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CCPM: TOC Based Project Management Technique

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Abstract

In this paper, we are presenting the drawbacks in the traditional project management techniques and represent the overview of Critical Chain Project Management (CCPM) and its advantages over the traditional project management techniques. Here, in overview of CCPM, we have covered the different undesired effect in the traditional project management techniques and how the CCPM overcomes that undesired effect and the different theories behind the CCPM techniques.

Index Terms: Undesired Effect, TOC, CCPM.

I. INTRODUCTION

By using the traditional project management concepts the cost and time required to complete the project often overruns by 40 to 50 percent of the original estimate. Critical Path-based project management was introduced as a cure for these problems with a goal of delivering projects within the original cost and time estimates. And in 1997, Critical Chain Project Management (CCPM), which was developed and publicized by Dr. Eliyahu M. Goldratt in his book Critical Chain, is introduced. The genius of Goldratt's approach resides in his 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. Goldratt is the inventor of the Theory of Constraints (TOC). TOC is a tool for managing repetitive production systems based on the principle that every system has a constraint, and system performance can only be improved by enhancing the performance of the constraining resource. CCPM is an extension of TOC designed specifically for project environments.

The CCPM project planning and control process directly addresses uncertainty and variation in project activity duration. It helps eliminate undesirable behaviors fostered by using scheduled dates and milestones within a project plan. It focuses on developing and managing project performance to meet or exceed reduced activity times, thereby reducing overall project duration.

CCPM differentiates itself from the classical methods for project planning and control, such as those contained in the management and engineering textbooks and those in professional stands, such as PMI's A Guide to the Project Management Body of Knowledge (PMBOK Guide) as follows:

- Specifies the critical chain, rather than the critical path, as the project constraint. This path includes resource dependencies, and does not change during project execution.
- Uses 50% probable activity times, and aggregates allowances for uncertainty of estimates and activity performance into "buffers" at the end of activity duration variability.
- Seeks to change project team behavior; encouraging reporting early completion of activities and elimination of multitasking.

However, the publication of Goldratt's book generated some controversy in the project management community. CCPM proponents claim it is a totally new, revolutionary way of thinking that can lead to superior performance in terms of reducing delivery time and increasing the ability to meet schedule and budget commitments. Others dismiss this as hype, arguing that experienced project managers have known the principles behind CCPM for decades, and CCPM's uniqueness is in the terminology rather than in its substance.

The following paper is organized as follows the Section II will introduces the undesired effect that has been answered in CCPM. Section III will describe the theories behind the CCPM process. Section IV will describe the CCPM process and Section V will conclude the paper.

II. UNDESIRED EFFECT

Undesired Effect 1: Excessive Activity Duration Estimates.

Most project managers include contingency time within each activity estimate to account for individual activity common cause variation. Contingency is defined as the difference between the 95% probable estimate and the 50% probable estimate. For example, let's take a situation if you are asked to estimate a task, you think about the task and the effort and decide that you can do the task in 5 days. Then, you think a little bit more. There may be something unfamiliar in the task. You worry about the effect of unplanned work interruptions. Finally, you want to make sure that you won't be late on your estimate because you don't want negative attention. Based on all this uncertainty, you announce that you can do the task in 10 days.

Thus, attempt to deal with uncertainty by including contingency in individual activity estimates are fruitless, and significantly extend project plan duration.

Undesired Effect 2: Little Actual Activity Positive Variation.

Goldratt described several effects that led to performance systematically overrunning estimates, although the estimates initially had extensive contingency time. Goldratt has described the student syndrome. According to this syndrome, if you have 10 days to do work which also include the contingency period, you put off really getting to work until fifth day of the task. This start should be ok because you have adequate safety in your estimate. Unfortunately, on the seventh or eighth day you encounter an unexpected problem with the work. Suddenly, you realize that your safety is gone, and that you will overrun your estimate no matter how hard you work. You spend the next two-three days working as fast as you can with an overrun of your original estimate.

Like the students in Critical Chain, you objectively look back on the task. You note that you wasted four days of safety in your slow start on the task. This makes feel like the activity was underestimated to begin with.

Undesired Effect 3: Failure to Pass on Positive Variation.

Projects do not get the benefit of many actual early activity completions. Even if completed "early," performing resources often fail to pass on positive variations. In most cultures, there is little or no reward for completing individual activities early, and punishment for being late or having quality problems. In many project environments, there is a significant disincentive to reporting an activity complete early. Work performed on "time and material" contracts results in less revenue if the work is completed early. Many companies budget work performed by internal functional organizations as if it were time and material contract work. If the functional organization completes the work in less time than estimated, they cannot continue to charge to the project. If individuals complete activities early, they get more to do. These cultures drive local optima, which means delivery on the scheduled date, but not before. This environment encourages hidden safety, the student syndrome, and Parkinson's Law effects.

Undesired Effect 4: Project Delay Caused by Activity Path Merging.

Most projects have multiple activity paths must merge into the critical path by the end of the project; if for no other reason than into a milestone that identifies project completion. Usually, the path merges tend to concentrate near 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. Activity path merging creates a filter that eliminates positive fluctuations, and passes on the longest delay. the reason is that merging activity paths means that all of the feeding paths are required to start the successor activity. Therefore, the successor activity cannot start until the latest of the merging activities completes.

Undesired Effect 5: Multitasking

Multitasking is the performance of multiple project activities at the same time. Let's us take of the example of simple multitasking and its bad effect. if the resource work one week on each project and then migrate to the next project. In this environment, the projects are accomplished in intermittent spurts. So, the first project will be completed after one week, next in next week and so on. And if the same three projects are done in multi tasking environment then the resource will spent some time on first project and then some time on second project and some time on third project. So, the completion time for all projects will eventually becomes the three weeks which will results in the efficiency loss.

Undesired Effect 6: Loss of Focus.

Several aspects of current project planning make it difficult for the project manager to know where to focus to ensure project delivery. These include:

- Early start schedules, which allow all activity paths to start at the same time. The instant jump to a high-activity level causes the project manager's attention to become diffused.
- Changing the critical path during project performance.

- Attempts to exclusively use earned value for project control.

III. THEORIES BEHIND THE CCPM

CCPM uses three theory tools to improve project performance. It applies the theory to eliminate six specific project effects that lead to project schedule overruns and discussed above.

Theory 1: Theory of Constraints.

CCPM applies the TOC to project management. Goldratt first described TOC in The Goal when applied it to production systems. TOC can be summarized by: "Any system must have a constraint. Otherwise its output would increase without bound, or go to zero."

The primary message of The Goal is focus. Focus on the goal of the company. Focus on the constraint that blocks achieving the goal of the company. The Goal ends with five focusing steps, which apply to any physical system which is discussed in the next section.

- Identify the system constraint.
- Exploit the system constraint.
- Subordinate everything else to the system constraint.
- Elevate the system constraint, and
- If, in the previous step, a new constraint has been uncovered, repeat the process.

Theory 2: Common Cause Variation.

Dr. W. Edwards Deming included "an understanding of variation" as one of his four points of profound knowledge. He identified two types of variation: (1) Common Cause Variation: A cause that is inherent in the system. The responsibility of management. (2) Special Cause Variation: A cause that is specific to some group of workers, or to a particular production worker, or to a specific machine or to a particular production worker, or to a specific machine, or to a specific local condition.

Projects have common cause variation in the performance time of activities. This variation represents uncertainty in the activity performance time. Although the time to perform individual project activities may be independent of each other, project activity networks define activity dependence. The project logic demands that successor activities cannot start until the predecessor activities complete.

Theory 3: Statistical Laws Governing Common Cause Variation.

"The project variance is the sum of the individual activity variances". The statistical method to combine variances means that we can protect a chain of activities to the same level of probability with much less total contingency time than we can protect each individual activity. Aggregation of the contingency times dramatically reduces the overall estimated time for a chain of activities.

A second factor that comes into play in aggregating activities is the central limit theorem. The central limit theorem states "as sample size increase, the distribution of the sample mean becomes closer to the normal distribution."

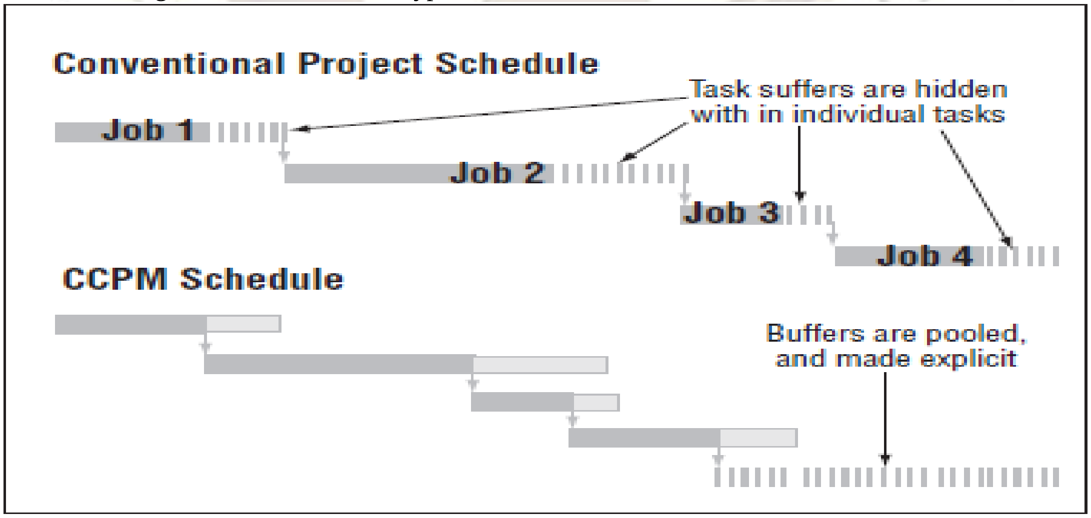

Figure 1: Conventional Schedule and CCPM Schedule

IV. CCPM METHOD

CCPM's starting point is a list of tasks with their duration estimates and dependencies. The first step consists of developing an initial schedule for project tasks. This is done while taking into account the dependencies among the tasks and the availability of resources, because at least some of the resources have limited availability. The resulting schedule is longer than the schedule obtained with the basic critical path method algorithm; critical activities are delayed while waiting for the resources they require.

CCPM identifies the critical chain as the set of task that results in the longest path to project completion after resource leveling. The critical chain yields the expected project completion date, resources required by the task on the critical chain are defined as the critical resources. The next step in the CCPM planning consists of recalculating the project schedule based on the original shortened task duration estimates. The rational while shortening the original duration estimates is as follows:

- All tasks in the project are subject to some degree of uncertainty.
- When asked to provide an estimate of the duration, the task owner adds a safety margin in order to be almost certain of completing the task on time i.e. task duration are overestimated.
- In most cases the task will not require entire amount of safety margin and should be completed sooner the schedule.
- Because the safety margin is internal to the task, if it is not needed, it is wasted. The resources for the next task are not available until the scheduled time. Therefore, when it becomes obvious that the buffer is unnecessary, the task owner will use the buffer time anyway, because there is little incentive to finish early. On the other hand,, any delays in the completion of tasks on the critical chain propagate to the successor tasks. Thus, gains are lost, delays are passed on in full, and the project is likely to finish late even if, on average there are enough buffers hidden in the tasks.

CCPM states that original duration estimates are such that likelihood of completion is 95% and they should be reduced to the point where the likelihood of completion is 50%.The difference between the project duration based on new estimates and the original project duration is called the project buffer and should be displayed on project Gantt chart as a separate task. Fig. illustrates the relationship between the Original Schedule and the CCPM Schedule based on the shortened task durations.

The buffers, which were previously hidden in each task, have been made explicit and pooled. This pooled buffer is called the project buffer.

It is improbable that all the critical chain tasks will exceed their 50% likelihood duration estimates. Under the assumption of statistical independence, about half the tasks will exceed the 50% mark, while the other half will be completed at less than 50%. By pooling together the safety margins of the individual tasks the protection against uncertainty is improved, so CCPM suggests that the combined project buffer can be less than the sum of the safety margins of the individual tasks. This argument is supported by statistical theory which is discussed in section II.

The same process of making safety margins explicit and pooling them can be applied to noncritical paths. As before, the safety margin in each task is identified, taken out, and pooled at the end of the path. Because this buffer is placed where the path feeds back into the critical chain path, it is called a feeding buffer.

The third type of buffer used by CCPM is called a resource buffer, which is a virtual task inserted prior to critical chain tasks that require critical resources. Its purpose is to issue a signal to the critical resource that a critical chain task to which they are assigned is due to start shortly. According to CCPM, this wake-up call will cause the critical resource to wrap up any noncritical work and be ready to start work on the critical chain task as soon as its predecessors are completed. The resource buffer does not actually consume any resource, and it adds neither time nor cost to the project.

- At this point, CCPM has created a new project schedule, which consists of the original tasks with reduced durations and various types of buffers; the project buffer, the feeding buffer and the resource buffer.

For project plan execution, CCPM prescribes the following principles:

- Resources working on critical chain tasks are expected to work continuously on a single task at a time. They do not work on several tasks in parallel or suspend their critical tasks to do other work;
- Resources are to complete the task assigned as soon as possible, regardless of scheduled dates;
- If the task is completed ahead of schedule, work on its successor is to begin

immediately. If the task successor utilizes a critical resource for which a resource buffer has been defined, advance warning is provided to that resource at the point in time where the resource buffer begins;

- If the task is completed past its planned completion date, as shown on the CCPM schedule, this is no reason for immediate concern, as the buffer will absorb the delay.

As progress is reported, the CCPM schedule is recalculated, keeping the final due date of the project constant by adjusting buffer sizes. Project control focuses on consumption of the buffer. Out of proportion buffer consumption is a clear indication for implementing corrective actions, such as reassignment of resources to the tasks on the chains leading to the buffer in question. In this manner, the extent of buffer utilization serves to monitor the likelihood of project completion by its committed due date.

V. CONCLUSION

In this paper, we have presented the undesired effect present in the traditional project management approaches and the different theories on which the CCPM is based.

In traditional project management technique, the buffer is associated with each task but it doesn't provide any improvement in management since the early competition of task doesn't propagate to the next step and delay is propagated to the next task. To overcome this drawback, the CCPM introduce the pooling of buffer so that early completion of task will results in early beginning of next task and the resource buffer guarantees the availability of resource to the critical task.

And it has been seen that the project using the CCPM have completed the project substantially under the time estimate. Companies such as Texas Instruments, Lucent Technologies, Honey-well, and Harris Semiconductor complete projects in one half or less the time of previous or concurrent similar projects, or as compared to industry benchmarks.

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