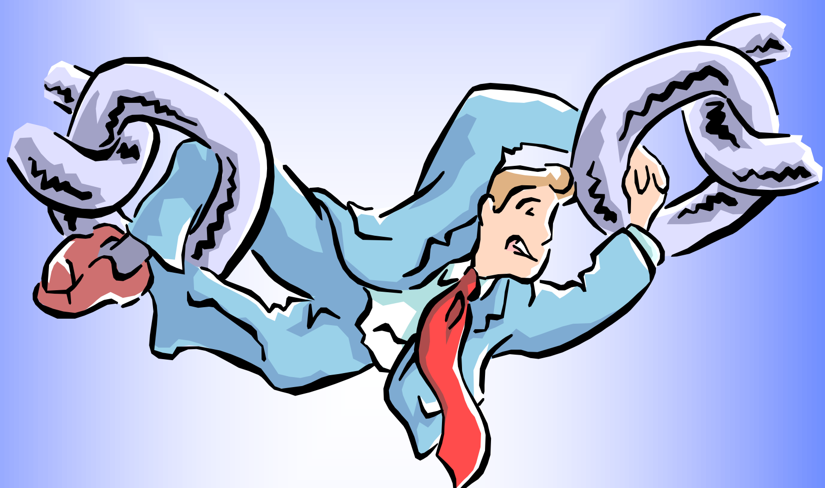
# Lean Project Management: Eight Principles for Success



Combining Critical Chain Project Management (CCPM) and Lean tools to accelerate project results.

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*It is important that an aim never be defined in terms of activity or methods. It must always relate directly to how life is better for everyone… The aim of the system must be clear to everyone in the system.*

W. Edwards Deming (1900 - 1993)

# PRINCIPLE ONE: PROJECT SYSTEM

Successful project delivery requires leading the system, comprised of people, process, and product. You must define a system that is effective for your environment and projects. Lean thinking enhances conventional project delivery systems in the areas of portfolio and individual project planning, execution, and control to deliver successful project results "*in half the time, all the time*".

Project planning and execution comprise a system, which I call the project delivery system. Some people are intimidated by *system thinking*, likening it to rocket science. The Theory of Constraints (TOC), an approach I have used to develop LPM, asserts that system thinking can and should be simple.

People interact with and design systems all the time, often without thinking about it that way. I defined *Critical Chain Project Management* (Leach, 2004) as the synthesis of several systems, including conventional project management, the Theory of Constraints (TOC), and Total Quality Management (TQM, now frequently called Six Sigma). The Lean system continues this synergy to include Lean Manufacturing principles, such as focusing on eliminating waste.

Project delivery systems deploy people to use processes to create a result: a product or service. As with all systems, the *relationships* between the entities over time determine the results. The relationships in a project delivery system, including most importantly the people, matter more than the entities themselves. For example, how you develop your plan determines how people will perform the work, and how people perform the work influences how you can measure and control it.

Figure 1-1 depicts a project system comprised of people, process, and the product that the project will produce. (Peter Piper picked a peck of pickled peppers, too.) The project system functions in the environment of many other systems; some larger, some smaller. How you define a system is always somewhat arbitrary because all things relate to some degree. The figure also shows that variation is a central part of the system, a key point addressed by TOC and Six Sigma, but often not given sufficient attention in conventional project management. The figure illustrates a few of the relationships between the entities shown. There are many more.

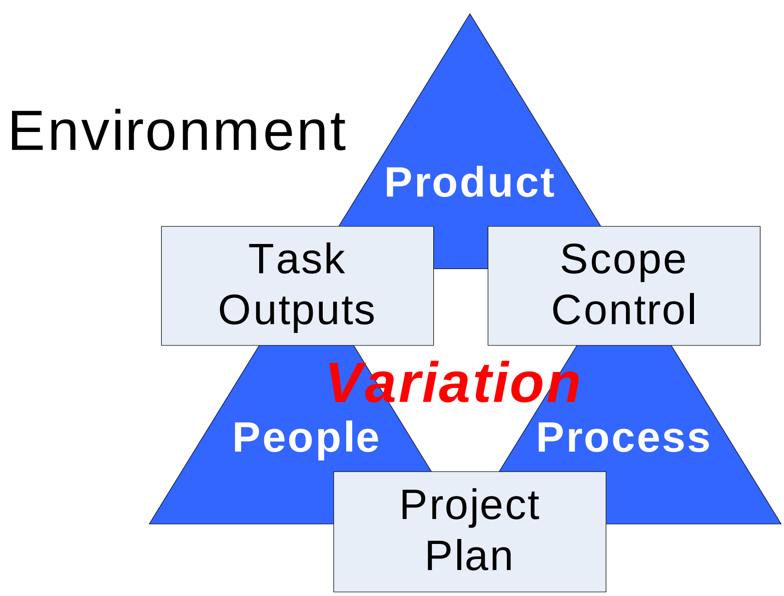


**Figure 1-1:** A view of the project system as the intersection of People, Process, and the Product the project will produce.

**Some relate project planning and execution to team sports. It often makes a fair comparison. In the Olympics, well-trained amateur**

## *LPM Principles and the Theory of Constraints*

Critical Chain Project Management (Leach, 2004) brings together the principles of the Theory of Constraints (TOC), Goldratt's critical chain (Goldratt, 1997), and the PMBOK™. The first TOC principle states that a constraint limits the output of any system. Some prefer this simple statement of the *theory* of constraints. A more recent and thorough definition has been posed by the TOC International Certification Organization (TOC/ICO):

> *A holistic management philosophy developed by Dr. Eliyahu M. Goldratt that is based on the principle that complex systems exhibit inherent simplicity, i.e., even a very complex system made up of thousands of people and pieces of equipment can have any given time only a very, very small number of variables – perhaps only one (know as a constraint) – that actually limits the ability to generate more of the system's goal.*

I subscribe to most of that definition, although am skeptical about the word "holistic", as effective LPM requires much more than TOC. TOC principles include focusing on the goal, working to maximize throughput in business systems, and deploying five focusing steps to improve systems; the first of which is to identify the constraint to achieving more of the system goal.

Following these principles, and understanding that projects are comprised of interdependent tasks, each of which experiences variation in task performance duration, LPM makes three radical assertions about project management:

- ❑ You do not have to finish each task on time to finish a project on time.
- ❑ Starting a project sooner does not mean it will finish sooner.
- ❑ Adding buffers reduces project duration and cost.

The following sections describe how LPM accomplishes these seeming paradoxes for a single project and in a multi-project system.

## *Lean Principles*

Lean manufacturing approaches focus on eliminating waste with five key principles:

1. Specify value.
2. Identify the value stream.
3. Flow.
4. Pull.
5. Perfection.

All of these principles synergize well with LPM. The link to value ties to TOC's focus on the Goal, and Six sigma's focus on the customer. Identifying the value stream for projects is the project delivery system. Focus on flow relates especially well to the TOC/CCPM multi-project approach, which seeks to maximize the flow of projects through the constraint. For single projects, the critical chain and buffer management implement pull, while for multiple project systems the drum schedule and capacity constraint buffer implement pull.

Womack and Jones (1996) define eight types of waste, called *Muda* in Japanese. They are:

1. Defects in products (i.e. rework).
2. Overproduction of items no one wants.
3. Inventory waiting to be processed.
4. Unneeded processing.
5. Unnecessary movement of people.
6. Unnecessary transport of goods.
7. People waiting for input to work on.
8. Design of goods and services that do not satisfy customer needs.

This book will not address all of the waste types (e.g. item 1) individually, as they easily demand books on their own. The design of LPM considers the relationships to the processes and process steps necessary to reduce all of the types of waste, and you should do so also as you design and deploy your project delivery system.

Management theories overlap as well as complement each other, and in those cases where the overlap seems to conflict, a return to the principles of each can show you the way to resolve the apparent conflict. The TOC perspective is that these conflicts must not be real because all seek the same goal. From my perspective, those that attempt to sell you on the idea that their view is the only one are akin to the six blind men feeling the elephant…they have just grabbed on to different parts of the animal. I do not want you to grab on to my part of the elephant…but I do intend to provide you some input so you can determine how to interpret your part, perhaps in a more useful way.

## *Single Project LPM Plan*

LPM develops a *critical chain*, rather than a critical path, as the primary focus of the project. The critical chain includes BOTH logical (that is, necessary technical task sequence, such as you have to build the first floor before you can build the second) and resource dependence (that is, who is going to do the work). LPM establishes the *critical chain* after removing resource contentions, rather than before considering the resource limitations. The *critical chain* remains unchanged for the entire duration of the project, and is the primary **focus** of the project manager.

Consider the project illustrated by the figure 1-4 Gantt chart. The Gantt chart, named after its creator Henry Gantt, is the most common way to show project schedules. It shows each project task as a bar, with the length of the task bar representing the time estimated for the task. This Gantt chart shows task relationships; i.e. an output from one task becomes the necessary input to another task, defining the task sequence or *relationship.*

The Figure 1-4 project could be a project to design a prototype of some product that involves software and hardware. Given that each task estimate assumes each resource working 100% of their time on the task, how likely is it that project will finish on time? Most people quickly recognize that it is unlikely because the plan calls for several resources to do two or three tasks at the same time. Doing so will stretch out those tasks, by at least a factor of two or three. Thus, it is unlikely the project would complete as scheduled. This is not news to the world of project management, and numerous approaches to resource leveling can resolve this problem. Figure 1-5 illustrates the same project after resource leveling, i.e. adjusting task scheduled dates to make the resource need less than or equal to the resource supply, in this case one of each person. Note that the project due date moves to the right.

| | WBS | Task Name | Low Risk Duration |
|---|---|---|---|
| 1 | **1** | **Component 1** | **30 days** |
| 2 | 1.1 | Design Component 1 | 10 days |
| 3 | 1.2 | Build Component 1 | 10 days |
| 4 | 1.3 | Test Componenet 1 | 10 days |
| 5 | **2** | **Component 2** | **24 days** |
| 6 | 2.1 | Design Component 2 | 8 days |
| 7 | 2.2 | Build Component 2 | 8 days |
| 8 | 2.3 | Test Componenet 2 | 8 days |
| 9 | **3** | **Component 3** | **18 days** |
| 10 | 3.1 | Design Component 3 | 6 days |
| 11 | 3.2 | Build Component 3 | 6 days |
| 12 | 3.3 | Test Componenet 3 | 6 days |
| 13 | **4** | **Integration** | **20 days** |
| 14 | 4.1 | Integrate Componenets | 10 days |
| 15 | 4.2 | Test Integrated Unit | 10 days |
| 16 | 4.3 | Project Complete | 0 days |

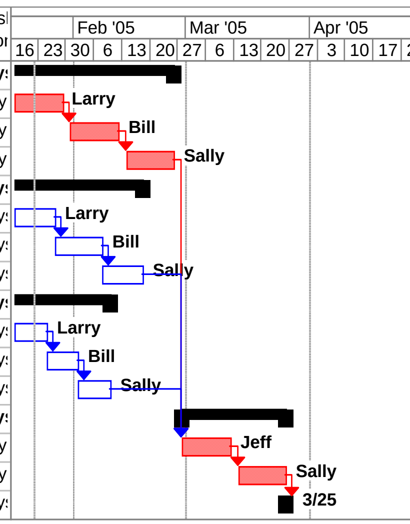


**Figure 1-4:** An example critical path project.

Although the resource-leveling capability exists in most project software, few project managers use it. My informal surveys at the PMI Seminars I give (a large portion of the attendees whom are certified Project Management Professionals) indicate that only about 5% of project managers resource level. My review of customer project plans indicates more severe planning problems in a large majority of cases; often using scheduling tools to draw Gantt chart pictures with no resource loading or task relationships, much less resource leveling.

Examine figure 1-5 carefully. Notice what happened to the critical path after resource leveling. Every path has a gap in it or before it starts, representing float. The software does not specify the algorithm used to select the particular tasks as critical, and I know that other software (including other versions of the software used) makes different choices. Since, after resource leveling, all of the paths show float, what should the software do?

Identifying the critical chain resolves this conflict. The critical chain is *the longest path through the network after resource leveling*. The critical chain has no float or slack when identified.

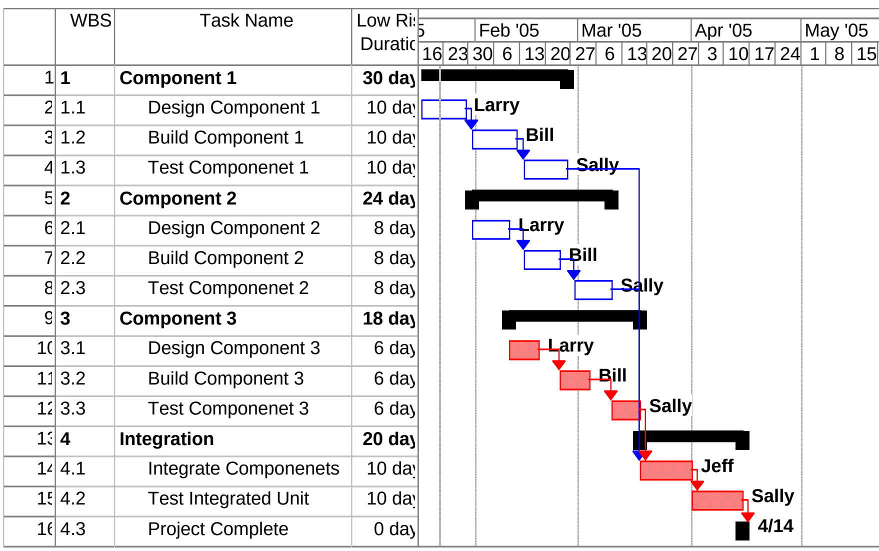


**Figure 1-5:** The resource leveled critical path project.

The critical chain usually differs from the critical path, as it can jump the task logic network. Figure 1-6 illustrates the critical chain for the figure 1-4 task network, comprising tasks 1.1, 1.2, 1.3, 2.3, 3.3, 4.1, and 4.2. Later steps in creating the complete critical chain network may introduce apparent float or slack into the network.

Note that the completion date of the critical chain schedule (Figure 1-6) is about the same as the critical path schedule, despite the large project buffer. This illustrates the effect of reducing activity duration to '50/50' duration, and addition of buffers.

The reason for reducing task duration is that all work exhibits variation. If you recorded the times it took you to do the same thing repeatedly (e.g. driving to work), you would find that it varies; usually quite a lot. If you want a project to complete on time, and you do not use buffers, you have to estimate each task at the longest time it could take.

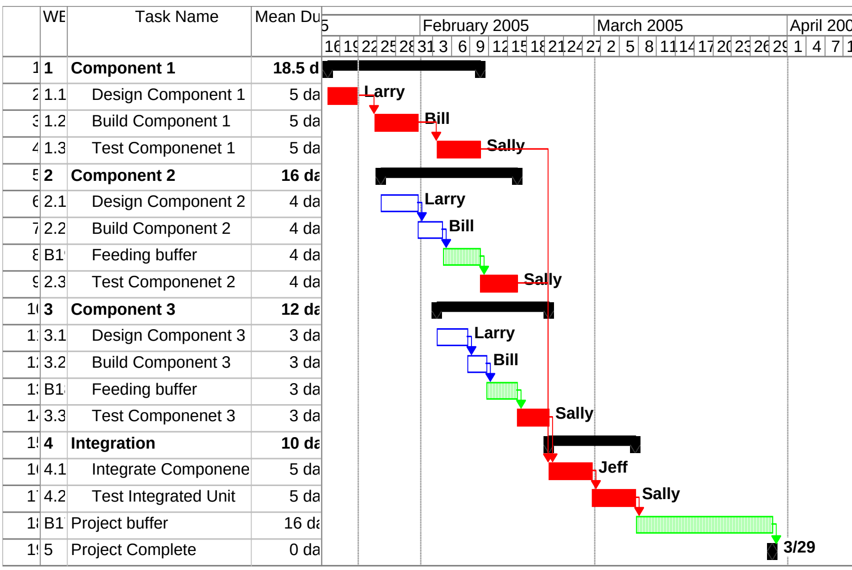


**Figure 1-6:** IDENTIFYING the constraint to a single project: the critical chain, and adding buffers.

Since all the tasks vary, it is better to estimate each task at its average time, and relocate that extra time from each task to a buffer at the end of the chain of tasks. It requires less total time in a buffer at the end of chain tasks than it does to protect each task because under-runs on some tasks will take care of some of the over-runs on other tasks in the chain. With critical chain plans, you should expect completion before the end of the project buffer, and half the time before the start of the project buffer.

The entities labeled Feeding Buffer (tasks 8 and 13) help ensure that both the inputs and the resources are available to start critical chain tasks. When a task requires input from more than one predecessor, that is called merging in a project network. In those cases, the successor task can not start until both of the predecessor tasks complete. This merging synchronization problem delays many projects.

## *Linking Measurement and Control to the Plan*

LPM uses buffer management during project execution to answer two primary questions:

1. For project and task managers: “Which task do I work on next?”
2. For the project manager, “When do I take actions to accelerate the project?

Tracking LPM projects requires identifying when tasks start and finish, and obtaining estimates on the remaining duration for tasks in work. The reason to use remaining duration rather than estimates of completion (% complete) is that humans tend to over-estimate the percentage complete. When called upon to look forward and consider the work remaining to complete a task, people tend to make more accurate estimates. Remaining duration is also the actual number needed to estimate project completion, and estimating it directly avoids the assumptions necessary to convert a percent complete estimate to a remaining duration estimate.

LPM project tracking then uses the estimates of remaining duration for incomplete tasks to calculate the impact of the task status, including the absorption of variation by feeding buffers, to determine how much of the project buffer has been used. Task managers place priority on the tasks that cause the greatest amount of project buffer penetration. Using task priority this way enables resources to focus on one project task at a time, thereby completing it in the minimum possible time. Tasks do not have due dates. This helps avoid having Parkinson’s Law (task durations extend to use available time) or Student Syndrome (waiting to start a task until the due date is urgent) cause late task delivery. The ability to update remaining duration after tasks start also encourages using mean task duration estimates.

The mechanism to complete projects as soon as possible answers two different questions. The answer to the first question, “Which project task should I work on next?” addresses the task and resource manager’s need to enable relay racer like task performance, avoiding bad multi-tasking. The answer to the second question, “When should we take action to recover schedule?” helps the project team decide when to take action to recover buffer that is being used up at too high a rate.

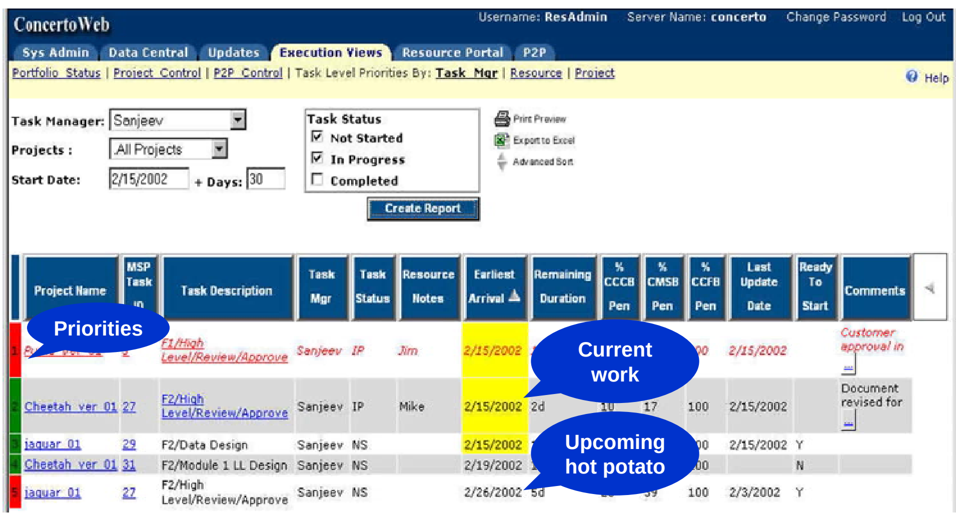


**Figure 1-7:** Critical chain software updates tasks using remaining duration, prioritizing tasks for work. (Used by permission from Realization, Inc.)

Figure 1-7 illustrates a task manager view into a LPM project that is underway. The tasks are color coded in the task number box on the left (not visible in the graphic) to highlight the priority of the task. Red tasks get the highest priority, as they are on a path that is causing significant project buffer use. The Concerto software used to generate this screen shot is the only multi-project LPM software that I know of that directly provides the task level priority for the multi-project environment.

Task level priority is generally not the same as project priority. For a given resource or task manager, a task on a lower priority project may require work more urgently than a task on a higher priority project. The dynamics of an individual project may require that non-critical chain tasks have higher priority than critical chain tasks. These conditions happen when predecessor tasks have caused delays threatening the project buffer more for the lower priority project or non-critical chain.

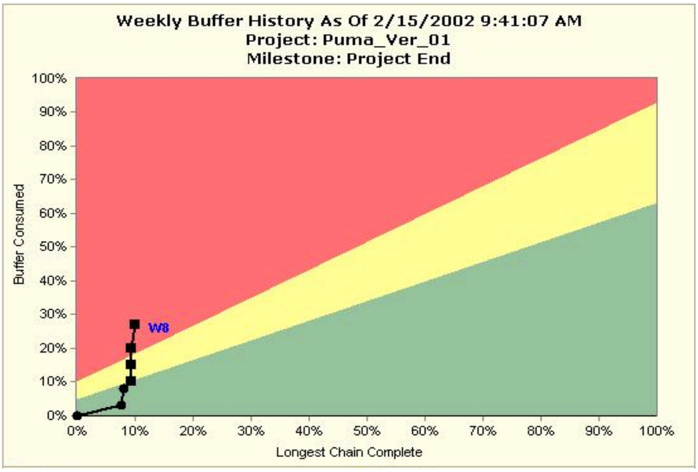


**Figure 1-8:** Tracking project progress with a 'fever chart' signals the project team when to take action to recover buffer.

The amount of project buffer penetration also answers the second question, by providing the signal to take proactive action to recover buffer (See figure 1-8). If the buffer is in the yellow (middle) region, the project team should develop plans to recover buffer. If the buffer penetration moves into the red (upper) region, the project team should implement the planned buffer recovery actions. This approach causes the project team to focus on the tasks delaying the project, vs. those that might earn the most 'value.' Figure 1-8 also shows the trend of buffer penetration, enabling anticipatory action and easy determination of the efficacy of buffer recovery action.

## *TOC Portfolio Management*

TOC portfolio management seeks to complete projects as soon as possible, and answer management's two questions:

…

### *When are you going to be done?*

Figure 1-12 illustrates the primary method used by LPM to track schedule performance on a portfolio of projects. The project tracking must be timely to aid the operational purposes of project management, thereby giving portfolio managers better insight to the performance of projects than many systems. A table providing the current projected completion date for each project, compared to the scheduled completion (i.e. when the project buffer would be 100% consumed), accompanies figure 1-12. This directly answers the question asked.

Projects that are in the green (lower region) are doing fine, and require no management attention. Projects in the yellow (middle region) should be creating buffer recovery plans. Projects in the red (upper region) should be implementing buffer recovery plans. Note that projects with buffer penetration less than 100% may still be on track to complete on time. Management should drill down for projects in the red to examine the trends and efficacy of the buffer recovery actions.

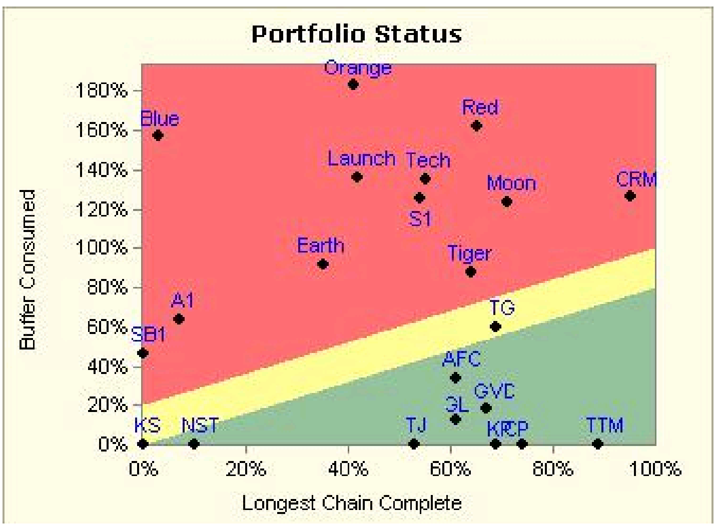


**Figure 1-12:** LPM simplifies viewing progress on a project portfolio, highlighting those requiring buffer recover action.

## *Summary of the First Principle*

- It's the system! You must design and implement an effective project delivery system appropriate to your projects, organization, and environment.
- The project system consists of people, process, and the product, and the relationships between them.
- Some of the basics of project management are essential to all projects, but few are necessary for every project. The project leader must sort out what matters most for the project at hand.
- *Any project worth doing is worth doing fast*.
- Critical Chain Project Management gives you the tools to do projects, in *half the time, all the time*.
    - You do not have to finish all tasks on time to finish a project on time.
    - Sometimes you can finish sooner by starting later.
    - Adding buffers reduces total project duration and cost.
- Your project system must include a process of ongoing improvement.

## *Discussion Questions*

1. What are the projects you are currently involved in or concerned about?
2. What are the rest of the projects in the portfolio?
3. What are the major differences between LPM and how you have managed projects in the past?
4. What parts of LPM are confusing at this point?
5. Is a PMO a Project Management Office, a Program Management Office, or Portfolio Management Office, and which might the differences be?

**Lean Project Management takes you through all of the steps to plan and execute projects using the exciting new Lean and Critical Chain Project Management (CCPM) methods. Larry Leach is uniquely qualified to integrate CCPM and Lean practices in a practical way that works for all kinds of projects, large and small. This book is a second edition of Eight Secrets to Supercharge Your Projects with CCPM, which has received outstanding reader reviews.**

**Results and praise for the Lean Project Management and CCPM methods.**

*"We have accelerated our drug development projects by five years".*

Senior Researcher, Pharmaceutical company.

*"Before CCPM, every ship was late. All of the ships we have used CCPM on left on-time or early."*

Captain, U.S. Coast Guard Shipyard, Baltimore, MD

*"Before CCPM, we completed most of the nuclear submarine repairs late. During the first year with CCPM, we completed 35% more repairs, with over 95% on time".*

U. S. Navy Commander, Pearl Harbor Naval Shipyard.

**Lawrence (Larry) Leach** is the principal of the Advanced Projects, Inc. (API), applying business tools to help clients improve their work processes and management systems. Prior to founding API, he was a vice president in several Fortune 500 companies, managing projects up to one billion dollars (US). His 30-plus years of experience as a project manager involve varied projects that include software development, research and development and construction. Leach has a master's degree in business management from the University of Idaho (USA) and a master's in mechanical engineering from the University of Connecticut (USA). He is a member of PMI and the American Society for Quality Control and has published many papers on related topics including articles in *PM Network* and in *Project Management Journal®* in June 1999 and 2003 on critical chain project management. Larry is a certified Project Management Professional (PMP). Artech House published his book, *Critical Chain Project Management*, *Second Edition,* which is available from the Advanced-Projects.com Web page and other sources.