Today’s Agenda...

- Q&A from Session #2
- Review of Network Logic Diagram
- Critical Path Method
  - How and Why
  - Float, Lag and Precedential Relationships
- Q & A
- Group Project Meeting

Questions about Session #2?
Planning a Project…NLD Review

**SCOPE**

**RESOURCES**

**NLD - SCHEDULE**

**WBS**

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First Step...

- Sequence the Activities from the lowest level(s) of the WBS
- Place in the *logical order* in which Activities *should* occur – this means without allowing for resource or calendar constraints (not yet!)
- Known as Determining the Precedence of the Activities

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A Gantt Chart View...

<table>
<thead>
<tr>
<th>ACT</th>
<th>DUR</th>
<th>WEEKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>15</td>
<td>01</td>
</tr>
<tr>
<td>B</td>
<td>30</td>
<td>02</td>
</tr>
<tr>
<td>C</td>
<td>20</td>
<td>03</td>
</tr>
<tr>
<td>D</td>
<td>12</td>
<td>04</td>
</tr>
<tr>
<td>E</td>
<td>30</td>
<td>05</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PREV</th>
<th>PREC</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td>APS</td>
<td>OPI</td>
</tr>
<tr>
<td>BIFS</td>
<td>OPFS</td>
</tr>
</tbody>
</table>

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Activities are always indicated as rectangles (Activity Boxes)

Arrows indicate Precedence Relationship between Activities

This example shows a Finish-to-Start (FS) relationship which is the most common type

Activity IDs are always shown in the center of the Activity Box

Activity Durations are always shown in units of time (usually defined days or defined weeks) outside and on top of the Activity Box

Use whole units of time – one day, one defined week

Here we will use days

Assume Activity finishes at end of a day

Assume Successor starts at beginning of next day

Example – Activity A has a Duration of 3 days
Activity A starts at beginning of Day 1
Activity A finishes at end of Day 3 (NOT Day 4!)
Successor Activity E starts at beginning of Day 4

Formula: “Start + Duration - 1 = Finish”
Planning a Project…with CPM

SCOPE

COST

CPM

TIME

ABC

WBS
How to Determine the Critical Path?

- By sequencing work in parallel we created two paths through the Widget Project
  - Path 1: ABE
  - Path 2: ACDE

- Last Session we determined which path had the longest duration
  - Path ABE: 65 days
  - Path ACDE: 71 days

- And we determined that the duration of the Project was...?

- Critical Path(s) – take the longest to complete and determine the duration of the Project

- Critical Path of the Widget Project –
  - Path ACDE

How to Determine the Critical Path?

- We perform a Forward Pass followed by a Backward Pass through the NLD – or whatever portion of it we choose

- The Forward Pass identifies the Early Start (ES) and Early Finish (EF) of every Activity

- The Forward Pass is the technique we employed in Session #2 when determining the Project Duration

- Formula: “Early Start + Duration – 1 = Early Finish”
  or “ES + Duration – 1 = EF”

The Completed Forward Pass...
How to Determine the Critical Path?

- Next we perform the Backward Pass through the NLD – or whatever portion of it we choose – beginning with the last Activity.
- The Backward Pass identifies the Late Start (LS) and Late Finish (LF) of every Activity – without delaying the end of the Project.
- Since we don’t want to delay the Project the Late Finish of the last Activity is always equal to its Early Finish.
- Formula: “Late Finish – Duration +1 = Late Start” or “LF – Duration +1 = LS”.

The Completed Forward and Backward Passes

Critical Paths determine the duration of our projects.
- ANY delay on a Critical Path delays our projects.
- If you need to shorten project duration you MUST identify and make changes to your Critical Path(s).
- Adding Resources anywhere OFF the Critical Path “wastes” those Resources… it will do nothing to shorten project duration!
Note that Activity B is the only Activity for which all of the following are true statements:
- $ES \neq LS$
- $EF \neq LF$
- Not on the Critical Path
- Coincidence? Not a chance...

Activity B is the only Activity in this Network Logic Diagram that has FLOAT.
Float is the amount of time that an activity can be delayed without delaying the end of the project.

Float is sometimes called **Total Float** and always abbreviated as **TF**.

Float is calculated for each activity as follows –

- **Formula**: $TF = LF - EF$

Float is not cumulative along a NLD path with many activities; a path’s TF is that of the highest TF of its activities.

Float is **NEVER** found on a Critical Path…there $FLOAT = 0$

Why might we want to identify Float if it isn’t on a Critical Path?

How might we use that information to improve our project schedule?

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Total Float in our NLD…
How Can This Schedule Be Optimized?

Three Ways to Optimize a Schedule
- **Remove** an activity (the work to be done) from the Critical Path
  - What does that require doing?
- **Shorten** the duration of a Critical Path activity
  - Use more resources
  - Use “better” resources – faster, more experienced, etc.
  - Known as **Crashing the Schedule**
- **Change the relationship** between Critical Path predecessor and successor activities
  - Known as **Fast Tracking the Schedule**
- **Check** that unacceptable risks or risk levels not introduced

Activity Precedence Relationships
- **Finish-to-Start (FS)** relationships are the most common; the “default” relationship between activities
- FS relationships are all we’ve worked with to this point
- Now consider these **Fast Tracking** possibilities...
  - **Start-to-Start (SS)** - activity can start as soon as its predecessor starts...example?
  - **Finish-to-Finish** – activity can finish only when its predecessor finishes...example?
Activity Precedence Relationships

1. SS (start-to-start)
2. FF (finish-to-finish)

Diagramming Precedence Relationships

- Here is a fragment of a NLD showing the familiar FS relationship between Activity J and Activity K...perform the Forward and Backward Passes...

- Here is a fragment of a NLD showing the new SS relationship between Activity L and Activity M...perform the Forward and Backward Passes...
Diagramming Precedence Relationships

- Here is a fragment of a NLD showing the new FF relationship between Activity N and Activity O...perform the Forward and Backward Passes...

```
  10
  N
/     \
\     / FF
\ 15/   \
  \
  46
  O
```

Using Different Precedence Relationships

- Not often easy or realistic to change Precedence Relationships between activities from FS to SS or FF no matter how useful to the schedule

  - Use of this tool helps
    - Lag - a period of delay between Predecessor and Successor Activities
    - FS2 - Successor starts 2 days after Predecessor finishes
    - SS3 - Successor starts 3 days after Predecessor starts
    - FF1 - Successor finishes 1 day after Predecessor finishes

Diagramming with Lags

- Here is a fragment of a NLD showing the familiar FS relationship between Activity J and Activity K with a Lag of 3...perform the Forward and Backward Passes...

```
  10
  J
/     \
\     / FS3
\ 15/   \
  \
  60
  K
```
Here is a fragment of a NLD showing the new SS relationship with a Lag of 3 between Activity L and Activity M…perform the Forward and Backward Passes…

Here is a fragment of a NLD showing the new FF relationship with a Lag of 3 between Activity N and Activity O…perform the Forward and Backward Passes…

Remove an activity (the work to be done) from the Critical Path
  What does that require doing?

Shorten the duration of a Critical Path activity
  Use more resources
  Use “better” resources – faster, more experienced, etc.
  Known as Crashing the Schedule

Change the relationship between Critical Path predecessor and successor activities, or Fast Tracking the Schedule

Decrease lag values on the Critical Path

Again, check for any unacceptable risk impacts
How Can This Schedule Be Optimized?

Determining Precedence: Widget Project

<table>
<thead>
<tr>
<th>Activity</th>
<th>Predecessor(s)</th>
<th>Successor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Develop Product</td>
<td>none</td>
<td>B, C</td>
</tr>
<tr>
<td>B. Manufacture 1000 Lots</td>
<td>A</td>
<td>E</td>
</tr>
<tr>
<td>C. Develop Marketing</td>
<td>A</td>
<td>D</td>
</tr>
<tr>
<td>D. Advertise Product</td>
<td>C</td>
<td>E</td>
</tr>
<tr>
<td>E. Sell 1000 Lots</td>
<td>B, D</td>
<td>none</td>
</tr>
</tbody>
</table>

Shorten Duration of Widget Project

- **CHANGE:** design/development has 15 wk duration, but marketing plan development can start after 6 wks
- **CHANGE:** manufacturing has 30 wk duration, but will have enough product to start selling after 12 wks
- **CHANGE:** due to Marketing Veep vacation plans, 1 wk delay between finish of marketing plan and start of advertising
- **CHANGE:** advertising campaign has 12 wk duration, but sales of widgets can start after 1 wk of ads
Shorten Duration of Widget Project

<table>
<thead>
<tr>
<th>Activity</th>
<th>Predecessors/Precedence</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Develop Product</td>
<td>none</td>
<td>15 wks</td>
</tr>
<tr>
<td>B. Manufacture 1000 Lots</td>
<td>A/FS</td>
<td>30 wks</td>
</tr>
<tr>
<td>C. Develop Marketing</td>
<td>A/SS6</td>
<td>24 wks</td>
</tr>
<tr>
<td>D. Advertise Product</td>
<td>C/FS1</td>
<td>12 wks</td>
</tr>
<tr>
<td>E. Sell 1000 Lots</td>
<td>B/SS12, D/SS1</td>
<td>20 wks</td>
</tr>
</tbody>
</table>

Diagram the Optimized Schedule...
...What's the New Project Duration?

Perform the Forward and Backward Passes
Benefits of Critical Path Method

- Calculates realistic project duration
- Boosts schedule optimization work
- Pinpoints schedule for each activity and its resources
- Illustrates opportunities for saving time
- Provides “Early Warning System”
- Enables “what if” analysis

Contrast with…
The Perils of Backward Scheduling

Implementing Critical Path Method

- Small projects typically have obvious parallel paths - NLDs are easily built and Critical Paths optimized manually
- Knowing the mechanics of doing so “by hand” as we have done is key to effectively using dynamic scheduling applications
- Tools such as MS Project can do much of this work for us
- But note that this level of detail only needed in medium/large projects
Questions?

Group Project Discussions

- How can today’s topics be applied to your Group Project?
- Here are some examples of questions to ask and explore –
  - Have there been Change Requests yet on the Project? What type (scope, schedule)? Who was the source (sponsor, end-user, other stakeholder)?
  - Among the Group members, what documentation and communication protocols have been implemented in connection with Change Requests and Change Controls? What useful practices and/or templates can you share that will be appropriate for the Group Project?

- …and more examples of questions to ask and explore –
  - Can you identify the longest path of activities that is determining project duration?
  - Which activities on that path could be changed from an FS relationship to a SS with a Lag in order to shorten the duration?
  - Are there any FS with Lag relationships in the project? If so, could the Lag be decreased?
Next Session...

- **Wednesday, April 27th at 9am**
- Groups will meet briefly for update on the Group Projects
- Topics to be presented –
  - Project Communication Planning
  - Project Stakeholder Management
- Groups will meet for discussions on the Group Projects

Thanks for your participation.

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