Critical Chain and Risk Management

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Protecting Project Value from Uncertainty

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Protecting the value of a project involves dealing with the uncertainty that will be associated with its delivery. The role of Project Management is to assist in turning uncertain events and efforts into certain outcomes and promises. If this is the case, then the primary process associated with project management should be that of risk management. How other processes, such as scope, schedule, and spending management support risk management is therefore critical for successful project management and for maximizing the value of our project-based efforts. One of the more recently introduced project management methodologies has at its core a focus on the management of uncertainty and risk.

Critical Chain-based project management has received considerable attention in the Project Management community since it was broadly introduced in Eliyahu M. Goldratt's book, **Critical Chain** (Goldratt, 1997). Most of this attention has been focused on the areas of schedule development and management. But the details of the scheduling methodology – the critical chain versus the critical path, just-in-time starts replacing as-soon-as-possible starts, the eschewing of task due dates and use of buffers of time to protect the project's promise and monitor its progress – are only means to an end. Or rather, ends – speed and reliability of project performance unencumbered by conflicting pressures and behaviors. And reliability of project promises is as much a result of a methodology's ability to support effective risk management, as it is a result of effective planning and scheduling.

Recognition of uncertainty and its associated risk are at the core of the initial stages of developing Critical Chain schedules. The emphasis on dependencies in the usual approach to developing a project network for a Critical Chain schedule helps to avoid risks of missing interactions of different parts of the project. The use of 2-point estimates to assess and address the early view of schedule risk associated with task uncertainty sets the tone up front for the appreciation of risk in the real world. In addition to task uncertainty, iteration uncertainty (a topic not written of much to date in the Critical Chain literature) can also be taken into account in the sizing of Feeding and Project Buffers. These resulting buffers themselves become a highly visible and direct assessment of the schedule risk associated with the project as a whole.

Critical Chain-based project management is more than just Critical Chain Scheduling and Buffer Management. The genesis of Critical Chain in the Theory of Constraints (TOC) has yielded a holistic view of project management that provides effective risk-focused approaches not only to scheduling and control, but also to initial scoping and planning, effective resource behaviors, and minimizing cross-project impacts. These key aspects of the methodology have a range of implications for the support of basic risk management processes and outcomes, including identification and assessment of risks, response development – bit it avoidance, mitigation, or acceptance, and guidance for response control (Pritchard, 1997).

PROJECT PLANNING – DEPENDENCIES AND DURATIONS

No matter how good a project schedule is or how well resources perform in the execution of tasks in that schedule, if critical dependencies associated with the project are not included in the description of the effort, they represent considerable risk to delivering project value.

The Dependency Network

The primary aspect of planning in a Critical Chain environment is a process known as Network Building. It is a multi-pass approach designed to assure that no key dependencies for the project are missed. Like all effective project management planning processes, it starts, as Stephen Covey might say, "with the end in mind." It requires careful consideration of what the project is about, emphasizing identification of the true value-generating aspects of the project. The TOC origins of Critical Chain provide a basis for this clarification, in terms of providing a focal point in the relationship of the project to the project owner's constraint and the contribution of the project to an enhanced ability to achieve (more of) the organization's goal. From this analysis comes necessary clarity of objectives, deliverables, and success criteria, assuring that everyone is on the "same page" regarding success of the project.

Once the end is understood, Network Building quickly shifts to a focus on task dependencies required to get there. The clear definition of deliverables serves as a high level WBS, but rather than continue developing the individual hierarchical branches of a WBS, Network Building shifts to dependency identification. To the extent that projects are highly interdependent efforts, this emphasis on what is needed to develop a handoff is a more straightforward way of building a holistic set of dependencies than trying to search across the lower levels of branches of a traditional WBS. This also assures an emphasis on deliverables and handoffs through their identification as necessary inputs, with clarity further enhanced by a strong preference for verbose task descriptions (Jacob, 1998).

Once the first pass of major dependencies, from end to beginning have been developed, it is addressed for identification of the minimum resource capability needed for task completions. Very often, this emphasis on "minimum capability" helps identify additional supporting task dependencies, as assumptions about the use of masters versus journeymen and apprentices are uncovered. Once resource identification is complete, if they haven't already been involved, the next pass in Network Building is a review of the task structure by representatives of those resources, highly useful for further catching missed dependencies and for assuring clarity of expected task outcomes.

Network Building and Risk Identification

The emphasis of Network Building in a Critical Chain environment is on clarity of task inputs necessary to support that task's deliverables. The resulting discussion of input requirements are directly related to risks associated with the ability of that task to do what needs to be done for its required output. The "backward" building of the network assures that outputs are understood before defining inputs. This focus on dependencies is, in effect a focus on risk, since missed dependencies in plans and schedules are a serious source of risk. The repeated questioning of "what do you need?" followed by "is there anything else that is needed?" serves to trigger thought of things that could go wrong, i.e., identification of potential risks in delivering task outputs.

The iterative process (initial identification of task outputs and inputs, through resource identification and review, to estimation of durations and iterations) provides a series of "safety nets" enhancing the chances of catching more missed dependencies and risks.

Network Building and Risk Avoidance/Mitigation

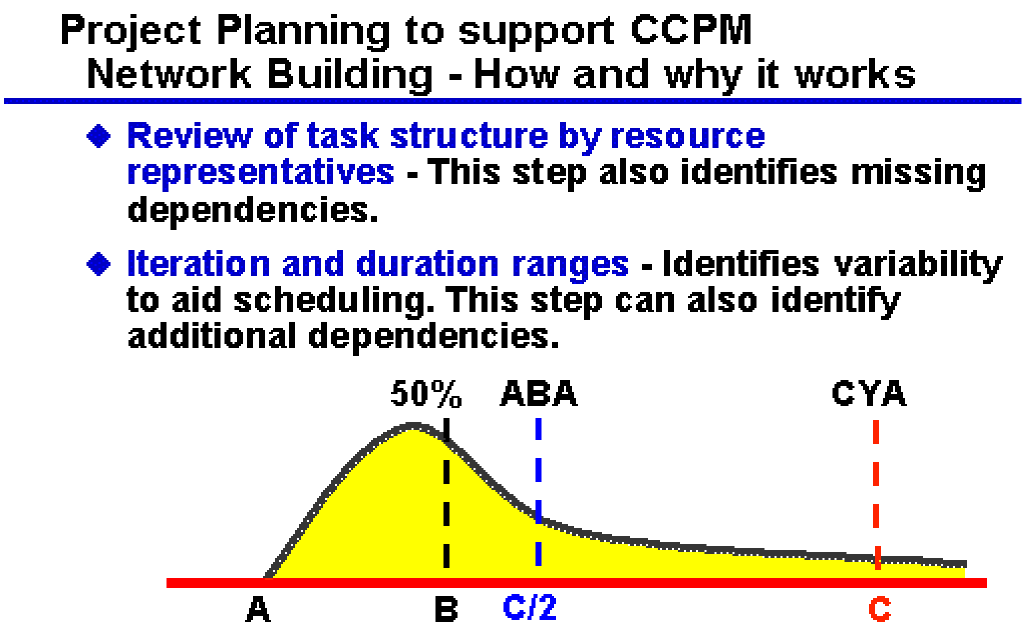
Any effective planning process is about the identification and inclusion of necessary handoffs. These handoffs are the linkages of the chain of tasks – they serve as inputs to some tasks and are developed as outputs of others. The plan – the dependency network – is simply the sum of handoffs that need to occur to overcome obstacles on the way to the project's objective and to minimize the effect of potential pitfalls along the way. To the extent that careful consideration is given to the completeness of necessary inputs, identified risks can be avoided or mitigated by adding additional tasks to the network.

In Network Building, the emphasis on input identification rather than on a flow of tasks or on isolated legs of a WBS helps to assure that risks of missed dependencies are avoided. It is far easier, once one's required outputs are identified, to come up with the full complement of necessary inputs, rather than try to guess what one's successor needs, especially when that successor is in some separate leg of a WBS.

Too often, plans include assumptions regarding the existence of necessary inputs. The incessant (some might say obsessive) focus on whether all identifiable inputs are sufficiently provided for in the network goes a long way to avoiding and mitigating risks that might have otherwise been buried in those assumptions.

Durations and Iterations

The final step in Network Building is the development of range estimates for both task durations and iterations. Critical Chain Scheduling utilizes a 2-point estimate, for both durations and iterations. Avoiding the idea of the oxymoronic "accurate estimate," the Critical Chain approach explicitly accepts and takes into consideration the reality of variation and uncertainty associated with every project endeavor. With knowledgeable representatives of the appropriate resources involved, it is critical to understand what might happen in the event that Murphy's Law strikes, and what could happen if the task in question "gets lucky." This is applicable to both durations of particular tasks, as well as to the number of iterations associated with dealing with things that are unknown up front.



To this end, resources are first queried for a safe estimate – one in which they have a high level of confidence, and are willing to consider a commitment. This defines the upper end of the possible requirements of the project components in terms of time. Once this upper limit is initially established, a second "aggressive but achievable" estimate is solicited – one that reflects a near "best case" situation that is "in the realm of possibility" if things go well in the performance of the task in question.

Two-Point Estimates and Risk Assessment/Avoidance/Mitigation

Schedule and cost risk assessment are inherent in Critical Chain's 2-point duration and iteration estimates. Once basic dependencies are identified in the Network Building process, the uncertainty and potential variation associated with individual tasks and groups of tasks are the next link related to the risk of keeping project promises and delivering desired value. Even if identified, mitigated, or avoided through additional tasks in the network, task delivery is still subject to technical or performance risk.

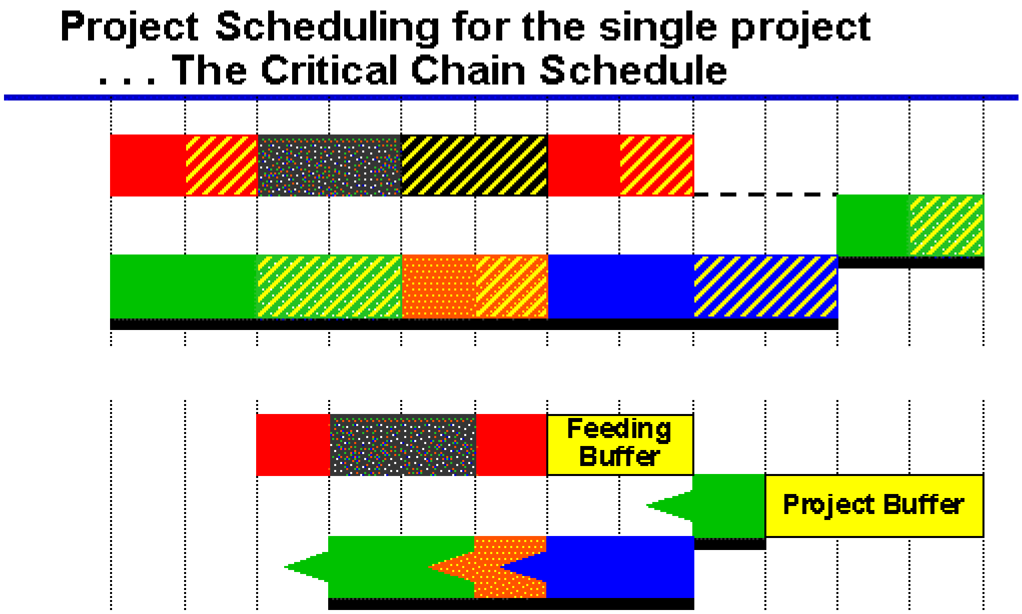
In addition to serving as the basis for turning the dependency network into a Critical Chain schedule, the 2-point estimation process is an excellent vehicle for further understanding risks and ways of addressing them. The first, commitment-level estimate should reflect the inherent task or iteration risk associated with the piece of the project in question. The difference between the larger and smaller estimates is directly related to the assessment of necessary "safety" associated with task estimates. The amount of safety necessary, relative to the aggressive but achievable estimate will highlight the level of risk associated with the task. The reasons for that safety, which should be a piece of the estimation discussion, will provide opportunities for identifying additional inputs and tasks that can serve to rationally reduce either or both of the estimates, or to help assure that they won't be exceeded in execution.

PROJECT SCHEDULING
– INTEGRATIONS, VARIATION, AND RATIONAL PROMISES

Some of the major beneficial effects of the Critical Chain approach come from the linking of scope and time management to risk management. The intimate interactions of these processes in the Critical Chain approach make them difficult to pigeonhole in the taxonomy of the traditional project management body of knowledge (Duncan, 1996), and therefore, they can easily be overlooked. The conduits for much of this connection are found in the development and use of schedule buffers and in the process of Buffer Management.

The Critical Chain Schedule

A Critical Chain schedule takes advantage of the 2-point estimate process to translate the dependency network into a reliable project promise. Reliability comes first from feasibility assured by explicitly including resource dependencies as well as handoff dependencies in the determination of the critical chain/path of the project.

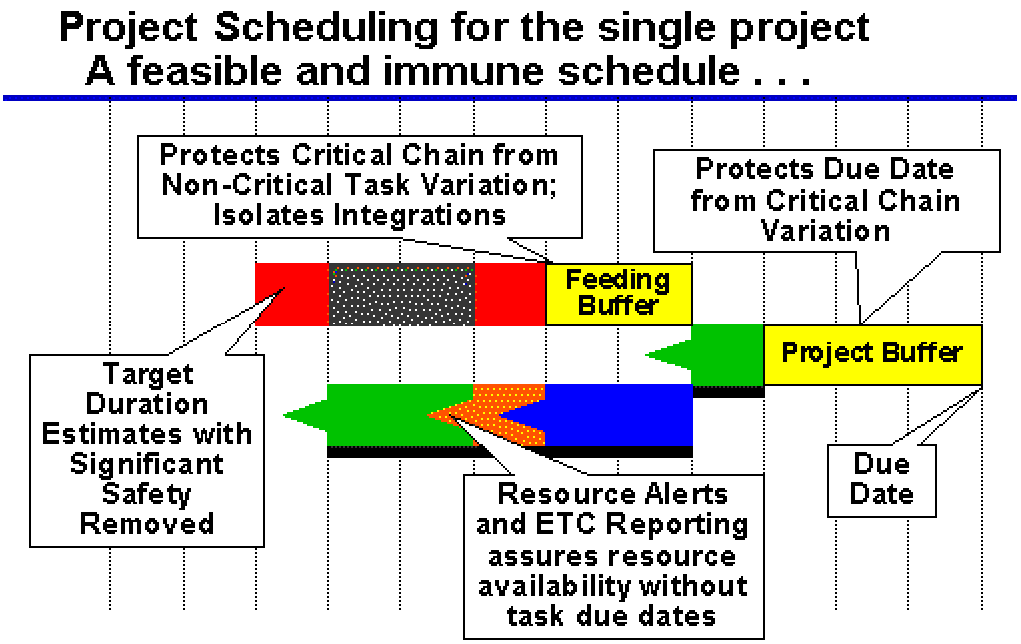


Secondarily, the two estimates developed in the planning process are used to aggregate and concentrate safety where it will do the most good to protect the project's promises and its intended value. The body of the schedule – the network of tasks and resources used to identify the critical chain – makes use of the smaller of the two estimates. The difference between the "safe" estimate and that "aggressive but achievable" estimate for critical chain tasks is used to develop the primary characteristic of the critical chain schedule – the buffers. A project buffer, which protects the final project due date from the variability in performance on those tasks is built from the estimates associated with the critical chain tasks. Feeding buffers, which are related to chains of tasks that feed into or merge with the critical chain, are similarly sized and placed to isolate the critical chain from the integration effects of those chains, essentially helping to keep the critical critical (Patrick, 1999a).

Critical Chain Schedules and Risk Assessment/Acceptance

Once developed, assessment of the full schedule, including the contribution of the buffers to project lead-time, provides a clear view into the identified potential of schedule risk for the project. In non-Critical Chain environments, when contingency is included, it is often hidden, either in management reserve, or in internal and external commitments. The common practice of keeping these components off the table hides their true impact and implications. The open and explicit communication of buffers (important as we will see in the discussion of project control) allows a clear assessment of what could happen "in the best of all possible worlds," versus what might happen if individual concerns accumulate to affect project performance.

The ultimate risk of a project is not delivering the promised value in the required time frame. If the schedule results in a lead-time that does not support business needs of the project, the critical chain schedule provides two primary sources for reduction – the critical chain and the project buffer. Assumptions that have been made on key critical activities can be revisited to assess whether additional actions or activities can be added to the project to reduce variability and the size of the project buffer, or whether task handoffs can be restructured to allow more parallel activity and reduce the length of the critical chain. At some point, limits on corrective action are reached, resulting in a buffered schedule that reflects the accepted risk of the project's lead-time and schedule promise.



Critical Chain Schedules and Integration Risk Avoidance/Mitigation

While a lot of emphasis is placed on the project buffer and its protection from critical chain variability, feeding buffers are just as important. They serve to protect project promises from a universal source of risk found in every project that involves parallel activity. Integration risk, i.e., the statistical nature of merging parallel paths, is the primary source of changing critical paths in traditionally managed projects. If a set of parallel paths of activity each have a relatively safe 85% probability of completion by certain point in time, it takes only 4 such paths to turn the chance of an on-time start for the task they integrate into to 52% -- not much more than that of a flip of a coin. When one considers that projects are typically made up of integrations of integrations or integrations, there is little wonder that critical paths change during the life of a projects, and that there is difficulty bringing projects in on time without relying on heroics or hoop-jumping.

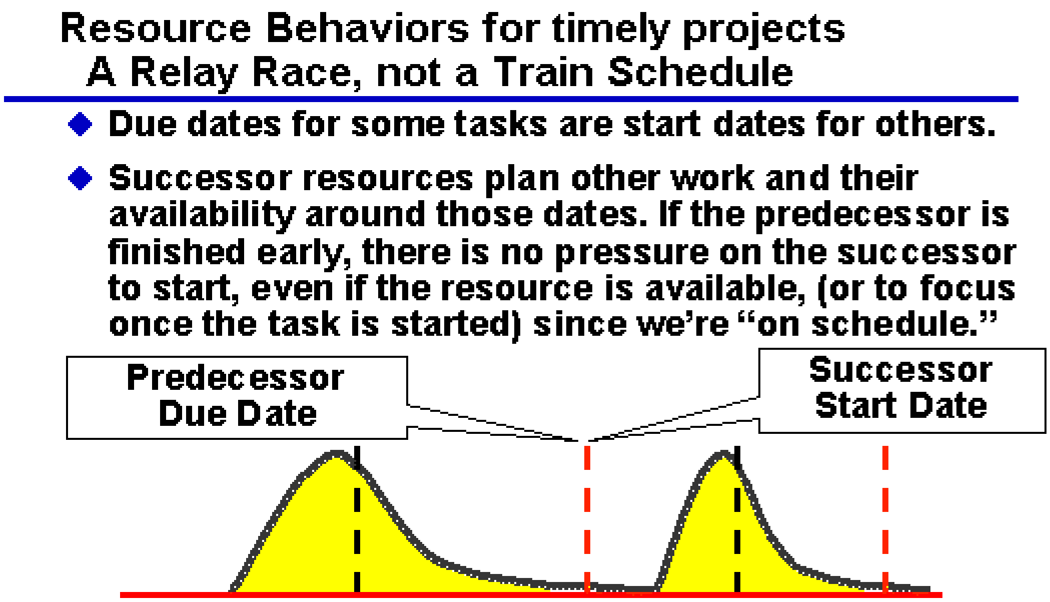
A common tool for assessing this characteristic of risk in traditional critical path project schedules is Monte Carlo simulation, which provides a view of the impact of these integrations on the probability of promised project completion. The critical chain schedule takes these integrations into account up front by explicitly building feeding buffers to deal with the variability in feeding chains (rather than relying on random amounts of slack or float). While Monte Carlo simulations advise on the probability of keeping promises, buffered critical chain schedules are designed to avoid integration risk and keep that probability high.

RESOURCE BEHAVIORS
– MINIMIZING THE EFFECT OF PARKINSON'S LAW

Non-Critical Chain-based projects often rely on safety embedded within tasks and task due dates (milestone schedules) to schedule and control projects. This approach runs the risk of suffering from the impact of common resource behaviors that will minimize the ability to gain time on the schedule. Parkinson's Law – "Work expands to fill the time allowed." – is a resulting reflection of these behaviors. Since ultimately, project performance hinges on appropriate behaviors, the underlying purpose of Critical Chain methodologies is to provide policies and procedures that support desired practices.

A Relay Race, not a Train Schedule

Most projects are managed by carefully watching the calendar, comparing where we are today against some baseline schedule. That schedule typically consists of a series of start and due dates for consecutive tasks, with due dates of predecessors matching start dates of successors. Like a train schedule, if a task arrives at its completion on or before its due date, that portion of the project is considered to be "on track." Successor resources plan other work and their availability around those dates. If the predecessor is finished early, the successor resource may not be available to pick up the handoff. Even if the resource is available, there is commonly little or no urgency for the successor to start (or to focus on it exclusively), since we're "ahead of schedule," and that resource will typically tend to other priorities.



The problem with this common practice is that while it is important for trains to arrive at and depart from their stations (their milestones) at appointed times, project value is more often tied to the absolute speed from beginning to end. The sooner the entire project is completed; the sooner project benefits can be accrued. A more appropriate metaphor to guide projects is a relay race, in which resources are encouraged to pick up the input handoff as soon as it is available, "run with it" in a full, focused, sustainable level of effort, and hand off the output as soon as it is complete.

This behavior is exacerbated in environments where schedules are built upon estimates that are considered commitments by the resources, and therefore contain a substantial amount of localized safety in each task to protect that commitment. If a project is deemed "on track," and a resource realizes that there is chance of completing the work well within the "safe" estimate, the desired sense of urgency is again diminished. As a result, resources are momentarily comfortable sharing their time among several tasks or issues, extending out the time that they would otherwise be able to hand off their output to the next leg of the relay race.

Milestone schedules, like training schedules, become, at best, self-fulfilling prophecies, at least in terms of expectations of speed. They may still (and often do) take longer due to being derailed by Murphy's Law because they have wasted what might have been early finishes which are now not available to offset tasks that take longer than anticipated.

Critical Chain Schedules, Resource Behaviors and Risk Mitigation

Critical Chain schedules address this question of lost safety in two ways. First, the usual system of task due dates itself is eliminated. The only dates in a critical chain schedule are launch dates for chains of tasks that have no predecessors, and final due dates associated with deliverables that are external to the project and which are protected by project buffers. Start dates of tasks are linked directly to the completion of their predecessors, and communicated through the buffer management project control process, discussed in more detail later in this paper. If you have no due-dates, you have gone a long way in eliminating due-date behaviors and in repealing Parkinson's Law.

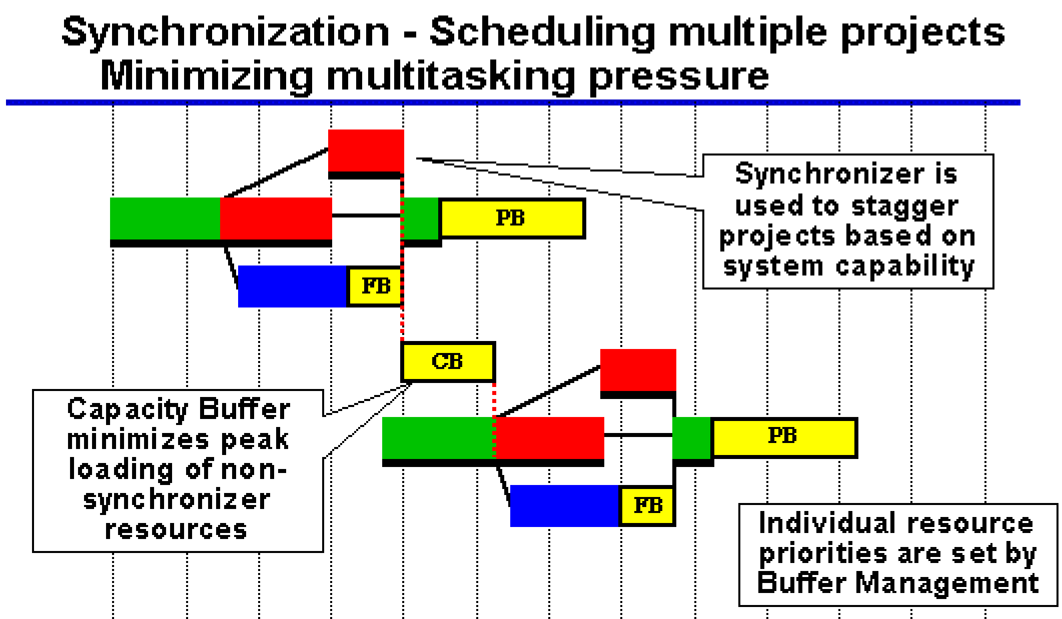
Secondly, the safety is moved out of the tasks to the buffers, thereby eliminating the idea of commitment that needs to be protected on one hand or that is good enough on the other. With the underlying assumption that the work of a task will take as long as it takes, no matter what the schedule model assumes, resources are directed to work on tasks without distraction until complete and handoffs are delivered. At least tasks won't be delayed by outside influences.

More importantly, management also must support the ability to do so, avoiding unnecessary distractions or conflicting priorities. If resources run their leg of the relay race in an effective and efficient manner, some tasks will take longer than anticipated in the schedule and some will take less. The project is in a position to take full advantage of early finishes. In this way, the cumulative risk associated with due-date behaviors is replaced by the consumption and replenishment of buffers.

SYNCHRONIZATION OF THE PIPELINE
– MINIMIZING RISK OF CROSS-PROJECT IMPACTS

In the previous section, the avoidance of distraction from the task at hand was identified as a critical component of "relay race" resource behaviors. Any time working on something other than the task will extend the time of completion of that task, delay handoffs, and threaten the ability to accrue maximum value from the project.

Most project environments do not have the luxury of being able to focus on only one effort. Most project environments are multi-project environments, where key resources are shared across projects and have to deal with contention for their attention. As a result, while a particular single project may be carefully planned, with effective risk management applied within its borders, it may still be subject to programmatic risk, particularly related to availability of resources that are involved in other, equally important projects.



Synchronization - Scheduling multiple projects

The TOC multi-project solution recognizes that the effectiveness of individual projects can be threatened if the organization tries to push more projects through its pipeline than it is capable of. Scheduling – the actual promising of individual project completions – must take into account any constraining aspects of that pipeline. While the common existence of practices like multi-tasking or due-date behaviors typically prove out to outstrip any actual resource constraint, the possibility of such a constraint is useful as an implementation tool for the multi-project aspect of the approach (Patrick, 1999b).

The process of synchronizing project launches to the ability of a commonly, heavily used resource to deal with those projects helps to minimize pressures to multi-task from the start. This process starts with a review of projects in the portfolio for the identification of potential candidates for the choice of a gating/synchronizing resource. The choice of one that is commonly used across projects and relatively heavily used compared to other resources will suffice.

The second step is to prioritize the current projects, in terms of criticality of current commitments, value to the organization, and use of the synchronizing resource. To the extent that there is no easy consensus of strategic priority for existing projects (a rare occurrence), basic TOC principles of throughput per constraint unit and throughput dollar days can be applied to this effort. The objective of this prioritization is to provide an order in which projects are scheduled through the synchronizing resource.

Once these priorities, procedures and processes are in place, individual project schedules can be developed and put into the calendar through the synchronizer schedule. If chosen correctly, and further protected with capacity buffers, the careful scheduling of this commonly, heavily used resource will result in a set of schedules in which any concerns about contention for other resources will be with the ability of buffer management to provide direction.

Synchronization and Risk Avoidance

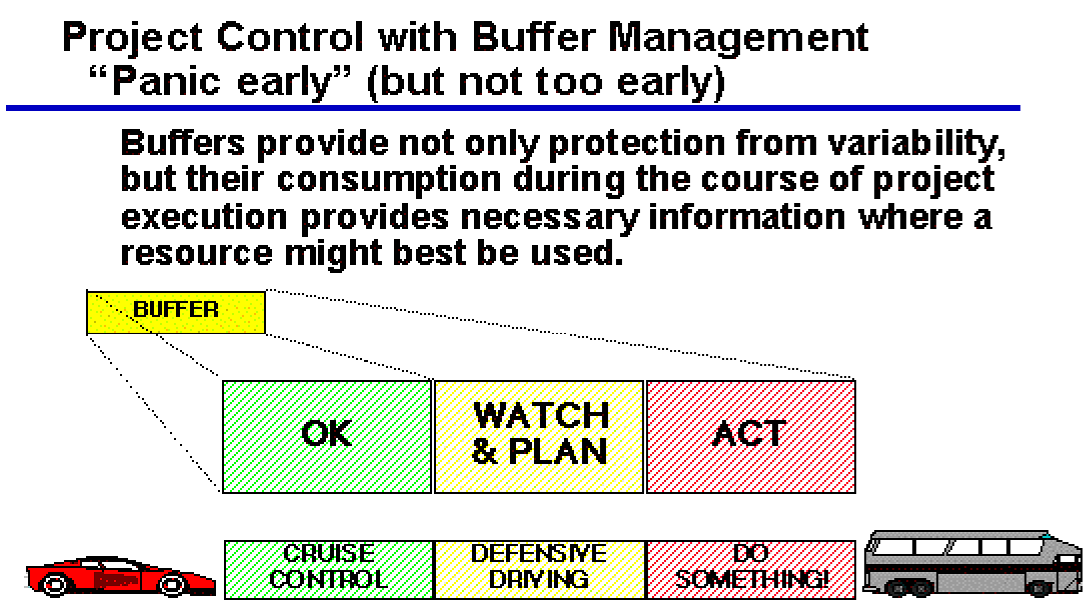
When you consider the duration-multiplying effect of multi-tasking, it should be clear that multi-project risks of cross-project interference could dwarf risks associated with the individual projects. If project value is time-sensitive, the delays suffered by projects due to resource time slicing across projects can be very expensive indeed.

The replacement of systemic pressure to multi-task with synchronization, combined with the management of resources for "relay race" behaviors will go a long way to reduce programmatic risk and to speed project completions across the portfolio. The combination of the two will help avoid having to deal with hard-to-predict cross-project risks. In addition, the required careful consideration of the makeup of the pipeline and the active management of the critical resources identified and used as the synchronization mechanism will aid in understanding potential weak links for future improvement.

Most importantly, if combined with effective and supporting processes for planning, scheduling, and control, synchronization of a project portfolio serves to minimize the overall risks to optimum bottom line performance of the organization that owns the projects and their outcomes.

PROJECT AND RISK RESPONSE CONTROL
– CLARITY OF PRIORITIES AND CORRECTIVE ACTION

At several points in this paper, the need for and benefit of effective project control has been highlighted. Planning, scheduling and synchronization are all processes that will create a model of expectation for the project organization. But that model needs to be managed once it comes into contact with reality. Appropriate resource behaviors, especially the required focus on the most important task at hand, require the occasional guidance to clarify priorities in a shifting situation. And if the critical chain scheduling process is used, something needs to be used to replace task due-dates to assess the health of project promises.

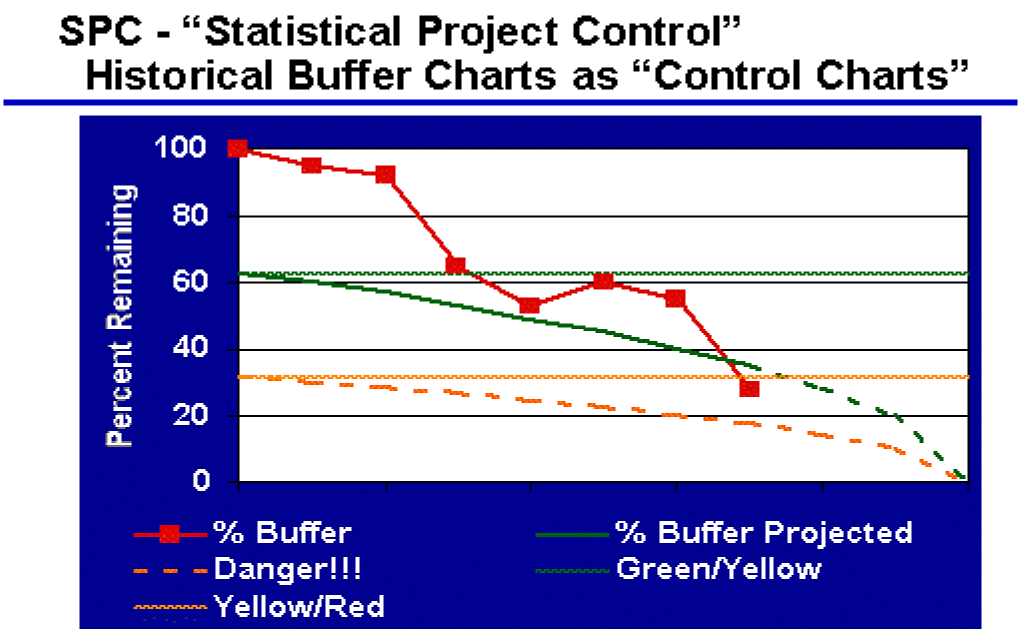


Project Control with Buffer Management

The buffers introduced in the Critical Chain scheduling methodology do not only serve to protect project promises in a static manner. They also provide an ongoing view of the health of the project as reality impacts the expected model that is the original schedule. As tasks take longer than the schedule anticipates, buffers are consumed. As they take less time, those buffers are replenished. Awareness of project buffer consumption relative to the completion of the critical chain (and to the expected variability of the remaining work on the chain) provides an important forward-looking focal point for managing project execution.

A number of straightforward ways of assessing buffer consumption make it clear to everyone involved when and where corrective actions need to be taken. Effective Buffer Management is a critical factor in successful implementations of Critical Chain-based project management systems.

Buffer Management typically involves a combination of real-time access to buffer condition and periodic "buffer management meetings." Real-time, daily updates of project and buffer status are feasible in a Critical Chain environment due to the simple data needed to update active tasks. That data requires only one number at the end of each day – a current estimate of time to complete the task at hand. Immediate issues can be quickly identified through this process.



Periodic multi-project buffer management meetings, typically involving project owners, project managers, and resource managers, start with buffer status of the portfolio's projects. Those with buffers "in the green" require little if any discussion. Those "in the yellow" or "in the red" are rightfully the focus of the meeting, with project managers highlighting identified opportunities and actions for buffer recovery (Patrick, 1999a). These meetings are also useful for supporting regular, forward-looking risk management as well, again with an eye to current buffer condition and to its ability to absorb the impact of identified risks.

Buffer Management and Risk Identification

Consistent buffer management is a major contributor to the establishment of a risk management culture in a particular project environment. Risks and their positive flip side – opportunities – are, by definition, potential future occurrences that require a forward-looking approach to support their identification. The everyday process of developing an estimate-to-complete task status keeps short- and immediate-term risks in the forefront of the mind of the reporting resources. In addition, the elimination of task estimates as commitments and the related transfer of safety to the buffer should support a greater willingness to raise concerns, if the buffer is there to absorb them and they are not expected to have to have an immediate solution to protect their personal performance.

Buffer management also provides a clear view of the cumulative risk effects of project performance. Buffer consumption at any point in time is the result of all previous work, which can eat away at the buffer quietly but insidiously as the project progresses. If buffer consumption is tracked against the amount of chain completed, or alternatively if buffer remaining is tracked against the amount of buffer required to protect what remains of the chain, trends of diminishing buffer condition or the crossing of pre-determined thresholds will serve to identify indications of risk for the project as a whole.

Buffer Management, Risk Assessment and Response Control

Once a possible risk is identified via its impact on buffers, assessment of whether is deserves further attention is required. There are two mistakes that can be made in dealing with identified risks – not acting on them if action is indicated and acting on them if they don't really matter. Project managers are probably sufficiently paranoid so that the risk of not acting is relatively remote. However, that same paranoia can sometimes drive analyses and actions that are not really necessary. And those unnecessary actions will only serve to distract resources and managers from getting on with the necessary work.

Buffer charts, tracking buffers condition against chain completion or buffer required for remaining work, can be utilized in a way that is not unlike the way control charts are used in statistical process control for production environments. For an identified risk, a "what-if" analysis can be easily performed, resulting in a view of the schedule or budget buffer after its run-in with the concern. If sufficient buffer remains for protection of the promise from the variation anticipated for the remaining work, then it is not worth the time and attention necessary to develop corrective actions. In this way, buffer management as risk response control has, embedded within it analysis useful for assessment of individual risks as well.

Buffer Management and Risk Mitigation

The quality of actions taken to avoid or mitigate identified risks is highly dependent on the quality of thinking that goes into their design. The quality of thinking applied to a situation is highly dependent on the environment in which it takes place. With buffer management as the primary project control mechanism, consideration of corrective action takes place when buffer status leaves what is commonly referred to as the "green zone" and crosses into the "yellow zone," or when trends of accelerating buffer consumption are detected. These assessment triggers occur when there is still considerable buffer, and therefore allow the necessary thinking to take place in an environment that is not one of "panic."

If, on the other hand, it does threaten to move the buffer "into the red," then the required mitigation needed to protect the project promise – in terms of buffer reclamation necessary to bring it back to "the green" – provides guidance on the magnitude of the required corrective action.

THE THEORY OF CONSTRAINTS – MORE THAN CRITICAL CHAIN PROJECT MANAGEMENT

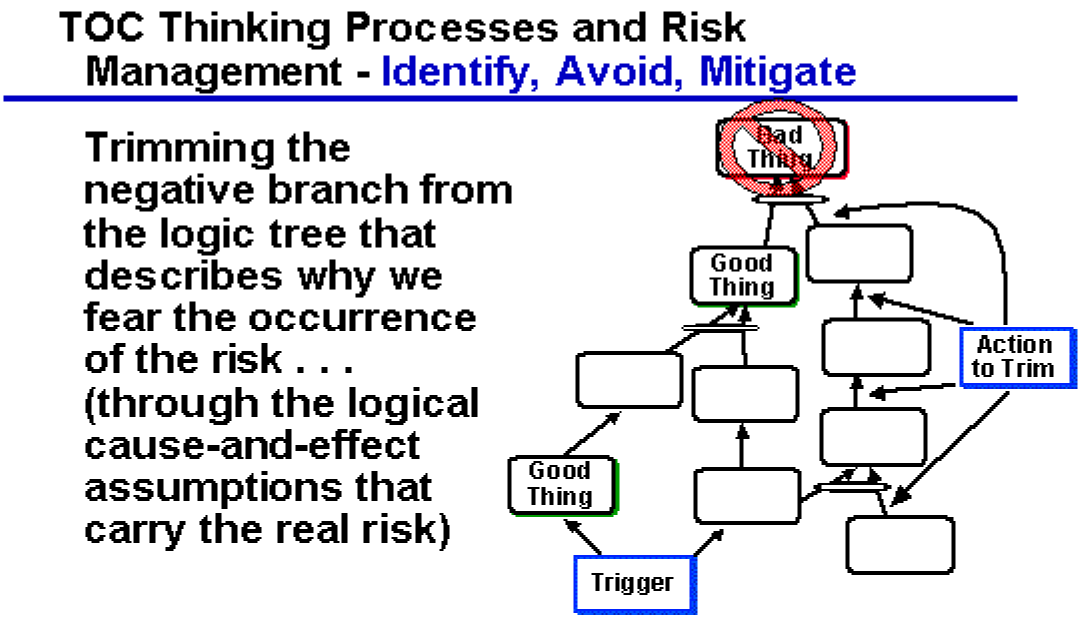
Hopefully, this paper has, at this point, made a case for the TOC approach to project management – Critical Chain Scheduling, Buffer Management, and Synchronized Multi-Project Management – as a coherent approach to project management that supports the basic processes associated with risk management for the protection of project value. But TOC is more than this approach to project management. Actually, the project management solution was derived by applying a set of logical thinking tools – tools that reflect the "hard science" origins of this management philosophy – to the problems commonly faced in the realm of project management (Goldratt, 1994).

Some of the "TOC Thinking Processes" are also applicable in stand-alone situations and should be in the toolkit of a project/risk manager. The first is the Negative Branch Reservation (NBR), a tool that helps to define the concern about a risk in a way that lays out its source in the current situation and the logical cause-and-effect steps that will lead to it. The second is known in various circles as the Evaporating Cloud or Conflict Diagram and is a graphical description of a dilemma or conflict used to raise assumptions about the situation that have within them the potential for a solution.

NBRs and Risk Identification/Assessment/Response Development

"If you define a problem (a risk) well, you probably have it half solved."

There is a lot of truth in that old saw, and it applies to the value of risk identification directly. An identified risk cannot only be the expression of fear of a particular outcome. For identification of a risk to be useful in its assessment and in developing action to deal with it, it needs to include sufficient clarity against which appropriate thought can be applied.



Risk and related issues can benefit from the NBR and the Cloud for developing this clarity. If the risk is related to a concern, a reservation, or seems to be expressed with "Yes, but…" the question may still remain as to if or how that risk may actually occur. The NBR will lay out the path from the starting situation to the concern with as fine a sense of logical cause and effect as is needed to understand it and deal with it. Built with repeated links of if-then-because, the NBR clarifies how the risk will come to pass. This is particularly useful for dealing with questions of technical risk when there is a question of sufficiency of the solution or of undesirable side effects.

If one thinks of the NBR as a "negative branch" on the cause-and-effect "logic tree" leading to the desired objectives of a project, then "trimming" that branch is the path to its avoidance or mitigation. Every logical if-then-because connection along the way has a range of assumptions associated with it. The process for trimming NBRs is one of continuing to ask why certain links must occur, identifying previously unverbalized assumptions that can then be questioned and replaced by new actions, which will then break the logical link. If the cause-and-effect chain leading to the risk is broken, the risk will not occur, at least through that path.

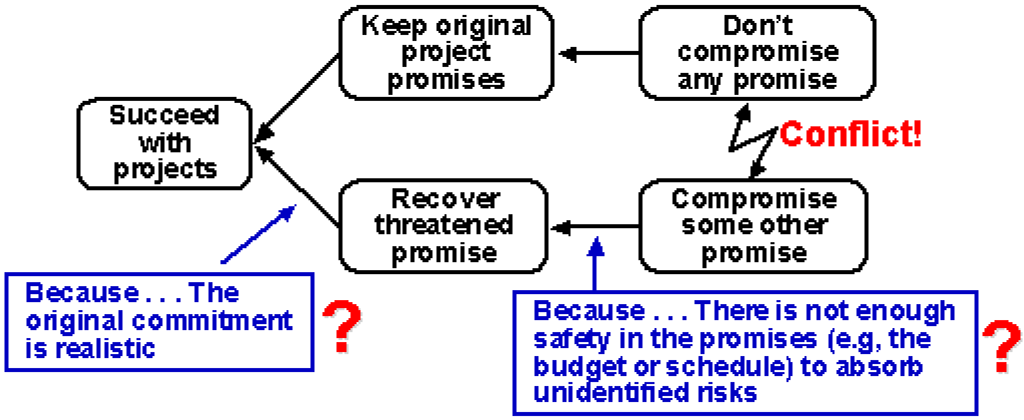
Evaporating Clouds and Risk Identification/Assessment/Response Development

The second need for clarity arises when a situation seems to put one "between a rock and a hard place." In a case such as this, there are usually certain necessary conditions associated with the objective of the project, which lead to a dilemma or a conflict between the courses of action perceived to support the two conditions. The Evaporating Cloud utilizes necessity logic – "in order to, we must…" – to define the necessary conditions (the needs) of the objective and the perceived requirements to make them happen. Once clearly verbalized, the conflict or dilemma can be confirmed as an issue that requires solution.

Once clearly identified and understood, the process to "evaporate" the dilemma follows a similar path to that of trimming the negative branch, inasmuch as it provides a context for raising and invalidating unverbalized assumptions. Between each "in order to, we must" connection of the cloud, the insertion of "because…" statements is the common approach to bringing these assumptions to the surface. At some point, certain assumptions become suspect, and then provide a way out of the dilemma as they suggest possible other ways of satisfying the real necessary conditions. The real risk is not the conflict that freezes action, but the unverbalized assumption that perpetuates that conflict (Patrick, 2001).

TOC Thinking Processes and Risk Management - Avoidance/Mitigation

"Evaporating" the dilemma (the real issue) through raising and invalidating assumptions



SUMMARY – A FORWARD-LOOKING APPROACH TO FUTURE RISKS

Critical Chain-based Project Management and the Theory of Constraints Thinking Processes provide a range of tools and processes to support Risk Management and the protection of project value. A common thread them is a forward-looking approach to the management of projects. Planning with Network Building looks forward to the objectives of the project before considering the path of activities to get there. The Critical Chain Schedule looks forward to the final project deliverables without being distracted by intermediate task due dates that only serve to sub-optimize schedule performance. "Relay race" resource behaviors look forward with fine focus on the making timely handoffs with quality. Synchronization looks forward to the capabilities of the pipeline. And Buffer Management eschews percent complete or earned value of completed work as water over the dam, and instead looks forward to the work remaining, and its variation and risks.

Summary - Risk Processes and related Critical Chain PM Processes

Risk Processes	CC Planning	CC Execution
Identification	▪ Network Building	▪ ETC Reporting ▪ Negative Branches
Assessment	▪ 2-Point Duration and Iteration Estimates	▪ Buffer Management
Response Development ▪ Avoidance ▪ Mitigation ▪ Acceptance	 ▪ Network Building ▪ Buffer Sizing ▪ Buffer Concept	 ▪ Negative Branches ▪ Conflict Diagram ▪ Network Rebuilding ▪ Buffer Management
Response Control		▪ Buffer Management

Management of uncertainty and risk in an effort to deliver promised project value with certainty is what project management is all about, and risk and uncertainty lie in the future. Critical Chain Scheduling and Buffer Management is not only a technique for the development and tracking of project schedules. It is a coherent and comprehensive approach to project management that encompasses and effects other processes and practices associated with project management as well. Most importantly, its implications for looking forward and taking appropriate actions for accepting, avoiding, and mitigating risk are significant and beneficial.

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About the Author

Francis S. "Frank" Patrick (fpatrick@focusedperformance.com) is founder and principal consultant of Focused Performance and an Associate in the A.Y.Goldratt Institute network of consultants and educators practicing in the realm of the organizational effectiveness. As such, he has been involved in assisting a wide range of organizations to achieve breakthrough solutions for significant results through the application of the Theory of Constraints. Focusing most of his efforts for the past several years in the area of Critical Chain-based project management in product development, IS, and engineering design, Frank has become a recognized advisor, writer, and presenter on the topic.