Controlling Projects Without a Critical Path

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Introduction

Assumptions embedded in a CPM* Schedule

Types of project not suited to CPM – Soft & Distributed Projects

Courts are rejecting CPM evidence for this type of project

Challenges in the absence of CPM

- Assessing progress
- Predicting completion
- Measuring delay & disruption
- Using EVM

An alternative to EVM – Work Performance Management (WPM)

Conclusions & future plans

* Critical Path Method

CPM Assumptions

CPM theory is derived from scientific management (SM)

- SM theory developed in the early 20th century (1910 - 1920)* - *the boss knows best*
- CPM was created in 1957 based on scientific management theories

CPM assumes there is one best way of doing the project, which can be accurately described in a schedule

The schedule allows the critical path and float to be calculated

Delays to be assessed based on their impact on the schedule

CPM Schedules are often developed in detail too early for people to know how the work will actually be accomplished

- Early development often imposed by contract conditions

*See ***The Origins of Modern Management***:
https://mosaicprojects.com.au/PDF_Papers/P050_Origins_of_Modern_Management.pdf

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CPM Assumptions

CPM theory and calculations are 65 years old

They have survived because they are useful in a lot of situations

Plus there is an entire industry devoted to maintaining the status quo

But there are many projects that cannot be effectively scheduled using CPM or other deterministic approaches

See: ***Scheduling Challenges in Agile & Distributed Projects***:
https://mosaicprojects.com.au/PDF_Papers/P208_Scheduling_Challenges_in_Agile_+_Distributed_Projects.pdf

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Project not suited to CPM

1. Soft projects

Soft projects are those where the final result is not defined by the creation of a tangible asset:

- Software developments
- Business change
- Marketing projects, etc.

The project's objective can be achieved in many different ways

Soft projects have largely abandoned CPM and gone 'agile' - Better delivery claimed

In the entire Agile / Scrum / Iterative project family:

- CPM (or more usually bar (Gantt) charts) can be used for the high level road map
- Other techniques are used for lower levels of control
- The essence of agile is flexibility – people choose what to work on next

Project not suited to CPM

2. Distributed projects

A significant portion of the work in distributed projects consists of a series of physically separated units of similar or identical in design

The need for the different units to be worked on in a specific sequence is either non-existent or minimal

- Replacing 2000 desktop computers across an organization
- Installing 15 new software modules
- Erecting wind farm turbines

Characteristics of distributed projects

- The sequence of work is easily changed for large parts of the project's work
- Management focus is (or should be) on optimizing resource workflows

Managing soft projects

Soft projects have largely abandoned CPM and gone 'agile'

There are many different forms of agile involving different tools and techniques
- Scrum, SAFe®, Disciplined Agile, Kanban, etc.

Across all of these different methodologies, the essence of agile remains:
- Intelligent flexibility; the people doing the work choose what to work on next
- Scope changes are welcome as long as the change increases the overall value
- Focus is on deliverables (early and often) and the project stakeholders

But there are only limited controls tools to measure progress
- Burndown charts, Kanban boards, etc

Virtually none to consistently predict the expected competition

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Managing distributed projects

An example: **Replace 200 Telstra pits in a suburb**

Work involved:
- Prerequisites:
  - Somewhere to dispose of the old pits (hazardous material)
  - New pits to install (procurement)
  - Trained people
  - Notice to home owners before work in street
- Repetitive element
  - Remove old fibro cement pits (asbestos hazard)
  - Replace with new 'plastic pits'
  - Tidy up the area
- Finalize the project

The repetitive work can be done in almost any sequence……..

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Managing distributed projects

The degree of constraint on the sequencing of work varies across a spectrum

Very few constraints → Highly constrained

Almost any sequence of work is acceptable	Considerable flexibility in some aspects of the work but not others	The sequence of work is largely predetermined
		
Agile approaches to management work well	Overall work flow needs deterministic planning but agility is required to optimize some aspects	Traditional deterministic (CPM) planning works well

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Managing distributed projects

Concept of CPM classes developed in ***Scheduling Challenges in Agile & Distributed Projects***

1. **Physically constrained** – there is only one viable work sequence
2. **Practically constrained** – management has agreed the one best work sequence
   - A road can be built from either end – But, once management decide on the start point all of the work needs to follow the imposed flow in sequence
3. **Overarching constraints** – Soft and distributed projects, there is a required overall sequence of working, with varying degrees of flexibility in the way the detailed work is performed
4. **Arbitrary constraints** – there is no required sequence of working (as in Class 1 or 2), but management has decided to impose a detailed sequence of work as a matter of choice

CPM works well in Class 1 & 2 projects

CPM is suboptimal in Class 3 & 4 projects

- Class 4 projects are facing legal challenges (next section) – should be managed as Class 3 projects
- Class 3 projects need improved management tools – the focus of this presentation.

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Managing distributed projects

Distributed projects need a pragmatic strategy:

- An appropriate level of detail in an overall 'road map'
- There are always likely to be some mandatory sequences that must be followed – this must be planned
- Then let the people doing the work take over – focus on resource workflows and optimization

Agile and Lean focus on the team knowing what's best but their planning focus is short term

Balancing overall constraints with flexibility to optimize resource utilization and overcome issues means:

- There is no 'one-size' solution, controls need to be designed for the project
- Standard forms of contract need to recognize the challenge
- There is a lot of similarity between managing a distributed project and managing a soft project

These issues are discussed in more detail in: ***Scheduling Challenges in Agile & Distributed Projects***: https://mosaicprojects.com.au/PDF_Papers/P208_Scheduling_Challenges_in_Agile_+_Distributed_Projects.pdf

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Class 4 projects – Imposed CPM

Most distributed projects still pretend there is one best way to do the work and use CPM

CPM is often a contractual requirement

But, under stress the CPM assumptions fall to bits :

- The schedule logic is ignored
- People keep working on the other available work
- Controls are ad hoc – usually based on common sense and conversation (no documentation)
- There are no tools for assessing genuine delay or disruption

Access to the next 'task' is based on conditions precedent (constraints), not mandated logic, but efficient workflows still need appropriate planning and preparation at each location

The artificial CPM outputs:

- Don't provide useful management information
- Are increasingly being rejected by the courts

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Courts are rejecting CPM evidence

Courts increasingly rejecting CPM evidence for Class 4 'distributed' projects

Costain Ltd v Charles Haswell & Partners Ltd [2009] EWHC B25 (TCC) (24 September 2009)*

Water treatment works – multiple buildings

CPM schedule was used as a basis of a time claim

Delay was proved to two foundations using a 'windows analysis' (experts only disagreed on extent of delay)

'Windows analysis' is a recognised way of assessing EOTs

- SCL *Delay and Disruption Protocol*
- AACEi Recommended Practice No. 29R-03 *Forensic Schedule Analysis*

* England and Wales High Court

Courts are rejecting CPM evidence

CPM analysis was rejected by Judge: *experts have agreed that the delays to the RGF and IW [foundations] were critical delays since those buildings were on the critical path of the project at the relevant time. Ordinarily therefore one would expect, other things being equal, that the project completion date would be pushed out at the end of the job by the same or a similar period to the period of delay to those buildings. However, as experience shows on construction sites, many supervening events can take place which will falsify such an assumed result. For example, the Contractor may rearrange his programme so that other activities are accelerated or carried out in a different sequence thereby reducing the initial delays.* [Clause 233]

See ***Costain vs Haswell Revisited***:
https://mosaicprojects.wordpress.com/2023/03/25/costain-vs-haswell-revisited/

Courts are rejecting CPM evidence

Courts increasingly rejecting CPM evidence for Class 4 'distributed' projects

White Constructions Pty Ltd v PBS Holdings Pty Ltd [2019] NSWSC 1166, 6th September 2019.*

Construction of a 100-lot subdivision on the NSW South Coast - There were delays in approving the sewage system

Delay experts were engaged by the parties, to construct as-built CPM schedules but the evidence of the experts was mutually contradictory

The Court appointed its own expert Mr McIntyre

Judgement:
[195] Mr McIntyre's opinion, upon which I propose to act, is that neither method [used by the parties experts] is appropriate to be adopted in this case.

* Supreme Court of New South Wales

Courts are rejecting CPM evidence

[196] Mr McIntyre's opinion, upon which I propose to act, is that close consideration and examination of the actual evidence of what was happening on the ground will reveal if the delay in approving the sewerage design actually played a role in delaying the project and, if so, how and by how much. In effect, he advised that the Court should apply the common law common sense approach to causation……..

Whilst there was evidence that approval of sewer designs was suspended for a period during construction, there were no details concerning how this suspension actively affected the progress of other aspects of construction

The contractor's resources were kept busy working for the full period – therefore no proof of actual delay

* Supreme Court of New South Wales

Courts are rejecting CPM evidence

In both cases, the judge refused to accept traditional CPM analysis – the CPM activity sequence did not reflect the reality of what actually occurred

If a crew could not work in one location, they could simply relocate to another - work is continuous but may be less efficient

But:

- most contracts are incapable of dealing with an agile approach to management
- Assessing the consequences of a delay or disruption contemporaneously is difficult
- Delays affecting sub-critical crews are expensive but may not delay overall completion

The SCL ***Delay and Disruption Protocol**** separates the cost of disruption from EOTs (but its approach is still dependent on a valid CPM schedule)

*See: https://www.scl.org.uk/sites/default/files/documents/SCL_Delay_Protocol_2nd_Edition_Final.pdf

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Courts are rejecting CPM evidence

This problem affects:

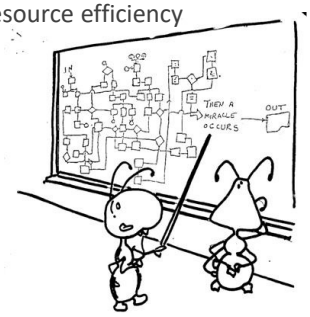
- All distributed projects
- All 'agile' projects (not just IT)
- Projects using 'lean construction' and 'last planner' techniques

There are no recognized techniques for assessing disruptions that affect resource efficiency where the inefficiency may flow through to a project delay

Determining the cost of the imposed inefficiency is difficult

Determining the consequential delay (if any) is difficult

A new paradigm is needed!



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Challenges in the absence of CPM

The courts have identified the failings in CPM when applied to distributed projects (Class 3 & 4)

The industry has identified the failings in CPM when applied to agile projects (Class 3)

But without a CPM schedule there are major challenges in:

- Measuring how is the work progressing to identify issues and opportunities
- Predicting project completion in a consistent and defensible way
- Assessing the consequences of delay and disruption to calculate EOTs and delay costs

This problem affects:

- All distributed projects
- All agile projects where development is done in sprints or iterations (not just IT)
- Projects using 'lean construction' and 'last planner' techniques

An effective solution to these problems is also likely to work on Class 1 & 2 projects, allowing the CPM schedule to be used proactively rather than contractually

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Assessing progress without CPM

Assessing progress needs to be based on comparing:

- The amount of work actually achieved at a point in time with
- The amount of work planned to have been achieved at the same point in time

This needs an impartial measure to assess the quantum of work planned and achieved, options include:

- Monetary values ($)
- Function or story points
- Physical unit counts, or
- Any other metric that can be impartially assessed and is consistent across most of the project's work

Note: Hours of effort not appropriate:

- Planned hours can be impartially assessed, but
- Hours worked do not directly relate to the quantum of work actually achieved by the workers

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Predicting completion without CPM

Predicting project completion in a consistent, defensible and repeatable way is essential

Existing approaches that have been shown to be accurate include:

- Earned Schedule (an extension to Earned Value Management)
- Earned Duration

Both use a process that:

- Identifies the quantum of work achieved to a point in time
- The point in time when this amount of work was planned to be achieved
- Calculates the ratio between the time needed, and the time planned, to complete the quantum of work
- Applies the ratio to the overall project duration to calculate an expected project completion date

The results are more reliable than CPM updates, repeatable, and defensible

This concept can be applied to distributed and agile projects

Assessing delay and disruption

Assessing delay and disruption in this type of project more difficult

The correct approach will depend on the nature of the intervening event:

- Changes in volume of work works can be assessed based on the planned rate of production
- Identified delay periods will be assessed the same as for CPM – 3 days rain = 3 days delay
- Disruptions to key resource workflows may be a more appropriate measure in many situations
- Assessing changes in predicted completion dates may be useful (but blends contract work with delays)

There needs to be agreements at the time of contract how delays will be measured

A future paper is planned analyzing the options: ***Assessing Delays in Agile & Distributed Projects*** (target *PM World Journal** – July or August 2023)

* PM World Journal: https://pmworldjournal.com/
Free monthly e-Journal

Applying EVM to Class 3 projects

A lot of work has been done on applying Earned Value Management (EVM) to Agile projects

The system works!

The same approach will work for applying EVM to all soft and distributed projects (Class 3)

The key elements of applying EVM to Class 3 Projects are:

- Work packages need to be focused on deliverables, not activity (sprints are an activity)
- All similar deliverables that will be produced by a single resource crew are best in the one work package:
  - The 'crew' may choose to work on any of its deliverables in any order
  - The key question is are they producing enough?
- Deliverables need to be countable and sizeable (eg, stories and story points with $ attached)

When EVM is applied effectively, Earned Schedule (ES) solves the rest of the issues:

- Determining current status ahead / behind
- Determining the predicted completion date

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Applying EVM to Class 3 projects

The only schedule input required is an assessment of when each work package can start and finish

- This sets the time element of the Performance Management Baseline

There is no need for a complex CPM schedule, simple heuristics will work most of the time

- A Bar Chart (Gantt Chart) is acceptable
- But there's no reason not to use a CPM schedule

Consider the schedule needed for the '***Telecom pit replacement***' project – 200 pits

- Contract period 13 weeks (3 months)
- Allow 2 weeks for initial procurement and training
- Allow 1 week for initial learning – 10 pits only
- Allow 1 week at the end for project finalization
- Therefore 9 weeks are left to install 190 pits = 21 per week (adjust week 1 to a target of 11 pits)
- **Note**: a contingency may be needed for inclement weather??

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Applying EVM to Class 3 projects

There may be 3 or 4 work packages – based on the schedule:

- Procurement – Weeks 0 to ? 5 or 6 (the end will depend on the situation)
- Training – Weeks 0 to 3 (includes initial installs of 11 pits)
- Installation – Week 4 to 12 (at 21 pits per week)
- Asbestos disposal – Weeks 4 to 13
- Close out – Week 13

Based on this data, a standard EVM PMB can be established and performance measured

Based on the EVM data, ES can calculate the current status and predicted completion date

EVM does not need to be complex:
https://mosaicprojects.com.au/Mag_Articles/AA015_Practical_EVM.pdf

But this presentation is focused on the projects that are not using EVM

Work Performance Management

Surveys show most projects do not use CPM or EVM for a variety of reasons

CPM has been found inappropriate for use on distributed projects

Agile methodologies have been designed not to use CPM

Work Performance Management (WPM) is designed as an alternative approach to project controls:

- Primarily for use in Class 3 (soft and distributed) projects, and is
- Also applicable to smaller / simpler Class 1 and 2 projects

The calculations can be run in a simple spreadsheet

The approach is based on Earned Schedule
(but without the need for either EVM or a detailed schedule)

Work Performance Management

WPM compares the amount of work planned to be accomplished to the amount of work actually achieved in a period

WPM focuses on the core elements of the work, peripheral and support elements can be ignored

WPM can be used to give reasonably reliable information about the current status and predicted completion of a project

The measure of 'work' can be flexible: $, Story Points, Telecom pits, etc.

All that's required is consistency

Work Performance Management

The inevitable acronyms are:

- **WP** = Work Planned (measured in an appropriate unit – cumulative over time)
- **WA** = Work achieved (measured on the same basis as WP)
- **PC** = Planned completion (number of time units, days, weeks, months)
- **TN** = Time Now (number of PC time units to the date of assessment)
- **TE** = Time Earned (the number of PC time units to the point where WA = WP)
- **WPV** = Work Performed Variance (TE - TN negative values show schedule slip)
- **WPI** = Work Performed Index (TE/TN values less then 1.0 show schedule slip)
- **EC** = Expected completion (calculated by PC/WPI = EC)

Work Performance Management

So how does this work? The following example is based on the '***Telecom Pit Project***'

1. Plot the measure of performance to create a project baseline:
   200 Telecom pits replaced
2. Using previously planned durations:
   - Contract period 13 weeks (3 months)
   - Allow 2 weeks for initial procurement and training
   - Allow 1 week for initial learning (11 pits only)
   - Allow 9 weeks to install 190 pits at 21 per week
   - Allow 1 week for project finalization

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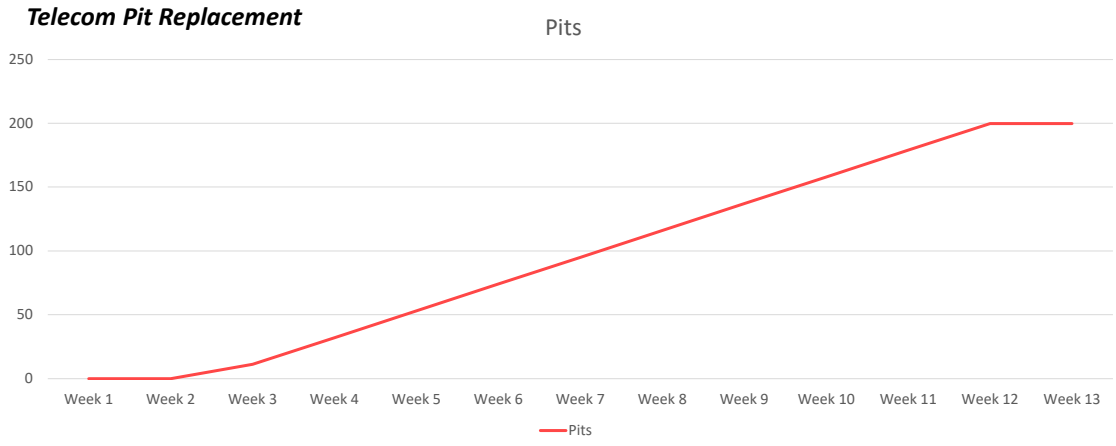
Work Performance Management



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Work Performance Management

Measured progress at the end of Week 8:

Time Now = 8	**TN = 8**
The actual progress is measured at 90 pits complete	**WA = 90**
The planned progress at Week 8 was 116 pits complete	**WP = 116**
90 pits were planned to be achieved during week 7 74 at the end of week 6 + 16/21 = 0.76 of week 7	**TE = 6.76**

WPV = 6.76 - 8 = **-1.24** weeks behind schedule

WPI = 6.76/8.0 = **0.845**

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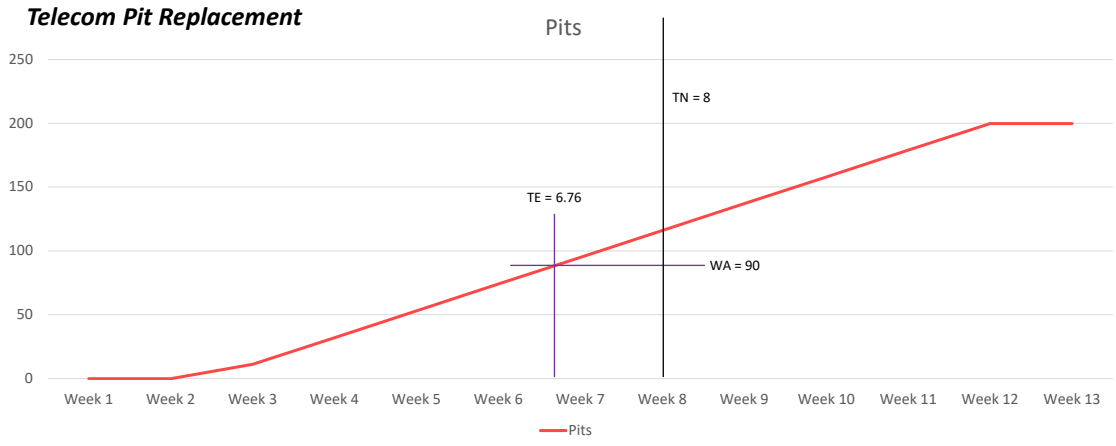
Work Performance Management



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Work Performance Management

The predicted project completion is calculated as:

EC = PC/WPI 13/0.845 = 15.38 weeks

The project is expected to complete 2.38 week (or 2 weeks 2 days) late

WPM is a simple robust performance measurement system that provides an accurate assessment of the project's status from a time management perspective

The two requirements to implement WPM are:

- A consistent measure of work planned and accomplished (it is not necessary to include everything)
- A simple but robust assessment of when the work is planned to be done

Conclusions

WPM provides a robust, simple system to measure the performance of work and assess the likely project completion date

The metric used can be a core deliverable (eg, 2000 computers replaced in an organization) or a representation of work such as the $ value of the components to be delivered

Peripheral and support activities can be ignored, they rarely impact the project delivery independently – failures in the support areas typically manifest in the primary delivery metric

WPM **is not** an alternative to EVM and CPM on major complex projects

WPM can provide a cost efficient, simple, rigorous controls tool for the many projects that are either:

- Relatively small requiring a straightforward controls tool, or
- Large, but with a single primary deliverable that is easy to measure, or
- Fall into the Class 3 classification of agile or distributed projects (but choose not to apply EVM)

Conclusions

The 'agile' approach is to assume the client, end user, and delivery team work together to proactively solve problems and create success – this is a good idea if it works….. **but**, WPM can provide the missing controls discipline

In many situations, traditional contracts are not fit for purpose – CPM does not work on agile and distributed projects*

Currently, the only management approach for dealing with continual change is to:

- Keep rigorous and detailed records of everything
- Provide all of the notices and determinations in the time required
- Try and sort the mess out afterwards by negotiation or mediation

* CPM can be forced to work on some Class 3 & 4 , but requires constant changes to the baseline schedule to accurately reflect the changing work sequences as they evolve over time.

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Conclusions

There is a lot of work needed in this area:

- Contract improvements are required to allow the use of WPM
- Protocols need to be developed for dealing with the issues pragmatically within existing forms of contract
  - For the contractor
  - For the superintendent / client
- The development of a simple tool to implement WPM

Watch this space, we are working to develop the concept of WPM……

Updates will be posted to the PGCS Linked-In page at https://www.linkedin.com/groups/12819082/ Join to be kept up to date.

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Questions?

Questions can be asked on-line now (typed Q&A), or

Contact the presenter at:

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