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## ***Praktické užití BIM na velkých infrastrukturních projektech – perspektiva zahraničního zhotovitele***

**Ing. VLADIMIR MALINA**

*Senior Civil Engineer, 38*



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**STRABAG**





Highways  
Bridges  
Ports  
Jetties  
Power plants  
Buildings  
Pipelines

+ \$3.5bil  
*(small to mega)*

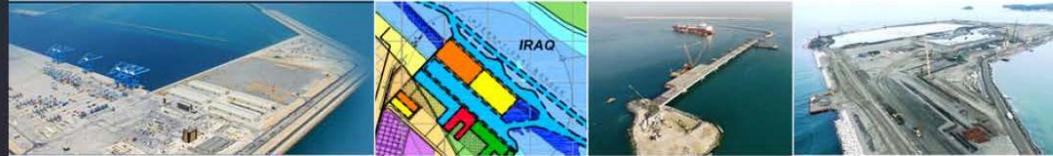
**D-B-B, D&B, EPC, ECI**

UK, UAE, Turkey,  
Canada, Costa Rica,  
Panama

### ROADWORKS



### MARINE STRUCTURES



### BUILDINGS & EXTERNAL WORKS



### POWER PLANTS



### TENDERS & BUSINESS DEVELOPMENT



### TECHNOLOGY & INNOVATION





# Digital Construction incubator (Dubai)

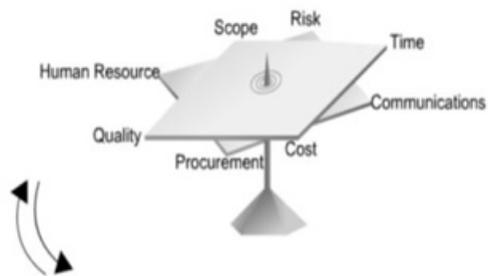
ADD VALUE TO TENDER AND PROJECT TEAMS, BY FOCUSING ON THEIR NEEDS AND APPLYING OUR ENGINEERING KNOW-HOW AND DIGITAL CONSTRUCTION TOOLS TO THEIR CHALLENGES





# Attributes of successful projects

## EXECUTION STRATEGY



## BALANCED CONTRACT vs. ESTIMATE



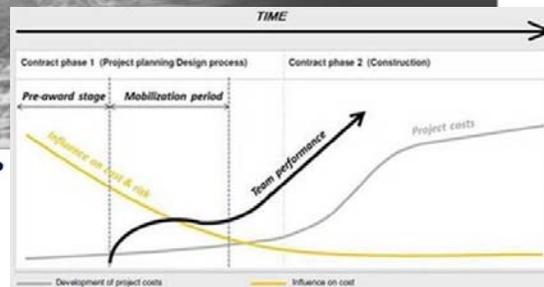
## FOCUS ON PROGRAMME MILESTONES



## COLLABORATION ACROSS PROJECT ORGANIZATION



## LEADERSHIP



## MANAGING RISK TRANSFER

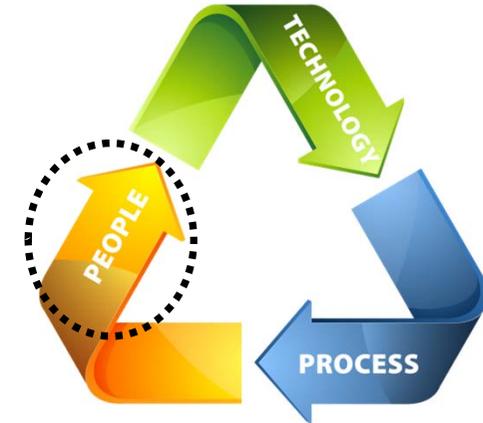


**BIM**



## Attributes of successful large projects

Making  
the  
difference



- *Assign the project team early*
- *Choose the right project delivery strategy*
- *Develop realistic estimates*
- *Actively manage project risks*
- *Senior management commitment and leadership*
- *Develop project-specific policies and procedures*
- *Assign project-specific roles and responsibilities*
- *Have frequent team meetings*
- *Stakeholder communication*
- *Project controls integration*
- *Continuously improve*

\* Source KPMG



DEFINITION



DEVELOPMENT



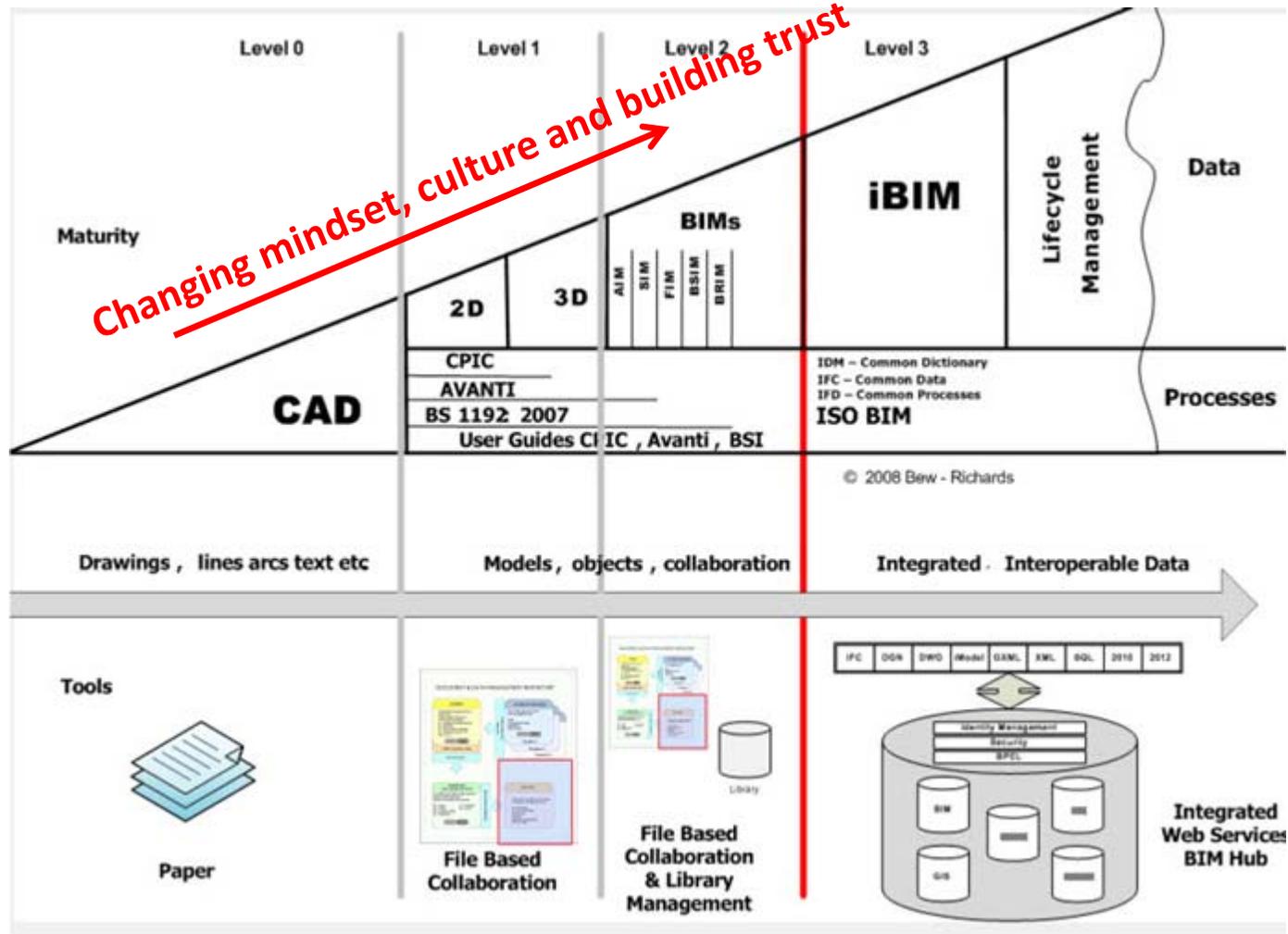
CONSTRUCTION



OPERATION



# BIM maturity curve

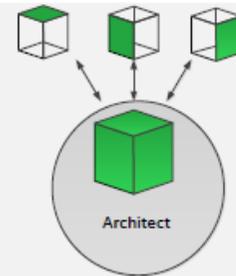




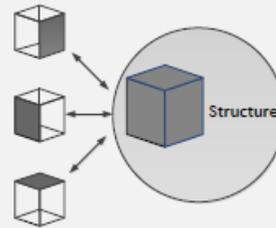
# BIM Level 1 (culture of silos)

● **Pre BIM**

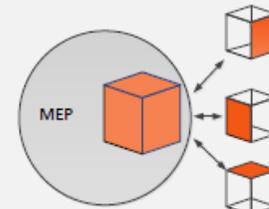
● Object based **Modelling** / Lonely BIM



**OBJECTIVE**



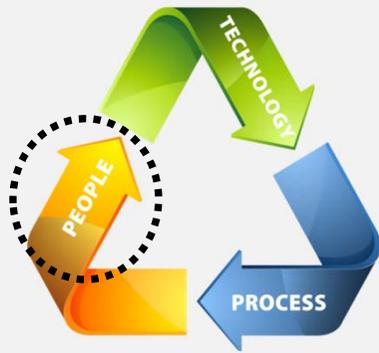
?



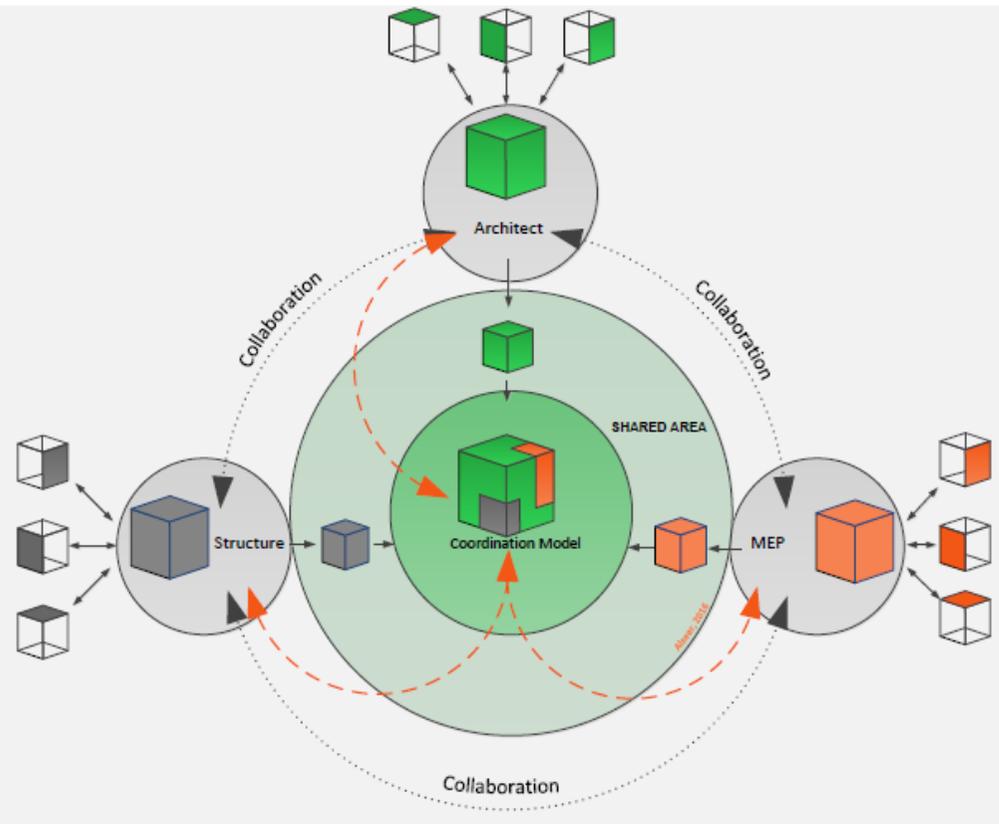


# BIM Level 2 (challenge)

- **Pre BIM**
- Object based **Modelling** / Lonely BIM
- Model based **Collaboration** / Social BIM

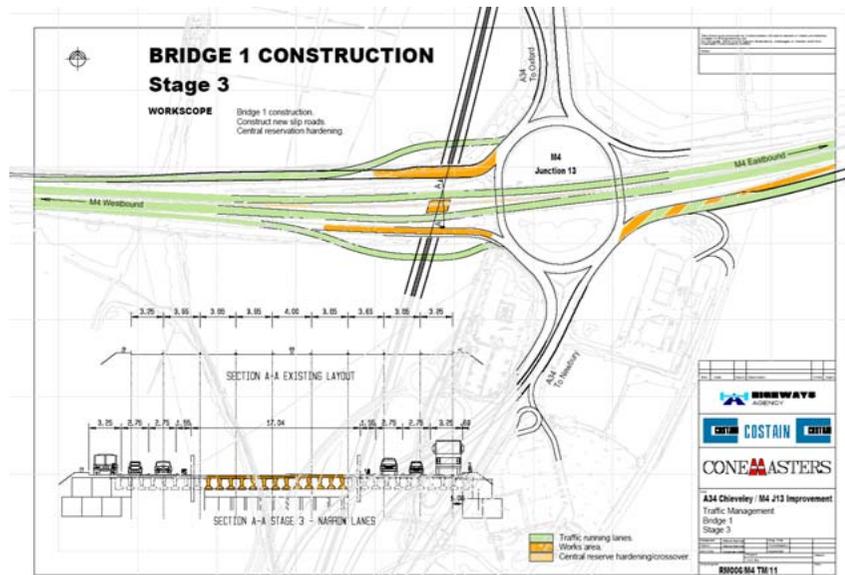


**CHANGE MANAGEMENT**  
**LEADERSHIP**  
**PROJECT BRAND / CULTURE**  
**TEAMWORK DEVELOPMENT**  
**RIGHT RECRUITMENT**





# Pre-BIM era: collaboration in 2003 (D&B)

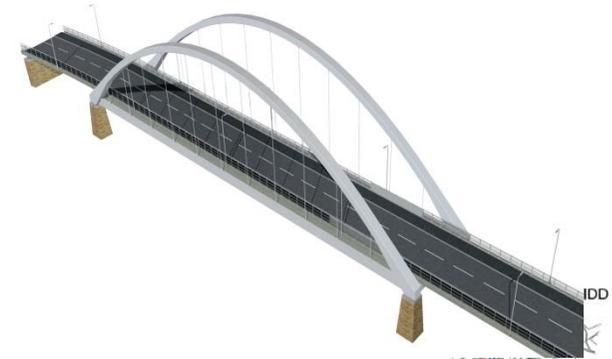
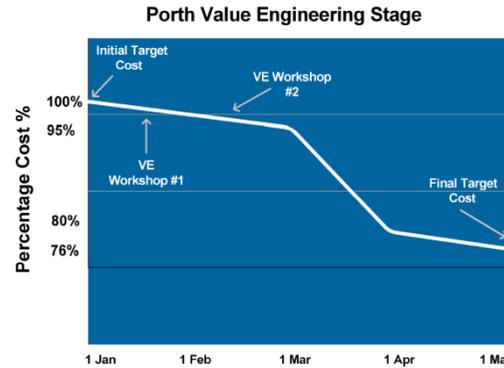


*Top-down construction, self-weathering steel, concrete best-practice awards, recycling .....*

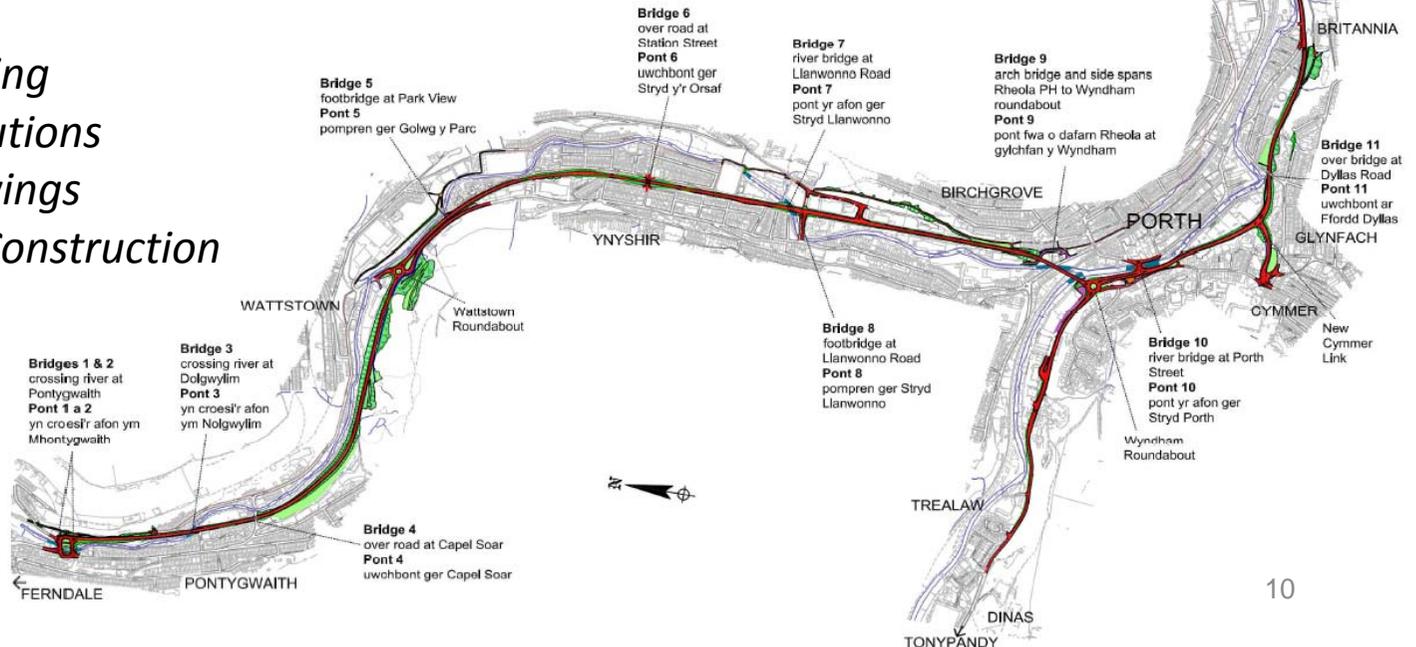




# Pre-BIM era: collaboration in 2005 (ECI)



- Lean construction*
- Community relations*
- Local material re-cycling*
- Innovative design solutions*
- Value Engineering savings*
- Modern Methods of Construction*





## Pre-BIM era: collaboration driver (UK)

“A successful construction industry is essential to us all. We all benefit from high quality housing, hospitals or transport infrastructure that are constructed efficiently. Nevertheless, the industry recognises that it needs to modernise in order to tackle the severe problems facing it.”

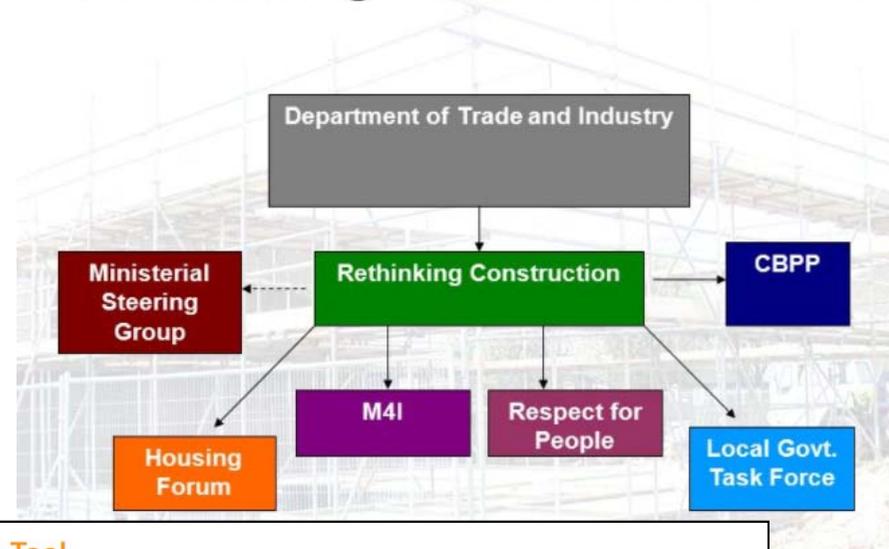
*The Construction Task Force, Sir John Egan, 1998 (UK)*



**NEC3, ECI,  
PARTNERING,  
LEAN, TRAINING,  
etc.**

26/06/2017

### Constructing Excellence Structure



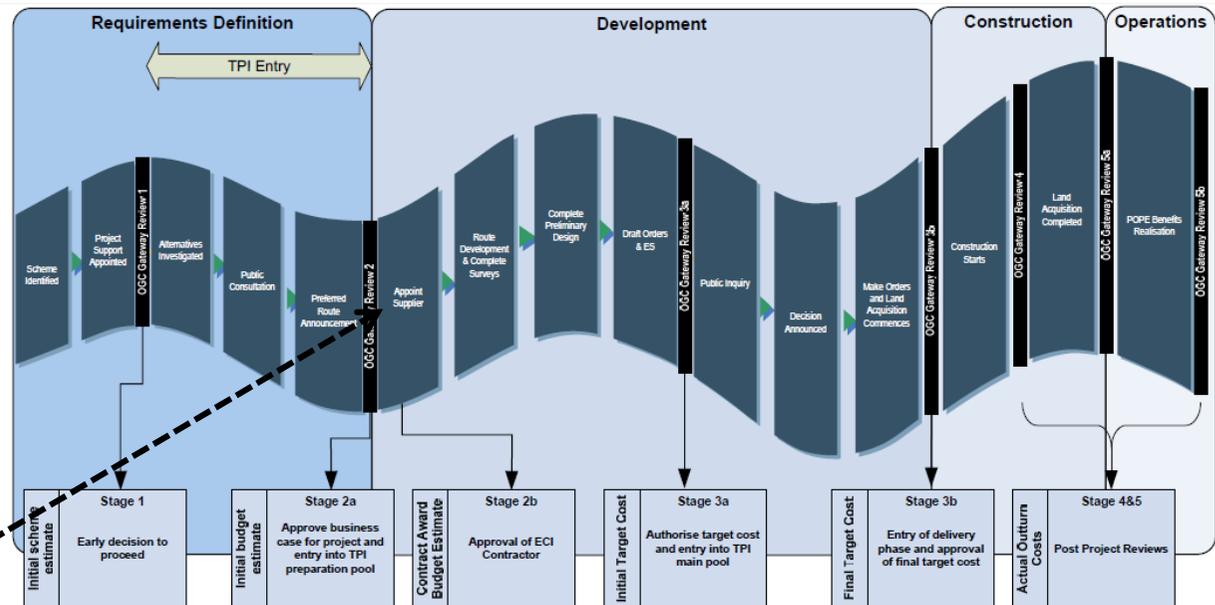
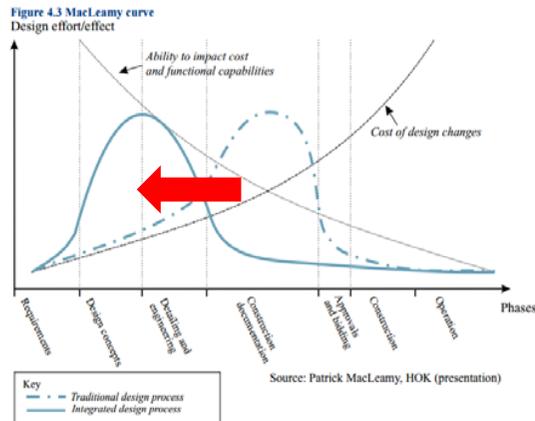
**Technology as a Tool**

62. The Task Force does not consider that technology on its own can provide the answer to the need for greater efficiency and quality in construction. There have been celebrated examples of new technology being used to reinforce outdated and wasteful processes – and it does not work. The advice offered to construction by leading manufacturing industries is to approach change by first sorting out the culture, then defining and improving processes and finally applying technology as a tool to support these cultural and process improvements.





# Highways Agency procurement (UK)



Entry of preferred ECI contractor:

Phase 1 – Consultant  
**(input to constructability)**

Phase 2 - Contractor

Scope of Process	<ul style="list-style-type: none"> <li>Level 1/2           <ul style="list-style-type: none"> <li>Initial Risk Assessment</li> <li>Comparison with similar projects</li> <li>Outline parametric pricing</li> </ul> </li> <li>Level 1/2           <ul style="list-style-type: none"> <li>Comparison with similar projects</li> <li>Parametric pricing</li> <li>Contractor Input</li> <li>Risk Assessment</li> </ul> </li> <li>Level 2/3           <ul style="list-style-type: none"> <li>Parametric Pricing using Cost Benchmarks</li> <li>Understanding of main cost drivers</li> <li>Tendering Contractor Input</li> </ul> </li> <li>Level 4           <ul style="list-style-type: none"> <li>Developed design</li> <li>Programme</li> <li>Bills of quantities</li> </ul> </li> <li>Level 4           <ul style="list-style-type: none"> <li>Some detailed design</li> <li>Detailed Programme</li> <li>Public Inquiry Scope Changes</li> <li>Bills of quantities</li> </ul> </li> <li>Actual Costs</li> </ul>					
Purpose For Estimate	<ul style="list-style-type: none"> <li>Route Selection</li> <li>Public Consultation</li> <li>Capital Funding</li> </ul>	<ul style="list-style-type: none"> <li>Commit to Procure</li> <li>Preferred Route Announcement</li> <li>TPI Entry</li> <li>Ministerial Approval</li> <li>Capital Funding</li> </ul>	<ul style="list-style-type: none"> <li>Award Contract</li> </ul>	<ul style="list-style-type: none"> <li>Agree Target Cost</li> <li>Publish Orders</li> <li>Sponsor Approval</li> <li>Public Inquiry</li> </ul>	<ul style="list-style-type: none"> <li>Commit to Construct</li> <li>Ministerial Approval</li> </ul>	<ul style="list-style-type: none"> <li>Road Open</li> <li>Contract Complete</li> </ul>
Department Accountable	Department for Transport	Department for Transport	Major Projects Highways Agency	Major Projects Highways Agency	Major Projects Highways Agency	Major Projects Highways Agency



# DIGITAL COLLABORATION (without model)

**Design Management**



**The Dartford Commitment**

**HIGHWAYS AGENCY**

**COSTAIN**

**JE JACOBS**

**mouchelparkman**

**BACHY SOLETANCHE**

**WALTERS U.K. LIMITED**

**fairfield mREC V**

**YEOMAN**

**ASSOCIATED QUALITY**

**Project Board**

**Purpose:** To improve safety and traffic flow through the Darenth Interchange

**Vision:** We're proud of our work - staying safe, reducing waste and caring for others, today and in the future

**Values/Principles and Behaviours**

**WALK THE TALK - WE WILL:**  
 Give feedback to each other  
 Share our concerns  
 Continuously measure our performance  
 Encourage communication within the team  
 Treat others as we would like to be treated

**TRUST - WE WILL:**  
 Do what we say we will do  
 Admit our mistakes  
 Keep each other informed of priorities and problems

**EXCELLENCE - WE WILL:**  
 Adopt the principles of Business Excellence and provide training  
 Adopt zero tolerance to accidents  
 We will be ambassadors for environmental stewardship

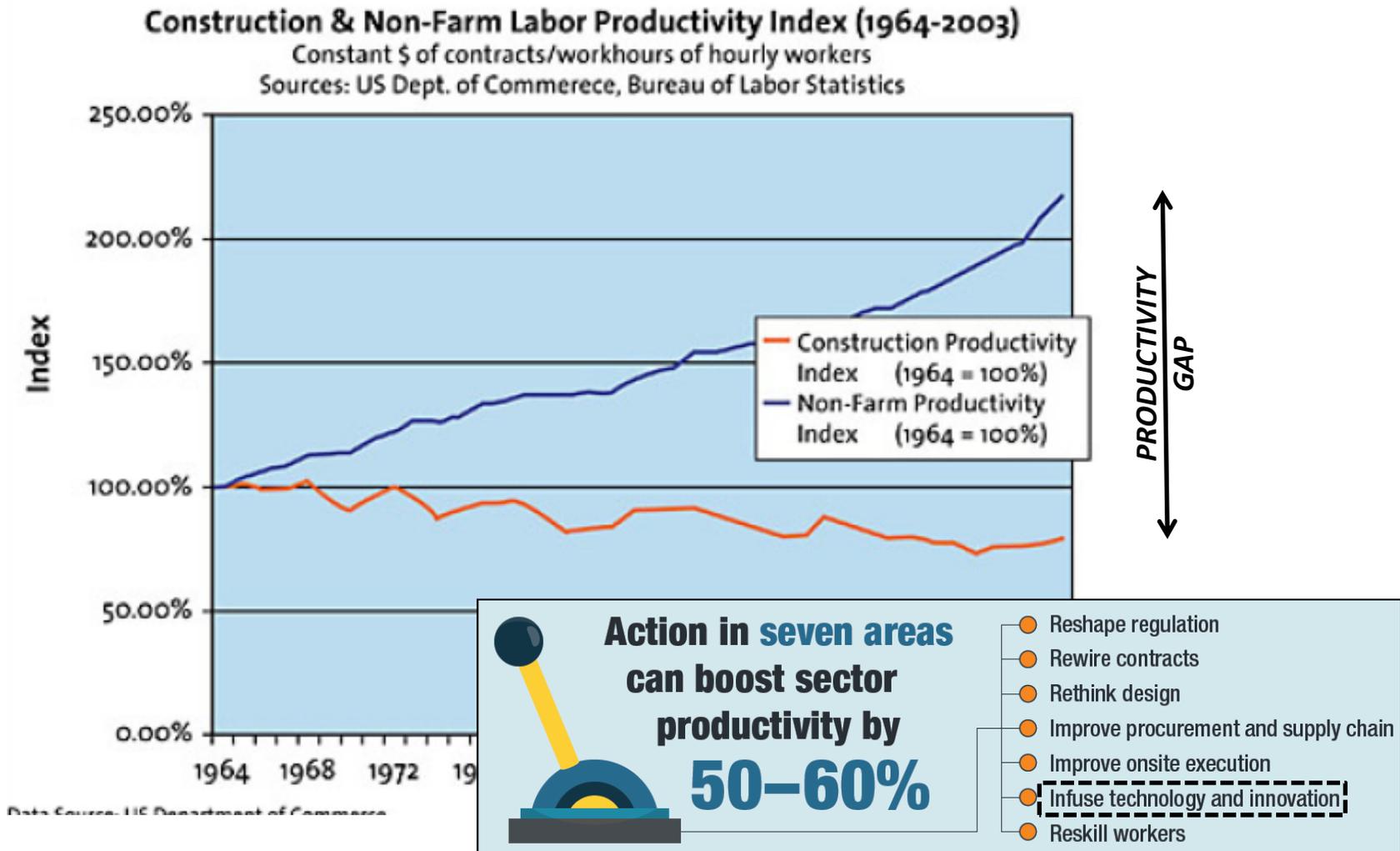
**TRANSPARENCY AND HONESTY - WE WILL:**  
 Admit mistakes and not blame  
 Proactively share information  
 Communicate with our neighbours

**RESPECT - WE WILL:**  
 Listen  
 Be punctual  
 Treat everyone equally  
 Be available and approachable  
 Be supportive of all specialisms

**UNITY - WE WILL:**  
 Encourage contributions  
 Call on anyone the Dertic  
 Talk to people, not about them  
 Refer to individuals as their roles not their organisations  
 Adopt a unified identity



# Technology – a driver of change

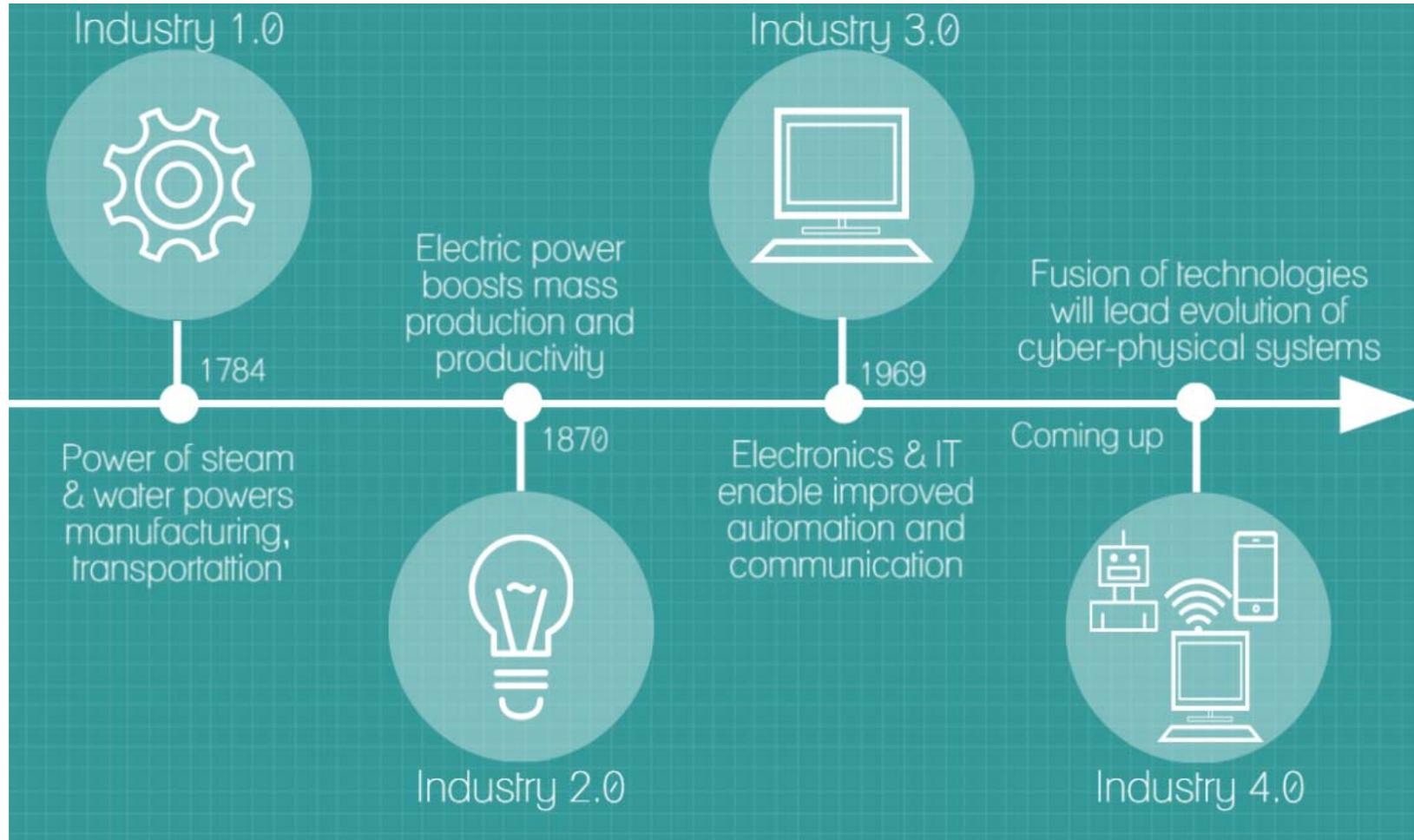


\* McKinsey 2016



## ***BIM – Why now?***

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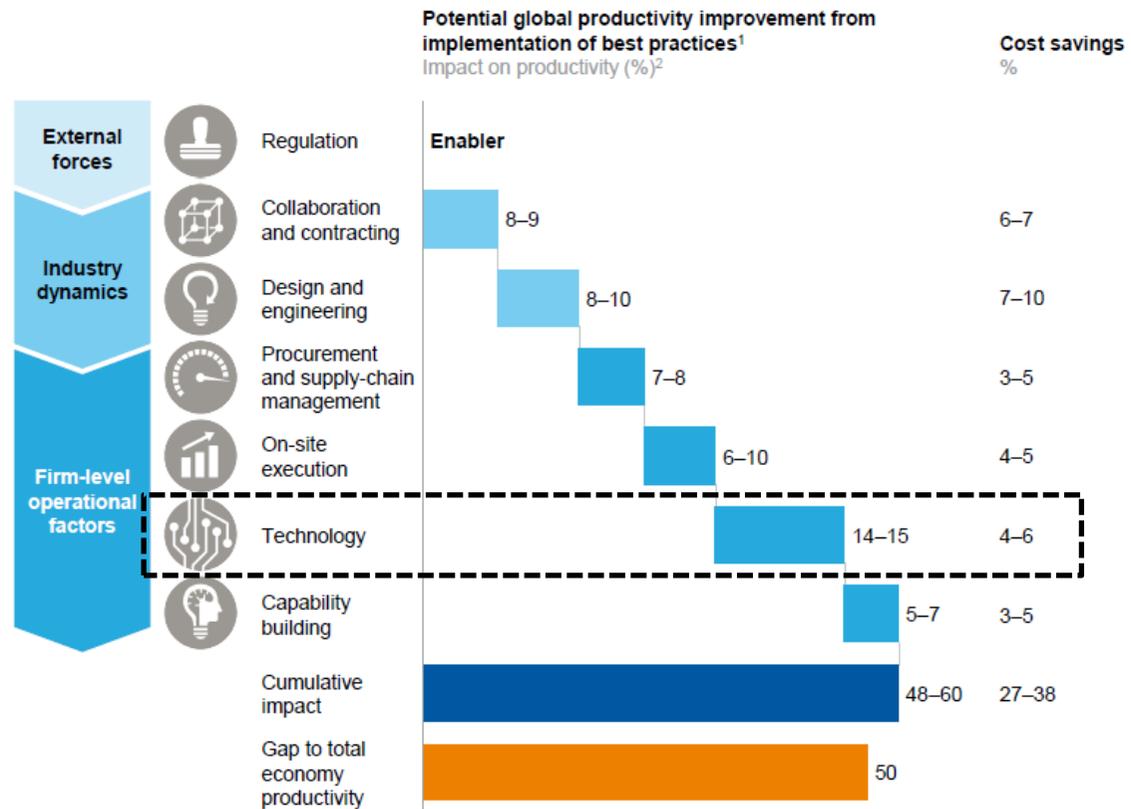
# BIM – Why now?

MCKINSEY  
GLOBAL  
INSTITUTE

Construction can catch up with total economy productivity by taking action in seven areas

Cascading effect

Regulation changes facilitate shifts in industry dynamics that enable firm-level levers and impact



<sup>1</sup> The impact numbers have been scaled down from a best case project number to reflect current levels of adoption and applicability across projects, based on respondents to the MGI Construction Productivity Survey who responded "agree" or "strongly agree" to the questions around implementation of the solutions.

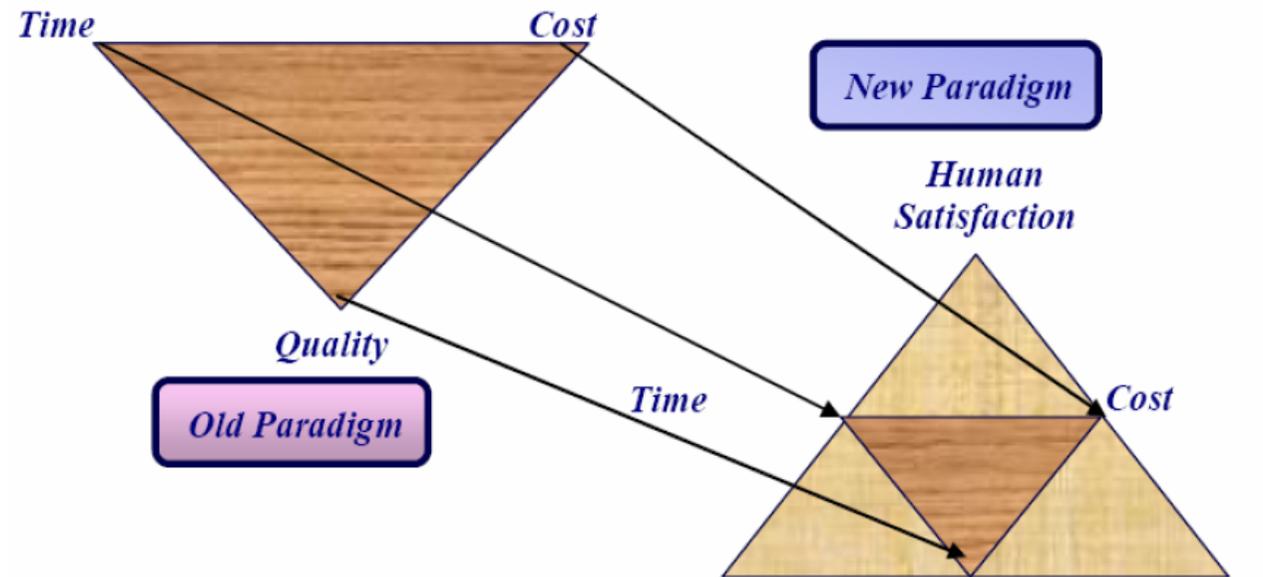
<sup>2</sup> Range reflects expected difference in impact between emerging and developed markets.

SOURCE: McKinsey Global Institute analysis



# BIM – Why now?

## Changing Paradigm – owners want more



HOW can the industry deliver the new attributes if it had trouble with the original triangle???

*Minimal Negative Environmental Impact*      *Quality*      *Safety*

- |                    |                           |
|--------------------|---------------------------|
| •Value-engineering | •Safety                   |
| •Design-build      | •IT                       |
| •Partnering        | •Productivity Improvement |
| •TQM /QFD          | •Computer Simulation      |
| •Constructability  |                           |



# ICT - enabled collaboration (BIM MODEL)



*T5 Heathrow (pilot demonstration of Single Model Environment across 25 design teams)*



## Uptake of BIM: pull and push factors

### *Pull factors*

Technologies ready and available off the shelf

Sustainable construction a priority for the EU

Expertise in BIM giving companies a competitive edge

Availability of standards to facilitate BIM use

### *Push factors*

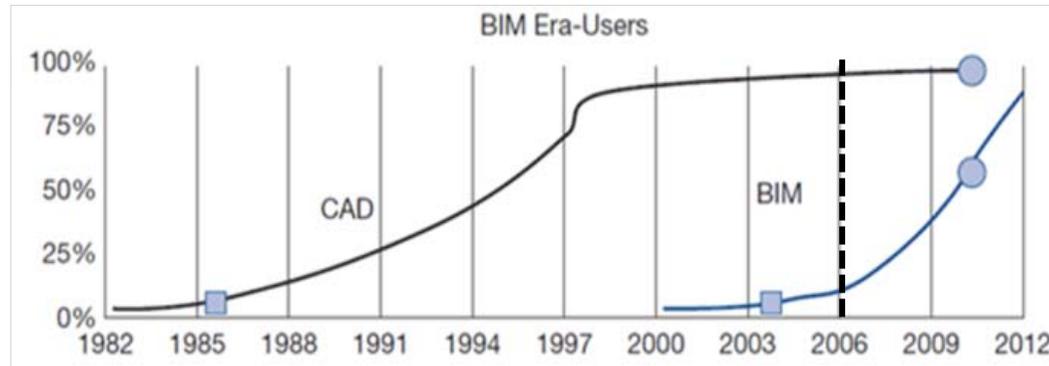
Need to improve productivity

Inefficiencies of using unstructured, non-computable information

£100 million wasted every year in UK through non-interoperable working (see p. 8)



# BIM tools (early days)



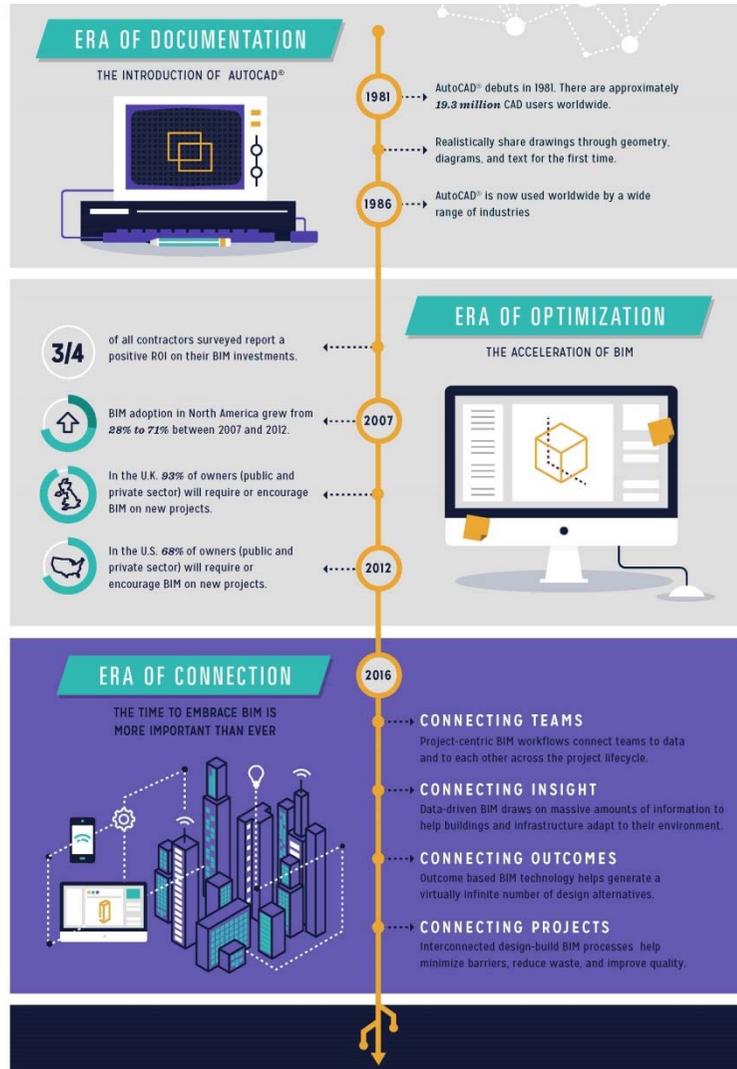
*Stakeholders liaising*

THE NEW DIMENSION IN CONSTRUCTION PROJECT MANAGEMENT

**Synchro**  
Explore options. Manage solutions.



# BIM tools (development)

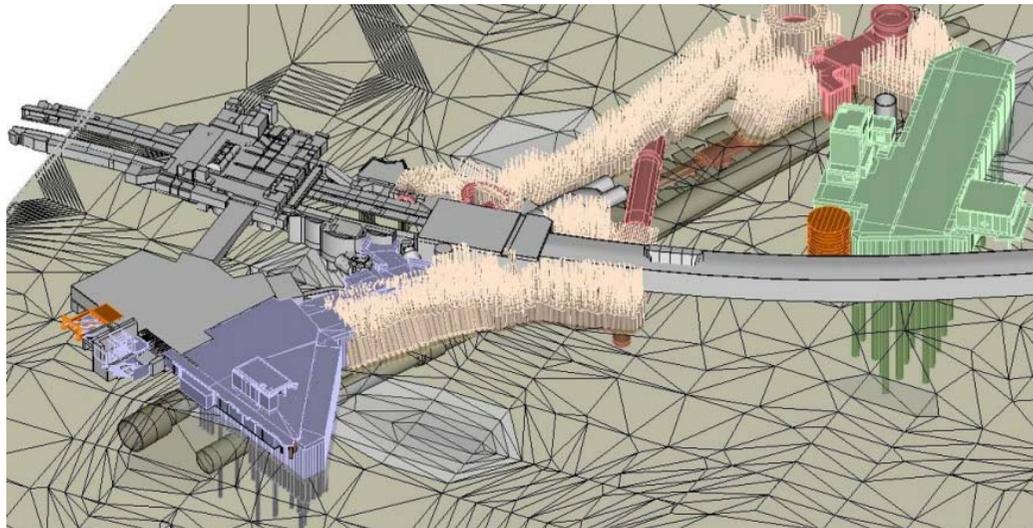
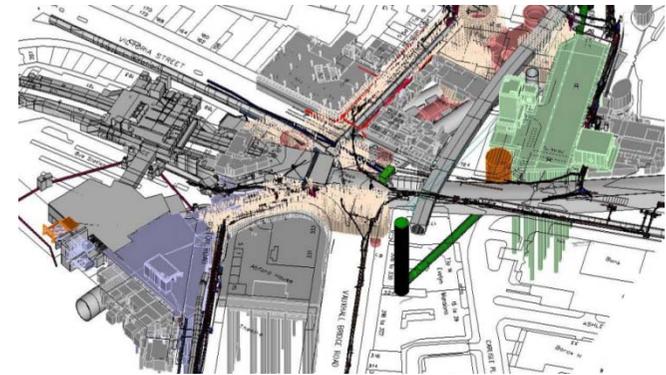
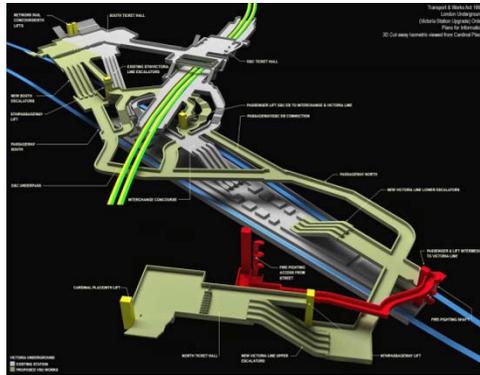


**BIM WORKFLOWS**





# 3D multidisciplinary model - development

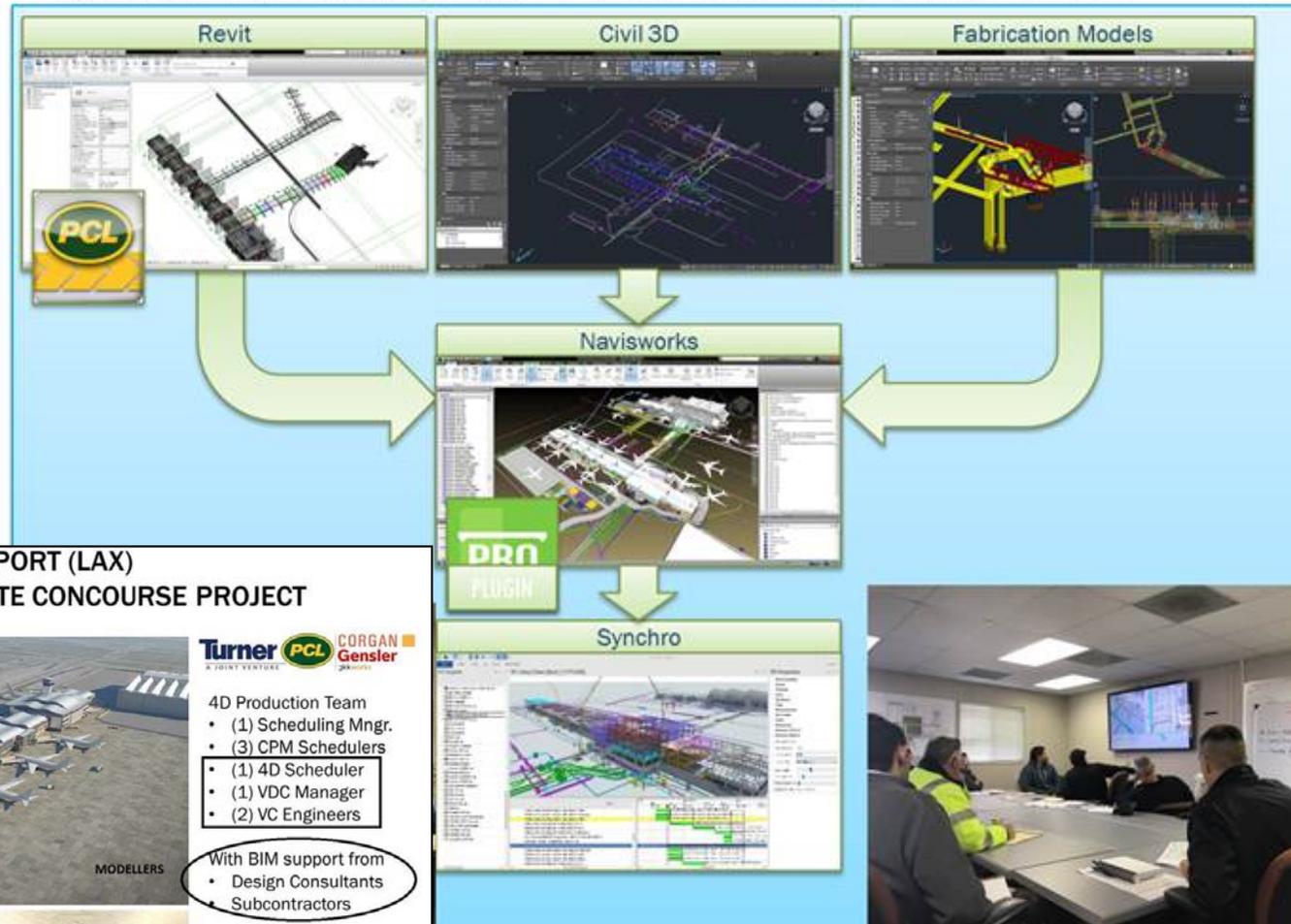


- Early collaboration
- Stakeholder engagement
- Improved quality
- Fewer coordination errors
- Potential production efficiency
- Reduced project risk
- Asset management potential



# 3D multidisciplinary model - development

## LOS ANGELES AIRPORT (LAX) MIDFIELD SATELLITE CONCOURSE PROJECT



**LOS ANGELES AIRPORT (LAX)  
MIDFIELD SATELLITE CONCOURSE PROJECT**

**Turner PCL CORGAN  
Gensler**  
A JOINT VENTURE

4D Production Team

- (1) Scheduling Mngr.
- (3) CPM Schedulers
- (1) 4D Scheduler
- (1) VDC Manager
- (2) VC Engineers

With BIM support from

- Design Consultants
- Subcontractors

MODELLERS



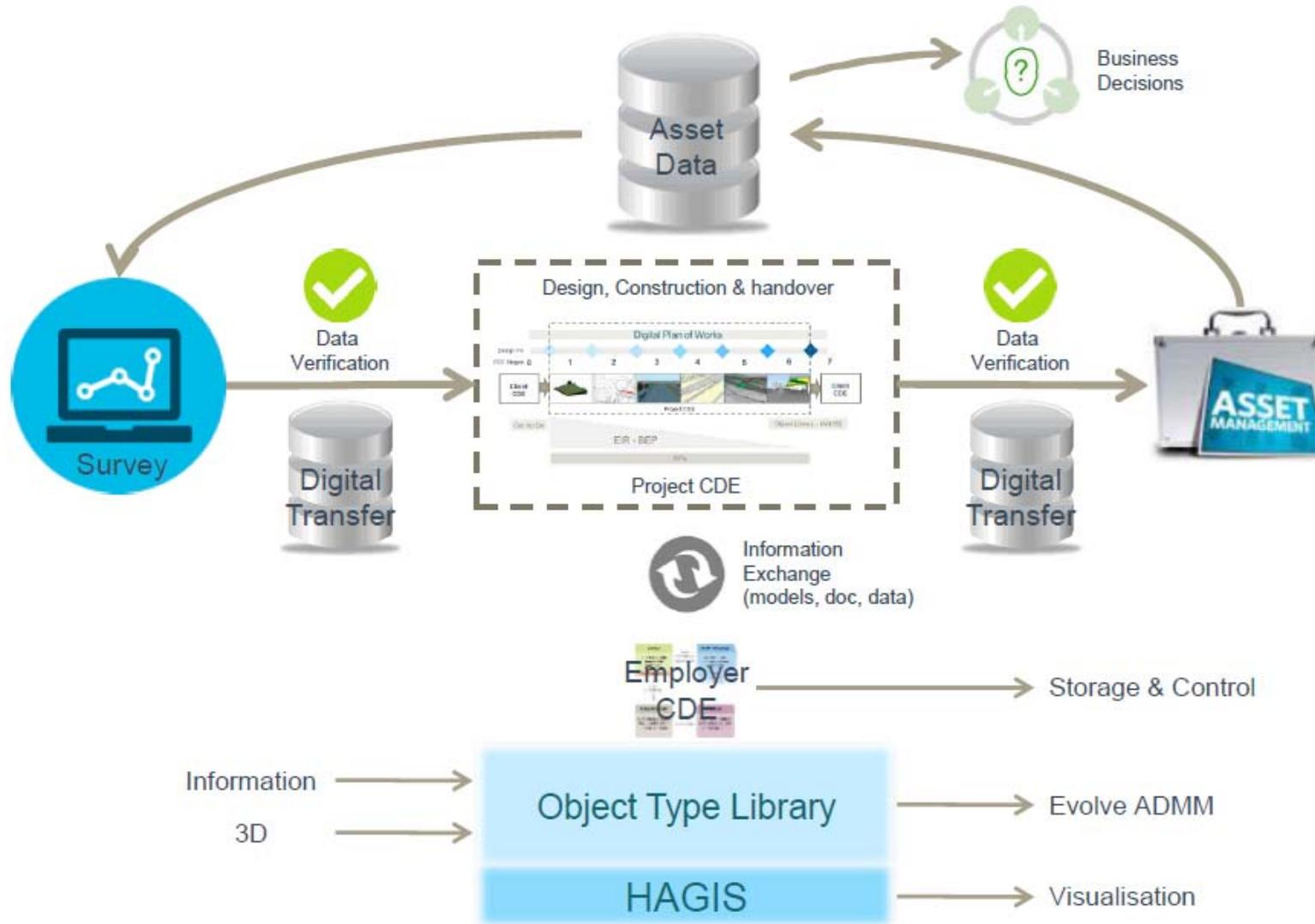
# BIM process (2017)



- **Intelligent GIS-enabled engineering model**
- **One version of truth (easily accessible information)**
- **Reduce silo working (better decision making)**
  - **Whole asset lifecycle**



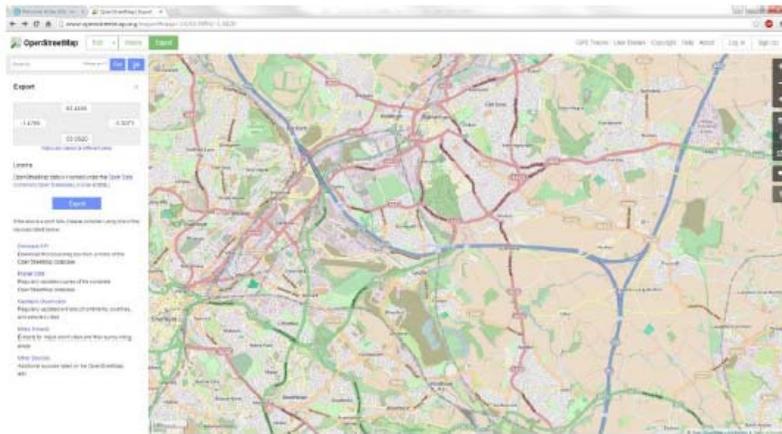
# Information Management



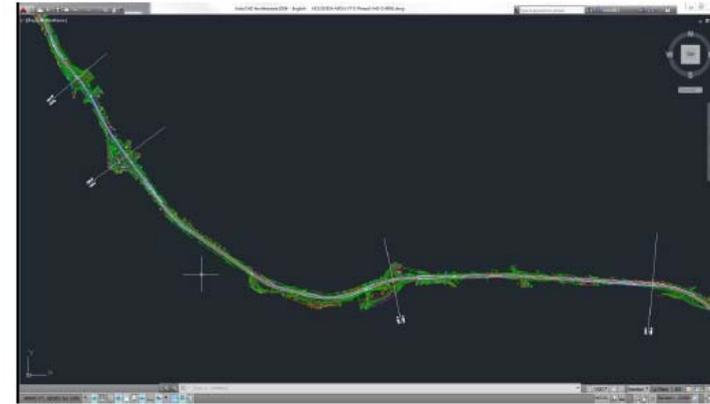


# Base model input (2017)

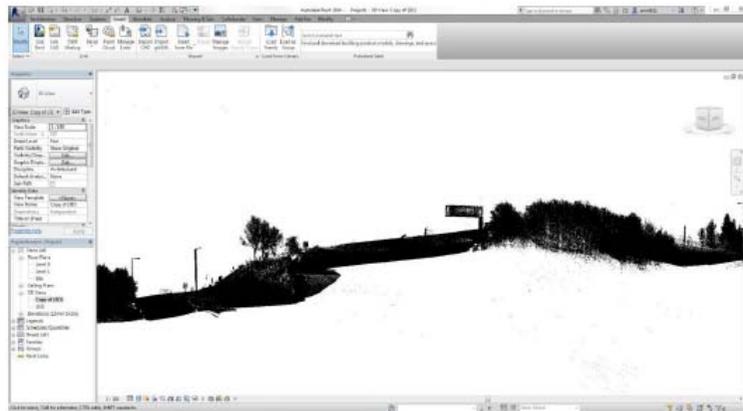
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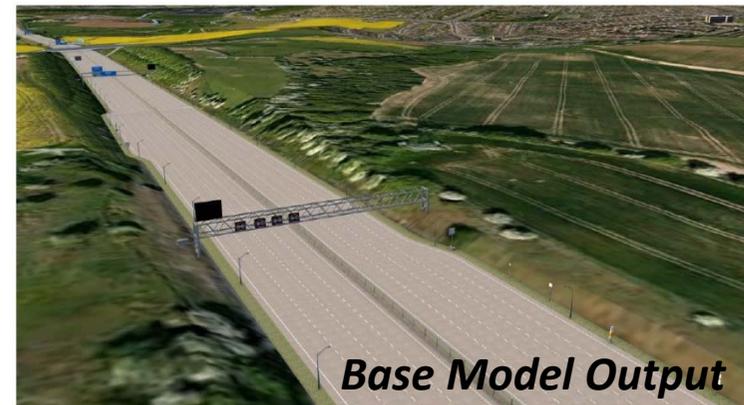
- Open Street Map Data



- LIDAR surveys



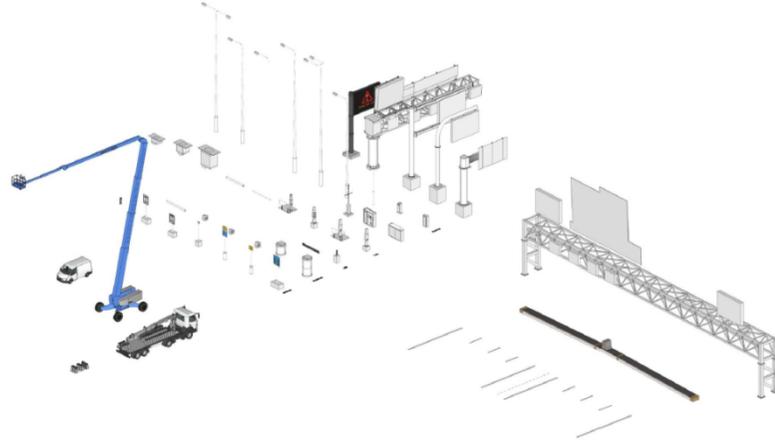
- Point cloud surveys



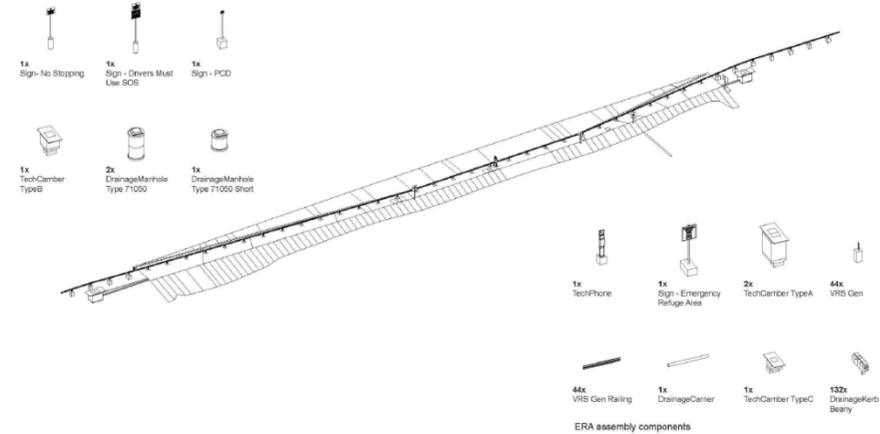


# Base model input (2017)

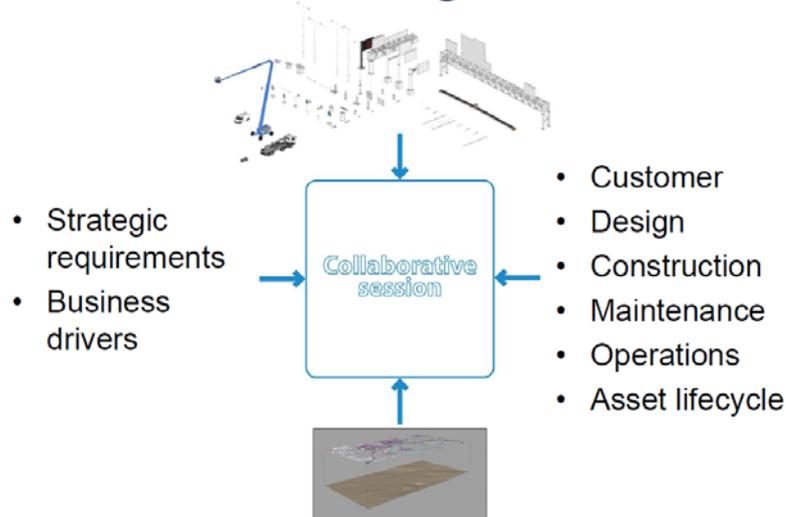
## BIM component library (Initially Smart Motorways and Expressways)



## BIM component library Assemblies



## Collaborative modelling

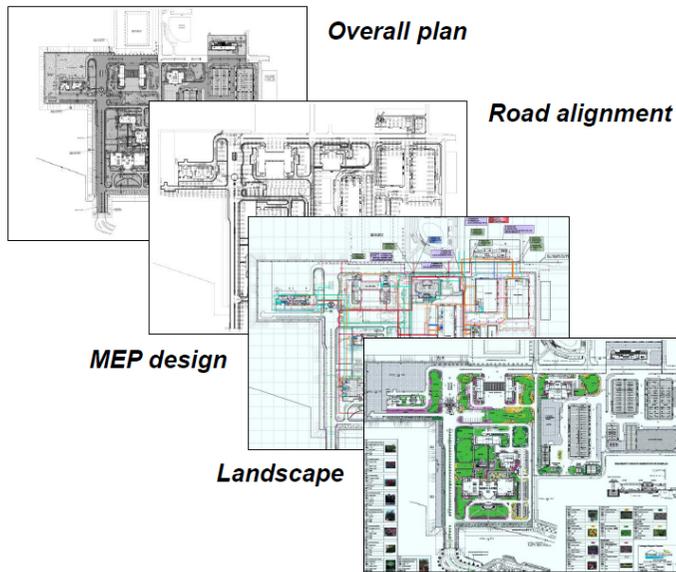


## ERA location study



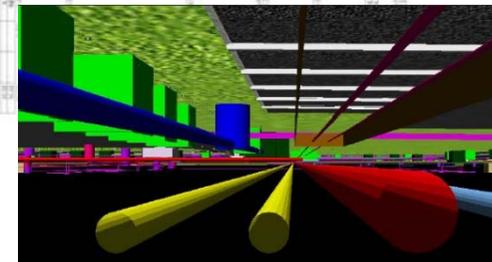
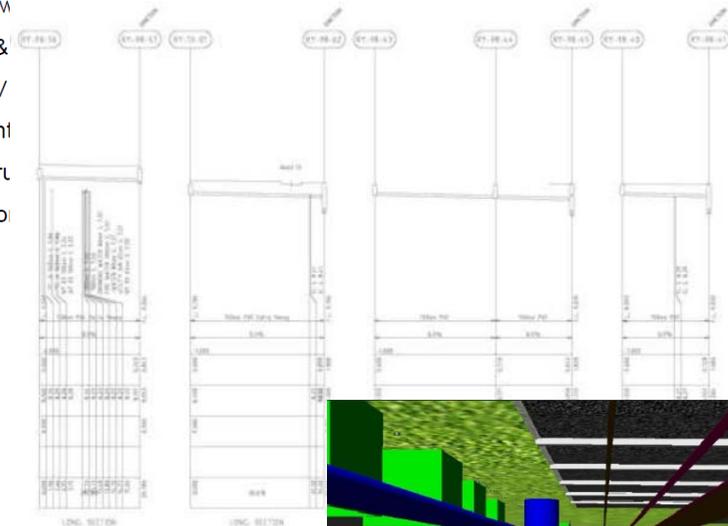


# 3D workflows – discipline collaboration



- Architect – site layout
- Civil – road alignment
- Civil - roadmarking
- Landscape Architect - plants
- Mechanical – sanitary drainage
- Mechanical – accidentally-oily drainage
- Mechanical – chilled water
- Mechanical – fire water
- Mechanical – utility service (water / air)
- Mechanical – stormw
- Eletrical – telecom &
- Eletrical – power HV
- Eletrical – street light
- Structural – misc stru
- Landscape - irrigatio

## X,Y,Z clash detection / offsets





# From design to site (work preparation)

**CLIENT**

CONCEPT DESIGN (seismic zone, nearshore marine and tropical environment conditions, local electrical regulations, client operational requirements)

NEW PORT TERMINAL SITE

Reclamation works – 2016  
Building works – 2017

Typical section through Substation enclosure

3D view of overall Substation complex

**DESIGNER**

DETAILED DESIGN (geotechnical soil model, architectural 3D model, structural analysis, steelworks and R.C. works detailing, interface co-ordination)

Rackhead gully, GIS building, RO building

**CONTRACTOR**

BIM CO-ORDINATION (co-ordination of services routing, integrating topside works & building 3D models, value engineering & constructability review)

**WORK PREP**

VIRTUAL CONSTRUCTION MODEL (execution methods and temporary works development, scaffolding design, logistics co-ordination, 4D planning)

**CONSTRUCTION**

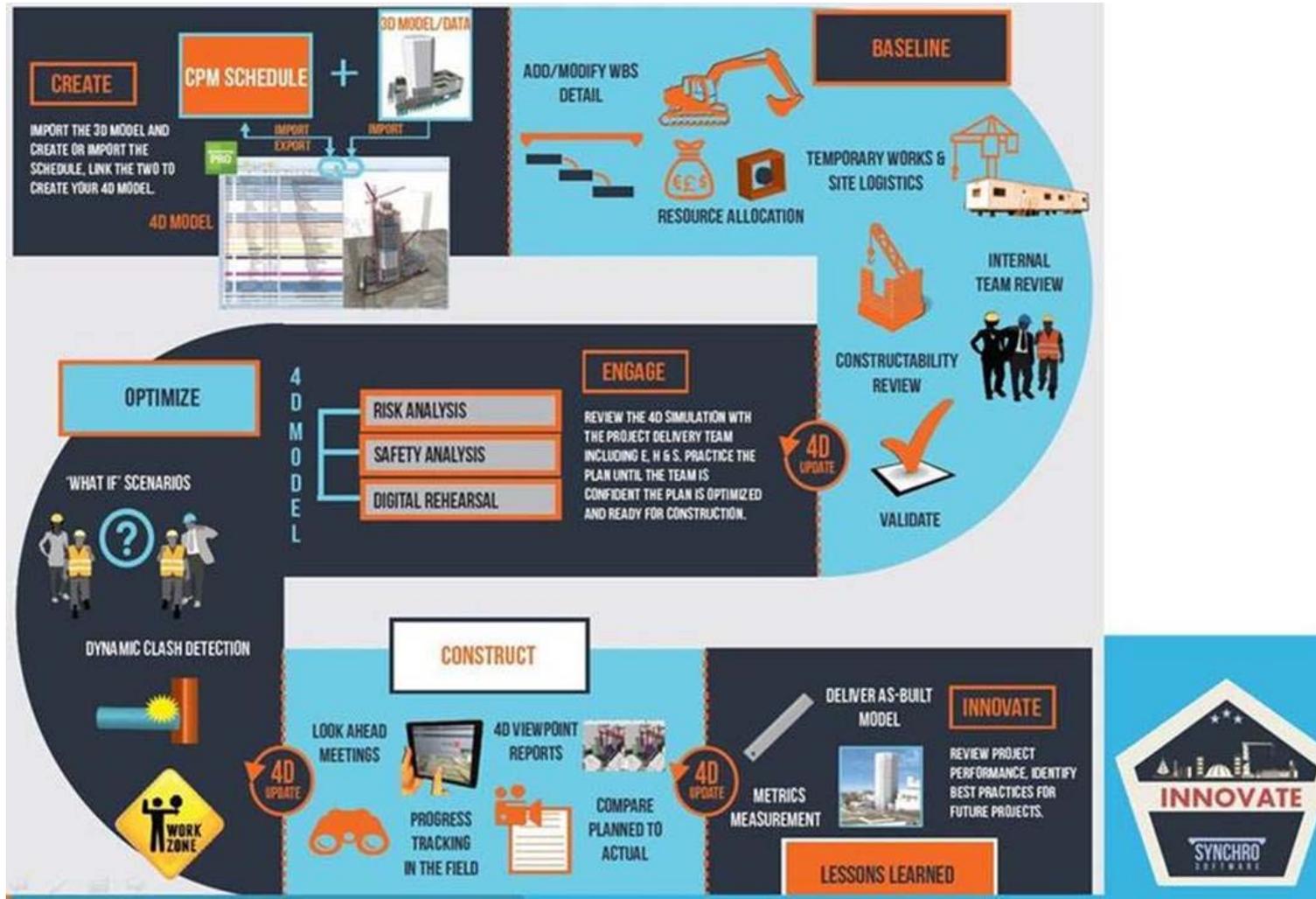
EXECUTION (location-based scheduling, drone aerial progress images, setting-out GPS model, as-built monitoring)

Area 14head, Area 14, Area 2

JANUARY 2017



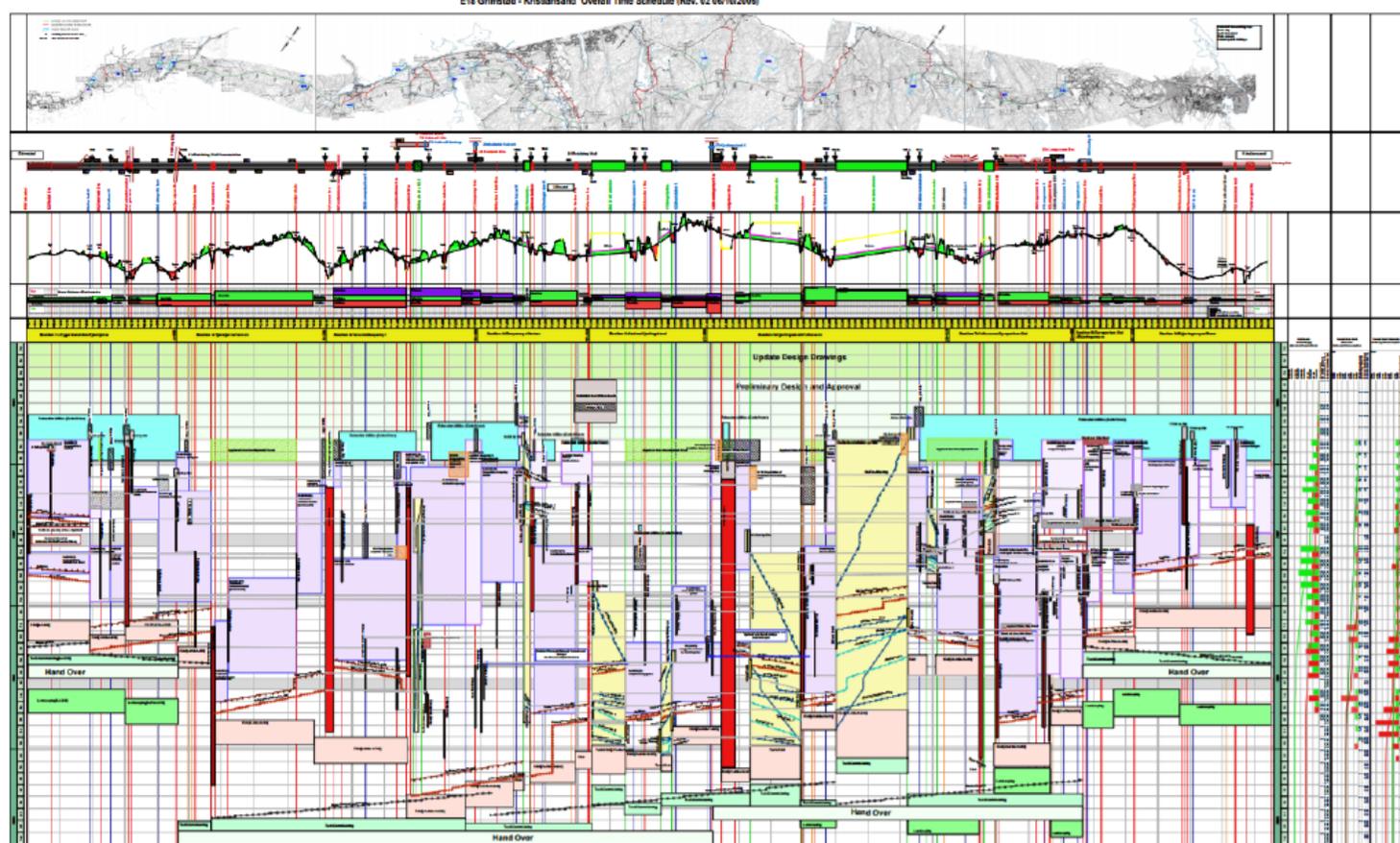
# 4D workflow





# Time-chainage diagrams

Horizontal linear construction (highways, pipelines, marine structures, bridges)





# 5D workflows – estimation

## LEGACY ESTIMATION SYSTEMS (complexity of integration and change management)

The screenshot displays a software interface for 5D BIM estimation. The top part shows a 3D perspective view of a building model with a yellow wall highlighted. Below this is a detailed table of quantities and a list of elements.

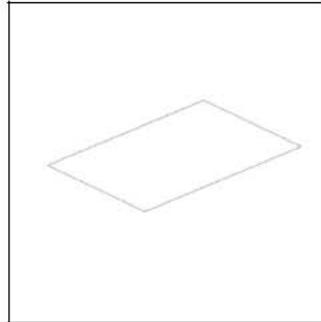
Structure	Code	Description	Quantity/Query	Quantity	UoM	Selection Set
<b>Element Planning</b>						
1.10 Walls						
1.10.10 Masonry						
1.10.10.10 Walls Sandline Brick 11.5 cm (m2)						
1.10.10.20 Walls Sandline Brick 24 cm (m3)						
1.10.20 Concrete Work						
1.10.20.10 Concrete Walls - 12" thick - 3000 psi						
1.10.20.20 Concrete Walls - including form work						
1.10.20.61 Formwork, smooth, Walls						
1.10.20.62 Concrete Steel IV S (500/550)						
1.20 Precast elements						
1.20.10 Precast Beam Type T231						
1.20.20 Precast Column Type S451						
1.20.30 Precast Column Type S452						
1.30 Slabs						
1.30.10 Formwork Slab						
1.30.20 Floor Slab - 3000 psi, 9 inches thick						
1.30.30 Floor Slab - 3000 psi, 6 inches thick						
1.30.65 Concrete Steel IV S (500/550)						
2.20 Room types						
2.20.10 Corridors						

Parameter	QuantityDetail	Length	Width	Height	Area	Piece	Value	UoM	Object	InstanceC
		2.74	7.0	3			3.807	m3	BW 2.4 Wall concrete 3	3D-Quantit
Schalungfl	2*(4.7*2.7)-(2*(2.7*0.3))						27.000	m²	BW 2.4 Wall concrete 3	3D-Quantit
	(2.7*21.9*0.3)-(1.92*1*0.3)-3*(1.92*0.86*0.3)						15.677	m³	BW 2.178 Wall concrete	3D-Quantit
Schalungfl	2*(21.9*2.7)-(1.92*1)-3*(1.92*0.86)-(2*(2.7*0.3))						106.133	m²	BW 2.178 Wall concrete	3D-Quantit
	2.74.85*0.3						3.529	m³	BW 2.15 Wall concrete	3D-Quantit
Schalungfl	2*(4.85*2.7)-(2*(2.7*0.3))						27.810	m²	BW 2.15 Wall concrete	3D-Quantit
	13.4*16.25*0.3-4*(2.12*1.01*0.3)						62.756	m³	BW 1.223 Wall concrete	3D-Quantit
Schalungfl	2*(16.25*13.4*4)-(2.12*1.01)-(2*(13.4*0.3))						426.410	m²	BW 1.223 Wall concrete	3D-Quantit
	(2.7*21.9*0.3)-9*(1.5*1.5*0.3)						11.664	m³	BW 2.173 Wall concrete	3D-Quantit
Schalungfl	2*(21.9*2.7)-9*(1.5*1.5)-(2*(2.7*0.3))						79.380	m²	BW 2.173 Wall concrete	3D-Quantit
	(13.4*16.25*0.3)-4*(2.12*1.01*0.3)						62.756	m³	BW 1.224 Wall concrete	3D-Quantit
Schalungfl	2*(16.25*13.4*4)-(2.12*1.01)-(2*(13.4*0.3))						426.410	m²	BW 1.224 Wall concrete	3D-Quantit
	(13.4*16.25*0.3)-4*(2.12*1.01*0.3)						62.756	m³	BW 1.225 Wall concrete	3D-Quantit



# 5D workflows – at what LOD?

**LOD 100**



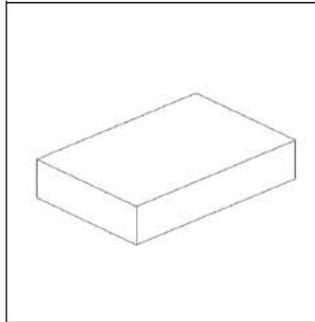
**LOD**

The foundation location is represented either by the external surface geometry (in plane) and form or by a geometric placeholder with an approximate geometry. The placeholder may be a base plate that shows the entire foundation.

**LOI**

Type  
Dimensions (approx.)

**LOD 200**



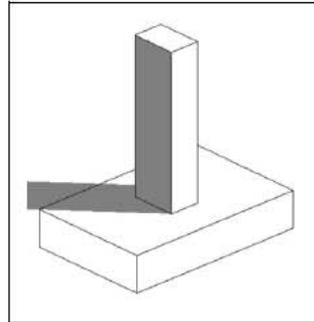
**LOD**

The foundation is represented as a generic foundation object with an approximate shape, where quantities, size, shape, location and orientation is specified.

**LOI**

Type  
Dimensions  
Elevation  
Classification  
Materials

**LOD 300**



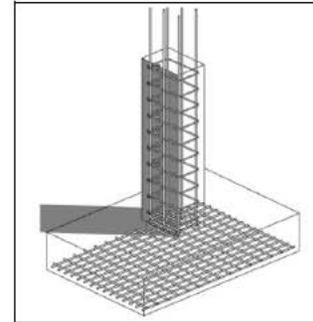
**LOD**

The foundation has real quantities, dimensions, shape and location. Moreover the orientation. Phasing plus slopes and holes plus recesses are included. Reinforcement plus building parts and connection details are clarified.

**LOI**

Type  
Dimensions  
Elevation  
Classification  
Materials  
Reinforcement degree

**LOD 350**



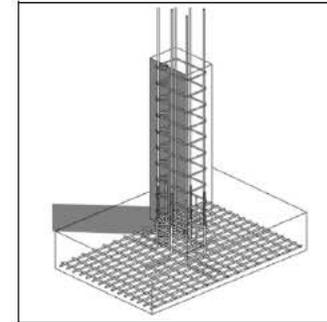
**LOD**

The foundation contains holes and recesses. Moreover, the insulation modelled.

**LOI**

Type  
Dimensions  
Elevation  
Classification  
Materials  
Reinforcement  
Concrete strength  
Environmental class  
Blinding layer  
Concrete, coarse

**LOD 400**



**LOD**

The foundation contains chamfers, location of embedded parts and main reinforcements appears in the modelle including laps and hooks.

**LOI**

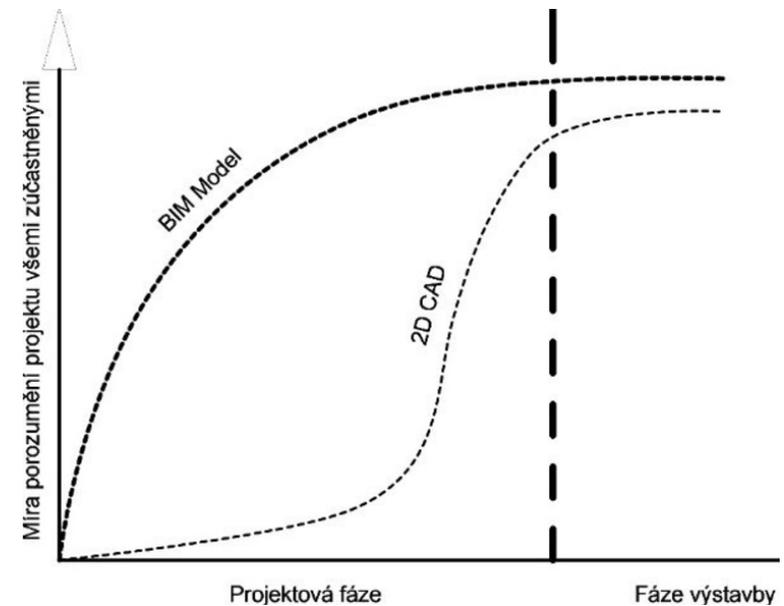
Type  
Dimensions  
Elevation  
Classification  
Materials  
Reinforcement  
Concrete strength  
Environmental class  
Blinding layer  
Concrete, coarse  
Surface Requirements / performance requirements  
elevation Tolerances  
Drying Protection



## ***BIM – Why now?***

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BIM provides insight for creating and managing projects faster, more economically, and with less environmental impact.





# 5D BIM – Disruptive technology

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