



# Critical Chain Project Management – The Basics

Marcia Pasquarella, Jonah, CFPIM, CIRM  
310-416-3035  
Marcia.L.Pasquarella@Boeing.com



# Marcia Pasquarella

- Marcia is currently a Critical Chain Subject Matter Expert for The Boeing Company in El Segundo, CA. She is a certified practitioner in **Critical Chain Project Management** by the Theory of Constraints International Certification Organization (TOCICO), as well as certified in **Supply Chain Logistics** and **Thinking Processes**. She is certified by APICS as a CFPIM (Certified Fellow in Production and Inventory Management) and CIRM (Certified in Integrated Resource Management). Marcia has a Master's Certificate in **Project Management** from George Washington University and a **Master in Engineering and Technology Management** from Washington State University. She is a past-president of the Anaheim and Seattle chapters of APICS and past-chair of the APICS Constraints Management SIG.

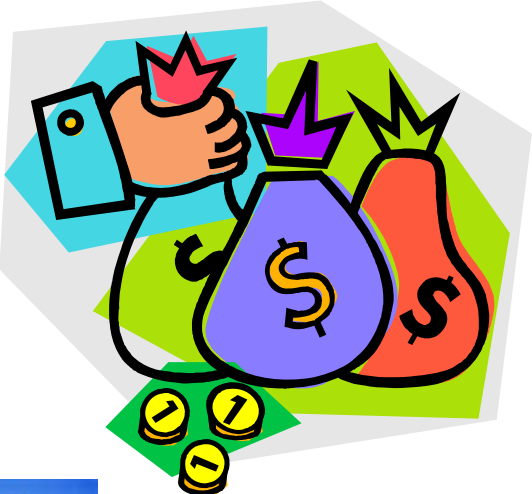
# Agenda

- **Project Definition and History**
- **Human Behaviors with regards to projects**
- **Development of a Critical Chain plan**
- **Pipelining or staggering your projects**
- **Monitoring and Execution**
- **Implementation**
- **Take-Aways**

# What is a Project?

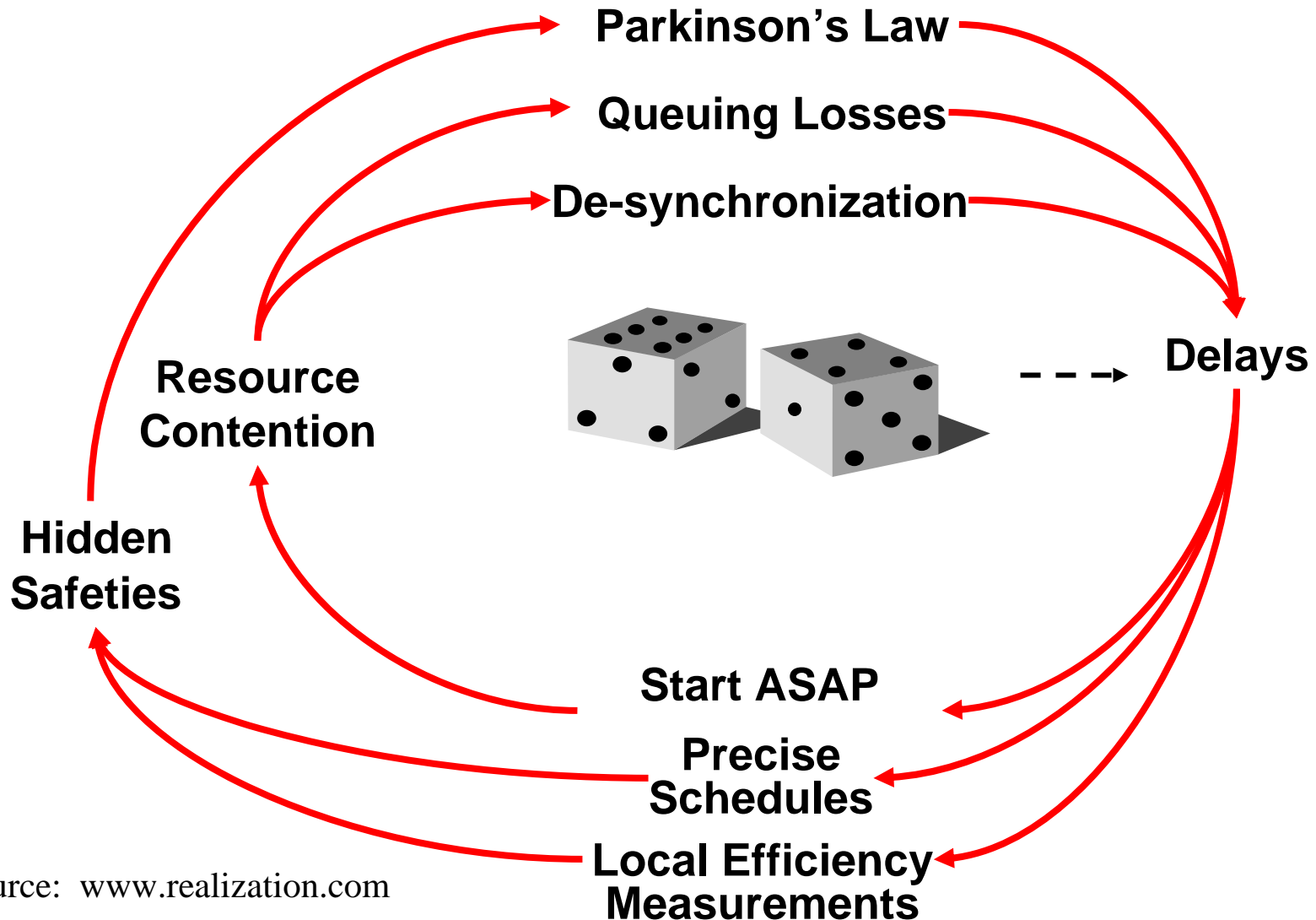
- A project is “a temporary endeavor undertaken to create a unique product or service.” (PMI PMBOK™)
- What do we know about projects?
  - The Standish Group's report, "CHAOS Summary 2009,"
    - "32% of all projects succeeding which are delivered on time, on budget, with required features and functions"
    - "44% were challenged which are late, over budget, and/or with less than the required features and functions"
    - "24% failed which are cancelled prior to completion or delivered and never used."
  - “This year's results represent the highest failure rate in over a decade“  
[http://www1.standishgroup.com/newsroom/chaos\\_2009.php](http://www1.standishgroup.com/newsroom/chaos_2009.php)

# What about your Projects?



# The Project Vicious Cycle

CONVENTIONAL RESPONSE TO UNCERTAINTY MAKES THE PROBLEM WORSE



Source: [www.realization.com](http://www.realization.com)

# Results from Critical Chain Projects

## Before Critical Chain

### ■ ABB, Halle

- 42 projects completed Jan-Dec 2007.  
On-time delivery of 68%.

---

### ■ Alcatel-Lucent

- 300-400 active projects with 30+ deliveries a month.  
Lead times were long.  
On-time delivery was poor.

---

### ■ Amdocs

- 8 projects in crisis requiring CEO level attention in 2007.  
Market pressures to reduce cost and cycle time of projects.

## After Critical Chain

- 54 projects completed Jan - Dec 2008.  
On-time delivery of 83% .

- Throughput was higher by 45% per person.  
Lead times are 10-25% shorter.  
90+% on-time delivery.

- 0 projects in crisis in 2008.  
Project cycle time decreased by 20%.  
Increase of 14% in revenue/man-month across 4,000 people.

Source: [www.realization.com](http://www.realization.com)

# More Results from Critical Chain Projects

## ▪ **LeTourneau Technologies, Inc.**

- Design Engineering took 15 months.  
Production Engineering took 9 months.  
Fabrication and Assembly took 8 months.

- Design Engineering takes 9 months.  
Production Engineering takes 5 months.  
Fabrication and Assembly takes 5 months with 22% improvement in labor productivity.

---

## ▪ **TATA Steel**

- Boiler Conversion projects took 300-500 days.  
Routine maintenance and upgrade took too long.

- Boiler Conversion projects took 120-160 days.  
In 2007, 1st year of Critical Chain, reduced maintenance and upgrade cycle times by 10-33%—saving of \$13.4 million.  
In 2008, achieved a further 5-33% reduction in cycle time.

---

## ▪ **Valley Cabinet Works**

- Struggled to complete 200 custom furniture projects per year.  
Revenues were flat, business was just breaking even.  
A lot of firefighting in execution.

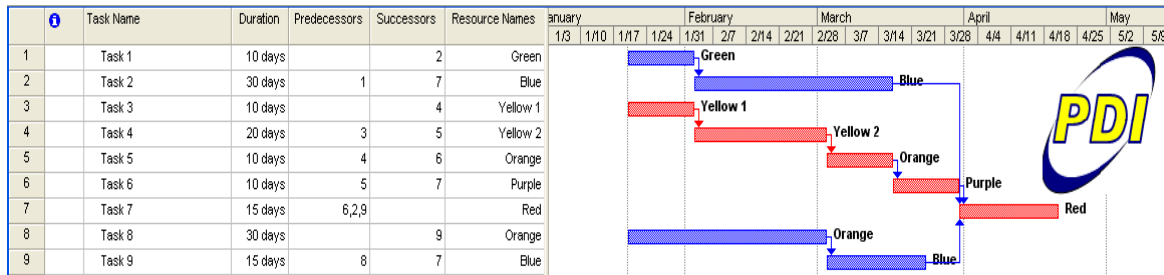
- Completed 334 projects in 9 months.  
Revenues increased 88% and profits increased by 300% in the first year.  
Firefighting and thrashing eliminated.

Source: [www.realization.com](http://www.realization.com)



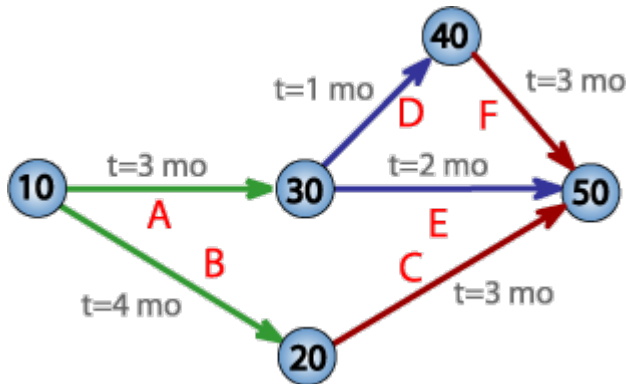
# Conventional Techniques – 1950s

## Critical Path Method (CPM)



Red tasks are critical path tasks

## Program Evaluation Review Technique - PERT



PERT network chart for a seven-month project with five milestones (10 through 50) and six activities (A through F).

# Project Environments

- **Single Project** – Where multiple projects may be run concurrently but each project is staffed with dedicated resources.
- **Multi-project** – Where multiple projects are run concurrently but resources are shared between projects.
- **Examples:**
  - An IT organization supports multiple applications, i.e., payroll, accounts receivable, accounts payable.
    - Each application has a dedicated team of programmers, analysts and their own servers.
    - Programmers, analysts, testers and servers are shared by the various application teams; although the Project Leader is dedicated to the application. Resources are generally owned by functional organizations and are “loaned” to the project.
- **Which is more typical for your organizations?**
- Source: Leach, Lawrence P., Critical Chain Project Management

# Critical Chain Project Management

- **Dr. Eliyahu M. Goldratt**

- An Israeli physicist who became a business management guru
- Innovator of Theory of Constraints (TOC); Drum-Buffer-Rope, Critical Chain Project Management, The Thinking Processes, The Distribution Solution and Throughput Accounting
- Author of business bestsellers: *The Goal*, *Critical Chain*, *It's Not Luck*
- Other books: *Necessary But Not Sufficient*, *The Haystack Syndrome*, *The Choice*, *Isn't It Obvious*

- **Lawrence P. Leach**

- Coined the term CCPM
- Author of *Critical Chain Project Management, 2<sup>nd</sup> Edition*

# Definitions

- **Critical Path** - a critical path is the sequence of project network activities which add up to the **longest overall duration**. This determines the shortest time possible to complete the project. Any delay of an activity on the critical path directly impacts the planned project completion date.
- **Critical Chain** – “the **longest time route of tasks through a project network considering both technological precedence and resource contention** in completing the project. **Where no resource contention exists**, the critical chain would be the same as the critical path.” TOCICO Dictionary
- Critical Path Method and PERT were developed during the 1950’s when resource constraints were not an issue.
- The initial constraint in Projects is time. However, resource constraints are a **reality**.

# Project Processes

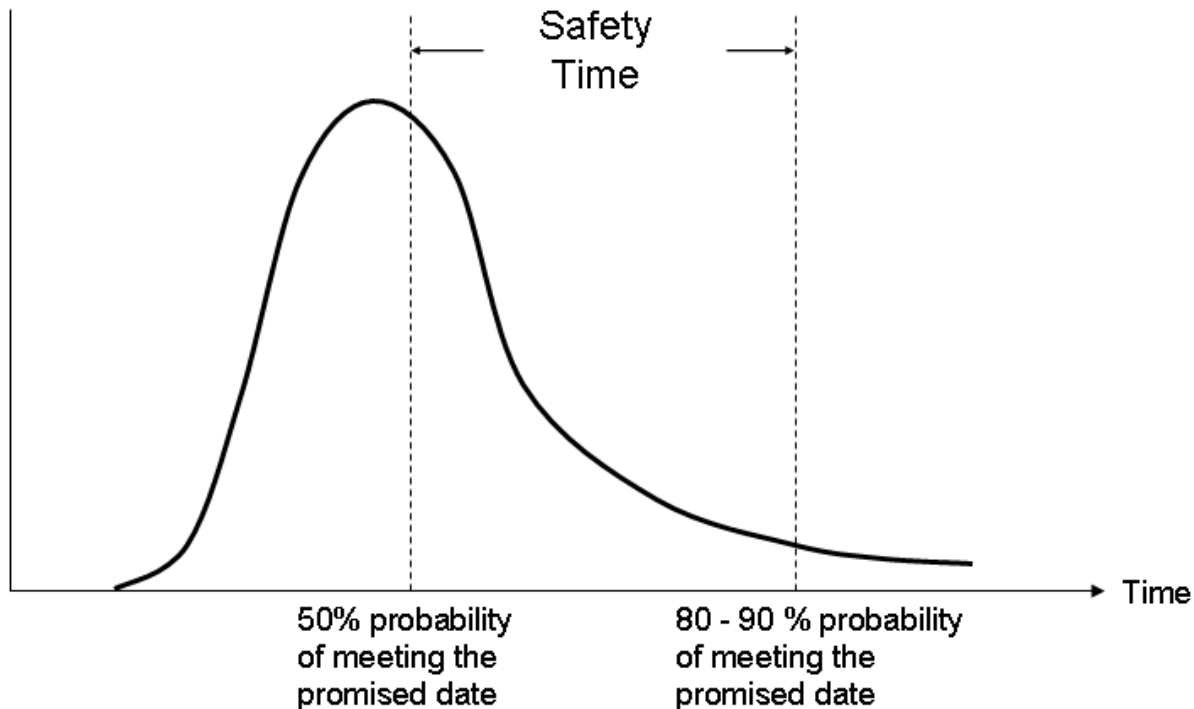
- **Project Management Processes per PMBOK™**
  - Initiating
  - **Planning**
  - **Controlling**
  - **Executing**
  - Closing

# Planning Processes

- **Minimum data needed to create a project network:**
  - Task names
  - Task durations
  - Task relationships
    - Predecessors
    - Successors
- **Additional data needed for a critical chain network**
  - Resource names and quantities
  - Remaining duration is used rather than duration

# What is the duration?

## Probability Distribution for Task Completion



For a 30 - 40% increase in the probability of meeting the promised date, we must increase the estimated time by 100 - 200%.

The concept in this diagram was developed by Eli Goldratt for his novel, [Critical Chain](#)

# Safe Estimates

- **People required to provide a time estimate usually double the median time it takes to perform the task. Why?**
  - To ensure they meet the schedule
  - To protect against variability
- **With Critical Chain, the safety in each task is removed, halved and then placed in a Project Buffer to protect the critical chain.**
  - Then how is it that people meet and or beat their critical chain commitments?



# Exercise – The Sixes Game

- **Set-up: Give each participant a fair die. Ask, “How many sides? What is the chance of rolling a Six on the first roll? How many times will you have to roll to be sure to get a Six?”**
- **Give a die to 20 people. Have everyone roll until they get a Six; counting their rolls. Record a Histogram of individual rolls to get a picture of the negative exponential nature of the process.**
- **Give a die to a second group of 20 people. Have everyone roll until they get a Six; counting their rolls. Record their rolls on the histogram.**
- **Once a rough histogram of the process is clear, we can start the Game.**

Source: <http://www.vancouver.wsu.edu/fac/holt/em530/tocgames>

# Exercise – The Sixes Game - Continued

- Give a die to a third group of 20 people.
- Have the players estimate how long it will take them to complete the project.
- Each person rolls until they get a Six.
- Review it against the estimate.
- If time, play a second time with a reduced estimate.

# Human Behaviors During Project Execution

- **Multitasking**
- **Student Syndrome**
- **Parkinson's Law**
- **Unreported Early Finish**
- **Successor Not Ready**
- **Manageable Work Units (Global vs. Local Efficiency)**

# Multitasking Exercise

- **If Internet is Available:**
- **<http://billiondollarsolution.com/multitasking.html>**





# Alternate Multitasking Exercise – Alpha-Number-Shape Game

- **Instructions:** Give each player a single sheet of paper that can be used on both sides.
- **Instruct the players they will be timed to do the process.** The process is simple. They will write on the paper the letters A through Z, the numbers 1 through 26 and repeat the shapes until there are 26 shapes.



- **The first time, they will write the letter, number and shape row by row as follows:**





- **Continuing down the page until all the letters, number and repeating shapes are written.**

<b>A</b>	<b>1</b>	
<b>B</b>	<b>2</b>	
<b>C</b>	<b>3</b>	
<b>D</b>	<b>4</b>	

Source: [www.vancouver.wsu.edu/fac/holt/em530/Docs/AlphaNumberShape.ppt](http://www.vancouver.wsu.edu/fac/holt/em530/Docs/AlphaNumberShape.ppt)

# Alternate Multitasking Exercise – Alpha-Number-Shape Game

- Have each person record at the top of the page the time it took to complete the simple process using the Row-by-Row approach.
- Repeat the same process on the opposite side of the paper only this time, do a Column of Letters first, then next to it a Column of Numbers and lastly a Column of the 26 repeating shapes (circle, square, triangle).
- Record the time to complete the second time doing the same process.
- Compare the differing times.

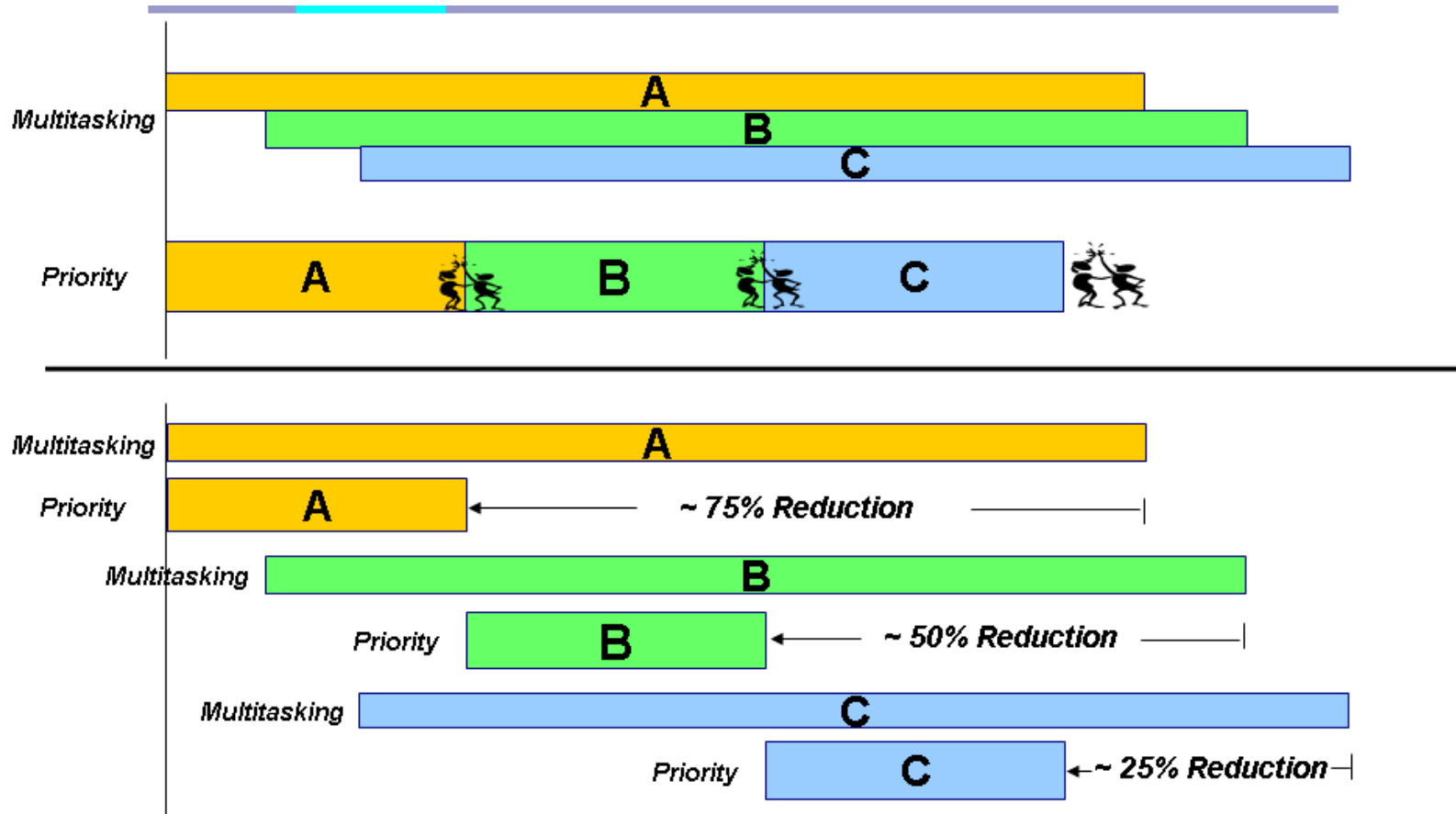
<b>A</b>	<b>1</b>	
<b>B</b>	<b>2</b>	
<b>C</b>	<b>3</b>	
<b>D</b>	<b>4</b>	

Source: [www.vancouver.wsu.edu/fac/holt/em530/Docs/AlphaNumberShape.ppt](http://www.vancouver.wsu.edu/fac/holt/em530/Docs/AlphaNumberShape.ppt)

# Multitasking Exercise Review

- **What Happened?**
  - How did you feel during Round 1? During Round 2?
  - What were the times like? Faster, Slower?
  - What was your approximate improvement?
  - What was your quality like?

# Multitasking



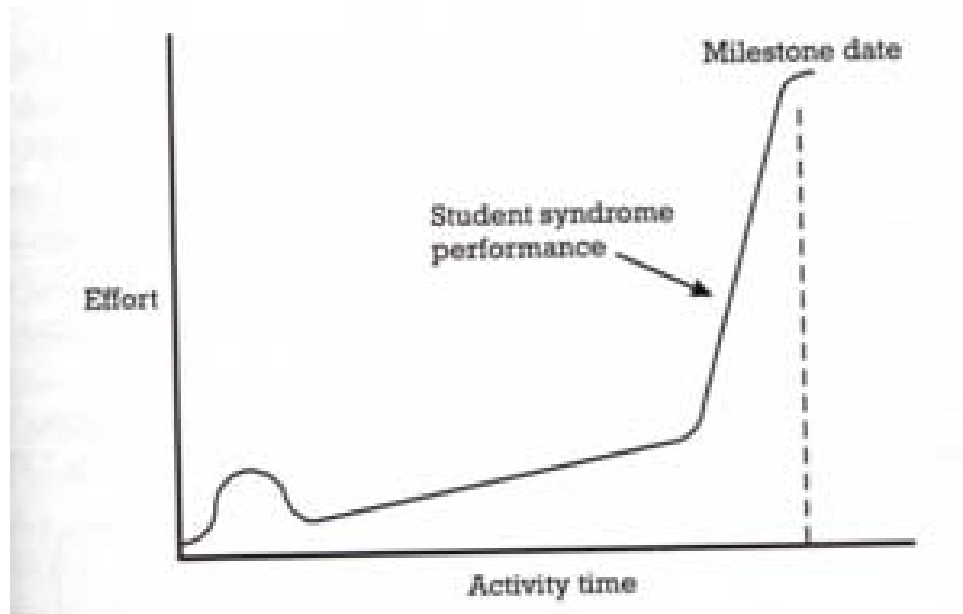
Eliminating multitasking usually reduces the lead time by 30%+<sup>3</sup>

Ref. Dr. James R. Holt, Ph.D., PE, Associate Professor Engineering Management, Washington State University



# Student Syndrome

Does the sense of urgency **increase** as you get closer to the milestone date?



“Less than a third of the work is done during the first two thirds of the activity duration. Two thirds of the work is done during the last third of the activity duration.

Where are they most likely to have problems – during the 1<sup>st</sup> third or the last third?”

Source: Leach, Lawrence P. Critical Chain Project Management, 2<sup>nd</sup> edition.

# Parkinson's Law

- Polishing – extra details added
  - No reward for finishing early
  - No Exit Criteria
- 
- **Work Expands to Fill the Available Time!**

# Unreported Early Finish & Successor Not Ready

- **Most Early Finishes go unreported because:**
- **Even if you finish early, the person you are giving it to may not be ready to start, so it will just sit anyway. (Successor Not Ready)**
- **There is no reward for finishing early, in fact there may be negative ramifications:**
  - If the boss finds out it took less time, he might make you cut your estimate next time and you might not be able to finish early the next time, so you'll miss your deadline.
  - You don't want the early finish to become the new expectation.
- **Most tasks finish exactly when due! (When there are no problems.)**

Source: Leach, Lawrence P., Critical Chain Project Management 2nd Edition

# Manageable Work Units & Global vs. Local Efficiency

- In projects, you need to group your tasks into manageable work units based on the resource hand-offs.
- Most people find natural increments – half a day, a day, a week.
- Define your tasks in conjunction with your frequency of updates. That is, if you are only going to update once a day, don't define tasks in 15 minute intervals. If all the 15 minute tasks are done by the same resource, group them so that you have a half-full day task.
- Don't make your tasks too long. Excessive durations invite Student Syndrome. Keep your task durations aggressive.
- Start work on tasks when they are planned, not to keep someone busy. Otherwise, when needed, the resources may not be available. (Global vs. local efficiency.)

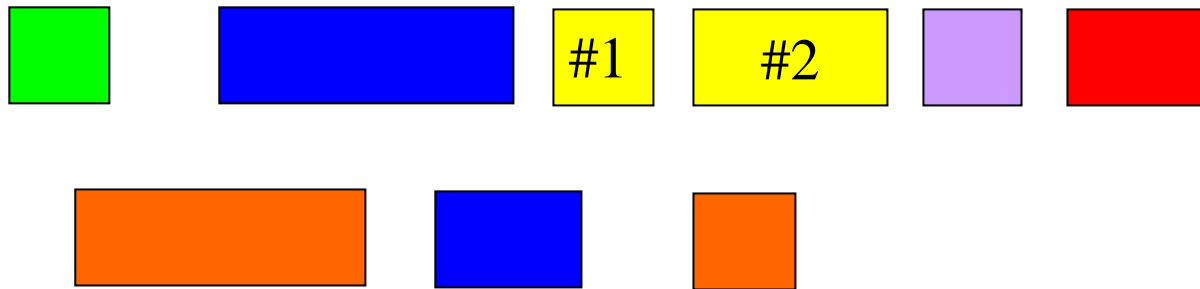
# Creating a Critical Chain Network

1. Identify precedence of tasks and critical path.
2. Identify resources required to complete each task.
3. Plan to an aggressive 50% confidence level.
4. Move all tasks as late as possible.
5. Deconflict resource constraints.
6. Find the critical chain. (Compare to critical path)
7. Insert project buffer.
8. Insert feeding buffers.

This is done automatically with software.

REF: Dr. James R. Holt, PE, Associate Professor Engineering Management, Washington State University

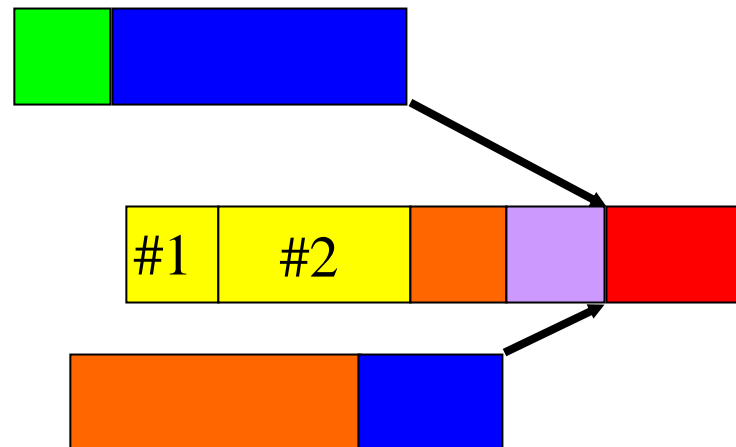
# 1. Identify precedence of tasks and critical path.



Network  
by:



**Task Precedence:** The order in which we need to perform the tasks.  
**Task Preference:** The order in which we'd like to perform the tasks.



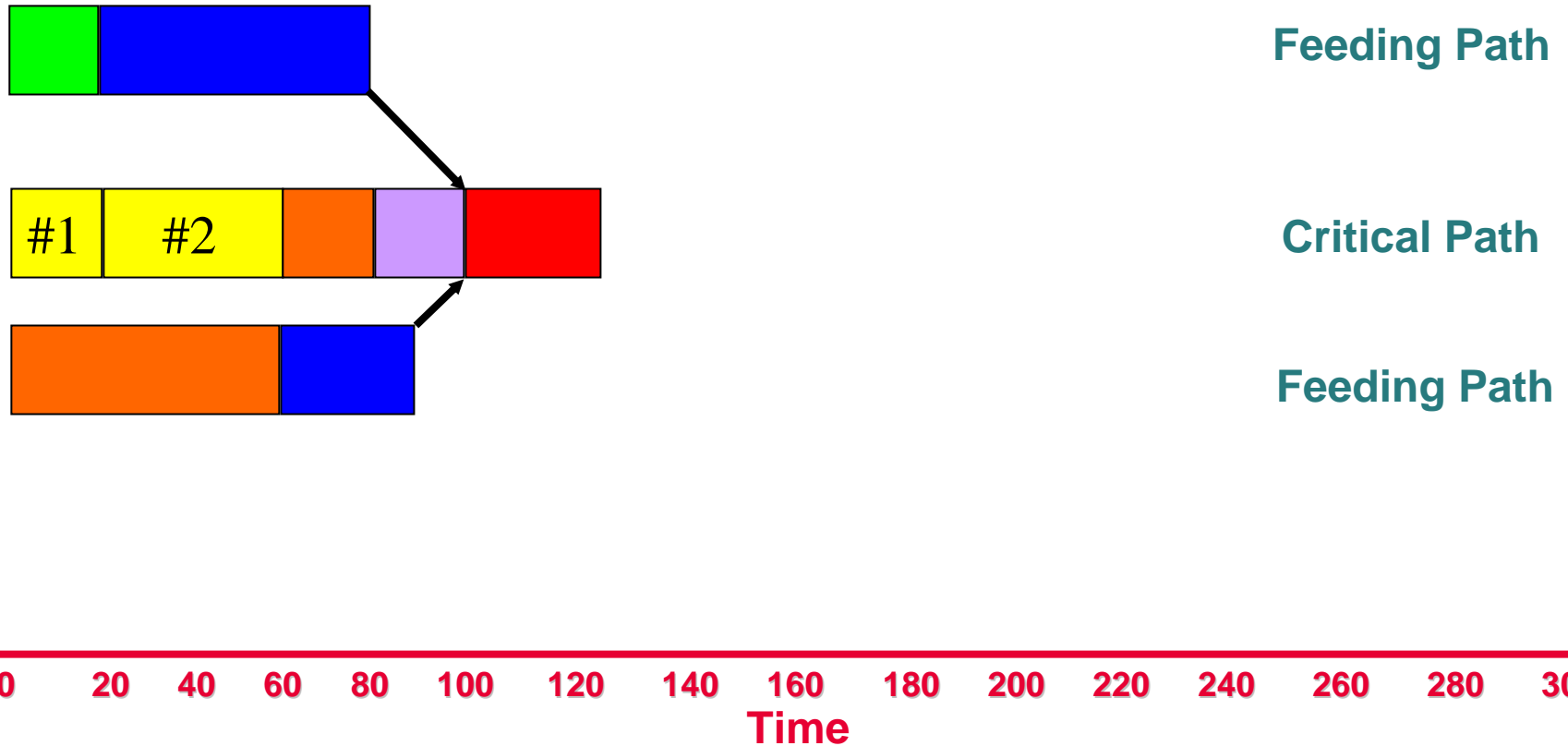
Feeding Path

Critical Path

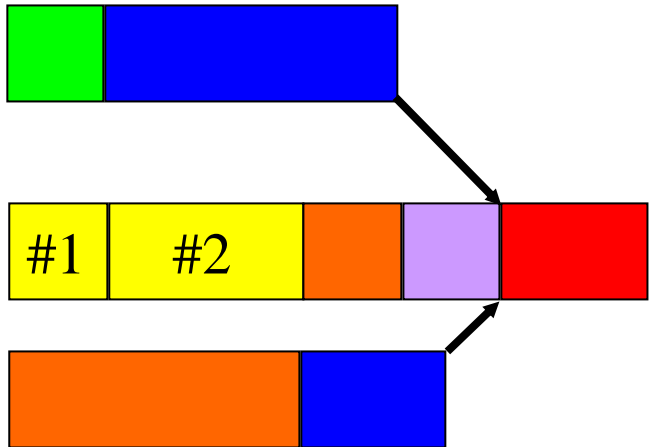
Feeding Path

## 2. Identify resources required

There is only 1 orange resource and 1 blue resource but 2 yellow resources.



### 3. Plan to an aggressive 50% confidence level.



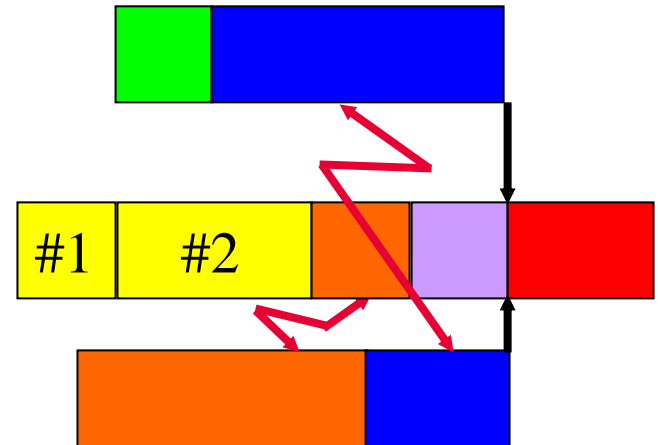
We cut the duration in half by altering the time scale.

Aggressive durations maintain the sense of urgency.





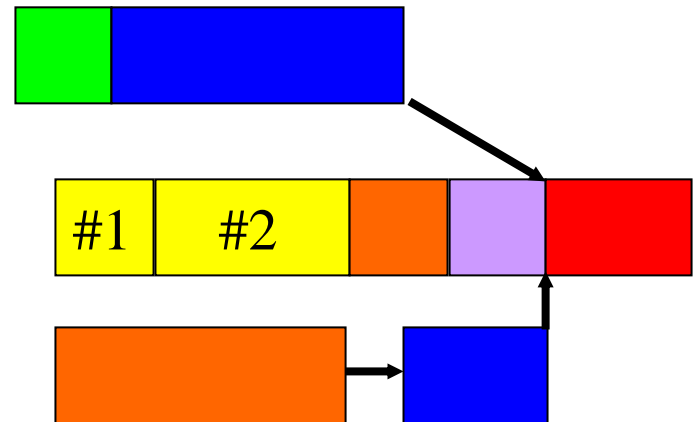
# 4. Move all tasks as late as possible



- Multitasking
- Student Syndrome
- Parkinson's Law
- Unreported Early Finish
- Successor Not Ready



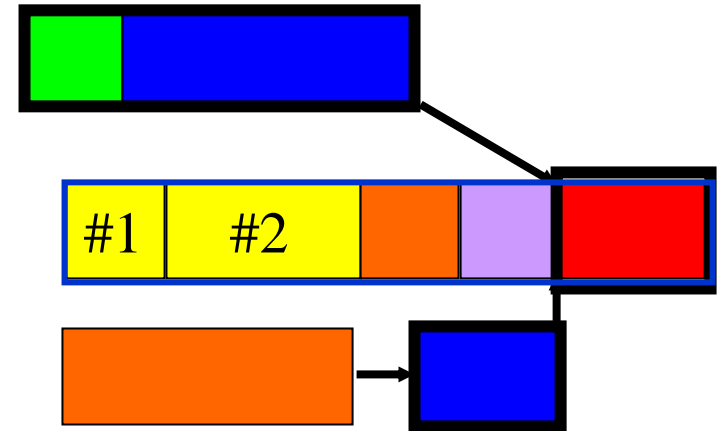
# 5. Deconflict resource constraints



This is the essence of critical chain where resources are deconflicted.



## 6. Select a Critical Chain



**Critical Chain** is the sequence of dependent events that determines how long a project will take to complete, considering *both* task dependencies and resource constraints.



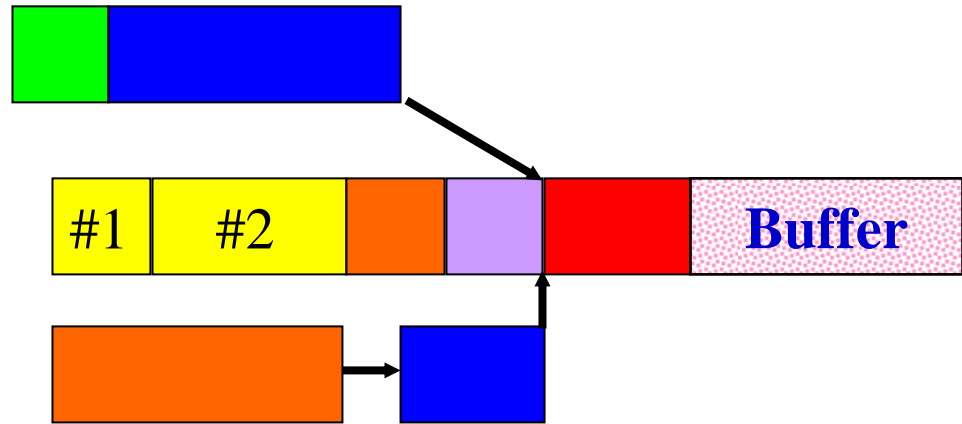
Critical Path



Critical Chain



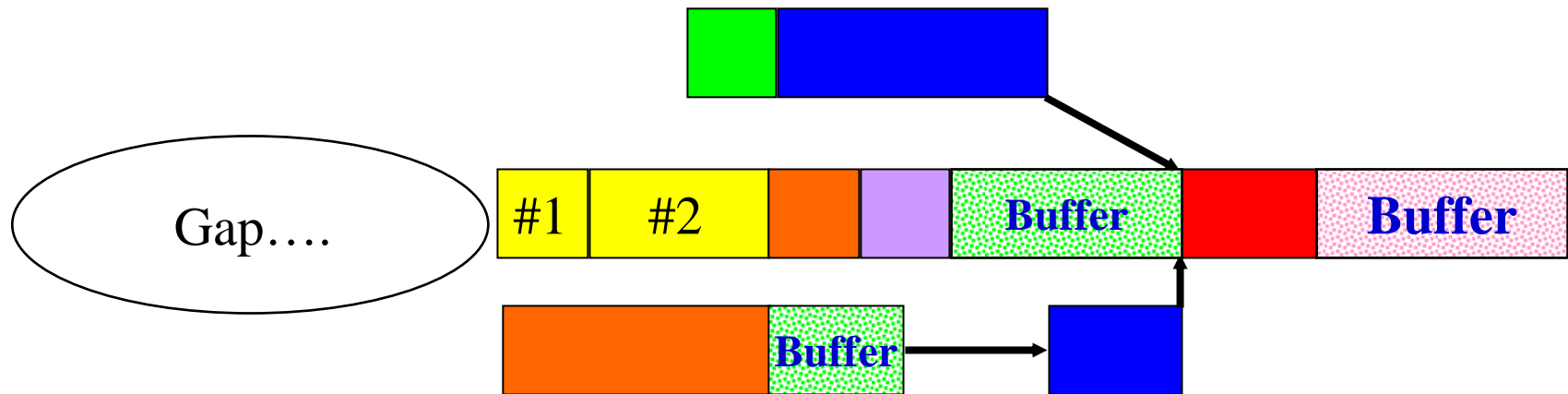
# 7. Insert Project Buffer



**The buffer helps us manage in the face of uncertainty and variation. (Like a McPherson strut – spring & shock absorber.)**



# 8. Insert Feeding Buffer



The feeding buffer protects the longest chain at the integration point.



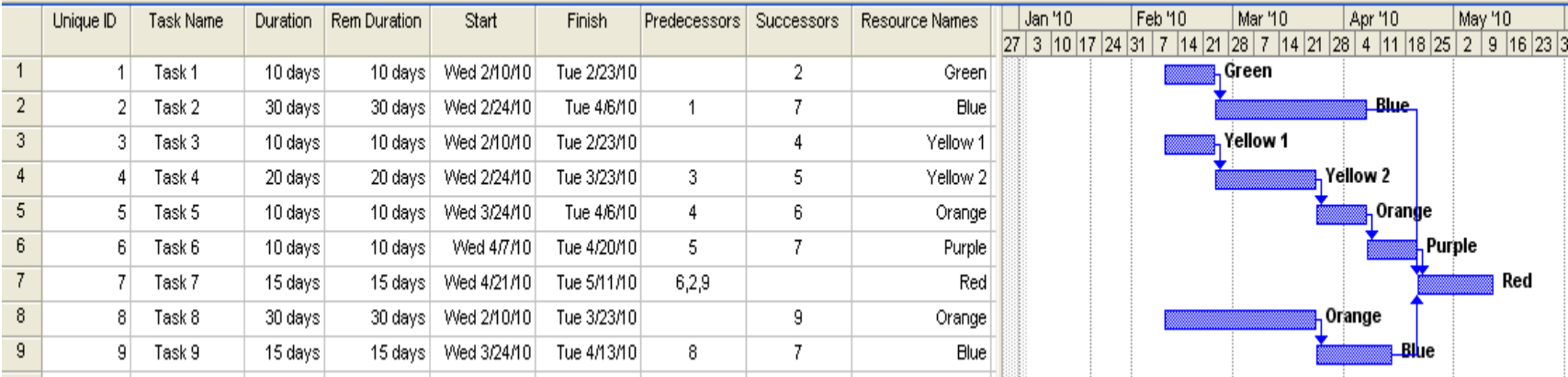
Feeding Buffer



Project Buffer



# Create Your Plan in MS Project

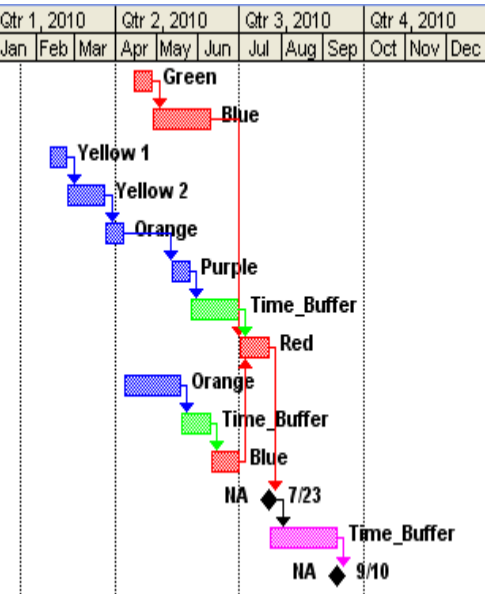


# Critical Chain Software

- Concerto – [www.realization.com](http://www.realization.com)
  - Prochain – [www.prochain.com](http://www.prochain.com)
  - CCPulse and MPulse – [www.pdinstitute.com](http://www.pdinstitute.com)
  - Being Management CCPM – [www.afinitus.com/bmccpm.html](http://www.afinitus.com/bmccpm.html)
  - CCPM+ – [www.advanced-projects.com](http://www.advanced-projects.com)
  - Aurora – [www.stottlerhenke.com](http://www.stottlerhenke.com)
  - PS8 – [www.sciforma.com](http://www.sciforma.com)
- 
- These are only some of the companies, there may be more.
  - Some of these companies sell their consulting services rather than their software only.

# Use Critical Chain Software to Develop Plan

	Unique ID	Task Name	Rem Duration	Start	Finish	Predecessors	Successors	Resource Names	Qtr 1, 2010		Qtr 2, 2010			Qtr 3, 2010			Qtr 4, 2010		
									Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
1	1	Task 1	10 days	Wed 4/14/10	Tue 4/27/10		2	Green											
2	2	Task 2	30 days	Wed 4/28/10	Wed 6/9/10	1	8	Blue											
3	3	Task 3	10 days	Wed 2/10/10	Tue 2/23/10		4	Yellow 1											
4	4	Task 4	20 days	Wed 2/24/10	Tue 3/23/10	3	5	Yellow 2											
5	5	Task 5	10 days	Wed 3/24/10	Tue 4/6/10	4	6	Orange											
6	6	Task 6	10 days	Wed 5/12/10	Tue 5/25/10	5	7	Purple											
7	34	CCFB-Task 6====>Task 7	25 days?	Wed 5/26/10	Wed 6/30/10	6	8	Time_Buffer											
8	7	Task 7	15 days	Thu 7/1/10	Thu 7/22/10	2,11,7	12	Red											
9	8	Task 8	30 days	Wed 4/7/10	Tue 5/18/10		10	Orange											
10	35	CCFB-Task 8====>Task 9	15 days?	Wed 5/19/10	Wed 6/9/10	9	11	Time_Buffer											
11	9	Task 9	15 days	Thu 6/10/10	Wed 6/30/10	10	8	Blue											
12	11	Project End MS	0 days?	Fri 7/23/10	Fri 7/23/10	8	13												
13	33	CCCB-pdicriticalchain	35 days?	Fri 7/23/10	Fri 9/10/10	12	14	Time_Buffer											
14	12	Project End	0 days?	Fri 9/10/10	Fri 9/10/10	13													



**Red Task = Critical Chain**

**Blue Task = Feeding Task**

**Green Task = Feeding Buffer**

**Pink Task = Project Buffer**

Note: There is only 1 orange and 1 blue Resource



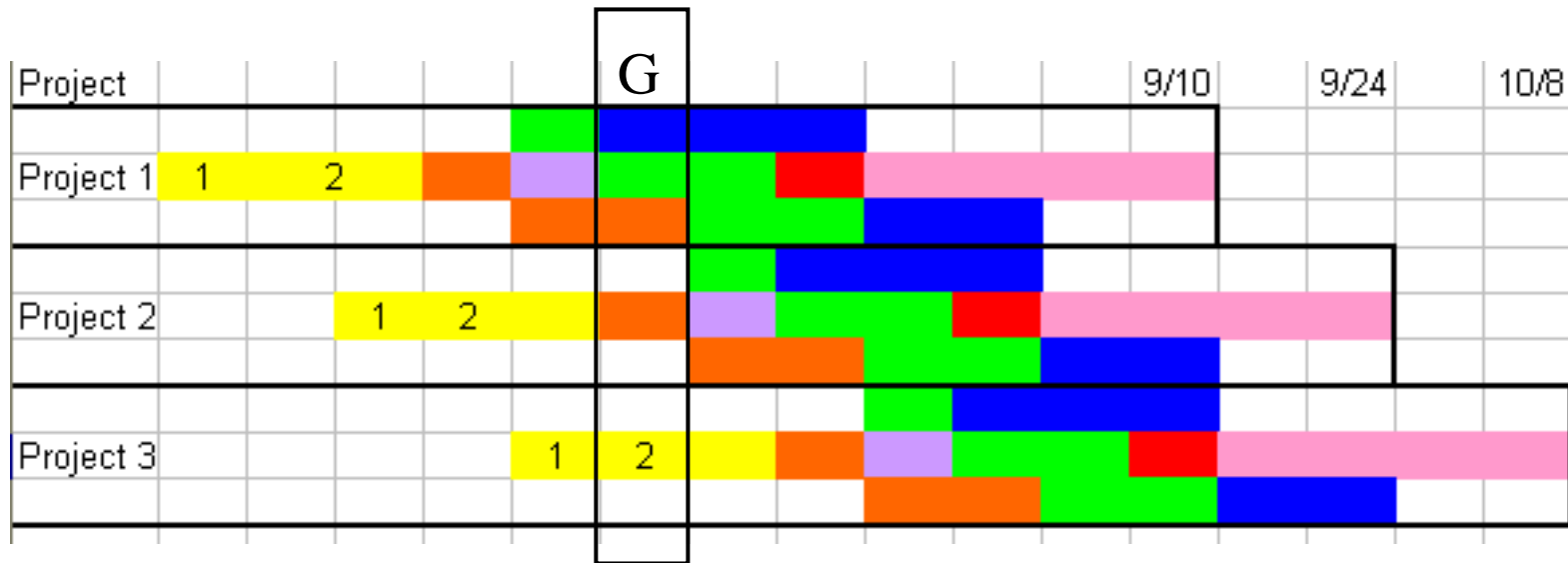
# Multi-Project Management

- Now that you have deconflicted the resources in your project, you need to look at what other projects those resources may be working on.
- This is known as pipelining or staggering the projects. This can be done with an excel spreadsheet or through software such as Concerto.
- Management must direct this step because they are responsible for the company-wide priorities of each of the projects.

# Multi-Project Management

- Let's assume you have 3 projects that use the same resources.
- Project 1 has an end date of 9/10/2010
- Project 2 has an end date of 9/24/2010
- Project 3 has an end date of 10/8/2010
- Let's see what happens without staggering (pipelining) the projects

# Before Pipelining

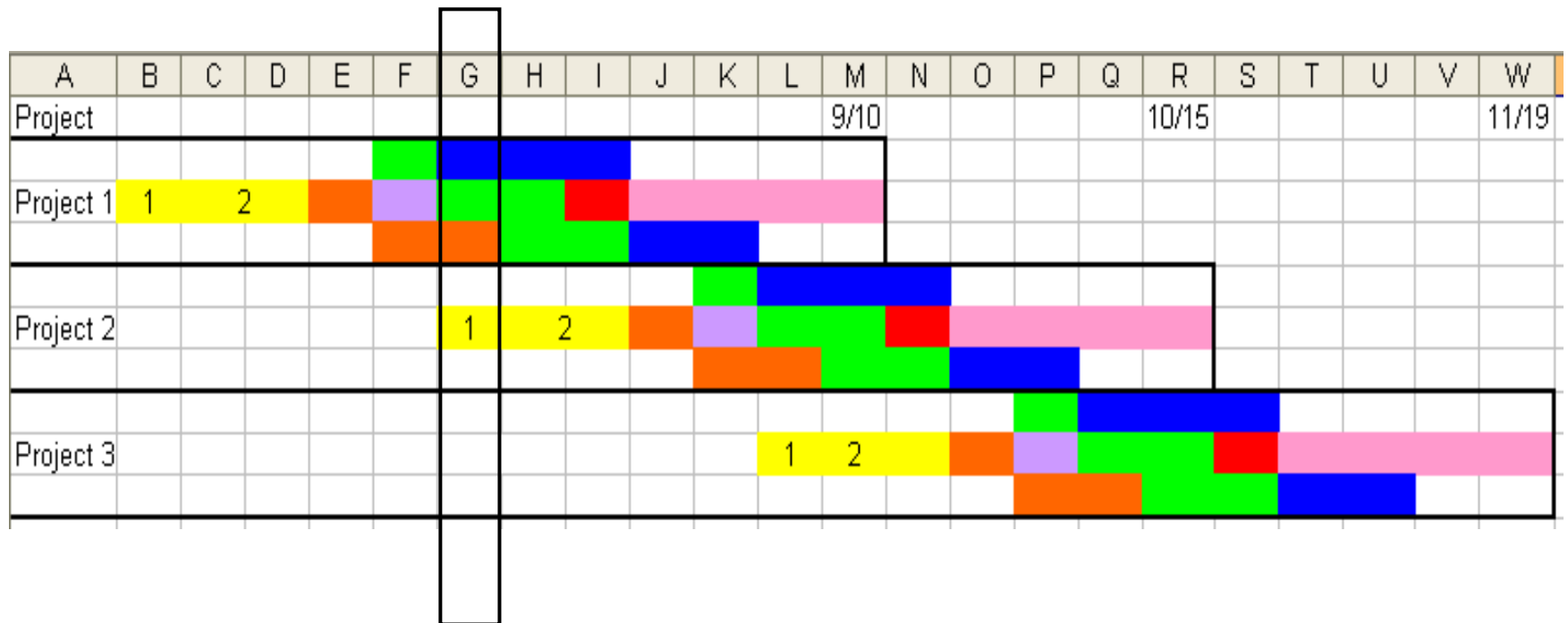


Look down each column. The first problem occurs in column G. You have a conflict on orange resources between Project 1 and Project 2.

Management has determined Project 1 is your top priority, Project 2 next and Project 3 has the lowest priority. When can these projects be completed?

The Blue Resource will be the drum resource.

# After Pipelining



Look down each column. Note that you no longer have any conflicts. You are still finishing Project 1 by the 9/10 due date. However, Project 2 now has an end date of 10/15 instead of 9/24 (3 weeks later). Project 3 has a new due date of 11/19, which is 6 weeks later. Whoa!

Is this ok?

# Pipeline Results

- The new pipelined dates are ok because now you have a schedule for the three projects that is
  - Feasible
  - Achievable
- Without pipelining, you would have been promising your customers a pipe dream – a due date that was unrealistic and impossible to meet, given your current resources.
- Management talks to the customers and gains concurrence on the new due dates.
- You can place the projects in execution, and wait for the start dates.

# No Multi-tasking

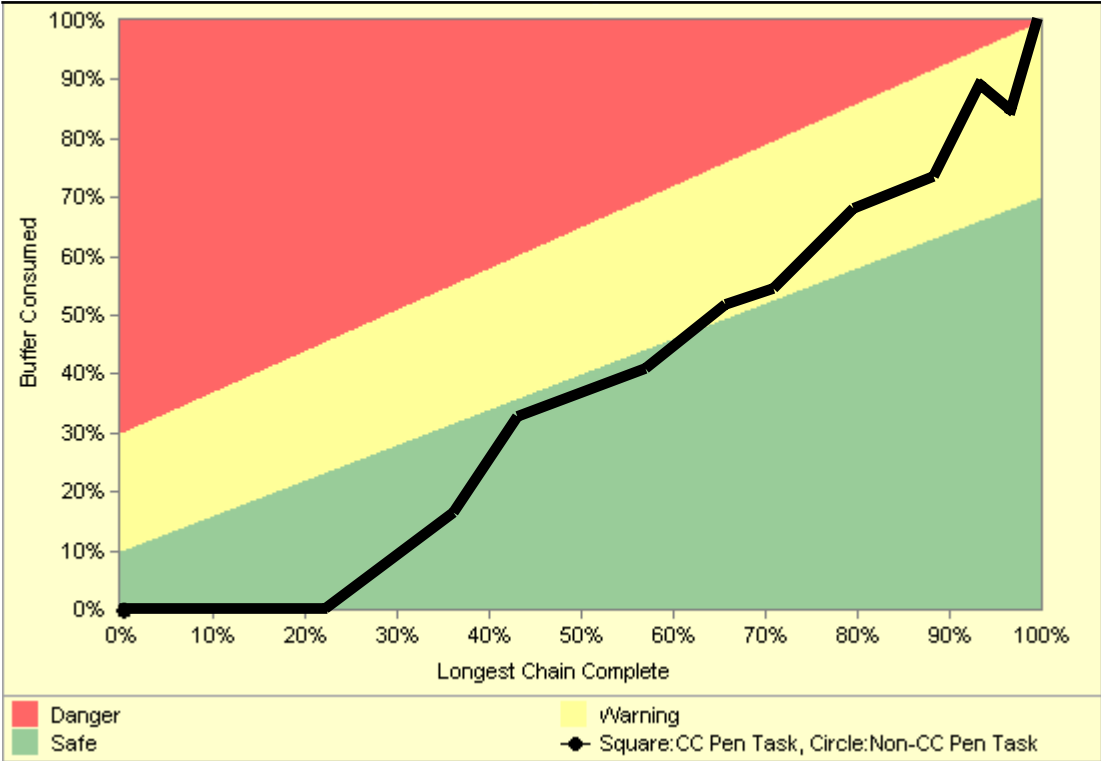
- Note that with these new end dates, none of the resources will be required to multi-task.
- Earlier you saw the consequences of multi-tasking; projects would take almost a third longer.
- So even with the end date moved out, the projects will be completed sooner!

# Execution

- The fastest and longest lasting successes come through leaders who are fully engaged in execution to get the significant results.
- “Rule 1: Limit the number of projects in execution, even if it means keeping some resources idle. Concentrating resources on fewer projects at a time not only allows them to be executed faster, but also reveals overall capacity to undertake more projects.”
- “Rule 2: In execution, allow individual tasks to be late against the plans. That way people won’t have to hide safeties inside their estimates, and tasks will get executed faster because work won’t have to expand just to fill the time available (Parkinson’s Law)”.
- “Rule 3: Provide uniform task priorities across all departments and levels of management. When everyone knows what to do and when, and is working on the same priorities, projects get done much faster.” Source: [www.realization.com](http://www.realization.com)

# Monitor Performance using Trend Charts

*Trend Chart*



Source: Concerto by Realization



# Execution Run Rules

- **Prioritize Tasks and Control Projects based on buffer impact**
- **Is WIP under control?**
  - Processes to limit the work are understood and followed
  - Concentrate resources to accelerate tasks on longest chain
  - Ensure remaining duration is managed and emergent work not being done unless prioritized.
- **Are resources not overloaded or spread thin?**
  - Prepare full kits and only release full kits
  - Don't start task if it cannot be finished
- **Are the buffers in Check?**
  - Task handoffs crisp (let next task know when you'll be done)
- **Replan, exploit, or elevate if necessary**
  - Issue resolution process with task escalation
  - Use Lean or Six Sigma tools to do process improvement

Source: Realization

# Implementation

- **Dr. Goldratt has developed a Strategy and Tactics tree documenting the CCPM implementation process**  
[www.toc-goldratt.com/webcast/ccpm/extract/](http://www.toc-goldratt.com/webcast/ccpm/extract/)
- **Dr. James R. Holt, Washington State University**
  - Master in Engineering and Technology Management
    - *EM526 Constraints Management*
    - *EM530 Application in Constraints Management*
    - *EM534 Contemporary Topics in Constraints Management*
- **Reference Books**
  - *Critical Chain, Dr. Eli Goldratt*
  - *Critical Chain Project Management, Lawrence P. Leach*
  - *Project Management in the Fast Lane, Robert Newbold*
  - *The Billion Dollar Solution, Robert Newbold*
- **Software Companies and Consultants mentioned previously**

# Take-Aways

- Prioritize your tasks
- Control your work in progress
- Eliminate Bad Multitasking
- Don't start a task if you can't finish it
- Once started, work it as quickly as possible
- Let the person you hand your work to know when to expect it, especially if you are going to finish early; so that they can be ready to start work as soon as they get it.
  
- **We are changing the rules by which we manage, not just using a new method to status and track progress!**

# Sources Used in This Presentation

1. Holt, James R., Washington State University, <http://www.vancouver.wsu.edu/fac/holt/>
2. Leach, Lawrence P., Critical Chain Project Management, Second Edition, Artech House, Inc., MA, 2005.
3. Newbold, Robert C., The Billion Dollar Solution – Secrets of Prochain Project Management, Prochain Press, VA, 2008.
4. Product Development Institute – [www.pdinstitute.com](http://www.pdinstitute.com)
5. Realization – [www.realization.com](http://www.realization.com)
6. The Standish Group - [http://www1.standishgroup.com/newsroom/chaos\\_2009.php](http://www1.standishgroup.com/newsroom/chaos_2009.php)



# Questions?

