Project Management Introduction

By Jim Davis

What is it?

Project management emerged as a separate discipline in the 1950s. It was strongly influenced by Henry Gantt and Henri Fayol. Gantt is the father of Gantt charts which will be discussed hereafter. Fayol is best know for his articulation of the five functions of management (plan, organize, staff, coordinate and control). Project management differs from business management in that the former is work that has a clear beginning and end, whereas the later is process oriented and ongoing. The three technologies that are best known in this field are: CPM (Critical Path Method), Gantt charts and PERT (Program Evaluation and Review Technique).

Prior to the 1950's most projects were managed ad hoc. The 1950's and 1960's saw a lot of growth in the field with the development and implementation of several new project management tools. The field didn't change much from the late 60s to the late 1990s.

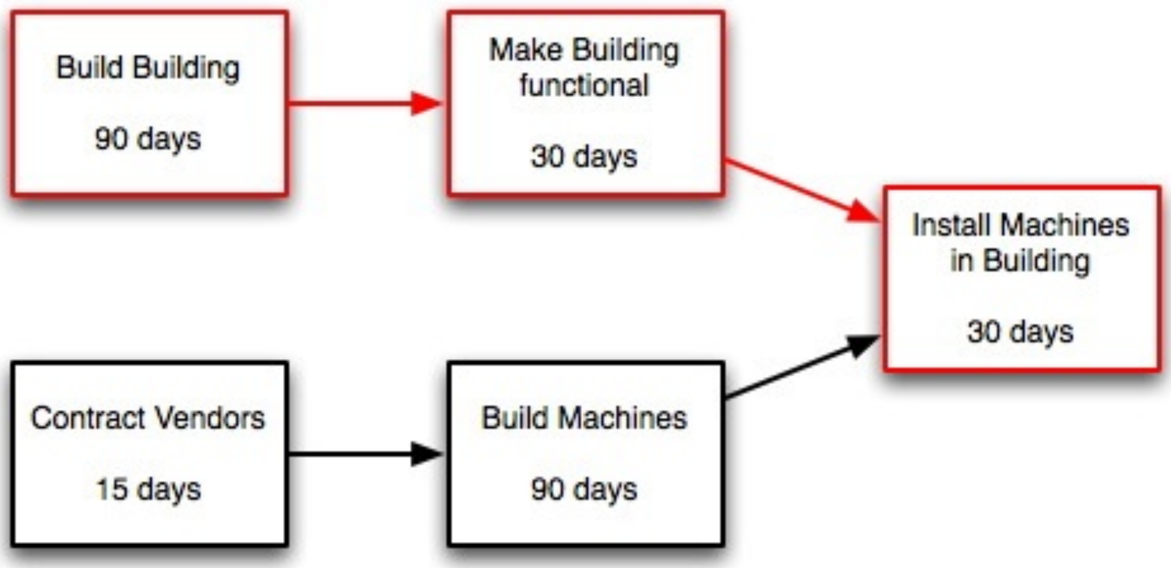
Methods

CPM - Critical Path Method

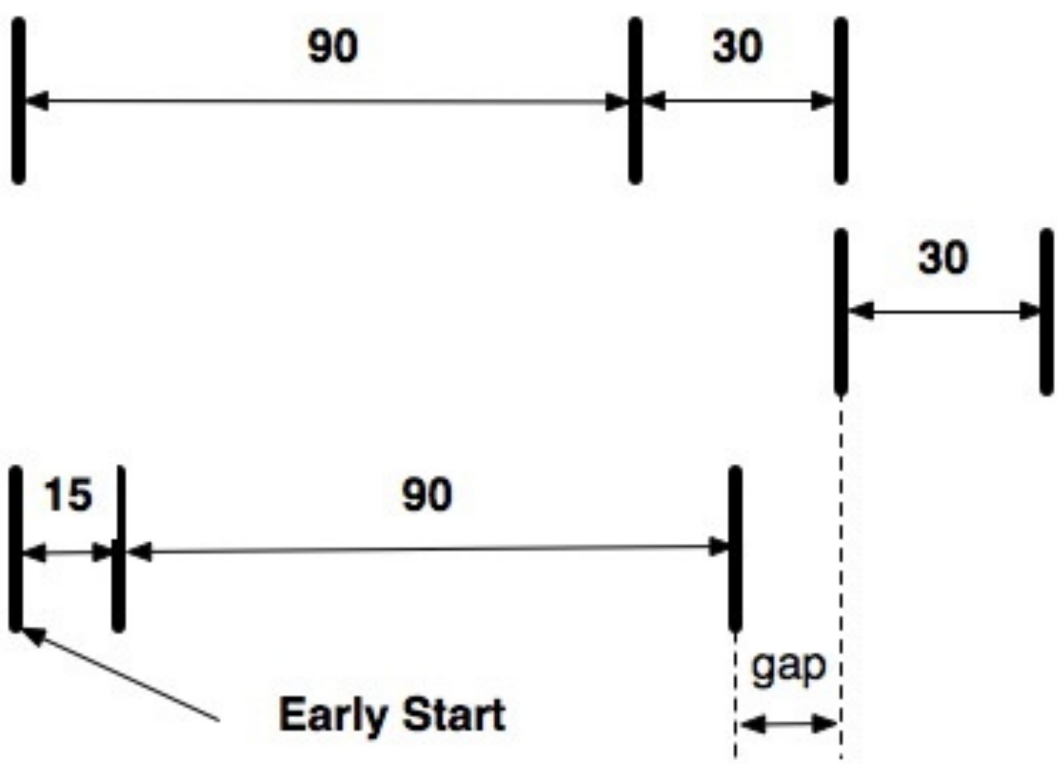
The purpose of CPM is to find out how long it will take to complete the project, and what sequence of tasks determines that time. CPM first lists all the tasks required for the project. Then the tasks are placed in diagram form to show how the tasks should be sequenced to accomplish the project. Next each task is assigned an estimated time to complete the task. Lastly the times are added up to determine which path through the project is the critical path. **The critical path is the longest chain of dependent tasks in the project**. Any delay in completing any task on this path will necessarily delay the project, hence the name: Critical Path Method. The essence then of the Critical Path Method is:.

A. Determine the tasks of the project,
B. Determine the correct sequence of the tasks and
C. Determine the Critical Path.

An example of a simple, and rather unrealistic task is shown above. The Critical path is shown in red and the non-critical path in black.



Example of a Critical Path



PERT Chart

This methodology, shown above, for organizing projects is similar to CPM. It also organizes and sequences the tasks which comprise a project. It is different from CPM in that it is organized around events rather than tasks. This lends itself to the establishment of milestones, which can be used to measure the progress of a project. Unfortunately, when something can be done, it usually is done whether is it wise to do it or not. The purpose of measuring progress is to ensure we finish on time. We will see later on, that using milestones not only fails to accomplish this purpose but is actually part of the cause of not finishing on time!

PERT also focuses on establishing possible start times both early and late. This determines the amount of slack which exists for activities and points out where decisions need to be made about when to start an activity. The Early start option is shown in the diagram on page 2. For the Late start we move the gap to the front of that sequence. Two possible criteria are used to determine whether we should use an early or late start time. These are time and money. **Historically money was the predominant criteria despite the fact that completion time is regarded as more important.** This is our first clue that there are two competing criteria for solving the project management problem. It is an important clue! Gantt charts are used to plan start time, but again because it can be done, it is done, whether or not it is a good idea. Again, money dominates when time should!

Gantt Charts

Developed between 1910-1915 by Henry Gantt, these bar charts show the timing of each task and sometimes the linkages between tasks. Whereas CPM is a tool to provide information to the project managers, Gantt charts require decisions to be made by those managers, such as when to start working on the non-critical paths.

For example, using the same project diagrammed above, managers must decide when to start the non-critical path. The two main choices: Early Start starts at the same time as the path above it; Late Start starts 15 days later and so the sequence ends at the same time as the path above it. So we can start the path early or we can start the path late. This type of decision has become known as an optimization problem and the literature is full of analyses offering advice as to which choice is the best. Most of these discussions involve factoring the cost of money against the time it will take. Unfortunately these analyses all miss the mark for three reasons.

- **The analyses focus on efficiency when the more critical concern is effectiveness! Unless we are effective efficiency doesn't matter.**
- **The analyses focus on project costs but delays on most projects have a far greater impact than any cost savings from delaying the start of any path!**
- **Using a late start causes the project manager to lose focus. Everything path becomes critical. This overloads the project manager and they lose focus!**

While starting at the early time means incurring costs earlier, starting late means that **all the paths are now critical**! If everything is critical then the project manager has absolutely no focus and no cushion against delays! The purpose of project management tools is to help the project manager maintain focus. **If focus is lost, the project will be late and most likely over budget too!**

CPM shows the manager the critical sequence of tasks. These require his attention. Gantt charts force decisions to be made to schedule the starting times for each task but unfortunately the operationalization of Gantt causes huge problems!

Common Characteristics of Projects

Almost all projects suffer from three common problems. There is a high probability of:

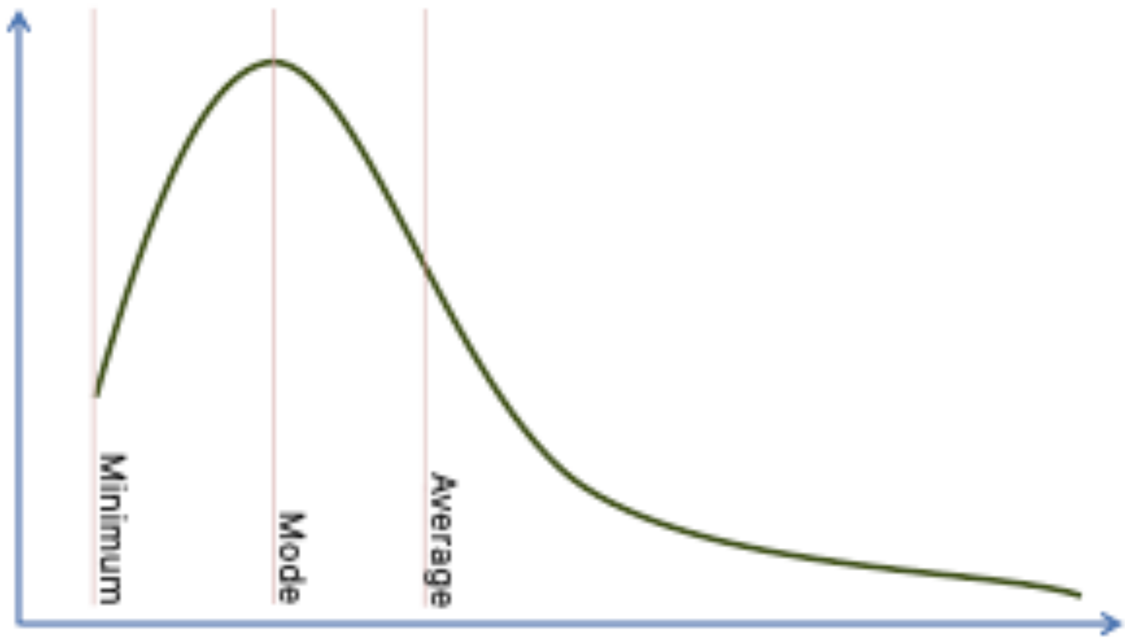
- a late finish
- budget overruns
- compromising the original specification of the project.

This is true for all projects especially those which which are unique, or attempting to do something for the first time. There are numerous examples which establish all of these effects. The exceptions are extremely rare! All three problems arise from the core problem of projects—**uncertainty**! Lets examine thoe three problems.

1. **Late Finishes**

   While many attribute late finishes to uncontrollable external factors, the real culprit appears to be a high degree of uncertainly inherent in the tasks. Some complain that top management has cut all the safety from their projects, but the numbers they report are 20-25% of the entire time of the project. To examine the safety built into each task requires an understanding of a probability distribution I refer to as the Task Curve. It is shown on the next page.

   The Task Curve is a probability distribution for any task. It is identical for all



The Task Curve

tasks and the time associated with a given task depends on the level of uncertainty. **Plotting time on the x-axis and Probability of Completion on the y-axis,** the distribution to accomplish any task is skewed to the left (mode is less than the mean). While all tasks have a minimum time in which they can be accomplished, the total time to finish can vary widely and depends on the uncertaintyin the project. This produces a curve similar to the one shown above.

How do people estimate the expected time for the task? Research suggests, people estimate the time a task will take based on past experience. However, if the estimator has been recently burned by a job that took much longer than the estimate, they compensate by increasing subsequent estimates, sometimes substantially. If you look at the distribution, then the expected time would be the statistical mode. Since the probability distribution represents what happens over many repetitions of the task, the mode represents the time the task most frequently takes. So it is the most likely time to accomplish the task. The average is the statistical mean, which is a longer time. and there is basically only a 50% probability any particular task will be finished by that time on any given attempt. This means that no one will willingly quotes that time **because 50% of the time we would be wrong, and unable to finish the task on time**.

This is a critical point to understand! An example illustrates what is going on. If it normally takes me 20 minutes to drive to work, then that is the time (mode) which I would estimate. The best time possible might be 12 minutes. If there are traffic problems then it will take longer than the expected time. If I am asked how long it takes to get to work and I sense that the answer is to be taken literally then I will not say 20 minutes. I will quote a longer time, say 30 to 35 minutes estimating the average. If I have an important meeting first thing in the morning, I would leave early just in case there was a traffic delay. By doing so I am building safety into my estimate for my driving time. If I leave 40 minutes before the appointment, I have built in 100% safety time. I expect to take 20 minutes and I have allowed for 20 minutes of safety.

If I want to be very sure that I will arrive on time then I would leave 60 minutes before work starts. **Past experience with projects typically shows that amount of safety—200%—will be adequate 80-90 percent of the time.**

It turns out that in projects people routinely turn in task time estimates that they feel give them an 80-90% chance of completing the task on time. When we look at the probability curve we see that they are building in at least 200% safety into each and every task! Please uderstand, people believe they are giving accurate estimates. They know that delays do occur, and no one wants to promise something they cannot possibly deliver. So they give what they think are accurate estimates. **Now, if every task routinely has that much safety built into it, cuts by top management on the order of 20-25% cannot possibly be responsible for the late finishes.** So why are so many projects so late and so much over budget?

2. Budget Overruns

It is common practice in business, and in projects, to accept bids based on the lowest price. As a consequence much less attention is paid to the cost overruns of projects. This is a serious error! The costs incurred from late completion usually far outweigh the savings achieved from cost cutting and lowest bid practices. This fact has been widely established in a number of studies. When people claim there are no negative consequences to a project finishing late, it is always because they haven't examined the lost income, carefully enough!

3. **Compromising the original specifications of the project.**
   Project managers are extremely familiar with this aspect of project management. When it becomes obvious that a project is going to be late participants begin to offer suggestions as to how to cut corners on the project and still bring it in as close to on time as possible. In other words we deliberately compromise the quality of the project in order to finish on time. Unfortunately, this is also a very common practice in project management.

How times for project tasks are estimated

When a project is planned, each task is assessed to estimate how much time it will take. Naturally, those providing the time estimates build in safety even though no one will admit to doing so. Everyone believes they are submitting reasonable estimates! It turns out there are three common methods for building in safety.

- Estimates are mainly based on the pessimistic end of the spectrum.
- Each level of management adds their own safety factor. The more levels there are, the higher the amount of safety added!
- Knowing that upper management is likely to impose global time cuts, estimators build in more safety in anticipation of these cuts. If the expected cut has been 20% then the estimator would add 25% onto the estimate before passing it on to their boss.

Notice the discrepancy between the amount of safety being built into the estimate for each task (200%) compared to the size of the cuts mandated by upper management (20-25%). **This means that the vast majority of task time, is safety**! So why are so many projects late when the vast majority of task time is safety?

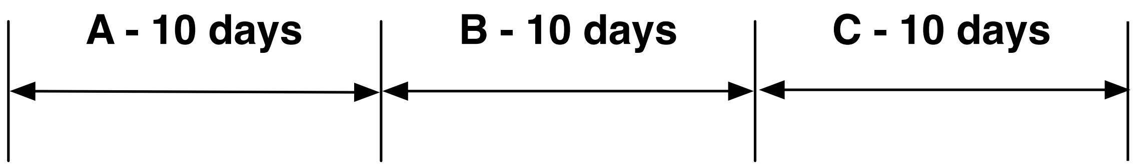
Where does all the safety go?

Just as there are three ways to build more safety into each task, there are three common ways by which we waste that safety.

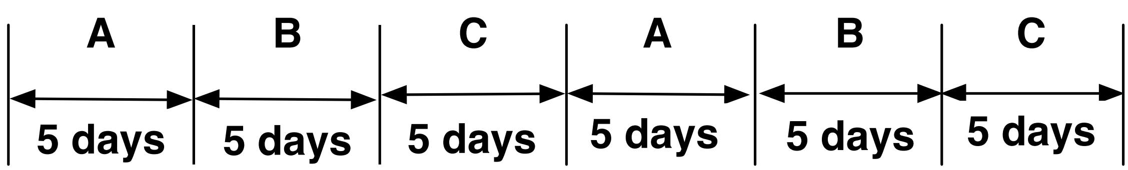
- If we believe the time proposed is insufficient to accomplish the task, we fight for more time! Once we think we have enough time, do we start the task immediately? No! **We think we have enough time, so we don't think we have to start immediately.** When problems arise, as they always do for a certain percentage of tasks, this practice guarantees that task will finish late. This method of wasting safety is sometimes known as the student syndrome because students will almost always fight to have adequate time to complete an assignment but then procrastinate starting it. (This should not happen if the participants understand and use the lesson of the task curve.)

- Multitasking is frequently used by, or forced upon departments which are bottlenecks in their organization. Multitasking **always** lengthens the time to complete a task because other tasks must wait while you work on something else! **You should always avoid multitasking!** Consider this example: Under multi-tasking Task A takes 20 days instead of 10 days. Task B takes 25 days instead of 20 days. Task C takes 30 days under both.

Single Tasking



Multi-Tasking



Note: Sometimes delays occur which prevent us from completing a particular task. In this case it is perfectly acceptable to set aside that task and using our time to work on something else until the delayed task becomes active again.

- Tasks that are dependent upon other tasks must be completed before the dependent task can start. As a result of this, and the **dominant practice of not reporting a task completed until the scheduled completion time**, gains from early completion are normally wasted but delays accumulate to the project as a whole.

So all of the safety which we so deliberately build in to protect our projects is wasted. The safety we so carefully build into each task doesn't protect our projects. **It is put there to protect each task, and it does absolutely nothing to protect our project!** Our project is still fully exposed to delays at every step along the way. We need a method which will protect the project as a whole not each step of it. To fix this we create the Project Buffer (See item 7 & 8 below).

How progress is measured for a project

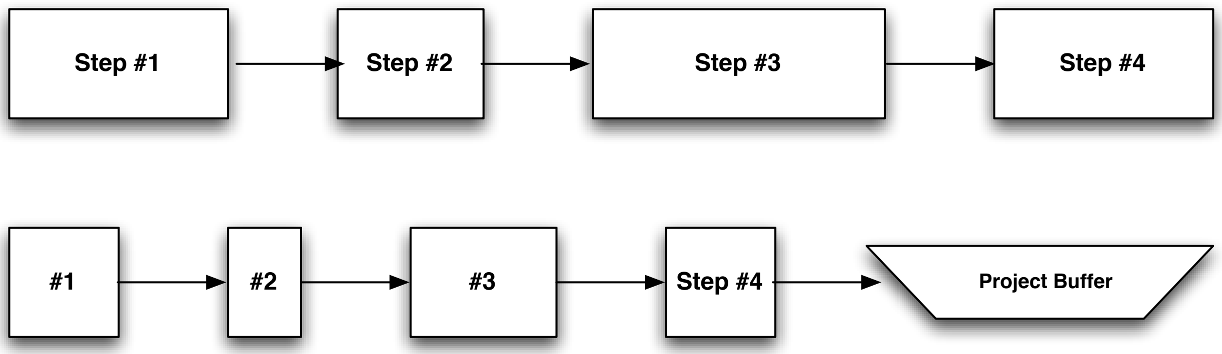
With Gantt charts we measure project progress by using milestones. Milestones tell us what percentage of the project has been completed, either in time, or in investment dollars. However, these measurements do not regard whether a task is on the critical path or not. This gives the impression that progress on any task is real progress on the project. So we get the situation where 90% of the project is completed in one year, only to have the last 10% take another full year. (No one associated with project work finds anything strange about this fact!)

We go to all the bother of figuring out the critical path (the sequence of events which determines how long it will take to complete the project) only to ignore it when we measure our progress toward completion. **To accurately measure the progress of a project, we must measure completion on the critical path only!** If the project is properly planned, the non-critical paths will take care of themselves. An effective project measurement system must measure the percentage of the critical path which has been completed.

How to use Safety to Protect a Project

The safety built into each step of the project is wasted as indicated above. However, what needs to be protected is not each step, but the project as a whole. To do this we need to take some of the safety out of each step and put it where it will do some good. Just as we protect a manufacturing bottleneck (downtime at a bottleneck is throughput lost to the entire system forever) by placing inventory in front of it to prevent it from ever being idle, we should protect the project bottleneck by placing our safety in the place which will protect the bottleneck. **For projects time is the scarce resource and therefore the critical thing to manage!** So we place a time buffer (safety) at the end of the critical path. We can also estimate how much safety is needed for each path feeding into the critical path and place buffers there to make sure we do not delay the critical path. **Note** This also gives us a practical answer to the problem of early versus late starts, without losing focus and without having to use optimization methods.

This project diagram without and then with a project buffer looks like this:



Plan without a Project Buffer, then Plan with a Project Safety Buffer

In implementing these improvements to project management it boils down to three changes.

First—We have to persuade people to cut their time to accomplish each step and then use that time to create a buffer which will protect the project. (typically 1/3 to 1/2 of the task estimate)

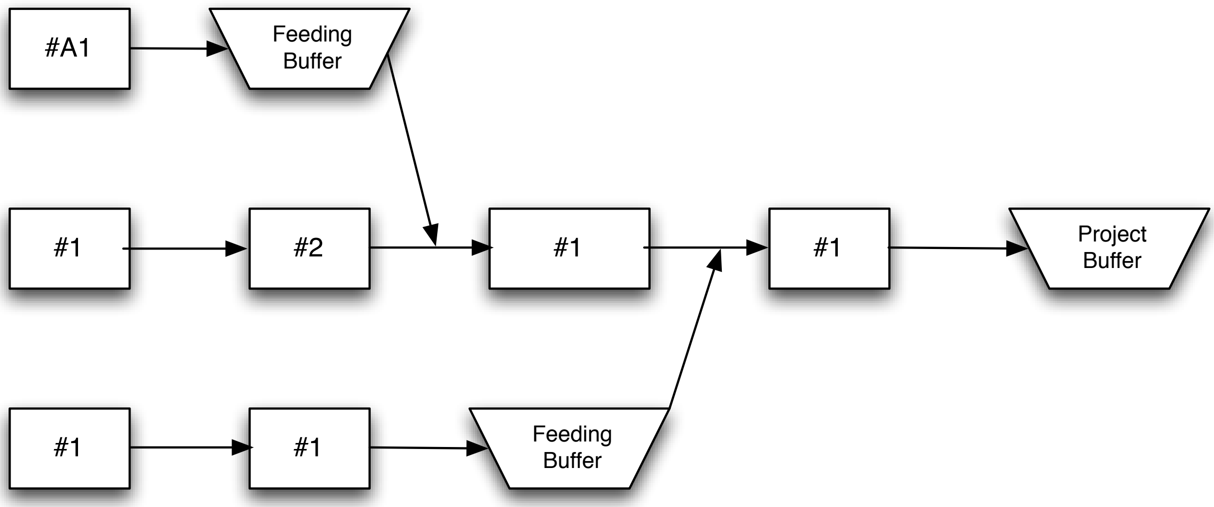
Second—We must eliminate milestones–completion dates for each step, because we need to work on each step **as fast as we can**. There is no such thing as having enough time becuse we never know when uncertainty is going to occur and delay our current task. We then regularly report the percent of the Critical Path that has been completed. (This may flutuate significantly from week to week).

Third—We must frequently report expected completion dates for the current task to those who will perform the next task. This allows others to know when to expect the current work will finish and thus when their work needs to begin. This prevents wasting time saved on early finishes for a task. **Communication about project progress along the critical path is absolutely critical!**

Buffers

Buffers are used to build in safety to a project. They can ensure that a project will finish on time or even ahead of time. Even the cost overruns of a project are relatively small when compared to the costs of a delayed or late project. These costs can often make the difference between profitability and insolvency! Buffers need to be inserted as discussed below.

a. **Project buffer**—is placed at the end of the critical path. Its sole function is to protect the critical path. If we finish without using the buffer then we

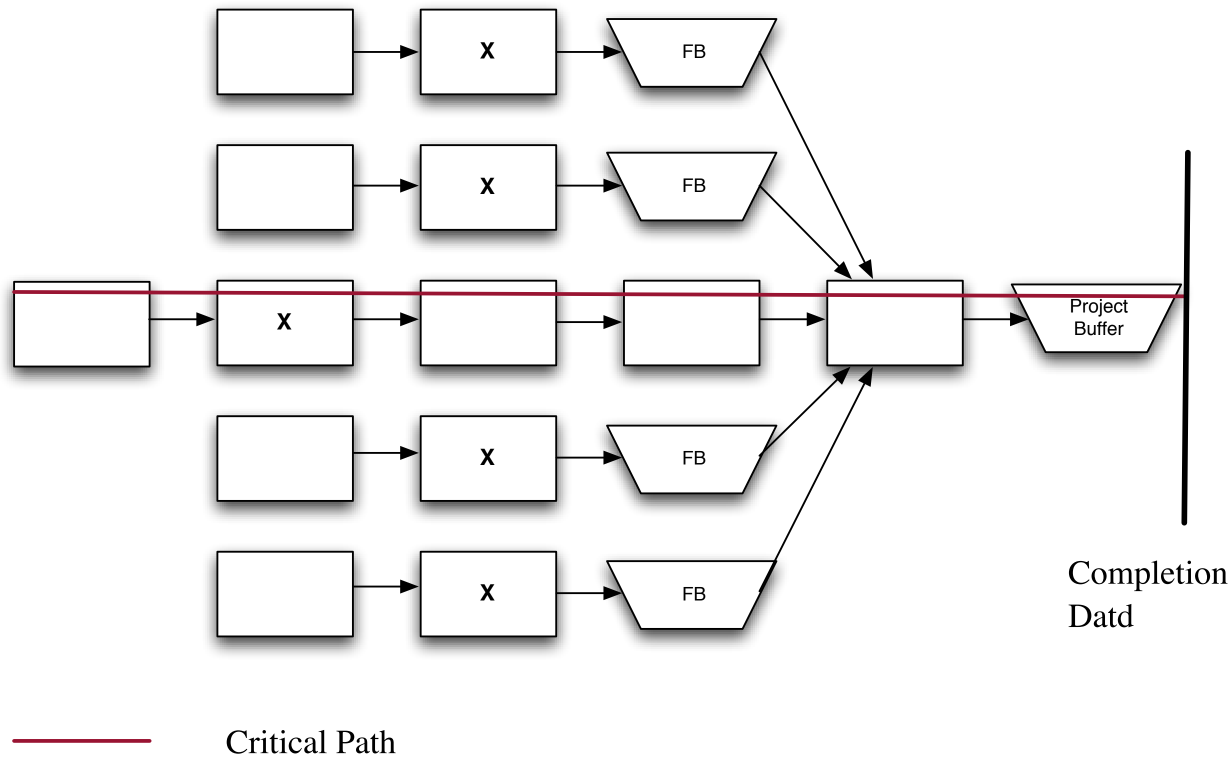


Project with Feeding buffers and Project Buffer

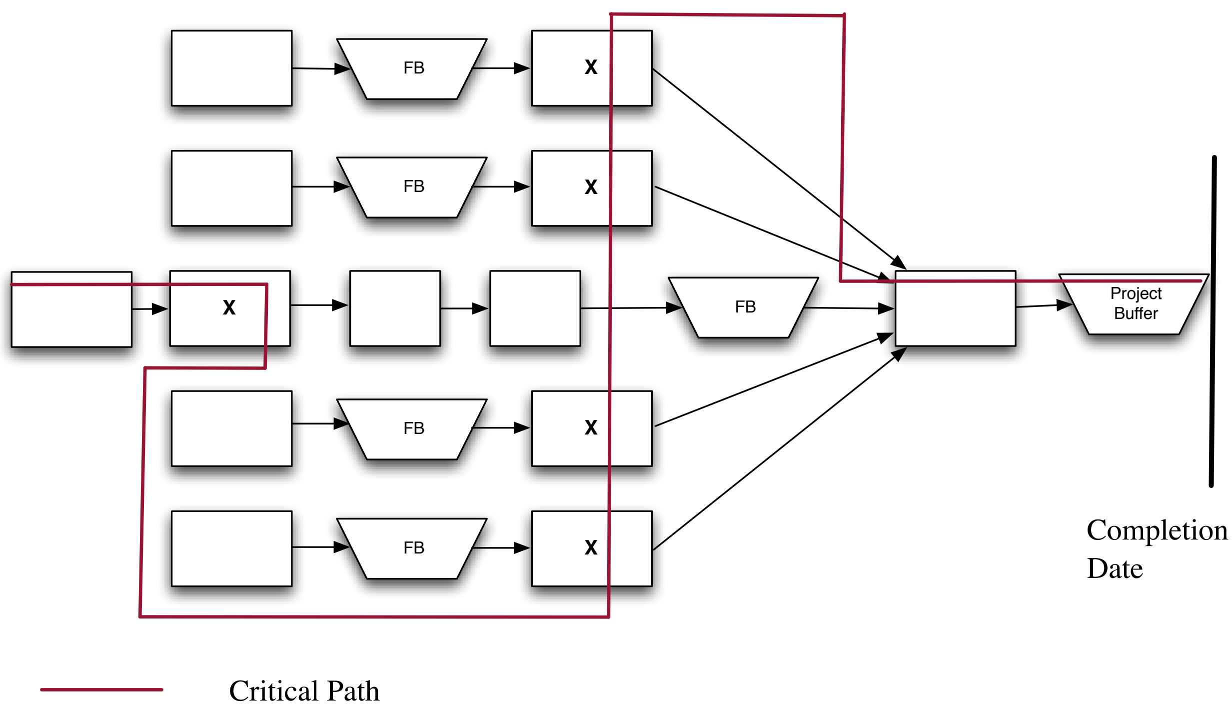
finish the project early. If we finish at the end of the project buffer we finish on time. If we go past the end of the buffer then we finish late. This is much less likely when we are using a project buffer. (see diagram above)

b. **Feeding buffer**—is placed at the end of any non-critical sequence of tasks as it joins the critical path. This builds safety for that sequence of tasks so that the branch will not delay the critical path and hence the entire project. If there is a delay beyond the allocated safety for a given sequence of tasks the project is still protected by the project buffer. Working backwards from the merge point also solves the start time problem without losing focus.

c. **Resource & Scarce resource buffers**—projects can also have problems completing a sequence of tasks if those tasks are all performed by the same resource - same person or same team - this is known as a critical chain to differentiate it from a critical path. If it is not recognized and planned, a project can miss the expected completion date because of faulty planning—failure to account for the critical chain. This buffer helps prevent this problem by protecting the critical chain. (x denotes tasks performed by the same resource. See next page.)



Project before Adjusting the Resource Buffer



Project after Adjusting for the Resource Buffer

Notice we must insert buffers before the scarce resource tasks. The critical chain flows through all of the resources which must be sequential because they are performed by the same person or team.

Summary

This paper is a synopsis of project management as adevocated by the Theory of Constraints. It captures the essential elements of Project Management. The central problem in Project Management is **uncertainty**. The common pitfalls and how to fix them for managing projects are outlined. The two necessary but conflicting conditions are money and time and while money is usually prioritized, time is the more important criteria. Understanding the task curve is essential and useful far beyond its project management application. When you understand the milestone problem it should become obvious that deadlines are counter productive to getting tasks done. The lesson of buffers is that we must not procrastinate tasks or we run a high risk of late completion!

References

Critical Chain, Eliyahi M. Goldratt, The North River Press, 19977