
Northeastern

Northeastern University

PJM 6025

Project Scheduling and Cost Planning

Week 3/Lecture 3

Schedule Development/Part 2

(Critical Chain and Schedule Compression)

In Part 2 of the 2 Part lecture on Schedule Development, we will focus on the Critical Chain and Schedule Compression.

In Part 1 of this lecture, we covered the Critical Path and its significance in developing a project schedule.

CRITICAL CHAIN

Northeastern University

Critical Chain Method

- Build Schedule Network Diagram using duration estimates and dependencies
- Calculate the Critical Path
- Assign resources based on availability and analyze changes to the dependencies and logical relationships
  - *Account for all resources – People, Material, Equipment*
- Account for non-working days, maintenance freeze periods, nights, holidays, etc.

4

As you first build the project schedule with the Critical Path Method as described in Part 1 of this lecture by using the Network Diagram, dependencies and adding duration estimates.

Once this is completed, you can determine the Critical Path, but you have not yet accounted for resources or resource availability.

With the Critical Chain Method, you modify the schedule *to account for resources, you may find that activities that could have been done in parallel, now have to done in sequence. For example if activities A and B need to be done by the same resource. Resource constraints on the critical path becomes part of the Critical Chain..*

Northeastern University

Critical Chain Method

- Once the resources are accounted for, the Critical Path will most likely change
  - *Why?*
  - *Activity Durations and Sequencing may change*
- New Critical Path is now the Critical Chain
  - *Most often is longer than the Critical Path*
- Add buffers to manage uncertainty

5

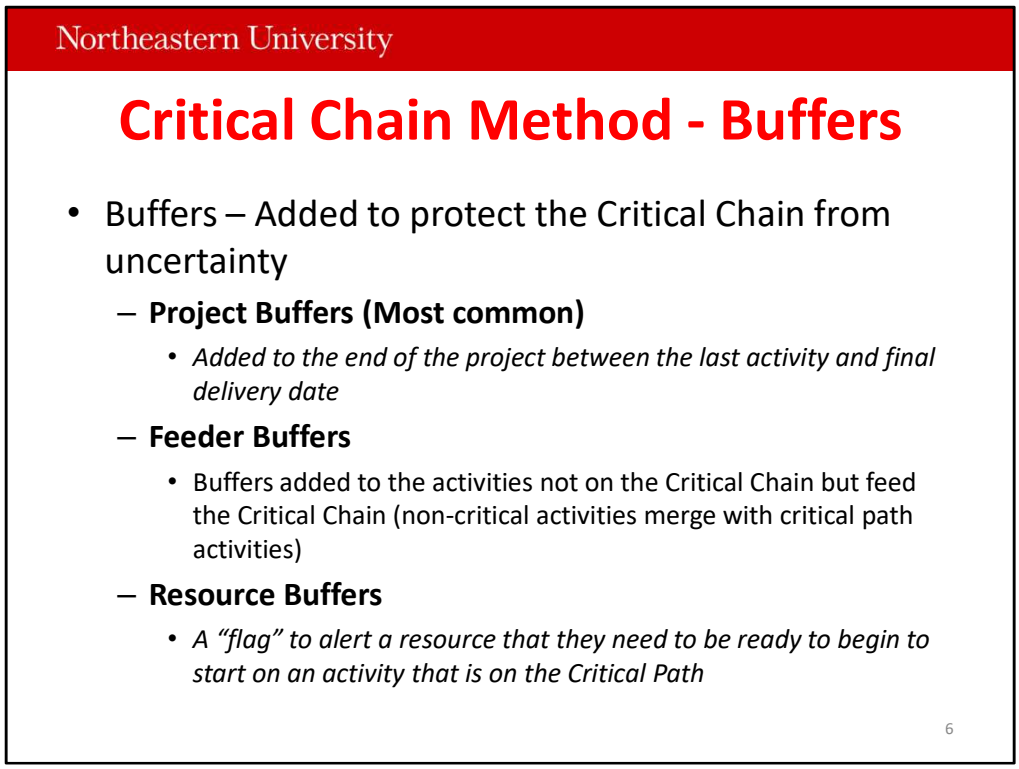
In some cases, the original Critical Path will be changed based on the resource availability to work the activities.

The new Critical Path is now called the Critical Chain.

The Critical Chain may be different from the Critical Path, since resource availability may force certain tasks to start later than originally planned.

With Critical Chain Method the focus on managing buffers rather float, most common approach is to add a buffer to the estimated end date to allow for uncertainty.

This is known as a Project Buffer.



Buffers are added to protect the Critical Chain from constraints and uncertainty.

There are three types of Buffers: Project, Feeder and Resource. These Buffers are added to manage uncertainty.

Project Buffer – Are used to protect the Project Finish Date and is placed at the end of the critical chain.

Feeder Buffers – Protect the Critical Chain – tasks that feed the critical chain. The focus is on managing buffers that are built into the schedule.

In using **Resource Buffers**, a Flag is set to alert resource in advance of the successor task beginning that the predecessor task will be finishing soon. This ensures that the necessary resources will be available on time for the next task and that this task will not be delayed by the resource not being available.

SCHEDULE COMPRESSION

Northeastern University

Schedule Compression

- Most Common Reasons
  - First pass results in **negative slack**
  - Customer requested an end date that is before your estimated project end date
  - To regain time lost
- Two methods
  - Fast Tracking
  - Crashing

8

There will come times when we need to look at reducing the duration of the project schedule.

It is very common to find that your estimated Project End Date is past the customer requested date. Basically, you have Negative Float.

Another common reason is that after the project begins many times there is time lost due to poor estimating or performance, risks that surface, or other issues that delay on the completion of Activities.

There are two common methods to compress a project schedule: Fast Tracking and Crashing

Northeastern University

Fast Tracking

- Examine sequencing, leads, and lags
- Challenge mandatory (hard) dependencies
- Evaluate discretionary (soft) dependencies
  - Are there other options?
  - Look to do activities in parallel rather than sequentially
  - Overlap tasks
- This may introduce risk

9

In Fast Tracking, we modify the network logic to overlap Activities where in the past these Activities were scheduled in sequence. This could involve changing a Finish to Start relationship to a Start to Start relationship, using Leads to start Successor tasks before the Predecessor task is completed, or reducing the Lag in certain task relationships.

As you analyze the network logic of your project, you will want to challenge any Mandatory (or Hard) Dependencies and evaluate any Discretionary (or Soft) Depenencies. Consider whether these Activities be done in parallel or be overlapped.

Fast Tracking may introduce additional Risk by changing relationship, for example, beginning to write code before the entire software design is completed may introduce risk if the design has significant changes and will require rework of the coding.

Northeastern University

Crashing

- Only works on activities where resources can be added to shorten an activity
- Reduction of time for the least cost (most likely resulting in increased cost)
  - Examples: overtime, hiring additional resources, outsourcing, equipment, additional materials, etc.
- No change to the project scope
- Consider impact to the team resources
  - Fatigue, morale, etc.

10

When you Crash a schedule, you are reducing the duration of an Activity. This usually accomplished by adding Resources to Activities to reduce the duration of that Activity. This can add cost to a project since there is a cost to add Resources as well as on-boarding and training the Resources. The new Resources may not be as productive. Also, if you double your Resources, you do not necessarily double your productivity. There will be some inefficiencies introduced as you add more people. Crashing may also include the use of overtime for your Resources.

When Crashing, analyze a number of alternatives to identify one where you can reduce the schedule for the least cost.

There is a balance and trade off between time and cost. For example, adding Resources, adding materials , working overtime.

Crashing a network looks to shorten the duration without changing the scope or any imposed dates.

It is important to understand project priorities with time and cost. At some point – adding Resources does not help. Cost and schedule trade offs are analyzed to secure the greatest amount of compression at the lowest cost.

Most cases, Crashing will result in increased costs to the overall project. For example, hire additional subcontractors at additional cost to reduce the duration of one or more Activities, however, the incremental cost to the project will increase.

Crashing may also have other impacts to your project team, such as fatigue and a loss of morale over time.

Northeastern University

Fast Tracking – Focus on Critical Path

- Critical Path activities that start earlier in the Critical Path
  - Allows for additional time later for corrections
- Critical Path activities that have a longer duration
  - Less risk than trying to reduce a short duration activity
  - Allows you to shorten the schedule using the fewest adjustments
- Shorten Lag
  - Less risky than adding a lead or increasing a lead
  - Shortening delays rather than overlapping activities
- Re-examine dependencies and constraints

11

When utilizing Fast Tracking, here are some key considerations:

First look at the Critical Path Activities earlier in the project. These Activities may have less impact and will be less risky as Risks increase the further you go into your project schedule.

Look at activities on the Critical Path that have a longer duration. You may be able to reduce your schedule with the fewest amount of adjustments to your schedule.

Look to see if certain lag relationships can be shortened.

You can also re-examine task Dependencies and other Constraints.

Northeastern University

Crashing – Focus on the Critical Path

- Prioritize activities based on the cost to crash and the reduction achieved
- Can you allocate resources from non-Critical Path activities to Critical Path activities?
- Examine the longest duration tasks first
  - Allows you to shorten the schedule using the fewest adjustments
- Consider skill levels and availability of the resources
- Can you use different resources, equipment, materials, systems or facilities
- Overtime – Short-term solution, diminishing returns the longer used

12

Here are some key considerations when crashing a schedule:

Look for Activities that can be crashed at a lower cost.

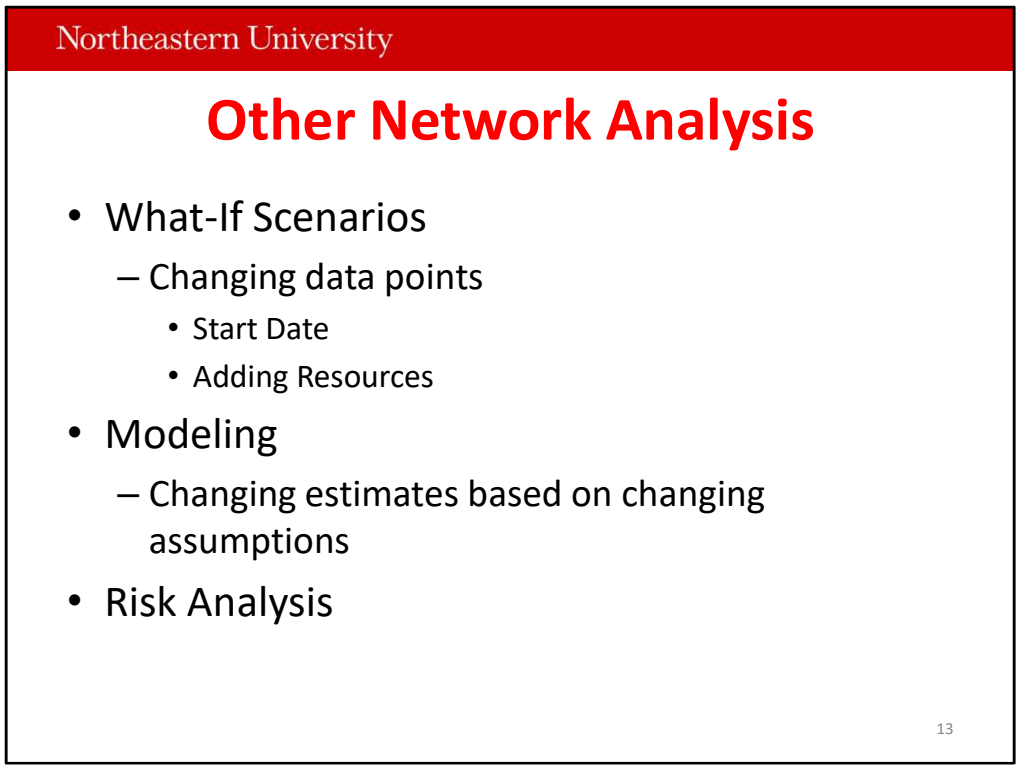
Can you take Resources from Activities that are not on the Critical Path and move them to Activities on the Critical Path? Identify Activities with a greater amount of Float.

Longer duration Activities should be considered first to minimize the number of adjustment you need to make.

Consider the skill levels and availability of your Resources. Higher skilled Resources will provide the biggest productivity gains. You will also need to consider what Resources are available for the tasks that need to be crashed.

Consider other Resource alternatives.

Remember that the of Overtime will provide a short-term solution but may lead to further problems in the long-term. It is best to use overtime sparingly and only when necessary.



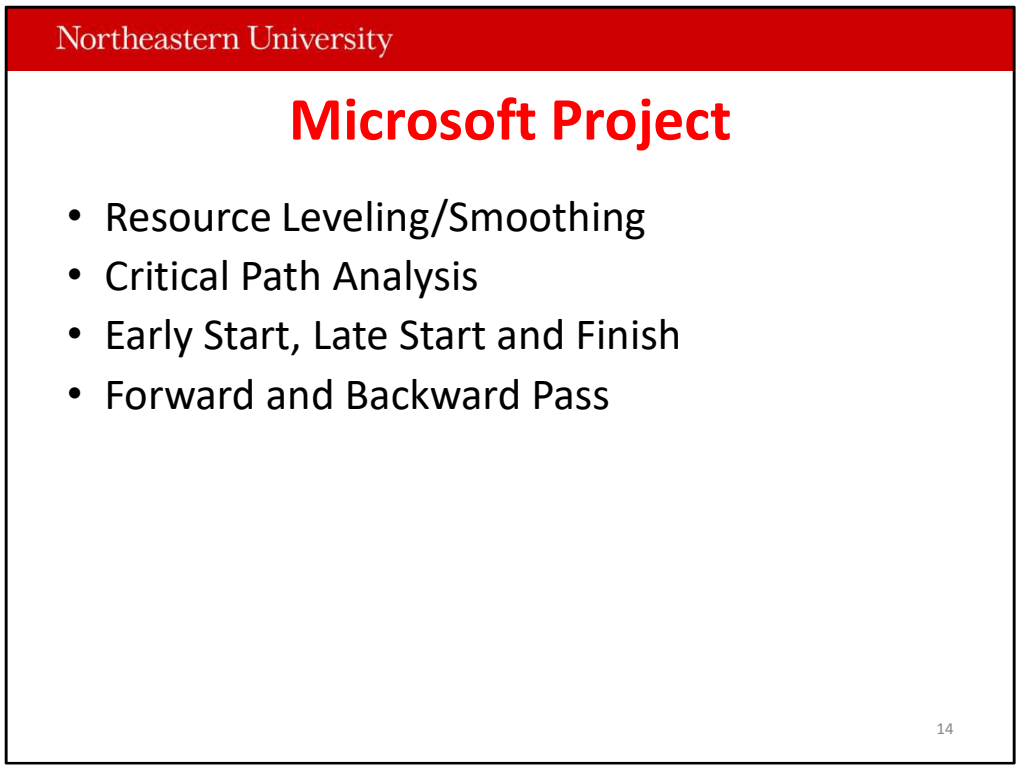
Other ways to analyze your options to reduce your project duration:

Look at different What-if Scenario. How will the schedule change with different adjustments. Also, consider any increased Risks with any of these alternatives.

You change certain data points such as changing the Start Date, or adding Resources and evaluate the impact on schedule, cost and scope.

The Output is used to evaluate the impact and options and also to evaluate Risk and create response plans.

Microsoft Project can also be used to aid with What if Scenarios. By using dependency relationships with all of your task, you can make a change and see how it impacts the rest of the schedule. You can easily undo changes and try other scenarios.



Microsoft Project is one of the major tools that can automate these manual calculations.

Northeastern University

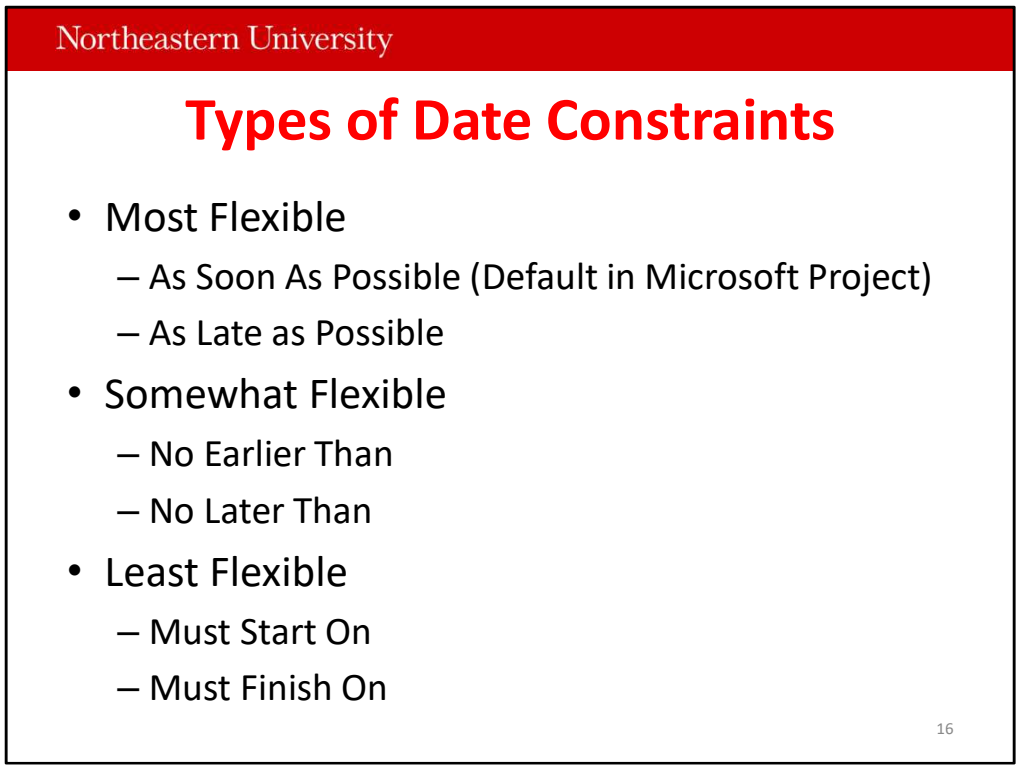
Microsoft Project

Task Name	Duration	Start	Finish	Predecessors	Early Start	Early Finish	Late Start	Late Finish	Total Slack	Free Slack	Critical
Optical Disk Preinstallation Project	**44 days**	**7/15/16**	**9/14/16**		**7/15/16**	**9/14/16**	**7/15/16**	**9/14/16**	**0 days**	**0 days**	**Yes**
Define Scope	6 days	7/15/16	7/22/16		7/15/16	7/22/16	7/15/16	7/22/16	0 days	0 days	Yes
Define Customer Problem	3 days	7/25/16	7/27/16	1	7/25/16	7/27/16	7/27/16	7/29/16	2 days	2 days	No
Define data records and relationships	5 days	7/25/16	7/29/16	1	7/25/16	7/29/16	7/25/16	7/29/16	0 days	0 days	Yes
Mass storage requirements	5 days	8/1/16	8/5/16	2,3	8/1/16	8/5/16	8/8/16	8/12/16	5 days	5 days	No
Consultant needs analysis	10 days	8/1/16	8/12/16	2,3	8/1/16	8/12/16	8/1/16	8/12/16	0 days	0 days	Yes
Prepare installation network	3 days	8/15/16	8/17/16	4,5	8/15/16	8/17/16	9/1/16	9/5/16	13 days	0 days	No
Estimate costs and budgets	2 days	8/15/16	8/16/16	4,5	8/15/16	8/16/16	9/2/16	9/5/16	14 days	1 day	No
Design section point system	1 day	8/15/16	8/15/16	4,5	8/15/16	8/15/16	8/26/16	8/26/16	9 days	9 days	No
Write request proposal	5 days	8/15/16	8/19/16	4,5	8/15/16	8/19/16	8/15/16	8/19/16	0 days	0 days	Yes
Compile vendor list	3 days	8/15/16	8/17/16	4,5	8/15/16	8/17/16	8/17/16	8/19/16	2 days	2 days	No
Prepare management control system	5 days	8/18/16	8/24/16	6,7	8/18/16	8/24/16	9/6/16	9/12/16	13 days	13 days	No
Prepare comparison report	5 days	8/22/16	8/26/16	9,10	8/22/16	8/26/16	8/22/16	8/26/16	0 days	0 days	Yes
Compare system "philosophies"	3 days	8/29/16	8/31/16	8,12	8/29/16	8/31/16	9/7/16	9/9/16	7 days	0 days	No
Compare total installation	2 days	8/29/16	8/30/16	8,12	8/29/16	8/30/16	9/8/16	9/9/16	8 days	0 days	No
Compare cost of support	3 days	8/29/16	8/31/16	8,12	8/29/16	8/31/16	9/7/16	9/9/16	7 days	0 days	No
Compare customer satisfaction level	10 days	8/29/16	9/9/16	8,12	8/29/16	9/9/16	8/29/16	9/9/16	0 days	0 days	Yes
Assign philosophies points	1 day	9/1/16	9/1/16	13	9/1/16	9/1/16	9/12/16	9/12/16	7 days	7 days	No
Assign installation cost	1 day	8/31/16	8/31/16	14	8/31/16	8/31/16	9/12/16	9/12/16	8 days	8 days	No
Assign support cost	1 day	9/1/16	9/1/16	15	9/1/16	9/1/16	9/12/16	9/12/16	7 days	7 days	No
Assign customer satisfaction points	1 day	9/12/16	9/12/16	16	9/12/16	9/12/16	9/12/16	9/12/16	0 days	0 days	Yes
Select best system	1 day	9/13/16	9/13/16	11,17,18,19,20	9/13/16	9/13/16	9/13/16	9/13/16	0 days	0 days	Yes
Order system	1 day	9/14/16	9/14/16	21	9/14/16	9/14/16	9/14/16	9/14/16	0 days	0 days	Yes

15

Microsoft Project includes fields for:

- Early Start
- Early Finish
- Late Start
- Late Finish
- Total Slack (Float)
- Free Slack (Free Float)
- Critical (Path)



You want to minimize any constraints to scheduling the start or completion of a Task or Activity, but sometime these Constraints are necessary due to Resource availability or other external Dependencies. Date Constraints will reduce the flexibility in developing your schedule and add risk because you may have more deadlines to meet.

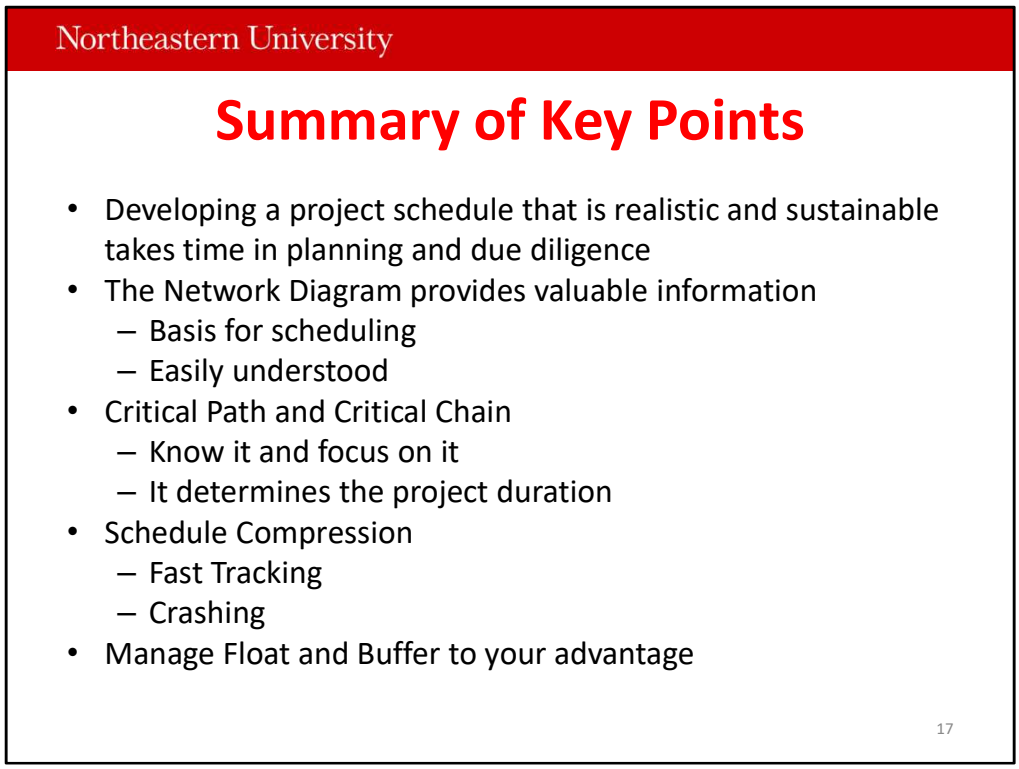
Here are the constraints that are used in Microsoft Project:

As Soon As Possible: The Activity or Task can start or finish as soon as the Predecessor Activity starts or finishes based on the Dependencies, and assignment of Resources

As Late As Possible : The Activity or Task can take place as late as possible based on the Dependencies, and assignment of Resources

No Earlier Than or No Later Than: The Activity or Task must start or finish no earlier or later than a specified date

On this Date: This is a hard Constraint, the Activity must start or finish on this specified date



As we wrap up this lecture, here are some key takeaways:

- Developing a schedule is hard work and the more time spent planning will result in a smoother implementation.

- The Network Diagram is an important tool, providing valuable information and it can be changed if requirements change.

- Be aware of your Critical Path. It can change of the life of a project. It should be an area of constant focus and you must monitor this very closely.

- Schedule Compression techniques will help to reduce the project duration. There will be times in most projects where you will need to use either Fast Tracking or Crashing.

- Know where you Float is and manage it, this also includes Project Buffers.

This concludes our lecture on Schedule Development. Thank you.