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ENGINEERING MANAGEMENT

(GE 404)

LECTURE #4

Scheduling and Bar Chart

Contents

- Objectives of the present lecture
- Planning and Scheduling
- Activity and Event
- Scheduling Techniques
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Objectives of the Present lecture

- *To provide an overview of scheduling*
- *To discuss how to draw bar chart*
- *To discuss advantages and shortcomings of bar charts*

Planning and Scheduling

- Planning is the process of thinking systematically about the future in order to decide what our goals are, and how we are going to achieve them.
- Scheduling is the process showing relationship of activities and determining of the project duration time and the project activities starting and finishing timings.

Planning versus Scheduling

Planning	Scheduling
• Planning can be thought of as determining "what" is going to be done, including "how", "where," and by "whom." • The majority of the work associated with defining *how the project effort will proceed called "planning"*	• In scheduling, this information is needed in order to determine "when". • Scheduling consists of determining the time needed for each of the planned tasks and the overall length of the project schedule.

Purpose of Scheduling

- Ensure that all activities are planned
- Their order of performance is accounted for
- The activity time estimates are recorded
- The overall project time is developed

What we consider in Scheduling

- How long the project is expected to take?
- When each activity should be started and ended?
- How resources can be used properly?
- What are the critical bottlenecks in the project?

Project Scheduling Principles

- Project scheduling is carried out before a project begins
  - It involves (1) identifying tasks, (2) estimating duration and (3) allocating resources
- Once the project is underway, the schedule may need to be revised based on initial progress
- The revision is done by creating milestones
  - This ensures (1) cost estimates and (2) time constraints are maintained at a specific level of quality and scope

Activity and Event

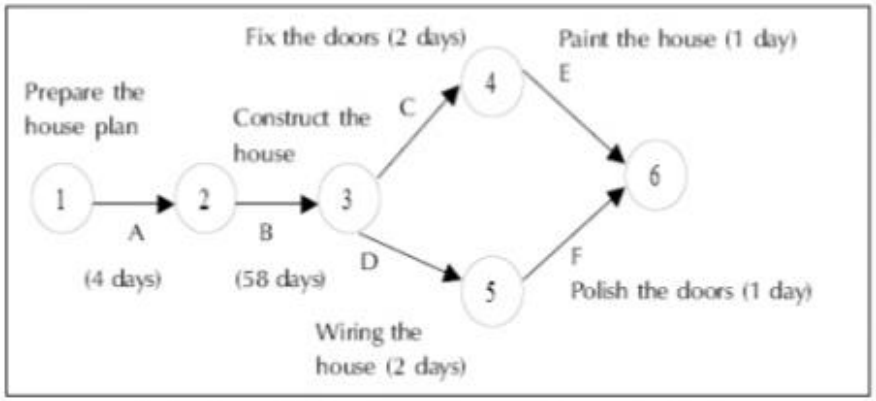
- *Activity* is a single work step (element) that has a recognizable beginning and end and requires time and resource for its accomplishment.
- An *Event* marks the point in time when an activity completes.

Note: Activity is often used as an alternative term for task.

Sequence of Activities for House construction project (Network diagram)

Name of the activity	Starting and finishing event	Description of activity	Predecessor	Time duration (days)
A	(1,2)	Prepare the house plan	--	4
B	(2,3)	Construct the house	A	58
C	(3,4)	Fix the door / windows	B	2
D	(3,5)	Wiring the house	B	2
E	(4,6)	Paint the house	C	1
F	(5,6)	Polish the doors / windows	D	1

Solution:



Note

- Predecessor activities mean coming before
- Successor activities mean coming after
- The *duration* of an activity is the time that will be consumed in completing a task
- Overlap the activities to reduce the project time

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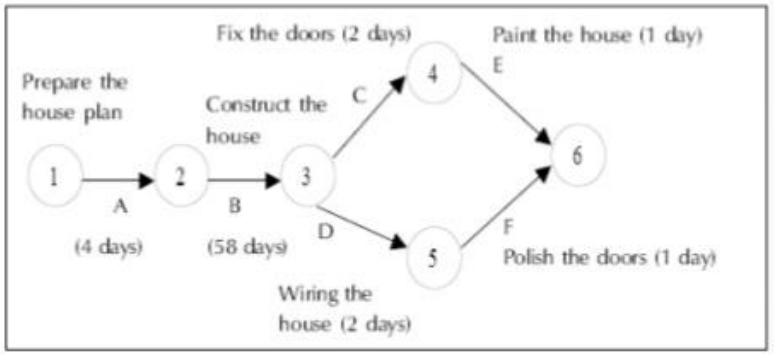


Activity Duration

- One of the following tools and techniques can be used for estimating the activity duration:
  - **Expert judgment**
  - **Quantitative calculations**
    - ***Duration of activity (D) = Quantity of work / [Production rate of a crew or equipment ×No. of crews]***

      Where production rate = Quantity produced in unit of time
    - ***Duration of activity (D) = Quantity of work × Unit rate productivity of a crew or equipment***

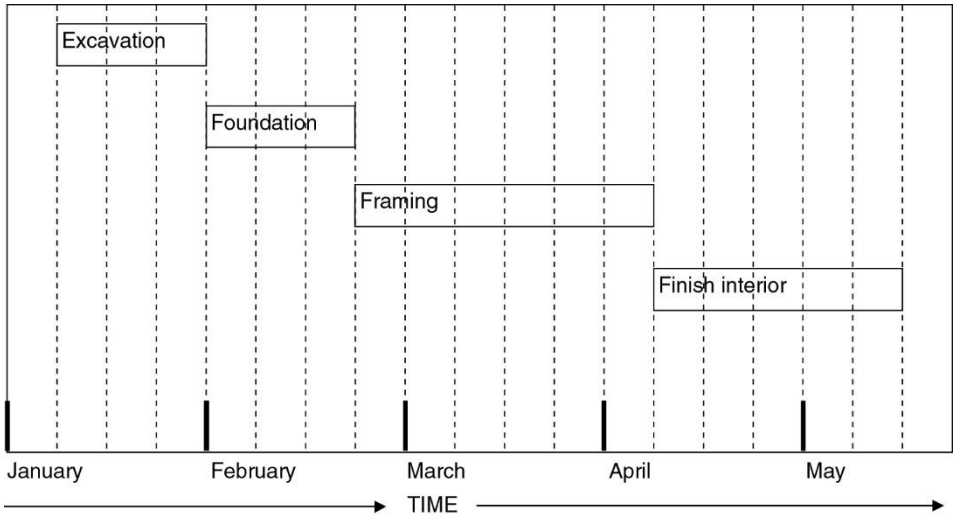
      Where unit rate productivity = Time needs to produce one unit of output
- Time unit (days, weeks etc.) is employed to specify activity duration.

Scheduling Techniques

- **Bar Charts and Linked Bar Charts**
- **Network Model (Analysis)**
  - **Activity on arrow (AOA)**
  - **Activity on node (AON)**
  - **Precedence Diagram**
- **Line of Balance**
- **Time-location Diagram**

Bar Charts

- **Henry Gantt** developed a method of relating a list of activities to a timescale in a very effective manner, by drawing bar charts.
- Activities are presented as bars on the chart, while across the top or bottom of the chart is a time line.
- For each activity, a bar is drawn from the activity's starting time until its ending time.
- Its primary advantage is that its simple graphic representation allows one to grasp schedule information quickly and easily.
- Bar charts are the most commonly employed and readily recognized scheduling models in use today.

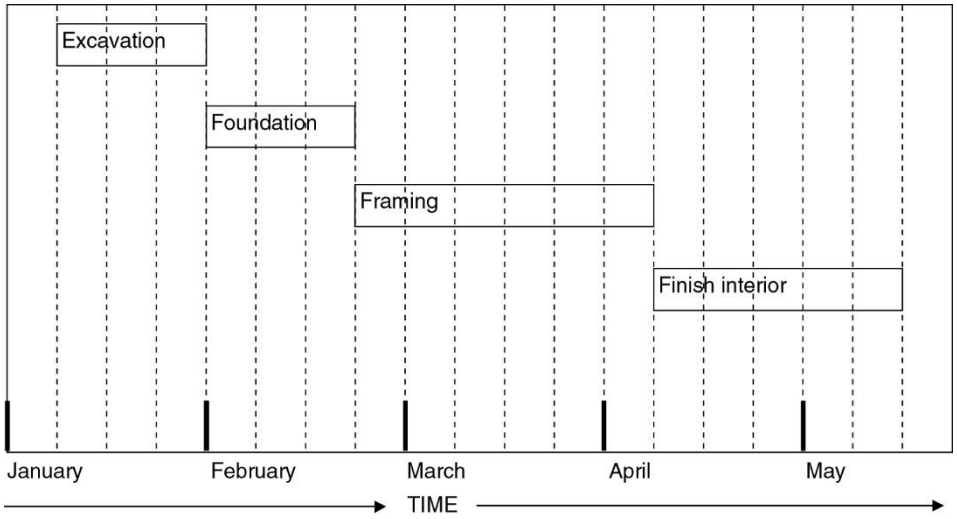


Bar chart showing General Construction Work Tasks

The activity sequencing is for an apartment, and one can easily see when each activity is to begin and when is to be completed.

Bar Charts (Contd.)

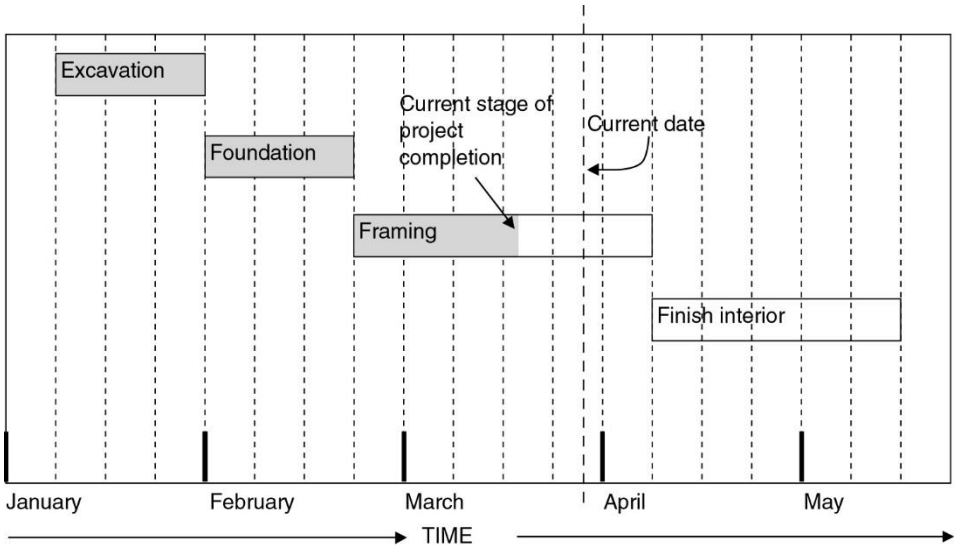
- This simple example shows at a glance how the different activities relate to each other.
- Note that the activities are time scaled and have been superimposed over a calendar.
- With the timescale presentation, a bar chart shows operations and the time consumed by each operation.



Bar chart showing General Construction Work Tasks

Use of Bar Chart in showing Scheduled versus Actual Progress

- Bar Chart can also show the scheduled versus actual progress.
- The heavy-dashed vertical line represents the current date, and the shaded portions of the activities indicate the amount of work that has been completed by the current date.
- It is obvious that the project is slightly behind schedule.
- The progress on the framing activity has not met expectations.
- It is evident that the project can be completed on time by accelerating the work effort on framing, finishing interiors, or both.
- This information is easy to grasp from this bar chart, and there is little chance of misinterpretation.



Bar chart showing scheduled versus actual performance

Adjustments to the schedule may be warranted if the delay in project completion(about 1 week) is not acceptable.

Uses of Bar Chart

- Showing the order of the different activities
- Showing when operations should start and finish
- Checking what labor or equipment are needed and when
- Checking out delivery dates for materials
- Explaining to everyone concerned what and when is due to happen
- Forecasting cash flow
- During execution, the chart can be used to control the work

Advantages of Bar Chart

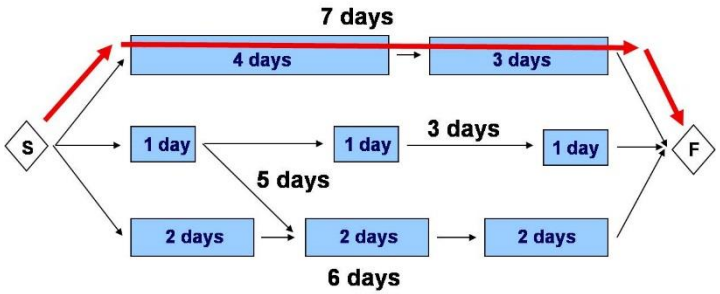
- A major strength of bar charts is the ability to clearly and quickly present the status of a project
- No extensive training is required to learn how to extract information from them

Shortcoming of Bar Charts

- Very cumbersome as the number of activities, increases
- Difficult to use for forecasting the effects of changes
- No indication where management attention should be focused
- Ineffective for project shortening

Critical Path and Critical Activity

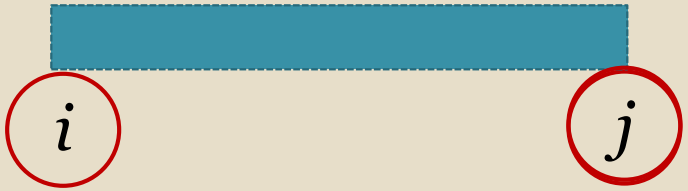
- Critical Path
  - Longest sequence of activities which must be completed on time for the project to complete on due date
- **Critical Activity**
  - A critical activity is any activity that is on the critical path. If there is a delay in any of these activities then the whole project will be delayed



- Note: *An activity on the critical path cannot be started until its predecessor activity is complete; if it is delayed for a day the entire project will be delayed for a day unless the activity following the delayed activity is completed a day earlier.*

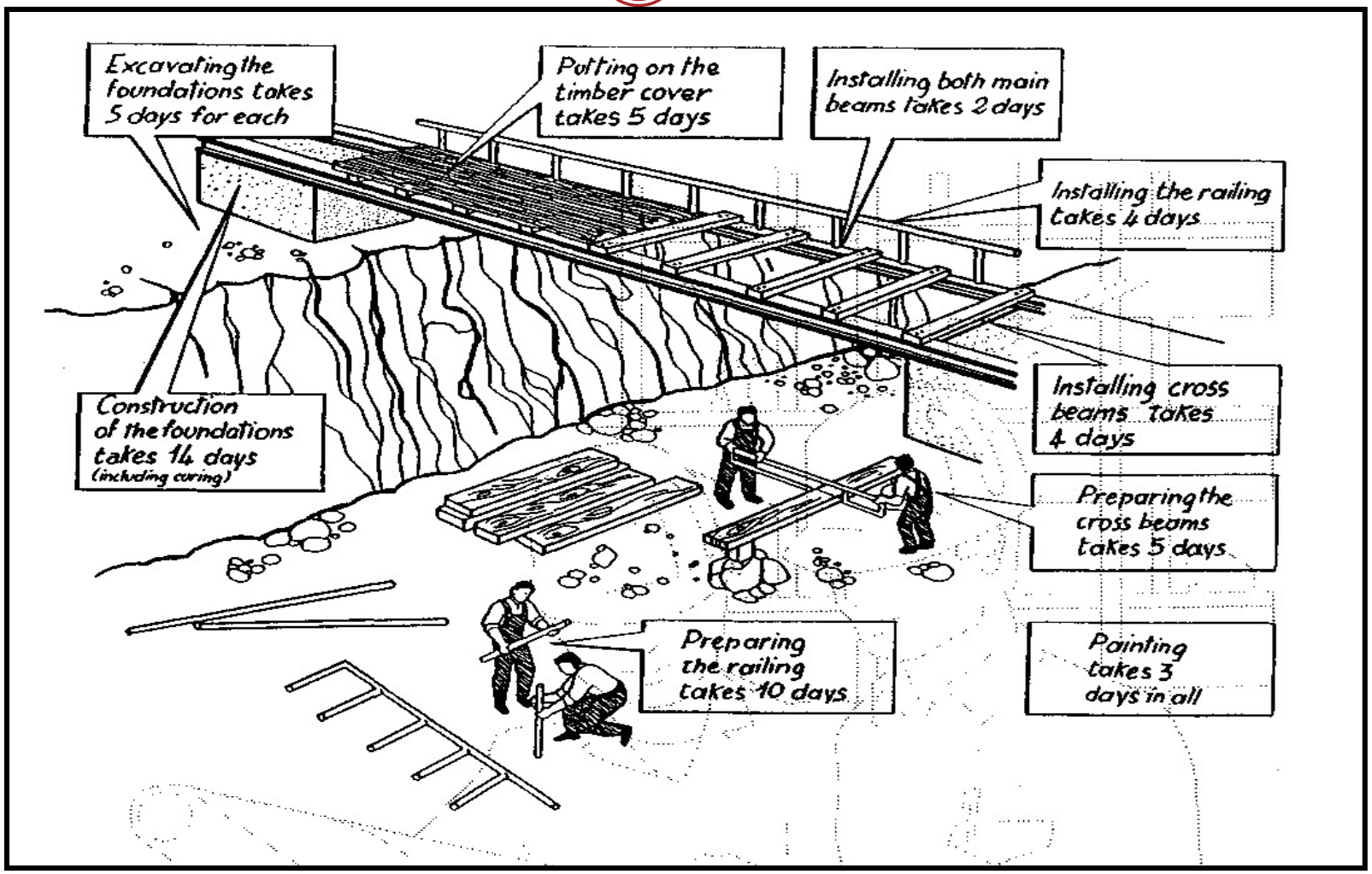
How to identify critical path in a bar chart

- Start with the last activity
- Draw a vertical line from the i^{th} node of the last activity

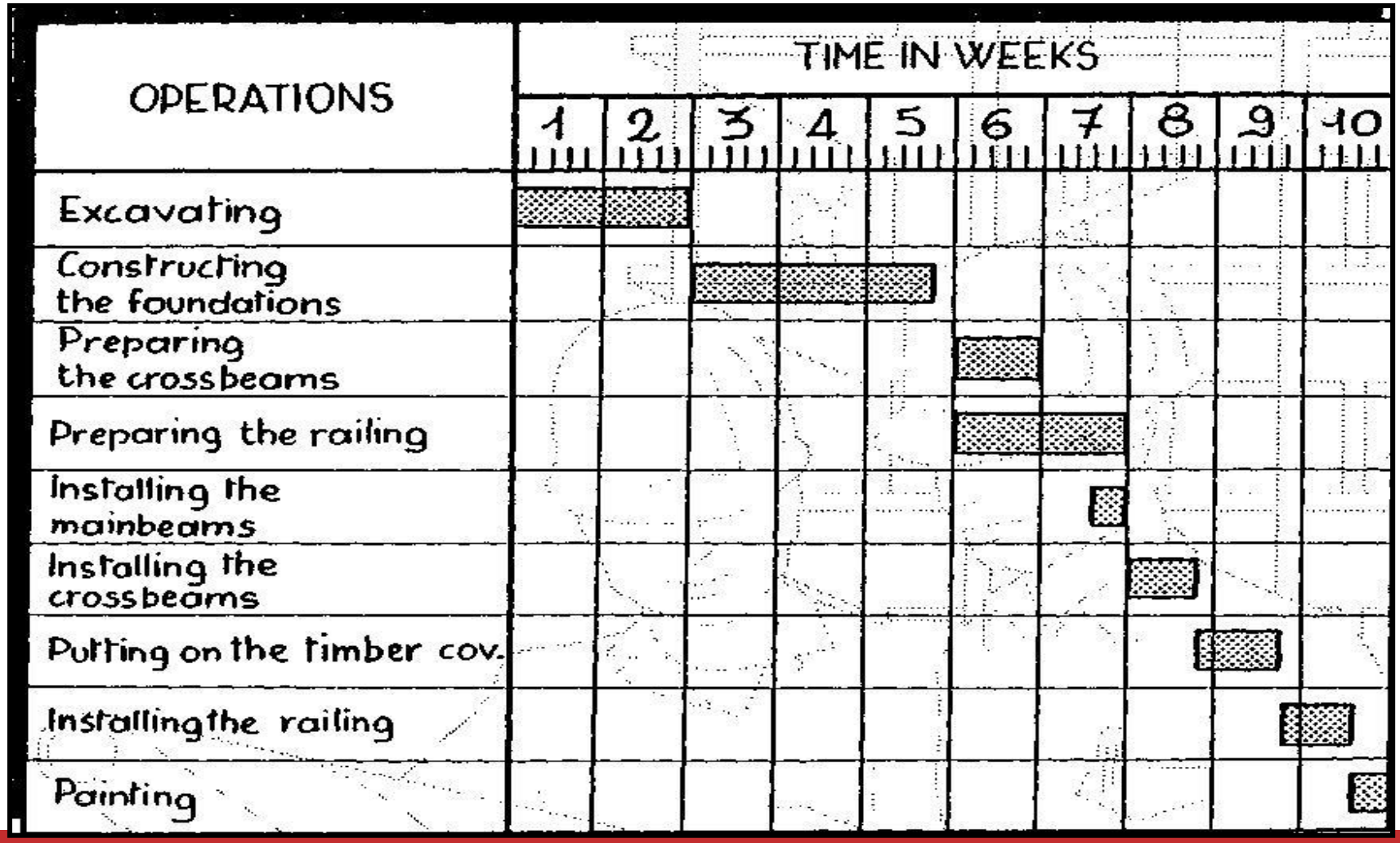


- The activities whose *j* nodes touch the vertical line, are *potential* critical activity
- Proceed in this manner until you reach time 0

Bar Chart for Building a Bridge



Bar Chart


OPERATIONS
TIME IN WEEKS
1
2
3
4
5
6
7
8
9
10
Excavating
Constructing the foundations
Preparing the crossbeams
Preparing the railing
Installing the mainbeams
Installing the crossbeams
Putting on the timber cov.
Installing the railing
Painting

Problem-1

Draw Gantt bar chart for a small Engineering project listed below and find

(a) Total duration of the project

(b) Critical activities

Activity	Depends on	Time (Weeks)
A	None	4
B	A	6
C	B	7
D	C	3
E	None	3
F	A, E	4

Solution

Activity	Depends on	Time (Weeks)
A	None	4
B	A	6
C	B	7
D	C	3
E	None	3
F	A, E	4

Activity	Duration (Wks)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
A	4																					
B	6																					
C	7																					
D	3																					
E	3																					
F	4																					

Project Duration = 20 weeks *Ans.*

Critical Activities = A, B, C, and D. *Ans.*

Problem-2

For the following project draw Gantt bar chart if the project starts on ***Monday*** 15/6/2015. Identify the critical activities and find the total duration of the project in terms of number of (i) working days; and (ii) Calendar days. Consider that workdays are six days a week (Saturday – Thursday).

Activity	Depends on	Time (days)
A	None	2
B	A	3
C	None	3
D	B,C	2
E	C	1
F	E,B	3

Solution

Activity	Depends on	Time (days)
A	None	2
B	A	3
C	None	3
D	B,C	2
E	C	1
F	E,B	3

Act.	Dur.	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI
A	2														
B	3														
C	3														
D	2														
E	1														
F	3														

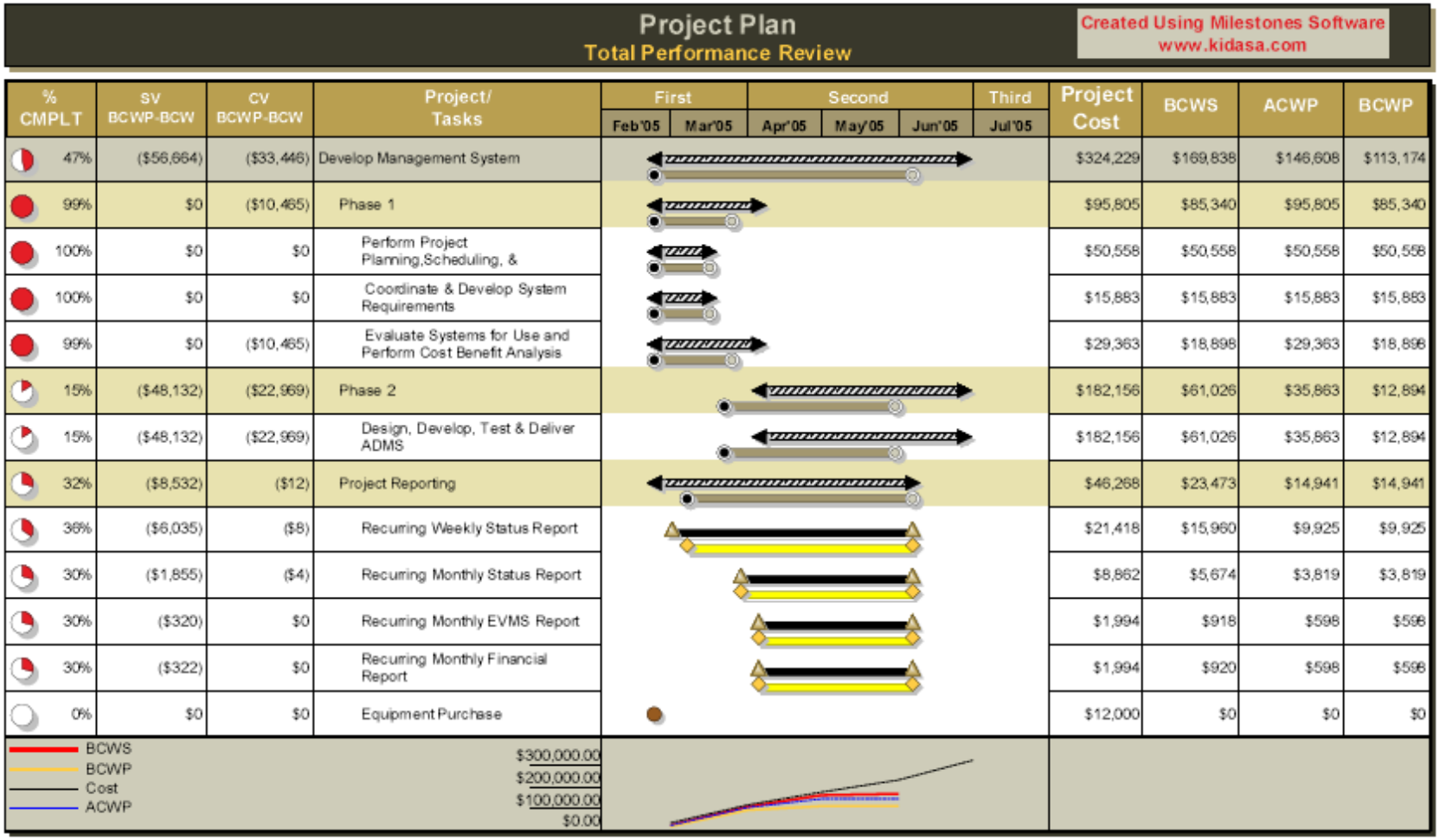
Project Duration:

Calendar days = 9 *Ans.*

Working days = 8 *Ans.*

Critical Activities: A, B and F. *Ans.*

Software generated bar charts



% CMPLT	SV BCWP-BCW	CV BCWP-BCW	Project/ Tasks	Project Cost	BCWS	ACWP	BCWP
47%	($56,664)	($33,446)	Develop Management System	$324,229	$169,838	$146,608	$113,174
99%	$0	($10,465)	Phase 1	$95,805	$85,340	$95,805	$85,340
100%	$0	$0	Perform Project Planning,Scheduling, &	$50,558	$50,558	$50,558	$50,558
100%	$0	$0	Coordinate & Develop System Requirements	$15,883	$15,883	$15,883	$15,883
99%	$0	($10,465)	Evaluate Systems for Use and Perform Cost Benefit Analysis	$29,363	$18,898	$29,363	$18,898
15%	($48,132)	($22,969)	Phase 2	$182,156	$61,026	$35,863	$12,894
15%	($48,132)	($22,969)	Design, Develop, Test & Deliver ADMS	$182,156	$61,026	$35,863	$12,894
32%	($8,532)	($12)	Project Reporting	$46,268	$23,473	$14,941	$14,941
36%	($6,035)	($8)	Recurring Weekly Status Report	$21,418	$15,960	$9,925	$9,925
30%	($1,855)	($4)	Recurring Monthly Status Report	$8,862	$5,674	$3,819	$3,819
30%	($320)	$0	Recurring Monthly EVMS Report	$1,994	$918	$598	$598
30%	($322)	$0	Recurring Monthly Financial Report	$1,994	$920	$598	$598
0%	$0	$0	Equipment Purchase	$12,000	$0	$0	$0

Further Reading

Read more about the scheduling and bar charts from

Jimmie W. Hinze. “Construction Planning and Management,” Fourth Edition, 2012, Pearson.

Thank You

Questions Please