PLANNING, SCHEDULING, AND CONTROL

The Components of the Precedence Diagram Method

The Precedence Diagram Method is referred to as Activity on the Node and each Box represents an Activity. The Precedence Diagraming Method consists of the following parts.

A Rectangular Box represents a specific activity in the logic network. The Activity Description is placed in the center of the box. The Activity Node Number is placed in the top center box. Each activity is given a sequential non-consecutive number normally separated by 5 to 10.

The Duration is in Days and it is placed in the bottom center box. This Diagram Starts with Zero (0) as the duration. The Activity Event Times are placed in the four corner boxes of each activity for scheduling the project.

The Earliest Start (ES) Time is placed in the top left hand box. This Diagram’s Earliest Start (ES) Starts with Zero (0).

The Earliest Finish (EF) Time is placed in top right hand boxes.

The Latest Start (LS) Time is placed in the bottom left hand box.

The Latest Finish (LF) Time is placed in the bottom right hand box.

NODE NUMBER

<table>
<thead>
<tr>
<th>NODE NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>ES 0 EF</td>
</tr>
<tr>
<td>START</td>
</tr>
<tr>
<td>LS 0 LF</td>
</tr>
</tbody>
</table>

DURATION

Precedence Diagram Abbreviations and Locations
The Project Activity Event Times

The Activity Event Times establish the Project Schedule. This step is dependent upon the logical sequence being correct. Computations are performed to determine the overall project completion date and the time requirements for each activity. To determine the project schedule, you must perform these network computations. First, calculate the Forward Pass to determine the earliest event times. The earliest event times calculations are described below.

The Earliest Start (ES) is placed in the top left hand portion of each activity. The ES is calculated at each Activity by completing the Forward Pass (Tail to head of the arrow). Start at the beginning of the project, use zero as the starting date and place in the top left hand portion of the first activity. Then add the duration to the Earliest Start of the activity(s) and place in the top right hand portion of the activity, called the Earliest Finish (EF).

To determine Earliest Start of the next activity(s) in the forward pass, select the Largest Early Finish from all preceding paths coming into the specific activity and place in the top left hand portion of the activity.

The Earliest Finish (EF) is placed in the top right hand portion of each activity. The EF is calculated at each Activity by completing the forward pass (Tail to head of the arrow) and taking the Earliest Start (ES) of that activity and adding the duration.

\[ EF = ES + DURATION \]

Second, calculate the Backward Pass to determine the latest event times. The latest event time calculations are described below.

The Latest Finish (LF) is placed in the bottom right hand portion of each activity. The LF is calculated at each Activity by 1) completing the BACKWARD PASS (head to the tail of the arrow). Start at the completion of the project and select the largest number and place in the bottom right hand portion of the last activity or activities. Then, subtracting the duration from the Latest Finish of that activity(s) and place in the bottom left hand portion of the activity, called the Late Starts (LS).

To determine the Latest Finish of the next activity in the backward pass, select the smallest Latest Start (LS) from all paths (head to the tail of the arrow) going into the specific activity and place in the bottom right hand portion of the activity.

The Latest Start (LS) is placed in the bottom left hand portion of each activity. The LS is calculated by taking the LATEST FINISH (LF) of that activity and subtracting the DURATION.

\[ LS = LF - DURATION \]
The **Total Float (TF)** is defined as the amount of slack or leeway through a path of activities and shared by all activities. Total Float is calculated by subtracting the Earliest Start (ES) from the Latest Start (LS) or by subtracting the Earliest Finish (EF) from the Latest Finish (LF).

\[ TF = LS - ES \quad \text{or} \quad TF = LF - EF \]

The **Free Float (FF)** is defined as the amount of slack or leeway within an activity. Free Float is calculated by subtracting the Earliest Finish (EF) of that activity from the Earliest Start of the next activity (ES(I)).

\[ FF = ES(I) \text{ next activity} - EF \text{ that activity} \]

The **Critical Path** is defined as the longest continuous path or paths with zero float. This is the path the project manager must focus their attention upon because if time is added to any of these activities the project completion will be delayed. Also, to shorten the project schedule the durations of the critical activities must be shortened.

The Critical Path is identified using this criteria For the Precedence Method:

A. The Earliest Start (ES) is equal to the Latest Start (LS).
   \[ ES = LS \]

B. The Earliest Finish (EF) is equal to the Latest Finish (LF).
   \[ EF = LF \]

C. The Total Float (TF) and the Free Float (FF) are equal to Zero.
   \[ TF = 0 \quad \text{and} \quad FF = 0. \]

The critical path(s) is normally indicated on the diagram using slashed lines ////////////// or a heavy dark line.
The Precedence Diagram Logic Network and Schedule Event Times Example

PRECEDENCE SCHEDULE EVENT TIME TABULATION SHEET
FOR THE PRECEDENCE DIAGRAM LOGIC

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>NODE</th>
<th>DAYS</th>
<th>EARLY START</th>
<th>EARLY FINISH</th>
<th>LATE START</th>
<th>LATE FINISH</th>
<th>TOTAL FLOAT</th>
<th>FREE FLOAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>START</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0*</td>
</tr>
<tr>
<td>LAYOUT &amp; EXC</td>
<td>20</td>
<td>8</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>0*</td>
</tr>
<tr>
<td>AWARD U/G UT</td>
<td>25</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>9</td>
<td>12</td>
<td>9</td>
<td>12 - 3 = 9</td>
</tr>
<tr>
<td>PLACE FOOTING</td>
<td>30-35</td>
<td>4</td>
<td>8</td>
<td>12</td>
<td>8</td>
<td>12</td>
<td>0</td>
<td>0*</td>
</tr>
<tr>
<td></td>
<td>30-40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0*</td>
</tr>
<tr>
<td>PLACE WALL</td>
<td>35</td>
<td>5</td>
<td>12</td>
<td>17</td>
<td>12</td>
<td>17</td>
<td>0</td>
<td>12 - 12 = 0*</td>
</tr>
<tr>
<td>PLACE U/G UTIL</td>
<td>40</td>
<td>5</td>
<td>12</td>
<td>17</td>
<td>12</td>
<td>17</td>
<td>0</td>
<td>12 - 12 = 0*</td>
</tr>
<tr>
<td>END</td>
<td>45</td>
<td>0</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>0</td>
<td>0*</td>
</tr>
</tbody>
</table>
The Design Sequence for each Engineering Discipline

Each engineering discipline on a Design/Build Project must show the following design activities on the logic diagram prior to the procurement sequence of activities. The general design sequence of activities is shown below.

A. Prepare the Schematic or Process Diagrams.

B. Prepare the Design Development Drawing Packages.

C. Formalize the Final Design and Develop the Contract Documents.

D. Client Approves and Bid Plans Are Issued.

Each engineering discipline, such as civil engineering, structural engineering, processing piping engineering, chemical engineering, mechanical engineering, electrical engineering and plumbing design, will contain the following design sequence at the beginning of the logic diagram on a separate line for each discipline. The design sequence for each engineering discipline will be shown as follows.

The Procurement Sequence for each Discipline or Construction Trade

The Procurement Sequence (Material Leadtime) on a project is the amount of time required prior to the item being installed at the jobsite. The following activities must be analyzed to determine the total amount of leadtime required.

1. Prepare Bid package, Request price Quotations, Select and award the contract to the Vendor or Subcontractor.

2. Vendor prepares and submits shop drawings, Product Data or Samples as outlined in the Technical Specifications.
3. Contractor reviews & approves field measurements and field construction methods on the Shop Drawings.

4. Architect or engineer reviews all design criteria prior to the fabrication or erection of the item.

5. Vendor or Subcontractor schedules the contract into their fabrication schedule and shop fabricates the items according to the approved and revised drawings.

6. Vendor arranges for shipment and delivers the materials to the job site.

Each Construction Trade, such as concrete, rebar, equipment, structural steel, sheet metal, boilermaker, pipe fitter, instrumentation fitter, sprinkler fitter, insulator, electrical and plumbing, will contain the following procurement sequence at the beginning of the logic diagram on a separate line for each construction trade. The procurement sequence for each construction trade will be shown as follows.

The courts have established rules for allowing the schedule to admissible evidence in a case. The basic considerations are that the diagram method must show the interrelationships of activities. Also, the project schedule must contain the design sequence, the procurement sequence, the construction sequence, planned weather anticipated each month, inspections and testing, owner furnished items, separate contracts negotiated by the owner, closeout procedures, and commissioning activities. In addition the schedule must be updated regularly to show contract change order and all delays whether caused by the contractor, the owner, the subcontractors or a weather caused delay.
The Time Scaled Network Method
This method uses a graph with each column representing a duration, usually a day or week, and each activity is displayed on the chart based upon the relationships of the other starting and finishing activities. Also, described as a graphic display plotting the interrelationship of activities using the Early Starts (ES) and Late Finishes (LF). The Time Scaled Diagraming Method consists of the following parts.

The Activity is represented by an open bar.
The Length of Activity is represented by the length of the open bar. Stated in days.
The Activity Restraint is shown using a heavy vertical line with an arrow head.
The Activity Description is placed on the top of each bar.
The Duration is in Days. It is placed at the bottom left hand portion of each activity.
The Free Float is shown as a horizontal dotted line between each activity.

Given the Preceding and Following activities for the construction of a Basement Foundation.

<table>
<thead>
<tr>
<th>Activity Description</th>
<th>Days</th>
<th>Preceding Activity</th>
<th>Following Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Layout &amp; Excavate</td>
<td>8</td>
<td>None</td>
<td>Place Footing</td>
</tr>
<tr>
<td>Place Footing Forms</td>
<td>4</td>
<td>Layout &amp; Excavation</td>
<td>Place Foundation Walls</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Place U/G Utilities</td>
</tr>
<tr>
<td>Award U/G Utilities</td>
<td>3</td>
<td>None</td>
<td>Place Utilities</td>
</tr>
<tr>
<td>Place U/G Utilities</td>
<td>5</td>
<td>Award U/G Utilities</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Place Footing Forms</td>
</tr>
<tr>
<td>Place Foundation Walls</td>
<td>5</td>
<td>Place Footing Forms</td>
<td>None</td>
</tr>
</tbody>
</table>

Time Scaled Network Example in Days

```
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21

LAYOUT BLDG & EXCAVATE PLACE FOOTING PLACE END WALLS

AWARD U/G UTILITIES PLACE U/G UTILITIES

9 DAYS FLOAT
```
The Actual or the Effective Amount of Time

The Multi-crew Effective Durations is defined as the Actual or Effective amount of time expended because multiple crews are working on a sequence of activities simultaneously. This can be best shown using the following construction activities.

<table>
<thead>
<tr>
<th>CSI DIV</th>
<th>ACTIVITY DESCRIPTION</th>
<th>CREW SIZE</th>
<th>DAILY OUTPUT</th>
<th>PLAN QTY</th>
<th>ACTIVITY DAYS</th>
<th>ACTUAL DAYS</th>
</tr>
</thead>
<tbody>
<tr>
<td>06</td>
<td>EXT STUDS</td>
<td>4</td>
<td>100 LF</td>
<td>280 LF</td>
<td>2.80</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EXT SHEATH</td>
<td>4</td>
<td>1200 SF</td>
<td>3200 SF</td>
<td>2.67</td>
<td>3.00</td>
</tr>
<tr>
<td></td>
<td>INT STUDS</td>
<td>2</td>
<td>80 LF</td>
<td>160 LF</td>
<td>2.00</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>PLUMBING</td>
<td>2</td>
<td>58 LF</td>
<td>150 LF</td>
<td>2.58</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HEATING</td>
<td>2</td>
<td>170 LF</td>
<td>120 LF</td>
<td>.70</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>ELECTRICAL</td>
<td>2</td>
<td>1300 LF</td>
<td>2600 LF</td>
<td>2.00</td>
<td></td>
</tr>
<tr>
<td>07</td>
<td>INSULATION</td>
<td>3</td>
<td>1000 SF</td>
<td>3200 SF</td>
<td>3.20</td>
<td>4.00</td>
</tr>
<tr>
<td>TOTALS</td>
<td></td>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td>10.00</td>
</tr>
</tbody>
</table>

Using the Multi-crew Effective days from above, the Time-scaled Network & Crew Distribution Chart is shown below. N showing each day and using the Time Scaled Network for the Multi-crew information.
The Crew Distribution (Utilization) Chart and Graph

Completing a construction project efficiently requires the efficient scheduling and allocation of available resources, specifically the workers, equipment and materials available. Therefore, the allocation or distribution of the workers and equipment required over the length of the project provides you with the capability to determine if your planned schedule is feasible. This planned schedule can then be compared to the physical size of the project and the availability of workers and equipment within the area or within the company.

The crew distribution chart is developed using the Time Scaled Network and indicating the number of workers for each activity. Finally, you total the number of workers for each day at the bottom of the chart. This information is utilized to develop the crew utilization graph. This graph indicates the planned crew sizes and the maximum total number of workers by month.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Place Exterior Studs</td>
<td>Plumbing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>4</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Place Exterior Sheathing</td>
<td>Heating</td>
<td>Insulation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>4</td>
<td>4</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Place Interior Studs</td>
<td>Electrical</td>
<td></td>
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<tr>
<td>Total Number of Workers per Day</td>
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<tr>
<td>8</td>
<td>10</td>
<td>10</td>
<td>6</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
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</tr>
</tbody>
</table>
To Develop a Crew Utilization Chart the following steps are involved.

1. Time Scale the Project using Latest Starts (LS)

2. Determine the crew size for each activity and distribute for each activity. This can be taken from the original estimate or it must be estimated for the Subcontractors.

3. Total the number of workers required for each day.

4. Using the worker totals, Prepare the crew utilization graph.

The Crew Utilization Graph below is for the number of workers anticipated for each day.

<table>
<thead>
<tr>
<th>Number of Days</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>#</td>
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<td></td>
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<tr>
<td>14</td>
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<td>0</td>
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</tr>
</tbody>
</table>
Project Scheduling Definitions

A **Bar Chart** is a graph showing the list of items down the left hand side, the Time periods across the top, usually in months or weeks, and the time required to perform each activity is represented by a thick dark line. The major disadvantages of a bar chart are 1) it does not show the interrelationship of activities 2) it does not show the amount of float that may exist within the activities and 3) it cannot predict a new course of action in case of a delay. The bar chart is an extremely poor planning document for construction but it is an effective tool for displaying job progress. Also, a bar chart which does not show the interrelationship of activities and the amount of float available for each activity is not admissible evidence in court. But if the activities are represented in a Time Scaled Network Form, showing the interrelationships of activities and their available floats then it is admissible.

**Fast Tracking** is the overlapping accomplishment of Design, Procurement and Construction activities to complete a project faster.

**Crashing** is the shortening of the project schedule along the critical path using the activities on the critical path with the Least Cost. No activity can be crashed to a zero duration.

**Resource Leveling** is the shifting of activities within the schedule using the float times available. This shifting occurs due to a limited number of resources available such as workers available, equipment availability, material availability and subcontractors available.

**Leadtime** is the amount of time to procure the materials.

**Activity Descriptions** are extremely important because they convey to everyone using the logic diagram what the primary activities that are included in each description. The activity descriptions can be developed by reviewing the Technical Specifications Division and Section headings such as CSI number 02225 titled Excavating, Backfilling and Compacting for Trenching and 720 Storm Sewer System Piping. The two section from Division 02 Sitework can be combined to have a construction activity description which reads Excavate, Place Pipe, Backfill and Compact for the Storm Sewer System.
Activity Duration is the number of days required to install the quantity on a project. Using the crew size and the daily output for an activity, you can determine the number of days required. For example, given the following crew size and daily output the number of days is calculated as follows:

<table>
<thead>
<tr>
<th>No.</th>
<th>CRAFT</th>
<th>Hours per Day</th>
<th>Total Workhours</th>
<th>Hourly Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Carpenters</td>
<td>x 8</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Building Laborer</td>
<td>x 8</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Total Per Day</td>
<td>x 8</td>
<td>32</td>
<td></td>
</tr>
</tbody>
</table>

Determine the Total Number of days to install the 1500 S.F.C.A.

\[
\text{Plan Quantities} = 1500 \text{ S.F.C.A.} = 7.89 \text{ days}
\]

\[
\text{Daily output} \quad 190 \text{ S.F.C.A./day}
\]

Activity Relationships
All logic diagrams require you to establish the interrelationship between activities by reading each activity Forward and Backwards to establish the logic network. This requires you to establish the interrelationship between activities using predecessors and successors. They are defined below.

Predecessors are activities that must logically occur before another activity can start.

Successors are activities that must logically occur after another activity is completed.

Precedence Activity Relationships
The Precedence Diagraming method lets you establish a variety of relationships between activities. The Precedence Method allows you to establish these relationships. The Finish to Start relationship is the most common relationship for non-overlapping activities. Other relationships that can help you refine your schedule are the Start to Start and Finish to Finish relationships for overlapping activity relationships. Below is a description of the Finish to Start relationship.

The Finish-to-Start Relationship is the most utilized relationship and the one that is utilized in establishing the initial relationships between activities. Finish-to-Start is a relationship in which the successor activity can only start when the predecessor is finished. In other words, this requires that the following activity (successor), cannot start until the preceding activity (predecessor) is 100 percent complete. In the Example logic network, the Activity 70 cannot start before the Client Review, Activity 10, is complete. In other words, the Design Process Diagram, Activity 70, cannot start until the Client Review, Activity 10, is complete.
Planning & Scheduling Exercise

1. Which of the following is the proper Design Activity Sequence that is used for every design discipline (such as mechanical, electrical and structural) on a Design/Build logic network according to acceptable legal practices.
   - A. Engineer, Design, and Build.
   - B. Design, Procurement, and Construction.
   - D. Obtain Construction Contract, Request Plans, Receive Plans, Award Subcontracts, Procure materials, and Construct activities.

2. Which of the following is the proper Procurement Activity Sequence that is used for every Vendor or Supplier (such as Rebar, Structural Steel and Sheet Metal) on a Design/Build logic network according to acceptable legal practices.
   - B. Order and Deliver Materials, Place Forms, Place Rebar, Pour Concrete, and Strip Forms.
   - C. Award Vendor Contract, Vendor Prepares Shop Drawings, Contractor Reviews Shops, A/E Reviews Shops, Vendor Fabricates and Delivers.

3. Many times the contractor must indicate a sequence of activities as consecutive because of crews or equipment available, What is the term for this sequence called?
   - A. Restraints.
   - B. Total Float.
   - C. Critical Path.
   - D. Project duration.

4. Leadtimes are used to determine the estimated time durations for what type of activities?
   - A. Design Activities.
   - B. Procurement Activities.
   - C. Construction Activities.
   - D. Project Closeout Activities.
Questions 5 and 6 are based on the following information. A list of sequential activities with a Finish to Start relationship and their estimated durations are provided below.

<table>
<thead>
<tr>
<th>ACTIVITY DESCRIPTIONS</th>
<th>DAYS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepare the Reinforced Concrete Schematic drawings</td>
<td>28</td>
</tr>
<tr>
<td>Prepare the Preliminary Plans for the Reinforced Concrete Structure</td>
<td>32</td>
</tr>
<tr>
<td>Develop the Reinforced Concrete Bid and Contract Documents</td>
<td>12</td>
</tr>
<tr>
<td>Issue the Plans for Bidding and A/E Obtains bids</td>
<td>22</td>
</tr>
<tr>
<td>Award Rebar Vendor Contract</td>
<td>7</td>
</tr>
<tr>
<td>Vendor Prepares Rebar Shop Drawings</td>
<td>24</td>
</tr>
<tr>
<td>Contractor Reviews Rebar Shop Drawings</td>
<td>10</td>
</tr>
<tr>
<td>A/E Reviews Rebar Shop Drawings</td>
<td>10</td>
</tr>
<tr>
<td>Vendor Fabricates the Rebar according to Approved Shop Drawings</td>
<td>33</td>
</tr>
<tr>
<td>Deliver the Rebar to the Job Site</td>
<td>6</td>
</tr>
<tr>
<td>Contractor moves the Rebar from the storage area to the Placement Area (Rehandles)</td>
<td>1</td>
</tr>
<tr>
<td>Contractor installs the Rebar for the Footing Columns</td>
<td>3</td>
</tr>
<tr>
<td>Contractor calls for a Footing Inspection and the Inspector Inspects and Approves Rebar</td>
<td>2</td>
</tr>
<tr>
<td>Contractor Pours Concrete for the Columns</td>
<td>1</td>
</tr>
<tr>
<td>Contractor installs the Rebar for the Elevated Slab</td>
<td>6</td>
</tr>
</tbody>
</table>

5. What is the total estimated time in days for the Design of the Rebar?

- A. 60
- B. 94
- C. 184
- D. 197

6. What is the total estimated in days for the Rebar Leadtime?

- A. 90
- B. 94
- C. 103
- D. 197
Planning & Scheduling Exercise

7. How should the nodes on a logic network be numbered?
   - A. Consecutively.
   - B. Separated by a minimum of five numbers.
   - C. The preceding node is greater than the following node.
   - D. The following node is greater than the concurrent node.

8. How is Free float defined?
   - A. The amount of slack in a node.
   - B. The amount of slack within an activity.
   - C. The amount of slack within a path (series) of activities.
   - D. The amount of slack accumulated throughout the logic network.

9. What is the name of the term called for shortening a logic network?
   - A. Crashing.
   - B. Fast tracking.
   - C. Resource Leveling.
   - D. Timed scaled networking.

10. What types of activities are considered first when shortening the length of a project?
    - A. Zero float and least cost.
    - B. Zero float and highest costs.
    - C. Highest floats and least cost.
    - D. High floats and highest costs.

11. What is the primary reason that the courts disfavor a Bar Chart?
    - A. It displays the activities time scaled.
    - B. It does not show the activity descriptions.
    - C. It displays the interrelationship of activities or the float within activities.
    - D. It does not display the interrelationship of activities or the activity floats.
Planning & Scheduling Exercise

12. How is the term fast tracking defined in construction?

   - A. Planning and Scheduling the design
   - B. Overlapping execution of the construction activities.
   - C. Finalizing the design and procurement before construction begins.
   - D. Overlapping execution of the design, procurement and construction.

13. What is the name of the term for shifting the activities within their available free floats in order to produce a uniform workforce and reduce the maximum resource usage requirements?

   - A. Crashing.
   - B. Crew Utilization.
   - C. Resource Leveling.
   - D. Time scaled Networking.

14. What is the best source for developing the activity descriptions for the logic network and schedule?

   - A. General Requirements.
   - B. Technical Specifications.
   - C. Financial Reports and the Balance Sheets.
   - D. Estimate and the Earned Workhour report.

15. How is Total float defined?

   - A. The amount of slack in a node.
   - B. The amount of slack within an activity.
   - C. The amount of slack within a path (series) of activities.
   - D. The amount of slack accumulated throughout the logic network.

16. For a Design-Build Schedule to be admissible evidence in court, it must contain the Design Activity Sequence, Procurement Activity Sequence and the Construction Activity sequence. Which of the following must also be on the preliminary schedule?

   - A. A bar-chart with owner-furnished items and planned weather losses each month
   - B. A time scaled with owner-furnished items and planned weather losses at the end.
   - C. A bar-chart with planned versus as-built activities, sequence changes & all delays.
   - D. A time scaled with owner-furnished items and planned weather losses each month
Planning & Scheduling Exercise

Questions 17 - 20 are based on the following diagram.

A letter has been placed at strategic locations within this diagraming method. Answer the following questions concerning the locations.

17. Using the diagram method above, What detail is displayed at Letter A?
   - ○ A. Late Start.
   - ○ B. Early Start.
   - ○ C. Early Finish.
   - ○ D. Activity Node.

18. Using the diagram method above, What detail is displayed at Letter B?
   - ○ A. Late Start.
   - ○ B. Late Finish.
   - ○ C. Activity Node.
   - ○ D. Activity Duration.

19. Using the diagram method above, What detail is displayed at Letter C?
   - ○ A. Late Start.
   - ○ B. Early Finish.
   - ○ C. Activity Node.
   - ○ D. Activity Duration.

20. Using the diagram method above, What detail is displayed at Letter D?
   - ○ A. Late Start.
   - ○ B. Early Start.
   - ○ C. Late Finish.
   - ○ D. Activity Duration.
Questions 21 - 25 are based on the following diagram.

|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10| 11| 12| 13| 14| 15| 16| 17| 18| 19| 20| 21|
| A |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   | B |
|   |   |   |   |   |   |   |   |   | D |   |   |   |   |   |   |   |   |   |   |   |   |   |   | C |
|   | - | - | - | - | B | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

A letter has been placed at strategic locations within this diagraming method.

21. Using the Diagraming method above, What detail is displayed at letter A?
   - A. Activity Duration.
   - B. Activity Restraint.
   - C. Activity Description.
   - D. Consecutive Activity.

22. Using the Diagraming method above, What detail is displayed at letter C?
   - A. Effective Days.
   - B. Job Description.
   - C. Activity Duration.
   - D. Activity Description.

23. What does the Vertical line with arrowhead at D indicate?
   - A. Float.
   - B. Latest Start.
   - C. Interrelationship.
   - D. Activity Duration.

24. What is this diagraming method called?
   - A. Arrow Diagraming Method.
   - B. Bar Chart Diagraming method.
   - C. Precedence Diagraming Method.
   - D. Time-scaled Diagraming Method.
Planning & Scheduling Exercise

Questions 25 - 27 are based on the following Crew information table.

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>CREW SIZE</th>
<th>DAILY OUTPUT</th>
<th>PLAN QUANTITY</th>
<th>ACTIVITY DURATION</th>
<th>EFFECTIVE DAYS</th>
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<tbody>
<tr>
<td>EXTERIOR MASONRY</td>
<td>6</td>
<td>400 SF</td>
<td>3220 SF</td>
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<tr>
<td>INTERIOR MASONRY</td>
<td>5</td>
<td>750 SF</td>
<td>8952 SF</td>
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<td></td>
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<tr>
<td>BOND BEAM LINTELS</td>
<td>5</td>
<td>280 LF</td>
<td>338 LF</td>
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<tr>
<td>SAWING MASONRY</td>
<td>1</td>
<td>300 LF</td>
<td>2522 LF</td>
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<td></td>
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<tr>
<td>WALL REINFORCING</td>
<td>1</td>
<td>20 CLF</td>
<td>35 CLF</td>
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<td></td>
</tr>
<tr>
<td>WASH INTERIOR WALL</td>
<td>4</td>
<td>4000 SF</td>
<td>8952 SF</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Assume that the interior and the exterior walls both require bond beams lintels, joint reinforcement and sawing of masonry.

25. How many (whole) activity days are needed to complete the Interior Masonry?

○ A. 1
○ B. 8
○ C. 12
○ D. 34

26. Which activities can be going on concurrently?

○ A. Interior Masonry and Wash Interior Walls.
○ B. Exterior Masonry, Bond Beam, SAWING Masonry and Wall Reinforcement.
○ C. Exterior and Interior Masonry, Bond Beams, SAWING Masonry and Reinforcement.
○ D. Exterior and Interior Masonry, Bond Beams, SAWING, Reinforcement and Washing the Interior Walls.

27. How many (whole) effective days to complete this sequence of activities?

○ A. 9
○ B. 15
○ C. 21
○ D. 34
Questions 28 - 31 refer to the John Adams Logic Diagram Exhibit # 1776.

28. What is the total number of days to complete this sequence of activities?
   - A. 13
   - B. 14
   - C. 18
   - D. 31

29. What are the critical activities for this logic network?
   - A. B, G
   - B. A, C, F
   - C. A, D, E, G
   - D. A, C, F, G

30. What is the total float for activity B?
   - A. 0
   - B. 1
   - C. 2
   - D. 8

31. What is the free float between activity C and G?
   - A. 0
   - B. 1
   - C. 10
   - D. 20
Planning & Scheduling Exercise for the John Adams Logic Network

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>NODE</th>
<th>DAYS</th>
<th>EARLY START</th>
<th>EARLY FINISH</th>
<th>LATE START</th>
<th>LATE FINISH</th>
<th>TOTAL FLOAT</th>
<th>FREE FLOAT</th>
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<tr>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>D</td>
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<td></td>
</tr>
</tbody>
</table>

John Adams Logic Network Exhibit # 1776
Planning & Scheduling Exercise

Questions 32 - 35 refer to the George Mason Logic Network Diagram Exhibit # 1777.

32. What is the total number of days to complete this sequence of activities?
   - A. 14
   - B. 15
   - C. 18
   - D. 32

33. What are the critical activities for this logic network?
   - A. R, P
   - B. M, Q, P
   - C. M, O, P, Q
   - D. M, N, O, P, Q

34. What is the total float for activity R?
   - A. 0
   - B. 1
   - C. 2
   - D. 8

35. What is the free float between activity N and 0?
   - A. 0
   - B. 1
   - C. 10
   - D. 20
## Planning & Scheduling Exercise for the George Mason Logic Network

### Activity Table

<table>
<thead>
<tr>
<th>Activity</th>
<th>NODE</th>
<th>DAYS</th>
<th>EARLY START</th>
<th>EARLY FINISH</th>
<th>LATE START</th>
<th>LATE FINISH</th>
<th>TOTAL FLOAT</th>
<th>FREE FLOAT</th>
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<td></td>
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</tbody>
</table>

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403
Planning & Scheduling Exercise

Questions 36 - 40 refer to the George Washington Logic Network Exhibit # 1787.

36. What is the total number of days to complete this sequence of activities?
   - A. 21
   - B. 25
   - C. 37
   - D. 93
   
37. What are the critical activities for this logic network?
   - A. D, J, K.
   - B. A, E, M
   - C. D, G, M.
   - D. D, H, J, K
   
38. What is the total float for Activity C?
   - A. 0
   - B. 15
   - C. 17
   - D. 20
   
39. What is the free float between activity F and K?
   - A. 12
   - B. 16
   - C. 17
   - D. 28

40. Reduce activities A, B, D and G each by two days. What is the length of the project?
   - A. 21
   - B. 29
   - C. 35
   - D. 85

Check Answers

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Planning & Scheduling Exercise for the George Washington Logic
### Planning & Scheduling Exercise Event Times Schedule Tabulation Sheet
for the George Washington Logic Network Exhibit # 1787

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>NODE</th>
<th>DAYS</th>
<th>EARLY START</th>
<th>EARLY FINISH</th>
<th>LATE START</th>
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<th>TOTAL FLOAT</th>
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