Modernise or Die!

10th February 2020

COMIT

Iain Miskimmin

COMIT

Bentley Institute

Crossrail

A man of many hats!

HM Government

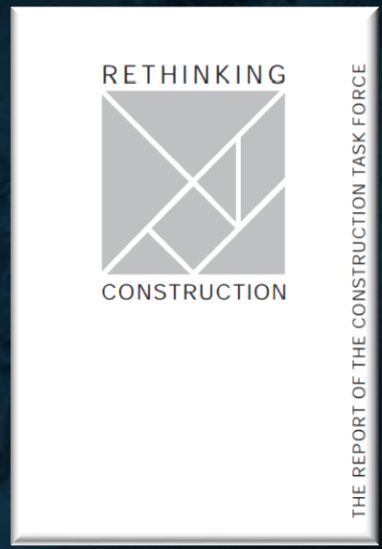
CSIC Cambridge Centre for Smart Infrastructure & Construction

COMIT

29 construction reports since 1934

1934. Reaching for the skies. Alfred Bossom.
1944. Simon Report. Placing and Management of Building Contracts.
1946. The Distribution of Building Materials and Components, Sir Ernest Simon.
1948. The Working Party Report to the Minister of Works: The Phillips Report on Building.
1962. Emmerson Report, Survey of Problems Before the Construction Industries.
1964. Banwell Report. The Placing and Management of Contracts for Building and Civil Engineering Work.
1966. The Tavistock Report: Interdependence and Uncertainty: A study of the building industry.
1965. The Future of Development Plans, Planning Advisory Group.
1967. Potts Report. Action on the Banwell Report: A Survey of the Implementation of the Recommendations of the Committee under the Chairmanship of Sir Harold Banwell on the Placing and Management of Contracts. Economic Development Committee for Building of the National Economic Development Office.
1969. Skeffington Report. 'People and Planning. Report of the Committee on Public Participation in Planning'.
1970. Large Industrial Sites. National Economic Development Council.
1975. Wood Report, The Public Client and the Construction Industries: the report of the Building and Civil Engineering Economic Development Committees Joint Working Party Studying Public Sector Purchasing.
1978 The PIG Report: Project Information - its content and arrangement. A report and proposals on the way forward, by the Project Information Group (PIG) of the Department of the Environment NCC Standing Committee on Computing & Data Co-ordination.
1980. Sir Montague Finston, Engineering Our Future: Report of the Committee of Inquiry into the Engineering Profession, HMSO.
1983. The British Property Federation Manual of the BPF system for building design and construction.
1983 Faster Building for Industry, National Economic Development Office (NEDO).
1988 Faster Building for Commerce, National Economic Development Office (NEDO).
1993. Latham, Trust & Money.
1994. The Latham Report, Constructing the Team.
1995. Progress through Partnership, Report from the steering group of the Technology Foresight Programme.
1995. Construction procurement by government. An efficiency unit scrutiny, Sir Peter Levene.
1996. Educating the Professional Team, Construction Industry Board.
1996. Constructing a Better Image, Construction Industry Board.
1996. Training the Team, Construction Industry Board.
1997. Framework for a National Register for Consultants, Construction Industry Board.
1997. Liability Law and Latent Defects Insurance, Construction Industry Board
1997. Partnering in the team, report of working group 12, Construction Industry Board
1998. Strategic Review of Construction Skills Training, Construction Industry Board.
1998. The Egan Report, Rethinking Construction.

The Egan Report 1998



Substantial changes in the culture and structure of UK construction are required to enable the improvements in the project process that will deliver our ambition of a modem construction industry. These include changes in working conditions, skills and training, approaches to design, use of technology and relationships between companies.

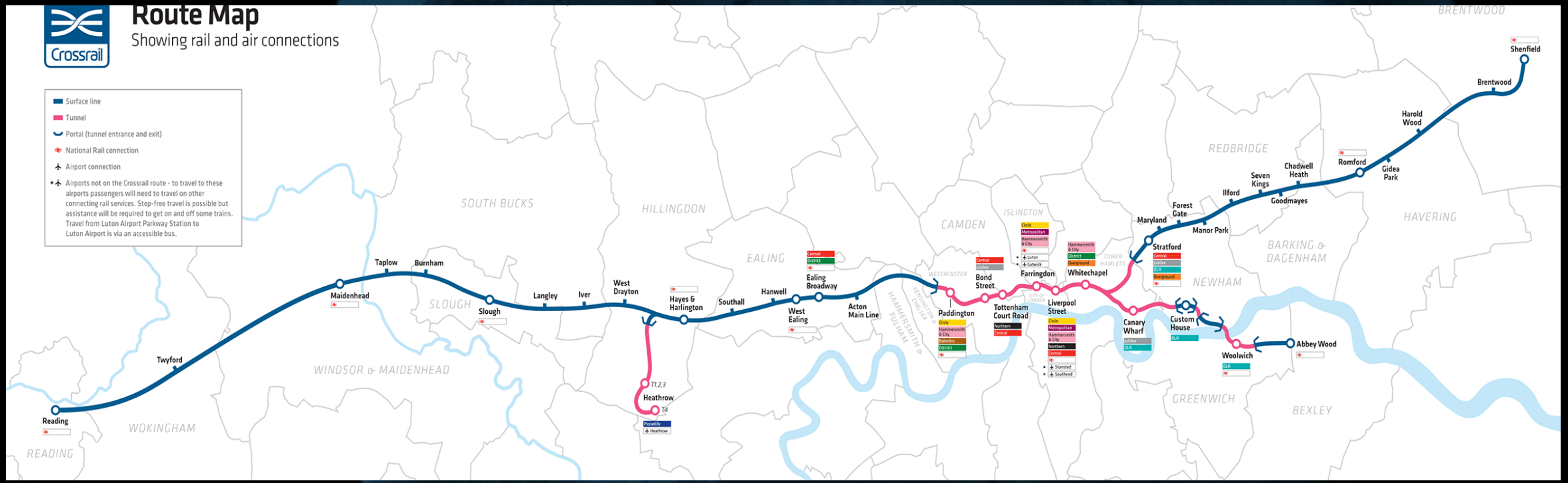
COMIT

42bn+ benefits to UK

14,000 people

24 trains per hour

200 m journeys per year



100+ km's of Surface Network

37 Upgraded or new stations

21 km's of Twin Bore Tunnels

19 Boroughs passed through

8 Sub-Surface Station Upgrades

5 Tunnel main drives

1 World Class Railway

Crossrail

2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020

Bill

Funding

Land & Property Acquisition

Engineering Design

Tunnels & Station Procurement

Enabling Works

Central Section Works Tunnelling & Stations

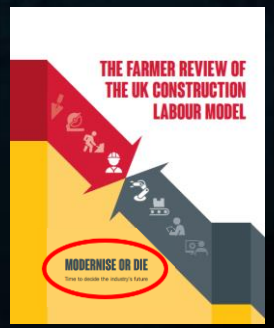
Sys. Procurement

Systems Installation

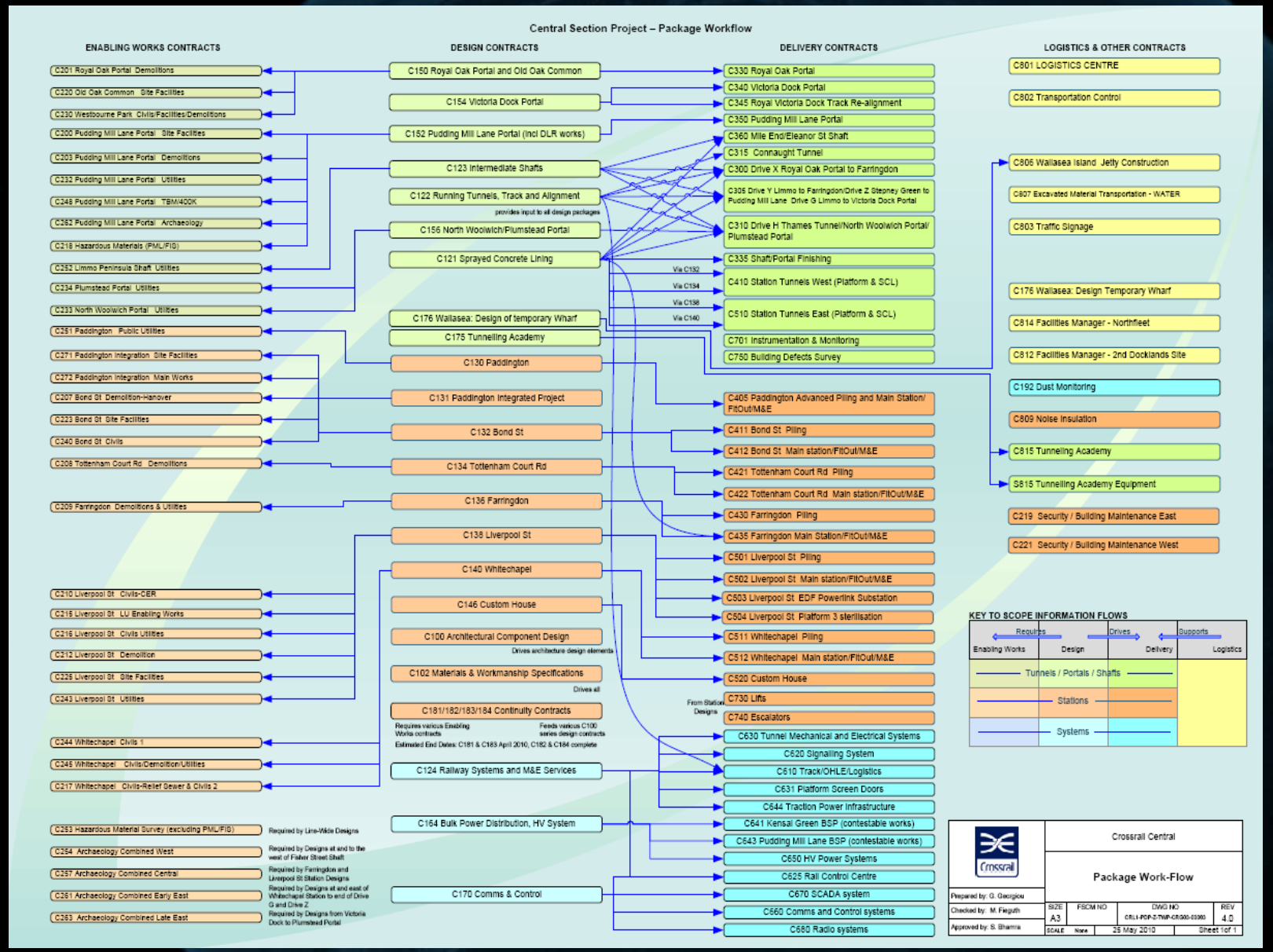
Rolling Stock and Depot – Spec, Procure, Build (CRL)

Testing / Commissioning

Trial Operations/ Staged Opening



COMIT


Central Section Project – Package Workflow
ENABLING WORKS CONTRACTS
C201 Royal Oak Portal Demolitions
C220 Old Oak Common Site Facilities
C230 Westbourne Park Civils/Facilities/Demolitions
C200 Pudding Mill Lane Portal Site Facilities
C203 Pudding Mill Lane Portal Demolitions
C232 Pudding Mill Lane Portal Utilities
C248 Pudding Mill Lane Portal TBM/400K
C262 Pudding Mill Lane Portal Archaeology
C218 Hazardous Materials (PML/FIS)
C252 Limmo Peninsula Shaft Utilities
C234 Plumstead Portal Utilities
C233 North Woolwich Portal Utilities
C251 Paddington Public Utilities
C271 Paddington Integration Site Facilities
C272 Paddington Integration Main Works
C207 Bond St Demolition-Hanover
C223 Bond St Site Facilities
C240 Bond St Civils
C208 Tottenham Court Rd Demolitions
C209 Farringdon Demolitions & Utilities
C210 Liverpool St Civils-CER
C215 Liverpool St LU Enabling Works
C216 Liverpool St Civils Utilities
C212 Liverpool St Demolition
C226 Liverpool St Site Facilities
C243 Liverpool St Utilities
C244 Whitechapel Civils 1
C245 Whitechapel Civils/Demolition/Utilities
C217 Whitechapel Civils-Relief Sewer & Civils 2
C253 Hazardous Material Survey (excluding PML/FIS)
Required by Line-Wide Designs
C254 Archaeology Combined West
Required by Designs at and to the west of Fisher Street Shaft
C257 Archaeology Combined Central
Required by Farringdon and Liverpool St Station Designs
C261 Archaeology Combined Early East
Required by Designs at and east of Whitechapel Station to end of Drive G and Drive Z
C263 Archaeology Combined Late East
Required by Designs from Victoria Dock to Plumstead Portal
DESIGN CONTRACTS
C150 Royal Oak Portal and Old Oak Common
C154 Victoria Dock Portal
C152 Pudding Mill Lane Portal (Incl DLR works)
C123 Intermediate Shafts
C122 Running Tunnels, Track and Alignment
provides input to all design packages
C156 North Woolwich/Plumstead Portal
C121 Sprayed Concrete Lining
C176 Wallasea: Design of temporary Wharf
C175 Tunnelling Academy
C130 Paddington
C131 Paddington Integrated Project
C132 Bond St
C134 Tottenham Court Rd
C136 Farringdon
C138 Liverpool St
C140 Whitechapel
C146 Custom House
C100 Architectural Component Design
Drives architecture design elements
C102 Materials & Workmanship Specifications
Drives all
C181/182/183/184 Continuity Contracts
Requires various Enabling Works contracts
Feeds various C100 series design contracts
Estimated End Dates: C181 & C183 April 2010, C182 & C184 complete
C124 Railway Systems and M&E Services
C164 Bulk Power Distribution, HV System
C170 Comms & Control
DELIVERY CONTRACTS
C330 Royal Oak Portal
C340 Victoria Dock Portal
C345 Royal Victoria Dock Track Re-alignment
C350 Pudding Mill Lane Portal
C360 Mile End/Eleanor St Shaft
C315 Connaught Tunnel
C300 Drive X Royal Oak Portal to Farringdon
C305 Drive Y Limmo to Farringdon/Drive Z Stepney Green to Pudding Mill Lane Drive G Limmo to Victoria Dock Portal
C310 Drive H Thames Tunnel/North Woolwich Portal/ Plumstead Portal
C335 Shaft/Portal Finishing
Via C132
Via C134
Via C138
Via C140
C410 Station Tunnels West (Platform & SCL)
C510 Station Tunnels East (Platform & SCL)
C701 Instrumentation & Monitoring
C750 Building Defects Survey
C405 Paddington Advanced Piling and Main Station/ FitOut/M&E
C411 Bond St Piling
C412 Bond St Main station/FitOut/M&E
C421 Tottenham Court Rd Piling
C422 Tottenham Court Rd Main station/FitOut/M&E
C430 Farringdon Piling
C435 Farringdon Main Station/FitOut/M&E
C501 Liverpool St Piling
C502 Liverpool St Main station/FitOut/M&E
C503 Liverpool St EDF Powerlink Substation
C504 Liverpool St Platform 3 sterilisation
C511 Whitechapel Piling
C512 Whitechapel Main station/FitOut/M&E
C520 Custom House
From Station Designs
C730 Lifts
C740 Escalators
C630 Tunnel Mechanical and Electrical Systems
C620 Signalling System
C610 Track/OHLE/Logistics
C631 Platform Screen Doors
C644 Traction Power Infrastructure
C641 Kensal Green BSP (contestable works)
C643 Pudding Mill Lane BSP (contestable works)
C650 HV Power Systems
C625 Rail Control Centre
C670 SCADA system
C660 Comms and Control systems
C680 Radio systems
LOGISTICS & OTHER CONTRACTS
C801 LOGISTICS CENTRE
C802 Transportation Control
C806 Wallasea Island Jetty Construction
C807 Excavated Material Transportation - WATER
C803 Traffic Signage
C176 Wallasea: Design Temporary Wharf
C814 Facilities Manager - Northfleet
C812 Facilities Manager - 2nd Docklands Site
C192 Dust Monitoring
C809 Noise Insulation
C815 Tunnelling Academy
S815 Tunnelling Academy Equipment
C219 Security / Building Maintenance East
C221 Security / Building Maintenance West
KEY TO SCOPE INFORMATION FLOWS
Requires
Drives
Supports
Enabling Works
Design
Delivery
Logistics
Tunnels / Portals / Shafts
Stations
Systems
Crossrail
Crossrail Central
Package Work-Flow
Prepared by: G. Georgiou
Checked by: M. Fleguth
Approved by: S. Sharma
SIZE A3
FSCM NO
DWG NO CRLI-POP-Z-TWP-CR000-03000
REV 4.0
SCALE None
25 May 2010
Sheet 1of 1

Data Strategy

‘To create an integrated 3D design, facilitating multidisciplinary collaboration throughout the life of the Project, becoming the base for an asset management system.’

System Solution Design

1,500+ Users
30+ Contracts

CAD Standards

Transport for London

Client

Multiple Office Locations

Legacy Data

Business Requirements

Publication

Multiple Worksites

BSi British Standards

Industry Standards

Security

Workflow

Legacy data – commencement of CDE, July 2009

- CAD Files 92,000
- Users 25
- Contracts 3

November 2013

- CAD Files 970,000+
- Users 1650+
- Contracts 64+

August 2014

- CAD Files 1,500,000+
- Users 2500+
- Contracts 84+

Final estimate is 2.5 million CAD Files (which is 17% of total file estimate)

British Standards – BS1192

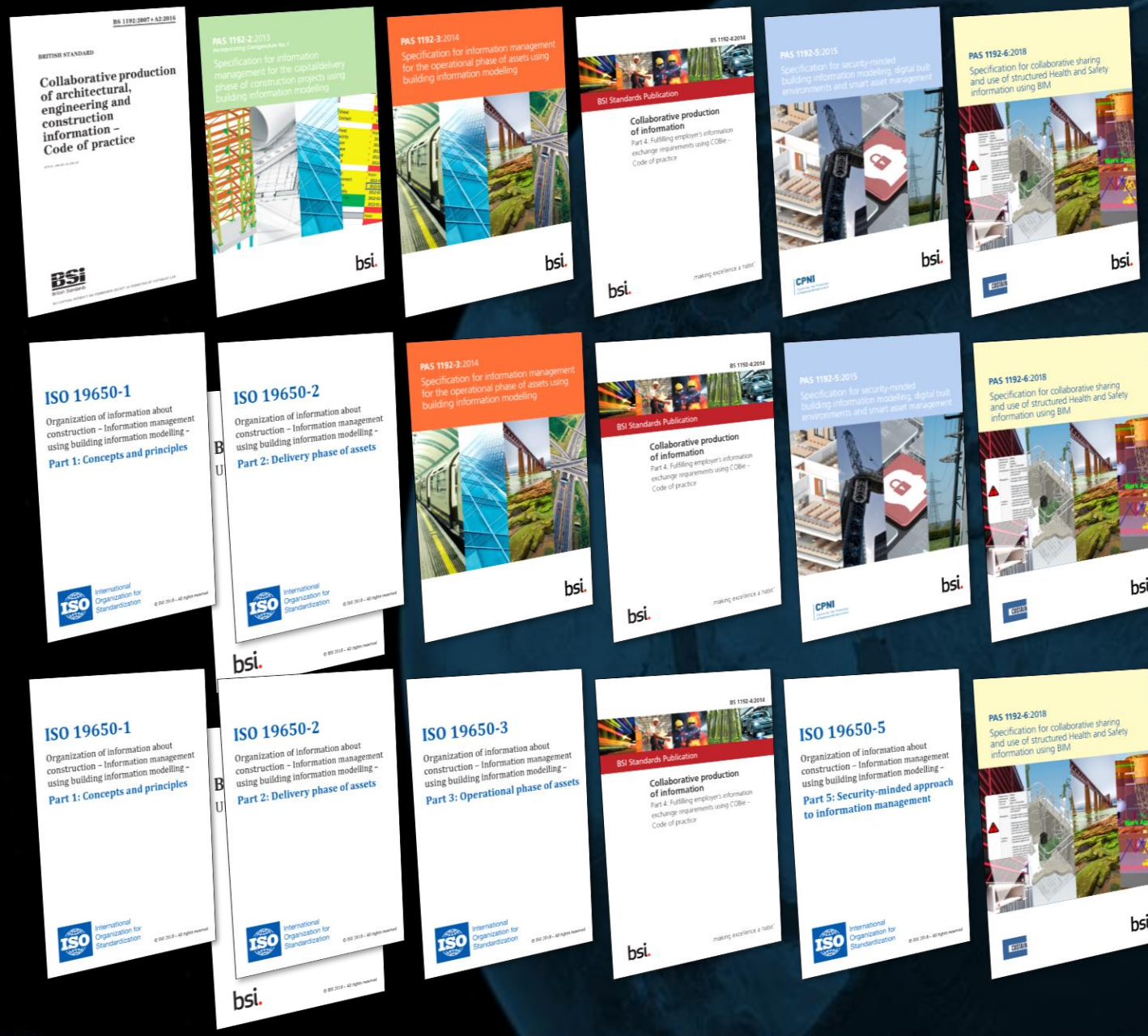
Now Replaced with ISO19650

"The Government Construction Strategy was published by the Cabinet office on 31 May 2011. The report announced the Governments intention to require collaborative 3D BIM (with all project and asset information, documentation and data being electronic) on its projects by 2016."

BS1192-2007

- The collaborative management process (WIP, Shared, Published, Archive)
- Naming of containers (files, layers and objects)
- Coding of Project, Originator, Divisions, Types and Roles
- Classification coding to ISO12006 and Uniclass
- Suitability coding
- Revision and Version numbering
- Zoning (breaking up of information into systems, spaces and volumes

COMIT



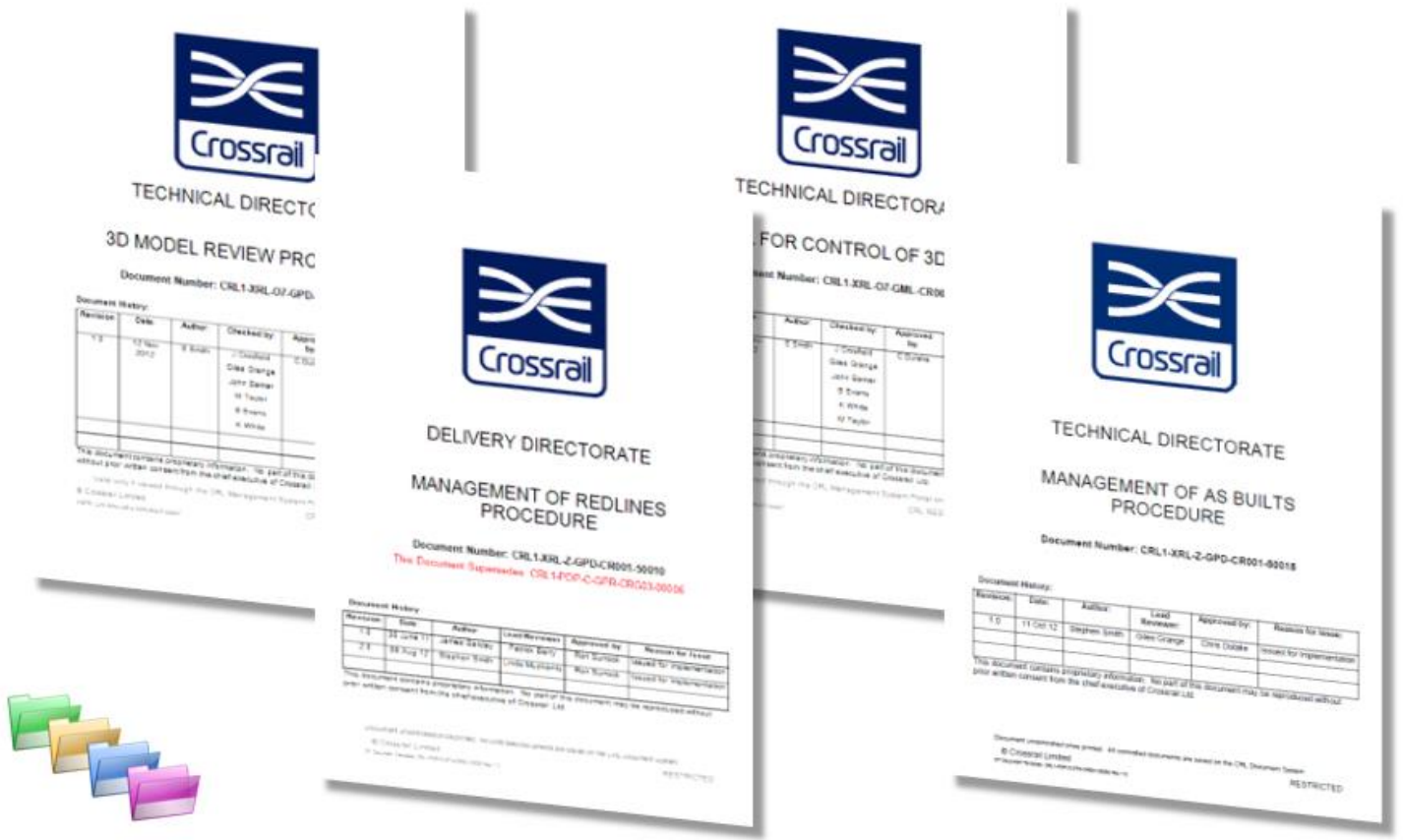
Current 1192 Series

From January 2019

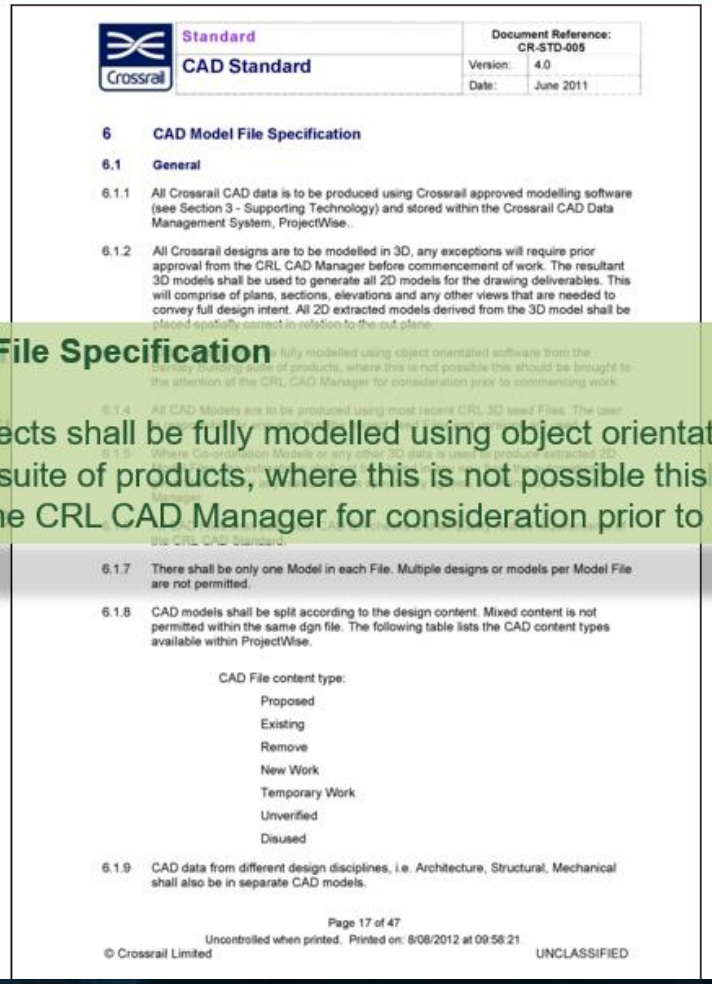
From mid 2020 TBC

COMIT

CAD Procedures



CAD Standards



Standard

CAD Standard

Document Reference: CR-STD-005

Version: 4.0

Date: June 2011

6 CAD Model File Specification

6.1 General

6.1.1 All Crossrail CAD data is to be produced using Crossrail approved modelling software (see Section 3 - Supporting Technology) and stored within the Crossrail CAD Data Management System, ProjectWise.

6.1.2 All Crossrail designs are to be modelled in 3D, any exceptions will require prior approval from the CRL CAD Manager before commencement of work. The resultant 3D models shall be used to generate all 2D models for the drawing deliverables. This will comprise of plans, sections, elevations and any other views that are needed to convey full design intent. All 2D extracted models derived from the 3D model shall be placed spatially correct in relation to the out plane.

6.1.3 "All 3D objects shall be fully modelled using object orientated software from the [redacted] suite of products, where this is not possible this should be brought to the attention of the CRL CAD Manager for consideration prior to commencing work"

6.1.4 All CAD Models are to be produced using most recent CRL 3D seed Files. The user

6.1.5 Where Co-ordination Models or any other 3D data is used to produce extracted 2D

the CRL CAD standard.

6.1.7 There shall be only one Model in each File. Multiple designs or models per Model File are not permitted.

6.1.8 CAD models shall be split according to the design content. Mixed content is not permitted within the same dgn file. The following table lists the CAD content types available within ProjectWise.

CAD File content type:

- Proposed
- Existing
- Remove
- New Work
- Temporary Work
- Unverified
- Disused

6.1.9 CAD data from different design disciplines, i.e. Architecture, Structural, Mechanical shall also be in separate CAD models.

Page 17 of 47

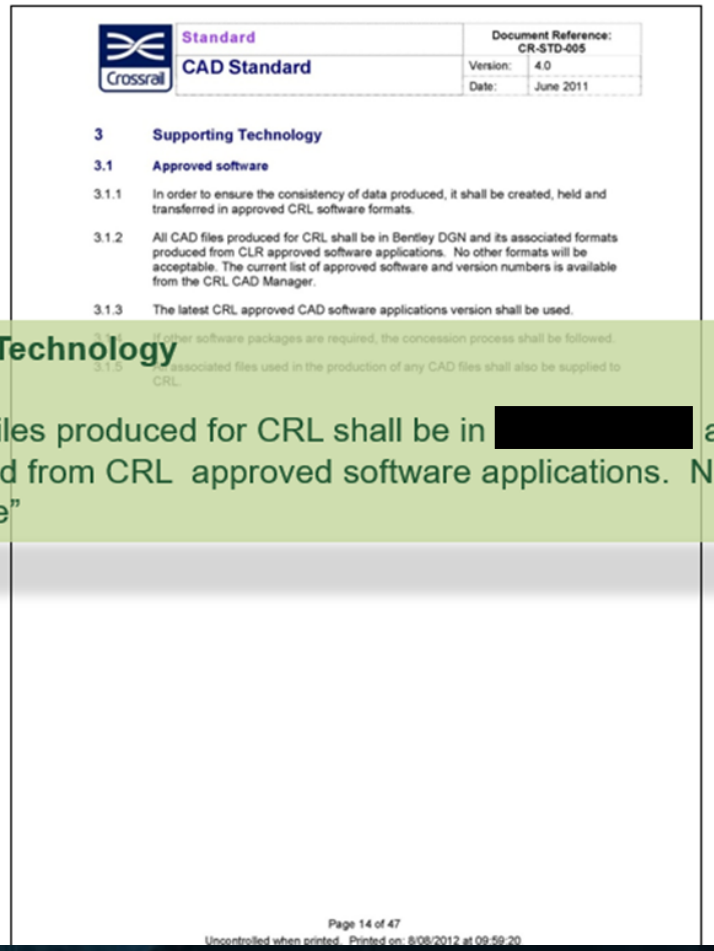
Uncontrolled when printed. Printed on: 8/08/2012 at 09:58:21

UNCLASSIFIED

6 CAD Model File Specification

6.1.3 "All 3D objects shall be fully modelled using object orientated software from the [redacted] suite of products, where this is not possible this should be brought to the attention of the CRL CAD Manager for consideration prior to commencing work"

CAD Standards



Standard

CAD Standard

Document Reference: CR-STD-005

Version: 4.0

Date: June 2011

3 Supporting Technology

3.1 Approved software

3.1.1 In order to ensure the consistency of data produced, it shall be created, held and transferred in approved CRL software formats.

3.1.2 All CAD files produced for CRL shall be in Bentley DGN and its associated formats produced from CLR approved software applications. No other formats will be acceptable. The current list of approved software and version numbers is available from the CRL CAD Manager.

3.1.3 The latest CRL approved CAD software applications version shall be used.

3.1.4 If other software packages are required, the concession process shall be followed.

3.1.5 All associated files used in the production of any CAD files shall also be supplied to CRL.

Page 14 of 47

Uncontrolled when printed. Printed on: 8/08/2012 at 09:59:20

3 Supporting Technology

3.1.2 “All CAD files produced for CRL shall be in [redacted] and its associated Formats produced from CRL approved software applications. No other formats will be acceptable”

Common Data Environment

Albums

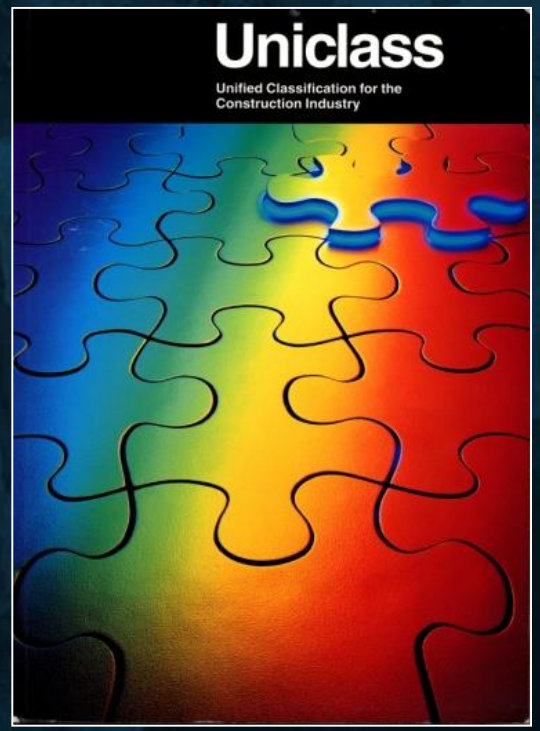
Music storage device

Playlists

Uniclass 1 – Not fit for infrastructure (but adopted and adapted by Crossrail)

Uniclass 2 – A vast improvement but not for Rail or Road.

Uniclass 2015* – Industry built for better coverage

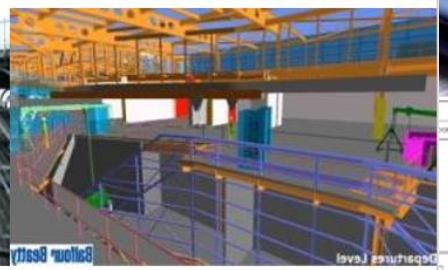


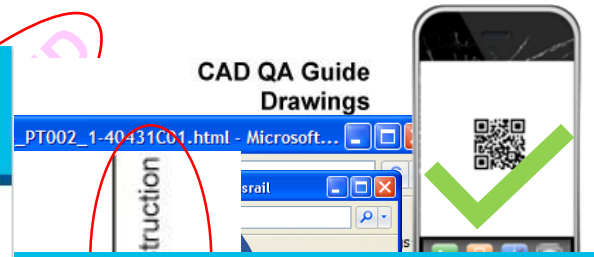
"Is a classification system providing a framework of common identification to assets"
*ongoing.

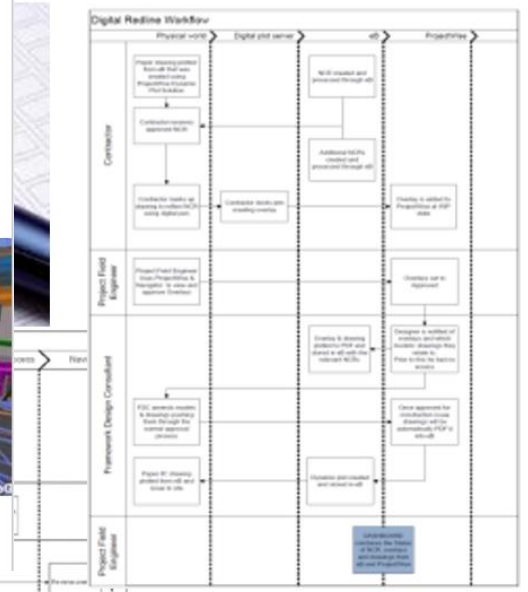
CDE – Approval Workflow

Laser Scanning

- The BiDWG “As-built” Task Group have been looking at the potential application of mobile laser scanning equipment and technologies for the following:-
  - Proving “swept path” for installation transit of bulky plant and equipment through enclosed spaces
  - Above may be in conjunction with 4D modelling
  - Proving swept path of e.g. wide loads, large mobile cranes in urban back-streets
  - Checking as-built impact of cumulative tolerances in critical areas, e.g. lift shafts
  - Checking as-built kinematic envelope clearances, e.g. platform edge copers, PES, OHLE
  - Checking alignment of extensive surfaces e.g. diaphragm walling








How and Why?

- Free Education & Awareness
- Free software
- Access to a central CDE
- Templates, libraries, seed files provided
- Free online training & support
- Level playing field for all contractors
- Any innovation is a shared pain, shared gain
- Additional cost savings for contractors

CARROT

STICK

- In the contract
- Penalties for not following standards
- Non standard files, formats or data not accepted.
- No change costs accepted if not following standards to the letter

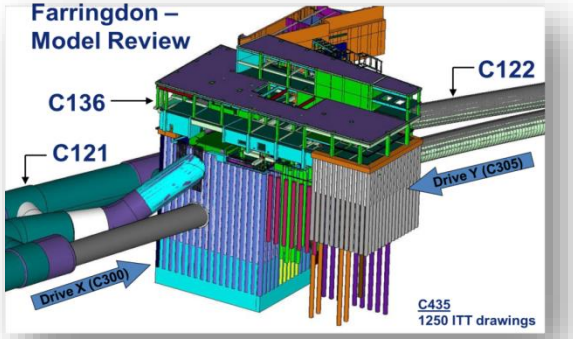
COMIT

3D Modelling: Benefits

- **The direct benefits we have delivered include:**
  - Reduced wastage (minimising clashes)
  - Improved efficiencies (faster cross discipline approvals)
  - 2D drawings are just an extracted published “document”
  - Reduced information loss (using only the most recent models)
  - Improved safety (model visualisations leading to better awareness)
  - Reduced programme risk (through 4D analysis)
  - Improved performance (linking 3D models into GIS mapping)
  - Collaborative model transfer from designer to contractor
  - Innovative asset management (linking models directly to our asset database)

Cost Benefits

- Information solutions and processes that support the efficient creation and management of all deliverables e.g. Records, Drawings, CAD Models, Asset Information
- Saving time finding information from our “single source of truth”
- Utilising benefits associated with 4D



At Farringdon Station

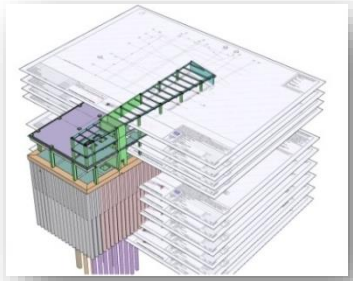
3D model linked to the delivery programme. Cost to develop the model was **£120k** but saved over **£8 million** from risk contingency due to (interfacing complexity)

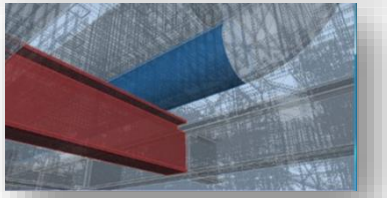
General Benefits

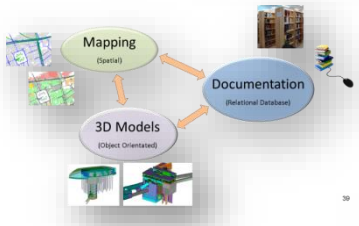
- **Safety**
  Better understanding of construction through visualisations, by combining 3D and 4D data

- **Efficiency**
  Reduction in waste through model clash detection

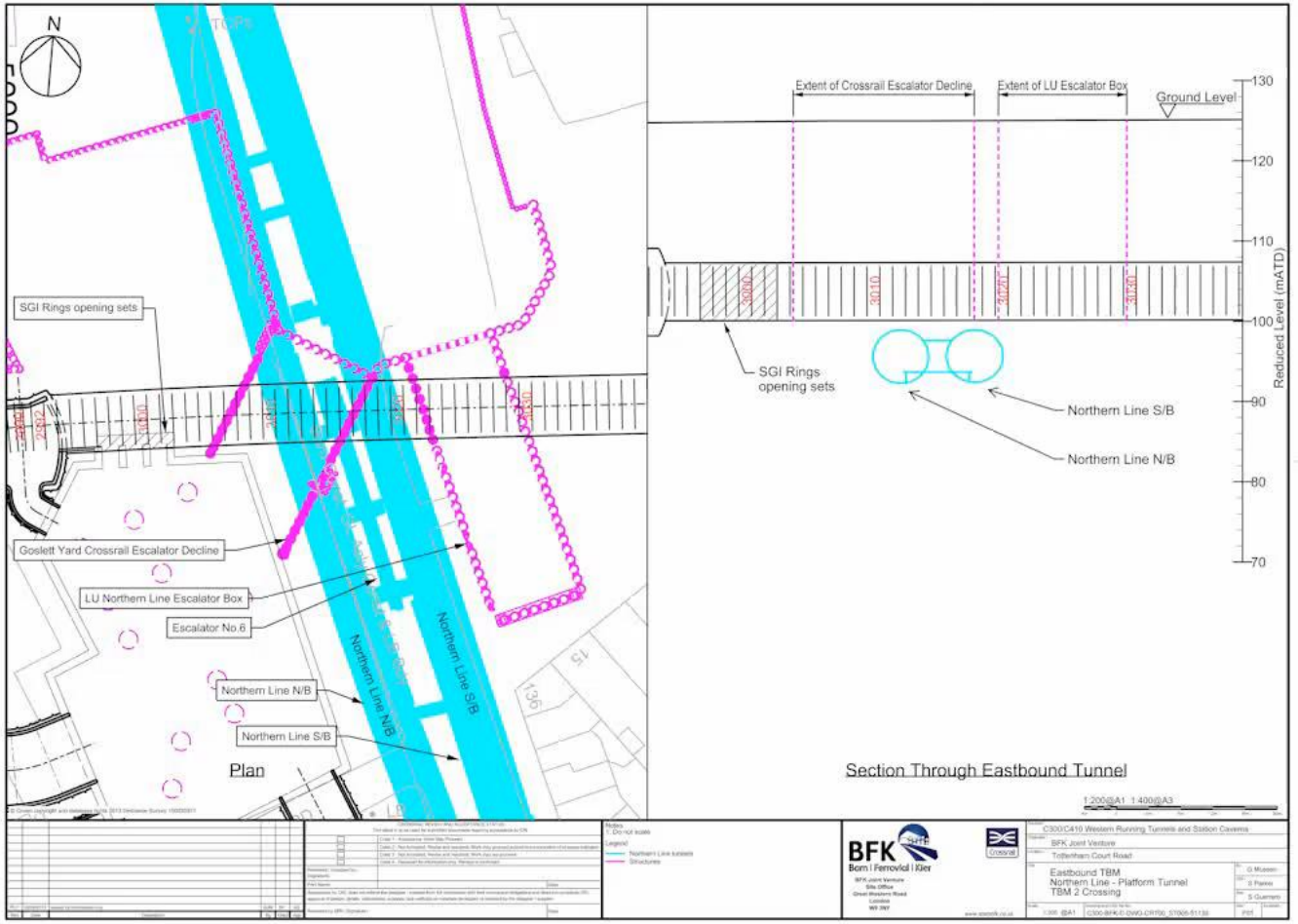
- **Effectiveness**
  Always using the most up-to-date information from an integrated single source of truth



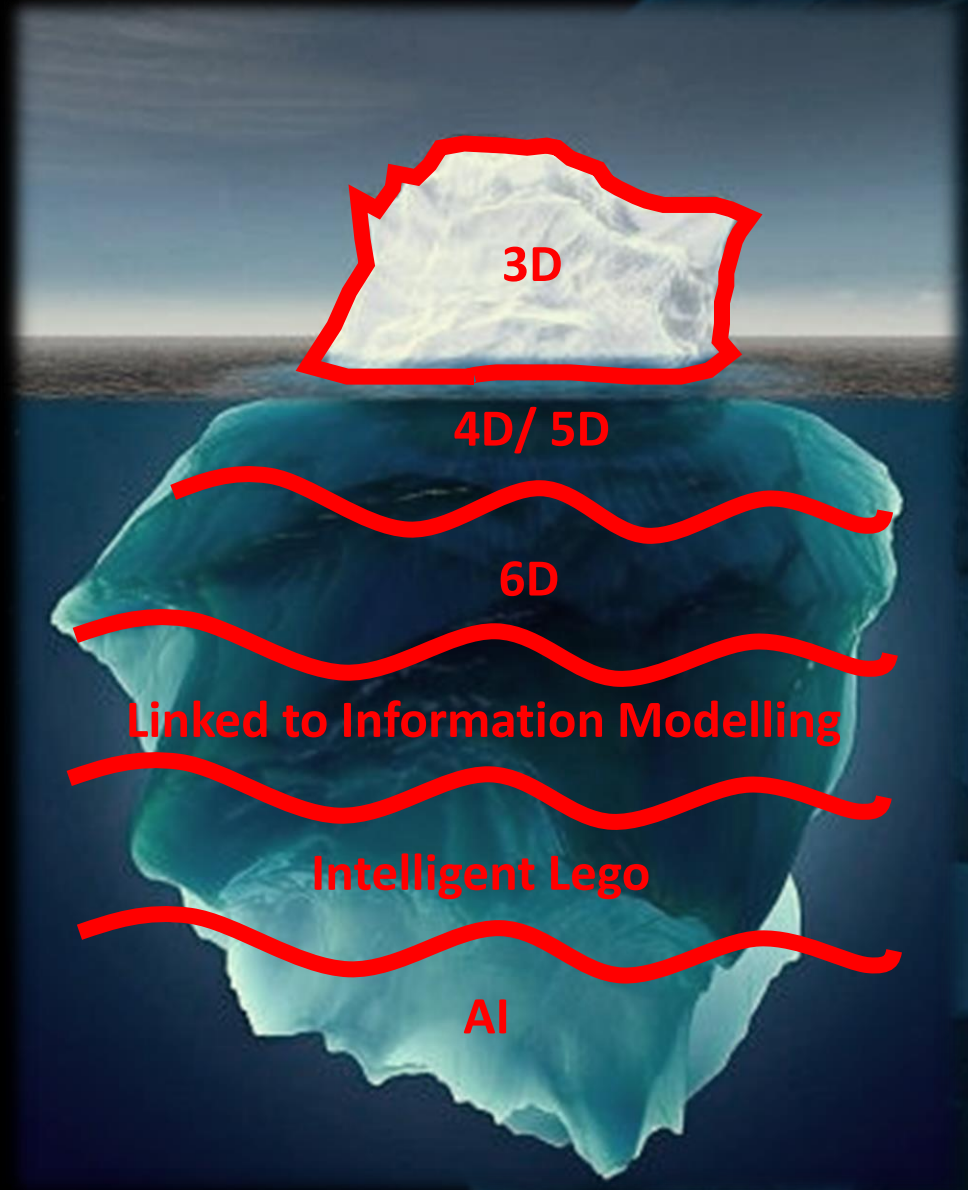




Threading the eye of the needle




This was 10 years ago
so what is happening now?



Coordination, clash resolution, design accuracy, improved safety, reduced risks, wastage, rework, improved security & 3D printing opportunities

Scheduling, sequencing, work packaging, further reduction of risk, logistics streamlining, cost control

Extending into operations and maintenance

Linking with business requirements, environmental, economic and social targets

Functional building blocks with defined components, parts lists and interface interactions

Automated design based on outcomes linked to manufacturing and delivery

COMIT

High impact industry recommendations:

1. Set up a Common Data Environment
2. Standardise:
    a. Templates
    b. Layer/ File naming
    c. Libraries
    d. Formats
3. Invest in training, education and capability awareness
4. Support through a “Digital Advancement” group

These will set the groundwork so that you can add dimensions into the future

Modernise or Die!

Thank you