TAMING *Uncertainty*

Critical-chain buffer management helps minimize risk in the project equation.

BY SHAILESH SOOD

When presented with the choice, most people would rather extinguish a match than fight a fire. That is, they'd rather prevent problems than fix them. In the last decade, computer-assisted collaboration and earned value management have become the preferred tools for improving efficiency and predictability during execution. However, a relatively new tool, critical-chain buffer management (CCBM), addresses the root cause of why projects are routinely delivered late or over budget to begin with.

Substantial time and capacity are lost as a direct result of the "cascade" effect:

- Work stops because either all of the preceding activities have not finished, or the needed resources are working elsewhere.
- Resources idle while waiting for work to arrive. People continue to fine-tune their already-finished work in the meantime.

As everyone is engulfed in firefighting, the plans and priorities previously laid down by management are pushed aside; moreover, most of the inefficiencies are hidden, making it difficult for managers to diagnose and fix problems.

Instead of addressing the symptoms, CCBM contains the cascade effect by weakening task dependencies.

How It Works

Essentially, the critical chain is the longest sequence of activities in a project, after resolving resource contentions. Buffers, or blocks of unscheduled time meant to absorb cumulative delays, are placed at the end of the critical chain and where non-critical chains meet the critical chain.

Feeding buffers, which are placed at the end of non-critical chains, weaken integration and in-project resource dependencies. Thus, delays on non-critical chains can't "cascade" to the critical chain.

Project buffers placed at the end of the critical chain allow gains to add up (critical chain tasks can be scheduled aggressively) and protect project deadlines from delays on the critical chain itself.

Constraints, or the most loaded resources, restrict the number of projects that can be completed. Projects are released for execution based on constraints' availability, so that naturally available spare capacity on non-constrained resources spreads; one project's delays don't propagate to the next. Also, projects do not get stuck in the pipeline, and pressure to multitask is minimized.

With buffering and pipelining, the cascade effect is contained but not eliminated. Therefore, contention for resources still will occur during execution. To minimize multitasking, task-level priorities are required within and across projects. For this, the buffer consumed for a chain of tasks is compared to the work completed in that chain (buffer burn rate). Tasks that lie on chains with the highest burn rate become priority, ensuring that resources work first on tasks that are most critical for meeting project deadlines.

A number of companies already have benefited from introducing this approach. The following CCBM success stories show the tool in action:

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Construction Supply Chain

Shea Homes, Phoenix Division, Ariz., USA, builds 2,000 new residences each year. While the general contractor performs the initial land development, its more than 50 trade partners actually construct the homes. If a crew arrives before a preceding task is finished, it leads to wasted resources. At the same time, if the previous work finishes and the next crew does not arrive, cycle time suffers.

CCBM has enabled many different subcontractors to collaborate on one integrated schedule in a high-variability environment. Today, partners log onto a password-protected portal, check the priority of tasks and plan their work for the following day accordingly. Buffer burn rate status also gives early indications on where schedules are likely to change, so crews do not have last-minute surprises.

Although Shea set out to reduce cycle time from 91 to 60 days, results have been better than expected. Cycle times were shortened to 56 days within a few months of implementing CCBM, and, with attention to buffer history and refining estimates, Shea has further cut cycle times to just 49 days.

Product Design and Development

Headquartered in Milpitas, Calif., USA, LSI Logic designs and manufactures communications, consumer and storage semiconductors for applications that access, interconnect and store data, voice and video. Founded in 1981, LSI Logic pioneered the application-specific integrated circuit industry.

CCBM has permitted LSI Logic to recognize improvements throughout the development design chain. Before undertaking a new project, engineers construct a project plan with aggressive task estimates and pooled buffers. A "firm" date is committed after checking for availability of resources across projects. Next, buffer burn rates are monitored closely during execution. Executives look at the buffer status of projects, and reviews are centered on the tasks that consume buffers and what can be done to recover the time.

More than 90 percent of projects in the library development group now finish within two weeks of planned dates. Also, customer relationships have improved as buffer status reviews allow the development group to update customers on expected delays—if any—sooner rather than later.

Clinical Trials

Pharmacia Corp., a Peapack, N.J., USA-based global drug company with more than $18 billion in yearly revenue and 59,000 employees in more than 60 countries, uses CCBM to manage its internal clinical supply preparation at all facilities as well as research and development work in its biopharmaceutical division.

The initiative started in clinical supply, an organization common in most research-based pharmaceutical companies that receives and analyzes clinical study protocols, coordinates the preparation of supplies for clinical trials, develops labels, packages the final product and ships supplies.

Although the work represents a small but crucial link in the overall drug development chain: A delay directly impacts overall time to market because the doctors and researchers cannot conduct clinical trials without supplies.

Lead times were typically eight to 12 weeks between the initial request for clinical packaging and the actual start of the studies, and on-time delivery was just 48 percent. In addition, the package rate was only 20 per month, while active studies per month had climbed to 65.

Implementing the new approach has boosted performance of clinical supply operations. Lead times were reduced from eight to 12 weeks to three weeks, a reduction of about 70 percent and substantially lower than the industry average of six weeks. Due-date delivery was more than 90 percent for five consecutive months. Without additional resources, approximately 50 studies were packaged every month, a production increase of 150 percent.

	PLANNING	EXECUTION	ONGOING
PROJECTS	• The critical chain limits project cycle time from compression. • Identifying the critical chain activities and resources makes project tradeoffs possible (cycle time vs. scope vs. resources).	• Chains with high buffer burn rates pose a high risk to the project deadlines. • Identifying activities and resources on at-risk chains makes it possible to plan buffer recovery.	• Tighten project plans and specifications for groups of activities that persistently cause the fastest increase in the buffer burn rate.
TASKS	• Concurrent engineering and other technical solutions for collapsing cycle time are prioritized and applied to activities that lie on the critical chain.	• Technical leads focus tactical solutions, such as encouraging a relay runner mode, on upcoming tasks that lie on chains with high buffer burn rates.	• Technical processes are tightened for tasks that persistently cause the biggest increase in buffer burn rate.
RESOURCES	• Scheduling the pipeline based on the most heavily loaded resources generates true demand for all other resources. • Genuine resource planning becomes possible (where to add capacity, where to cut capacity, where to pool resources and where to cross-train).	• Resources with a high portion of their peak loads coming from "red tasks" (tasks on chains with high buffer burn rates) pose a systemic risk to delivery of all projects. • Identifying those resources and tasks allows smart decisions to be made about overtime and assigning skilled individuals to specific tasks.	• Skills are upgraded and better tools are provided to resources that consistently cause the fastest increase in the buffer burn rate.
PORTFOLIO	• A what-if analysis of pipeline schedules allows deadline tradeoffs among competing projects. • Capacity needed at a constraint can be used to guide portfolio planning; projects providing the highest value per unit of constraint capacity will maximize portfolio value.	• Projects in which the buffer burn rate keeps increasing and the resources where red tasks accumulate require a readjusted plan or extraordinary actions.	• Policy and other artificial constraints that persistently cause buffer burn rates to be high are removed. These constraints include organizational structure, incentive plans, vendor selection, customer service protocols and batching of tasks.

Table 1. CCBM provides enterprisewide decision support during various project stages.

As the rank-and-file do not multitask (because they get clear task-level priorities), they can focus on delivering high quality.

CCBM expansion into areas of portfolio management and integrated program management provides executives with the ability to assign work to resources across global sites to boost efficiency and reduce lead-times even further (see Table 1).

Research Projects

Nuclear Research Center, Kamag, Israel, engages in basic and applied research for harnessing the potential of nuclear technologies. Uncertainty is high because scientists work with unproven technologies, and many of the concepts are in the beginning stages. In this environment, resource planning is difficult. Because resources are shared across projects, resource conflicts were common.

CCBM has been easy to implement in this environment as it works well with a high-level project plan without having to replan as events unfold, as buffers absorb most of the impact.

Introducing a buffer burn rate-driven single priority system has helped scientists avoid multitasking and ensure that projects get resources without having to plan too far in advance. The institute also has established a novel process to kill projects early rather than later: Once the buffer burn rate of a project exceeds a predetermined level, the project is automatically included among most likely candidates for killing at go/no-go points.

Core Management System

By weakening the cascade effect and minimizing multitasking, CCBM creates an environment where management decisions gain credibility.

CCBM schedules also can be leveraged to simplify decision-making in an inherently complex environment. Critical-chain buffering and constraints-based pipelining processes highlight the factors that limit throughput, providing a good basis for planning. During execution, buffer signals not only provide advance warning of potential delays, but also highlight areas to get schedules back on track.

Monitoring consumption of buffers over time also can underscore the areas where process improvement will impact system performance. PM

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