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**PROJECT GOVERNANCE BY PROJECT
MICRO-MILESTONES**

Construction Management

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**PROJECT GOVERNANCE BY
PROJECT MICRO-MILESTONES**

LOCATION-BASED MICRO-MILESTONES AND PRE-REGISTERED PAYMENT DISTRIBUTION

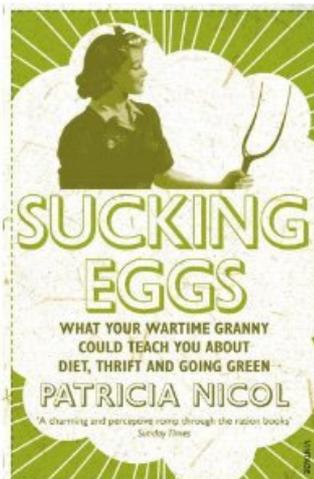
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- Professor, Management Swinburne University of Technology
- Visiting Professor of Construction Unitec New Zealand
- Director – Micro Planning International
– LBMS Pty Ltd
- Exploring the role of location in construction and asset management

Learning objectives



Issues



"Having the money tree has really helped out."

1. Cash flow is critical in construction
2. Security of payments legislation not effective, nor fair
3. Governments are exploring Project Banks (PBs)
4. PBs are reliant on monthly progress payments
5. Can we improve the payment system?
6. Can we improve control?

Christchurch's Urban Construction in liquidation, creditors owed \$1.5 million



- owing about \$1.5 million
- leaving nearly 150 unsecured creditors unlikely to see a cent
- Liquidator Rodgers Reidy attributed the company's demise to cashflow difficulties, loss of a significant contract, delays in workflow and loss of support from the company's financier.

Stonewood contractors owed hundreds of thousands



- The faltering business owes about \$15 million to unsecured creditors and is part-way through building 110 homes

One of Queensland's biggest builders has hit the wall

- Matrix Projects, which built the likes of the Mosaic development in Fortitude Valley as well as major Gold Coast high rises, collapsed just before Christmas with debts of almost \$7 million.
- A creditors report, by liquidators Peter Lucas and Glenn Shannon, cites \$6.7 million in debts, owed mainly trade creditors



Greg Stolz, The Courier-Mail
January 30, 2015 9:48pm

South Australian construction and civil engineering firm York Civil goes into administration

- Opposition transport spokesman Tom Koutsantonis blamed York Civil falling into administration on the lack of infrastructure projects.
- "There is a valley of death in infrastructure spending that we warned about — and it's here," the former treasurer said.
- "Its first victim is a great South Australian company with nearly 30 years worth of history here in South Australia gone."
- He said he hoped the government had not been withholding payments to York Civil because of a dispute of who was to blame for the tramline delay



ABC: By [Leah MacLennan](#)
Updated 6 Aug 2018, 2:54pm

Ebert Construction's collapse stokes fears of NZ's booming building and construction industry going bust

- The liquidation of Ebert Construction leaves hundreds of workers and contractors across the country in limbo, facing an uncertain future.
- It's estimated at least \$40 million is owed to creditors.
- Fisk said Ebert's 15 contracts included a new \$57m acute mental health unit for Middlemore Hospital



Ebert Construction builds mansion for its managing director

- A director of failed Ebert Construction was building a multi-million dollar mansion in an exclusive seaside enclave while his company teetered on the brink of collapse.



How to make money

- “About 20 years ago Kim Macdonald’s tradesman father did a job for a highly regarded businessman who promised to boost his income significantly overnight without changing a single thing about his work.
- The businessman promised to reveal the secret to greater success once her father completed the job and she remembers her parents being excited about the impending life-changing advice.
- The advice, exclaimed the businessman, would bring the father more money for doing absolutely nothing. It would change the way he lived and saw the world. Everything would be better. He would be richer and happier.
- **‘Pay all your bills late’**, was the advice”.

[Kim Macdonald](#) The West Australian
Tuesday, 27 March 2018 2:46PM

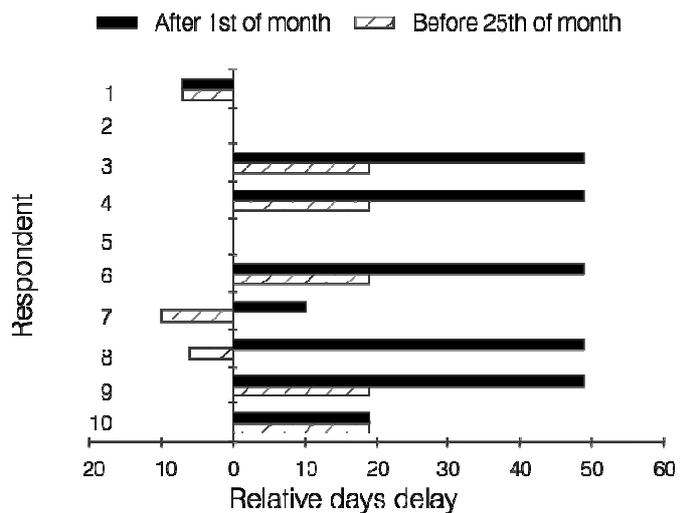
Payment terms

- She continues...
- This approach has been embraced by the building industry. It is now the modus operandi for many big building companies and head contractors to pay subcontractors as late as possible, while accruing substantial interest on their multi million-dollar contracts.
- While the law stipulates payment must be made within 42 days, a recent Federal Government survey showed most were paid more than two months after finishing a job and 13 per cent routinely waited 90 days for payment.

[Kim Macdonald](#)The West Australian
 Tuesday, 27 March 2018 2:46PM

Payment terms

Interpretation of contract terms as described by Kenley & Wood (1996), who demonstrated that the payment terms "30 days" are frequently interpreted to suit the head contractor, with 30 days frequently meaning 60 days and often as much as 90 days from the date of the work being executed



Australia's Large Builders Hoard Cash Owed to Suppliers

- Large builders throughout Australia are hoarding cash owed to suppliers and subcontractors and are using muscle to pay invoices later...
- They have the luxury of referring the contractor to 'the accounts department' and that is where the contractor remains...for months.
- The accounts person blames the project manager, and the project manager refers back to accounts.
- This is deliberate and a planned strategy



Andrew Heaton: Construction
6 June, 2017
Citing: Dunn & Bradstreet : first quarter
2017 analysis of payment trends

Australian Construction Firms Owed \$15.4 Billion in Unpaid Debt

- Small and medium sized construction businesses throughout Australia are 'drowning in a sea of unpaid customer bills' according to the latest report which found that small and medium businesses throughout the sector are owed a combined total of \$15.4 million in unpaid debts.



"I don't have any cash flow problems.
It all washed away in the flood."

Story by Andrew Heaton - Sourceable.net

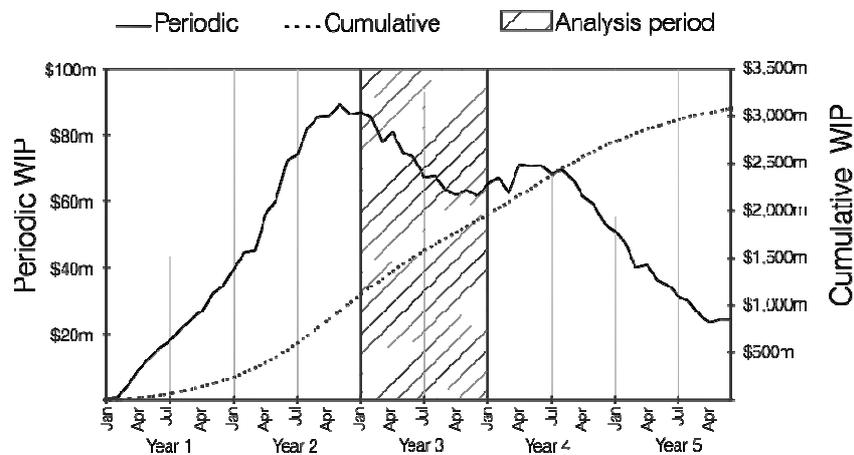
Cash farming

- Gyles coined the phrase "cash farming" to describe these practices and accepted that they are significant whether companies are solvent or not.
- "The liquidator noted that, largely, the company was funded by progress payments in excess of work in progress"



Gyles Royal Commission 1992

Cumulative working capital: approx 20% turnover



What goes wrong

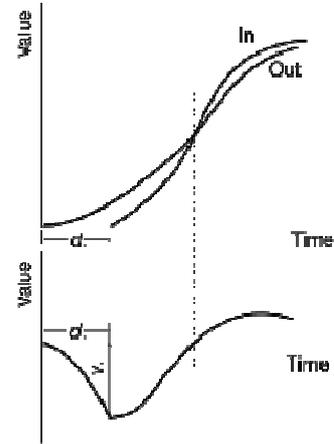
- “The company's cash flow initially suffered from delays on projects caused by unusually wet weather. The cash flow shortage, together with under-pricing on certain projects led, in many cases, to an inability to complete jobs. Further, the lack of new projects resulting from a decline in the construction industry denied the company any chance of trading its way out of difficulties”

What I said in 1997 :

- The practice is endemic in the industry and company failure results from perpetrators being unable to accommodate changes in their financial circumstances. There are four factors at work.
 - An initial shortage in capital
 - Funds for operations are derived from projects
 - The funds available from operations are reallocated to either paying out losses or reinvested in non-liquid assets, and
 - There is a cut-off in supply of funds usually caused by a slowdown in supply of projects or delays in their execution.
- If one of these points does *not* apply, then firms may, practically, continue to trade.
- But, when they do... Bam!

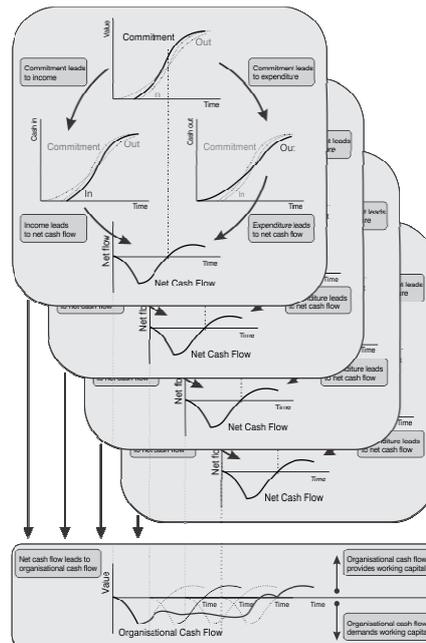
Cash flow

How a project contributes to working capital



Working Capital

How many projects contribute to working capital

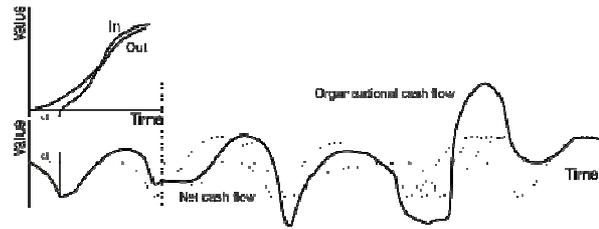


Working Capital

How many projects contribute to working capital

- A series of projects contribute an overall pattern of WC

Poor cash management

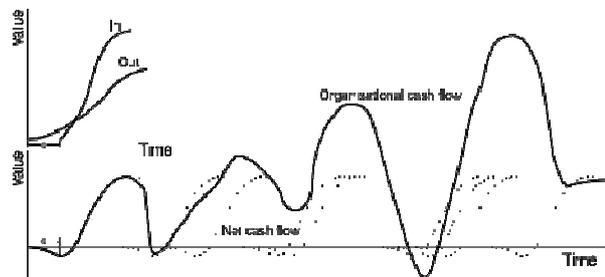


Working Capital

How many projects contribute to working capital

- A series of projects contribute an overall pattern of WC

Good cash management

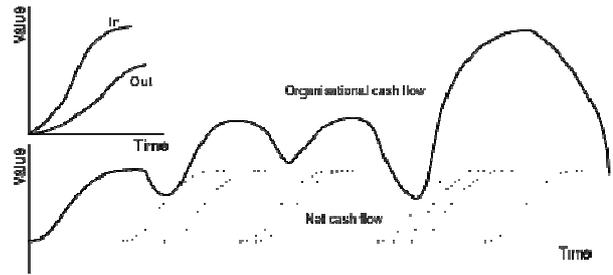


Working Capital

How many projects contribute to working capital

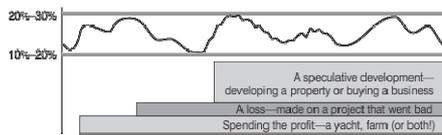
- A series of projects contribute an overall pattern of WC

Great cash management

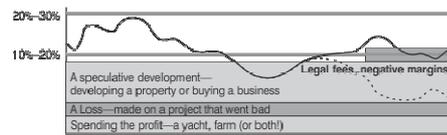


Working Capital

Wow, we are rich!

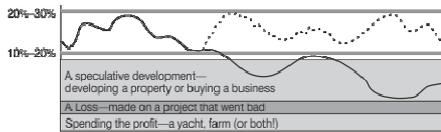


Hmmm, business is getting tough

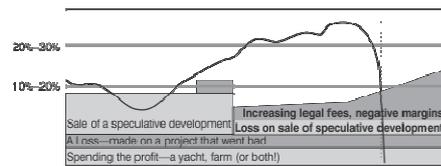


Working Capital

What can we sell, delay payment?



How did that happen?
How can we owe \$50m
when each project is only worth \$50m



Fixing the problem: Project Bank Accounts

Do project bank accounts help?

- The way to fix this is to introduce project bank accounts for any government or private project worth more than \$1 million, and separate trust accounts for retention payments.

[Kim Macdonald](#) The West Australian
Tuesday, 27 March 2018 2:46PM



Trials of PBAs

Australian Jurisdictions

- WA (trial) (\$1.5m to \$100m)
- NSW (10 trial PBAs)
- Vic (trial)
- NT (tials)
- Qld (evaluating)
- Generally
- Exclude Infrastructure

International

- Highways England since 2012
 - 35 PBs as at April 2015

Deloitte Access Economics 2018



PBAs: two models

Principal established

- The Principal and Head Contractor executing a trust deed to establish a trust with the **Principal as trustee** and Head Contractor and Subcontractors as beneficiaries.

Contractor established

- The Principal and Head Contractor executing a trust deed to establish a trust with the **Head Contractor as trustee** and naming the Head Contractor and Subcontractors as beneficiaries.

Deloitte Access Economics 2018



Payment system: two models

Principal established

- The Head Contractor prepares a Progress Payment Instruction (PPI) including all amounts certified as payable to each Subcontractor.
- If the PPI is correct, the Principal deposits the payment into the PBA and provides the Bank with the PPI, authorising the bank to disburse funds in accordance with the PPI.
- The bank then pays the Head Contractor and Subcontractors from the PBA as per the PPI.

Contractor established

- The Head Contractor then prepares the Progress Payment Instruction (PPI) including all amounts certified as payable to each Subcontractor.
- Unlike Model 1, the Principal does not confirm the accuracy of each individual payment amount.
- The Principal provides the Subcontractor with a copy of the relevant portion of the final PPI. The Principal deposits the progress payment into the PBA.
- The Bank then pays the Head Contractor and Subcontractors from the PBA in line with the PPI.

Deloitte Access Economics 2018



Impact on working capital

- The most significant cost to head contractors under both the Government-only Scenario and the Industry-wide Scenario is the reduced working capital from the loss of access to progress payments (which under the Base Case can be utilised by the Head contractor as working capital), which amounts to a cost of \$143m under the Government-only Scenario and \$3.4bn under the Industry-wide Scenario.
- The avoided 12% financing cost amounts to a saving to sub-contractors of approximately \$191m in present value terms (over 20 year evaluation period) under the Government-only Scenario and \$4.6bn under the Industry-wide Scenario.



"I just need enough money to tide me over until I need more money to tide me over."

Deloitte Access Economics 2018

Loss/Gain of working capital (=20% turnover)

That's a loss of 20% of turnover
for Head Contractors!



That's a gain of 20% of turnover
for Sub-Contractors!



Calculating payments: monthly progress claims

Progress claim based on WIP

- Agreement between head contractor and client's rep
- Something of a negotiated settlement
- Sub-contractors not represented

What is wrong

- Incentive to commence work
- Incentive to claim 80% of work
- No incentive to complete work
- Little sensitivity for control
- Little accountability for actual sub-contractors work



Can we fix it? Yes we can!



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Proposal

The problem

- Fair payment for subcontractors
- Improving project performance
- Improving project control and governance

The solution: **micro-milestones**

- Location-based, micro-milestone payments
- Triggered by completion events
- Auto-generated payment processes

Improving client confidence in the payment system requires a rethink in the way cash flow is managed

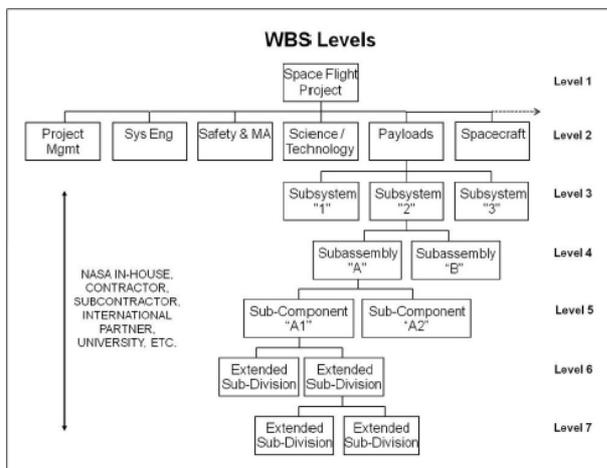
Two interventions are suggested

- First, that projects be broken down into micro-milestones (usually based on locations) with micro-payments being made solely on the basis of certified completion of the milestone.
- Secondly, that the payment system use pre-registered (and agreed) interests to distribute client funds directly to stakeholders for each micro-payment



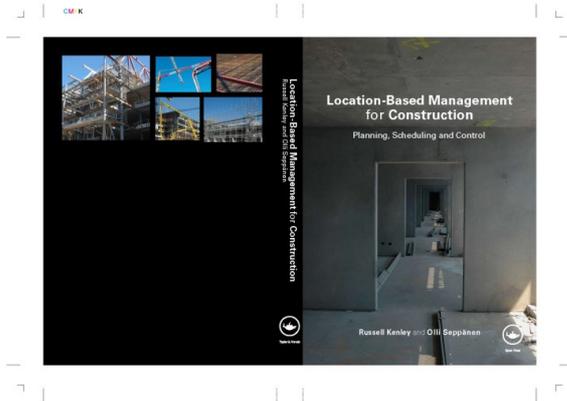


Tree structures



Level 1	Level 2	Level 3	Level 4
Project	Task 1		Outlining
		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

Location-based management systems



Location-based management systems

- Infrastructure has a physical reality
- All about location



Location-based management systems

The map displays a route through 15 numbered locations in New South Wales, Australia, starting from Finley (1) in the south and ending at Goondiwindi (15) in the north. Major highways like the Mitchell Highway and Gwydir Highway are shown. Regional areas such as Central West, Southern, and Illawarra are also labeled.

Swinburne

A 3D visualization of a grid structure, consisting of a 5x5x5 arrangement of white cubes, representing a discrete location-based system.

SCIENCE | TECHNOLOGY | INNOVATION

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Location-based management systems

- Managing what is in each location
- Complexity is merely variation in needs

A photograph showing a grid of cardboard boxes, each containing a different variety of nuts, illustrating the concept of managing complexity through location-based systems.

Location-based management systems

Analog



Digital





- B01 RESI. BLDG.PROJECT
- ...
- B01.4 CONSTRUCTION
- ...
- B01.4 .3 Super Structure
- B01.4 .3 .1 Ground Floor Level
- B01.4 .3 .1 .A Slab Work
- B01.4 .3 .1 .A . 1 Column
- B01.4 .3 .1 .A . 1.1 Rebar
- B01.4 .3 .1 .A . 1.2 Form Work
- B01.4 .3 .1 .A . 1.3 Concreting
- B01.4 .3 .1 .A .2 Shear Wall
- B01.4 .3 .1 .A .2 .1 Rebar
- B01.4 .3 .1 .A .2 .2 Form Work
- B01.4 .3 .1 .A .2 .3 Concreting
- B01.4 .3 .1 .A .3 Slab
- B01.4 .3 .1 .A .3 .1 Form Work
- B01.4 .3 .1 .A .3 .2 Rebar
- B01.4 .3 .1 .A .3 .3 MEP Work
- B01.4 .3 .1 .A .3 .4 Concreting
- B01.4 .3 .2 First Floor Level
- B01.4 .3 .2 .A Slab Work
- B01.4 .3 .2 .A .1 Column
- B01.4 .3 .2 .A .1 .1 Rebar
- B01.4 .3 .2 .A .1 .2 Form Work
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- B01.4 .3 .3 .A .1 Column
- B01.4 .3 .3 .A .2 Shear Wall
- B01.4 .3 .3 .A .3 Slab
- B01.4 .3 .3 .B Part 2
- B01.4 .3 .3 .B .1 Column
- B01.4 .3 .3 .B .2 Shear Wall
- B01.4 .3 .3 .B .3 Slab
- B01.4 .3 .3 .B .3 .1 Form Work
- B01.4 .3 .3 .B .3 .2 Rebar
- B01.4 .3 .3 .B .3 .3 MEP Work
- B01.4 .3 .3 .B .3 .4 Concreting
- B01.4 .3 .4 Third Floor Level
- B01.4 .3 .4 .A Part 1
- B01.4 .3 .4 .A .1 Column
- B01.4 .3 .4 .A .2 Shear Wall
- B01.4 .3 .4 .A .3 Slab
- B01.4 .3 .4 .B Part 2
- B01.4 .3 .4 .B .1 Column
- B01.4 .3 .4 .B .2 Shear Wall
- B01.4 .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)



- B01 RESI. BLDG.PROJECT
- ...
- B01.4 CONSTRUCTION
- ...
- B01.4 .3 Super Structure
- **B01.4 .3 .1 Ground Floor Level**
- B01.4 .3 .1 .A Slab Work
- B01.4 .3 .1 .A . 1 Column
- B01.4 .3 .1 .A . 1.1 Rebar
- B01.4 .3 .1 .A . 1.2 Form Work
- B01.4 .3 .1 .A . 1.3 Concreting
- B01.4 .3 .1 .A .2 Shear Wall
- B01.4 .3 .1 .A .2 .1 Rebar
- B01.4 .3 .1 .A .2 .2 Form Work
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- B01.4 .3 .1 .A .3 .2 Rebar
- B01.4 .3 .1 .A .3 .3 MEP Work
- B01.4 .3 .1 .A .3 .4 Concreting
- **B01.4 .3 .2 First Floor Level**
- B01.4 .3 .2 .A Slab Work
- B01.4 .3 .2 .A .1 Column
- B01.4 .3 .2 .A .1 .1 Rebar
- B01.4 .3 .2 .A .1 .2 Form Work
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- B01.4 .3 .3 .B .1 Column
- B01.4 .3 .3 .B .2 Shear Wall
- B01.4 .3 .3 .B .3 Slab
- **B01.4 .3 .4 Third Floor Level**
- B01.4 .3 .4 .A Part 1
- B01.4 .3 .4 .A .1 Column
- B01.4 .3 .4 .A .2 Shear Wall
- B01.4 .3 .4 .A .3 Slab
- B01.4 .3 .4 .B Part 2
- B01.4 .3 .4 .B .1 Column
- B01.4 .3 .4 .B .2 Shear Wall
- B01.4 .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.



- 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 .4 .B .3 Slab

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.

Product Breakdown Structure = Location Breakdown Structure X Work Breakdown Structure

- BO1 RESI. BLDG.PROJECT
- ...
- BO1.4 CONSTRUCTION
- ...
- BO1.4 .3 Super Structure
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- 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 .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



LBS (L1 .L2 .L3)

- 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

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





- 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

Work-Location Breakdown Matrix

Work Breakdown Structure

- 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 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											

Task

- 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



- 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

Work-Location Breakdown Matrix

Work Breakdown Structure

- 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 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

- 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

Micro-milestones

- Each tick represents a small package of work
- They are easily monitored
- Payment can be triggered on completion

Work-Location Breakdown Matrix

Work Breakdown Structure	Location Breakdown Structure									
	B01.1 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	B01.4 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		✓	✓	✓	✓	✓	✓	✓	✓	✓

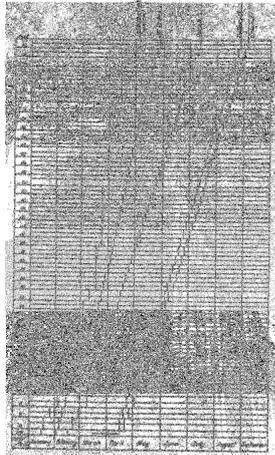
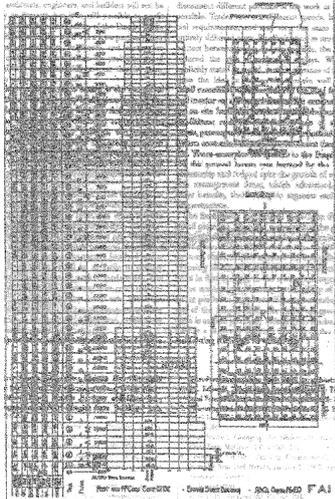
Empire State Building: LBMS



- 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

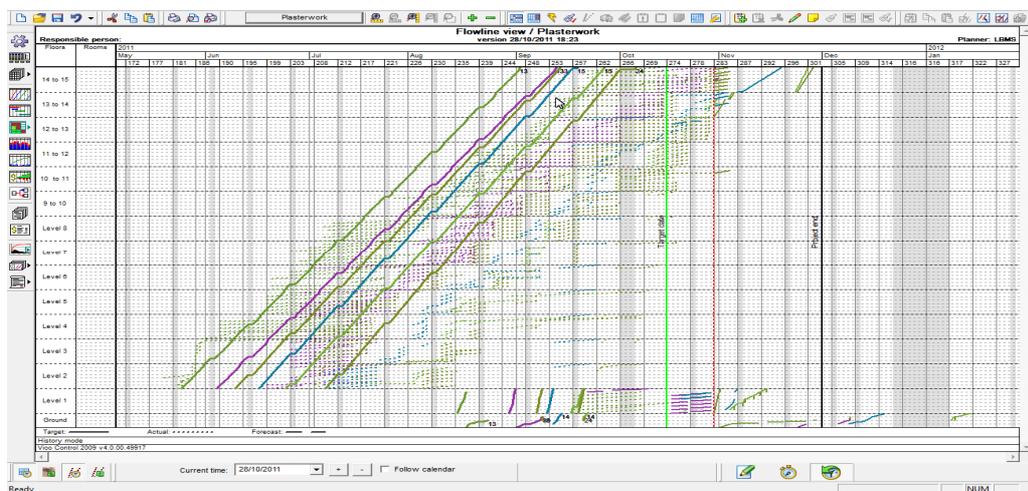


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A modern use



Controlling completions

What is needed

- We require a method to motivate completion
 - **Micro-milestones**
 - Trigger
 - On completion of location
 - Quality reports
 - Payments to all parties
 - Ensure prompt payment
- This requires improved work breakdown structures
 - QS to breakdown BOQ by location
 - Work packages to be mapped to locations
 - Project banks accounts to be automated for payments as locations are completed
 - No monthly progress claims!



What about Earned Value/Schedule

Earned Value

- Depends on quality and level of detail of schedule
- Relies on estimates of progress

Micro-milestones

- Requires more detailed WBS
- Relies on micro-completions

Work-Location Breakdown Matrix

Work Breakdown Structure	Location Breakdown Structure	BD1	BD2	BD3	BD4	BD5	BD6	BD7	BD8	BD9	BD10	BD11	BD12	BD13	BD14	BD15	BD16	BD17	BD18	BD19	BD20	
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 Form Work																						
4.3.1.2.2 S/Wall Rebar																						
4.3.1.2.3 S/Wall Form Work																						
4.3.1.2.4 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																						



Imagine...

- A subbie finishes plasterwork in Hotel room 212
- Next the work is inspected and approved as complete
 - A quality inspection report is filed
 - A completion event is recorded for the work
- Immediately, the approval triggers a payment sequence in the Business Process Management System
 - A payment claim is made to the client and a deposit into the PBA made
 - The payment is then split into the (confidential) pre-registered interests
 - Payments are simultaneously made to the contractor as well as all registered sub-contractors
 - The contractor manages all subbies not pre-registered in the normal way
- Within 7 days, all pre-registered parties have been paid
- The payment system drives performance

Bliss

