Scheduling of Repetitive Projects

Repetitive Projects Scheduling

Linear Projects

- Repetitive uniform of work (multiple houses, ...)
- Geometrically linear (pipeline, highways, ...)
- Some non typical units may exist
- Projects assumed to be comprised of n typical units
- Complex to schedule and monitor
Repetitive Projects Scheduling

**Duration-driven Vs Resource-driven Schedule**

**Duration-driven schedule**
- Basic units: activities, durations, relationships
- Resources are functions of activities durations
- Resources are assumed to be available

**Resource-driven schedule**
- More focus on resources
- Meeting a deadline
- Line of balance (LOB)
- Summary diagrams

**Summary Diagrams**
- Similar activities in all units are summarized in one activity
- Activity duration = duration of single unit x no of units
- To maintain logic: Add S-S relationships and F-F relationships
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Summary Diagrams

Forward path
- \( ES_B = ES_A + \text{Lag}_{SS} \)
- \( EF_B = ES_B + D_B \), or
- \( EF_B = EF_A + \text{Lag}_{FF} \)

Backward path
- \( LF_A = LF_B - \text{Lag}_{FF} \)
- \( LS_A = LF_A - D_A \), or
- \( LS_A = LS_B - \text{Lag}_{SS} \)

3 sequential activities A, B, & C with durations 3, 2, & 2 days

4 similar units

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Summary Diagrams

- 3 sequential activities A, B, & C with durations 3, 2, & 2 days
- 4 similar units
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Summary Diagrams

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Line of Balance (LOB)

- Meet deadline date
- Focus on resources
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Line of Balance (LOB)

How Many Crews Needed to Meet Deadline?

One Activity & 3 Crews

Site

<table>
<thead>
<tr>
<th>Crew 2</th>
<th>Crew 1</th>
<th>Crew 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>2</td>
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<td>2</td>
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<td>1</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Crew 2
Crew 1
Crew 2
Crew 1

Site

0 1 2 3

Time

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Line of Balance (LOB)

Sites

Diff. Durations Parallel Crews Stagg. Crews

9 8 7 6 5 4 3 2 1

Time
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Line of Balance Calculations

- Crew synchronization and work continuity equation
- Computation of project delivery rate to meet a deadline
- Calculating resource needs
- Drawing the LOB schedule
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Line of Balance Calculations (work continuity)

\[ R = \frac{C}{D} \quad \quad C = D \times R \]

\[ R = \frac{1}{(D / C)} \quad \quad C = D \times R \]
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Line of Balance Calculations (Meeting a deadline)

\[ R = \frac{n - 1}{T_L - T_1} \]

\[ R = \frac{n - 1}{T_L - T_1} + TF \]
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Line of Balance Calculations (work continuity)

- Draw the CPM for one unit and determine activities floats; $TF_i$
- Calculate CPM duration for one unit; $T_1$
- Calculate $R_i = \frac{(n-1)}{(T_L - T_1)} + TF_i$
- Calculating Number of crews needed $C_i = R_i \times D_i$
- Calculate actual number of crews $C_{ai} = \text{Round up } C_i$
- Then calculate actual delivery rates $R_{ai} = \frac{C_{ai}}{D_i}$

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Line of Balance Calculations (Example)

- A 5 Kilometer pipeline project
- The activities involved in one Kilometer is given below
- Project deadline 30 days
- Assume 2 days buffer time between activities

<table>
<thead>
<tr>
<th>Activity no.</th>
<th>Activity name</th>
<th>Duration (days)</th>
<th>Preceding activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Locate and clear</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Excavate</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>String pipe</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Lay pipe</td>
<td>4</td>
<td>2, 3</td>
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<tr>
<td>5</td>
<td>Pressure test</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>Backfill</td>
<td>2</td>
<td>5</td>
</tr>
</tbody>
</table>
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Line of Balance Calculations (Example)

\[ T_1 = 19 \text{ days} \]
\[ T_L = 30 \text{ days} \]
\[ N = 5 \text{ units} \]
\[ R_i = \frac{(n-1)}{T_L - T_1 + TF_i} = \frac{4}{11 + TF_i} \]

<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration ( D_i )</th>
<th>Total Float</th>
<th>( R_i )</th>
<th>( C_i = D_i \times R_i )</th>
<th>( C_{\text{round up}} )</th>
<th>( R_{ai} = C_{ai} / D_i )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0.364</td>
<td>0.364</td>
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<td>0.728</td>
<td>1</td>
<td>0.5</td>
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</tbody>
</table>

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Line of Balance Calculations (Example)

Activity 1:
D = 1 day; R = 1 unit/day; Horizontal projection = \( \frac{4}{1} = 4 \)

Activity 2:
D = 3 days; R = 0.667 unit/day; Horizontal projection = \( \frac{4}{0.667} = 6 \)

Activity 3:
D = 1 day; R = 1 unit/day; Horizontal projection = \( \frac{4}{1} = 4 \)

Activity 4:
D = 4 days; R = 0.5 unit/day; Horizontal projection = \( \frac{4}{0.5} = 8 \)

Activity 5:
D = 1 day; R = 1 unit/day; Horizontal projection = \( \frac{4}{1} = 4 \)