Goldratt Research Labs

Using critical chain project management for a turbine manufacturer to reduce lead times and improve reliability

Speakers:

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Abstract

In 2015 Goldratt Research Labs (GRL) was approached by a major project management consultant to help them implement Critical Chain Project Management (CCPM) at a leading turbine manufacturer. The objective was to simulate the benefit for the manufacturer of implementing CCPM instead of the traditional project management methodology they have been using.

This model posed a unique challenge since few tools exist that simulates project and portfolio management using CCPM. AnyLogic does not contain specific modules or libraries that on e can easily use or configure to simulate a project environment.

Through the use of custom objects in AnyLogic, GRL managed to build a dynamic simulation model that was designed to answer three simple but important questions:

1) What will likely be the due date and financial performance for a portfolio of programs if you keep using traditional project management rules for planning and execution?

2) How much better can you do if you are willing to change the rules to Theory of Constraints' CCPM rules?

3) What CCPM rules will provide you with the simplest, fastest and lowest risk way to achieve the best operational and financial results?

The model provides valuable insights for project management for such complex environments and further development opportunities for the simulation to be used as a planning and estimation tool. The model acts as safe and risk-free environment for project managers to test assumptions like resource allocations and enable them to give more confident due date commitments by taking variability and interdependencies of project tasks into consideration.

CCPM Simulation Scenario Comparisons

Scenario 1

- We try and determine what the likely completion date will be for all programs if the execution of the projects followed conventional project management rules. These rules are:
  1. Release programs and projects as per planned start dates (almost everything is released ASAP)
  2. Not quote longer lead times considering backlog and limited capacity
  3. Use FIFO or Planned Due Date as priority mechanism
  4. Multi tasking (resources with more than 1 active task waiting for them are switching at least once a week to show progress on all tasks)

Scenario 2

- We try and determine how much faster we can get all programs completed using Critical Chain Project Management (CCPM) Rules. For CCPM to work, a number of rules and behaviors must be followed during project execution:
  - Tasks and projects must be prioritized.
  - Higher priority tasks have precedence for limited resources.
  - A resource is to work diligently on one task until it is completed.
  - Resources are to turn in work when completed (task deliverables are available).
  - Tasks must have all inputs available before starting.
  - Task status is to be reported as Remaining Duration (effort only).
  - •Status is collected frequently, usually daily.
- In scenario 2 we try and control work in progress (WIP) at the project level with a project WIP limit.

CCPM Simulation Scenario Comparisons

Scenario 3

- The problem with Project based WIP control in scenario 2 is we struggled to maintain synchronization at program level. E.g. We might be freezing a project from being released to maintain WIP but this project is needed to complete a program.
- In scenario 3 we are controlling WIP at the program level with a program WIP limit.

Scenario 4

- The problem with Program based WIP control in scenario 3 is that we struggled to reduce WIP equally among resource types and locations. We normally target a WIP reduction of 25-50%. However, some resources are only working on some programs. So if we freeze release of those programs we could be totally starving those resources while other resources that only work on programs we released might not have their WIP cut at all even though
- there is a WIP control at program level. The benefit of program level WIP control is that at least all projects for each program is released together so easier to maintain synchronization.
- Scenario 4 we try to control WIP at the program level with a program WIP limit but using a simple rule to see if a specific type of resource is being starved then it will look for a single project program that need that resource and release that program. If it cannot find a single project program, it will look for a program with two projects of which one of the first phases require the resource being started. So this hybrid rule in scenario 4 is a dynamic WIP control limit while in scenarios 2 and 3 the same WIP control limit is used throughout the whole period.
- The idea of the Hybrid rule is to maintain synchronization benefits of Program based WIP control while addressing limitation of asymmetrical WIP reductions across different types of resources.

Model results screenshots

Goldratt CCPM simulator – Round Results

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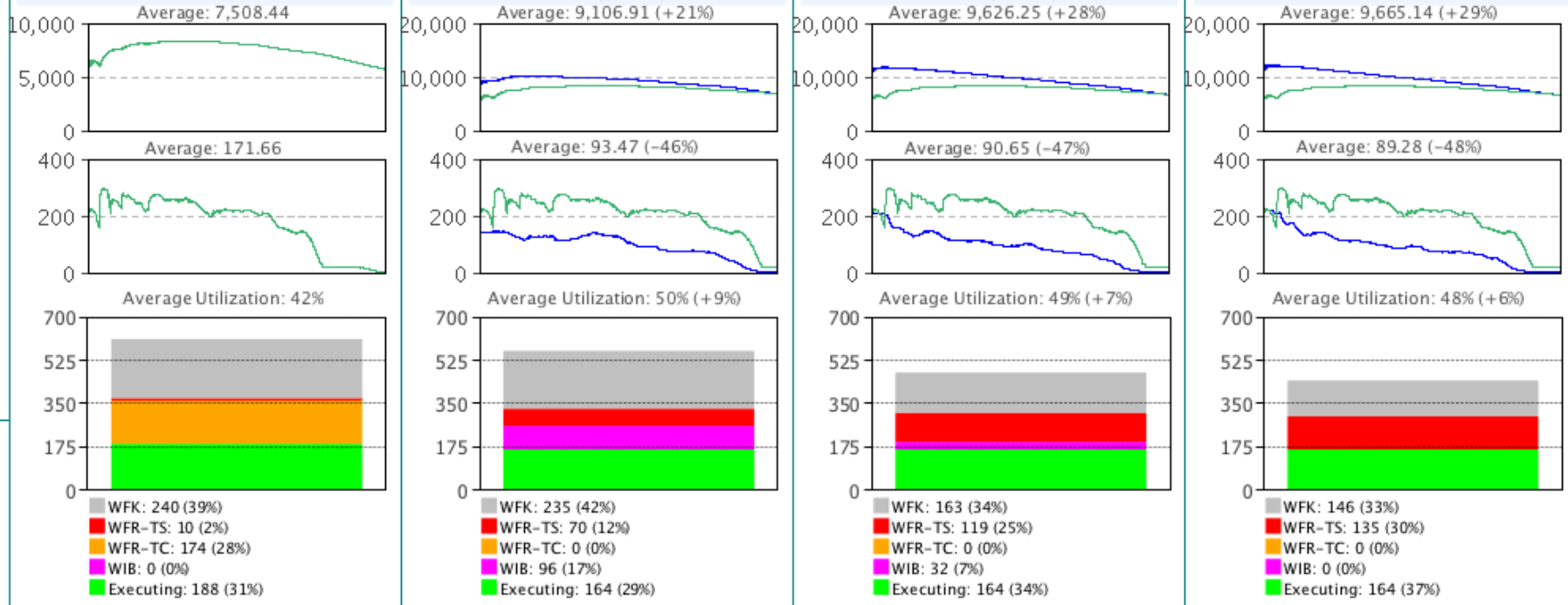
		Round 1 (Run Round 1)	Round 2 (Run Round 2)	Round 3 (Run Round 3)	Round 4 (Run Round 4)
		No CCPM Rules Used	Apply CCPM Rules WIP Control at Project Level	Apply CCPM Rules WIP Control at Program Level	Apply CCPM Rules Hybrid Rule to Control WIP
Due Date Performance	Date all programs finished	02 / 07 / 24	10 / 04 / 22 (491 days earlier)	12 / 17 / 22 (417 days earlier)	01 / 23 / 23 (380 days earlier)
	% programs finished on time	0%	9% (+9%)	14% (+14%)	23% (+23%)
	% projects within planned time	19%	77% (+57%)	55% (+36%)	54% (+34%)
	% phases within planned time	33%	100% (+67%)	100% (+67%)	100% (+67%)
Financials	Revenue, $M	358.89	358.89 (0.00)	358.89 (0.00)	358.89 (0.00)
	Costs, $M	318.18	264.05 (-54.13)	272.21 (-45.97)	276.29 (-41.90)
	Penalties, $M	209.76	33.43 (-176.33)	75.01 (-134.75)	82.40 (-127.36)
	Bonuses, $M	0.00	10.86 (+10.86)	8.90 (+8.90)	7.51 (+7.51)
	Planned Net Profit, $M	12.33	12.33 (0.00)	12.33 (0.00)	12.33 (0.00)
	Planned Net Profit, %	34%	34% (0%)	34% (0%)	34% (0%)
	Actual Net Profit, $M	-169.06	72.26 (+241.32)	20.57 (+189.63)	7.71 (+176.77)
	Actual Net Profit, %	-47%	20% (+67%)	6% (+53%)	2% (+49%)
	Lost sales, $M	125.62	44.47 (-81.15)	56.97 (-68.65)	63.09 (-62.52)
Resources, Work in Progress, Throughput	Average Throughput, man-month eqvs / month	Average: 7,508.44	Average: 9,106.91 (+21%)	Average: 9,626.25 (+28%)	Average: 9,665.14 (+29%)
	WIP, phases	Average: 171.66	Average: 93.47 (-46%)	Average: 90.65 (-47%)	Average: 89.28 (-48%)
	Resources utilization, %	Average Utilization: 42%	Average Utilization: 50% (+9%)	Average Utilization: 49% (+7%)	Average Utilization: 48% (+6%)
	Delay days analysis	WFK: 240 (39%) WFR-TS: 10 (2%) WFR-TC: 174 (28%) WIB: 0 (0%) Executing: 188 (31%)	WFK: 235 (42%) WFR-TS: 70 (12%) WFR-TC: 0 (0%) WIB: 96 (17%) Executing: 164 (29%)	WFK: 163 (34%) WFR-TS: 119 (25%) WFR-TC: 0 (0%) WIB: 32 (7%) Executing: 164 (34%)	WFK: 146 (33%) WFR-TS: 135 (30%) WFR-TC: 0 (0%) WIB: 0 (0%) Executing: 164 (37%)



Main Menu

Run All Rounds

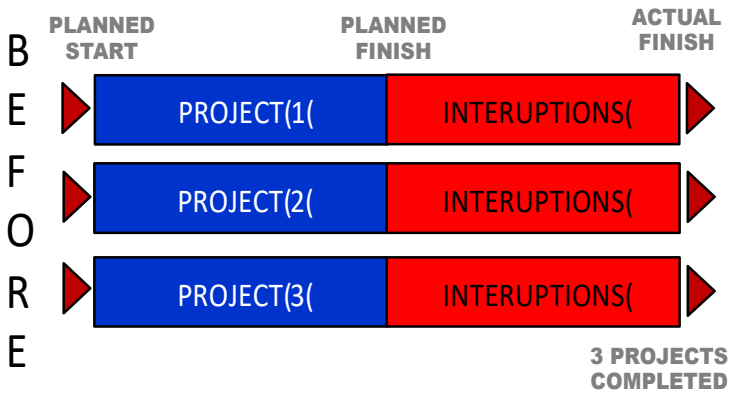
Clear Results

Run: 5 Idle | Time: - | Simulation: Stop time not set | Date: - | Memory: 596M of 910M

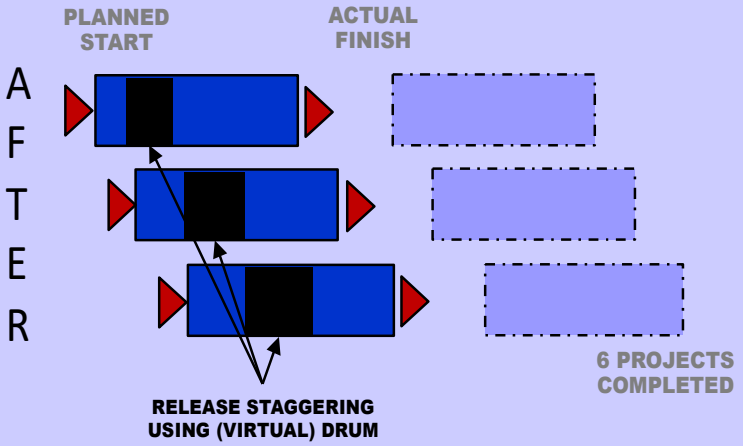
Background to CCPM vs Traditional rules

RULE 1 – PIPELINING

TRADITIONAL PIPELINING

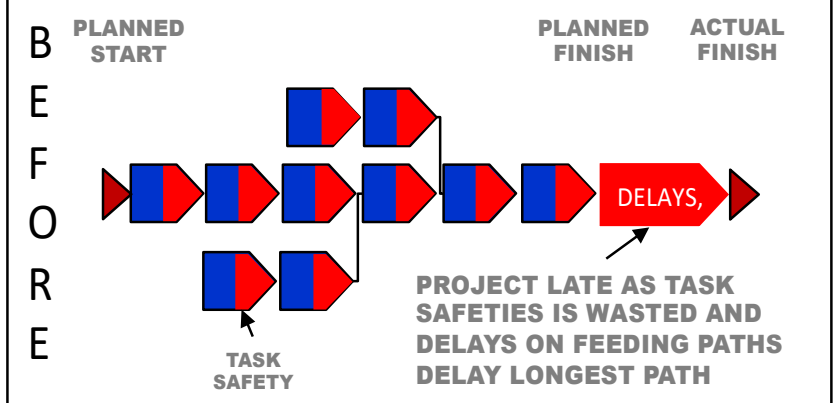


CRITICAL CHAIN PIPELINING

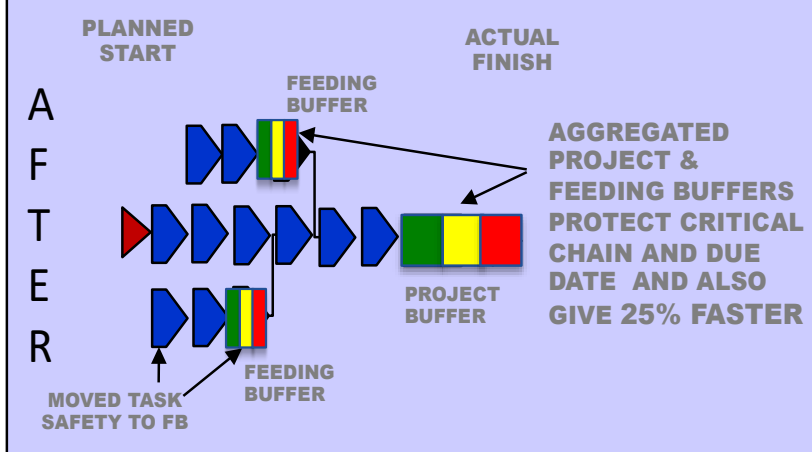


RULE 2 – BUFFERING

TRADITIONAL BUFFERING

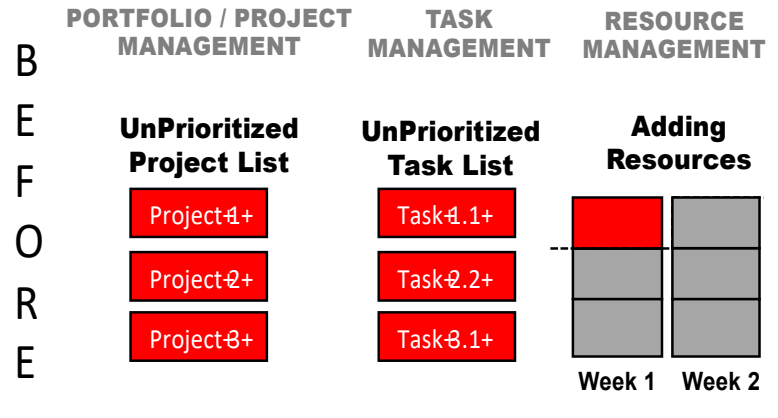


CRITICAL CHAIN BUFFERING



RULE 3 – BUFFER MGT

TRADITIONAL EXECUTION



CRITICAL CHAIN EXECUTION