4.4Towards Desired Effects

4.4.1Resolving the Core Conflict

Resolving the core conflict requires identifying one or more assumptions that can be made invalid by changing the system. Assumptions underlie each arrow of the core conflict diagram. The Critical Chain method arises from attacking the assumption that adding contingency to each task is the only way to manage uncertainty.

One element of resolving the core conflict must be to correct for the behavior elements: multitasking, Parkinson's law, and student syndrome. The solution to it is the first new rule: focus. The new project delivery system must enable people to focus on one task at a time until they complete it. They must be allowed to limit their personal WIP. While it helps if it is the right task to focus on (more on what that means later), when you eliminate multitasking, all of the tasks you were working on finish sooner than they would with multitasking because of eliminating the task nonworking time and the wasted time of task switching. So even if you work on tasks in the wrong sequence, all (on average) still complete sooner than they would have with multitasking. You will also make fewer errors.

Dr. Goldratt was uniquely positioned to develop the Critical Chain solution for projects. The Critical Chain solution comes from recognizing that the variation in task performance and dependent events is at the root of the behavior of the present system. He had tremendous success in applying the solution for production management described in *The Goal* (Goldratt, 1984). He knew that, in most cases, the uncertainty in project duration estimates is much larger than the variation in production processes. He knew that in many cases the task dependencies in projects were equal to or greater than the dependencies that exist in production. It is natural that he would look at projects from this perspective to find the assumption to attack.

Goldratt describes the impact of variation and dependent events by the saga of Herbie in *The Goal*. He used the scenario of a troop of Boy Scouts on a hike through the woods. The trail is narrow, so the scouts cannot pass the one in front. As they hike, the line grows longer and longer. Alex Rogo, our hero in *The Goal* and the troop leader for this weekend, realizes what is happening. The speed of the Boy Scouts is not the same. There are statistical fluctuations in how fast they walk. They are dependent on the scout in front of them, though, because they cannot pass. These fluctuations cause the length of the line to grow continuously. Herbie turns out to be the slowest scout, the constraint. The gaps in the line compare to inventory in a manufacturing plant.

For a project the gaps in the line of Boy Scouts compare to time. If the next resource is not ready to start when a predecessor activity completes early, the project loses time. We lose the positive variances in statistical fluctuations. This is like a faster boy behind a slower boy; he can catch up, but not pass. The line grows in length. This is worse than the manufacturing case. In manufacturing, they eventually use

conservation of time.

The direction of the solution that Goldratt proposed follows from his TOC production solution. The first step is to identify the constraint of the project system. His focus on throughput led him to focus on the time it takes to complete the project. The longest path through the project is the evident constraint. At first look, this is the critical chain.

How then is the critical chain exploited? Dr. Goldratt was a Ph.D. physicist. He knew statistics and knew a lot about the "cloudy" behavior of much of reality. He knew that the only way to take advantage of our statistical knowledge is through dealing with numbers of events. Deming and Shewhart (Shewhart, 1986) before him had pointed out that science could not make predictions about a single instance of a statistical event. This leads to a very simple (in retrospect) insight: concentrate the uncertainty for many of the tasks of the project at the end of the project in a buffer. The buffer has a direct counterpart in his production solution where buffers of in-process inventory are strategically placed in front of machines to prevent them from running out of work. This solution implements Rule 2: Buffer.

Concentrating contingency in the buffer creates two significant bonuses. The first bonus is a shorter schedule. It is a mathematical fact the variances of the sum of samples from a series of independent distributions add. The variance is the square of the standard deviation. The standard deviation is proportional to the amount of variation in a single task. In other words, the uncertainty in the sum of tasks is the square root of the sum of the squares of the individual variations. While attempting to protect the completion date of each task in a project, each task had to include its own allowance for uncertainty. These allowances add up along the path. When we take these allowances out of each task and put them at the end of the path they add as the square root of the sum of the squares, a much smaller total amount. Figure 4.14 illustrates how this works for a very simple case. The reason for this is evident. Some of the tasks should overrun, and some of them should underrun. The distribution of the sum need not be as large as the sum of the individual variations because some can cancel out if you can eliminate Parkinson's law and the student syndrome.

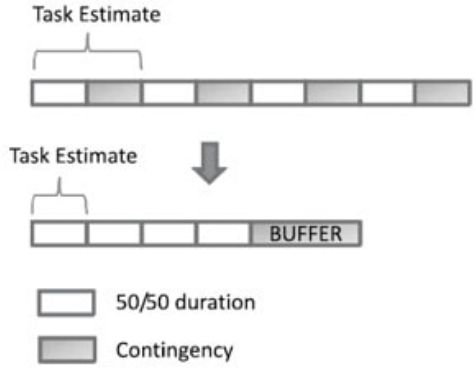

Figure 4.14 Concentrating contingency at the end of the path requires less total project time.

A second statistical fact comes into play with this strategy. The central limit theorem of statistics states that the distribution of samples from a variety of independent distributions tends towards a normal distribution. A normal distribution is a symmetrical distribution. It does not have the long tail to the right that many individual task distributions may have. This means that concentrating contingency at the end of a path reduces the likelihood that it will be overrun by a large amount.

A key part of the direction of the solution Goldratt proposed uses average task completion times in the schedule and adds an aggregated buffer at the end of the schedule for overall project contingency. Mathematically, the mean for each task duration is the average duration that sums along a path. The project buffer is one part of the second of the three new rules introduced in Section 2.8.

4.5Solution Feasibility (Evidence)

Using the scientific method as the theory of knowledge leads to selecting the preferred theory through critical discussion and test. Comparing Critical Chain to CPM shows more content in the Critical Chain theory because it:

1.Provides an explicit method to manage common cause uncertainty.
2.Explicitly resolves the resource constraint.

Popper (1976) noted that a new theory should contain and explain the old theory. With unlimited resources, the critical chain is the same path as the critical path. With a resource constraint, the critical chain is an acceptable solution to the resource-leveled critical path. Thus, Critical Chain contains the critical path solution.

Popper suggested that the primary method of testing a new theory be through critical discussion. This discussion checks the new theory against the old, looking for logical deductive reasoning and evidence supporting the suppositions (assumptions) made in the new and the old theory. Summarizing the reality of the scientific method, Popper stated (Popper, 1976):

> (1) Induction, i.e., inference based on many observations is a myth. It is neither a psychological fact, nor a fact of ordinary life, nor one of scientific procedure.
>
> (2) The actual procedure of science is to operate with conjectures: to jump to conclusions—often after one single observation…
>
> (3) Repeated observations and experiments function in science as tests of our conjectures or hypotheses, i.e., as attempted refutation.

This chapter developed the reasoning behind the way Goldratt defined the problem with the current theory. It does not explain the jump to his proposed direction for the solution: improved management of uncertainty. It is unlikely that others without his