

# LEAN DESIGN MANAGEMENT IN A MAJOR INFRASTRUCTURE PROJECT IN UK

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# Introduction

- Design management has been left to improvisation:  
(Freire and Alarcon 2002)
  - Poor communication among stakeholders
  - Incomplete documentation for the subsequent process
  - Unclear input information
  - Poorly levelled resources
  - Unbalanced workloads
  - Lack of coordination between different disciplines
  - Erratic decision making
- Lean process, tools and methods have been developed for the design management to improve these deficiencies  
(Ballard and Koskela 1998), (Freire et al. 2002), (Koskela et al. 1997)
  - Design Structure Matrix (DSM)
  - Last Planner System (LPS)

# Introduction

- This paper presents:
  - A case study of lean design management implementation in a major infrastructure project in the UK
  - 2 phases:
    - In phase 1 - Collaborative Planning with LPS
    - In phase 2 - DSM incorporated into the Gives & Gets tool, supported by a control room.
- Identify the main benefits of implementing lean design management into a major infrastructure project, its limitations and room for improvement.
- The main contribution of this paper is the contextualisation of two different project organisational structures and its influence on the success of the LDM tools implementation

# Literature Review

- Design Management
  - The design process in the AEC industry is known for being problematic: High levels of rework, change orders, delays and un-constructible solutions for construction (Emmitt et al. 2004), (Macomber et al. 2012).
  - In an AEC project, design management is a challenging effort that must deal with increasing architectural complexity, a high number of interdependencies, uncertainty, and erratic decision-making by authorities and clients (Koskela et al. 1997).
  - In construction projects is often carried out under time pressure which requires a proper planning and control system, with a focus on information flow among participants (Tzortzopoulos et al. 2001)
- Lean Design Management (LDM) is a response from the lean construction community to overcome the chaotic design process.
  - It is rooted in the Transformation, Flow and Value (TFV) Theory (Koskela 2000),
    - it considers the design as a production process (Ballard 2002; Ballard and Koskela 1998).
  - A set of tools and methods is recommended to facilitate design management and enhance transparency
    - The Design Structure Matrix (DSM) and the Last Planner System (LPS) have been deployed in lean design management with some success (Koskela et al. 1997).

# Literature Review

## Last Planner System in Design

- LPS in design promotes process transparency, designers' collaboration and communication, and the use of project performance measurement. (Biotto 2018)
- LPS requires more flexibility and adaptation to the design context (Hamzeh et al. 2009), (Bolviken et al. 2010; Tiwari and Sarathy 2012)
  - High amount of change orders or delays in the clients' decisions,
  - Difficulties in the lookahead plan, analysing the root causes, and planning the design activities (Biotto 2018)
- In the UK, the partial use of LPS is known as Collaborative Planning Limited to a few elements of the LPS - Use in the design is scarce (Daniel et al. 2017)

## Design Structure Matrix

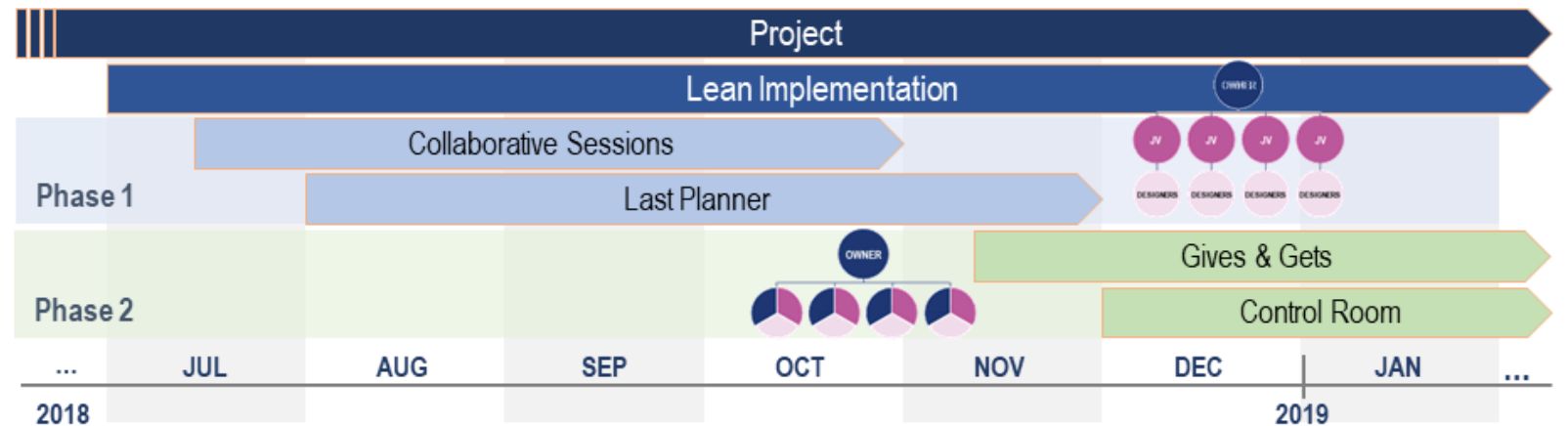
- Design Structure Matrix (DSM) to support the flow view in design management.
- The DSM is a network modelling tool for visually representing elements of a system and their interactions and supporting the decomposition and integration problems (Browning 2001; Eppinger and Browning 2012).
- DSM can be applied in different contexts
  - product development, project planning, project management, systems engineering and organisation design

# Project and Joint-Venture (JV) Descriptions

- Europe's largest infrastructure project - New high-speed railway (UK)
  - 555km of new track (Birmingham, Manchester and Leeds)
  - From July 2017 to be completed in 2033 (expected)
  - When fully operational, the railway should carry:
    - 100 million passengers a year,
    - Up to 48 trains running per hour
    - 25 stations served directly.
- JV - Section between Birmingham and London - main civil work contract
  - 80km section
  - 17 viaducts
  - 22km of road diversions
  - 75 overbridges
  - 24 million cubic metres of excavation.
- At the JV office, there were 165 employees divided into 19 functions: Procurement, Finance, Safety, Logistics, Risk, among others.
- All functions were responsible for:
  - Receiving the drawings from the design subcontractor - DJV
  - Producing deliverables to the owner, e.g. drawings, reports of cost, accessibility, logistic, environmental, programme, risk, health and safety.
- The authors of this paper were lean consultants for the JV,
  - Facilitate the production of these deliverables through the lean design management in the scheme design phase of the project.
  - The consultancy focused on integrating the production from different functions, planning and control the information flow, reducing the lead-time, rework, and times of gathering information

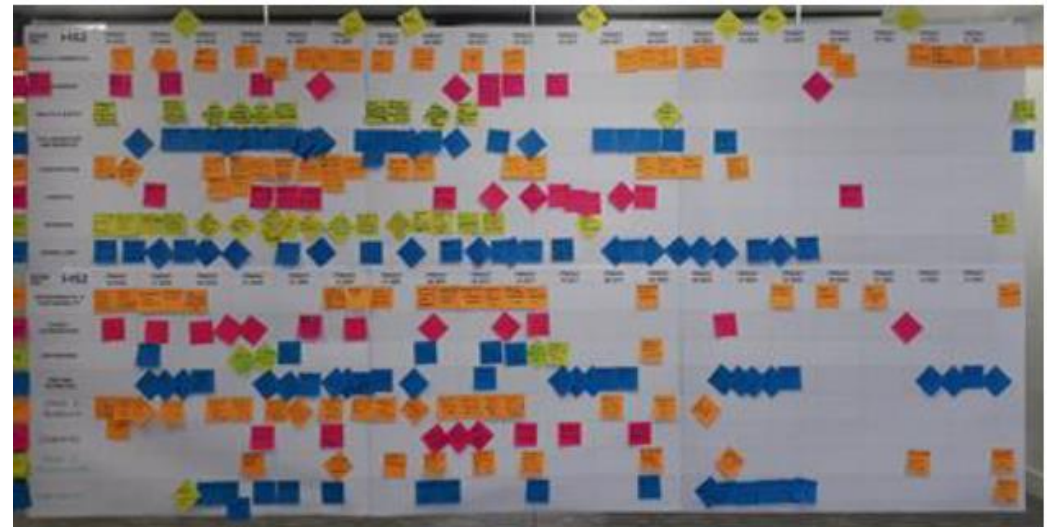
# LDM Implementation Process

- Phase 1
  - JV Functions working in 'silos'
  - Independent schedules
  - Unbalanced workload
  - No collaboration  
(JV, DJV and owner)
  
- Phase 2
  - Co-located
  - Mixed in working groups
    - Type of Deliverable  
(Programme, cost, structure, etc.)



# LDM Development – Phase 1

- Collaborative Planning (CP) Sessions
  - Set goals
  - Define main phases
  - Pull key activities
  
- 2 sessions
  - 32 Functions leads
  - 19 different functions + Owner and Design Team
  
- Identify interdependencies
- Improve sequence of activities
- Create unified and optimized plan

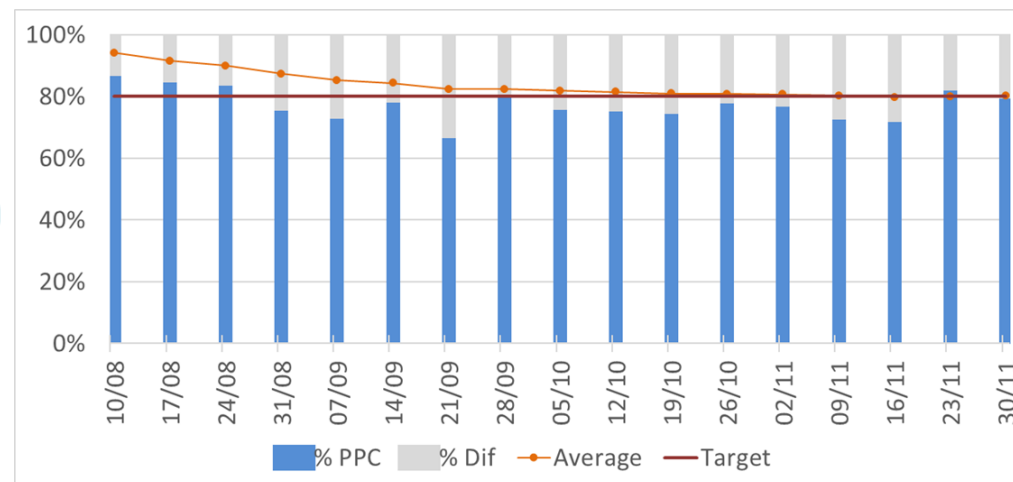
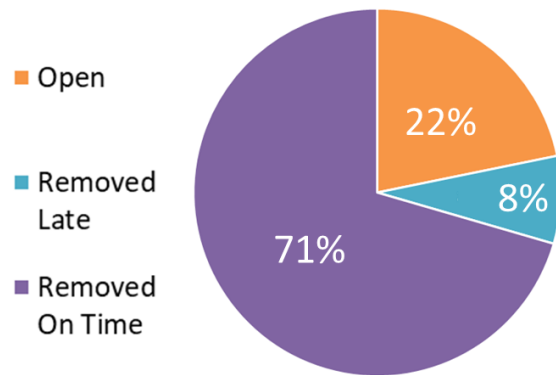




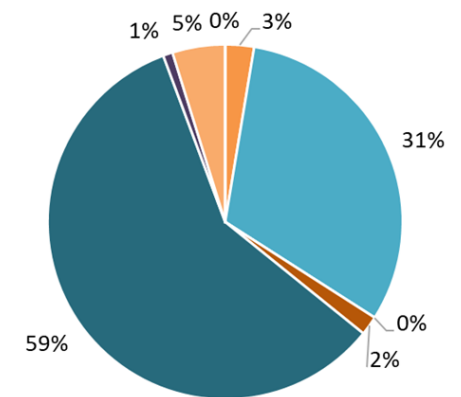


# LDM Development – Phase 1

- Make-Ready Planning
  - Identifying and removing constraints
- Commitment Planning
  - Control ‘last week’ and commitment ‘following week’
  - PPC and Reasons for non-completion



- A - Resource Capacity
- B - Late Information
- C - Design Change
- D - Task Underestimated
- E - Change in Priorities
- F - Preceding Activ Incomplete
- G - Inputs
- H - IT System

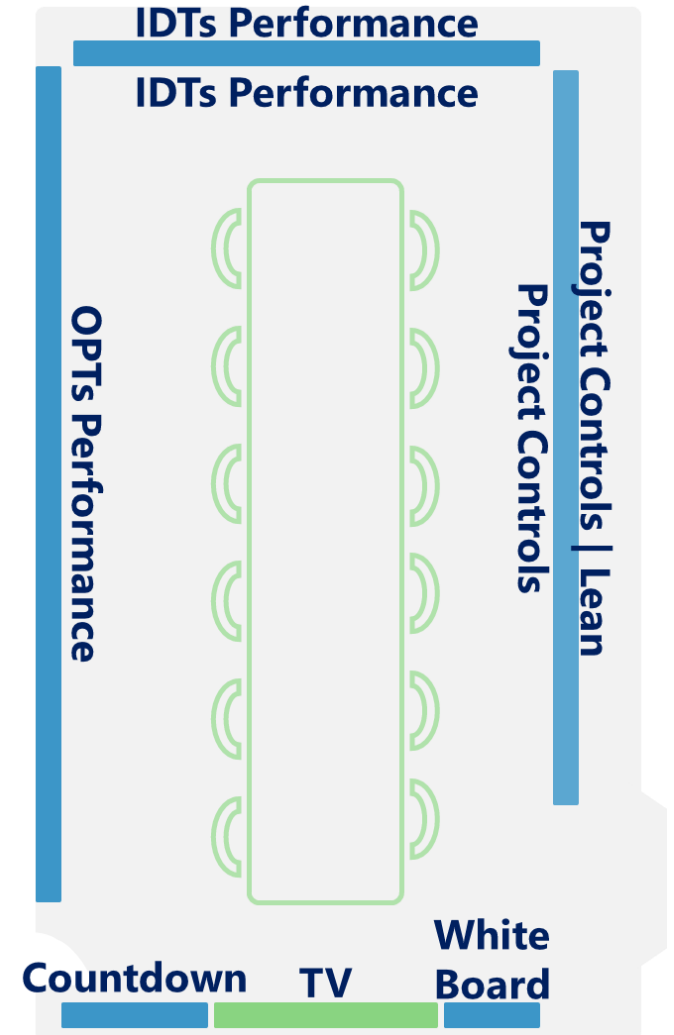




# LDM Development – Phase 2

- Control Room (*Obeya*)
  - Visual Management
  - Graphics and Charts
    - Programme
    - Cost
    - Milestones
    - progress-to-date information
  - Results as a team
    - Accelerated decision making
    - Encouraged collaboration
    - Increased transparency

OPT name	
Terms of Reference	Route Map
Target Savings	Affordability
Info	Info
Info	Info



# Discussion: Comparing Phase 1 vs. Phase 2

- Collaboration culture among teams
- Stakeholder involvement
- Acceptance of project context
  - changes in requirements and deadlines

	<b>LDM in Phase 1</b>	<b>LDM in Phase 2</b>
<b>Project organisation</b>	Silos: over the wall approach (segregated functions)	Cross-functional teams (OPTs)
<b>LDM method to Master Planning</b>	Collaborative Planning Sessions to integrate different functions schedules	Primavera P6 file
<b>LDM method to Make Ready Planning</b>	Adapted LPS (integrated meetings)	Gives & Gets
<b>LDM method to Weekly Planning</b>		Primavera P6 file
<b>Visual management</b>	CP post-its; Charts of metrics (only electronic report)	Control Room; Gives & Gets cards and panel
<b>Meetings frequency</b>	Weekly	Weekly
<b>Metrics</b>	Constraints status, PPC, Reasons for non-completion	Deliverables status
<b>Number of people involved</b>	165 people	≈ 250 people
<b>Co-located work</b>	No. Only the same function employees.	Yes

# Discussion: Comparing Phase 1 vs. Phase 2

- Phase 1
  - Better control (weekly metrics)
  - Focus on activities, commitments and constraints
  - Collaborative Session – only opportunity to visualise relationships and constraints between functions
- Phase 2
  - Change structure – ‘silos’ to working groups
  - Co-location
    - Enhanced problem-solving
    - Process more agile
  - Gives & Gets
    - Better engagement and number of constraints
  - Fewer control measurements
  - Control Room – fundamental support for visual management

# LDM Results

- **Key Benefits**
  - Organisational culture and structure
    - Changes in the organisational structure facilitated the planning of constraints and improved staff engagement
  - Effective communication
    - High participation in sessions
    - Commitment to weekly meetings
  - Teamwork
    - Increased collaboration
- **Limitations**
  - Lack of Lean knowledge
  - Several change orders
  - Lack of collaboration (Working in 'silos')
- **What to improve**
  - Better requirements management
  - Change management (deliverables)
  - Lean training
  - Feedback data from weekly plans to master plan
  - Combine Last Planner with Gives & Gets

# Conclusions

- Improvements in short time (7 – 8 months) - Lean efforts are worth
- Lean Design Management is a suitable effort for improving performance and embedding a continuous improvement culture
- The project had effectively adapted Lean to the Design phase
- Phase 1
  - Collaborative Planning sessions was crucial to integrate different Function schedules
    - Difficult to visualize the constraints across the Functions
  - LPS was important to formalize the planning and control process – providing metrics for continuous improvement
- Phase 2
  - Structure into cross-functional teams - Better collaboration
  - Facilitated visualization of constraints among teams – DSM matrix and Gives & Gets tool
  - Fewer metrics
  - Control room enhanced visual management



# Acknowledgements

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[www.logikalprojects.com](http://www.logikalprojects.com)



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