Project Management Articles

Project-Speak: Critical Path

What's on your critical path?

Important tasks? Sure. Really important tasks? Of course. But is that all there is? After, all project tasks are important in one way or another, and even the most important task may not lie on the critical path. Within any project, the critical path is more than just a series of important tasks .... it is a means for scheduling and management that relies on connections and consequences as a basis for planning project tasks and timelines. Critical path tasks are not deemed "critical" on the basis of value or visibility, but on the basis of dependencies, which determine the overall length of the project. Since critical path tasks are connected, any delay in one, can lead to a delay in all....

As such, the critical path tells you what you need to do to get your project done on time.

Critical Path Analysis:

As a project management practice, critical path analysis provides value in four key respects:

1. To estimate overall project duration.
2. To create a logical sequence of project tasks.
3. To track project progress and identify potential delays.
4. To identify potential "fast-track" possibilities.

The Basics: Critical Path Concepts

Critical path analysis relies on a few simple assumptions:

- Projects are made up of tasks.
- Tasks are combined to form a timeline.
- Within this timeline, tasks are either concurrent (can occur simultaneously) or sequential (one task cannot begin until the predecessor [superior task] is complete).
- Sequential, dependent tasks make up the critical path.

Find Your Critical Path:

Critical path analysis begins with a task list, identifying all the key tasks required to complete the project at hand. This task list can be broken down into the following elements:

- Tasks: Specific work activities.
- Predecessors: Tasks that must be completed before any subsequent, dependent task can begin.
- Durations: Task time estimates (from start to completion).
- Early Start Time: The earliest point in the schedule at which a task can begin (based on predecessor connections).
- Early Finish Time: The earliest point in the schedule at which a task can finish (based on predecessor connections and estimated task durations).
- Latest Start Time: The latest point in the schedule at which a task can start without causing a delay in the overall timeline.
- Latest Finish Time: The latest point in the schedule at which a task can finish without causing a delay in the overall timeline.

Critical Path in Practice:

Example: You are planning a project with five key tasks, and have developed the following assumptions regarding task connections:

- Task 3 cannot begin until Tasks 1 and 2 are completed.
- Task 4 cannot begin until Task 2 is completed.
- Task 5 cannot begin until Task 3 is completed.

Task	Predecessor	Duration	Earliest Start Time	Earliest Finish Time	Latest Start Time	Latest Finish Time
1	None	1 week	Week 1	Week 1	Week 2	Week 3
2	None	2 weeks	Week 1	Week 3	Week 1	Week 3
3	1, 2	1 week	Week 3	Week 4	Week 3	Week 4
4	2	2 weeks	Week 4	Week 6	Week 5	Week 7
5	3	1 week	Week 6	Week 7	Week 6	Week 7

Looking at this example, you will note the similarities between Tasks 2, 3 and 5. Each of these tasks have the same early and late "starts" and "finishes", indicating a lack of "float time". Because of the identified dependencies, each of these tasks must begin and end on time, or the subsequent, dependent task will be delayed, thus elongating the overall project timeline. Any slippage in one may lead to a slippage in all. As such, these tasks constitute the critical path.

On the other hand, Tasks 1 and 4 have a more independent nature. Looking at the chart, we can see that Task 1 will take one week to complete, and because of the identified dependency, it must be completed before Task 3 begins. Task 3 must begin on Week 3, therefore, Task 1 must be completed by the start of Week 3. Since Task 1 only requires one week to complete, planning options exist. Task 1 can be started on Week 1 or Week 2, and can still finish in time for Task 3 to start. As such, the start and finish of Task 1 can "float" without impacting any other task or the overall timeline..

Task 4 also has float, but in a different way. Task 4 cannot begin until Task 2 is completed, but there are no subsequent tasks dependent upon the completion of Task 4 itself. The end point of Task 4 is determined by the end of the project itself, or the latest finish time of the final project task (Task 5). Since the project is set to complete on Week 7, Task 4 must be completed by that time. Since it will take 2 weeks to complete Task 4, the latest starting point for Task 4 is Week 5. Since it is possible for Task 4 to begin on Week 4, then Task 4 has a float of one week. As such, Task 4 can begin on Week 4 or Week 5 without impacting the end point of the project. If the completion of Task 4 were to extend beyond Week 7, the entire project timeline would be delayed.

From a practical standpoint, critical path analysis is all about "breathing room" .... to identify the tasks that must start and end at a specific point in time, versus those tasks which offer scheduling flexibility. Any worthwhile project management software will calculate critical path for you based on the tasks, dates and dependencies entered, but the logic behind these calculations should not be a total mystery, for it is the human element that must respond to project issues and changes on a daily basis … in real time.

Critical Path Calculations:

As you can see from the chart above, critical path is all about timing .... finding the earliest and latest points at which tasks can begin and end. The calculation of earliest start times (EST) and earliest finish time (EFT) is used to create the project schedule. The calculation of latest start times (LST) and latest finish times (LFT) is used for schedule management, delay resolution, and fast-track planning.

Calculations: Early Starts and Finishes

EST of tasks with no predecessors = First logical starting point.

EST of tasks with predecessors = Predecessor EFT (Earliest Finish Time).

EFT of tasks with no predecessors = Estimated task duration.

EFT of tasks with predecessors = (Task EST + Estimated task duration).

On the other side of the coin, latest start (LST) and latest finished times (LFT) are backwards calculations, considering the earliest starting point of the first subsequent task, minus the expected duration of the task under calculation. To calculate LST and LFT, you will start with the latest finish time and work backwards to calculate the latest possible start time.

Calculations: Late Starts and Finishes

Step 1 - Finding the LFT (latest finish time):
Considering the estimated "earliest start time" of any subsequent dependencies, what is the latest finish time for this task?

Task LFT = EST of the first dependent task.
(Example: LFT of Task 1 = EST of Task 3)

Step 2 - Finding the LST (latest start time):
Considering the identified "latest finish time", what is the latest starting time for this task?

Task LST = (LFT – Task duration).
(Example: LST of Task 1 = (Task 1 LFT - Task 1 Duration)).

CONCLUSIONS.....

Considering the nature of most projects, critical path analysis can be a mind numbing experience. But every project schedule is a living entity, which must be continually monitored and manipulated. For simplicity and manageability, it best to break every project down into smaller, logical pieces, managing critical path for discrete phases and milestones, as opposed to the unwieldy whole.