05-1 Scheduling a Construction Project

Deterministic approach

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Scheduling > Today Lecture

Deterministic scheduling

Basics of structuring breakdowns of project activities (WBS and CBS)

Principles applying to deterministic scheduling process

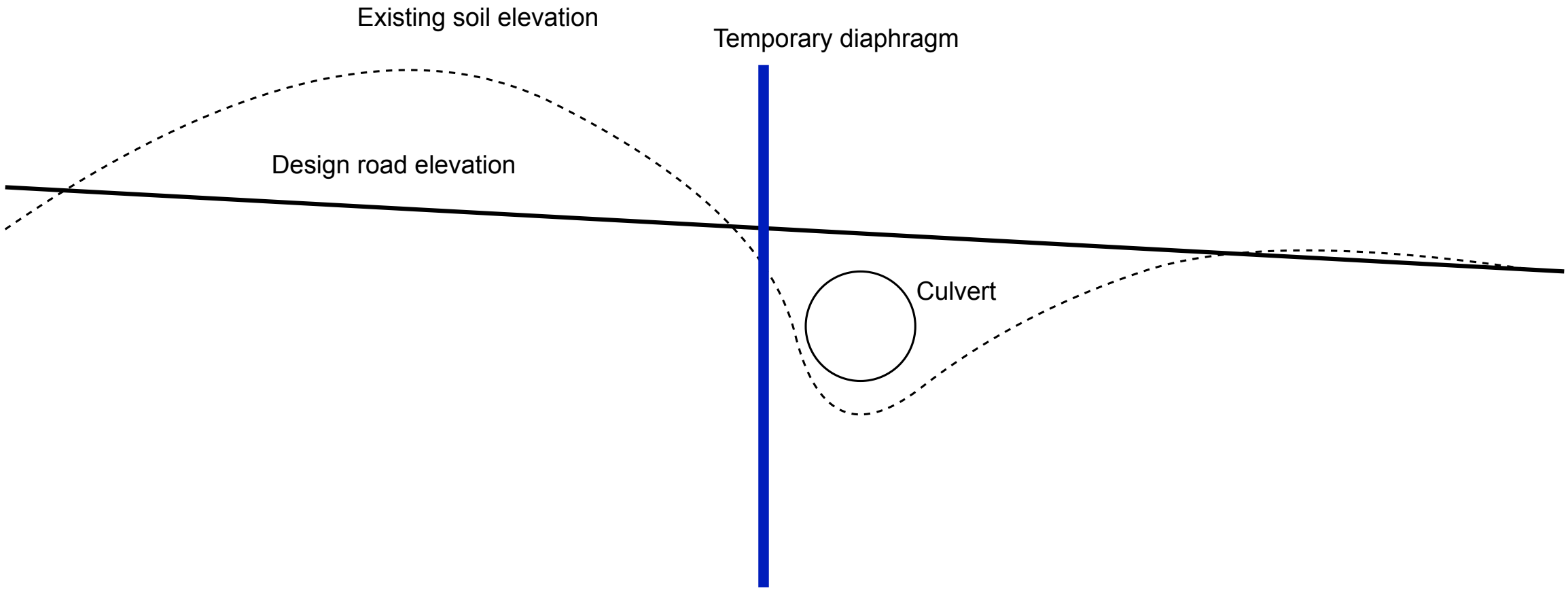
Standard scheduling documents, primary scheduling methods

Scheduling > Organizational Challenge

- The project environment needs a detailed schedule showing the planned start and end times of the project activities to establish the overall project schedule baseline.
- Although there are more simplistic approaches, the Network diagramming technique allows to calculate project timing based on estimated activities durations, resource constraints and sequence of activities.

Network diagramming - Inputs

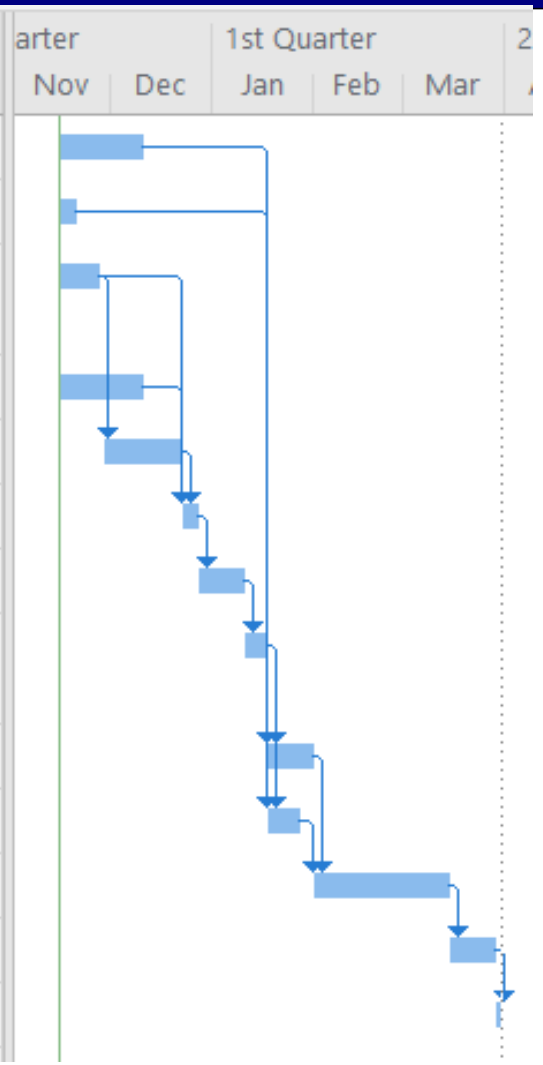
- Clarify the project scope, including objectives, deliverables, requirements and boundaries, by defining the end state of the project. Obtain: **Scope statement, Requirements**
- Provide a hierarchical decomposition framework for presenting the work that needs to be completed, in order to achieve the project objectives. Obtain **WBS**
- WBS can be developed using standardized decomposition logics (see Omniclass in links)


Existing soil elevation
Temporary diaphragm
Design road elevation
Culvert

Network diagramming - Detail the nodes

- Obtain the WBS from Scope group of processes
- Detail activities that are to be implemented in a **monitored way**.
- Assign:
  - estimated deterministic duration
  - estimated costs
  - resources

	Task Mode	Task Name	Duration	Start	Finish	Predecessors
1		WB - Excavation	20 days	11/15/21	12/10/21	
2		EB - Excavation	5 days	11/15/21	11/19/21	
3		Temp. Diaphgram-Contruct	10 days	11/15/21	11/26/21	
5		Culvert - Procure liner	20 days	11/15/21	12/10/21	
4		Culvert - Excavation	18 days	11/29/21	12/22/21	3
6		Culvert - Liner install	3 days	12/23/21	12/27/21	3,4,5
9		Culvert - Selected b/fill	10 days	12/28/21	1/10/22	6
10		Temp. Diaphgram-Remove	5 days	1/11/22	1/17/22	9
7		WB - Structure	10 days	1/18/22	1/31/22	10,1
8		EB - Structure	8 days	1/18/22	1/27/22	10,2
11		Paving	30 days	2/1/22	3/14/22	7,8
12		Barriers and kerbs	10 days	3/15/22	3/28/22	11
13		Signals	2 days	3/29/22	3/30/22	12

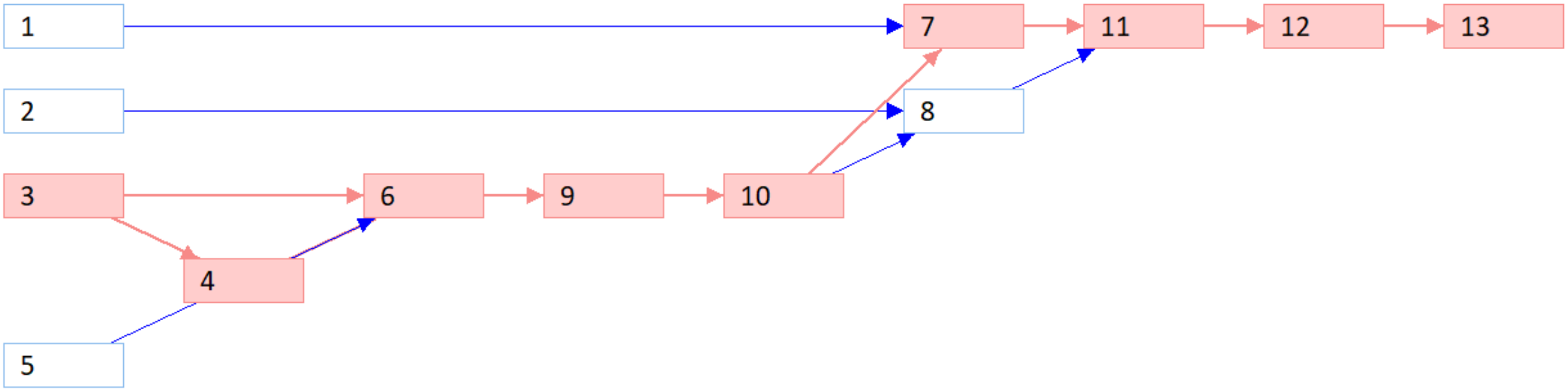


Network diagramming - Detail the links

- Establish the logical and objective system of relationships (precedences and dependencies) between activities.
- Type of relationships:
  - End - Start
  - Start - Start
  - End - End
- It is also possible to assign lags and overlaps, using the Precedence Diagramming Method. However this makes the network model improperly formed

Network diagramming - CPM: solve the Network

- Once we have defined the network nodes and links we can fully calculate the key time metrics required to manage a time schedule:
- Early start and end: the earliest dates an activity can start and therefore end
- Late start and end: the latest dates an activity can start and therefore end **without delaying the project**
- The floats (or slacks im MsProject's parlance) as the difference between late minus early set of dates.
- It represents the freedom we have in moving in time our activities, tuning start, duration and therefore end to suit various project requirements.


1
2
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7
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9
10
11
12
13

	Task Name	Duration	Predecessors	Early Start	Early Finish	Late Start	Late Finish	Free Slack	Total Slack
1	WB - Excavation	20 days		11/15/21	12/10/21	12/21/21	1/17/22	26 days	26 days
2	EB - Excavation	5 days		11/15/21	11/19/21	1/13/22	1/19/22	41 days	43 days
3	Temp. Diaphgram- Contruct	10 days		11/15/21	11/26/21	11/15/21	11/26/21	0 days	0 days
4	Culvert - Excavation	18 days	3	11/29/21	12/22/21	11/29/21	12/22/21	0 days	0 days
5	Culvert - Procure liner	20 days		11/15/21	12/10/21	11/25/21	12/22/21	8 days	8 days
6	Culvert - Liner install	3 days	3,4,5	12/23/21	12/27/21	12/23/21	12/27/21	0 days	0 days
7	WB - Structure	10 days	10,1	1/18/22	1/31/22	1/18/22	1/31/22	0 days	0 days
8	EB - Structure	8 days	10,2	1/18/22	1/27/22	1/20/22	1/31/22	2 days	2 days
9	Culvert - Selected b/fill	10 days	6	12/28/21	1/10/22	12/28/21	1/10/22	0 days	0 days
10	Temp. Diaphgram- Remove	5 days	9	1/11/22	1/17/22	1/11/22	1/17/22	0 days	0 days
11	Paving	30 days	7,8	2/1/22	3/14/22	2/1/22	3/14/22	0 days	0 days
12	Barriers and kerbs	10 days	11	3/15/22	3/28/22	3/15/22	3/28/22	0 days	0 days
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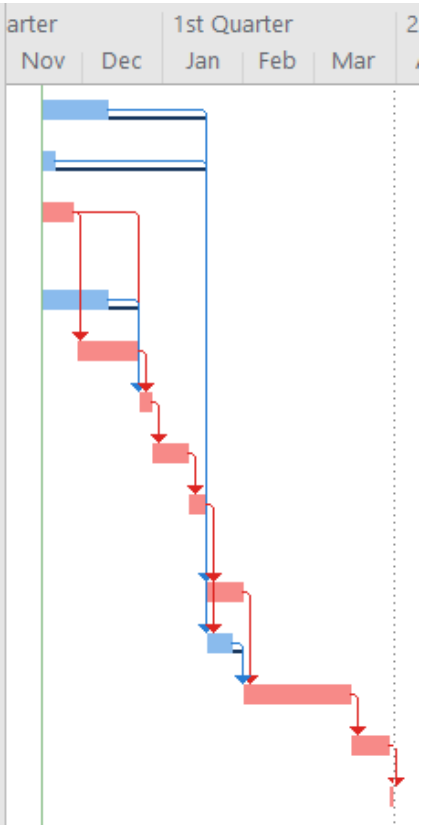

Network diagramming > CPM: the Algorithm

Using a scheduling system the CPM algorithm is transparent to the user.

See this video for details https://youtu.be/-TDh-5n90vk

Network diagramming > Critical path

The Critical Path(CP) and it is the longest of all paths in the network system.

In all network based project there at least one Critical Path, that has no slack: the activities in this path must be completed on time, otherwise the entire project will be delayed.

Network diagramming > Managing paths

Network diagramming allows to see project timing according to all the possible paths leading from project's start to end.

Each path possesses a total float, the sum of path's activities float.

While the the Critical path is the longest at planning time, project uncertainty may lead to changes in durations. Implementing new durations in the CPM algorithm may yield different paths.

Network diagramming > Indexing paths

Path priority index

$$\lambda_{path} = \frac{\alpha_2 - \beta}{\alpha_2 - \alpha_1}$$

$$\alpha_1 : min(slack_{paths}) = 0$$

$$\alpha_2 : Max(slack_{paths})$$

$$\beta : slack_{path}$$

In this way, we can classify all paths and pay attention as λ is high

Network diagramming > Reading

A. De Marco, Project Management for Facility Constructions, Second Edi. Springer International Publishing, 2018:

§ 7.3 Scheduling systems, 7.4 Critical Path Method