Work Breakdown Matrix

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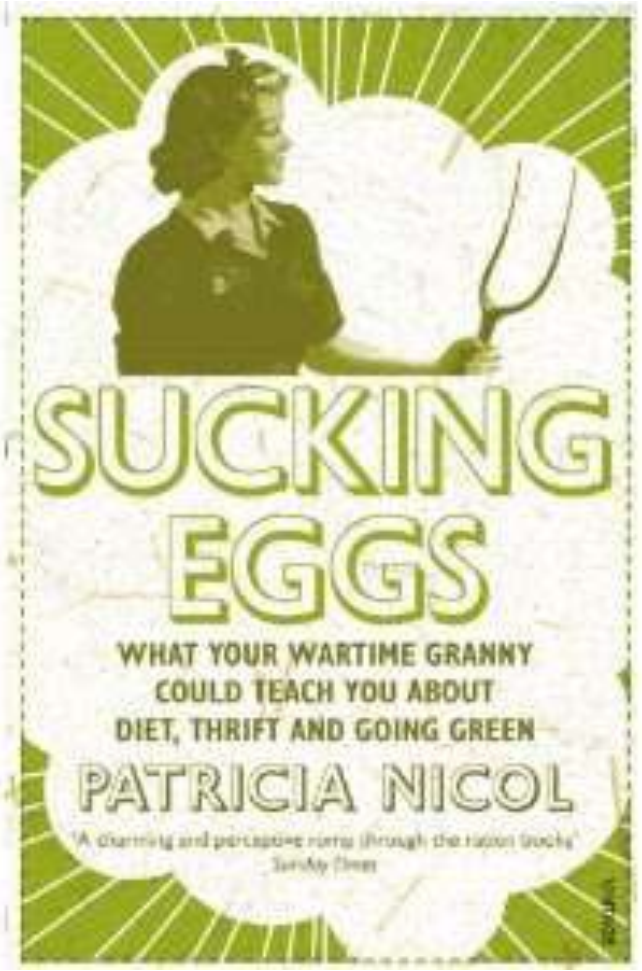
Learning objectives



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Method

Who am I?

- Professor of Management
  Swinburne University of Technology
- Visiting Professor of Construction
  Unitec New Zealand
- Director – Micro Planning International
- Designing underlying theory for LBMS and developing applications
- SBEnrc Program Director 2010-2015

Introduction

Issues

- Project decomposition is important
- WBS is a well developed method
- Its been with us now 55 years
- Is it time to revisit?
- Current methods are repetitive and hard work
- Project control remains a problem
- There is a better way

Proposal

- Need to go back to basics
- Recognise the role of location
- Extract location from the WBS
- Use a Location-work breakdown matrix
- Redesign PM processes and software!

Development of WBS

History

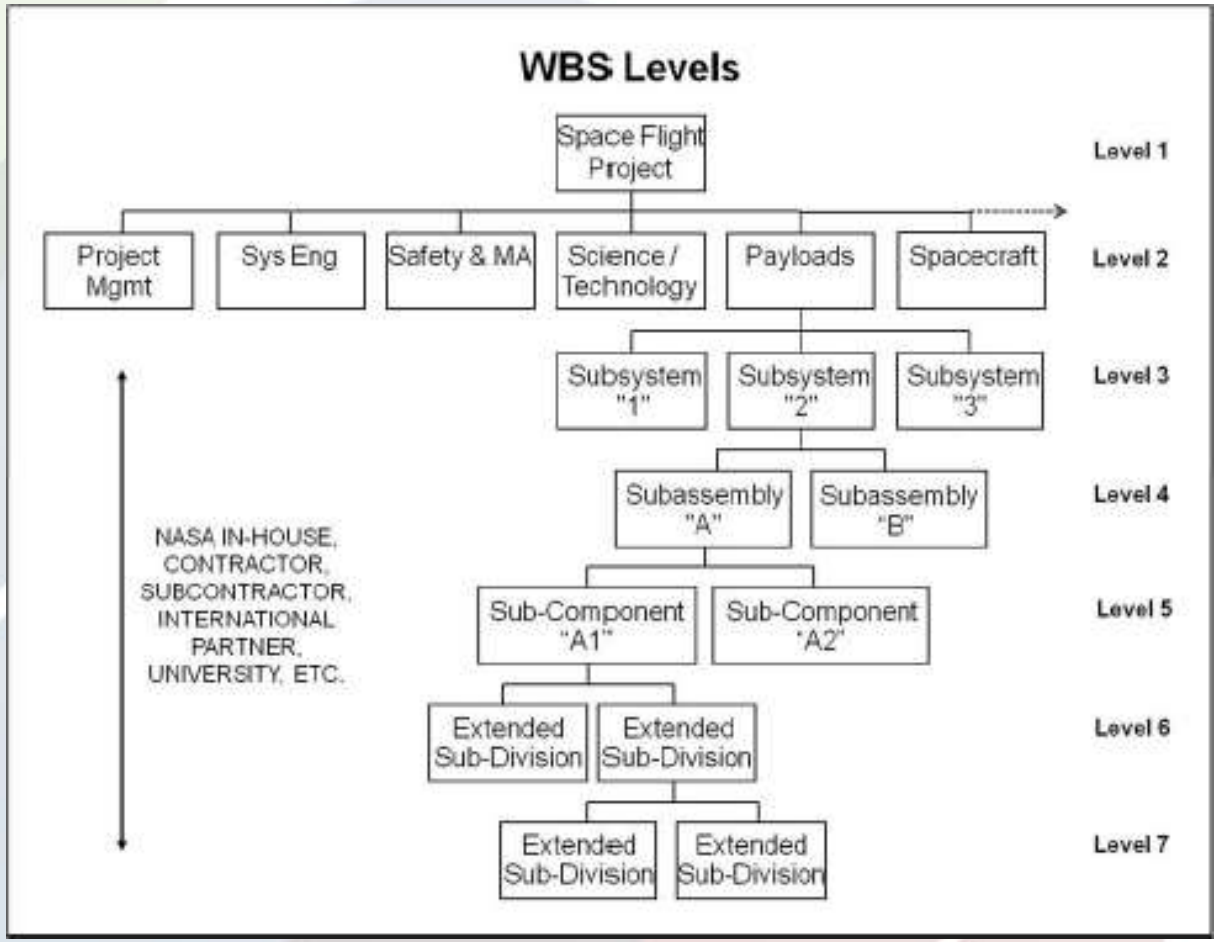
- Designed into the US Navy Polaris Missile project in 1957
- Defined and published by 1962 in DoD Guide to PERT
- Codified into a standard in 1968 in US MIL-STD-881
- Adopted in DEF(AUST)5664 (1995) and Rev A (2004)
- Developed as a practitioner's tool for project decomposition

What is it?

- A task-oriented family tree of activities which organises, defines and graphically displays the total work to be accomplished in order to achieve the final objectives of the project (PMI, from Chandrashekar et al. 1993)
- The WBS is the cornerstone of a project and provides the basis for technical, cost and schedule control. [DEF(AUST)5664A]

WBS representation

Tree structures



Outlining

Level 1	Level 2	Level 3	Level 4
Project			
	Task 1		
		Sub Task1.1	
			Work Package 1.1.1
			Work Package 1.1.2
			Work Package 1.1.3
			Work Package 1.1.4
		Sub Task1.2	
			Work Package 1.2.1
			Work Package 1.2.2
			Work Package 1.2.3
			Work Package 1.2.4
	Task 2		
		Sub Task2.1	
			Work Package 2.1.1
			Work Package 2.1.2
			Work Package 2.1.3
			Work Package 2.1.4
		Sub Task2.2	
			Work Package 2.2.1
			Work Package 2.2.2
			Work Package 2.2.3
			Work Package 2.2.4
		Sub Task2.3	
			Work Package 2.3.1
			Work Package 2.3.2

AUS(DEF)5664 Requirement 1

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- Integrated – A single top WBS Element covers the total body of work.
- Distinct – Every WBS Element is a distinct Product or Enabling Service, which is mutually exclusive from other Products and Enabling Services.
- Children – Every WBS Element has either no children, or multiple children.
- Descendant – Every child WBS Element has only one parent and is a descendant of the top WBS Element.
- Necessary – Every child WBS Element is needed to deliver the parent.
- Sufficient – If all child WBS Elements are complete, their parent is complete.
- Complete – The complete scope of work is captured in the WBS.

- Rules I have issue with

- 100% Rule (Project Scope)
- Every WBS Element has either no children, or multiple children.

Can we fix it?

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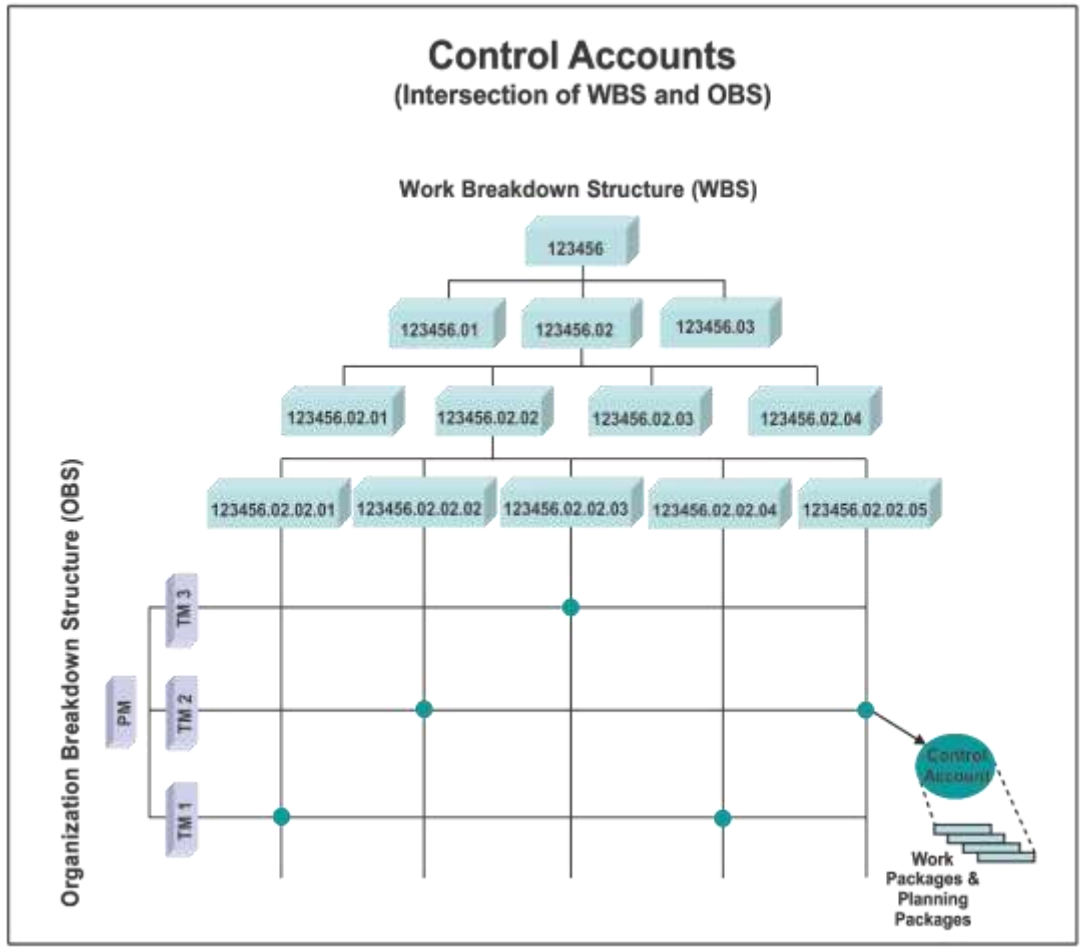
Can we fix it? Yes we can!

Relationship to other decomposition structures



NASA WBS Handbook (2010)

- Organisational Breakdown Structure (OBS)
- Bill of Materials (BOM)
- Resource Breakdown Structure (RBS)

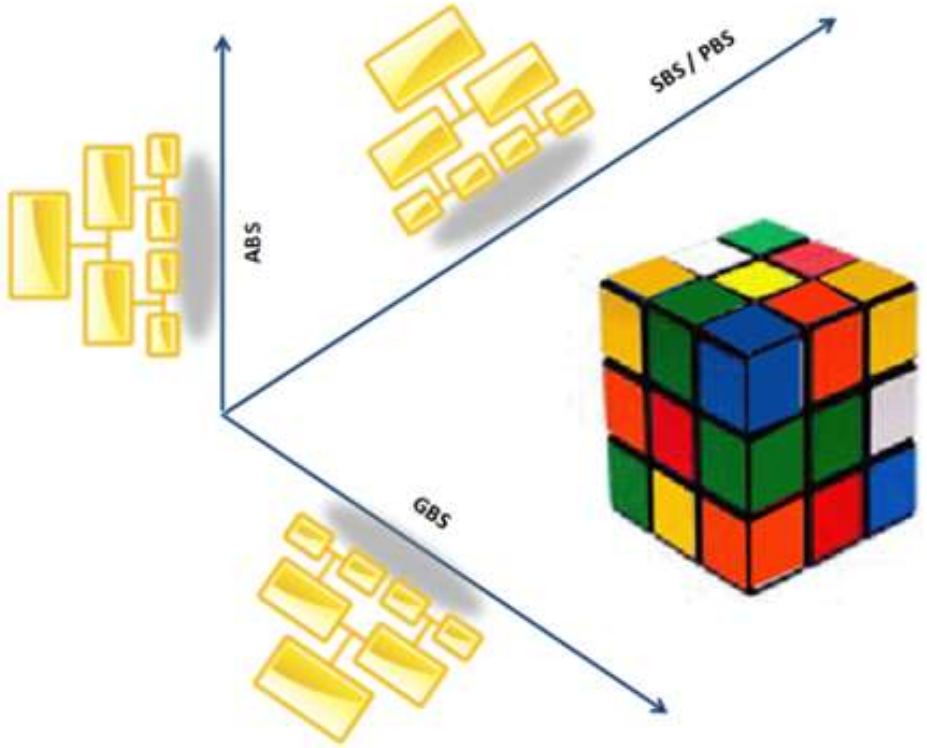
- None of these change the demands on the WBS

Multi-dimensional decomposition relationships

NASA

NASA WBS Handbook (2010)

Moine's 3DWBS



Moine (2012)

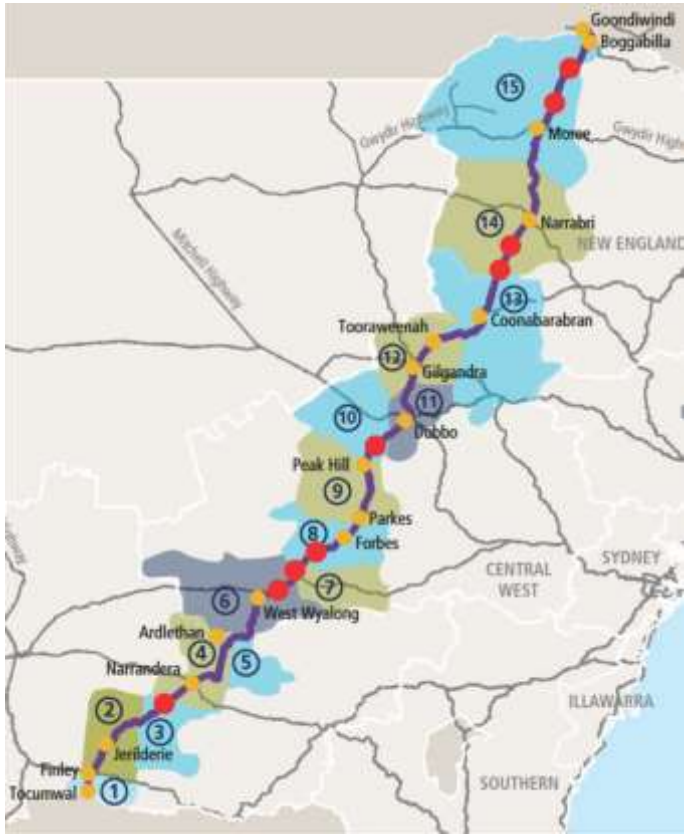
Infrastructure project decomposition

Vertical Infrastructure

Horizontal Infrastructure

Infrastructure project decomposition

Distributed Infrastructure Assets



Distributed Construction/Maintenance

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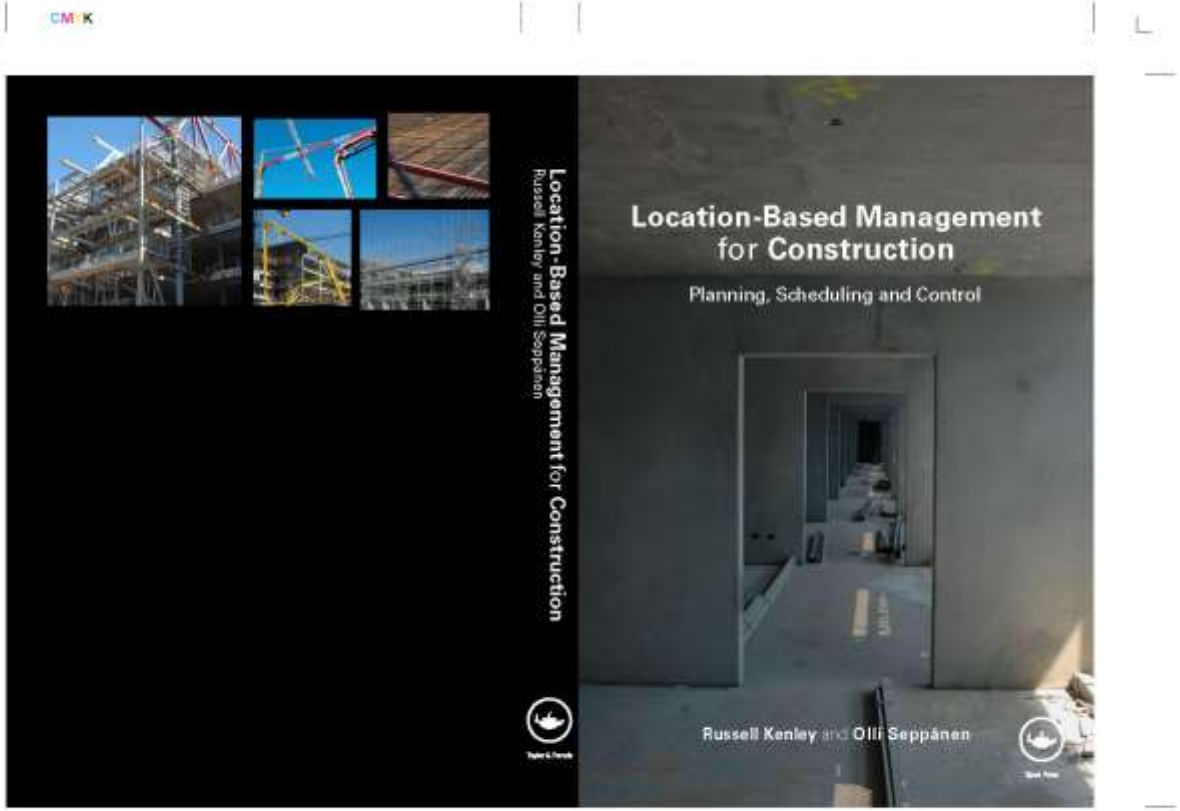
8
8
4

Location-based management systems

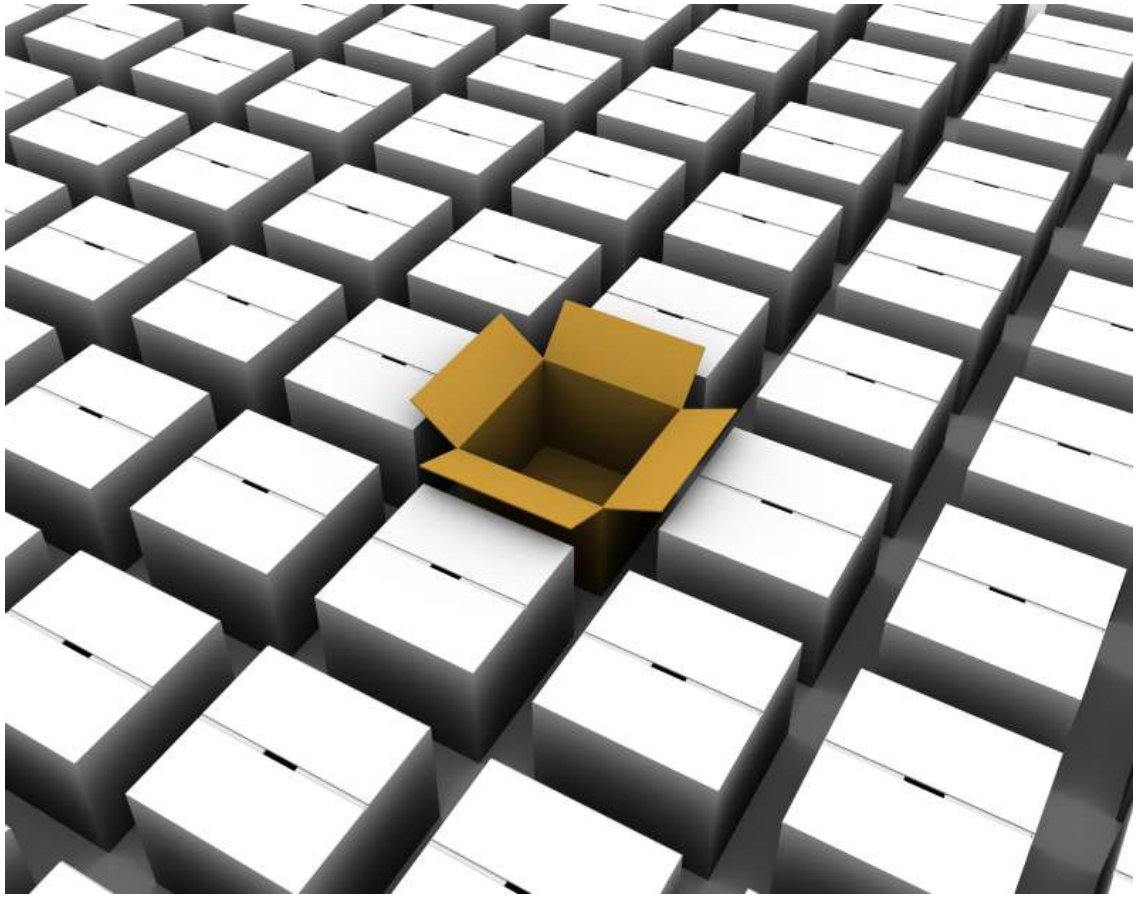
- Managing by location in construction improves production



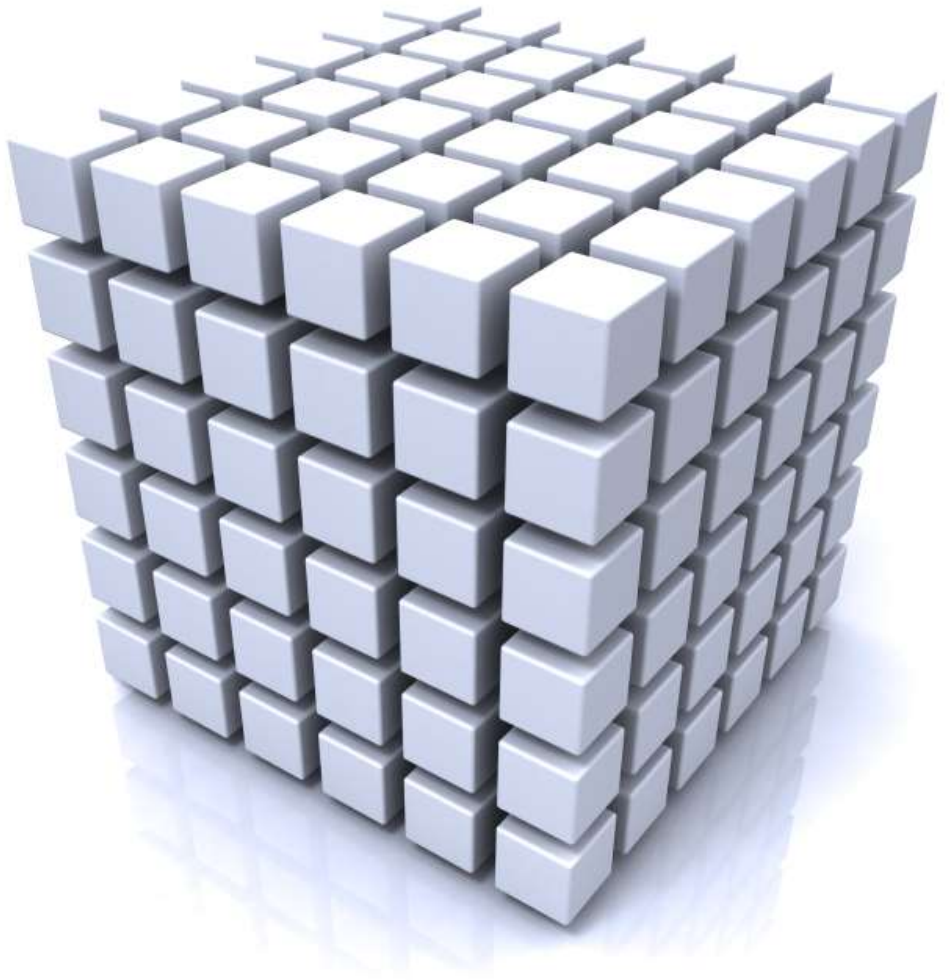
Location-based management systems

Swinburne

Location-based management systems



Location-based management systems



Location-based management systems

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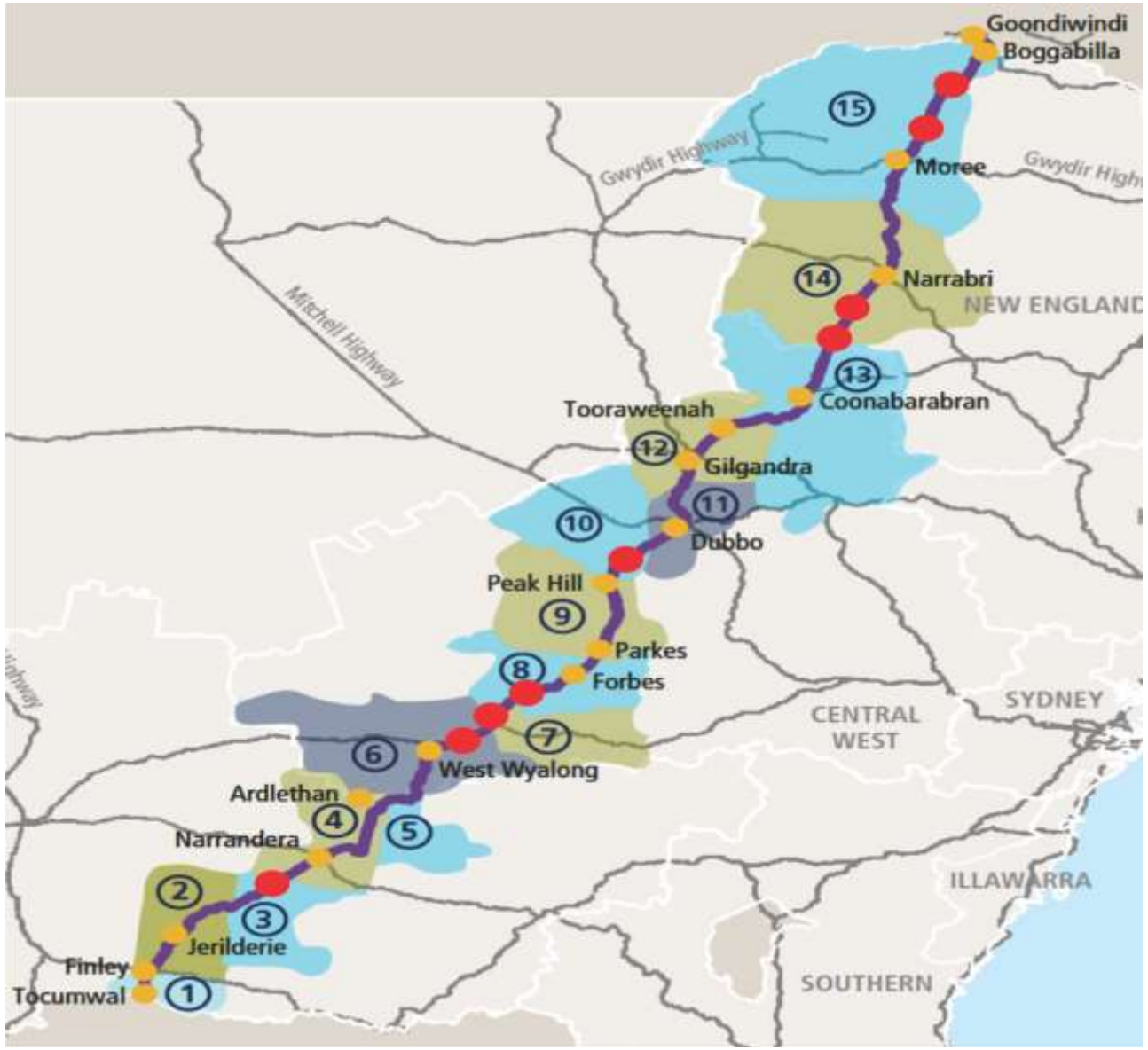

Location-based management systems

Analog

Digital

Location effects on project decomposition

- BO1 RESI. BLDG.PROJECT
- …
- BO1.4 CONSTRUCTION
- …
- BO1.4 .3 Super Structure
- BO1.4 .3 .1 Ground Floor Level
- BO1.4 .3 .1 .A Slab Work
- BO1.4 .3 .1 .A . 1 Column
- BO1.4 .3 .1 .A . 1.1 Rebar
- BO1.4 .3 .1 .A . 1.2 Form Work
- BO1.4 .3 .1 .A . 1.3 Concreting
- BO1.4 .3 .1 .A .2 Shear Wall
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- BO1.4 .3 .3 .A .3 Slab
- BO1.4 .3 .3 .B Part 2
- BO1.4 .3 .3 .B .1 Column
- BO1.4 .3 .3 .B .2 Shear Wall
- BO1.4 .3 .3 .B .3 Slab
- BO1.4 .3 .4 Third Floor Level
- BO1.4 .3 .4 .A Part 1
- BO1.4 .3 .4 .A .1 Column
- BO1.4 .3 .4 .A .2 Shear Wall
- BO1.4 .3 .4 .A .3 Slab
- BO1.4 .3 .4 .B Part 2
- BO1.4 .3 .4 .B .1 Column
- BO1.4 .3 .4 .B .2 Shear Wall
- BO1.4 .3 .4 .B .3 Slab

- Location has been found to be a key breakdown component of traditional WBS (Ibrahim et al., 2009)
- Integrating ‘location’ into [traditional] WBS decomposition necessitates substantial repetition in data and processes (Stal-Le Cardinal & Marle, 2006)

Location-Work Breakdown Matrix

- **BO1 RESI. BLDG.PROJECT**
- …
- BO1.4 CONSTRUCTION
- …
- BO1.4 .3 Super Structure
- **BO1.4 .3 .1 Ground Floor Level**
- BO1.4 .3 .1 .A Slab Work
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- BO1.4 .3 .1 .A .3 .4 Concreting
- **BO1.4 .3 .2 First Floor Level**
- BO1.4 .3 .2 .A Slab Work
- BO1.4 .3 .2 .A .1 Column
- BO1.4 .3 .2 .A .1 .1 Rebar
- BO1.4 .3 .2 .A .1 .2 Form Work
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- BO1.4 .3 .2 .A .3 .1 Form Work
- BO1.4 .3 .2 .A .3 .2 Rebar
- BO1.4 .3 .2 .A .3 .3 MEP Work
- BO1.4 .3 .2 .A .3 .4 Concreting
- **BO1.4 .3 .3 Second Floor Level**
- BO1.4 .3 .3 .A Slab Work
- BO1.4 .3 .3 .A .1 Column
- BO1.4 .3 .3 .A .2 Shear Wall
- BO1.4 .3 .3 .A .3 Slab
- BO1.4 .3 .3 .B Part 2
- BO1.4 .3 .3 .B .1 Column
- BO1.4 .3 .3 .B .2 Shear Wall
- BO1.4 .3 .3 .B .3 Slab
- **BO1.4 .3 .4 Third Floor Level**
- BO1.4 .3 .4 .A Part 1
- BO1.4 .3 .4 .A .1 Column
- BO1.4 .3 .4 .A .2 Shear Wall
- BO1.4 .3 .4 .A .3 Slab
- BO1.4 .3 .4 .B Part 2
- BO1.4 .3 .4 .B .1 Column
- BO1.4 .3 .4 .B .2 Shear Wall
- BO1.4 .3 .4 .B .3 Slab

The used coding may be mapped as follows:

L1 .X1 .X2 .L2 .L3/X3 .X4 .T

Where:

L1=Building	– coded B01
X1=Construction	– coded 4
X2= Superstructure	– coded 3
L2=Level	– coded 1 to 3
L3=Zone	– coded A to B
X3=Element	– **not coded**, described
X4=Component	– coded 1 to 3
T=Activity	– coded 1 to 4

The merging of L3 and X3 into a single code greatly increases confusion in interpreting this structure.

Location-Work Breakdown Matrix

- BO1 RESI. BLDG.PROJECT
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The result will be a two lists:

- LBS: the location breakdown (the where [L])
  in this case: L1 .L2 .L3

- WBS: the work breakdown (the what [X] and how [T])
  in this case: X1 .X2 .X3 .X4 .X5 .T

With the actual work (.T) belonging at the intersection of the two lists **and thus belonging to both** which is why it requires the matrix to describe all work.

Location effects on project decomposition

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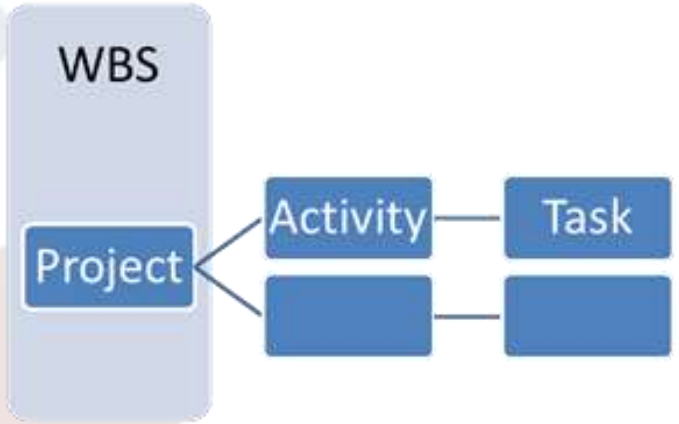
LBS (L1 .L2 .L3)

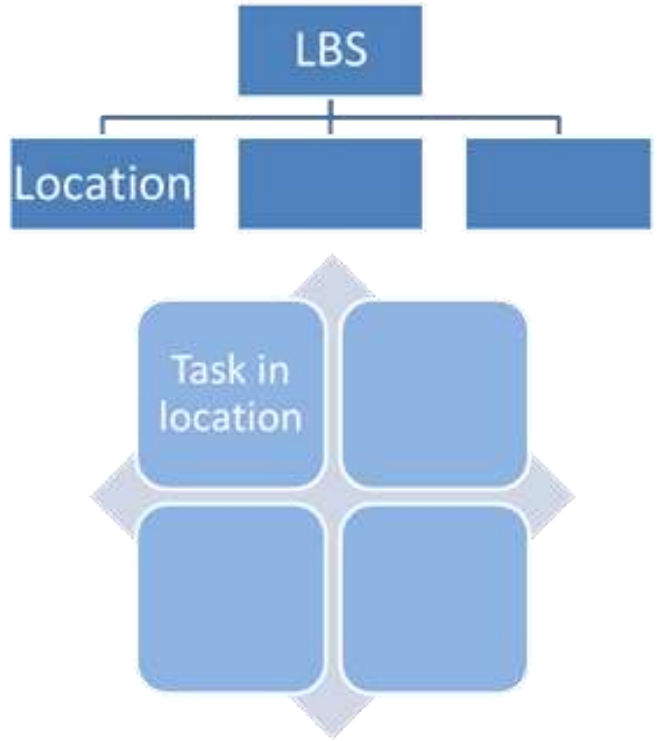
- BO1 RESI. BLDG.PROJECT
- BO1.1 Ground Floor Level
- B01.1.A Zone A
- BO1.2 First Floor Level
- B01.2.A Zone A
- BO1.3 Second Floor Level
- B01.3.A Zone A
- B01.3.B Zone B
- BO1.4 Third Floor Level
- B01.4.A Zone A
- B01.4.B Zone B

WBS (X1 .X2 .X3 .X4 .X5 .T)

- 4 CONSTRUCTION
- 4 .3 Super Structure
- 4 .3 .1 Slab Work
- 4 .3 .1 .1 Column
- 4 .3 .1 .1.1 Column Rebar
- 4 .3 .1 .1.2 Column Form Work
- 4 .3 .1 .1.3 Column Concreting
- 4 .3 .1 .2 Shear Wall
- 4 .3 .1 .2 .1 S'Wall Rebar
- 4 .3 .1 .2 .2 S'Wall Form Work
- 4 .3 .1 .2 .3 S'Wall Concreting
- 4 .3 .1 .3 Slab
- 4 .3 .1 .3 .1 Slab Form Work
- 4 .3 .1 .3 .2 Slab Rebar
- 4 .3 .1 .3 .3 Slab MEP Work
- 4 .3 .1 .3 .4 Slab Concreting

Location-Work Breakdown Matrix





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Work-Location Breakdown Matrix

Work Breakdown Structure	Location Breakdown Structure: BO1 RESI. BLDG.PROJECT	BO1.1 Ground Floor Level	B01.1.A Zone A	BO1.2 First Floor Level	B01.2.A Zone A	BO1.3 Second Floor Level	B01.3.A Zone A	B01.3.B Zone B	BO1.4 Third Floor Level	B01.4.A Zone A	B01.4.B Zone B
4 CONSTRUCTION											
4 .3 Super Structure											
4 .3 .1 Slab Work											
4 .3 .1 .1 Column											
4 .3 .1 .1.1 Column Rebar			✓		✓		✓	✓		✓	✓
4 .3 .1 .1.2 Column Form Work			✓		✓		✓	✓		✓	✓
4 .3 .1 .1.3 Column Concreting			✓		✓		✓	✓		✓	✓
4 .3 .1 .2 Shear Wall											
4 .3 .1 .2 .1 S'Wall Rebar			✓		✓		✓	✓		✓	✓
4 .3 .1 .2 .2 S'Wall Form Work			✓		✓		✓	✓		✓	✓
4 .3 .1 .2 .3 S'Wall Concreting			✓		✓		✓	✓		✓	✓
4 .3 .1 .3 Slab											
4 .3 .1 .3 .1 Slab Form Work			✓		✓		✓	✓		✓	✓
4 .3 .1 .3 .2 Slab Rebar			✓		✓		✓	✓		✓	✓
4 .3 .1 .3 .3 Slab MEP Work			✓		✓		✓	✓		✓	✓
4 .3 .1 .3 .4 Slab Concreting			✓		✓		✓	✓		✓	✓

Location-Work Breakdown Matrix

- BO1 RESI. BLDG.PROJECT
- …
- BO1.4 CONSTRUCTION
- …
- BO1.4 .3 Super Structure
- BO1.4 .3 .1 Ground Floor Level
- BO1.4 .3 .1 .A Slab Work
- BO1.4 .3 .1 .A . 1 Column
- BO1.4 .3 .1 .A . 1.1 Rebar
- BO1.4 .3 .1 .A . 1.2 Form Work
- BO1.4 .3 .1 .A . 1.3 Concreting
- BO1.4 .3 .1 .A .2 Shear Wall
- BO1.4 .3 .1 .A .2 .1 Rebar
- BO1.4 .3 .1 .A .2 .2 Form Work
- BO1.4 .3 .1 .A .2 .3 Concreting
- BO1.4 .3 .1 .A .3 Slab
- BO1.4 .3 .1 .A .3 .1 Form Work
- BO1.4 .3 .1 .A .3 .2 Rebar
- BO1.4 .3 .1 .A .3 .3 MEP Work
- BO1.4 .3 .1 .A .3 .4 Concreting
- BO1.4 .3 .2 First Floor Level
- BO1.4 .3 .2 .A Slab Work
- BO1.4 .3 .2 .A .1 Column
- BO1.4 .3 .2 .A .1 .1 Rebar
- BO1.4 .3 .2 .A .1 .2 Form Work
- BO1.4 .3 .2 .A .1 .3 Concreting
- BO1.4 .3 .2 .A .2 Shear Wall
- BO1.4 .3 .2 .A .2 .1 Rebar
- BO1.4 .3 .2 .A .2 .2 Form Work
- BO1.4 .3 .2 .A .2 .3 Concreting
- BO1.4 .3 .2 .A .3 Slab
- BO1.4 .3 .2 .A .3 .1 Form Work
- BO1.4 .3 .2 .A .3 .2 Rebar
- BO1.4 .3 .2 .A .3 .3 MEP Work
- BO1.4 .3 .2 .A .3 .4 Concreting
- BO1.4 .3 .3 Second Floor Level
- BO1.4 .3 .3 .A Slab Work
- BO1.4 .3 .3 .A .1 Column
- BO1.4 .3 .3 .A .2 Shear Wall
- BO1.4 .3 .3 .A .3 Slab
- BO1.4 .3 .3 .B Part 2
- BO1.4 .3 .3 .B .1 Column
- BO1.4 .3 .3 .B .2 Shear Wall
- BO1.4 .3 .3 .B .3 Slab
- BO1.4 .3 .4 Third Floor Level
- BO1.4 .3 .4 .A Part 1
- BO1.4 .3 .4 .A .1 Column
- BO1.4 .3 .4 .A .2 Shear Wall
- BO1.4 .3 .4 .A .3 Slab
- BO1.4 .3 .4 .B Part 2
- BO1.4 .3 .4 .B .1 Column
- BO1.4 .3 .4 .B .2 Shear Wall
- BO1.4 .3 .4 .B .3 Slab

Work-Location Breakdown Matrix

Work Breakdown Structure	Location Breakdown Structure: BO1 RESI. BLDG.PROJECT	BO1.1 Ground Floor Level	B01.1.A Zone A	B01.1.B Zone B	B01.2.A Zone A	B01.2.B Zone B	BO1.3 Second Floor Level	B01.3.A Zone A	B01.3.B Zone B	BO1.4 Third Floor Level	B01.4.A Zone A	B01.4.B Zone B
4 CONSTRUCTION												
4 .3 Super Structure												
4 .3 .1 Slab Work												
4 .3 .1 .1 Column												
4 .3 .1 .1.1 Column Rebar			✓		✓		✓	✓		✓	✓	
4 .3 .1 .1.2 Column Form Work			✓		✓		✓	✓		✓	✓	
4 .3 .1 .1.3 Column Concreting			✓		✓		✓	✓		✓	✓	
4 .3 .1 .2 Shear Wall												
4 .3 .1 .2 .1 S'Wall Rebar			✓		✓		✓	✓		✓	✓	
4 .3 .1 .2 .2 S'Wall Form Work			✓		✓		✓	✓		✓	✓	
4 .3 .1 .2 .3 S'Wall Concreting			✓		✓		✓	✓		✓	✓	
4 .3 .1 .3 Slab												
4 .3 .1 .3 .1 Slab Form Work			✓		✓		✓	✓		✓	✓	
4 .3 .1 .3 .2 Slab Rebar			✓		✓		✓	✓		✓	✓	
4 .3 .1 .3 .3 Slab MEP Work			✓		✓		✓	✓		✓	✓	
4 .3 .1 .3 .4 Slab Concreting			✓		✓		✓	✓		✓	✓	

Task

Location-Work Breakdown Matrix

- BO1 RESI. BLDG.PROJECT
- …
- BO1.4 CONSTRUCTION
- …
- BO1.4 .3 Super Structure
- BO1.4 .3 .1 Ground Floor Level
- BO1.4 .3 .1 .A Slab Work
- BO1.4 .3 .1 .A . 1 Column
- BO1.4 .3 .1 .A . 1.1 Rebar
- BO1.4 .3 .1 .A . 1.2 Form Work
- BO1.4 .3 .1 .A . 1.3 Concreting
- BO1.4 .3 .1 .A .2 Shear Wall
- BO1.4 .3 .1 .A .2 .1 Rebar
- BO1.4 .3 .1 .A .2 .2 Form Work
- BO1.4 .3 .1 .A .2 .3 Concreting
- BO1.4 .3 .1 .A .3 Slab
- BO1.4 .3 .1 .A .3 .1 Form Work
- BO1.4 .3 .1 .A .3 .2 Rebar
- BO1.4 .3 .1 .A .3 .3 MEP Work
- BO1.4 .3 .1 .A .3 .4 Concreting
- BO1.4 .3 .2 First Floor Level
- BO1.4 .3 .2 .A Slab Work
- BO1.4 .3 .2 .A .1 Column
- BO1.4 .3 .2 .A .1 .1 Rebar
- BO1.4 .3 .2 .A .1 .2 Form Work
- BO1.4 .3 .2 .A .1 .3 Concreting
- BO1.4 .3 .2 .A .2 Shear Wall
- BO1.4 .3 .2 .A .2 .1 Rebar
- BO1.4 .3 .2 .A .2 .2 Form Work
- BO1.4 .3 .2 .A .2 .3 Concreting
- BO1.4 .3 .2 .A .3 Slab
- BO1.4 .3 .2 .A .3 .1 Form Work
- BO1.4 .3 .2 .A .3 .2 Rebar
- BO1.4 .3 .2 .A .3 .3 MEP Work
- BO1.4 .3 .2 .A .3 .4 Concreting
- BO1.4 .3 .3 Second Floor Level
- BO1.4 .3 .3 .A Slab Work
- BO1.4 .3 .3 .A .1 Column
- BO1.4 .3 .3 .A .2 Shear Wall
- BO1.4 .3 .3 .A .3 Slab
- BO1.4 .3 .3 .B Part 2
- BO1.4 .3 .3 .B .1 Column
- BO1.4 .3 .3 .B .2 Shear Wall
- BO1.4 .3 .3 .B .3 Slab
- BO1.4 .3 .4 Third Floor Level
- BO1.4 .3 .4 .A Part 1
- BO1.4 .3 .4 .A .1 Column
- BO1.4 .3 .4 .A .2 Shear Wall
- BO1.4 .3 .4 .A .3 Slab
- BO1.4 .3 .4 .B Part 2
- BO1.4 .3 .4 .B .1 Column
- BO1.4 .3 .4 .B .2 Shear Wall
- BO1.4 .3 .4 .B .3 Slab

Work-Location Breakdown Matrix

Work Breakdown Structure	Location Breakdown Structure: BO1 RESI. BLDG.PROJECT	BO1.1 Ground Floor Level	BO1.1.A Zone A	BO1.2 First Floor Level	BO1.2.A Zone A	BO1.3 Second Floor Level	BO1.3.A Zone A	BO1.3.B Zone B	BO1.4 Third Floor Level	BO1.4.A Zone A	BO1.4.B Zone B
4 CONSTRUCTION											
4 .3 Super Structure											
4 .3 .1 Slab Work											
4 .3 .1 .1 Column											
4 .3 .1 .1.1 Column Rebar			✓		✓		✓	✓		✓	✓
4 .3 .1 .1.2 Column Form Work			✓		✓		✓	✓		✓	✓
4 .3 .1 .1.3 Column Concreting			✓		✓		✓	✓		✓	✓
4 .3 .1 .2 Shear Wall											
4 .3 .1 .2 .1 S'Wall Rebar			✓		✓		✓	✓		✓	✓
4 .3 .1 .2 .2 S'Wall Form Work			✓		✓		✓	✓		✓	✓
4 .3 .1 .2 .3 S'Wall Concreting			✓		✓		✓	✓		✓	✓
4 .3 .1 .3 Slab											
4 .3 .1 .3 .1 Slab Form Work			✓		✓		✓	✓		✓	✓
4 .3 .1 .3 .2 Slab Rebar			✓		✓		✓	✓		✓	✓
4 .3 .1 .3 .3 Slab MEP Work			✓		✓		✓	✓		✓	✓
4 .3 .1 .3 .4 Slab Concreting			✓		✓		✓	✓		✓	✓

Parade of Trades

Location-Work Breakdown Matrix

Work-Location Breakdown Matrix

Work Breakdown Structure	Location Breakdown Structure: BO1 RESI. BLDG.PROJECT	BO1.1 Ground Floor Level	B01.1.A Zone A	B01.2 First Floor Level	B01.2.A Zone A	B01.3 Second Floor Level	B01.3.A Zone A	B01.3.B Zone B	BO1.4 Third Floor Level	B01.4.A Zone A	B01.4.B Zone B
4 CONSTRUCTION											
4 .3 Super Structure											
4 .3 .1 Slab Work											
4 .3 .1 .1 Column											
4 .3 .1 .1.1 Column Rebar			✓		✓		✓	✓		✓	✓
4 .3 .1 .1.2 Column Form Work			✓		✓		✓	✓		✓	✓
4 .3 .1 .1.3 Column Concreting			✓		✓		✓	✓		✓	✓
4 .3 .1 .2 Shear Wall											
4 .3 .1 .2 .1 S'Wall Rebar			✓		✓		✓	✓		✓	✓
4 .3 .1 .2 .2 S'Wall Form Work			✓		✓		✓	✓		✓	✓
4 .3 .1 .2 .3 S'Wall Concreting			✓		✓		✓	✓		✓	✓
4 .3 .1 .3 Slab											
4 .3 .1 .3 .1 Slab Form Work			✓		✓		✓	✓		✓	✓
4 .3 .1 .3 .2 Slab Rebar			✓		✓		✓	✓		✓	✓
4 .3 .1 .3 .3 Slab MEP Work			✓		✓		✓	✓		✓	✓
4 .3 .1 .3 .4 Slab Concreting			✓		✓		✓	✓		✓	✓

- This is actually a representation with work (T) sorted by product breakdown (PBS).
- The matrix makes sorted by either LBS or PBS simple.

Work Breakdown Matrix

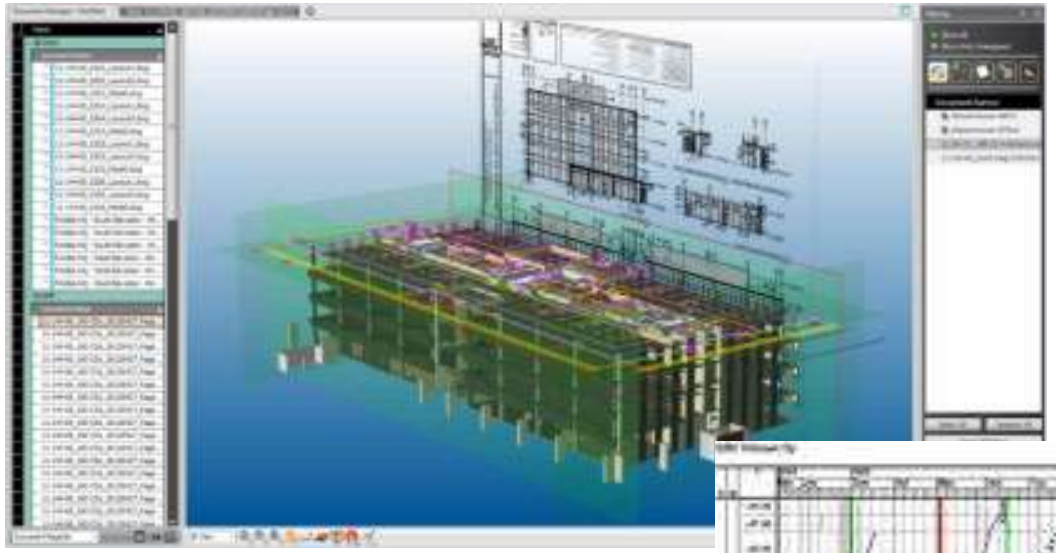
Work-Location Breakdown Matrix

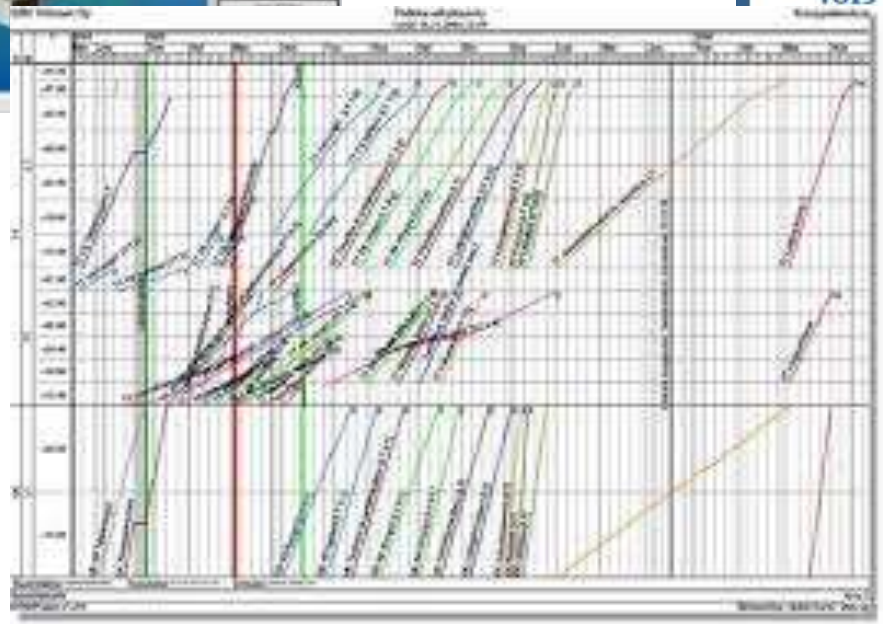
Work Breakdown Structure	Location Breakdown Structure: BO1 RESI. BLDG.PROJECT	BO1.1 Ground Floor Level	B01.1.A Zone A	BO1.2 First Floor Level	B01.2.A Zone A	BO1.3 Second Floor Level	B01.3.A Zone A	B01.3.B Zone B	BO1.4 Third Floor Level	B01.4.A Zone A	B01.4.B Zone B
4 CONSTRUCTION											
4 .3 Super Structure											
4 .3 .1 Slab Work											
4 .3 .1 .1 Column											
4 .3 .1 .1.1 Column Rebar			✓		✓		✓	✓		✓	✓
4 .3 .1 .1.2 Column Form Work			✓		✓		✓	✓		✓	✓
4 .3 .1 .1.3 Column Concreting			✓		✓		✓	✓		✓	✓
4 .3 .1 .2 Shear Wall											
4 .3 .1 .2 .1 S'Wall Rebar			✓		✓		✓	✓		✓	✓
4 .3 .1 .2 .2 S'Wall Form Work			✓		✓		✓	✓		✓	✓
4 .3 .1 .2 .3 S'Wall Concreting			✓		✓		✓	✓		✓	✓
4 .3 .1 .3 Slab											
4 .3 .1 .3 .1 Slab Form Work			✓		✓		✓	✓		✓	✓
4 .3 .1 .3 .2 Slab Rebar			✓		✓		✓	✓		✓	✓
4 .3 .1 .3 .3 Slab MEP Work			✓		✓		✓	✓		✓	✓
4 .3 .1 .3 .4 Slab Concreting			✓		✓		✓	✓		✓	✓

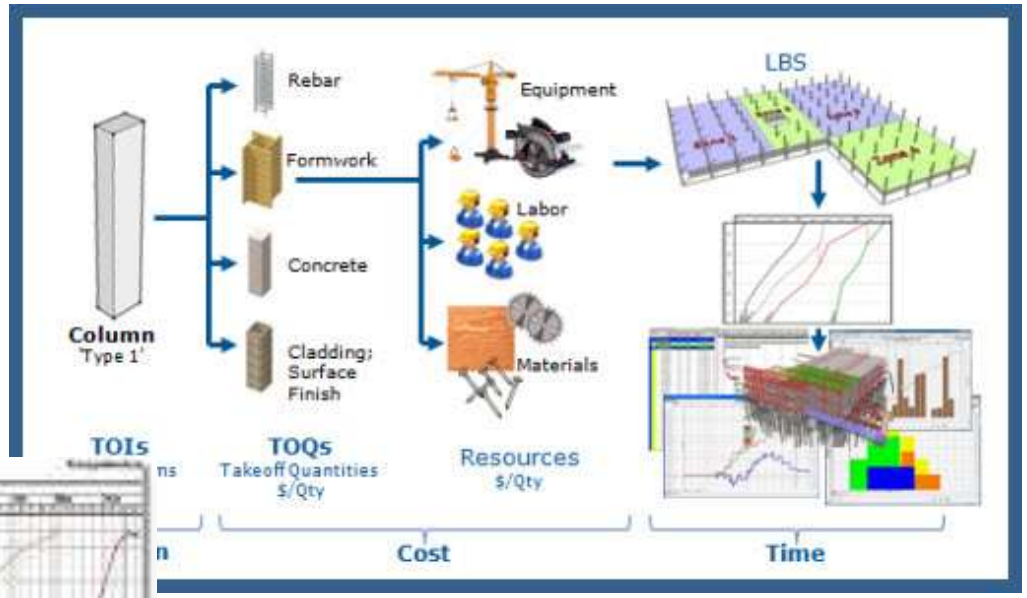
- Should the axis actually be
  - Product Breakdown (X)
  - Location Breakdown (L)
- And should the matrix be:
  - Work Breakdown Matrix

Location-based management systems

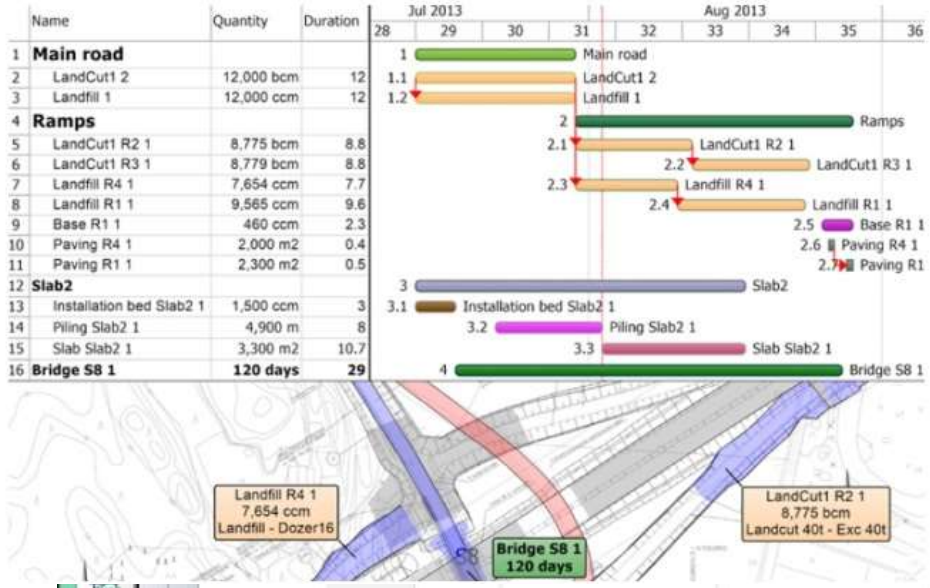
- Examples: Trimble (4.475B company): Vico Office

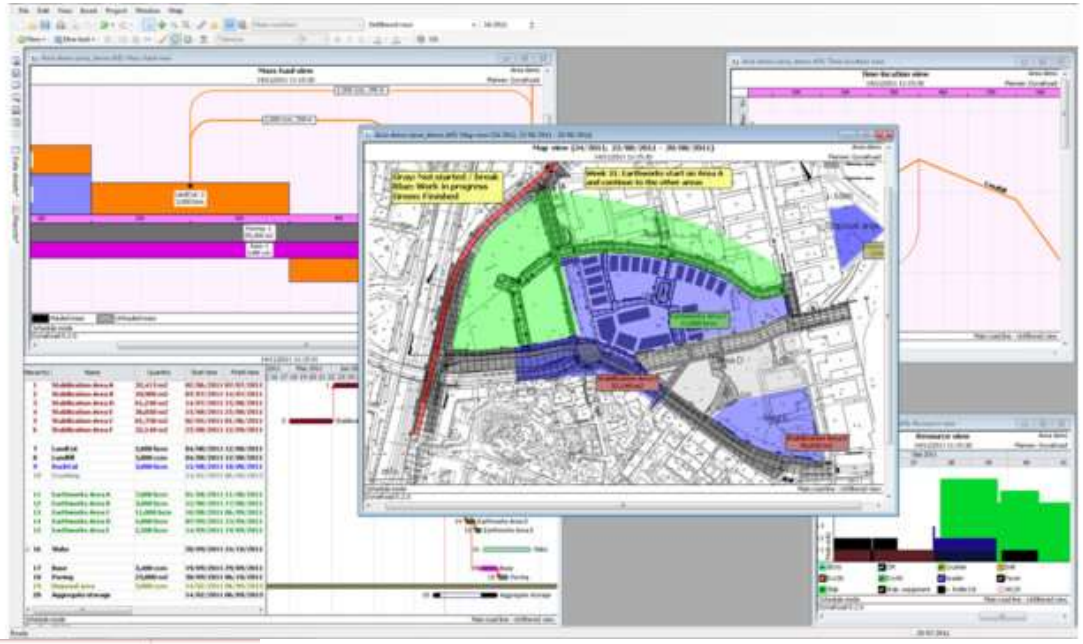






- Examples: TopCon (1.56B company): DynaRoad

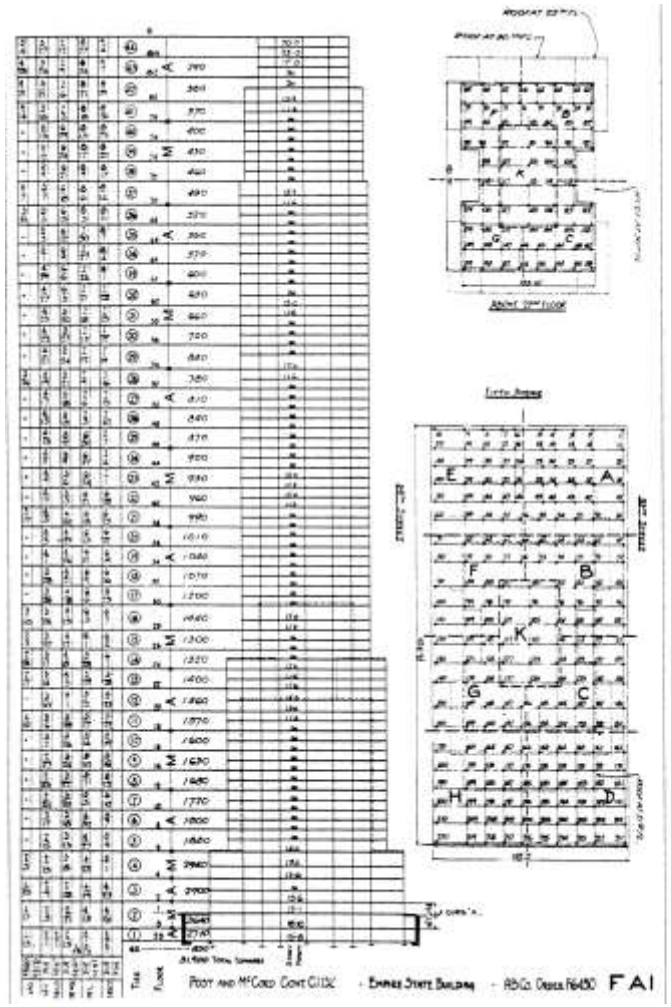


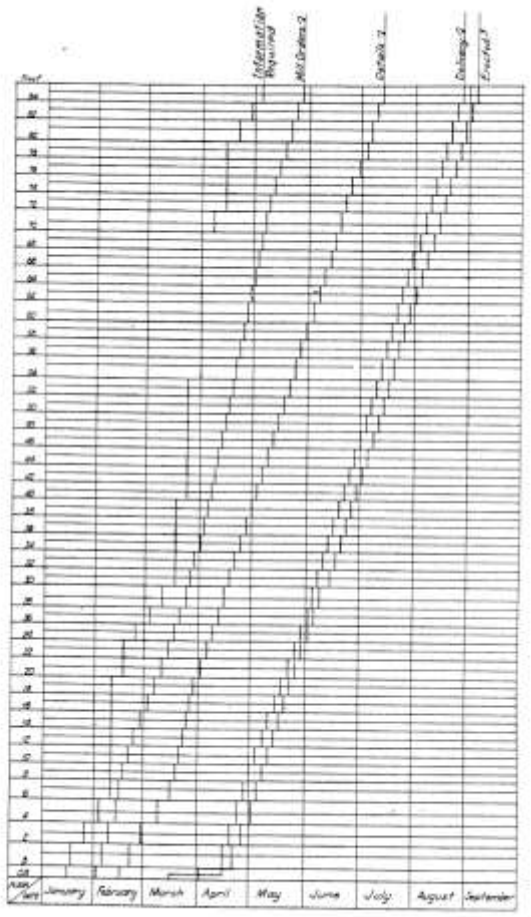


Empire State Building: LBMS

- A 102 level building,
  - sketch designs to opening for business in 18 months;
  - achieving (aligned) floor cycles of one floor per day;
  - structure completed in 4.5 months.
- The production was run like an assembly line
  - continuous and aligned production
- Emphasis on controlling the work.
  - First, actual quantities placed in locations were monitored daily.
  - Second, the work crews were checked to ensure they were working in the correct location three times per day.

Empire State Building: LBMS





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  - achieving (aligned) floor cycles of one floor per day;
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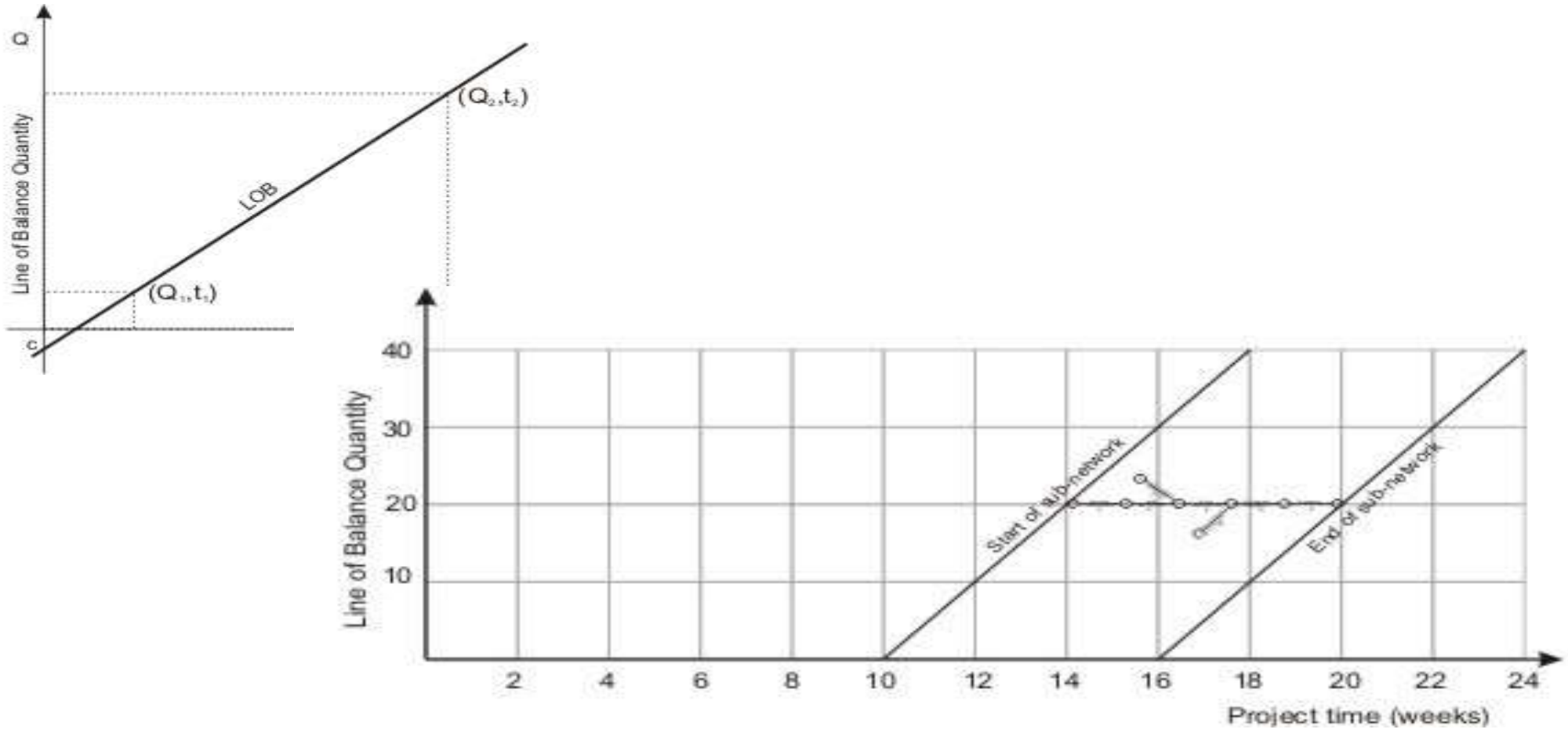
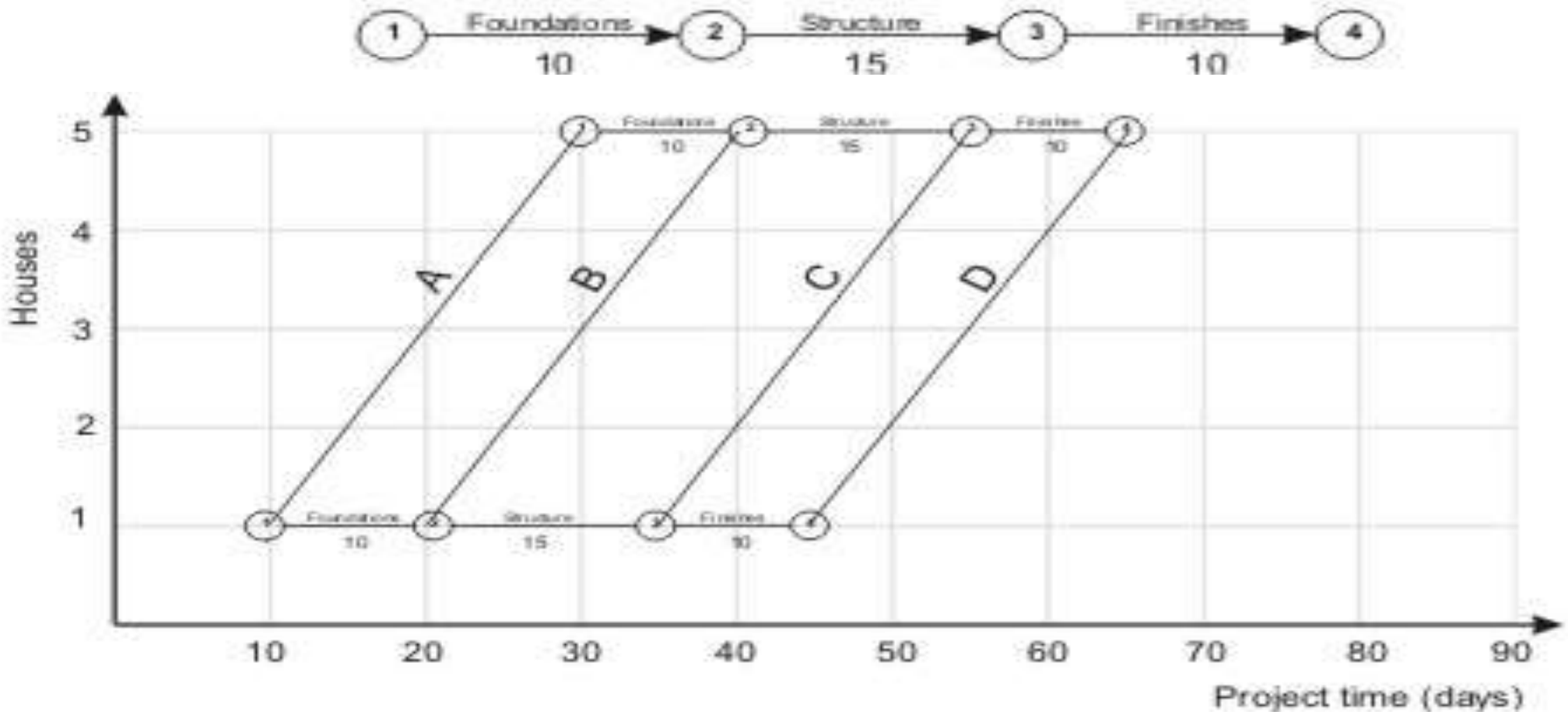
Basic Line-of-Balance

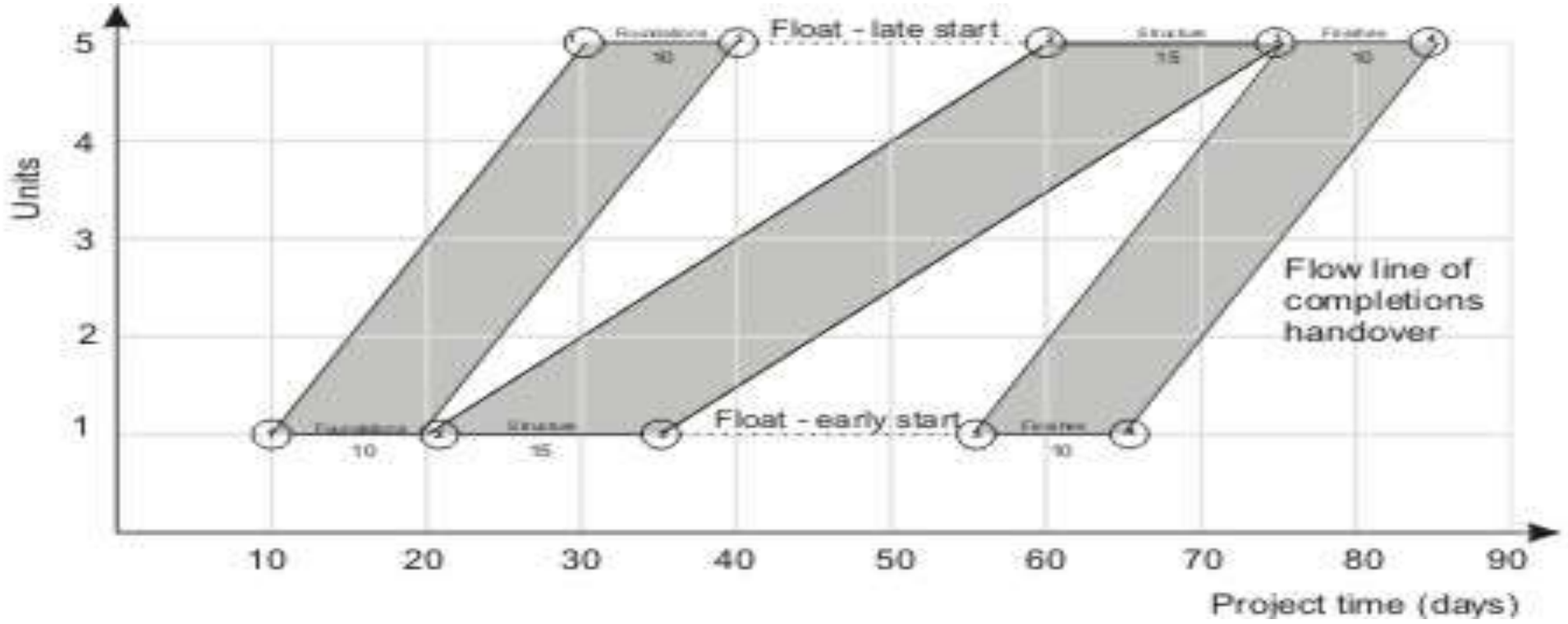


Basic Line-of-Balance

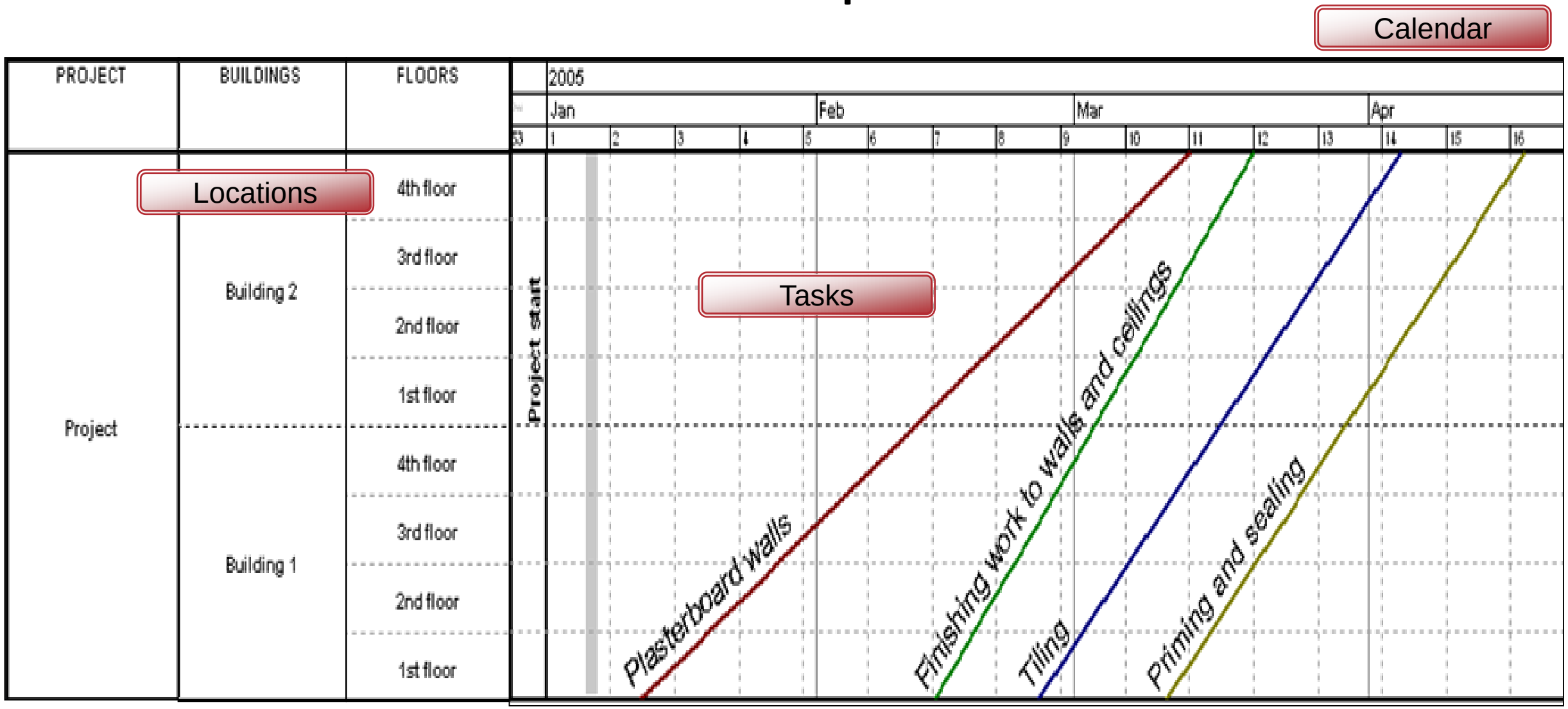


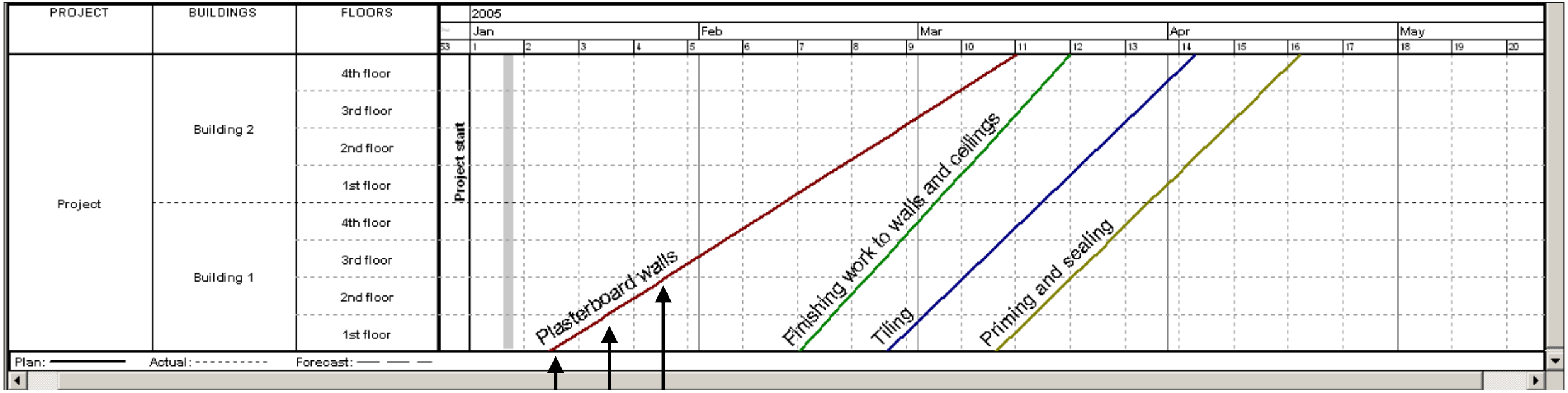
Integrating CPM/LoB

The relationship between the underlying logic (CPM) and the limits of the lines-of-balance



Simple Flowline




PROJECT
BUILDINGS
FLOORS
2005
Jan
Feb
Mar
Apr
May
53
1
2
3
4
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10
11
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13
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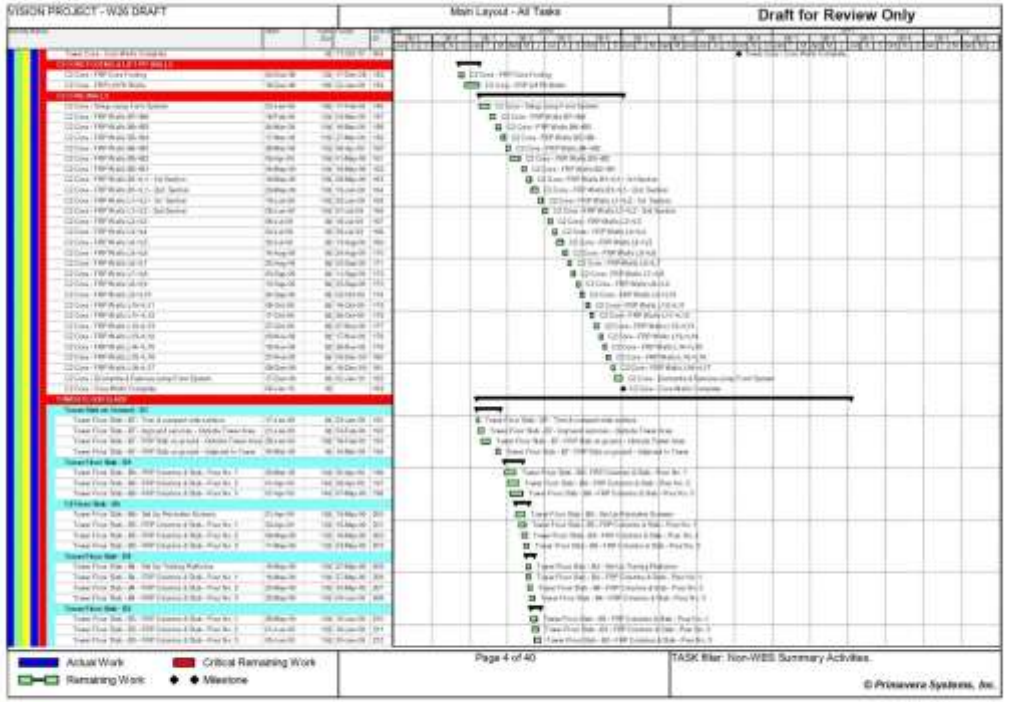
16
17
18
19
20
Project
Building 2
Building 1
4th floor
3rd floor
2nd floor
1st floor
4th floor
3rd floor
2nd floor
1st floor
Project start
Plasterboard walls
Finishing work to walls and ceilings
Tiling
Priming and sealing
Plan:
Actual:
Forecast:

Case studies

Some issues that I have encountered while working with VDC

- Planning for structural cycles
- Planning for production efficiency
- Planning for problem solving
- Project monitoring and control
- Defensive scheduling
- Horizontal infrastructure



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Planning for structural cycles

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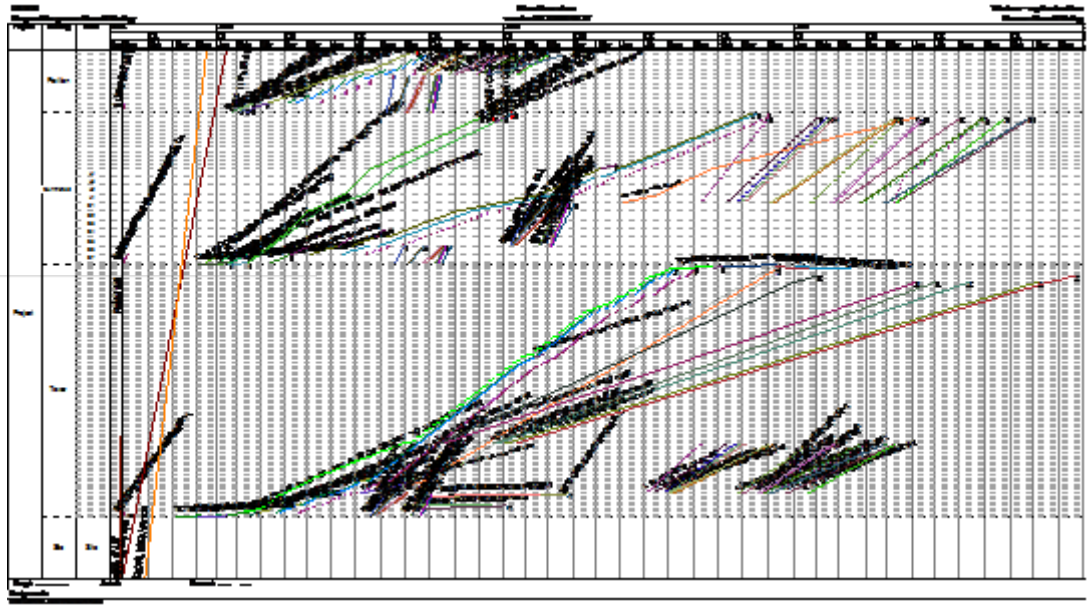
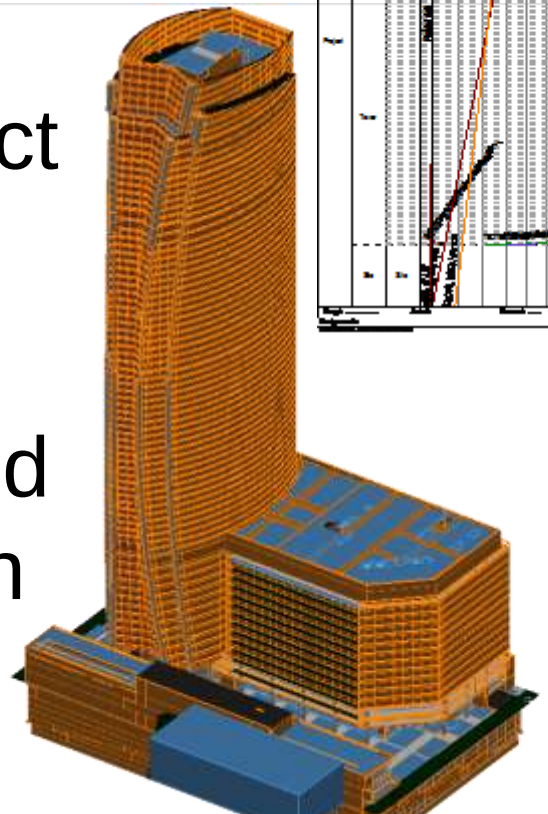
- Planning a structural cycle should not be an accident.
- Location plays a critical role in determining project duration and resource efficiency.
- Here six months removed by changing the Location Breakdown Structure





Planning for structural cycles

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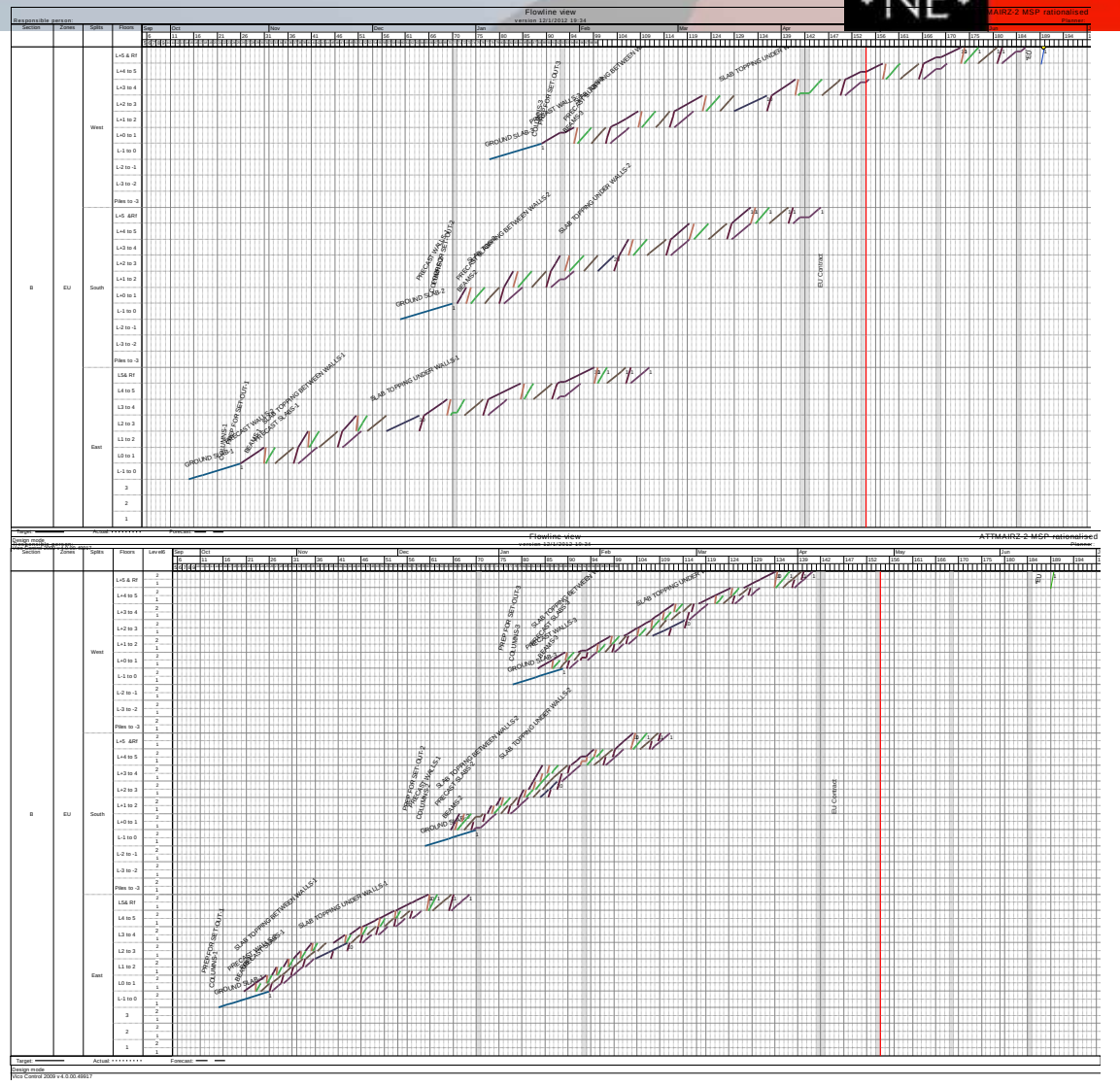
- Removing waiting time by using a smaller cycle area



Planning for structural cycles

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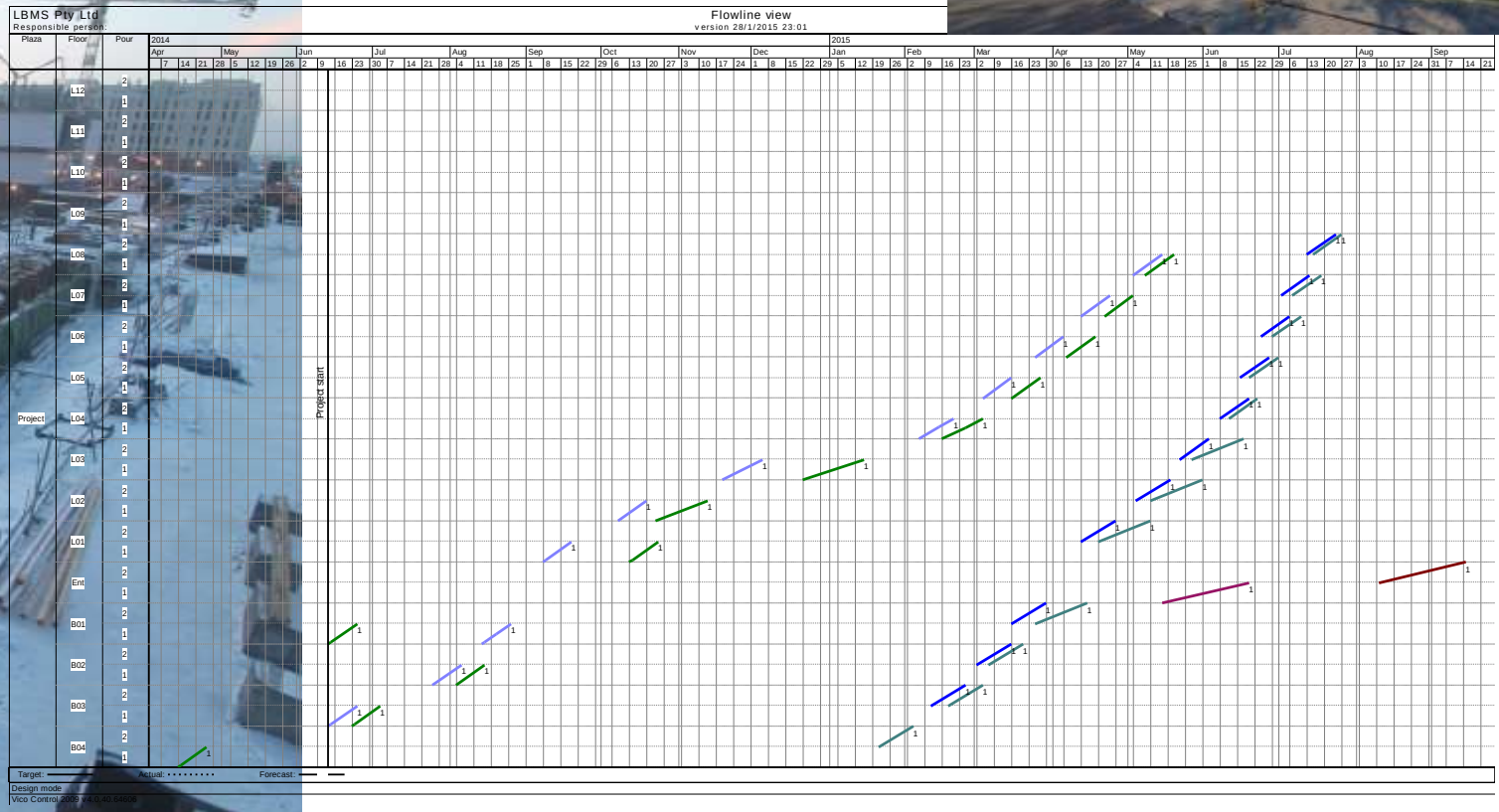
- Splitting a pour but running them apart – why?



Use 4D with care

- If you cannot see the fit-out inside a complex model
- How do you visualise the complexity of resource management

Planning for production efficiency

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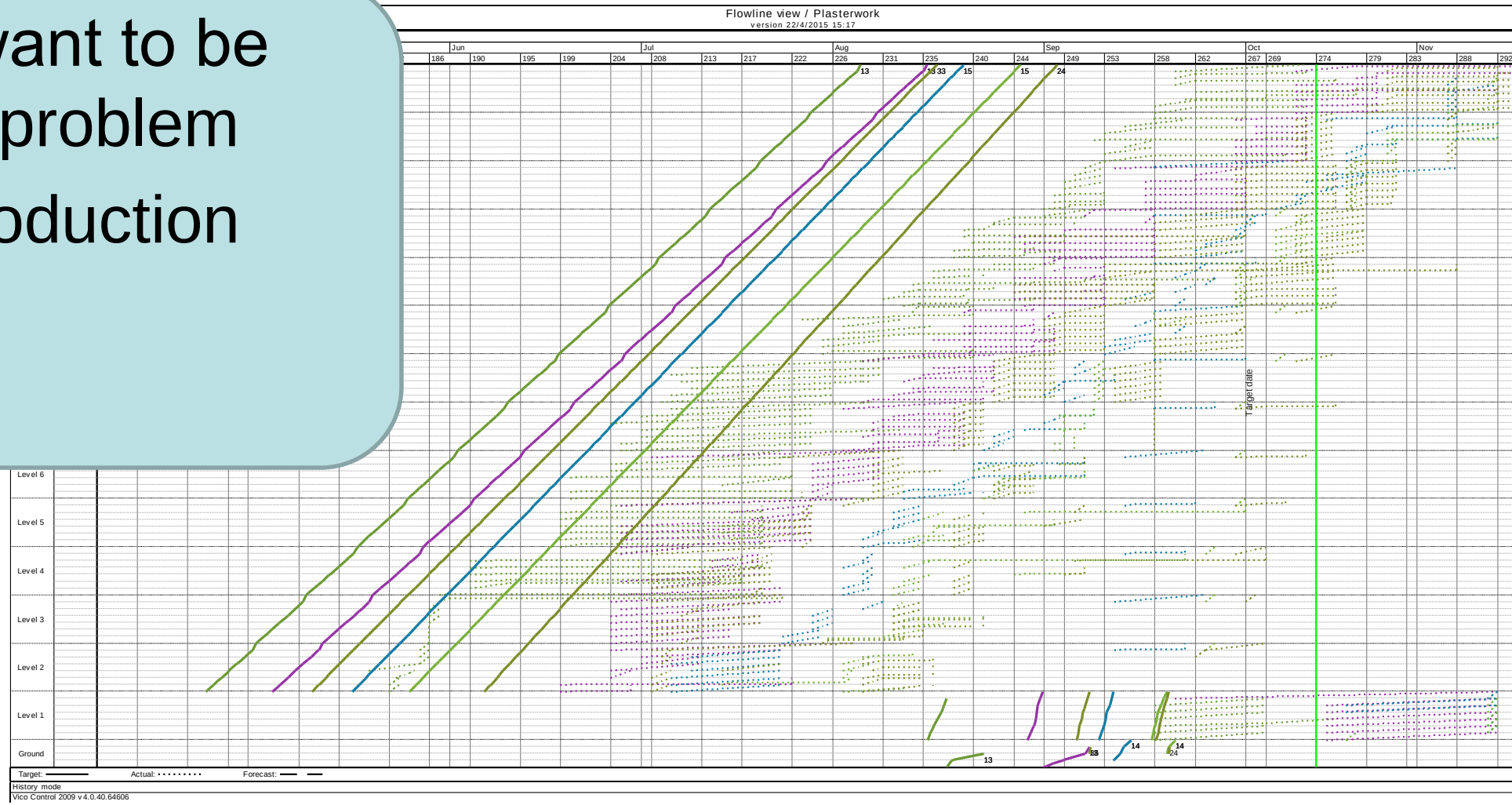
- We don't want to be part of the problem
- Plan for production efficiency



Planning for problem solving

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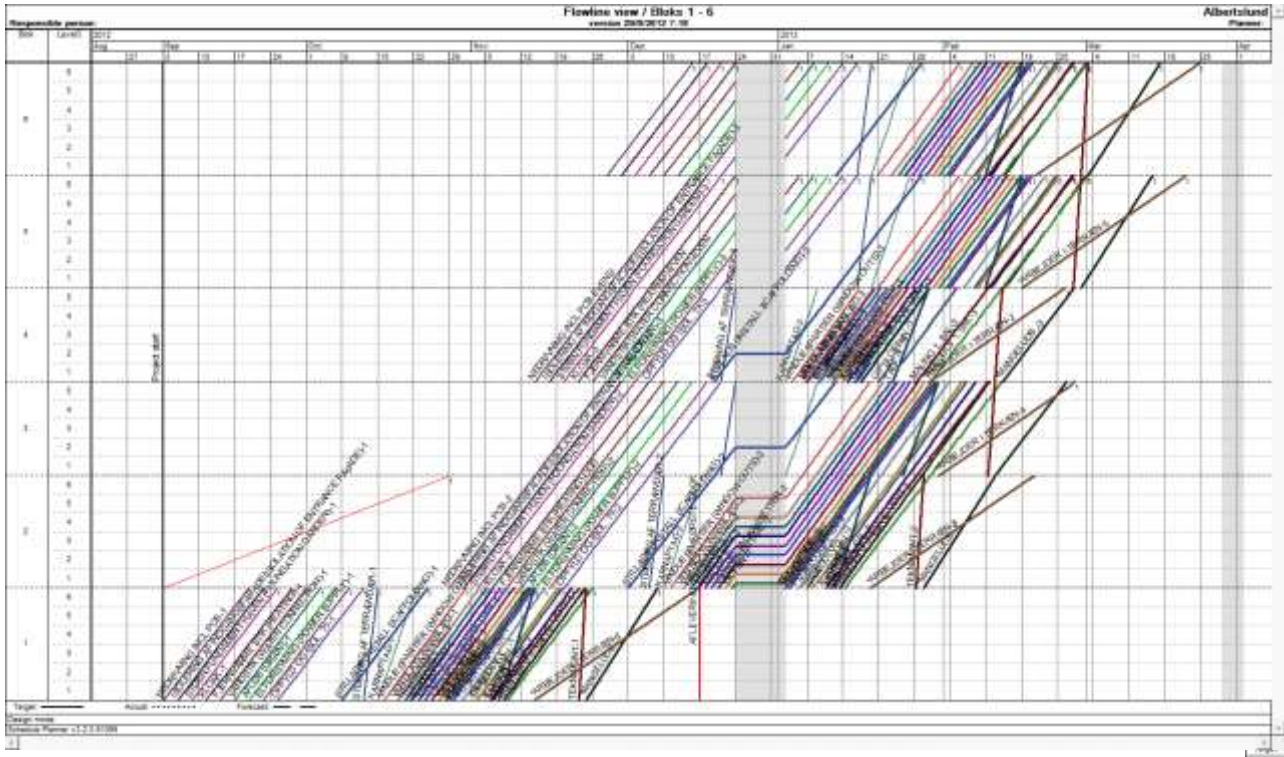
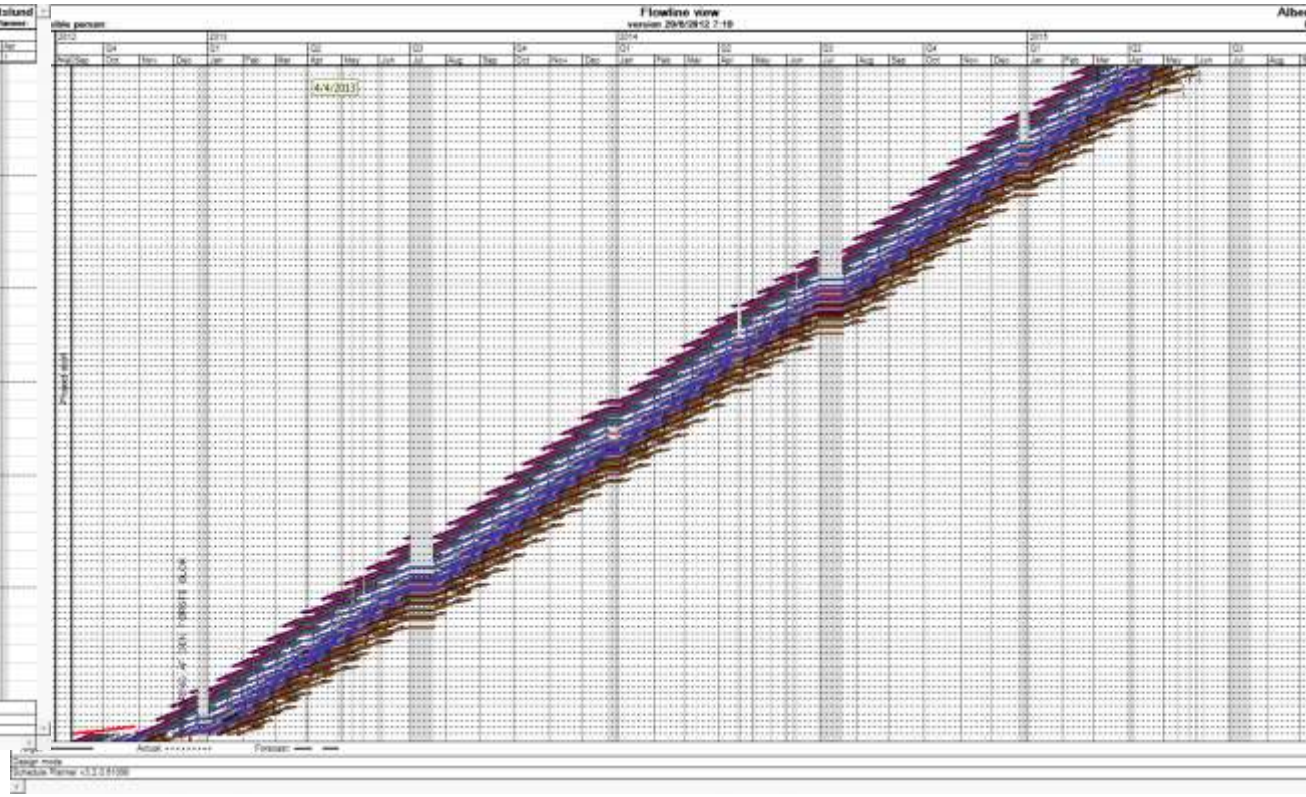
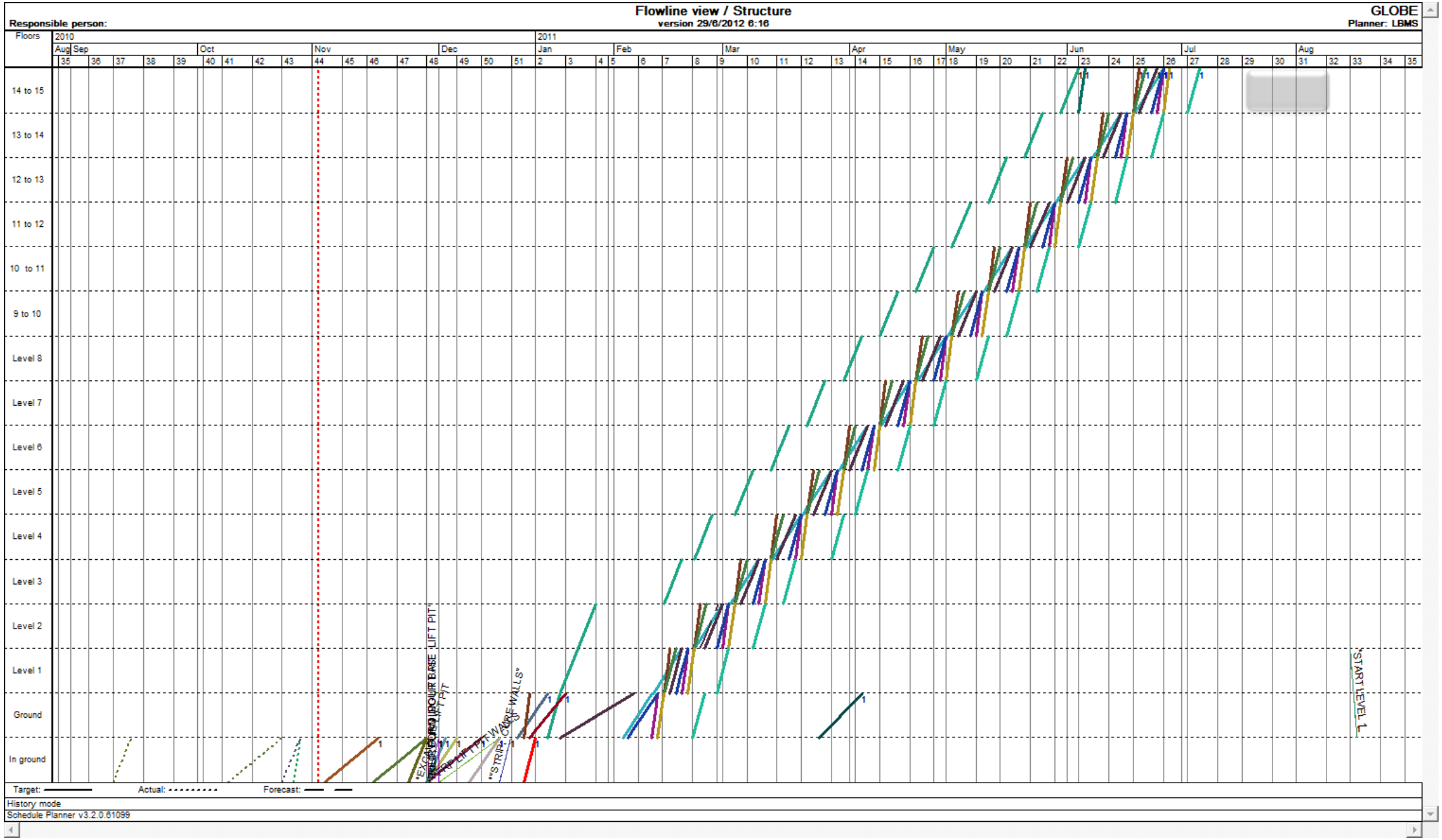




Project monitoring and control

- Contractors are displaying very bad practice when controlling projects
  - Poor logic with errors
    - Eg. Dangles, reverse logic
  - No baseline
  - Revising schedule every month
  - Not monitoring progress regularly
  - Poor status reports
  - No forecasting
    - Status is based on whether ahead or behind schedule (so always on schedule!)


Flowline view / Structure
version 29/6/2012 6:16
GLOBE
Planner: LBMS
Responsible person:
Floors
2010
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14 to 15
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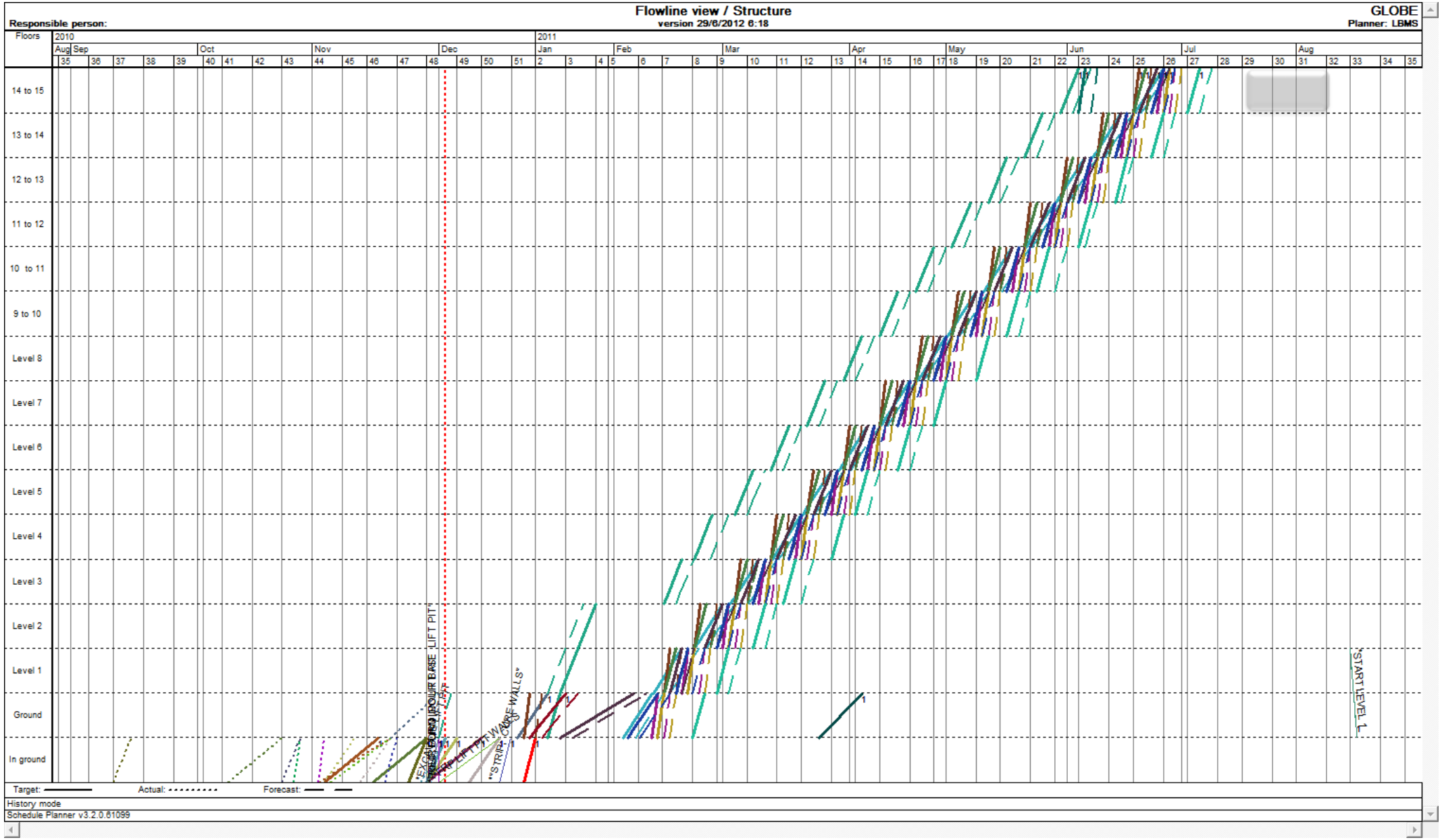
11 to 12
10 to 11
9 to 10
Level 8
Level 7
Level 6
Level 5
Level 4
Level 3
Level 2
Level 1
Ground
In ground
"START LEVEL 1"
"STRIP - CORE WALLS"
Target:
Actual:
Forecast:
History mode
Schedule Planner v3.2.0.61099


Flowline view / Structure
version 29/6/2012 6:18
GLOBE
Responsible person:
Planner: LBMS
Floors
2010
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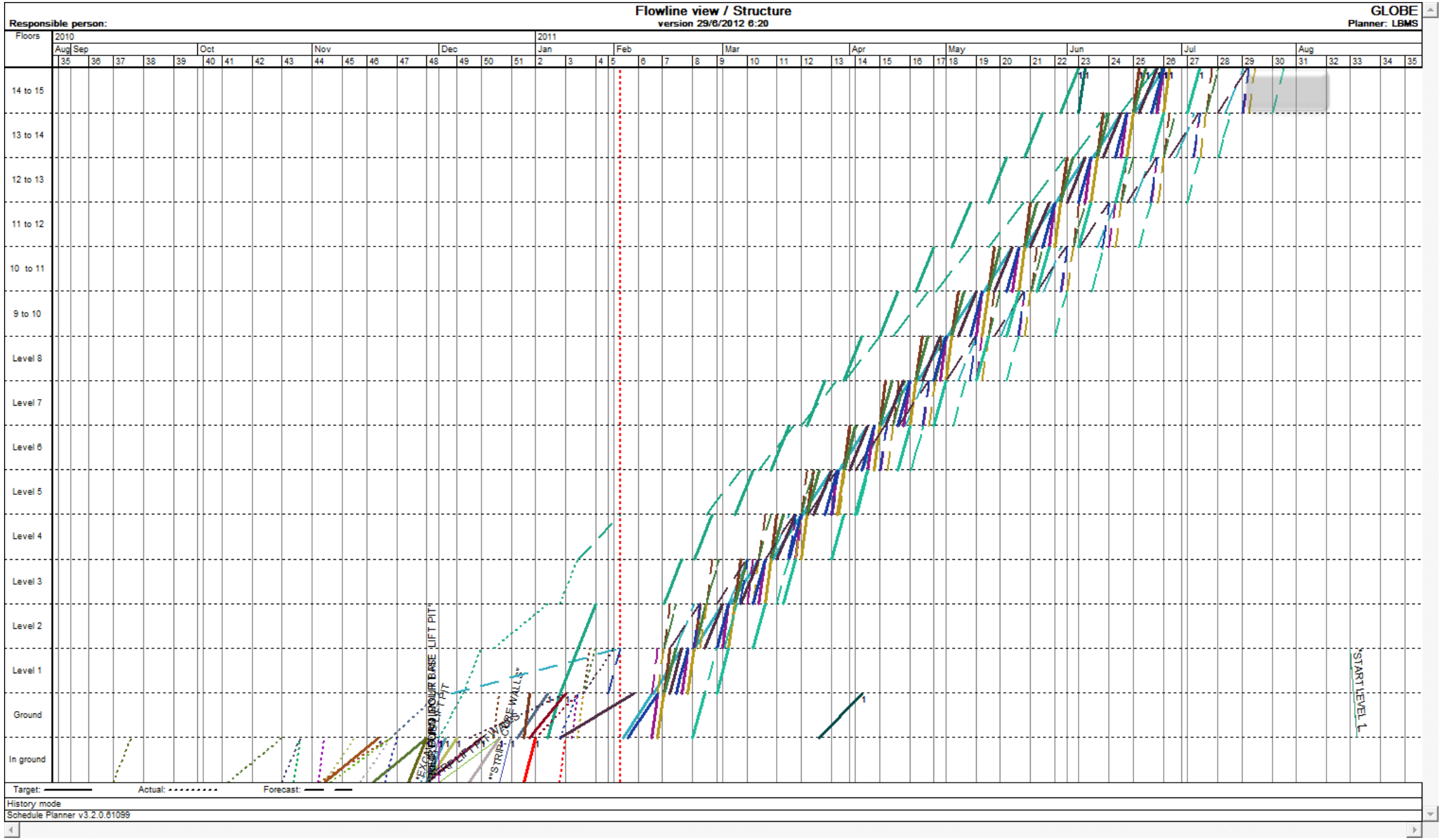
35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35
14 to 15
13 to 14
12 to 13
11 to 12
10 to 11
9 to 10
Level 8
Level 7
Level 6
Level 5
Level 4
Level 3
Level 2
Level 1
Ground
In ground
"EXCAVATE FOUNDATIONS & LIFT PIT"
"LIFT PIT WALLS"
"STRIP CORE WALLS"
"START LEVEL 1"
Target:
Actual:
Forecast:
History mode
Schedule Planner v3.2.0.61099


Flowline view / Structure
version 29/6/2012 6:20
GLOBE
Responsible person:
Planner: LBMS
Floors
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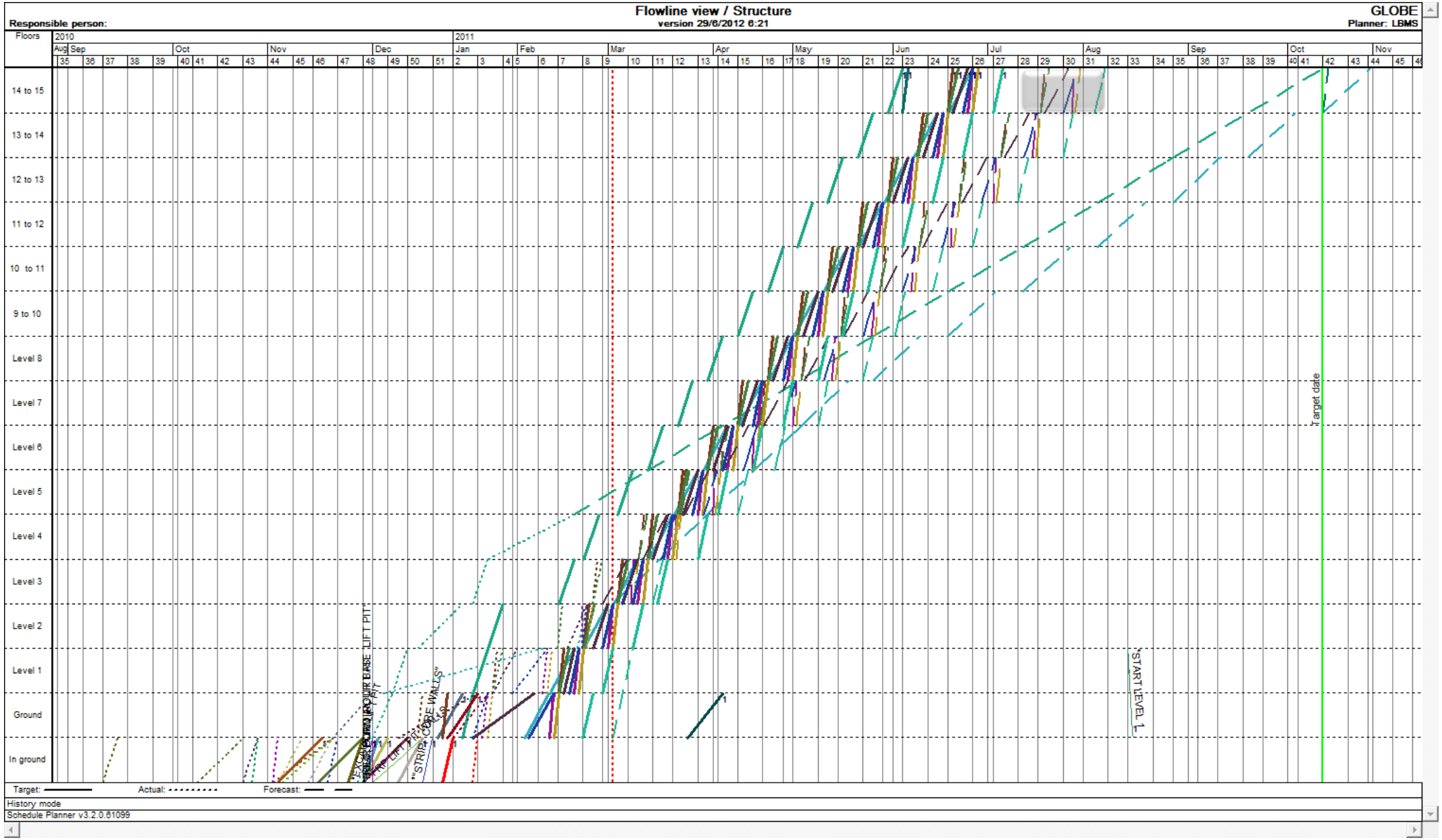
35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35
14 to 15
13 to 14
12 to 13
11 to 12
10 to 11
9 to 10
Level 8
Level 7
Level 6
Level 5
Level 4
Level 3
Level 2
Level 1
Ground
In ground
"START LEVEL 1"
"STRIP CORE WALLS"
"LIFT PIT"
Target:
Actual:
Forecast:
History mode
Schedule Planner v3.2.0.61099


Flowline view / Structure
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Responsible person:
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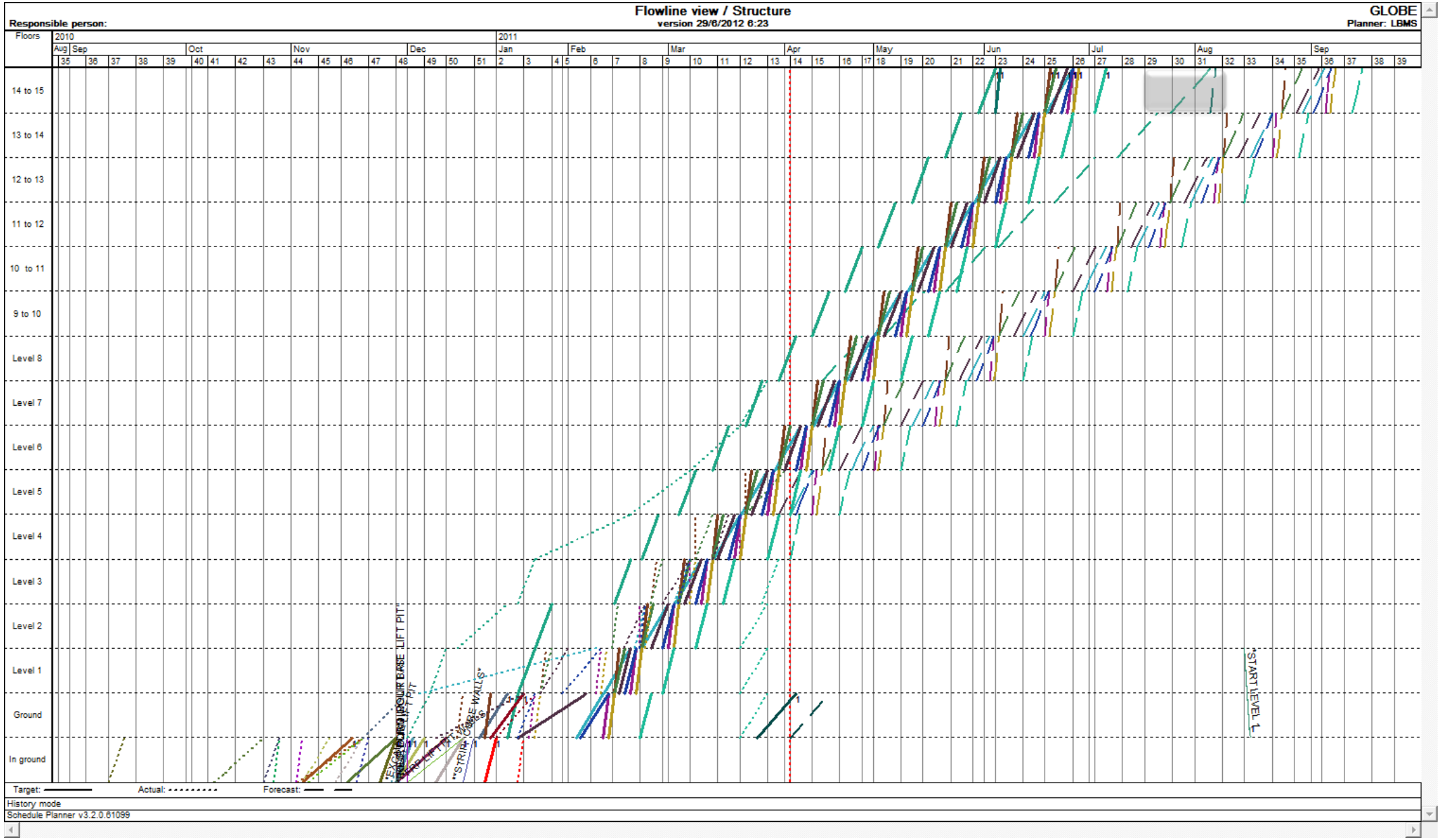
10 to 11
9 to 10
Level 8
Level 7
Level 6
Level 5
Level 4
Level 3
Level 2
Level 1
Ground
In ground
Target date
"START LEVEL 1"
"STRIP CORE WALLS"
Target:
Actual:
Forecast:
History mode
Schedule Planner v3.2.0.61099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Responsible person:
GLOBE
Planner: LBMS
Floors
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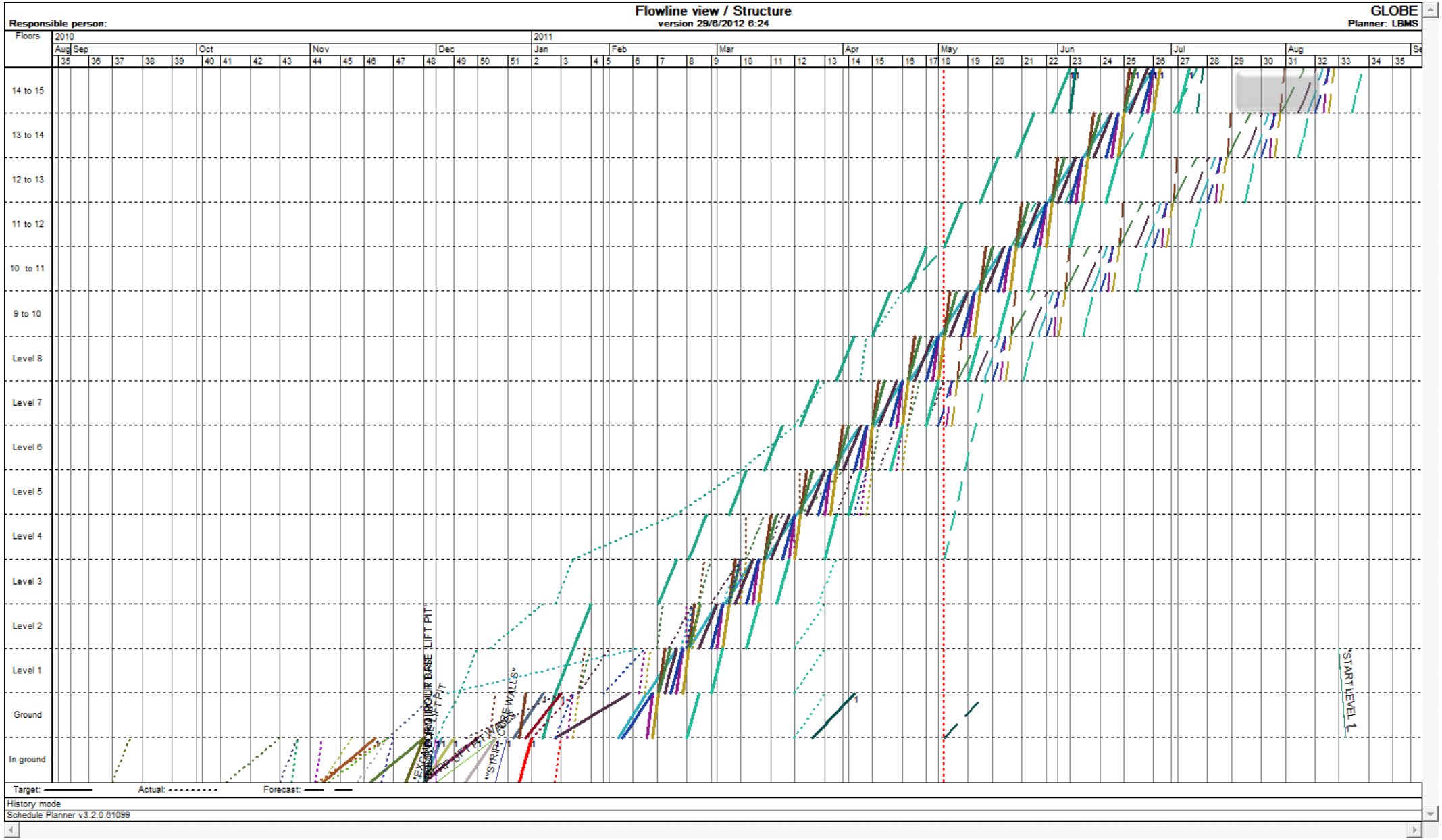
11 to 12
10 to 11
9 to 10
Level 8
Level 7
Level 6
Level 5
Level 4
Level 3
Level 2
Level 1
Ground
In ground
*START LEVEL 1
Target:
Actual:
Forecast:
History mode
Schedule Planner v3.2.0.61099


Flowline view / Structure
version 29/6/2012 6:24
GLOBE
Responsible person:
Planner: LBMS
Floors
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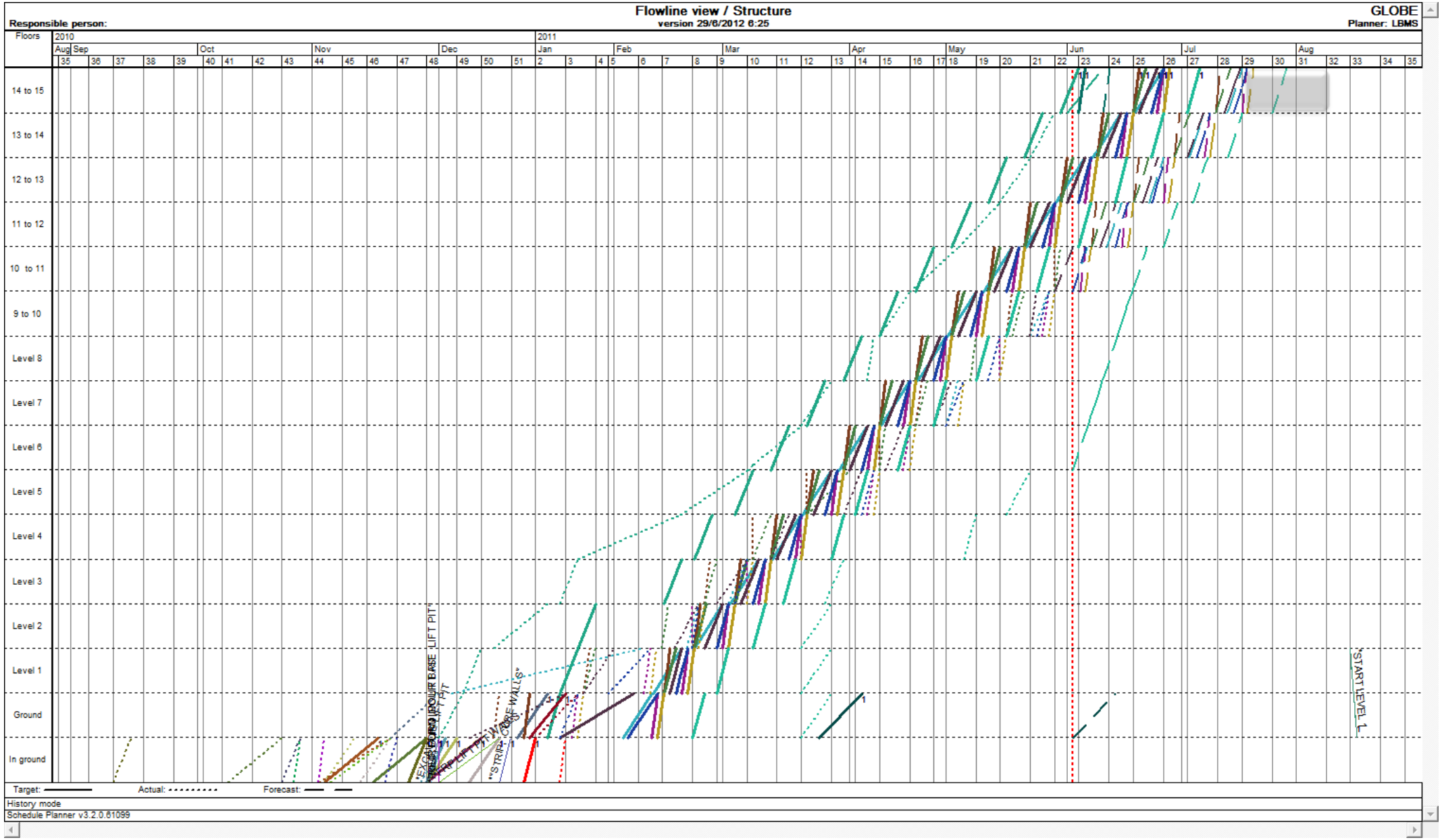
35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35
14 to 15
13 to 14
12 to 13
11 to 12
10 to 11
9 to 10
Level 8
Level 7
Level 6
Level 5
Level 4
Level 3
Level 2
Level 1
Ground
In ground
"START LEVEL 1"
Target:
Actual:
Forecast:
History mode
Schedule Planner v3.2.0.61099


Flowline view / Structure
version 29/6/2012 6:25
GLOBE
Responsible person:
Planner: LBMS
Floors
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14 to 15
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Level 8
Level 7
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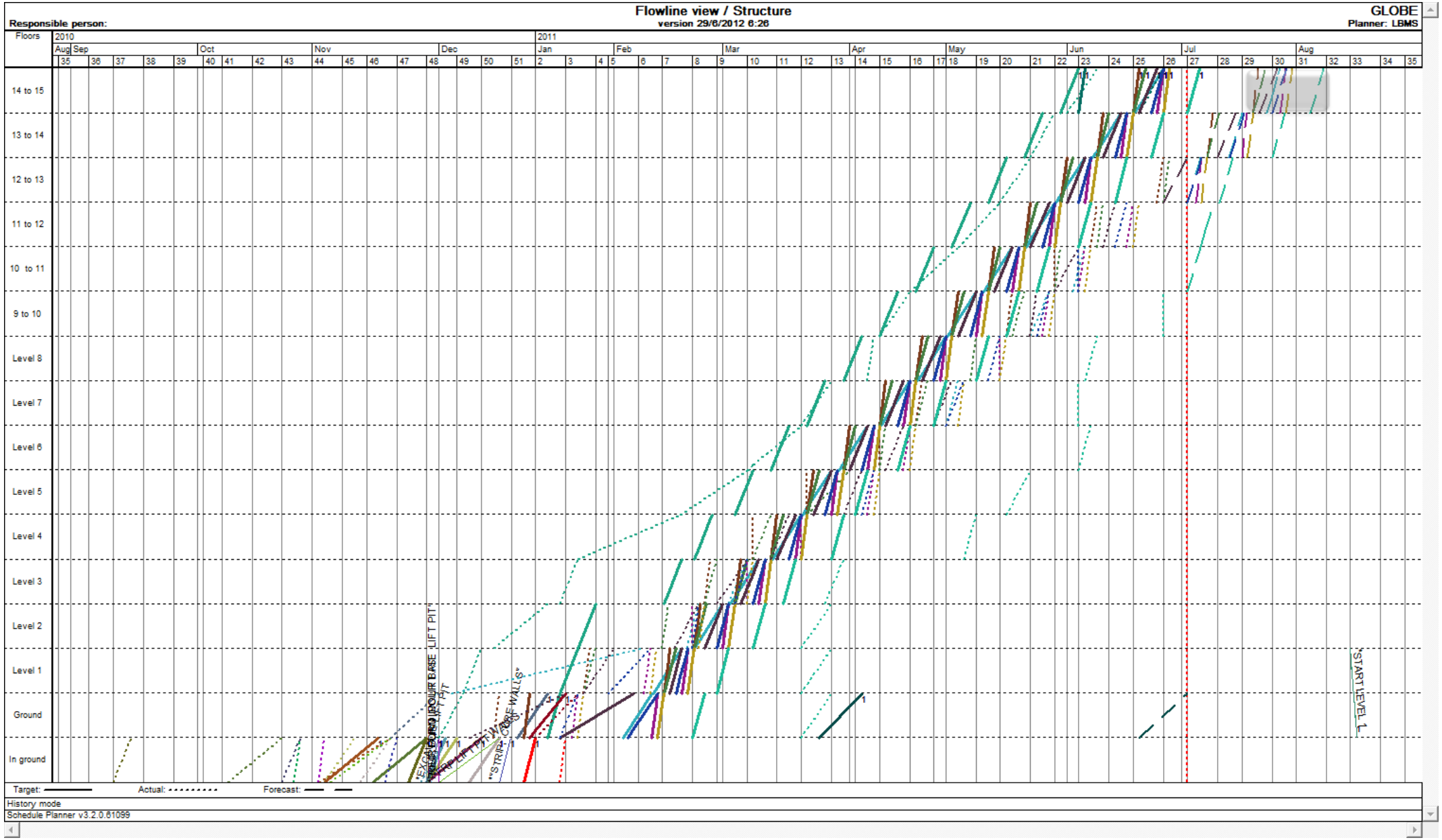
Level 2
Level 1
Ground
In ground
"START LEVEL 1"
Target:
Actual:
Forecast:
History mode
Schedule Planner v3.2.0.61099


Flowline view / Structure
version 29/6/2012 6:26
GLOBE
Responsible person:
Planner: LBMS
Floors
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14 to 15
13 to 14
12 to 13
11 to 12
10 to 11
9 to 10
Level 8
Level 7
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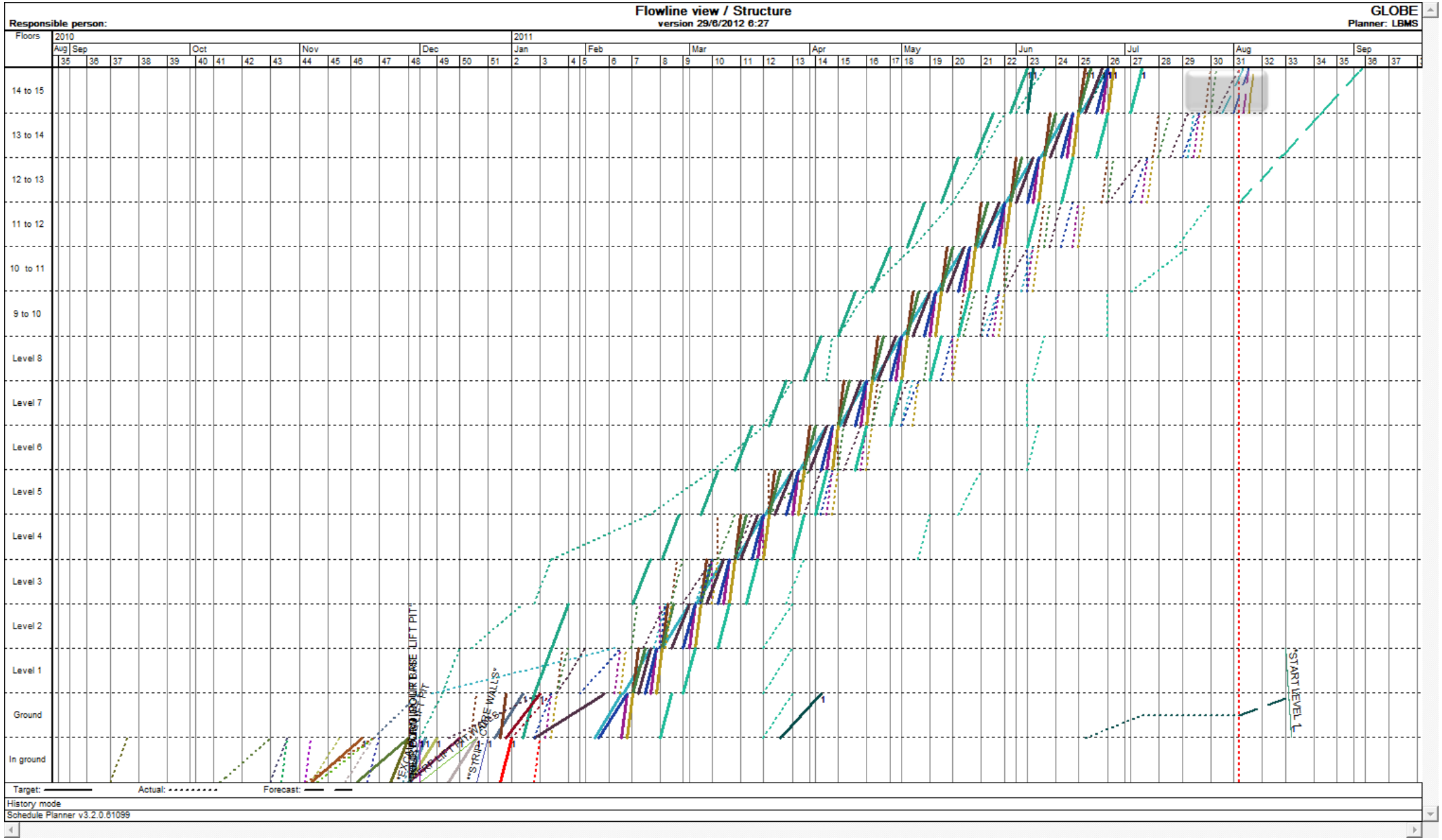
Level 5
Level 4
Level 3
Level 2
Level 1
Ground
In ground
"EXCAVATE BELOW BASE LIFT PIT"
"LIFT PIT WALLS"
"STRIP LIFT PIT WALLS"
"START LEVEL 1"
Target:
Actual:
Forecast:
History mode
Schedule Planner v3.2.0.61099


Flowline view / Structure
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Planner: LBMS
Responsible person:
Floors
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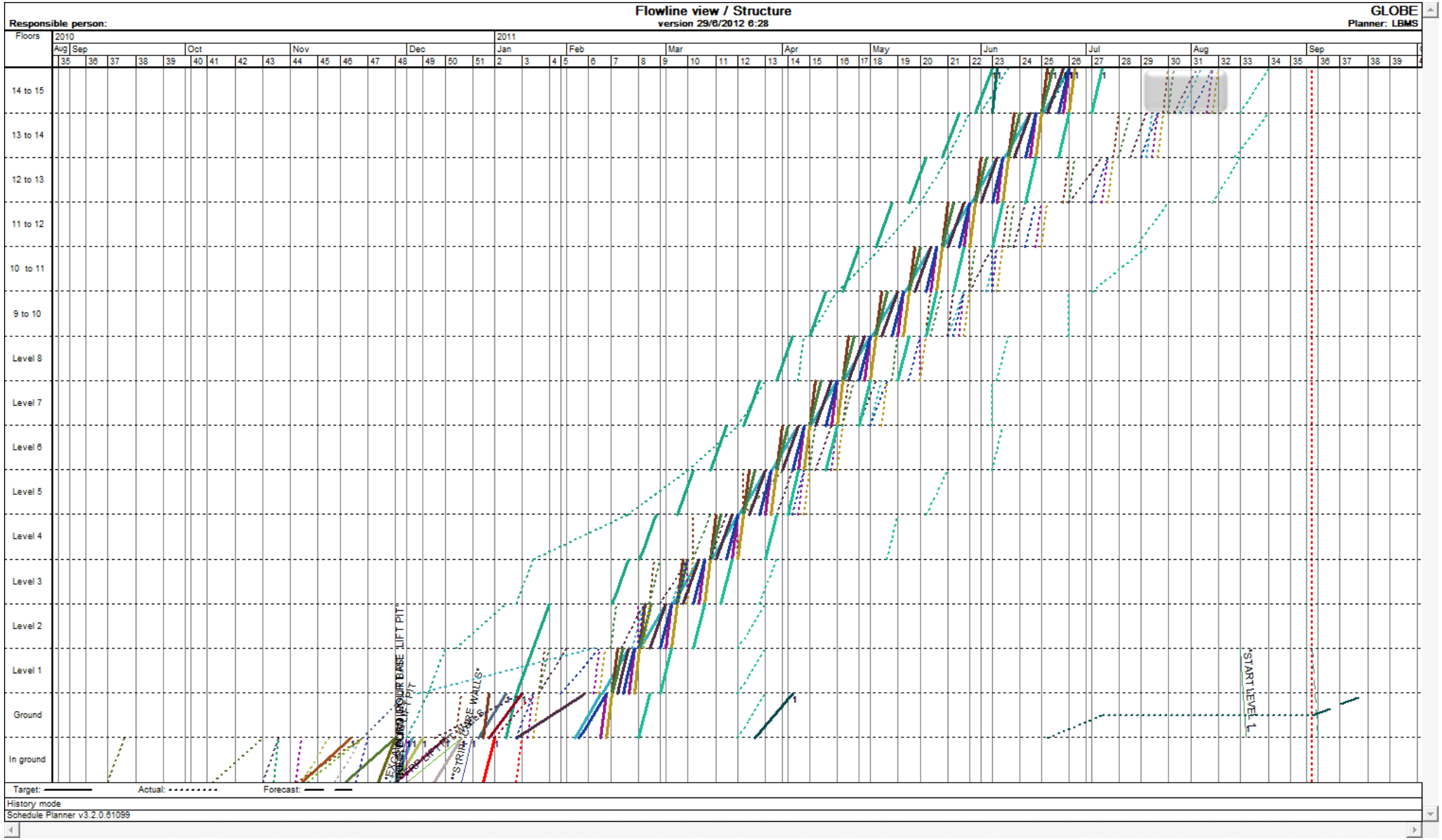
Ground
In ground
"START LEVEL 1"
Target:
Actual:
Forecast:
History mode
Schedule Planner v3.2.0.61099


Flowline view / Structure
version 29/6/2012 6:28
Responsible person:
GLOBE
Planner: LBMS
Floors
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11 to 12
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Level 8
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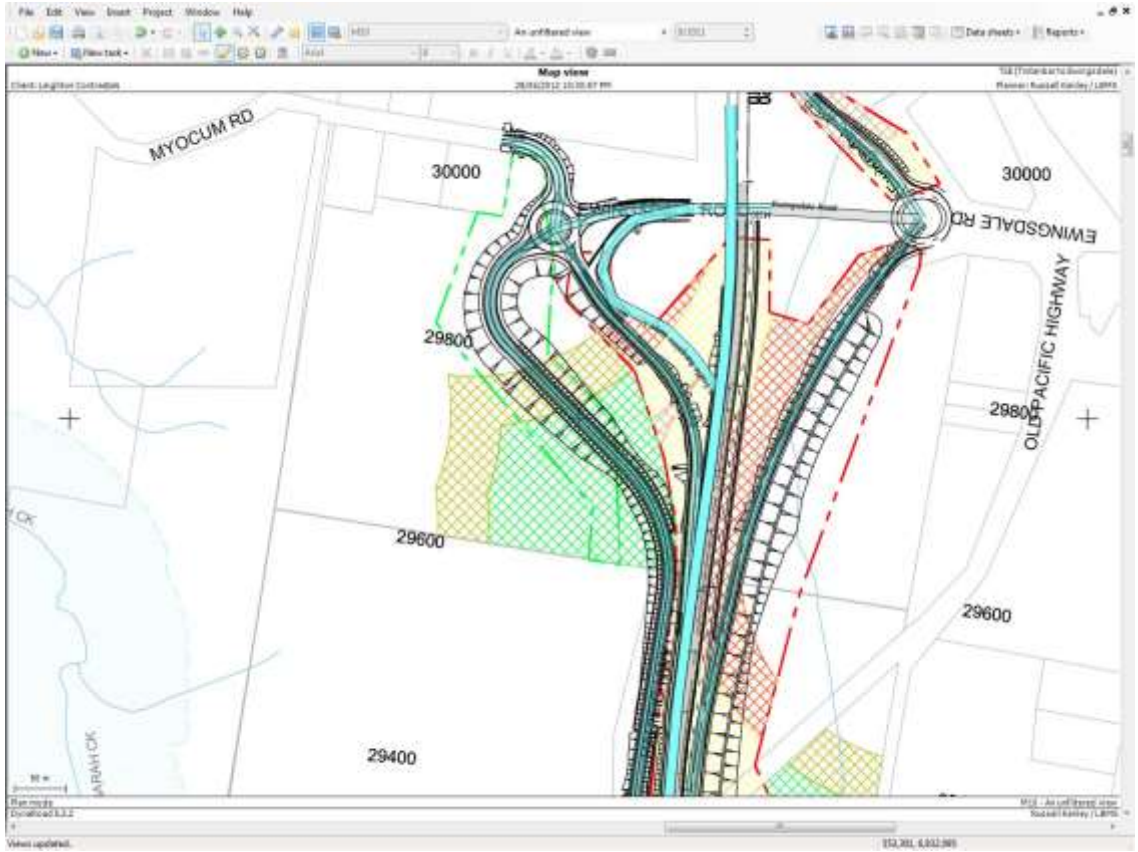
Level 1
Ground
In ground
"START LEVEL 1"
Target:
Actual:
Forecast:
History mode
Schedule Planner v3.2.0.61099

Rapid scheduling

- Rapid prototyping

Horizontal infrastructure

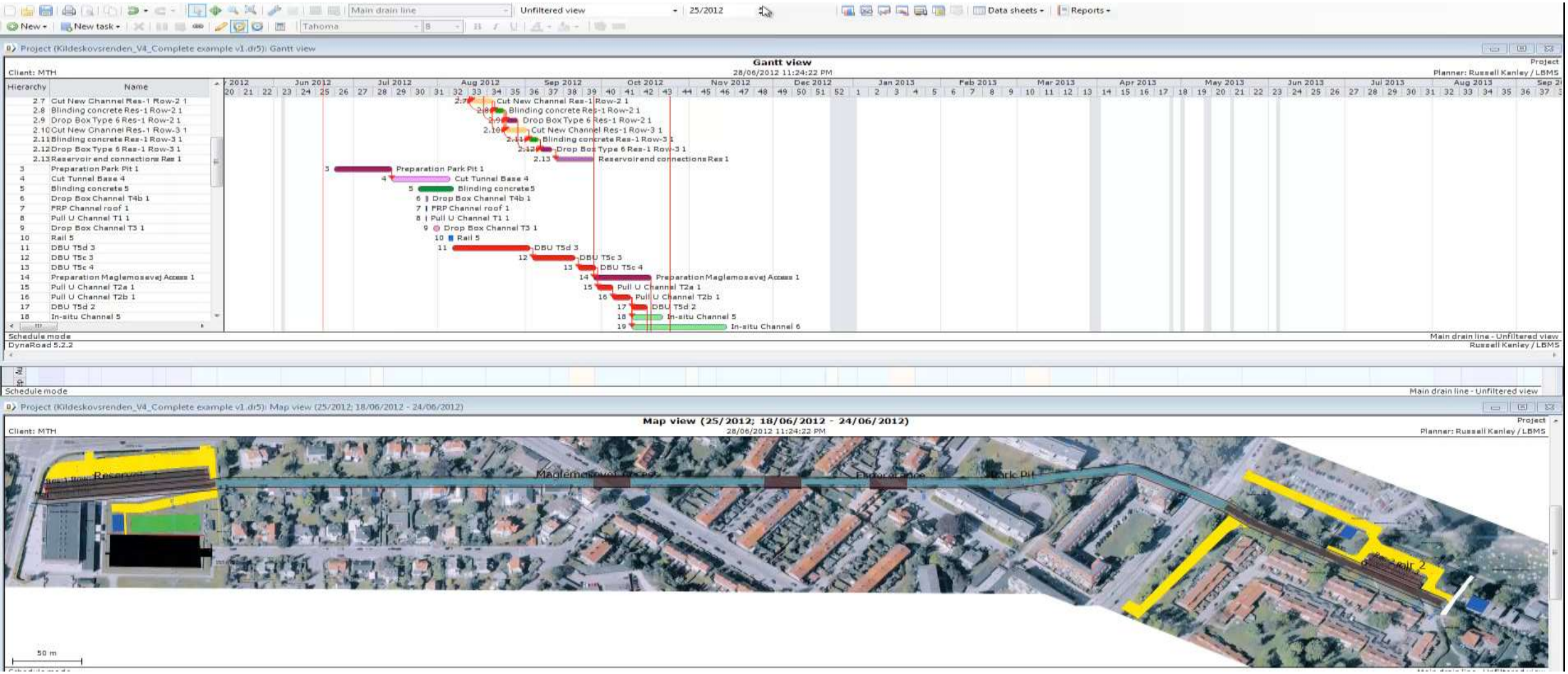
Sustainable Built Environment National Research Centre



- Alignment based
- Real-world coordi

Horizontal infrastructure

Horizontal infrastructure



Distributed Construction or Maintenance

- Distributed work involves location
- Resources can be managed across locations
- Management by location should be explicit
- Partnering with MPI to create new *Location* functionality for CPM

Questions?