# Application of Project Controls methods in the Design & Engineering stage of major construction and infrastructure projects

Paul Waskett, Director at Adept Management





#### Content

- Introduction
- The Design and Engineering Process
- Process Definition and Planning
- Design Process Management
- Change Modelling
- Lessons



# Introduction



### **Our Services**





#### **Our Experience**



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#### Where we Trade





The Design and Engineering process





## **Design & Project Performance**



#### **Predictability Time - Design**

#### **Predictability Time - Construction**

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\* Data from UK Industry Performance Report 2019 (UK Construction KPI's)

Department for Business, Energy

- Over the last ten years in the UK across all capital projects, big and small, design & engineering work is as likely to be late as on time.\*
- The performance trend line over those 10yrs aligns with the performance of construction
- This is not unique to the UK



#### Some characteristics of the design process

- Design is an iterative process
- Driven by intangible information
- Can be highly complex
- Silo-based dispersed teams
- Usually broken into sub-problems
- Can involve many people
- Normally undertaken in stages





#### The Complexity of the Process





#### **Plan versus Reality**







#### **Plan versus Action**













427 ft skyscraper residential



40,375 sq ft industrial facility



#### **Process Definition & Planning**



### The Complexity of the Process





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#### Define

### 'Top-down' or 'bottom-up' resource allocation

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Define



#### **Streamline the Process**











#### 'Plan' the Process

Search by name	Task	ks 🗸	[Any] 🖌   1087 of 108	7 Tasks	Jan 29 30 31 0	Feb	2018	01 02 05 06 07 08 09	Mar 2018							
CIS Expansion																
▼ SCHEMATIC DESIGN PHASE																
ARCHITECTURE									Activity ID	Activity Name	Original	Actual	Remaining	Start	Finish	
DESIGN TASKS										2 C	Duration	Duration	Duration			2019 2020 Nov Dec Jan Feb Mar Apr May
Confirm required rooms preferred room		05-Eeb-18	28-Feb-18						STANDING SEAM	ROOF	1184	704	328	20-Aug-19 A	12-Mar-20	STANDING SEAM ROO
sizes and adjacencies		00 100 20	20100 20						A1311	Workshop with selected Sub-contractor to review detailing & verify requirements to be incorp	c 32	24	0	20-Aug-19 A	23-Aug-19 A	selected Sub-contractor to review detailing & verify requirement
				_					A1577	HDeM Update of Drawings to suit Sub-contractors' details & requirements - Standing Seam Ro	c 120	112	0	18-Nov-19 A	06-Dec-19 A	HDeM Update of Drawings to suit Sub-contractor
Establish preferred types & extent of	10 → 10	19-Feb-18	09-Mar-18						A1860	Sub-contractor Development of Final Construction Drawings for review & approval - Standing	5 0	264	0	21-Oct-19 A	05-Dec-19 A	3 Sub-contractor Development of Final Construction
cladding with owner				_					A2222	Release of Sub-contractor Construction Drawings - Standing Seam Roof	0	0	0		05-Dec-19 A	Release of Sub-contractor Construction Drawings
Update initial architectural site plan		05-Feb-18	23-Feb-18						A2297	Review & Approval of Sub-contractor Construction Drawings by the Novated team - Standing Se	e 40	32	0	16-Dec-19 A	20-Dec-19 A	📕 Review & Approval of Sub-contractor Constru
Ein steren 9. en erzil building beight		OF Fair 10	16 Eab 10						A2431	Review & Approval of Sub-contractor Construction Drawings by the TA team - Standing Seam Review & Approval of Sub-contractor Construction Drawings by the TA team - Standing Seam Review & Standing Seam	o 80	0	80	16-Jan-20	29-Jan-20	Review & Approval of Sub-contra
dimensions		03-FED-10	10-LED-10						A2467	Update inc comments and issue Final Sub-Contractor Construction Information to commence L	40	0	40	30-Jan-20	05-Feb-20*	📮 Update inc comments and issu
differences				_					A2537	Earliest Start On Site - Standing Seam Roof	0	0	0		12-Mar-20*	🗴 Earliest Start On Sit
Fix building grid line positions		19-Feb-18	26-Feb-18						A836	Planned Order Date - Standing Seam Roof	0	0	0		23-Aug-19 A	Date - Standing Seam Roof
Identify approximate locations of MEP		19-Feb-18	26-Feb-18						EVEL 01 LAYOUT	rs (ROOFING)	904	152	560	11-Nov-19 A	22-Apr-20	
rooms		10-100-10	20-100-20						A1732	HDeM Update of Drawings to suit Sub-contractors' details & requirements - Flat Roofing	120	112	0	18-Nov-19 A	06-Dec-19 A	HDeM Update of Drawings to suit Sub-contractor
				_					A1863	Sub-contractor Development of Final Construction Technical Submission and Typical Details for	0 0	144	0	11-Nov-19 A	05-Dec-19 A	y Sub-contractor Development of Final Construction
Define egress strategy and routes	5 → 5	19-Feb-18	07-Mar-18						A2147	Release of Sub-contractor Construction Technical Submission and Typical Details - Level 01 La	y 0	0	0		05-Dec-19 A	Release of Sub-contractor Construction Technical
Define fire egress plan	5 → 5	19-Feb-18	07-Mar-18						A2318	Review & Approval of Sub-contractor Construction Technical Submission and Typical Details b	n 80	0	80	16-Jan-20	29-Jan-20	Review & Approval of Sub-contra
	= =			_					A2447	Review & Approval of Sub-contractor Construction Technical Submission and Typical Details b	n 80	0	80	30-Jan-20	12-Feb-20	Review & Approval of Sub-co
Define fire compartmentation zones	5 → 5	01-Mar-18	07-Mar-18						A2476	Update inc comments and issue Final Sub-Contractor Construction Information to commence L	40	0	40	13-Feb-20	19-Feb-20	📮 Update inc comments and
Agree locations of fire / plumbing chase	5 → 5	19-Feb-18	07-Mar-18						A2541	Earliest Start On Site - Level 01 Layouts (Roofing)	0	0	0		22-Apr-20*	💲 Earliest
walls & approximate thicknesses									LEVEL 2&3 LAYO	UTS (ROOFING)	480	184	296	16-Dec-19 A	06-Mar-20	LEVEL 2&3 LAYOUTS (R
Estimate and all and the of an include		00 F-1-40	00.1440						A1819	Sub-contractor Development of Technical Submission and Typical Details for review & approve	a 48	40	0	16-Dec-19 A	23-Dec-19 A	Sub-contractor Development of Technical Su
Estimate space allocation of major plant	5 - 5	26-FED-18	08-Mar-18						- A2266	Release of Sub-contractor Construction Technical Submission and Typical Details - Level 2&3 L	.i 0	0	0		23-Dec-19 A	🗴 Release of Sub-contractor Construction Tech
				_					A2329	Review & Approval of Sub-contractor Construction Technical Submission and Typical Details b	n 80	64	16	06-Jan-20 A	17-Jan-20	Review & Approval of Sub-contracto
Agree space allocation of major plant	5 → 5	26-Feb-18	08-Mar-18						A2437	Review & Approval of Sub-contractor Construction Technical Submission and Typical Details b	n 80	0	80	20-Jan-20	31-Jan-20	Review & Approval of Sub-contra
spaces									A2465	Update inc comments and issue Final Sub-Contractor Construction Information to commence L	40	0	40	03-Feb-20	07-Feb-20	Update inc comments and issu
Locate and size fire stairs		26-Feb-18	26-Feb-18						A2551	Earliest Start On Site - Level 2&3 Layouts (Roofing)	0	0	0		06-Mar-20*	🕏 Earliest Start On Site -
									CORE 3 (ROOFING	s)	544	40	360	16-Dec-19 A	18-Mar-20	CORE 3 (ROOFING)
Produce typical document set for	5 → 5	09-Mar-18	15-Mar-18	Ŧ					A1961	Sub-contractor Development of Final Construction Technical Details for review & approval - Co	o 48	40	0	16-Dec-19 A	23-Dec-19 A	Sub-contractor Development of Final Constru
									A2103	Release of Sub-contractor Construction Technical Details - Core 3 (Roofing)	0	0	0		16-Jan-20	Release of Sub-contractor Construction

A2344

A2420

A2506

Review & Approval of Sub-contractor Construction Technical Details by the Novated team - Core 80

Review & Approval of Sub-contractor Construction Technical Details by the TA team - Core 3 (Rc 80

Update inc comments and issue Final Sub-Contractor Construction Information to commence Li 40



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16-Jan-20

30-Jan-20

13-Feb-20

29-Jan-20

12-Feb-20

19-Feb-20

Review & Approval of Sub-contract

Review & Approval of Sub-cont

Update ind comments and is

0000 0000 0000

#### **Resource allocation plan**

Architecture + 1 Head of Department Director of Design QC Design Project Manager Kirk Van Cleave Stephanie Welch Stacy Strand Bernie Boesch Bernie Test Assistant Design Project Manager Project Architect Senior Job Captain Design Job Captain Senior Design Project Coordinator Design Project Coordinator Design Technical Coordinator Design Intern Design QC Administrator Field Operation **Civil Engineer** Processing System Waste Treatment Geosynthetic Liner Structural Engineer Mechanical/Plumbing ъ I Electrical Engineer - E Fire Protection Design Pursuits



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#### **Design Process Management**



### **Deliver: Progress & Issues**

	Current Period	Ending: 6 days tim	^	Particul	0-00 Pl-4-0 0-	Constrained 5	Started at Risk 2 Finished at Ris	
			Reason For D	Delay		8		
	Progress		Produce General A	rrangements, Schedules & Det	ail Drawings for Sig	nage (Levels		
	XXX	Define egress strate	15-42)				Late Ready	1
			Туре	Awaiting Client Decision	~		Started At Risk	
	XXX	Agree locations of t thicknesses	Description	Client yet to issue brief on sig	gnage	5	Late Ready	0
		-SCHEMATIC DESIGN PH	Reported On	01-Jul-20				
SS	XXX					s		
ě			Action	Client to issue signage brief				
rog			Assign To	Moda		5		0
Δ.	XXX		Due On	10-Jul-20	<b>**</b>	is		0
			Notes					
	XXX							0
	XXX	Schematic modellin SCHEMATIC DESIGN PH	Save Cancel	LEING TADIO DIAD ERGE MORREELING	o uays unic	การบูเธรรณ จายสูงจายทร	Constrained	0





#### **Deliver: Performance & Forecast**



Deliver

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#### **Deliver: Actions & Control**

	Action	Status 🛧	Action Owned By	Relates To	Issue Raised By
Ø	Don to issue NTP	21-Nov-19 Closed: 22-Nov-19	Don Rogers -Field Operation	Resource Not Available: RQ waiting on PEMB builder responses for negotiations Issue in Appoint PEMB System Specialist	Bernie Boesch -Architecture-Design Project Manager
	Cody to finish field investigation Gov't issued letter that Range Access Road to be per RFP making this a mute point	27-Nov-19 Closed: 27-Nov-19	Cody Phillips -Field Operation	Programme Priorities Changed Or Incorrect: reviewed and requested at CDW Issue in Start Site Investigations	Bernie Boesch -Architecture-Design Project Manager
ð	RQ to setup a meeting with SS&A	27-Nov-19 Closed: 29-Nov-19	Bernie Boesch -Architecture-Design Project Manager	Awaiting Design Information: waste oil system selection Issue in MEP Development of Model & Documents for DD	Bernie Boesch -Architecture-Design Project Manager
<b>₽</b>	Machinex to provide floor drain location for system sorting machine	27-Nov-19 Closed: 27-Nov-19	Simon-Pierre (SP Therrien -Processing System	Awaiting Design Information: Floor Drain and Roll-Up gate at system sorting machine Issue in Ongoing Development of Architectural Model & Documents for DD	Bernie Boesch -Architecture-Design Project Manager
Ø	SCS to provide response if septic tank can handle high water temperature and/or disinfection chemicals Bob noted that is should be able to handle 170+ degrees, but not chlorine shall be used, Ken to confirm	02-Dec-19 Closed: 02-Dec-19	KA Ken Armentrout	Awaiting Design Information: septic tank disinfection protocol Issue in MEP Development of Model & Documents for DD	Bernie Boesch -Architecture-Design Project Manager
<b>₽</b>	Move Range Access Road from Critical Path 1 to Design Path 2	05-Dec-19 Closed: 02-Dec-19	Bernie Boesch -Architecture-Design Project Manager	P160 Solid Waste Facility Plan in Period: 24-Aug-20 to 31-Aug-20	None
<b>₽</b>	MBI to provide hot water demand for Ponds RQ to coor. meeting with MBI and SS&A (mech and elect)	06-Dec-19 Closed: 03-Jan-20	Joel Bowdan -Waste Treatment	Awaiting Design Information: Heating Hot Water Demand Issue in MEP Development of Model & Documents for DD	Bernie Boesch -Architecture-Design Project Manager
<i>₽</i>	Rick Perry to review and coor meeting between RQ an SS&A	06-Dec-19 Closed: 27-Dec-19	RP Rick Perry -Field Operation	Awaiting Design Information: Mech BOD and system selection Issue in MEP Development of Model & Documents for DD	Bernie Boesch -Architecture-Design Project Manager
Ø	RQ to setup meeting with coffman to discuss	06-Dec-19 Closed: 10-Dec-19	Bernie Boesch -Architecture-Desig Project Manager	Awaiting Design Information: RQ and Coffman to review items stored and potential RFI itmes	Bernie Boesch -Architecture-Design Project Manager



#### **Deliver: Actions & Control**

- Design Team Meetings:
  - Issues & Problems
  - Actions
  - Responsibilities & Deadlines
  - Commitments
  - Action Closure









#### **Progressed schedule**

Search by name	Tacke	✓ [Anv]    182 of 182 Tacks						Jan	2020											Feb	2020				
Search by home in	10383		16	5 17	20	21	22 23	3 23	24 2	28	29	30 3	1 04	05	06 07	10	11	12 1	13 14	17	18	19 20	21	24 2	j 1
RQ Validate Team Responses →	23-Jan-20	23-Jan-20							_	_															
Critical Path Package #1 Pre-Final Design Package Review Meeting with the Government →	24-Jan-20	24-Jan-20							]	_	_														
▼ CRITICAL PATH PACKAGE #1 FINAL DESIGN FOR CONSTRUCTION																									
CRITICAL PATH PACKAGE #1 FINAL DESIGN FOR CONSTRUCTION & PREPARE	DOCS																								
Ongoing coordination of the Critical Path Package #1 with Pre-final Package $\rightarrow$ Development	23-Jan-20	24-Jan-20							7																
Finalize Critical Path Package #1 Design for Final Design Submission	03-Feb-20	06-Feb-20										4			+		4								
Finalize the Critical Path Package #1 Specifications	03-Feb-20	06-Feb-20										4			-		4	_							
<ul> <li>FINAL CIVIL DESIGN FOR CONSTRUCTION REVIEWS</li> </ul>																									
Issue the Final Critical Path Package #1 Design Documents to RQ for DQC Review $\longrightarrow$		06-Feb-20	1												•		4	->							
Issue the Final Critical Path Package #1 Design Specs & BOD to RQ for DQC Review $\longrightarrow$		06-Feb-20	I												•	-	4	-0							
Compile the Final Critical Path Package #1 Design Documents for DQC Review	07-Feb-20	07-Feb-20													4										-
RQ DQC Review of the Final Critical Path Package #1 Design Docs	07-Feb-20	12-Feb-20													4			-		4	_				
Issue the Final Critical Path Package #1 Design DQC Review Comments to Consultants $ ightarrow  ig$		12-Feb-20																		4	-0				
Design Team Revise / Update the Final Critical Path Package #1 Design Documents	13-Feb-20	18-Feb-20																4					4	=	
Issue the Updated Final Critical Path Package #1 Design Documents to RQ for Printing $ ightarrow  $		18-Feb-20																					4	$\diamond$	
RQ Back-check / Package / Print the Final Critical Path Package #1 Design Docs	19-Feb-20	24-Feb-20																			4			1	
Submit the Final Critical Path Package #1 Design Package to the Government $\mathbb{F} \to \mathbb{F}$		24-Feb-20																						l 🖕	

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#### **Resource allocation profile inc. time booked**



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# Change Modelling



# Change Control Wizard

₫	X 0) ? & < # > D H C - + + < < B Q & 1 D >	
4	WBS > CONCEPT > MEPFP DESIGN > SURVEYS	
	check Tasks V [All] V Horizen Tasks	View in schedule
	BIM Process Building Project Demo     CONCEPT     MEPFP DESIGN     SURVEYS     Check information on existence & extent of public utilities     Check information on any existing services     MEPFP DESIGN     GENERAL ACTIVITIES     GENERAL ACTIVITIES     DETAILLING     Z Final check on size and location of penetrations for MEPFP services     CONTRACTOR ORDERS     G Compile Quotations Into Cost Check	<ul> <li>Check information on any existing services CONCEPT→MEPPP DESIGN→SURVEYS Primary Resource: Mechanical Engineer OBS Activity: 0 days remaining Calendar: [Default Calendar]</li> <li>Start: 10-May-21, Finish: 12-May-21</li> <li>✓</li> <li>✓</li> <li>✓</li> <li>Predecessors (0)</li> <li>✓</li> <li>Successors (2)</li> </ul>
~		✓ The prepare Concept Design Submittal Start: 17-Jun-21, Finish: 23-Jun-21
		CONCEPT¬CONCEPT DOCUMENTATION Design Process Manager
(II) (O)		FS     FS     Produce report on any existing services installations (if     Start: 19-May-21, Finish: 21-May-21     necessary)     CONCEPT-MEPFP DESIGN~SURVEYS
0		
~~		Actions [0]
		Issues [0]
		Allocations [0]
		Codings [0]
		Comments [0]
BIM F	rocess Building Project Demo, 541 Tasks, 1806 Links	Ready.



#### Indicate any Rework

Change Control Wizard - Step 1		8
Check information on any existing services ¬CONCEPT¬MEPFP DESIGN¬SURVEYS	0 of 3 day	/5



#### **Further Potential Rework is Identified**

Check information on any existing services         acCONCEPT¬MEPFP DESIGN¬SURVEYS         Prepare Concept Design Submittal         acCONCEPT¬CONCEPT DOCUMENTATION         O       c 5 days         Oroduce report on any existing services installations (if necessary)
Check information on any existing services       1       I       of 3 days         CONCEPT¬MEPFP DESIGN¬SURVEYS       0       c 5 days         Operate Concept Design Submittal       0       c 5 days         Operation on any existing services installations (if necessary)       0       c 3 days
Prepare Concept Design Submittal     0     c 5 days       CONCEPT¬CONCEPT DOCUMENTATION     0     c 5 days       Produce report on any existing services installations (if necessary)     0     c 3 days
roduce report on any existing services installations (if necessary)
¬CONCEPT¬MEPFP DESIGN¬SURVEYS



#### **Confirm All Required Rework**

Change Control Wizard - Step 1 Check information on any existing services of 3 days ¬CONCEPT¬MEPFP DESIGN¬SURVEYS Prepare Concept Design Submittal 5 days ¬CONCEPT¬CONCEPT DOCUMENTATION Produce report on any existing services installations (if necessary) 3 days 2 ¬CONCEPT¬MEPFP DESIGN¬SURVEYS Review & Comment on Concept Design 10 days ¬CONCEPT¬CONCEPT DOCUMENTATION Fix site / building footprint dimensions and building positions 3 days 3 ¬PRELIMINARY DESIGN ¬ARCHITECTURE ¬GENERAL ACTIVITIES ¬KEY DECISIONS Finalize room dimensions & layout 5 days ¬DETAILED DESIGN¬ARCHITECTURE¬GENERAL ACTIVITIES¬KEY DECISIONS



#### Name the Change; Identify the Rework Start Date

Change C	Control Wizard - St	ep 2	8
Name	Further surveys to establis	h buried cable position	ns
Starting	26-Jul-21		
Apply	lose		



#### **Re-work Activities embedded into Schedule**

₫	🔀 O > ? 🗞 < 🏟 > O H C 🛞 Default View 🗸 🖨 Auto Zoom 🕥	<b>1</b> 2
#	26-Jul-21 05-Aug-21	
"C	Change Tasks 💙 [All] 🗸	7 of 548 Task
	Name         Progress Icons         Baseline         Baseline         Baseline         Start         Finish         Image: Constraint of the start of the	09 10
t3	▼ CONCEPT ▼ MEPFP DESIGN	
0	SURVEYS Starting Change: Further surveys to establish buried cable positions     A 26-Jul-21 26-Jul-21	
ŧ	Check information on any existing services - Change: Further surveys to establish buried     1 → 1     26-Jul-21     26-Jul-21	
ì	Produce report on any existing services installations (if necessary) - Change: Further 2 → 2 27-Jul-21 28-Jul-21 28-Jul-21	
۲	← CONCEPT DOCUMENTATION	
٢	Prepare Concept Design Submittal - Change: Further surveys to establish buried cable 1 - 1 29-Jul-21 29-Jul-21	
	Review & Comment on Concept Design - Change: Further surveys to establish buried 1 -> 1 30-Jul-21 30-Jul-21	
o O		
~	GENERAL ACTIVITIES     GENERAL ACTIVITIES     GENERAL ACTIVITIES	
Ô	KET DECISIONS     Fix site / building footprint dimensions and building positions - Change: Further surveys 3 → 3 02-Aug-21 04-Aug-21 to establish buried cable positions	
۲	✓ DETAILED DESIGN	
2		
	KEY DECISIONS  Finalize room dimensions & layout - Change: Further surveys to establish buried cable     1 → 1 05-Aug-21 05-Aug-21 positions	
3IM P	Irocess Building Project Demo, 7 Tasks Ready.	é

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#### Summary & Lessons



#### **Predictability Time - Design**

#### **SAVING TIME**

- Improved predictability of project schedule
- Removal of turbulence from complex project process
- Agile decision-making to minimise delays in delivery
- Improved co-ordination of outputs reducing rework cycles
- Schedule savings through the integration of suppliers into the process

#### SAVING MONEY

- Improved cost certainty throughout the project lifecycle
- Control of design and engineering fees
- Control and mitigation of risks and change events
- Savings in delivery as a result of co-ordinated processes and information
- Operational benefits through the early completion of projects

Project C



dictability Time - Construction





#### **Project Performance**



# flow

#### **Benefit versus Effort**





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