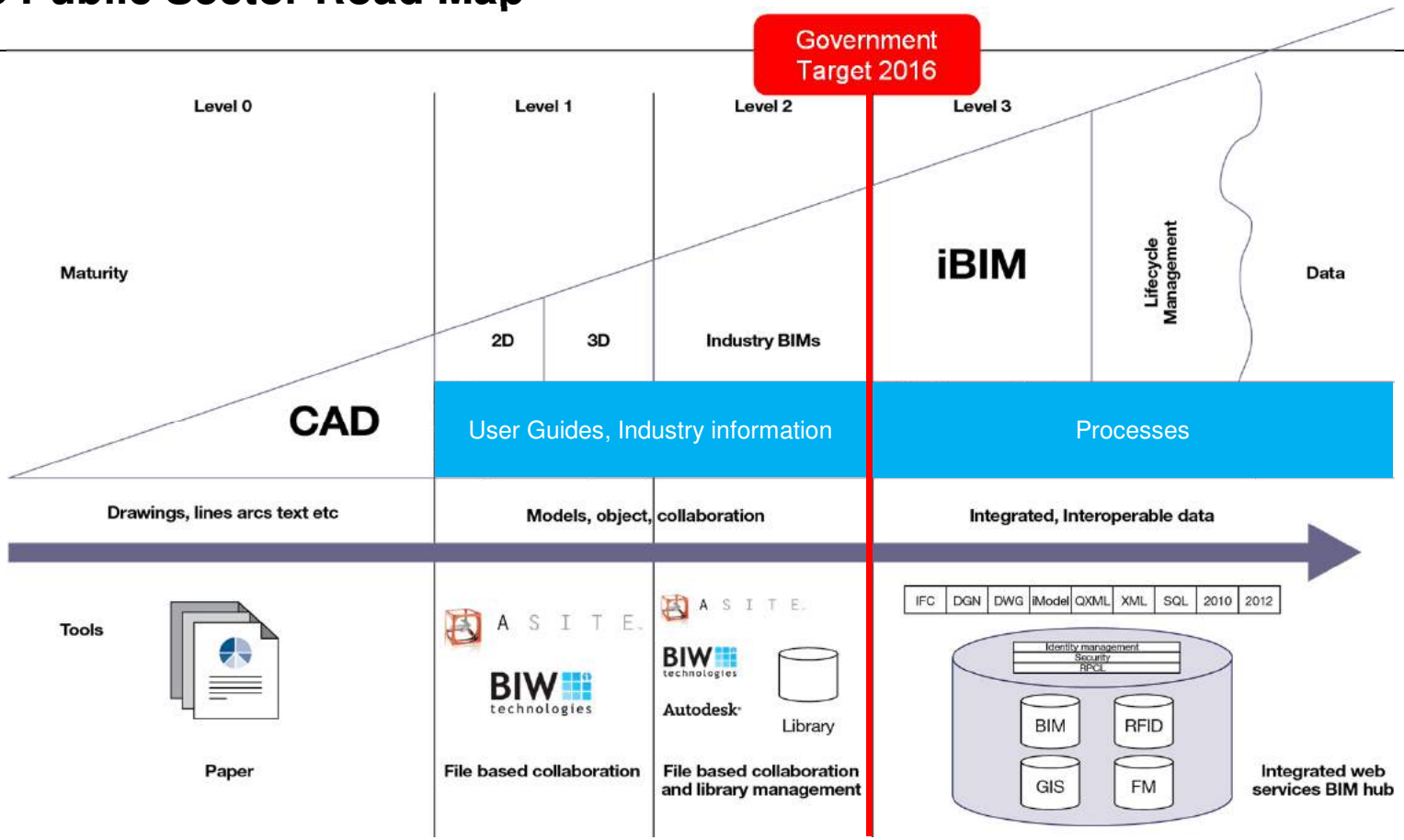
1–9, Sequence clearly articulated through the use of the 3D model linked to programme and methodology



Digital Engineering

Why?

The Public Sector Road Map



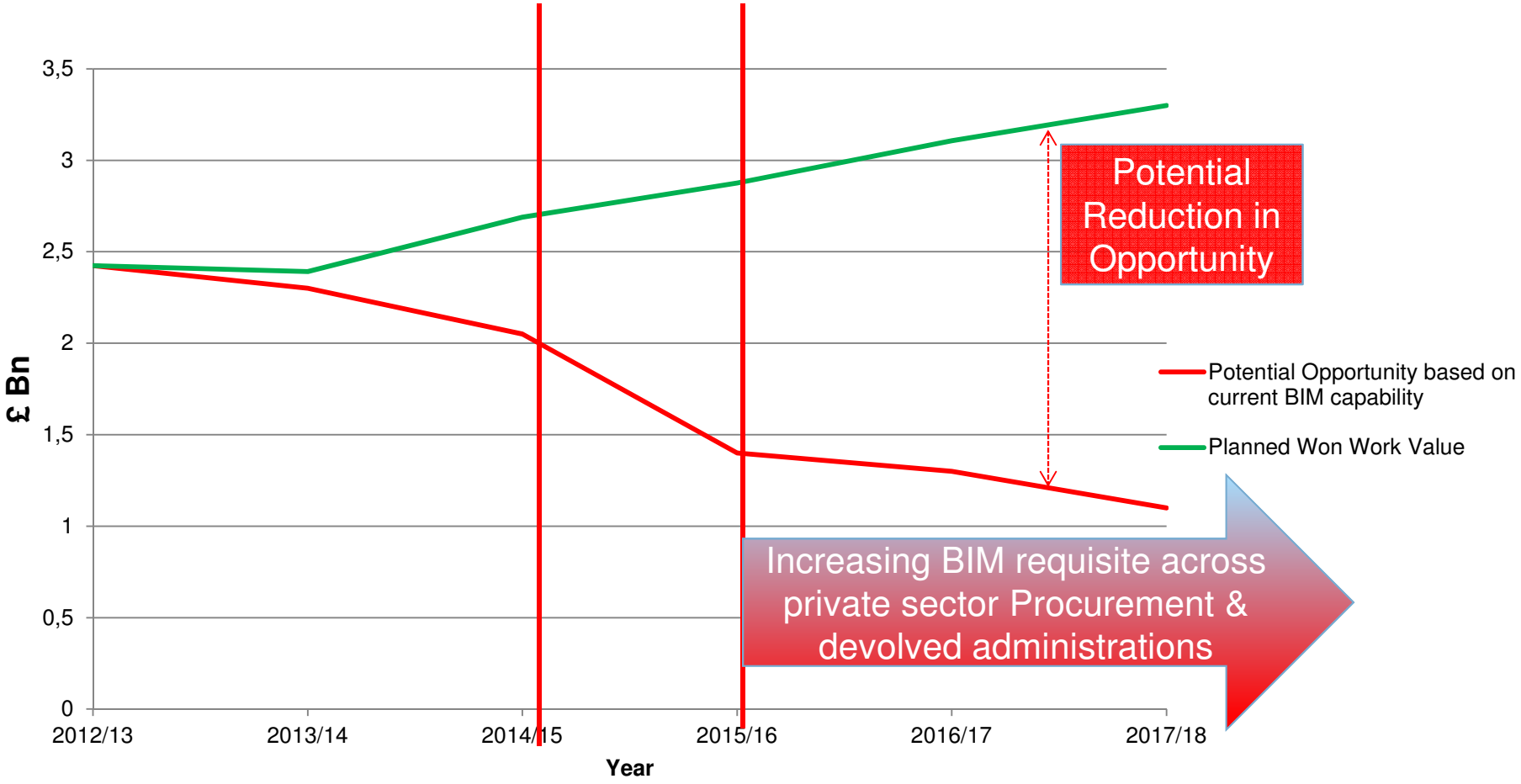
Level 0
Unmanaged 2D CAD with paper or uncontrolled electronic exchange

Level 1
Managed 2D/3D CAD in collaborative environment, using some common data structures. No integration of commercial function

Level 2
Controlled 3D collaboration with multidiscipline data shared, possibly using 4D, 5D and feeding operational systems

Level 3
Fully open process and data integration through web based data systems and compliant with IFC/IFD standards
To deliver an integrated set of geometric models, data and documentation that builds over a the life of a project to capture all knowledge related to that project

Potential Impact on LOR UK Work Opportunity due to low Investment



Assumed against a continued flat UK work win volume & 55/45% public/private sector split

Early public sector adopters eg. MOJ Procurement

Public sector Level 2 BIM mandate in place

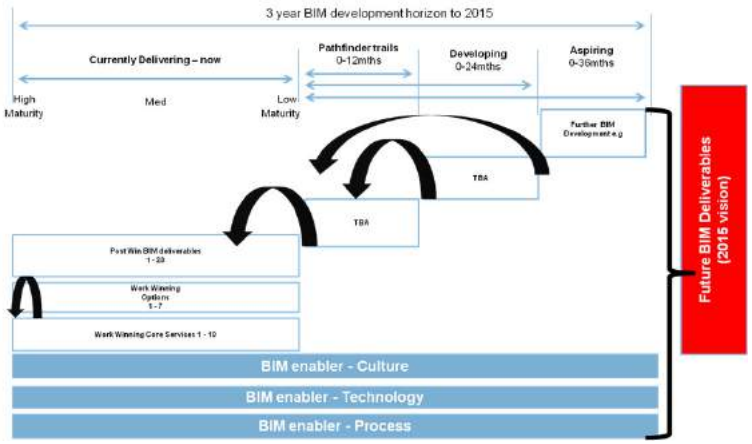
Why? – Opportunity...

Government publications are quoting at least 5% saving opportunity, 10% on BAA projects

5% Opportunity across DE value areas

Assumed continued £1.8bn UK turnover

£90m opportunity



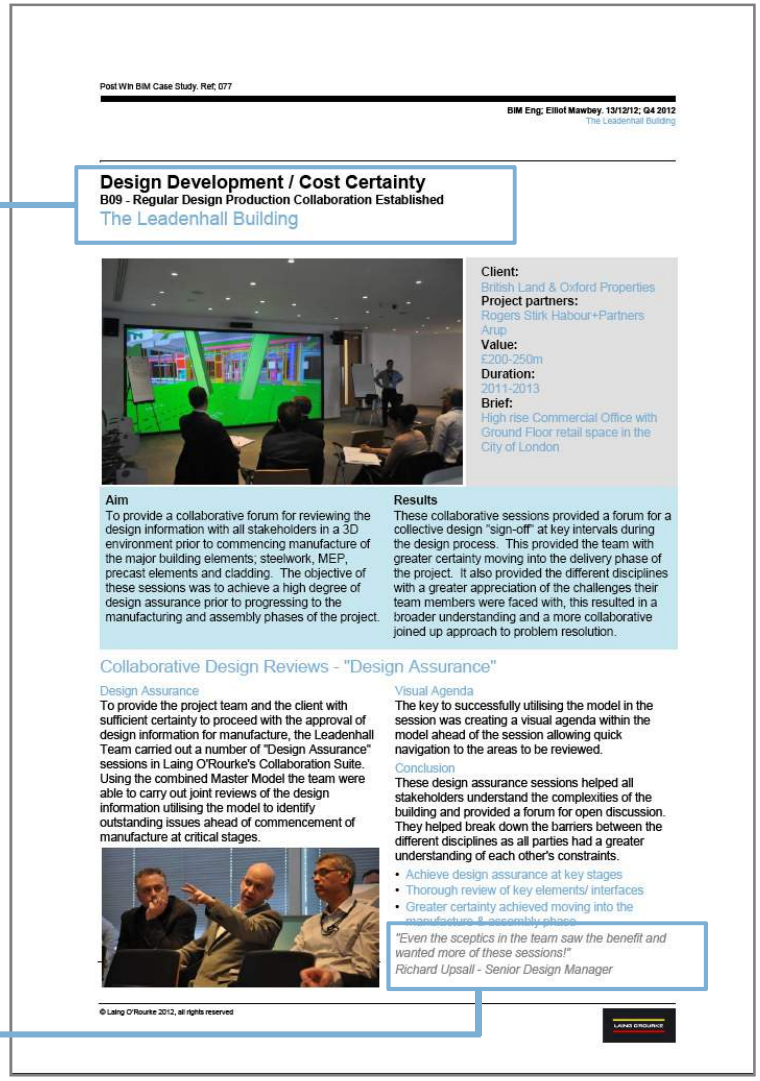
Continued Investment

- Greater opportunity in Commercial settlement
- Improved Margin

Digital Engineering – Capturing Evidence

Digital Engineering Case Studies

- Project Case Studies written quarterly;
- linked to DE Value Wheel & Deliverables Menu
- Produced at Bid & throughout Project Delivery



Post Win BIM Case Study. Ref; 077

BIM Eng; Elliot Mawbey. 13/12/12; Q4 2012

The Leadenhall Building

Design Development / Cost Certainty

B09 - Regular Design Production Collaboration Established

The Leadenhall Building

Client: British Land & Oxford Properties
Project partners: Rogers Stirk Habour+Partners, Arup
Value: £200-250m
Duration: 2011-2013
Brief: High rise Commercial Office with Ground Floor retail space in the City of London

Aim
To provide a collaborative forum for reviewing the design information with all stakeholders in a 3D environment prior to commencing manufacture of the major building elements; steelwork, MEP, precast elements and cladding. The objective of these sessions was to achieve a high degree of design assurance prior to progressing to the manufacturing and assembly phases of the project.

Results
These collaborative sessions provided a forum for a collective design "sign-off" at key intervals during the design process. This provided the team with greater certainty moving into the delivery phase of the project. It also provided the different disciplines with a greater appreciation of the challenges their team members were faced with, this resulted in a broader understanding and a more collaborative joined up approach to problem resolution.

Collaborative Design Reviews - "Design Assurance"

Design Assurance
To provide the project team and the client with sufficient certainty to proceed with the approval of design information for manufacture, the Leadenhall Team carried out a number of "Design Assurance" sessions in Laing O'Rourke's Collaboration Suite. Using the combined Master Model the team were able to carry out joint reviews of the design information utilising the model to identify outstanding issues ahead of commencement of manufacture at critical stages.

Visual Agenda
The key to successfully utilising the model in the session was creating a visual agenda within the model ahead of the session allowing quick navigation to the areas to be reviewed.

Conclusion
These design assurance sessions helped all stakeholders understand the complexities of the building and provided a forum for open discussion. They helped break down the barriers between the different disciplines as all parties had a greater understanding of each other's constraints.

- Achieve design assurance at key stages
- Thorough review of key elements/ interfaces
- Greater certainty achieved moving into the manufacture & assembly phase

"Even the sceptics in the team saw the benefit and wanted more of these sessions!"
Richard Upsall - Senior Design Manager

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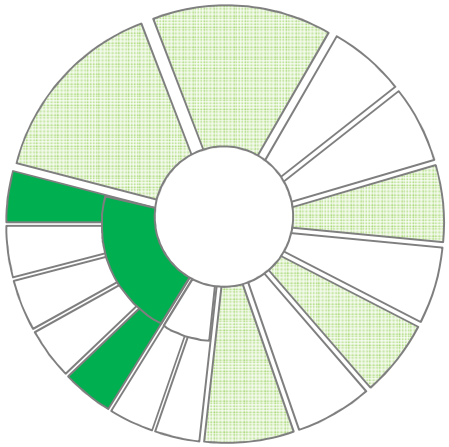
- Project Team Member Testimonials
- Case Studies published to iGATE

Digital Engineering – Project Overview

- **Project Name**
- Leadenhall Project



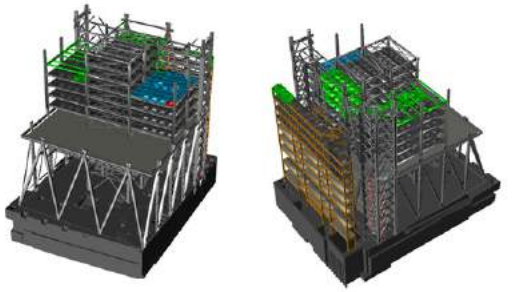
Value - £235m

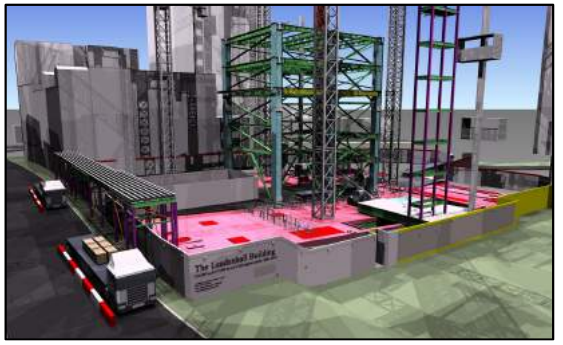
A landmark job in central London with a highly complex structure. With limited influence on the design Laing O'Rourke have used BIM to resolve co-ordination issues with the design team and supply chain ahead of constructing on site whilst delivering innovative construction techniques, ensuring high level HSE standards on a project that presents a higher proportion of risk due to the nature of the building.

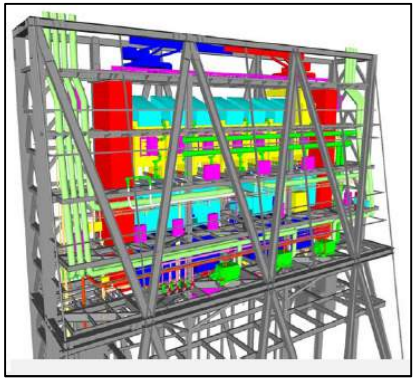
Areas of impact

Primary
- Design development
- Co-ordination and clash detection

Secondary
- Programme and Methodology
- HSE performance
- DfMA
- Reputation
- Quality







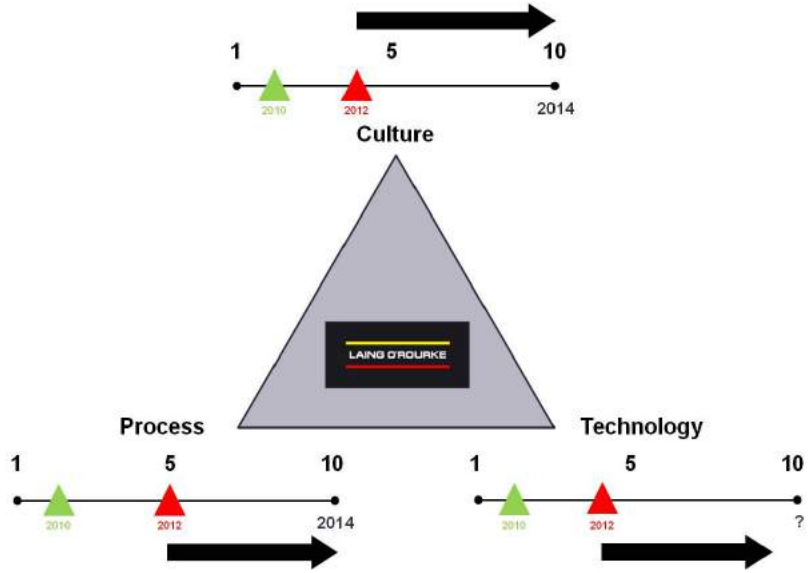
The Right Organisation

Right People (appropriately trained*, with right culture operating in right structure)

Working with the *Right* tools (technology* ie hardware / software and supporting infrastructure)

Working in the *Right* way (our agreed strategy and our business processes*)

On the *Right* projects (improved pipeline selection process)



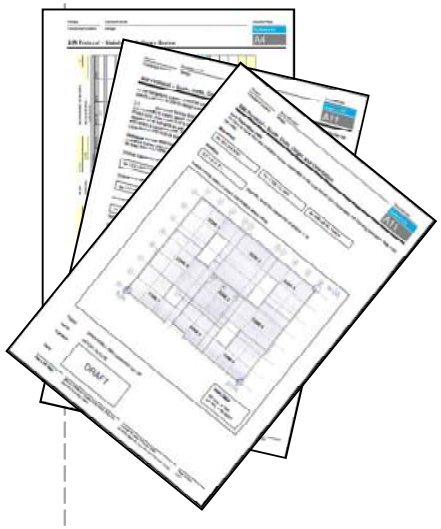
Deployment of Digital Engineer – towards 2020

BID | **Pre-Construction** | **Construction** | Operate

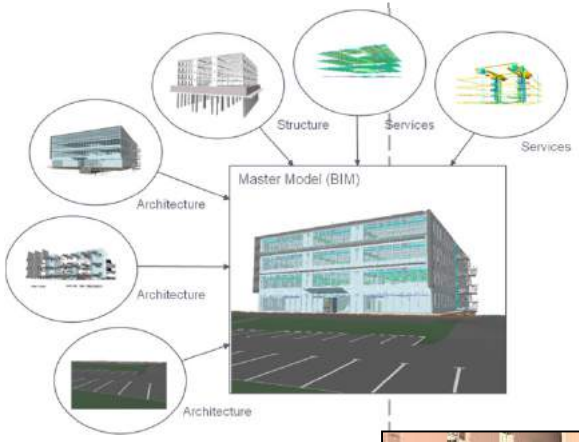
Initial Project Set-up

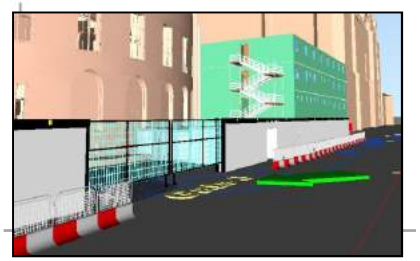
Digital Engineer area of focus

DE Protocols / Level of Delivery



Delivery of Project Specific DE Objectives



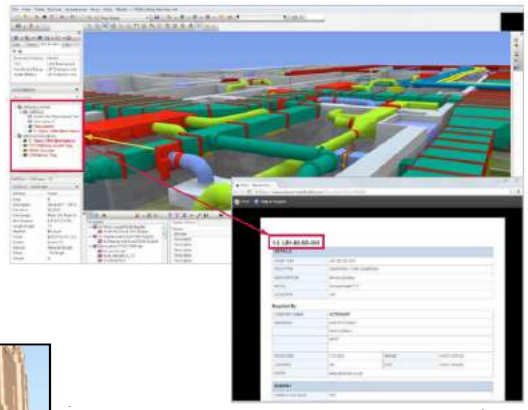


Developing DE Objectives

Digital Engineer area of focus

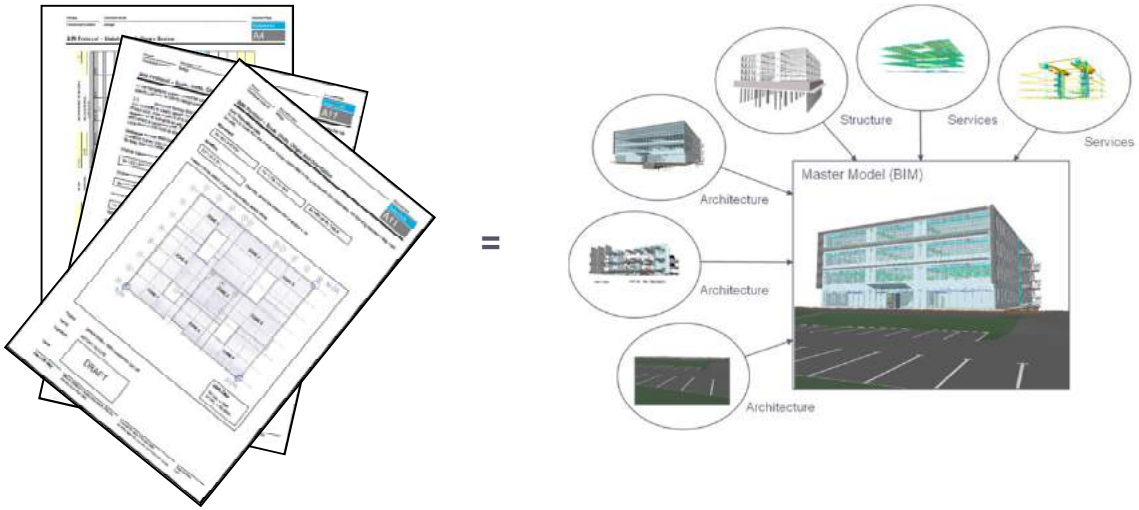
Pathfinder, Developing

& Aspiring Projects

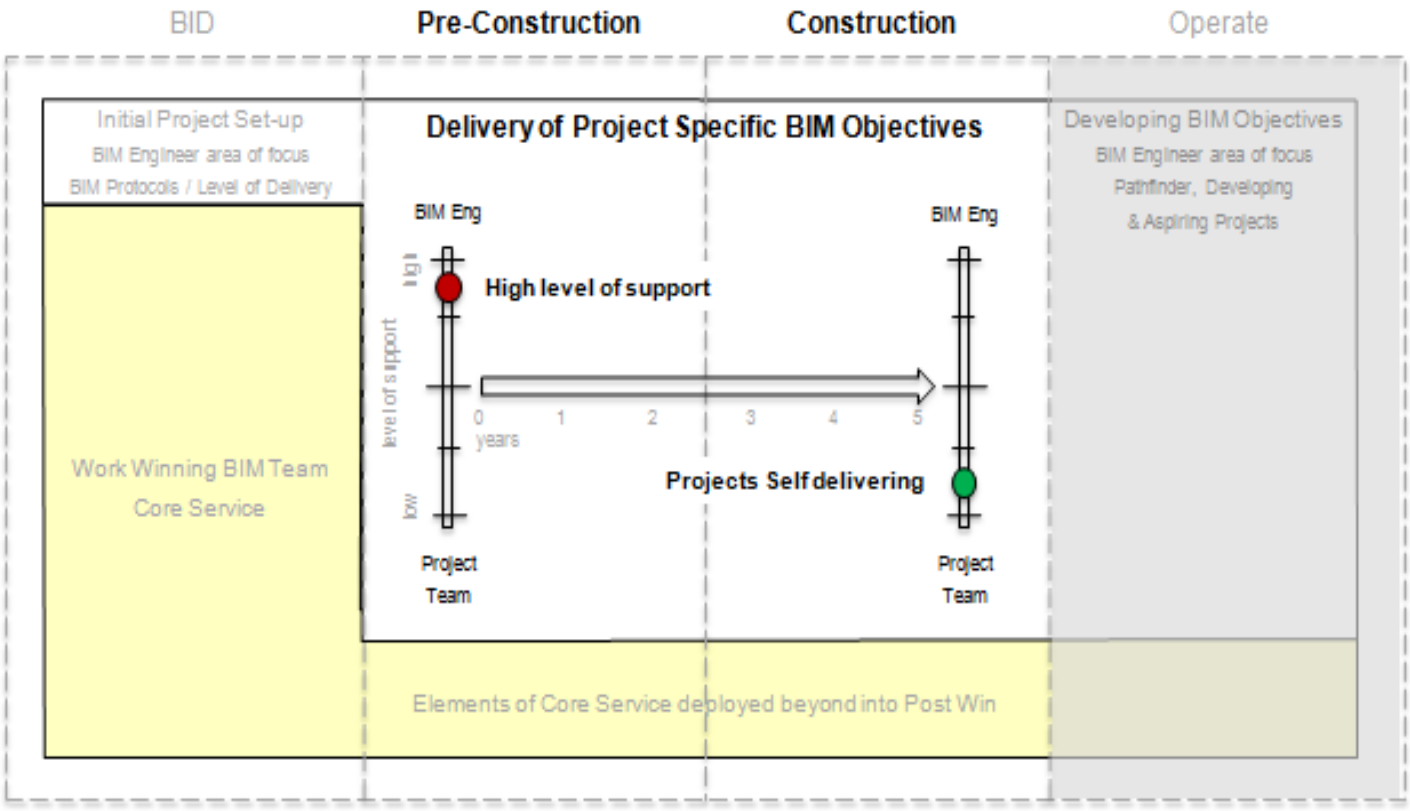


DE Protocols

- **Why are these so fundamentally important?**
  - review capability & capacity of the stakeholders
  - review software and file format for data exchange
  - agree overall model responsibilities
  - agree who is modelling what, to what level of detail and when
  - agree model grid, origin & orientation
  - sets out regular model sharing process
  - sets out specific modelling requirements to support DE Deliverables
- **Need to be agreed at the earliest opportunity**

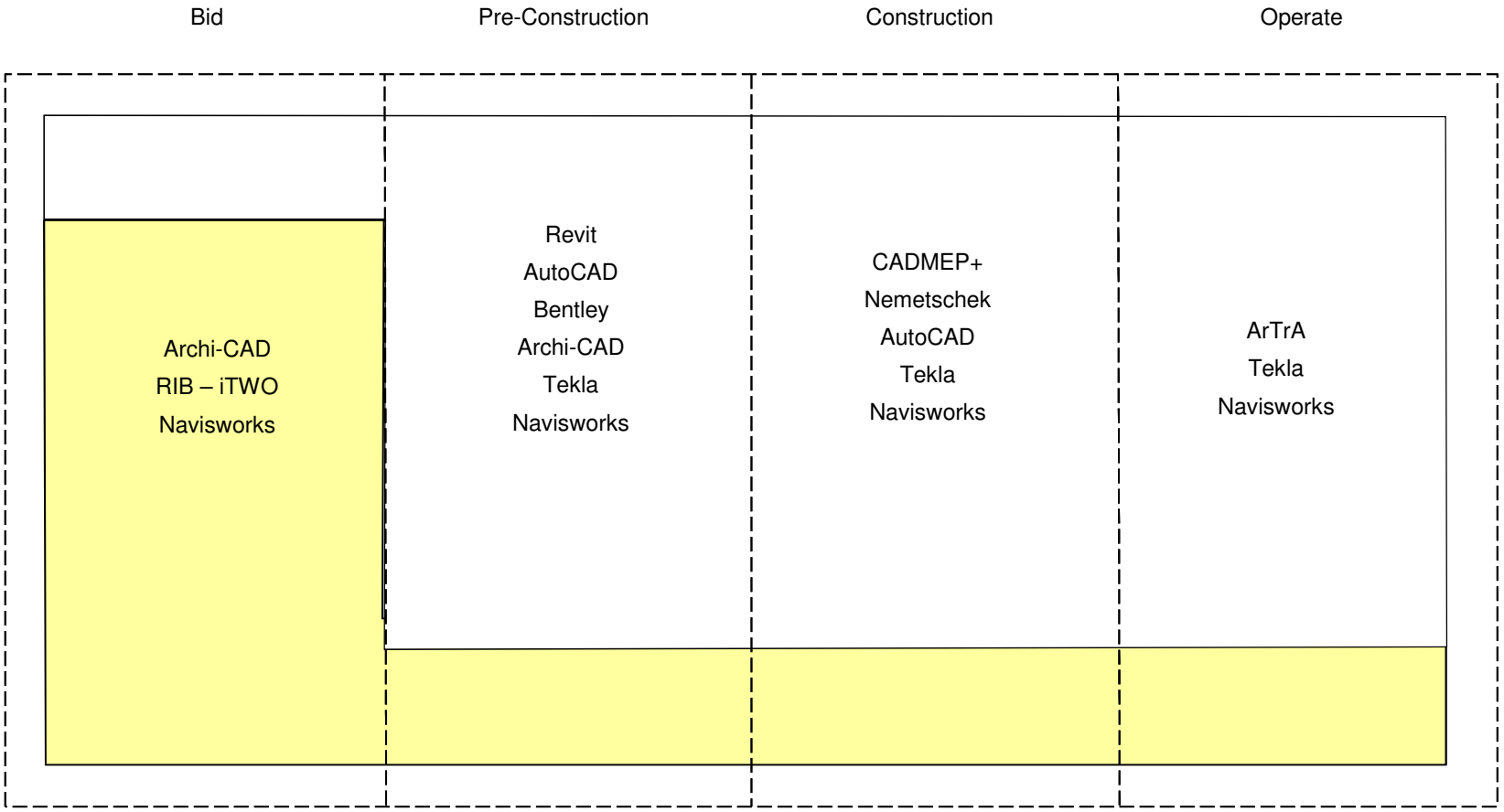


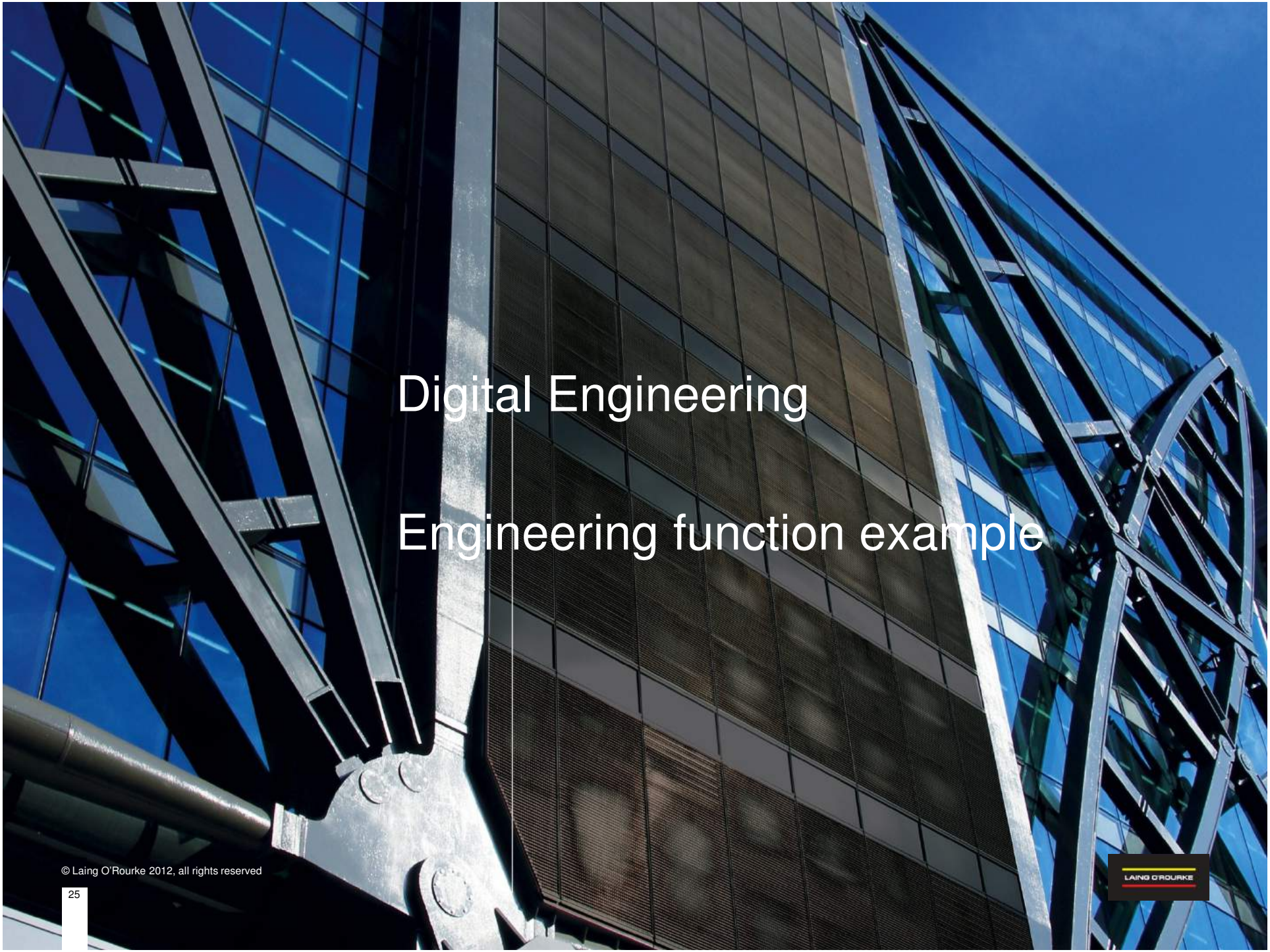
BIM Engineer Support



Intensity of BIM Engineer support to drop over time as project teams become able to take on role/responsibility of delivery

Technology
Software Interface – ‘typical software’

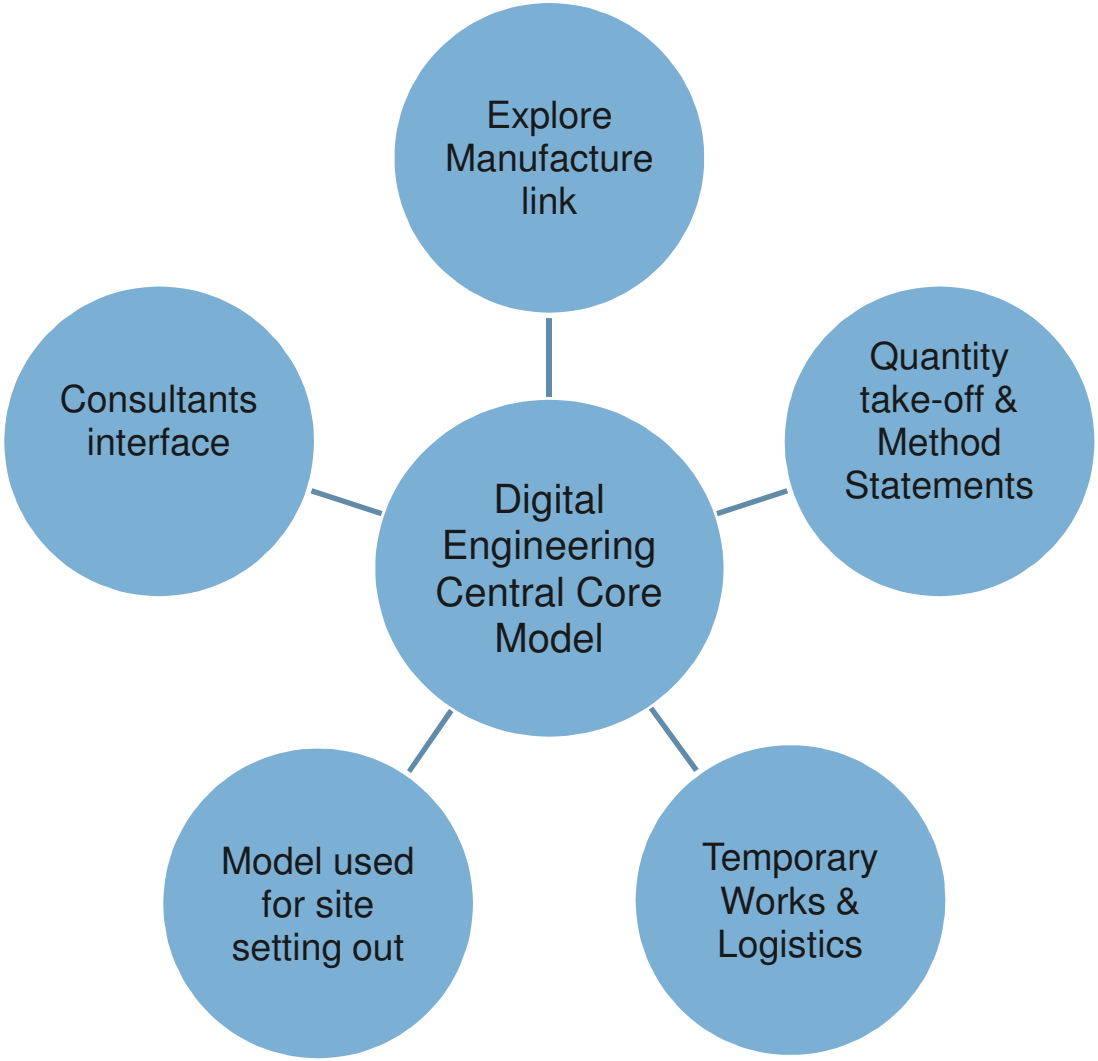




Digital Engineering

Engineering function example

Digital Engineering in Delivery for Engineers



Digital Engineering in Delivery - where are we now?

Where are we now?

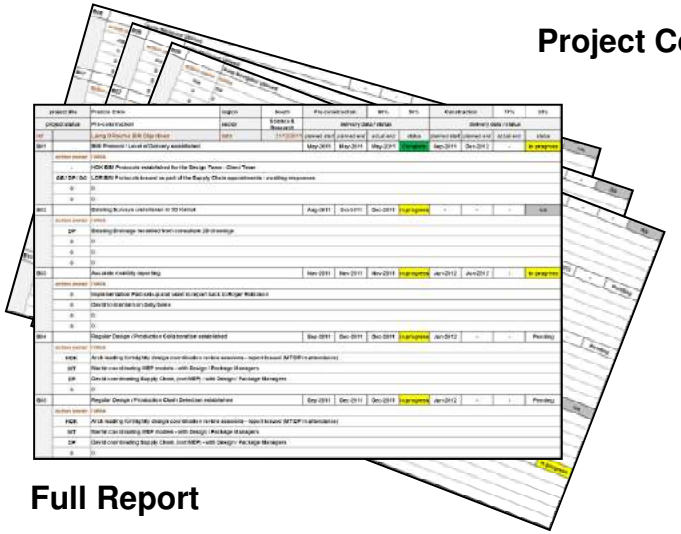
- Sometimes a Digital Engineer from the office sorts it.
- Some projects have a model, some don't,
- Some consultants provide their model, some don't,
- Pricing & Digital Engineering manage the development and implementation of Digital Engineering along with site based Digital Engineers to ensure consistent approach and processes across the Bu's and focus investment in R&D.

Where we need to be?

- Delivery teams drive Digital Engineering (Our Digital Engineers support). Engineers are well placed to drive the best from Digital Engineering.
- Our consultants providing the right information in the right format, at the right time. Digital Engineering protocols used to manage this process.
- The Digital Engineering model in delivery is authored by the design teams and managed by Laing O'Rourke.
- The business expects Digital Engineering to be deployed to its optimum across all projects.

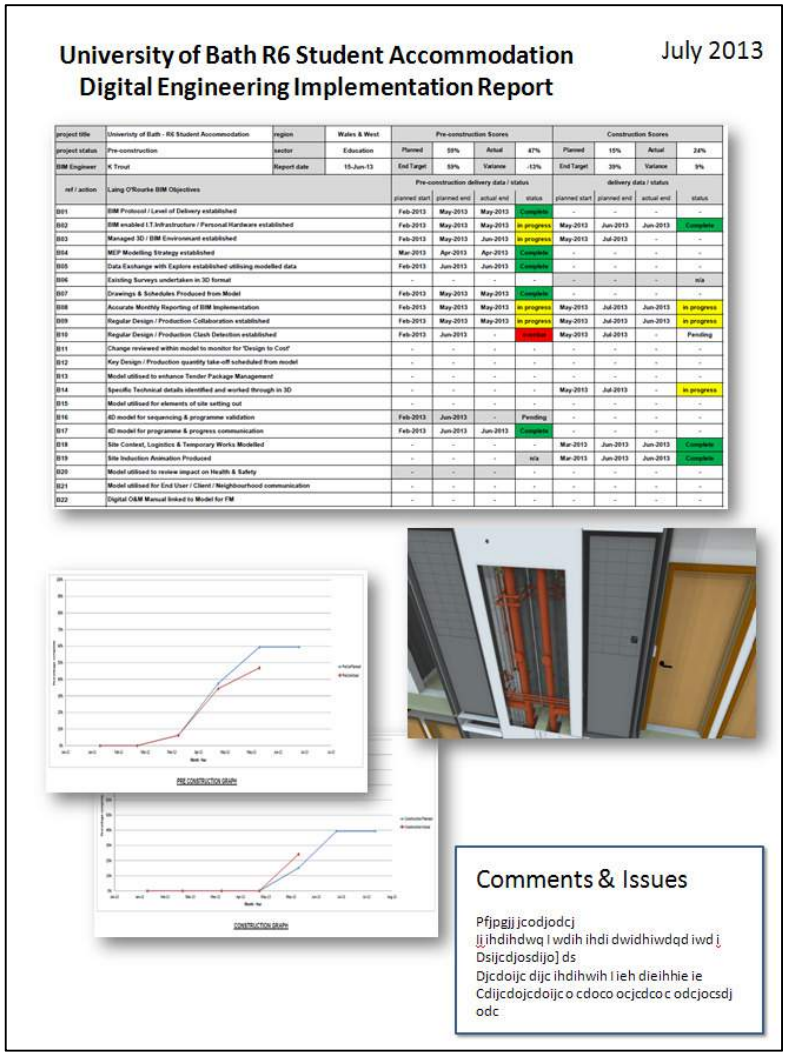
Digital Engineering Implementation Plan

- **DE Deliverables form Project Implementation Plan**
- deliverables & responsibilities
- revised contract review form
- on-going point of reference



Full Report

Project Control Room



Digital Engineering Implementation Plan

- **DE Deliverables form Project Implementation Plan**
- awareness, training & application engagement
- on-going point of reference

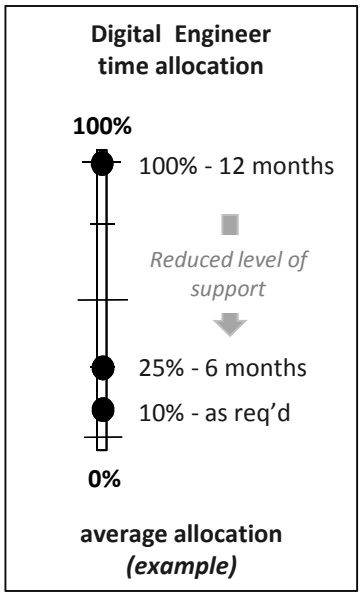
Surname	Forename	Department	BIM Engagement		
			Awareness	Software Trained	Applying
		Project Leader			
		Design Manager			
		Planner			
		Planner			
		Engineer			
		Engineer			
		Engineer			
		Engineer			
		Commercial			
		Construction Manager			

Legend (training / application)

Red — in-complete / not applying

Amber — in-part / partial

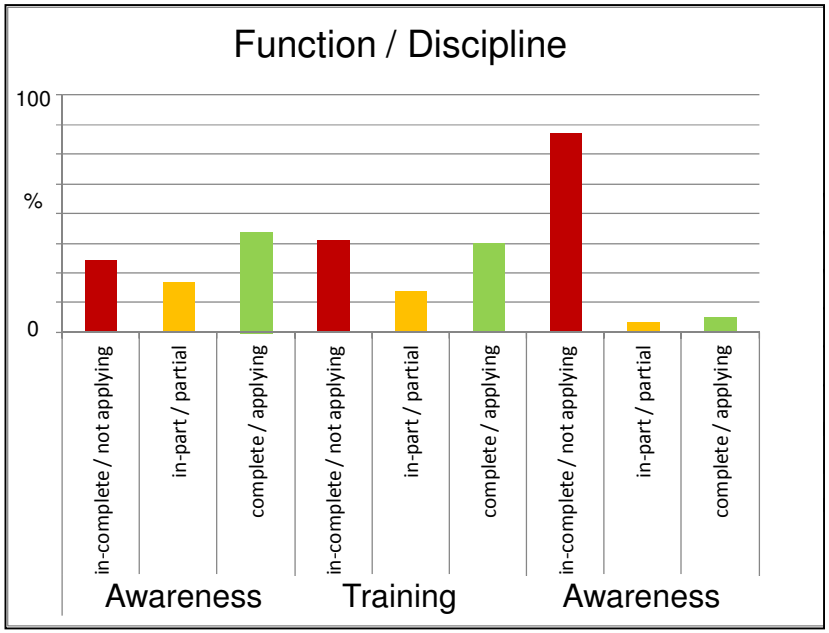
Green — complete / applying



Digital Engineering Reporting

- **DE Implementation Plans form summary reports**
- Project reporting
- Engagement reporting
    - Quarterly update to Functional Leaders
        - Update & Key Issues
        - Feedback for continuous improvement & function / discipline requirements

Post Win Projects (28)

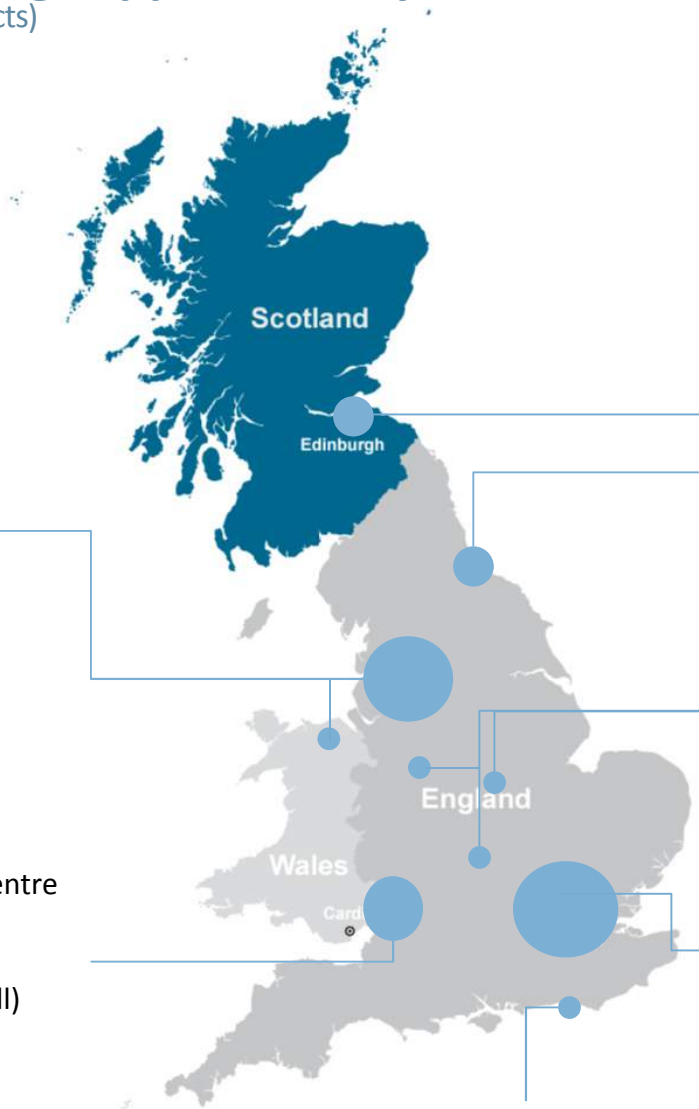


UK: Digital Engineering supported Projects in delivery

(Level of support varies across projects)

Aug 2013

Manchester Town Hall
Manchester St Peters Sq
West Cumberland Hospital
Alder Hey Children's Hospital
Glan Clwyd
Oldham College
Salford BSF Schools
Beswick Hub
Stoke CBD
Chester Zoo
Victoria Gate Shopping centre



RHSC Royal Hospital for Sick Kids
Ryhope (Pride)
Monkwearmouth (Pride)
Monument Mall
Scottish Power HQ
Scottish Water (SR10);
• Forehill & Bothwellbank

Stafford Area Rail Improvement
A453 Road Widening
Oxford University Blavatnik

Liverpool Street Station (Crossrail)
Tottenham Court Road Station (Crossrail)
Custom House (Crossrail)
Francis Crick Institute
Kings Health Partnership @ Guys
Leadenhall
WSQ Dagenham Housing
Heathrow - MSCP CP2
Clarges Estates
Elephant Road
Cambridge Adenbrookes

Bristol Royal Infirmary Ward Block
Bristol Haematology & Oncology Centre
University of Bath R6
Llandough AMHU – Cardiff)
Aberdare Community School (Sobell)
Ysgol Cwm Gwendraeth
SCCC

Brighton 3T's Hospital

Digital Engineering

Project Examples

Salford BSF: Phase 2

BIM (post win) summary by Andy Radley

Salford BSF –	Phase 1:	Walkden High School
		Irlam High School
Salford BSF –	Phase 1b:	The Oasis Academy
Salford BSF –	Phase 2:	St Ambrose RC High School
		St Patricks RC High School
		Moorside Campus

St Ambrose RC High School
Project value: £21.6m
Contract duration: 72 weeks

St Patricks RC High School
Project value: £18.0m
Contract duration: 72 weeks

Moorside Campus
Project value: £32.0m
Contract duration: 81 weeks

Project design team

Architects:	Aedas
Structure & Civil:	Aecom
MEP Design:	Aecom
Landscaping:	Plinke

Level of delivery

Architecture:	3D parametric (building)
Structure:	3D parametric (building)
M&E:	3D parametric (main vertical and horizontal distribution runs)

External works & landscaping – 2D only

Salford BSF: Phase 2 – Asite Navigator utilised

Salford Phase 2: St Patricks - Model upload and review / comment schedule (prior to each DTM)

Design Team Meeting Day: Wednesday

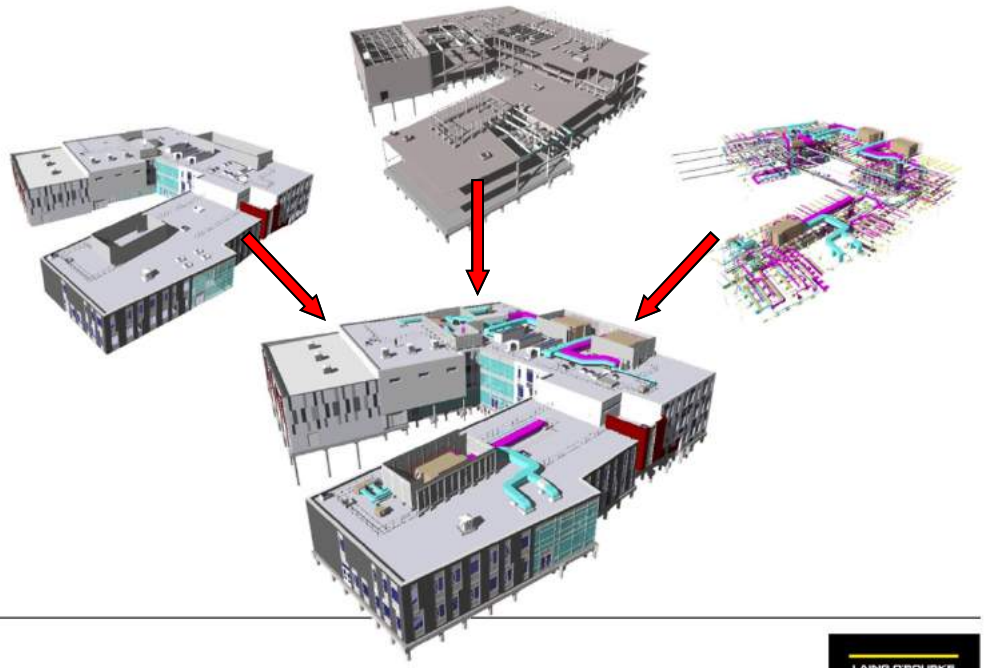
	Monday	Tuesday	Wednesday	Thursday	Friday	Sat	Sun	Monday	Tuesday	Wednesday	Thursday	Friday	Sat	Sun
Main Contractor: LOR			UPLOAD						REVIEW	DTM				
Architect: Aedas			UPLOAD					REVIEW		DTM				
Structural: Aecom			UPLOAD		REVIEW					DTM				
MEP: Aecom			UPLOAD	REVIEW						DTM				
Crown House			UPLOAD	REVIEW						DTM				
Other			UPLOAD							DTM				
Other			UPLOAD							DTM				
Other			UPLOAD							DTM				
Other			UPLOAD							DTM				
Other			UPLOAD							DTM				

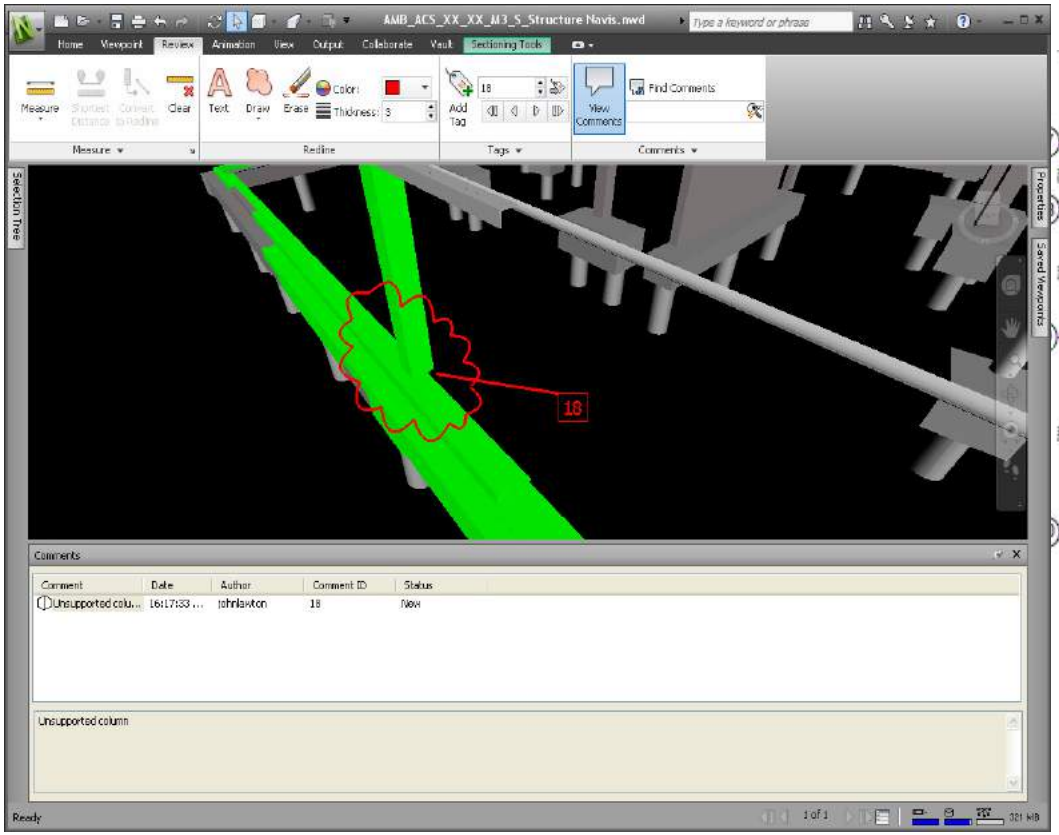
NOTE: The date of the Design Team meetings is to be co-ordinated by the Design Manager

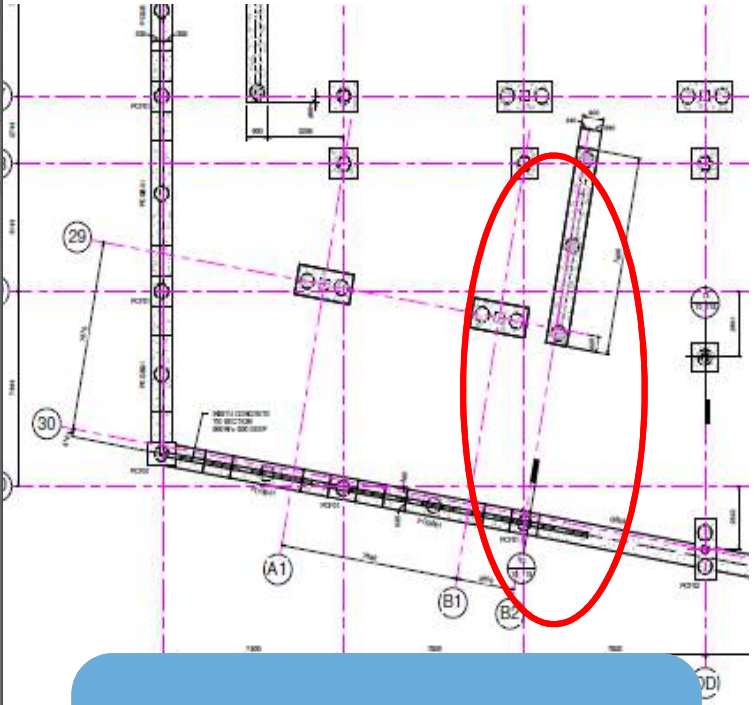
UPLOAD: This refers to the day each consultant who produces a model file publishes it to Asite in their relevant folder under 'BIM Live Data' and is to be captured as a work in progress.

REVIEW: This refers to day allocated to a consultant across the combined model file (Navisworks) and comment as required. Access to the combined model is to be through the use of Asite Navigator.

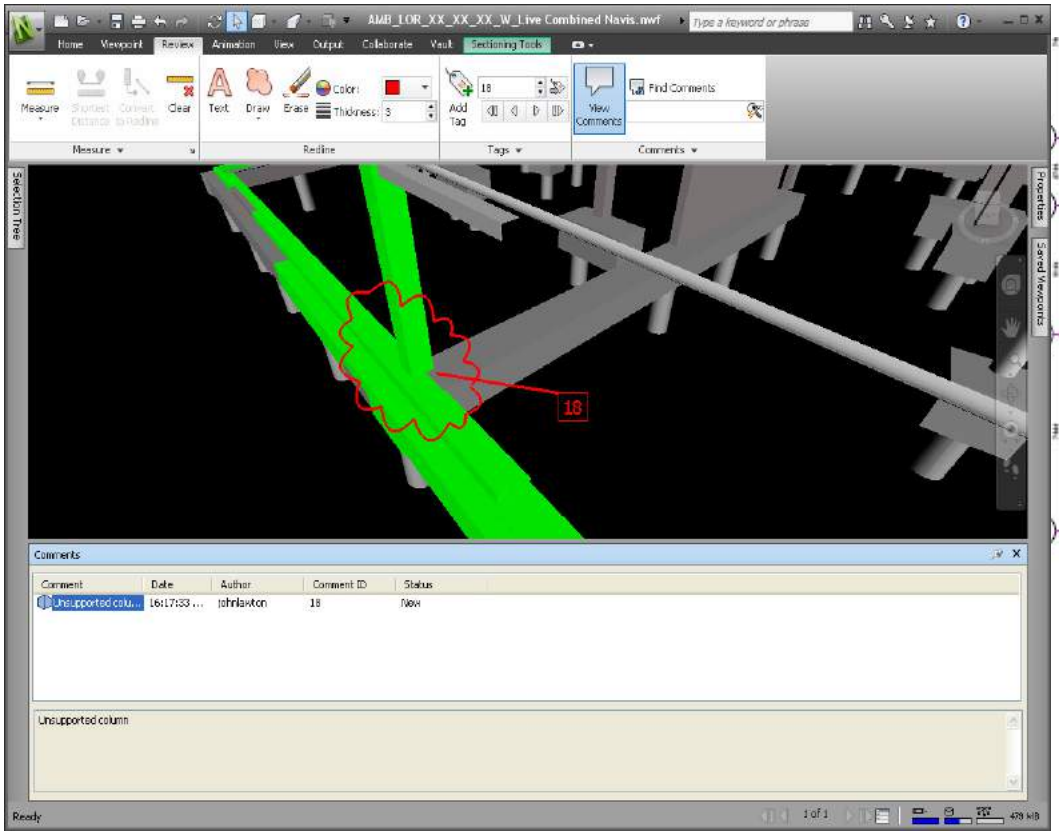
NOTES:
The combined model file will be created and published to Asite using Asite Navigator by the project BIM Engineer. All issue relating to this schedule and the use of Asite Navigator is to be directed to the project BIM Engineer.
The use of Asite Navigator is essential to maintain a working Live BIM model environment and to manage to commenting process. This process is to be managed by the project Design Manager with support by the BIM Engineer.

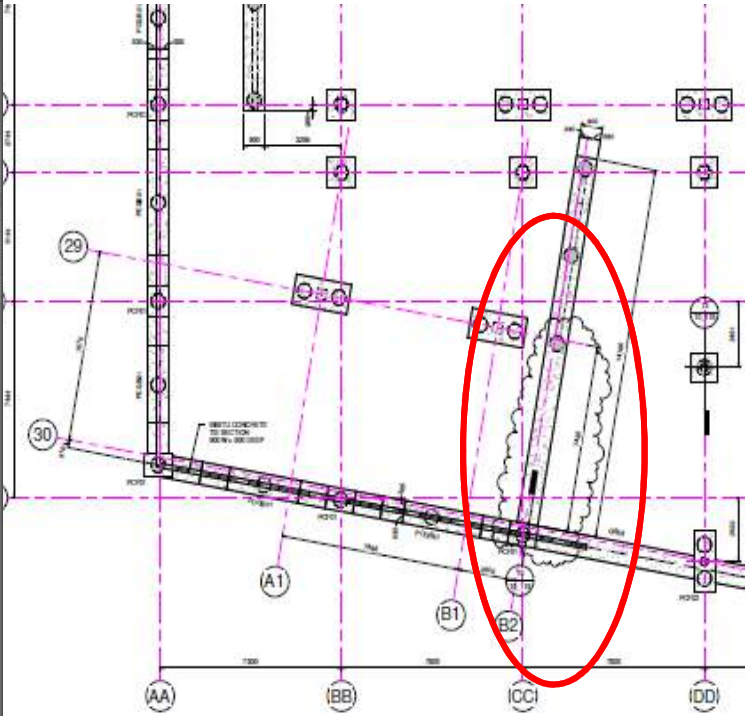


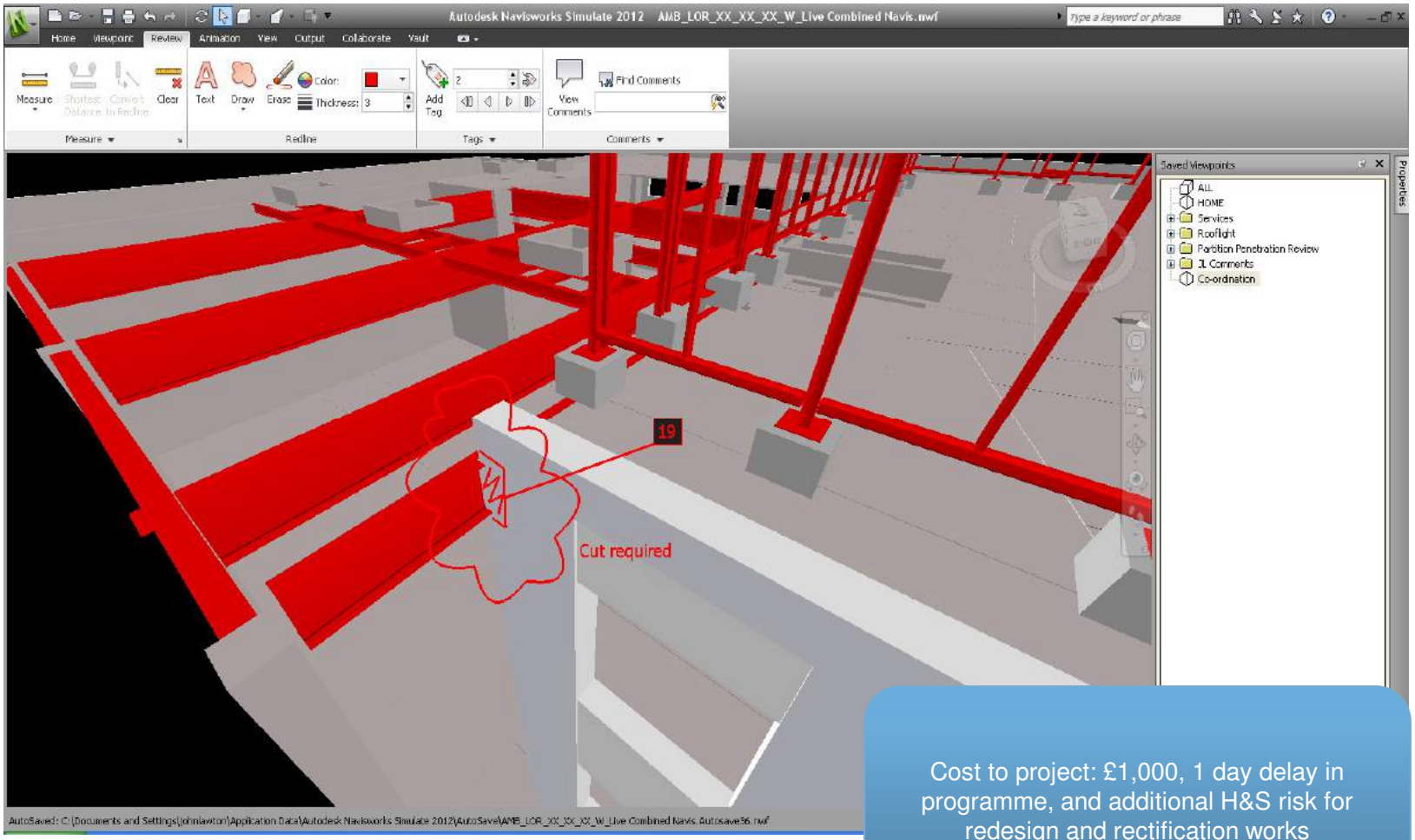




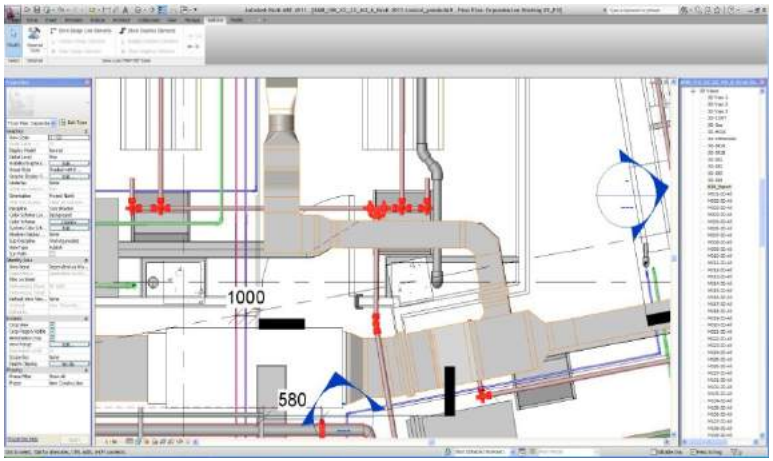
Cost to project: £2,000 and 3 day delay in programme for redesign and rectification works

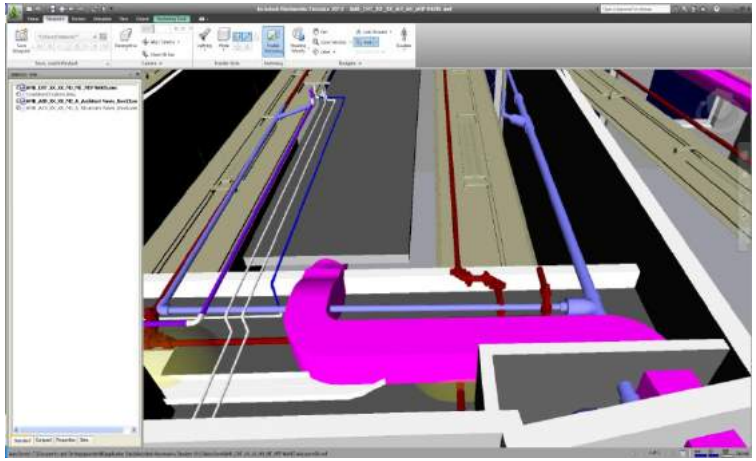


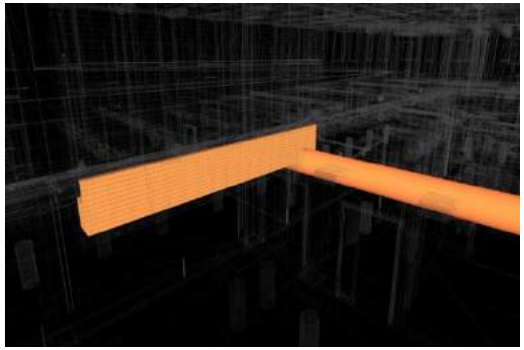


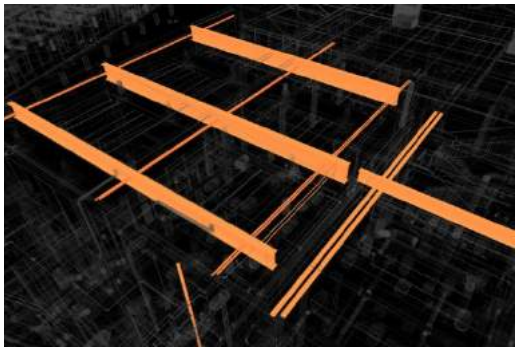


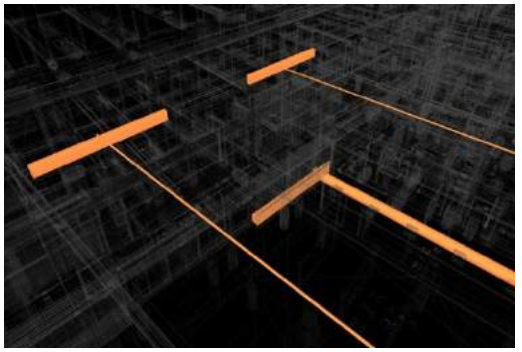
Cost to project: £1,000, 1 day delay in programme, and additional H&S risk for redesign and rectification works





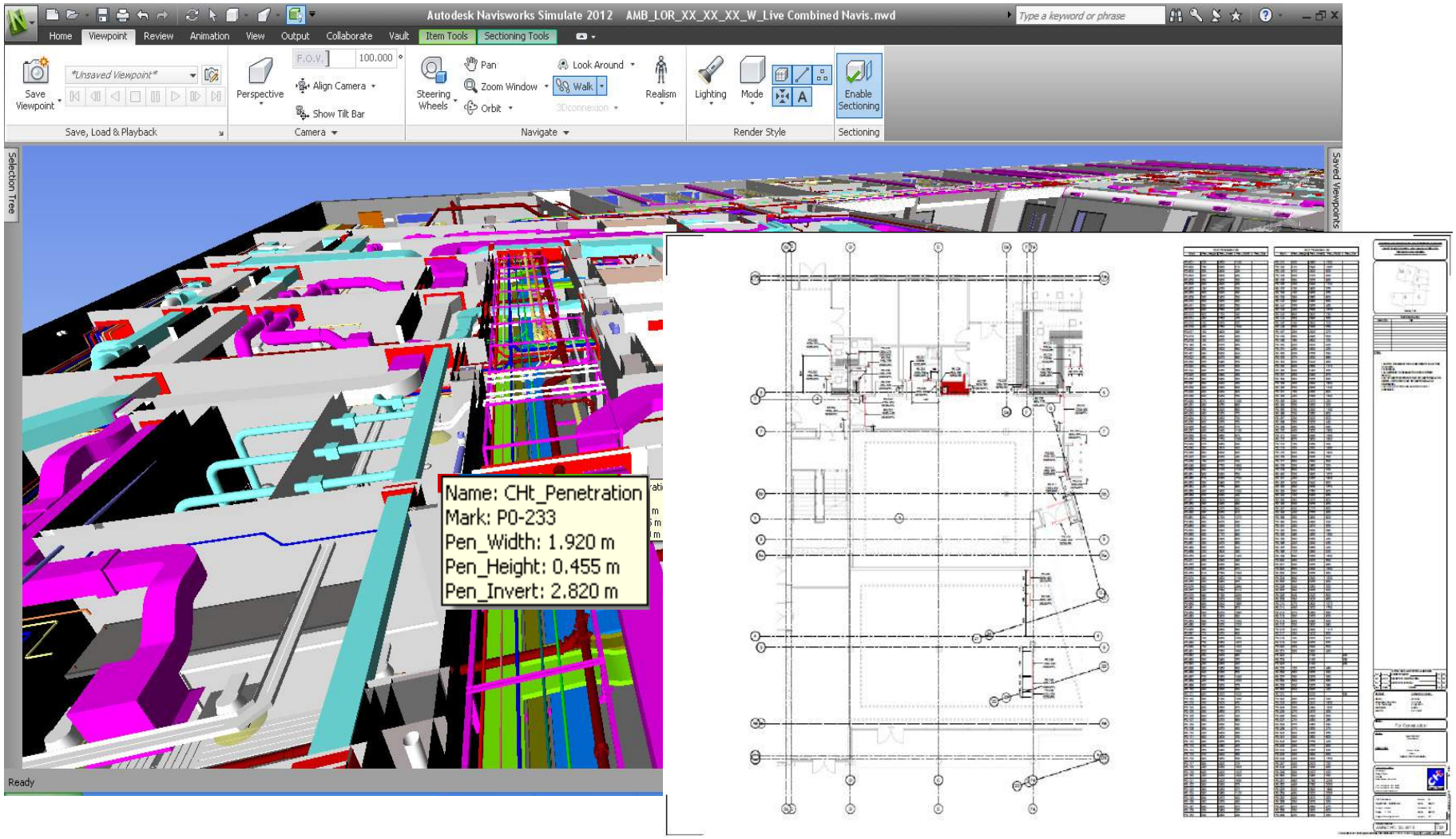




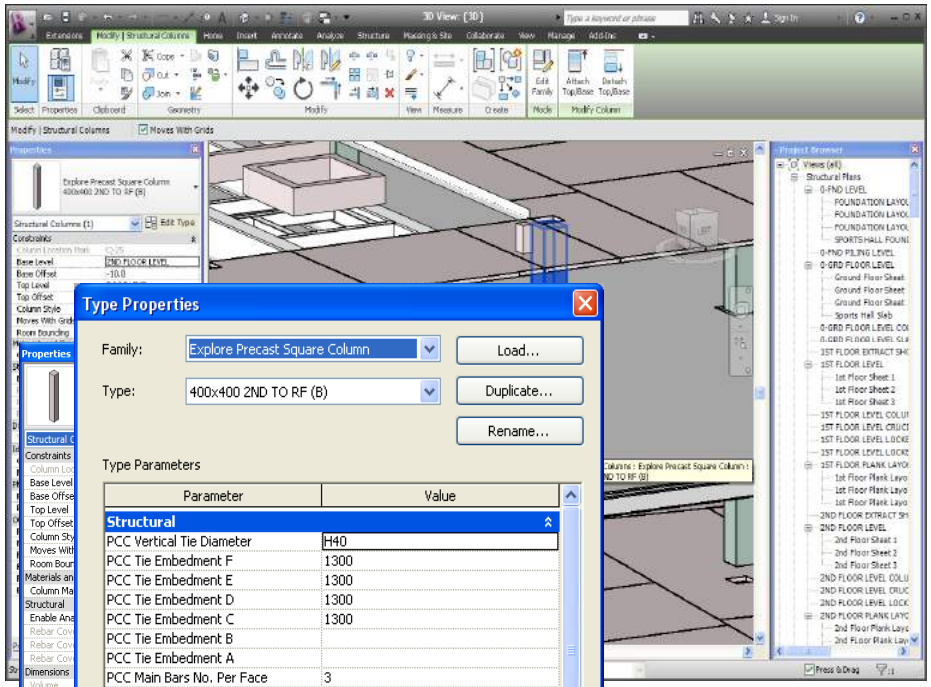


1. AECOM M&E base Revit model
2. CHt developed AECOM model to produce a production Revit model
3. Exported to CADMEP+ for module manufacture

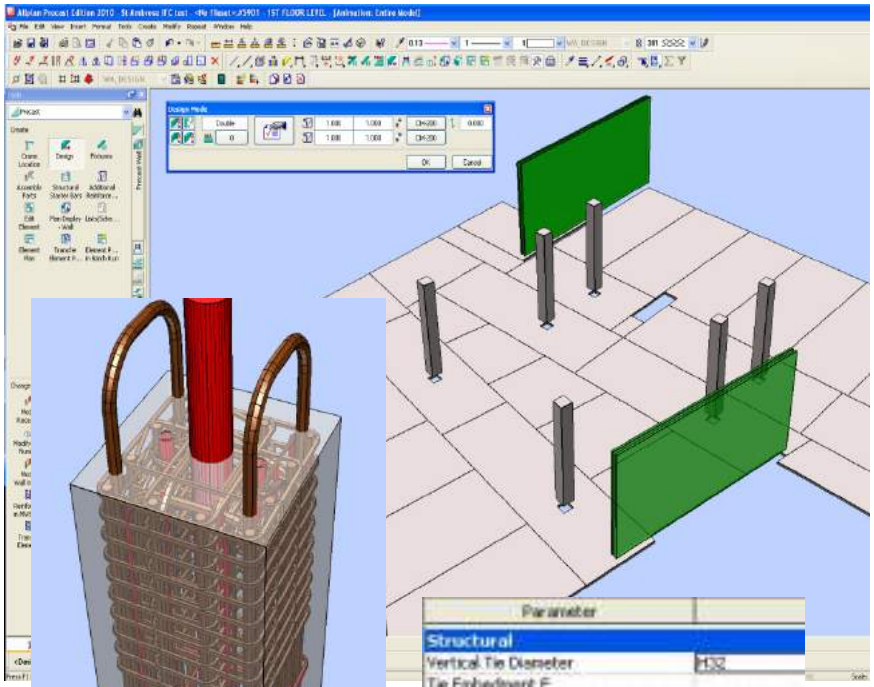
Salford BSF: Phase 2 – MEP Penetrations modelled & co-ordinated

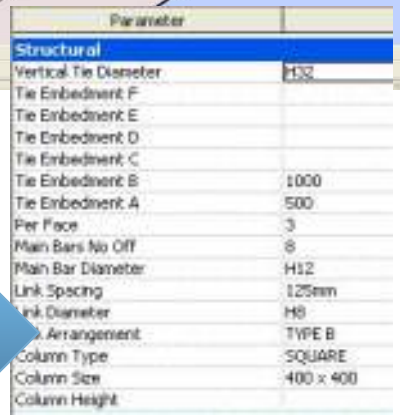


Consultants Revit design model

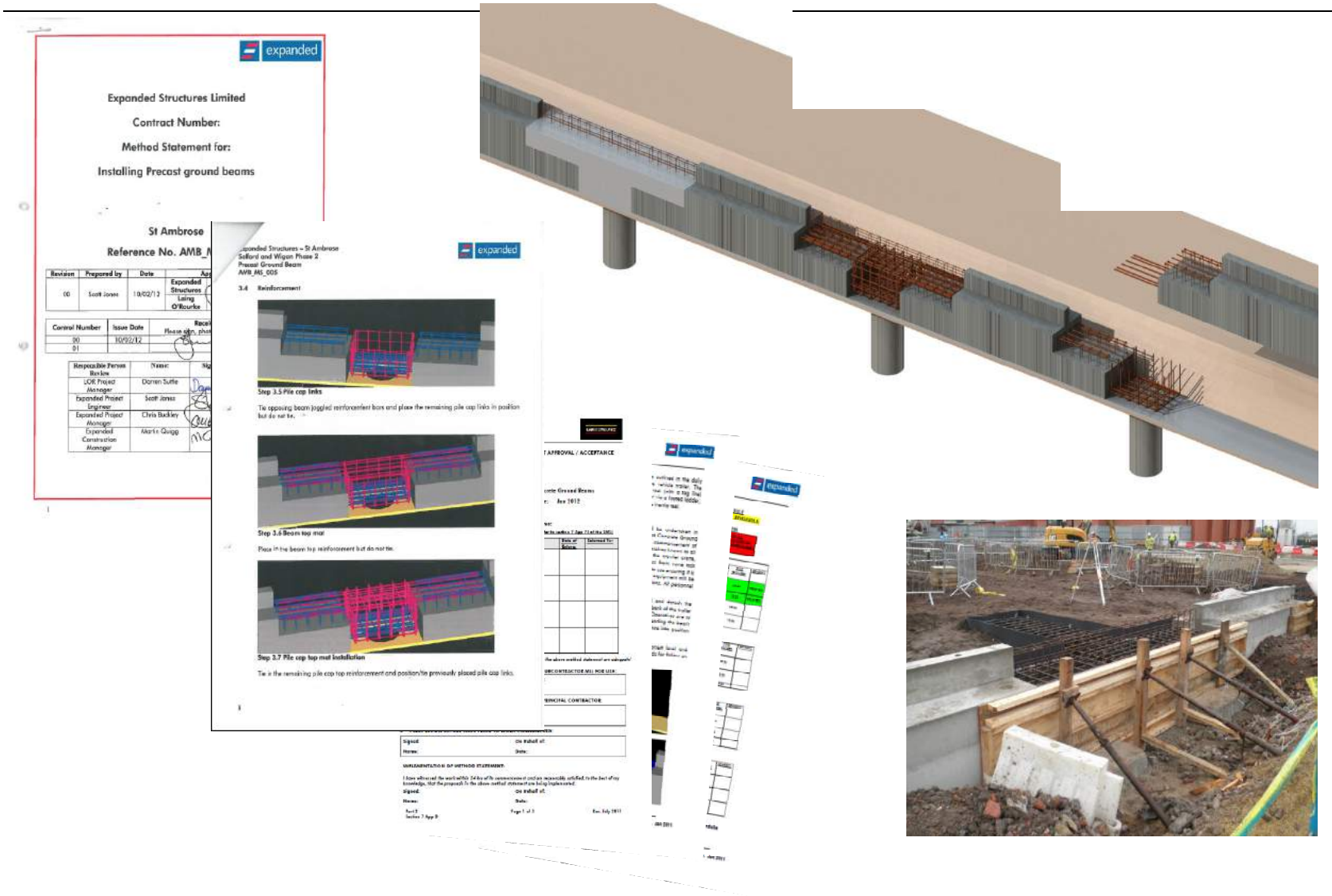


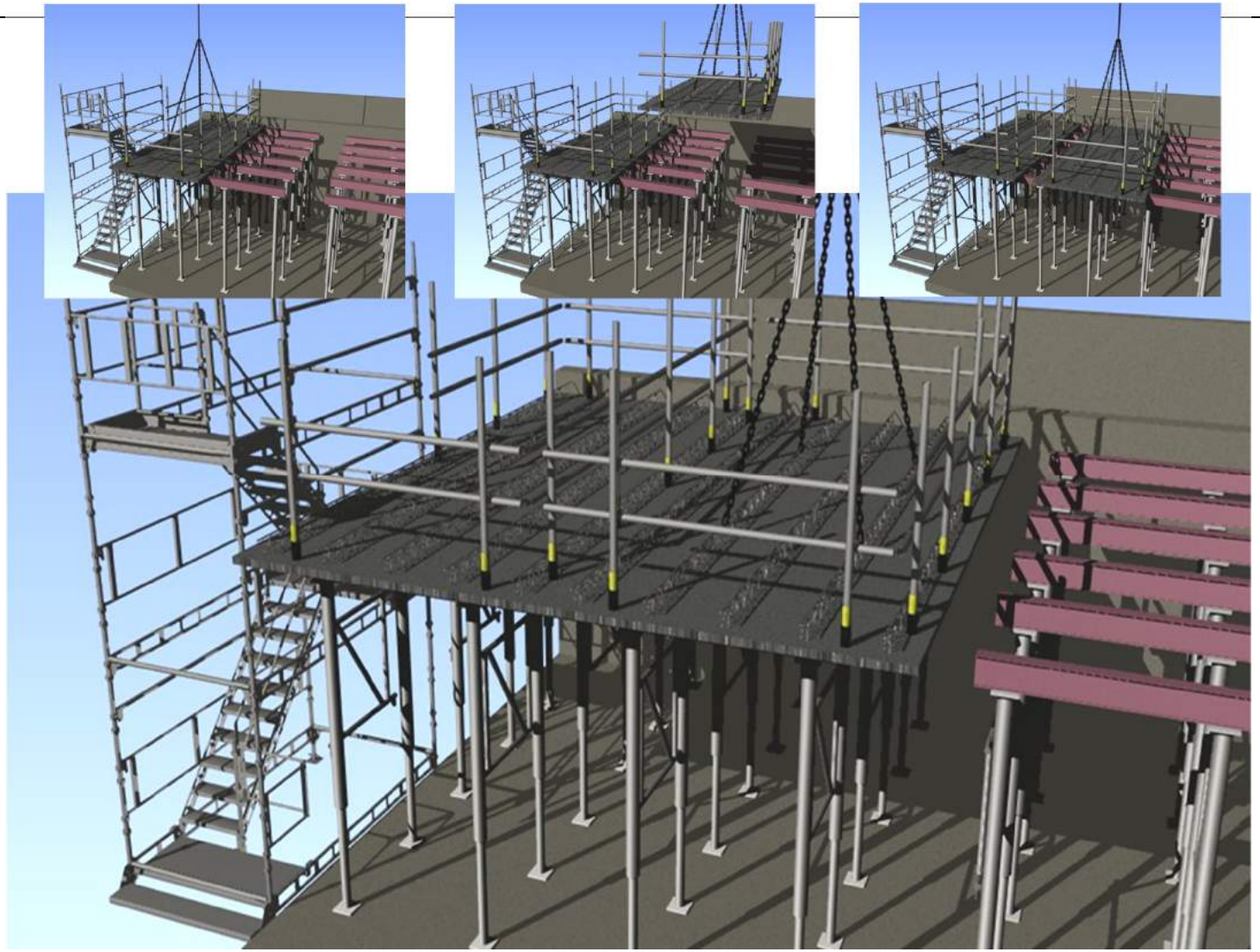
Explore's Nemetschek production model



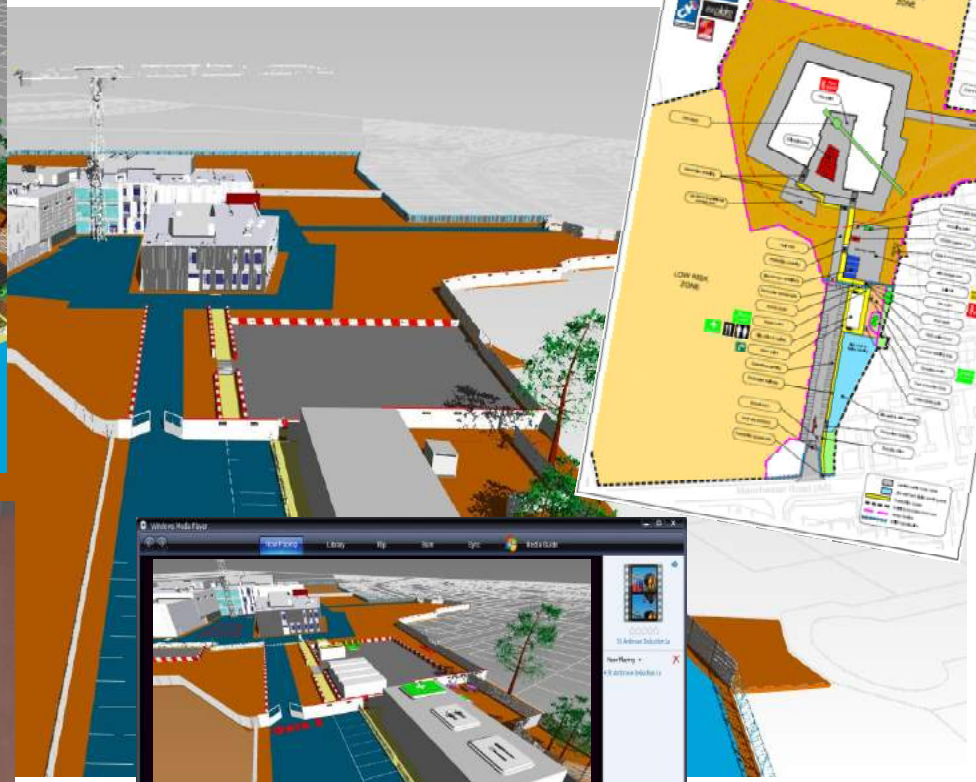


Design to Manufacture



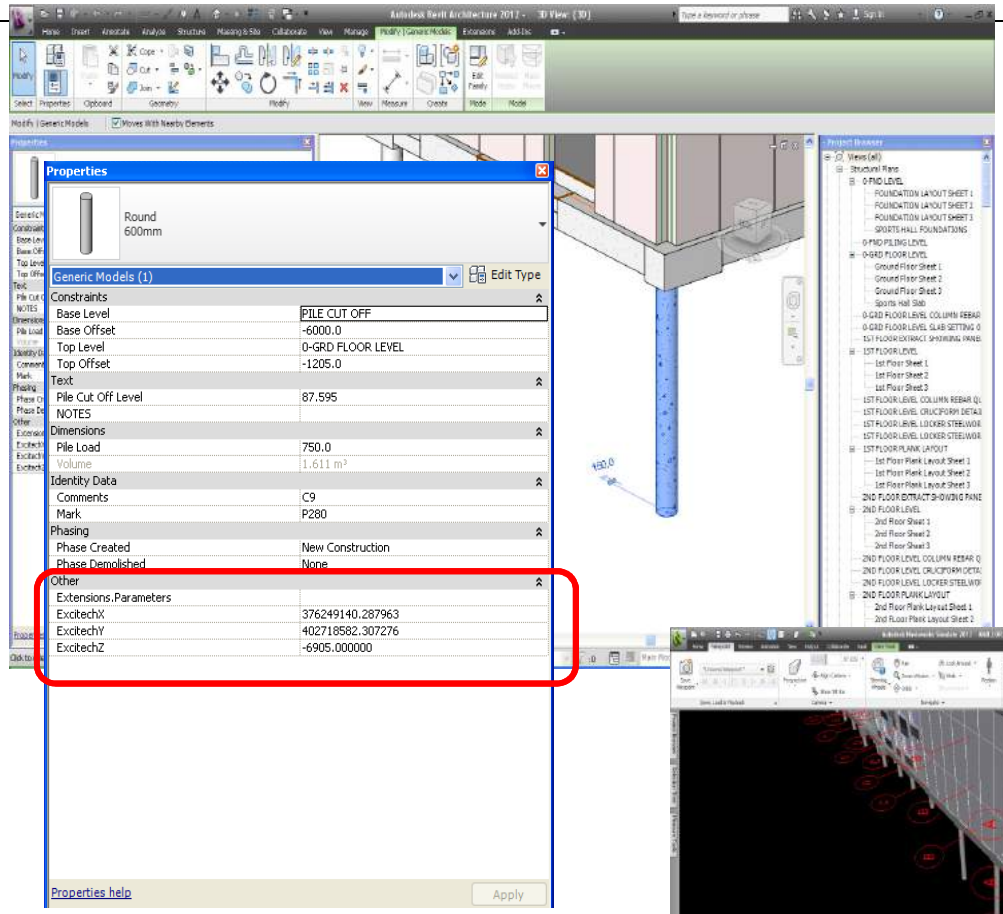


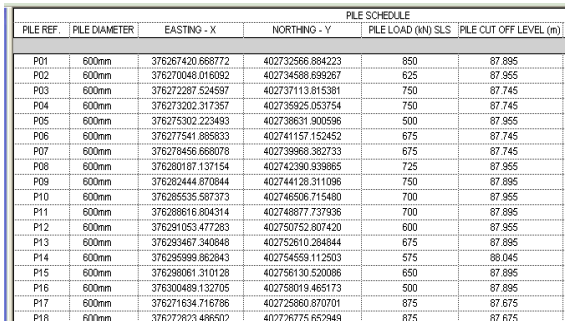
Salford BSF: Phase 2 – Logistics modelled & used within site induction



Rory O'Donoghue: Construction Manager

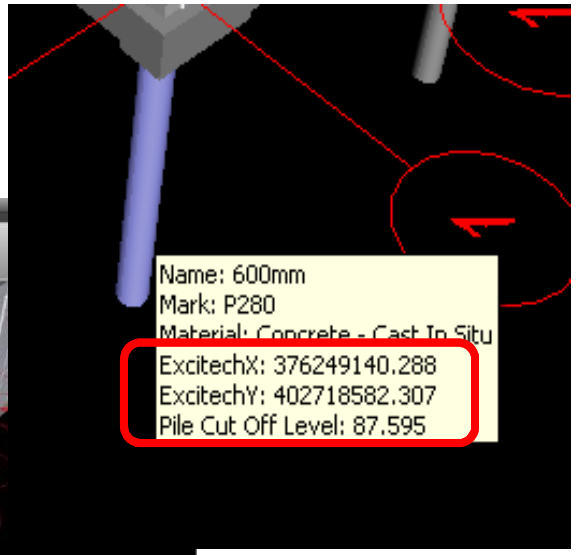
..."It worked really well, and I would definitely use it again..."

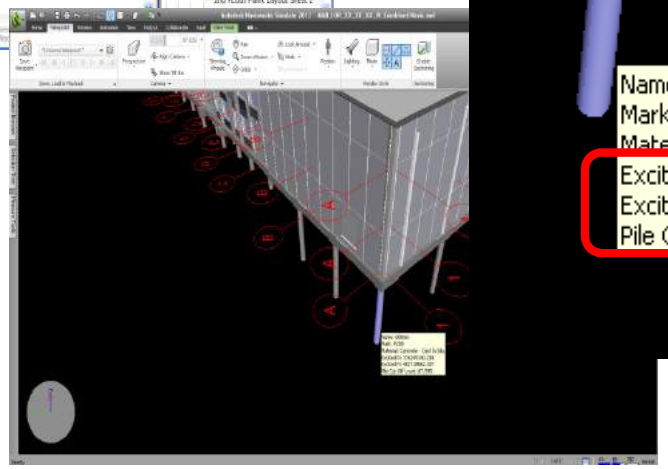




PILE SCHEDULE

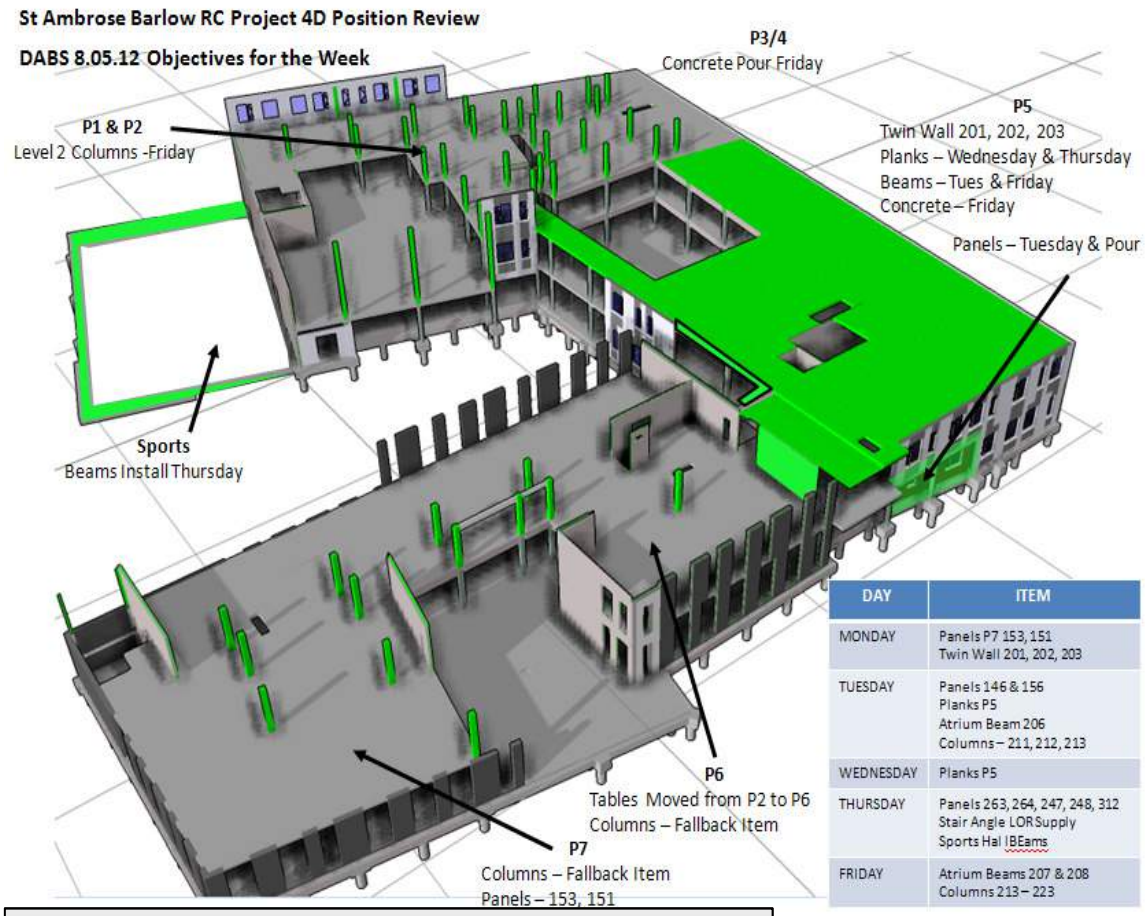
PILE REF.	PILE DIAMETER	EASTING - X	NORTHING - Y	PILE LOAD (kN) SLS	PILE CUT OFF LEVEL (m)
P01	600mm	376267420.668772	402732566.884223	850	87.895
P02	600mm	376270048.016092	402734588.699267	625	87.955
P03	600mm	376272287.524597	402737113.815381	750	87.745
P04	600mm	376273202.317357	402735925.053754	750	87.745
P05	600mm	376275302.223493	402738631.900596	500	87.955
P06	600mm	376277541.885833	402741157.152452	675	87.745
P07	600mm	376278456.668078	402739968.382733	675	87.745
P08	600mm	376280187.137154	402742390.939865	725	87.955
P09	600mm	376282444.870844	402744128.311096	750	87.895
P10	600mm	376285535.587373	402746506.715480	700	87.955
P11	600mm	376288616.804314	402748877.737936	700	87.895
P12	600mm	376291053.477283	402750752.807420	600	87.955
P13	600mm	376293467.340848	402752610.284844	675	87.895
P14	600mm	376295999.862843	402754559.112503	575	88.045
P15	600mm	376298061.310128	402756130.520086	650	87.895
P16	600mm	376300489.132705	402758019.465173	500	87.895
P17	600mm	376271634.716786	402725860.870701	875	87.675
P18	600mm	376272823.486502	402726775.652949	875	87.675



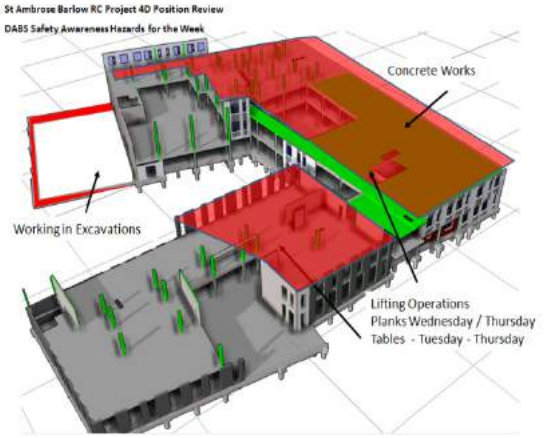


excitech
technology for design

LAING O'ROURKE



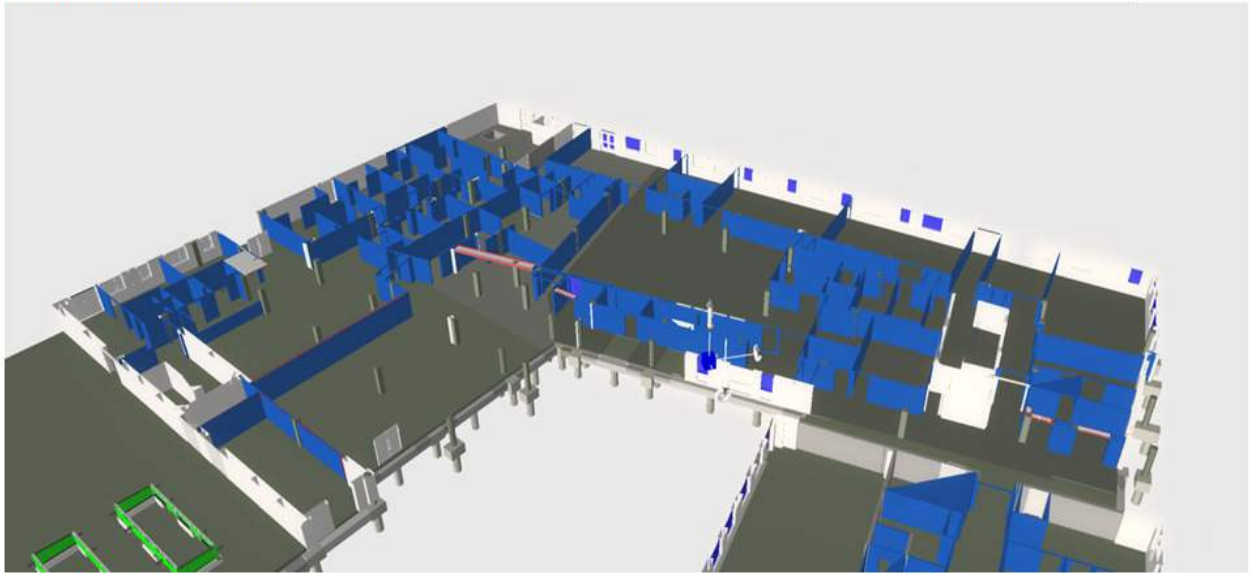
DAY	ITEM
MONDAY	Panels P7 153, 151 Twin Wall 201, 202, 203
TUESDAY	Panels 146 & 156 Planks P5 Atrium Beam 206 Columns – 211, 212, 213
WEDNESDAY	Planks P5
THURSDAY	Panels 263, 264, 247, 248, 312 Stair Angle LORSupply Sports Hal IBEams
FRIDAY	Atrium Beams 207 & 208 Columns 213 – 223



Chris Buckley: Expanded Project Manager

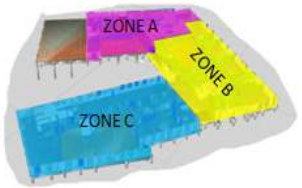
...”When you get the lads on site asking for the 3D visual you know its working...”

WC 16th July 2012 – Objectives for the Week
Construction Zone A & B



1st Side Boarding In Progress | 1st Side Boarding Complete | M&E Drops & Patresses To Progress | M&E Drops & Patresses Signed Off

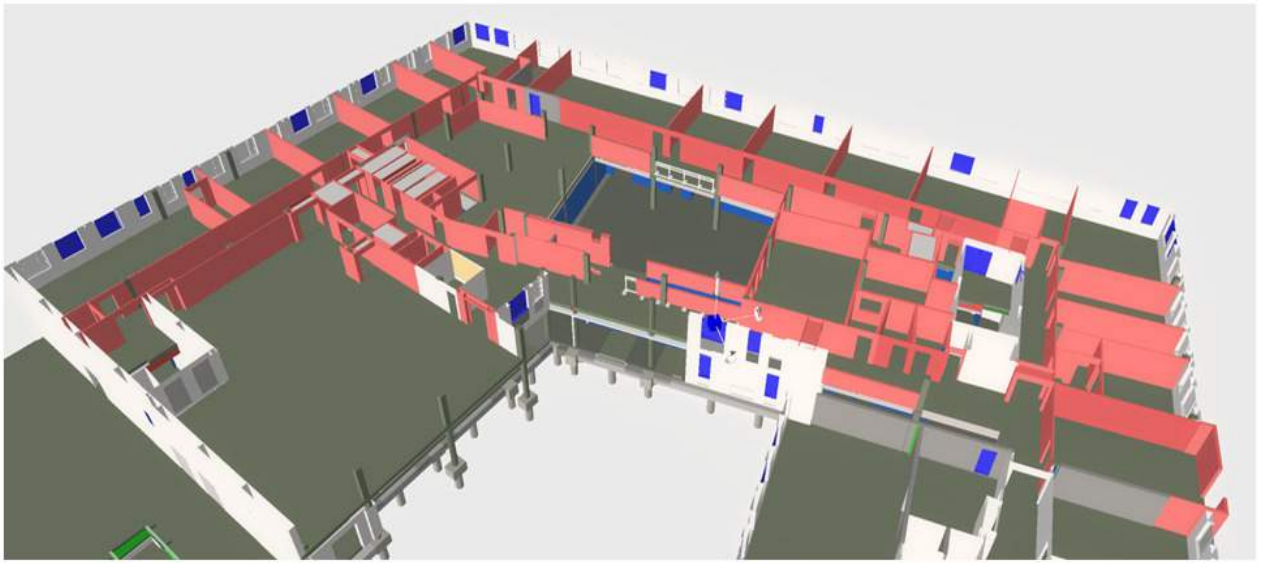
Action	Owner	Target Date
M&E Patresses Marked Out	Rory O'D / G Sullivan	20.07.12
Conduit / Containment Electrical Drops in Walls	James Thrall, Gary Sullivan	20.07.12
Builders Works Patresses Marked Out	Rory O'Donoghue	20.07.12
Patresses Installed	Jock Nugent / Rory O'Donoghue	20.07.12
Sign Off Walls for 2nd Side	LOR, CHT & Jock Nugent	20.07.12



St Ambrose Weekly Planning Progress & Objectives W/c 16.07.12

Ground floor

WC 16th July 2012 – Objectives for the Week
Construction Zone D



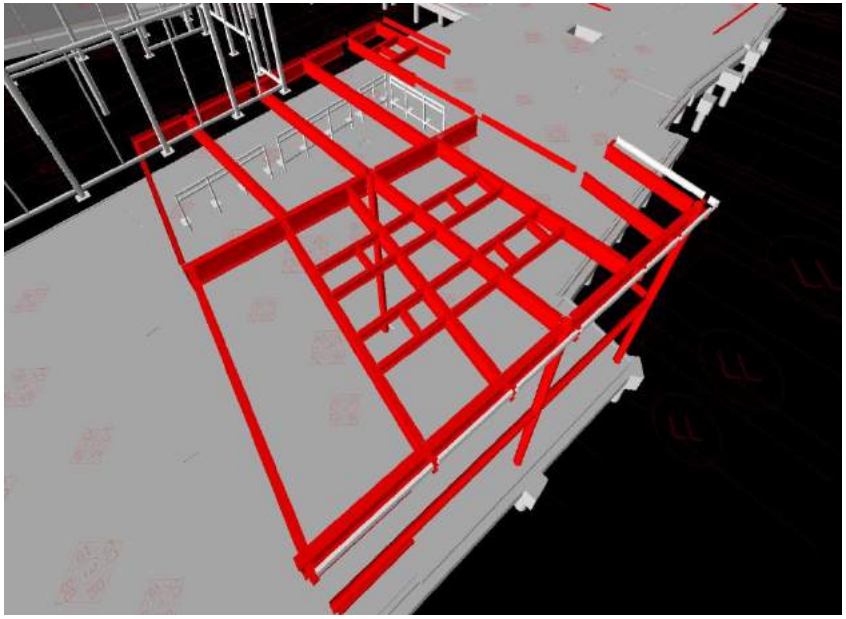
1st Side Boarding In Progress | 1st Side Boarding Complete | M&E Drops & Patresses To Progress | M&E Drops & Patresses Signed Off

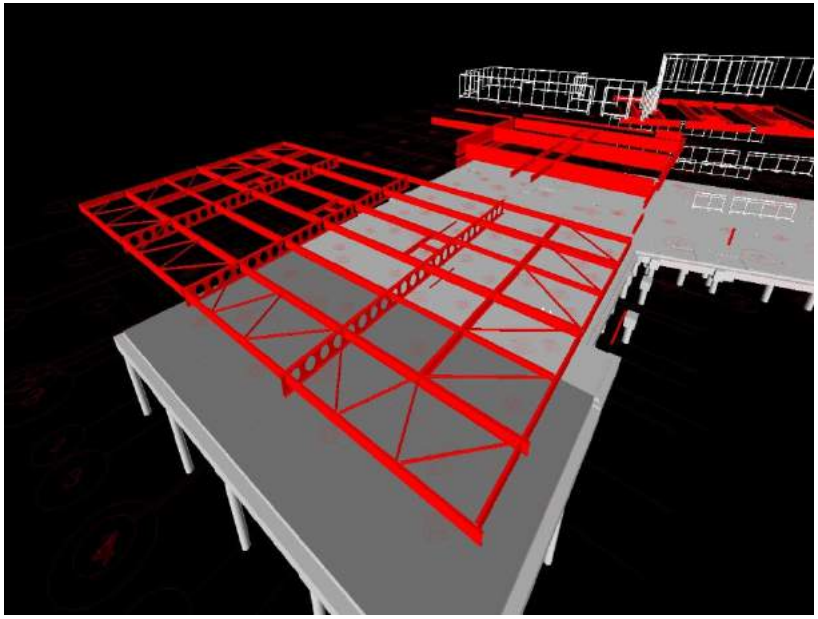
Action	Owner	Target Date
Corridor Boarding High Level Both Sides	Rory O'D / J Nugent	20.07.12
1st Side Boarding	Rory O'D / J Nugent	20.07.12
M&E Corridor Modules	Gary Sullivan	20.07.12

St Ambrose Weekly Planning Progress & Objectives W/c 16.07.12

First Floor

St Ambrose Barlow RC – Asphalt Package
Programme – Sub Contract Work Areas





1. Fire protected steelwork highlighted
2. Images and Model sent with a link to Navisworks Freedom to external contractor to support package scope of works

Lessons learnt for next project

- BIM integration being part of consultant appointment
- Specifically selected external design team members
- Improve understanding of LOR message to functions – people are unaware
- Early Project engagement and appointment of objective leads
- Promote greater design stage collaboration and clash detection