Chapter Sixteen

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Arrow Diagrams

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Introduction

- Arrow diagrams will be encountered and it is in those situation that understanding of arrow diagrams can be valuable.
- Arrow diagrams were widely in the construction industry in 1960s and 1970s their use has steadily declined since that time .

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Arrow Diagrams

- The traditional form of arrow diagram is also called an activity on arrow (A-on-A) network .
- Arrow diagram consist of two basic elements event and activates that are denoted by nodes and arrows , respectively .
- Nodes , termed events , are typically drawn as small circles oval or rectangles and represent a point in time an arrow diagram ..

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Arrow Diagrams (Cont.)

They are used to signify the start and completion .

- the tail of the arrow represents the starting point of the activity and the head of the arrow represents its finish.

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Arrow Diagrams (Cont.)

- In the arrow diagram the relationships between events and activates illustrate the logic of the process used to complete the project . Each activity occurs between two events namely the start and finish times for the activity , as soon as the beginning event (i node) is reached ,the activity can begin , its end event (j node) cannot occur until the activity has been completed .

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Activity relationships

- Several basic types of relations are found in arrow diagrams figure 1 illustrates the most simple and basic relationship that can exist between two activities .
- In this example activity B cannot begin until activity A has been completed .
- In figure 2 illustrates an example in which three activities are dependent on the completion of a single preceding activity .

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Activity relationships (Cont.)

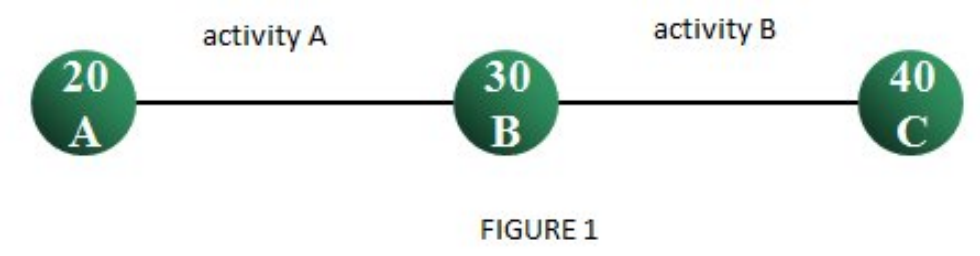
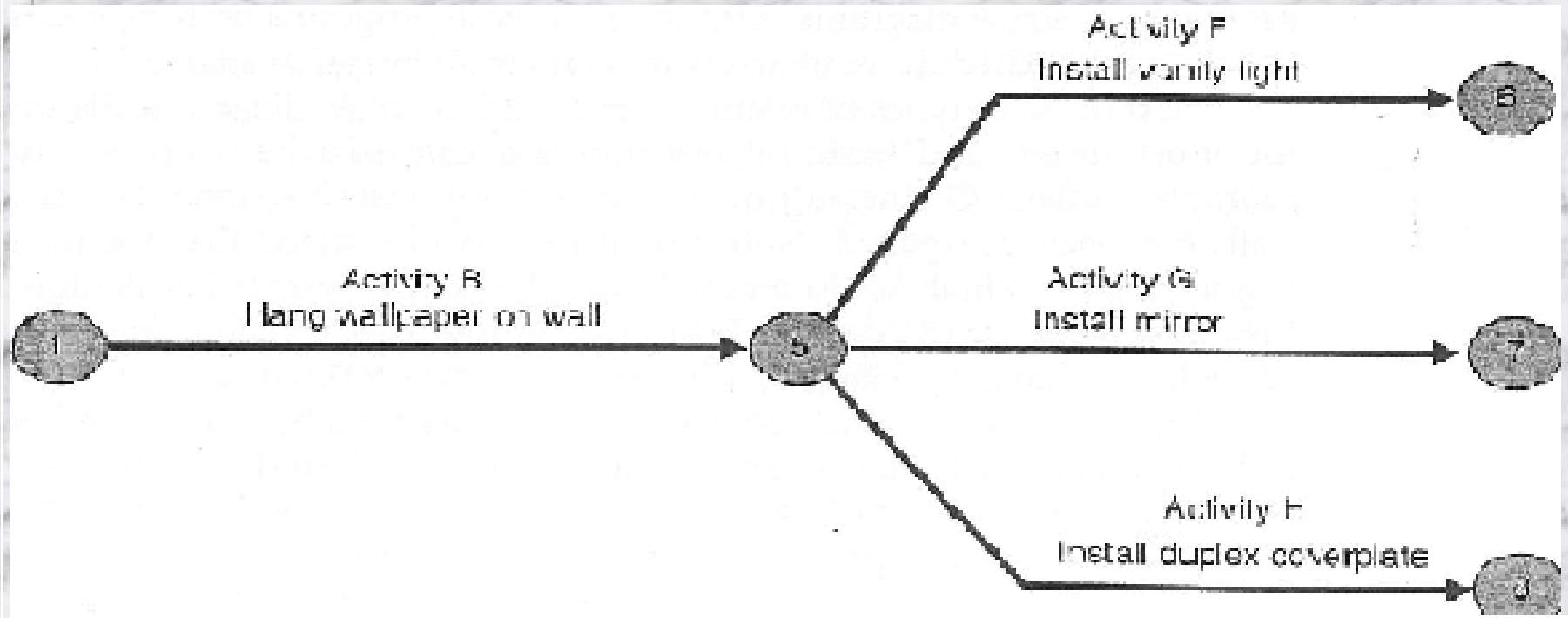


FIGURE 1



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The i-j Notation Of Activities

- As mentioned earlier , arrow or activities are frequently designated by their starting and ending nodes commonly referred to as their “i” and “j” nodes . Activity are then often identified by the numbers of the two events or nodes that precede and follow them .

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The i-j Notation Of Activities (Cont.)

Node numbering should be done systematically following such guides as :

- Make each activity's i node smaller than its j node.
- Leave gaps in numbers to allow for future network changes and additions (e.g. : 5,10,15,20 …)
- Make each activity's i-j node combination unique , See figure 3 .

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The i-j Notation Of Activities (Cont.)

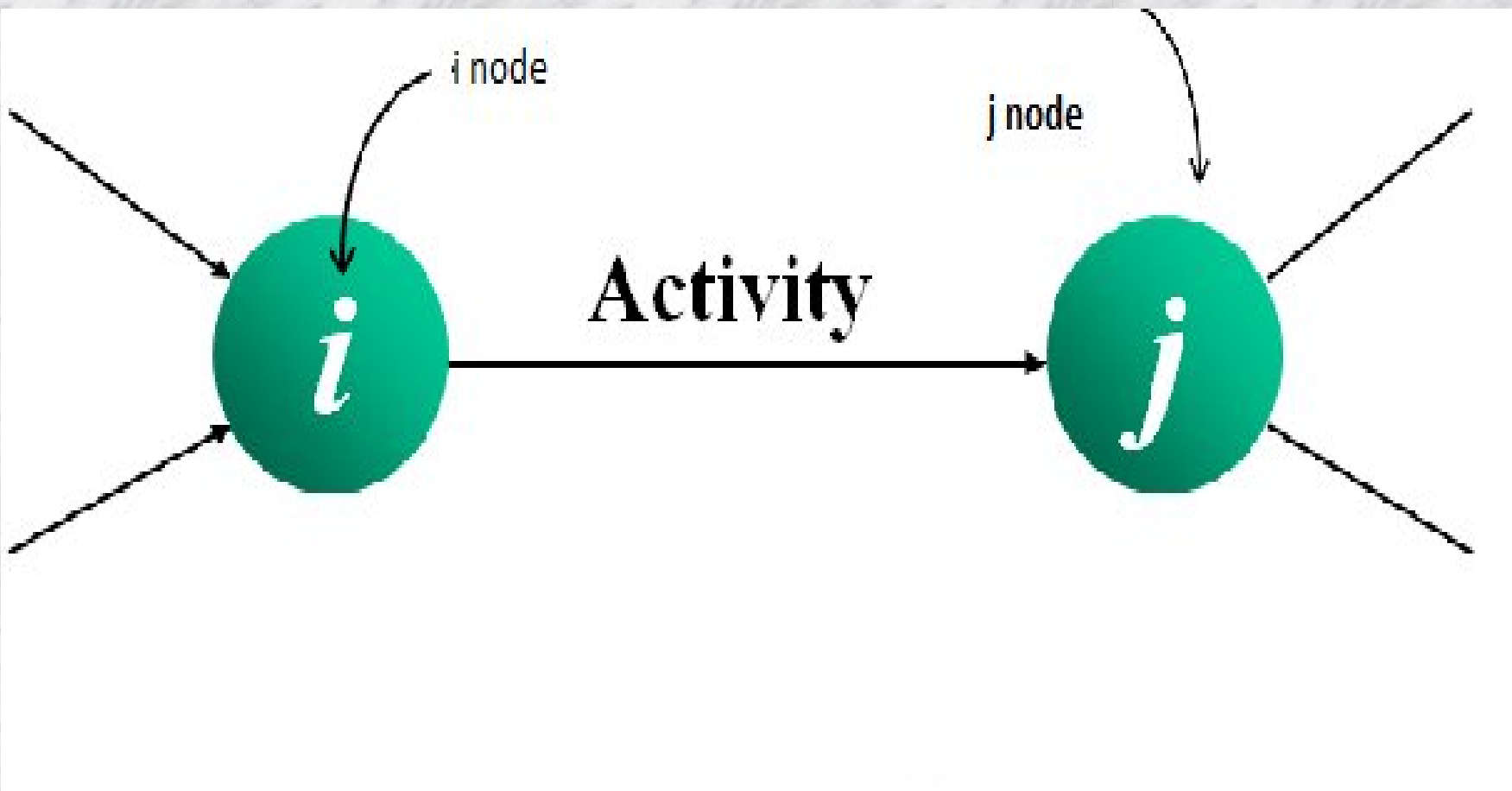

Figure 3

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Dummies

- A dummy is treated as an activity (normally drawn as a dotted line) but it is assigned no duration , meaning it does not consume time or any other resources , it may be necessary to include in the diagram.

Dummy may be used to ensure unique i-j node numbering for all activities , permit proper logic (activity ordering) to be displayed , or , in rare cases , serve a beginning or ending activity for the network .

- In figure 4 the dummy is required to avoid having two activities with the same i-j of 10-15 designation

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Dummies (Cont.)

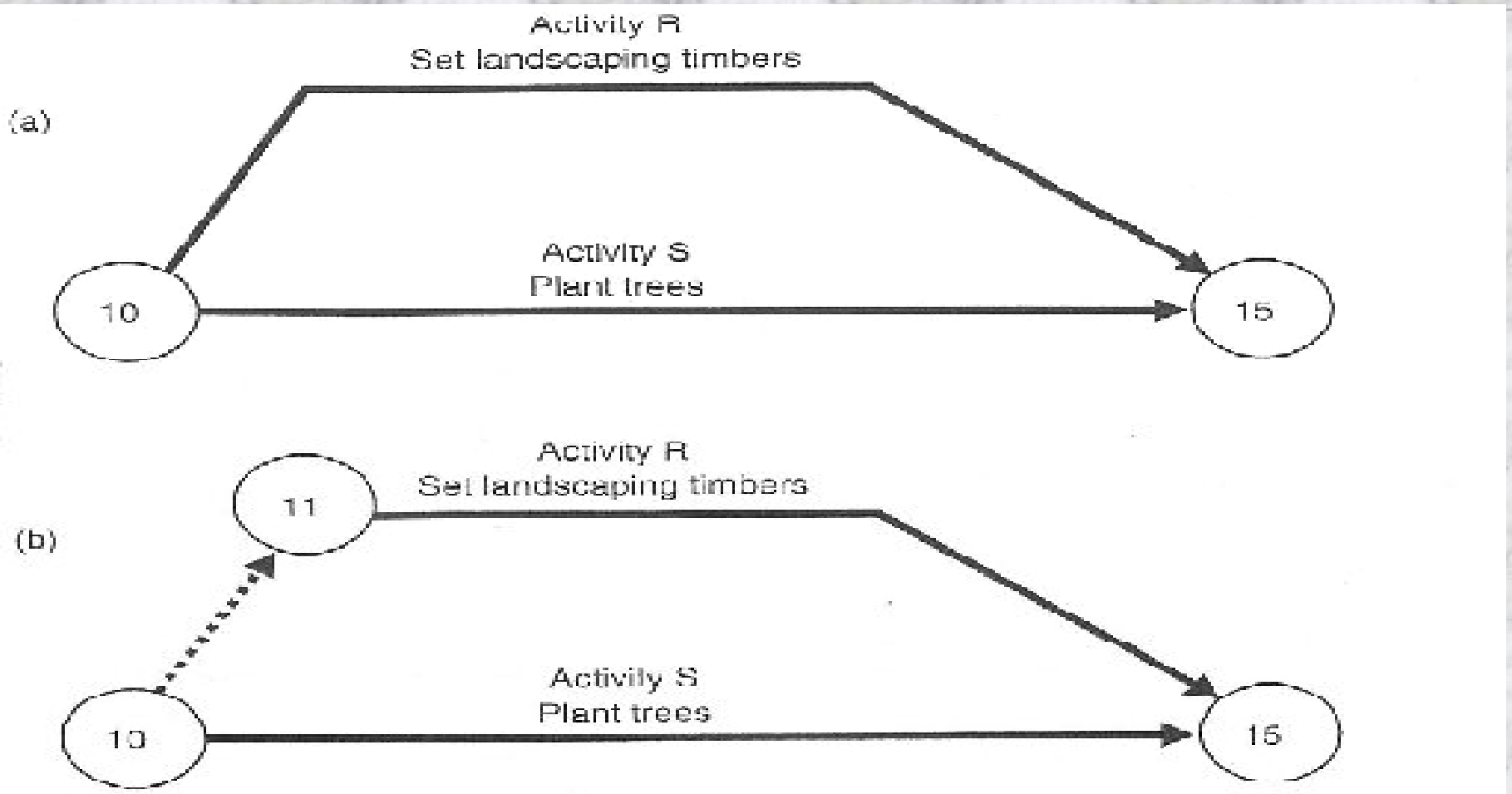

Figure 4 Unique Activity Designation Through the Use of a Dummy

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Dummies (Cont.)

- One must understand the use of dummies to become an accomplished scheduler with arrow diagram . As with arrow diagrams an activity cannot begin until the immediately preceding event has been reached .

- Figure 5 include scenarios designed to help explain this fundamental issue , especially as it relates to the use of dummies .

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Dummies (Cont.)

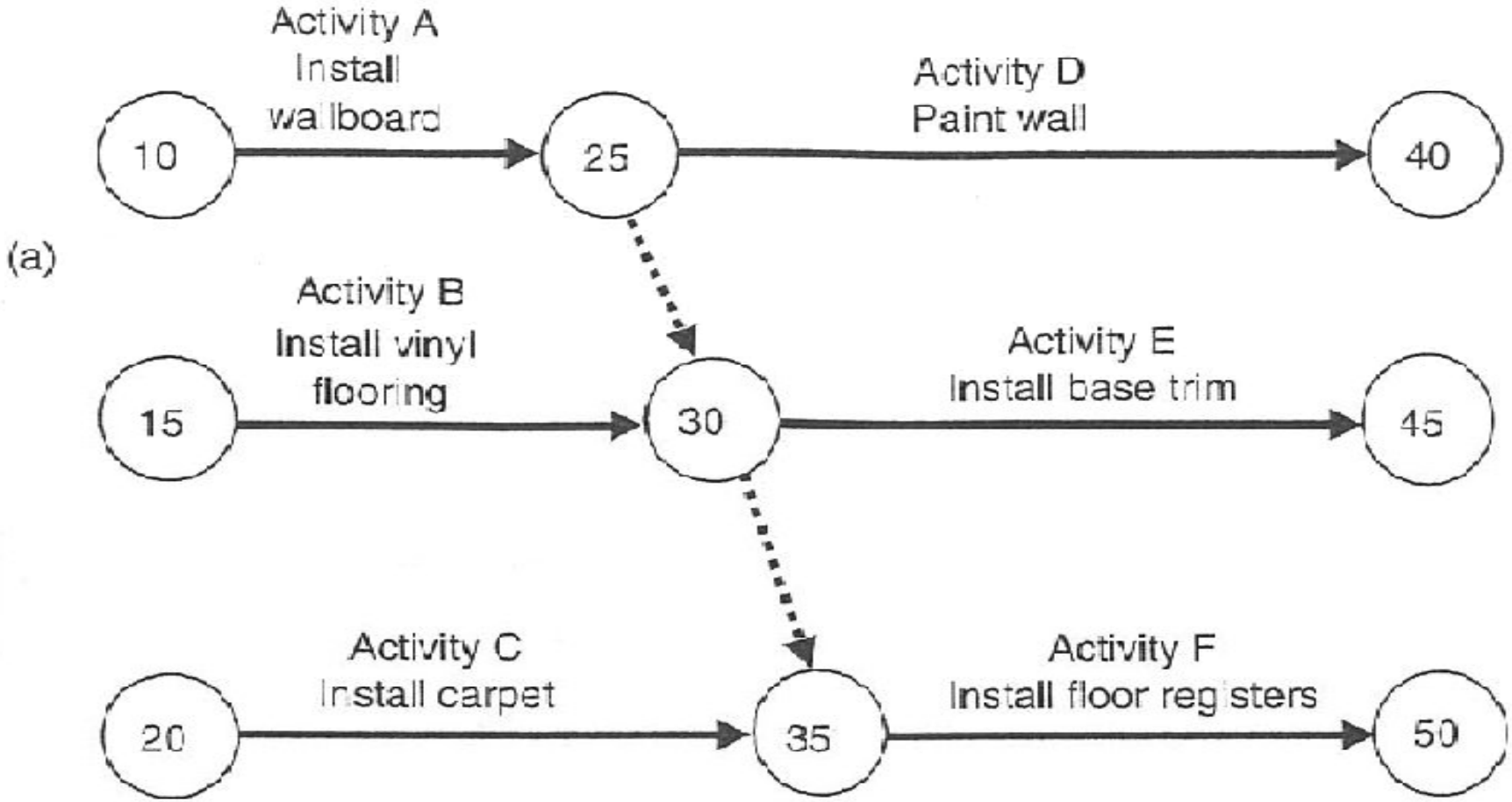

figure 5 a

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Dummies (Cont.)

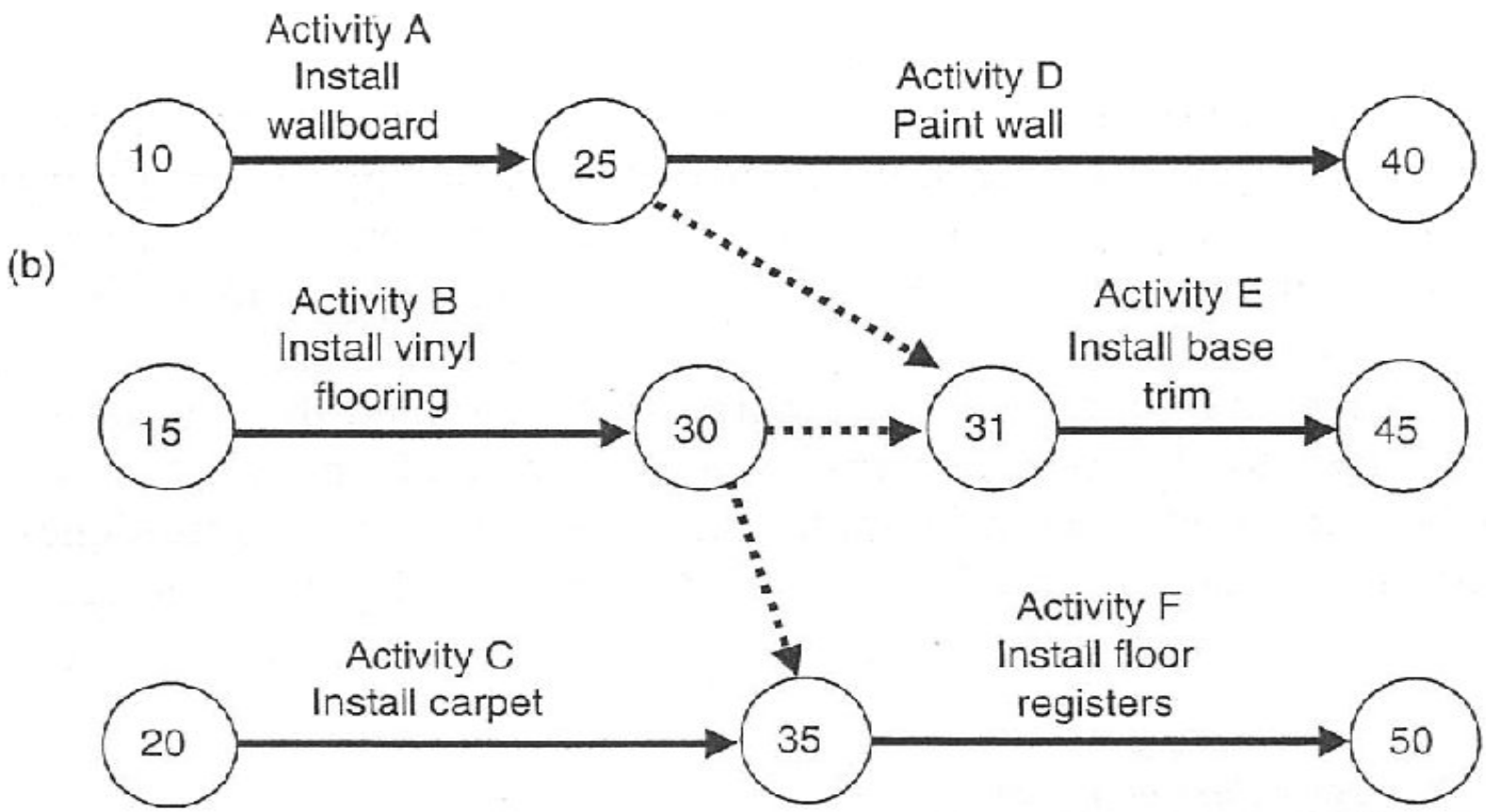

figure 5 b

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Dummies (Cont.)

- Other uses of dummies are to establish a single starting activity and a single end activity for project network .

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Calculations

Four time values associated with each activity:

1. ESD Early Start Date
2. EFD Early Finish Date
3. LSD Late Start Date
4. LFD Late Finish Date

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Calculations (Cont.)

- The initial project event is assumed to occur at time zero
- All activities are assumed to start as soon as possible, that is , as soon as all the predecessor activities are completed.
- The early finish time of an activity is merely the sum of its early start date and the estimated activity duration.

$EFD_{ij} = ESD_{ij} + T_{ij}$

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Calculations (Cont.)

- The late start date LSD_{ij} is found by subtracting the activity duration T_{ij} from the late finish date LFD_{ij}

$$LSD_{ij} = LFD_{ij} - T_{ij}$$

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Scheduler Floats

- Every project has several types of floats, these types are:

1. Total float: that amount of time in which the completion of an activity may occur and not delay the termination of the project.

$$TF_{Act.} = LFD_{Act.} - EFD_{Act.}$$
$$= LSD_{Act.} - ESD_{Act.}$$

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Scheduler Floats (Cont.)

2. Free float : That amount of time span in which the completion of an activity may occur and not delay the finish of the project nor delay the start of any following activity.

$$FF_{Act.} = ESD_{Following\ Act.} - EFD_{Act.}$$

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Scheduler Floats (Cont.)

3. Interfering Float: that amount of time in which the completion of an activity may occur and not delay the termination of the project but within which completion will delay the start of some other following activity.

$$INTF_{Act.} = TF_{Act.} - FF_{Act.}$$

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Scheduler Floats (Cont.)

4. Independent Float: that amount of time in which the completion of an activity may occur and not delay the termination of the project, nor delay the start of any following activity, and not be delayed by any preceding activity.

$$INDF_{Act.} = ESD_{Following\ Act.} - LFD_{Preceding\ Act.} - Duration_{Act.}$$

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Critical Path

- It is the longest path in the network.
- It gives the project overall duration.
- Any late in the completion of one of the critical path activity, leads the project to be prolonged by that amount of time.

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New Approach in Determining the Free and Total Floats

- This approach is affected by the existence of dummies in certain portions of the network.
- These rules apply when an arrow diagram has at least one critical path with total float for each activity equals zero. That is, the late and early finish dates of the last activity are the same.

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The General Rules used in this Approach

- For all critical path activities, TF = 0 and FF = 0
- There is an activity with minimum value of total float after each node and is equal to that minimum total float for an activity that precede the node.
- For each node, there is at least one activity with free float equals to zero.

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The General Rules used in this Approach (Cont.)

- For activities that intersect the critical path, the total float is equal to the free float.

- In chain of activities (there is only one activity that enters each node), the total float is the same except possibly the last activity. The free float is zero for all the activities.

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The General Rules used in this Approach (Cont.)

- The sum of the duration for the critical path activities is equal to the summation of the duration and free float for any other path
- The free float for the minimum total float that precede the node is zero.

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The General Rules used in this Approach (Cont.)

- The free float for other activities can be computed by:

$$FF_{Act\cdot} = TF_{Act\cdot} - TF_{\text{smallest TF value prior to node}}$$

Or

$$TF_{Act\cdot} = FF_{Act\cdot} + TF_{\text{smallest TF value prior to node}}$$

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