OVERVIEW OF CRITICAL CHAIN PROJECT MANAGEMENT

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1. ABSTRACT

Critical Chain is a project scheduling and management approach that leads to a significant improvement in project performance. This is achieved by modifying team behaviour to eliminate bad work habits. Other changes include the aggregation of safety in the form of buffers, which protect the project completion date. This paper provides an overview of the principles of Critical Chain project management.

2. INTRODUCTION

In 1997, Dr. Eliyahu Goldratt introduced the first significant new approach to project management in over thirty years with the publication of his best selling business novel, *Critical Chain*. His approach resulted in the development of a new paradigm that addresses, for the first time, both the human side and the algorithmic methodology side of project management in a unified discipline.

3. ESTIMATING

Although some experienced Project Managers state that, 'people tend to give optimistic estimates, this does not hold up under examination for several reasons. In most project environments, people avoid pain by attempting to complete activities on the due date. Hardly anyone wants to be known as the person who delivers late. Also, people remember selectively. They easily remember worst-case outcomes (pain), but not necessarily all of the times things went well.

The result is that people try to provide activity duration estimates, which include significant safety to help ensure that they complete the activity in the specified time. This is often called a 90% estimate, as the person concerned believes there is a 90% chance of completing the task within the specified time.

However, having planned tasks containing safety, people proceed to waste the available safety. This is done in various ways :

4. STUDENT SYNDROME

If people believe they have some extra time in their estimates, they are often willing to accept other 'higher priority' work at the beginning of the activity. This tends to waste their 'safety time'. This is especially true for busy people in high demand. Dr. Goldratt calls this the Student Syndrome.

People do less than a third of the work on an activity during the first two thirds of the activity duration, and the final two-thirds during the last third of the activity duration. They are more likely to find they have a problem to complete the activity in the remaining time when most work is done. They have little chance to recover from an unanticipated problem, such as computer failures. This makes if *feel* like the activity was underestimated to begin with.

5. PARKINSON'S LAW

Parkinson's Law states that 'Work expands to fill the available time'. In most cultures, there is little or no reward for completing individual activities early. If a person completes a task early, he/she is given more work to do with no additional benefit. They may also be accused of over-estimating. People will simply adjust the level of effort to keep busy for the entire task.

Work performed on 'time and material' contracts results in less revenue if the work is completed early. In some companies, if the work is completed in less time than estimated, they cannot continue to charge to the project. They must find alternative work for the resources. In addition, if work is finished early, the other team who is dependent on the work, is not expecting early delivery and has not scheduled to start early – there is therefore no benefit to finish early. Once again, safety is wasted.

6. MULTI TASKING

Multi-tasking is the attempt to work on multiple project activities at the same time.

Most people think of multi-tasking as a good way to improve efficiency. It ensures everyone is busy all of the time. However, multi tasking is perhaps the biggest single cause of un-productivity in South Africa, and perhaps the world.

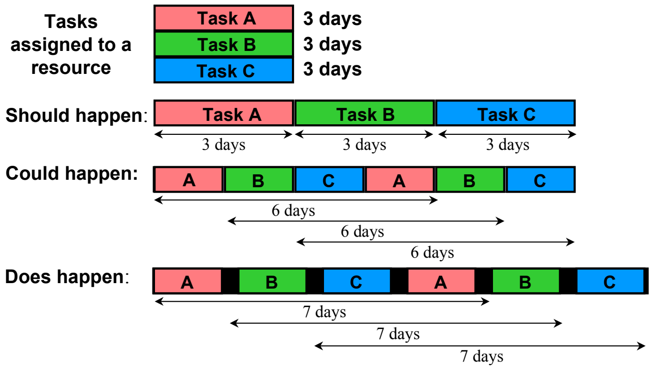

Fig 1. Multi-tasking results in serious delays in task completion.

Resources tend to migrate between projects in response to the latest, loudest customer demand in an attempt to keep as many customers satisfied as possible. This focus on showing progress on as many active projects as possible is the major cause of multi-tasking. This focus is to the detriment of the overall project thru-put of the organization.

Multi tasking encourages all activities to take much longer than required. If management allows employees to concentrate on an activity without interruption, such activities could be delivered much sooner. In addition, the workers gain more work satisfaction from being able to concentrate on a job and finish it without interruption.

7. SOME STATISTICS

Most projects have multiple activity paths. All activity paths must merge into the critical path by the end of the project. One reason for this is that 'assembly' or 'test' operations tend to occur near the end of the project, requiring many elements to come together. The following demonstrates how merging of tasks create a built-in mechanism that eliminates positive fluctuations, and passes on the longest delay.

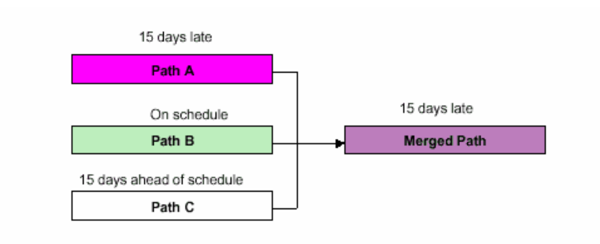

Fig 2. Merging of tasks result in delays being propagated.

Consider an activity on the project critical path that requires three separate inputs in order to start. This is very frequent where everything has to be ready for delivery. Usually, there are many more than three. However, even with three tasks, if each has a 50% chance of being done in the estimated time, the probability that at least one is late is over 88% which affects project completion. However, if any one of the tasks is early, it has no or little effect on project completion.

Thus, statistically, there is a much greater chance of a project being late, compared to delivering early.

8. THE PROPOSED SOLUTION

When taking into account factors such as Student Syndrome, Parkinson's Law, with the likelihood of no early finishes and the merging of tasks, traditional project management methods loose the effects of early finishes of tasks, and only propagate late finishes in the schedule. In other words, the best they can do is to finish on time, and the likelihood of that happening is small.

To complete projects in a shorter period, one needs a different approach, and that is what Goldratt's Critical Chain delivers. Let's see how the Critical Chain Method delivers better project performance.

9. AS-LATE-AS-POSSIBLE SCHEDULING

In Critical Chain planning, your tasks are scheduled as-late-as-possible (ALAP) based upon the target end date. There are many benefits to planning ALAP tasks, and one drawback.

Costs are not incurred earlier than necessary thus improving cash flow. From the project manager's viewpoint, due to fewer tasks starting, there is better focus at the start of the project. Importantly, in complex, knowledge work, your knowledge increases the further you go into the project. By scheduling tasks as-late-as-possible, more knowledge is available and will significantly minimize the need for re-work.

The single drawback is that all ALAP tasks are critical. An increase in duration of any task will push out the project end date by the increased amount. Fortunately, Goldratt has a simple, elegant solution to this problem. In Critical Chain planning, buffers are inserted at key points in the project plan that act as shock absorbers to protect the project end date against task duration increases. With the buffer approach, you get the benefits of as-late-as-possible scheduling with adequate protection against uncertainty.

10. 50% TASK ESTIMATING

Critical Chain task estimating requires a change in individual and organizational behavior to be effective. An organizational culture has to be established that removes the fear of exposing the safety and removing it from task estimates. (With conventional project management, the safety has always been hidden.) Instead of throwing away the safety, it is pooled as a project buffer, as opposed to a hidden task-level safety. Also project teams have to embrace uncertainty rather than think that they can defeat it with better estimating techniques. When one removes the safety from a task, it must accepted that the task has a good probability, say 50%, of exceeding the estimate. This is normal. Task actuals cannot be compared to baseline estimates and overruns must not be reported. If this occurs, teams will adjust their behavior to the measurements, and will put deeply hidden safety back in their next estimates thereby defeating the method.

11. IDENTIFYING THE CRITICAL CHAIN

Goldratt defines the Critical Chain as the longest chain of tasks that consider both task dependencies and resource dependencies. This is different from the definition of the Critical Path, which is defined as the longest chain of tasks based upon task dependencies. This is a subtle, but important difference. Critical Chain recognizes that a delay in resource availability can delay a schedule just as a delay in dependent tasks. Software such as PS8 provides a function for finding the Critical Chain based upon both task and resource dependencies.

12. INSERTING BUFFERS

After having removed the safety from the tasks, this safety will now be pooled at key points in the project. In the event that tasks overrun, buffer incursion occurs without affecting the project end date.

When using software such as PS8, the size of the buffer is automatically determined. The usual approach is to calculate the buffer size as 50% of the safety that was removed from the tasks. In effect, the total safety that would have been hidden in the individual Critical Chain tasks has been removed and replaced by a reduced amount in the Project Buffer. This reduction in total safety is based upon the same theory of pooled risk that is used in the insurance business.

In order to protect the Critical Chain from non-Critical Chain tasks that link to the Critical Chain, Feeding Buffers are inserted at the point where the non-critical chain intersects with the Critical Chain. Usually, the size of the Feeding Buffer is 50% of the length of the feeding chain. In software such as PS8, this is calculated automatically..

13. CONTROLLING PROJECT EXECUTION

In traditional Critical Path project management, every task has a published start and finish date. While this concentration on task start and finish dates seems logical, it does not promote speed-to-market driven project performance. In fact, due to factors such as Student Syndrome, Parkinson's Law and no early finishes and other statistical factors, current project management ensures that early finishes are lost, and only late finishes accumulate in the schedule.

Projects should be managed similar to a relay race. Runners are able to capitalize on an early finish of the preceding runner; a fast leg can offset a slow leg to the benefit of the team. When using Critical Chain project management, when a task is reaching completion, the next task's resources should be ready to go immediately after the preceding task is complete. This relay race approach means that teams must de-emphasize the task original start and finish dates and concentrate, instead, on triggering their preparation based on the preceding task's progress.

Once a task is started, the resources work as fast as possible towards completion. Resources on following tasks should be given a heads-up alert that they should start getting ready to work on a new task.

14. BUFFER MANAGEMENT

Buffers allow focus, simplified priorities and provide early warning regarding the health of the project. Buffer management is the key to tracking project performance in Critical Chain project management. Treat the buffer as if it were divided into three equally sized regions.

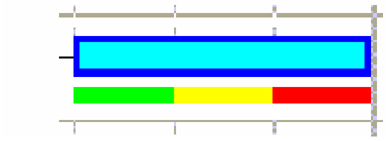

Fig 3. Buffer penetration colours

The first third is the green zone, the second third is the yellow zone, and the final third is the red zone. If the penetration is in the green zone, no action is required. If the penetration enters the yellow zone, then the problem should be assessed for possible courses of action. If the penetration enters the red zone, then action should be taken. Action plans should involve ways to finish uncompleted tasks in the chain earlier or ways to accelerate future work in the chain to bring the buffer penetration back out of the red zone.

15. MULTI-PROJECT CRITICAL CHAIN

The Critical Chain approach to multi-project management is based upon synchronizing projects based on the availability of key resources. Goldratt uses the term "drum resource" (think of the drummer on a galleon who controls the speed of the ship). The drum resource is usually the resource that is always in the most demand or is so limited by capital costs that it is the bottleneck around which schedules are drawn. New projects are staggered in a manner that avoids conflict with drum resources allocated to existing or higher priority projects.

When synchronizing projects around a drum resource(s), an invisible buffer, called a Capacity Buffer, is created between tasks of different projects on which the drum resource is working.

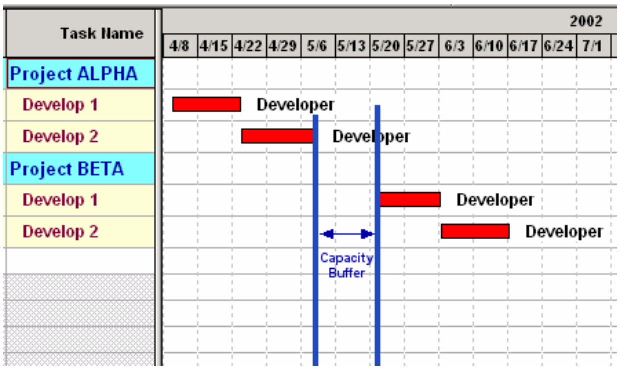

Fig 4. Capacity Buffer between projects for the Drum Resource

In Fig. 4, only tasks are shown on which the Drum Resource is allocated. The Capacity Buffer was created automatically (when using a package such as PS8) between tasks Project ALPHA and tasks from Project BETA. The Capacity Buffer protects Project BETA from any delays in Project ALPHA.

16. SUMMARY

The essential changes introduced by Critical Chain Project Management (relative to the current Critical Path practices) are:

1. Reduction of activity estimated times to 50% to produce task durations devoid of safety.
2. Development of the Critical Chain, using both activity logic and resource constraints.
3. Addition of a Project Buffer to protect completion of the Critical Chain.
4. Addition of Critical Chain Feeding Buffers to immunize the Critical Chain from delays in the feeding chains and effects when tasks merge.
5. Using buffer management as the primary tool for project management and control.
6. Using behaviors conducive to the global project optimization, such as relay race activity performance

17. CONCLUSION

Critical Chain project management provides the following major benefits to project organizations:

- Projects will be completed significantly faster.
- The project team's morale and effectiveness will improve as they will be operating in an environment that is comfortable with uncertainty and that avoids micro management. In addition, team members have the satisfaction of being able to achieve task objectives with minimal interruption.
- Managers and executives will have a simple, highly effective macro-level method for monitoring project performance using green-yellow-red buffer management.
- Executives will have an effective tool for making decisions on projects based upon project priority and organizational capacity using the project synchronization capabilities.

18. REFERENCES

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19. AUTHOR

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