

Project Management

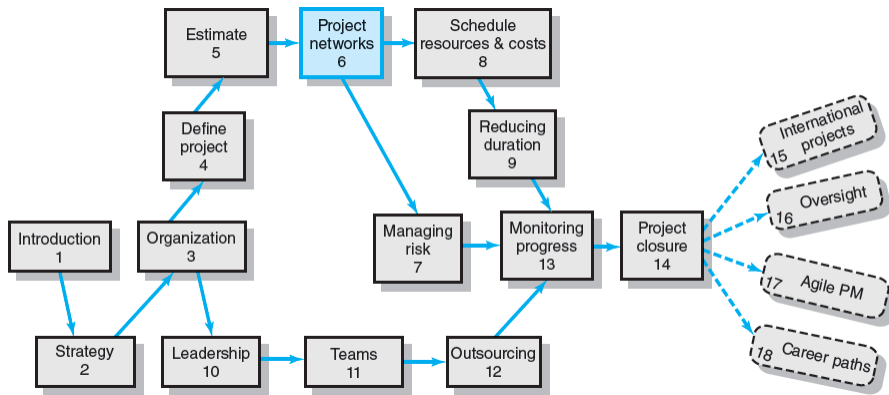


Developing Project Plans



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Where We Are Now



6-3

Developing the Project Plan

• The Project Network

- A flow chart that graphically depicts the sequence, interdependencies, and start and finish times of the project job plan of activities that is the **critical path** through the network.
 - Provides the basis for scheduling labor and equipment.
 - Enhances communication among project participants.
 - Provides an estimate of the project's duration.
 - Provides a basis for budgeting cash flow.
 - Identifies activities that are critical.
 - Highlights activities that are "critical" and can not be delayed.
 - Help managers get and stay on plan.

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WBS/Work Packages to Network

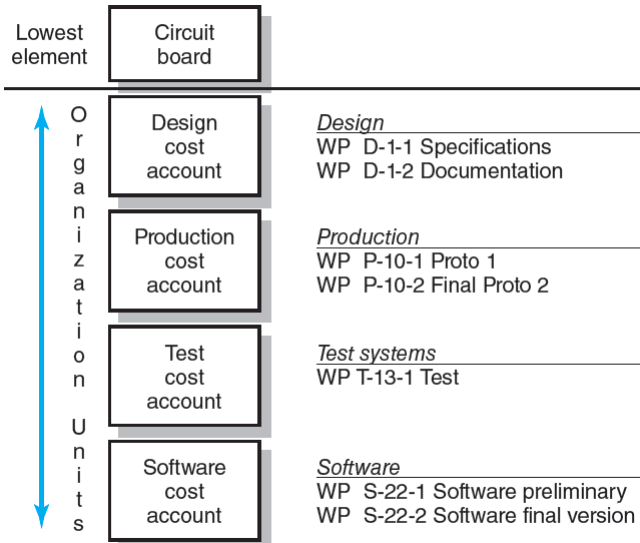


FIGURE 6.1
6-5

WBS/Work Package to Network (cont'd)

Activity network for circuit board work packages

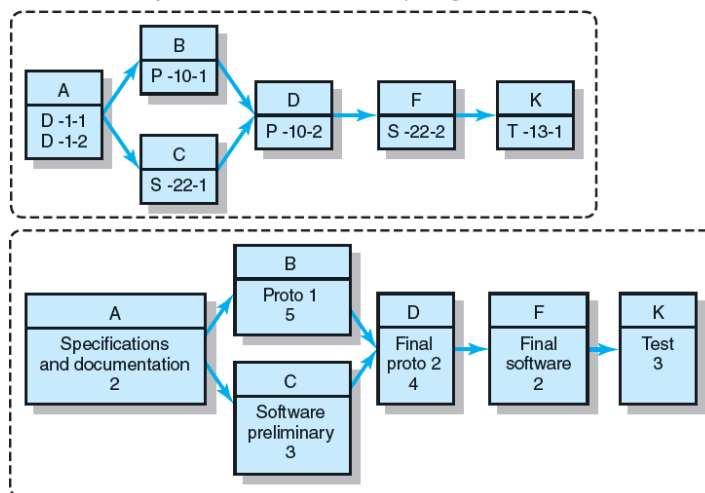
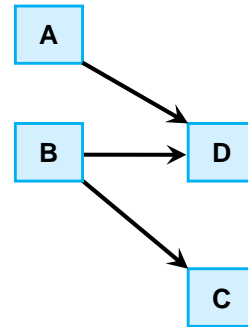


FIGURE 6.1 (cont'd)
6-6

Constructing a Project Network

• Terminology

- **Activity:** an element of the project that requires time.
- **Merge Activity:** an activity that has two or more preceding activities on which it depends.
- **Parallel (Concurrent) Activities:** Activities that can occur independently and, if desired, not at the same time.

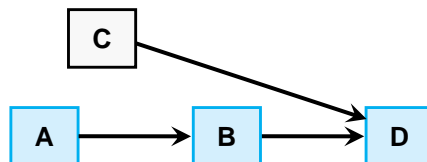


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Constructing a Project Network (cont'd)

• Terminology

- **Path:** a sequence of connected, dependent activities.
- **Critical path:** the longest path through the activity network that allows for the completion of all project-related activities; the shortest expected time in which the entire project can be completed. Delays on the critical path will delay completion of the entire project.



(Assumes that minimum of $A + B >$ minimum of C
in length of times to complete activities.)

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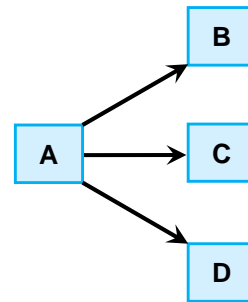
Constructing a Project Network (cont'd)

- Terminology

- **Event:** a point in time when an activity is started or completed. It does not consume time.
- **Burst Activity:** an activity that has more than one activity immediately following it (more than one dependency arrow flowing from it).

- Two Approaches

- Activity-on-Node (AON)
 - Uses a node to depict an activity.
- Activity-on-Arrow (AOA)
 - Uses an arrow to depict an activity.



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Basic Rules to Follow in Developing Project Networks

1. Networks typically flow from left to right.
2. An activity cannot begin until all preceding connected activities are complete.
3. Arrows indicate precedence and flow and can cross over each other.
4. Each activity must have a unique identify number that is greater than any of its predecessor activities.
5. Looping is not allowed.
6. Conditional statements are not allowed.
7. Use common start and stop nodes.

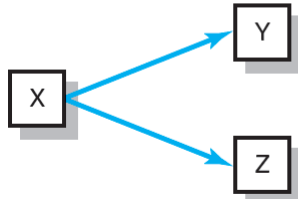
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Activity-on-Node Fundamentals



A is preceded by nothing
B is preceded by A
C is preceded by B

(A)



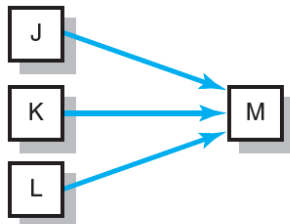
Y and Z are preceded by X

Y and Z can begin at the same time, if you wish

(B) X is a burst activity

FIGURE 6.2
6-11

Activity-on-Node Fundamentals (cont'd)

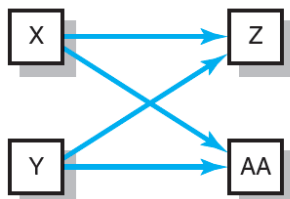


J, K, & L can all begin at the same time, if you wish (they need not occur simultaneously)

but

All (J, K, L) must be completed before M can begin

(C) M is a merge activity



Z is preceded by X and Y

AA is preceded by X and Y

(D)

FIGURE 6.2 (cont'd)
6-12

Network Information

AUTOMATED WAREHOUSE Order Picking System

Activity	Description	Preceding Activity
A	Define Requirements	None
B	Assign Team	A
C	Design Hardware	A
D	Code Software	B
E	Build and Test Hardware	C
F	Develop Patent Request	C
G	Test Software	D
H	Integrate Systems	E, F, G

TABLE 6.1
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Automate Warehouse—Partial Network

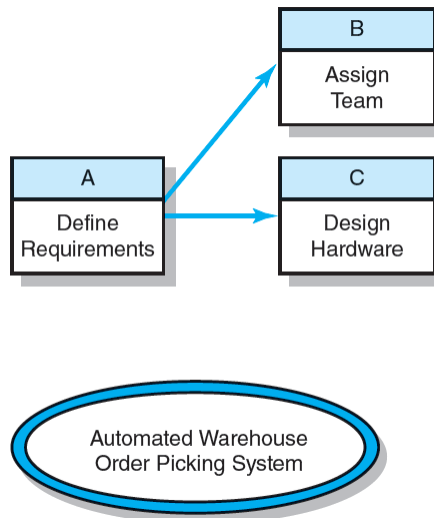


FIGURE 6.3
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Automated Warehouse—Complete Network

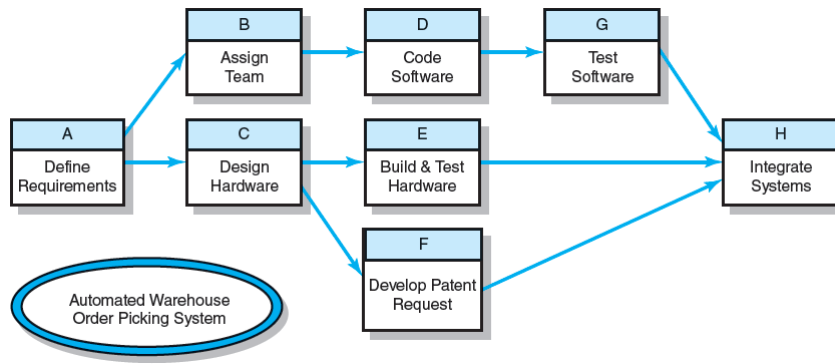


FIGURE 6.4
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Network Computation Process

- **Forward Pass—Earliest Times**
 - How soon can the activity start? (early start—ES)
 - How soon can the activity finish? (early finish—EF)
 - How soon can the project finish? (expected time—ET)
- **Backward Pass—Latest Times**
 - How late can the activity start? (late start—LS)
 - How late can the activity finish? (late finish—LF)
 - Which activities represent the critical path?
 - How long can activity be delayed? (slack or float—SL)

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Network Information

AUTOMATED WAREHOUSE Order Picking System

Activity	Description	Preceding Activity	Activity Time
A	Define Requirements	None	10 workdays
B	Assign Team	A	5
C	Design Hardware	A	25
D	Code Software	B	20
E	Build & Test Hardware	C	50
F	Develop Patent Request	C	15
G	Test Software	D	35
H	Integrate Systems	E, F, G	15

TABLE 6.2
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Activity-on-Arrow Network

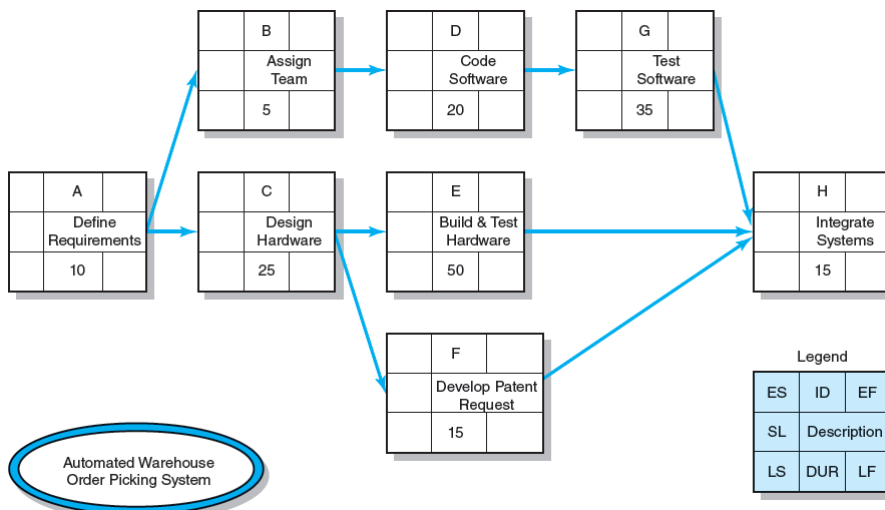


FIGURE 6.5
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Activity-on-Arrow Network Forward Pass

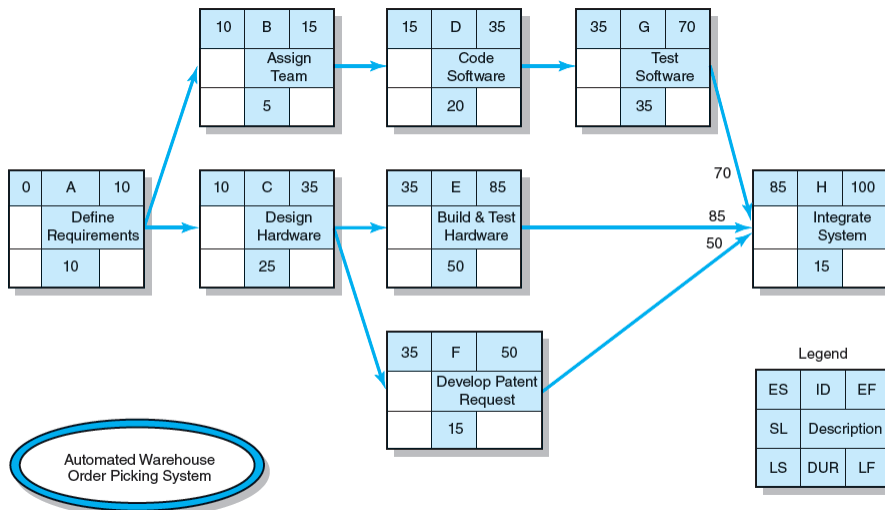


FIGURE 6.6
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Forward Pass Computation

- Add activity times along each path in the network ($ES + \text{Duration} = EF$).
- Carry the early finish (EF) to the next activity where it becomes its early start (ES) **unless...**
- The next succeeding activity is a merge activity, in which case the largest EF of all preceding activities is selected.

Activity-on-Arrow Network Backward Pass

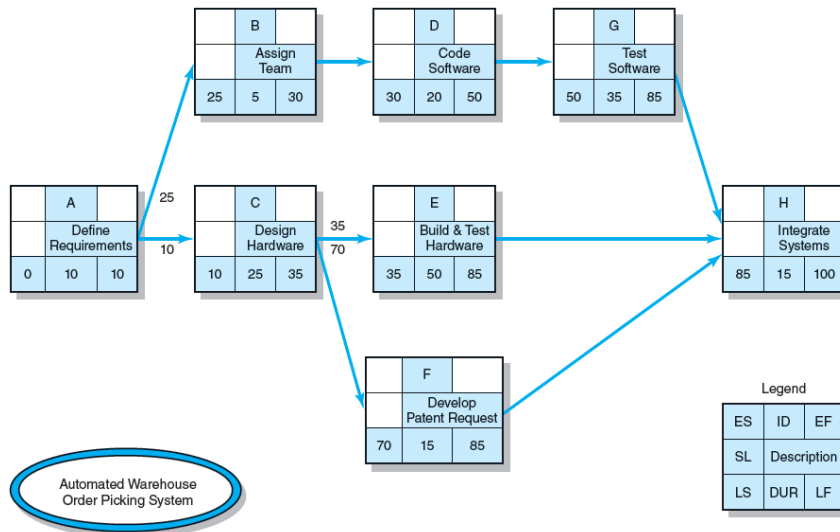


FIGURE 6.7

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Backward Pass Computation

- Subtract activity times along each path in the network ($LF - \text{Duration} = LS$).
- Carry the late start (LS) to the next activity where it becomes its late finish (LF) **unless**
- The next succeeding activity is a burst activity, in which case the smallest LF of all preceding activities is selected.

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Determining Free Slack (or Float)

• Free Slack (or Float)

- Is the amount of time an activity can be delayed after the start of a longer parallel activity or activities.
- Is how long an activity can exceed its early finish date without affecting early start dates of any successor(s).
- Allows flexibility in scheduling scarce resources.

• Sensitivity

- The likelihood the original critical path(s) will change once the project is initiated.
- The critical path is the network path(s) that has (have) the least slack in common.

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Forward and Backward Passes Completed with Slack Times

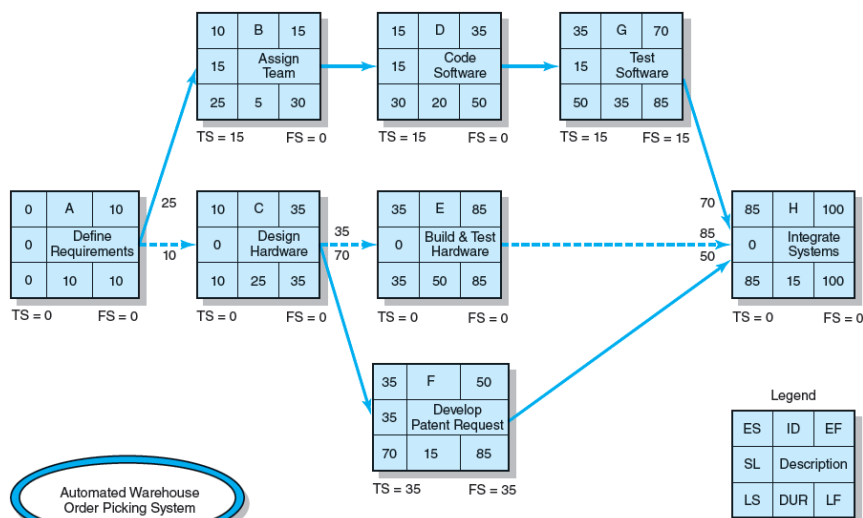
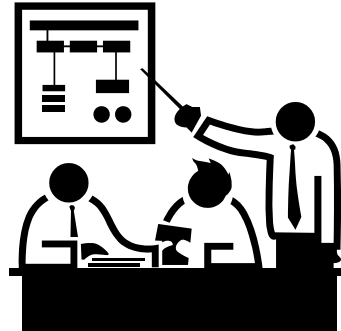


FIGURE 6.8

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Practical Considerations

- Network Logic Errors
- Activity Numbering
- Use of Computers to Develop Networks
- Calendar Dates
- Multiple Starts and Multiple Projects



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Network Logic Errors: Illogical Loop

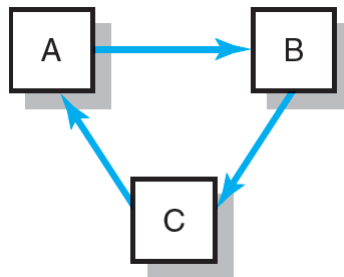


FIGURE 6.9
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Automated Warehouse Order Picking System Network

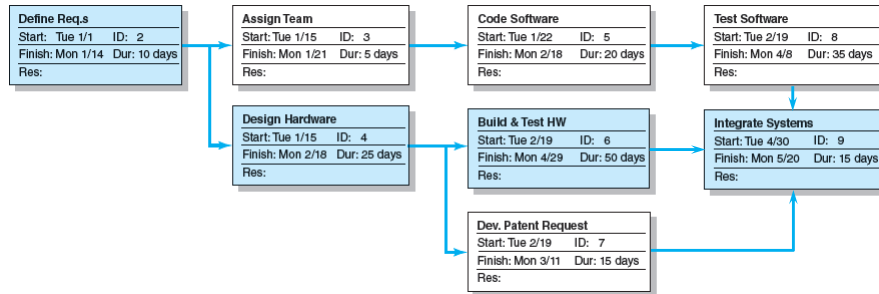


FIGURE 6.10
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Automated Order Warehouse Picking System Bar Chart

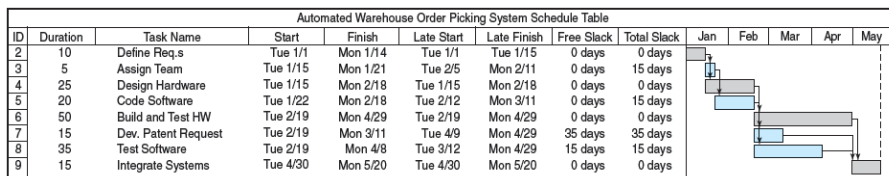


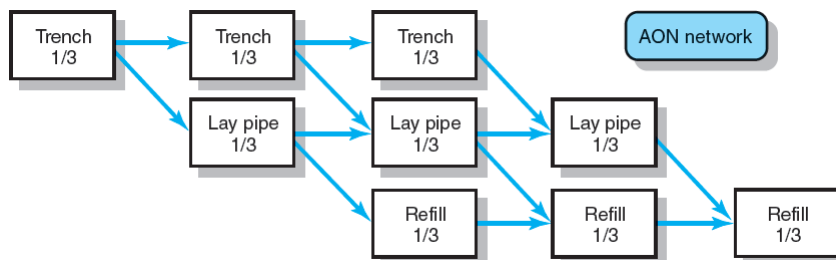
FIGURE 6.11
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Extended Network Techniques to Come Close to Reality

- Laddering
 - Activities are broken into segments so the following activity can begin sooner and not delay the work.
- Lags
 - The minimum amount of time a dependent activity must be delayed to begin or end.
 - Lengthy activities are broken down to reduce the delay in the start of successor activities.
 - Lags can be used to constrain finish-to-start, start-to-start, finish-to-finish, start-to-finish, or combination relationships.

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Example of Laddering Using Finish-to-Start Relationship



Use of Lags

Finish-to-Start Relationship

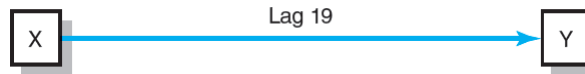
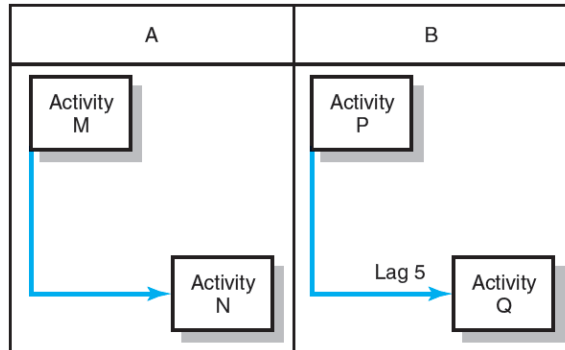


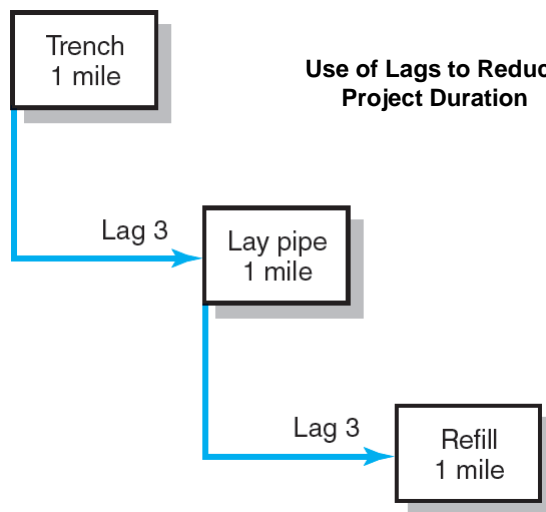
FIGURE 6.13

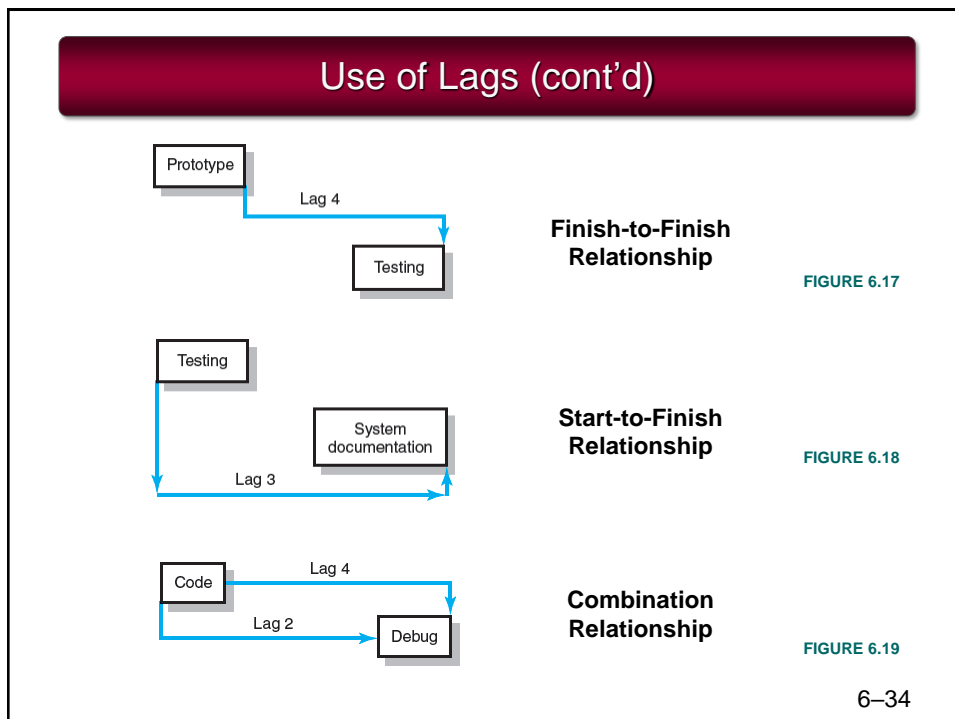
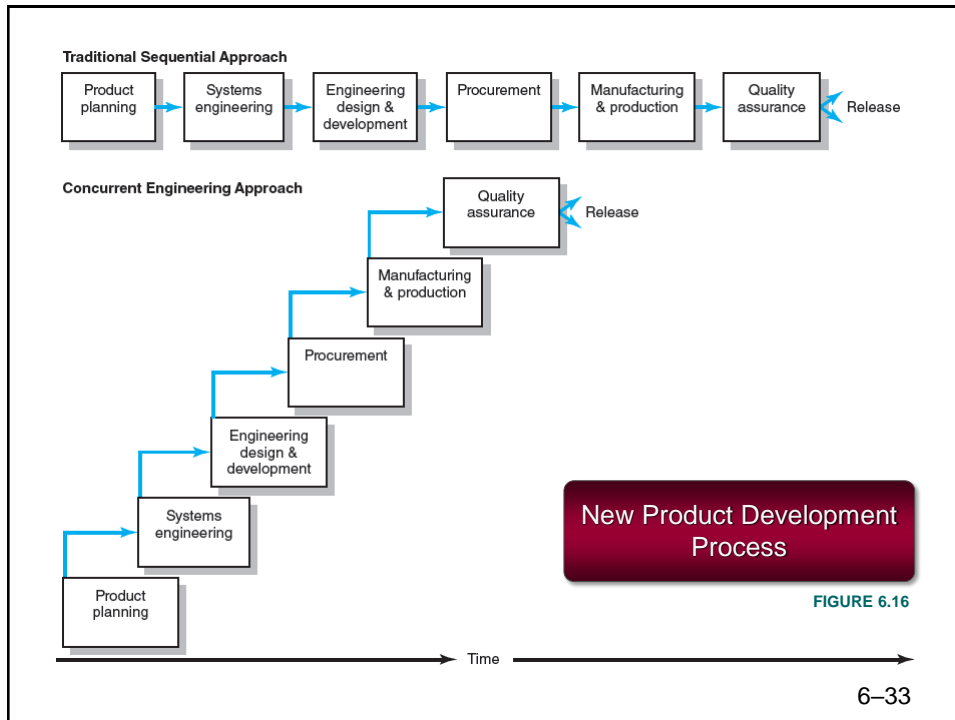
Start-to-Start Relationship

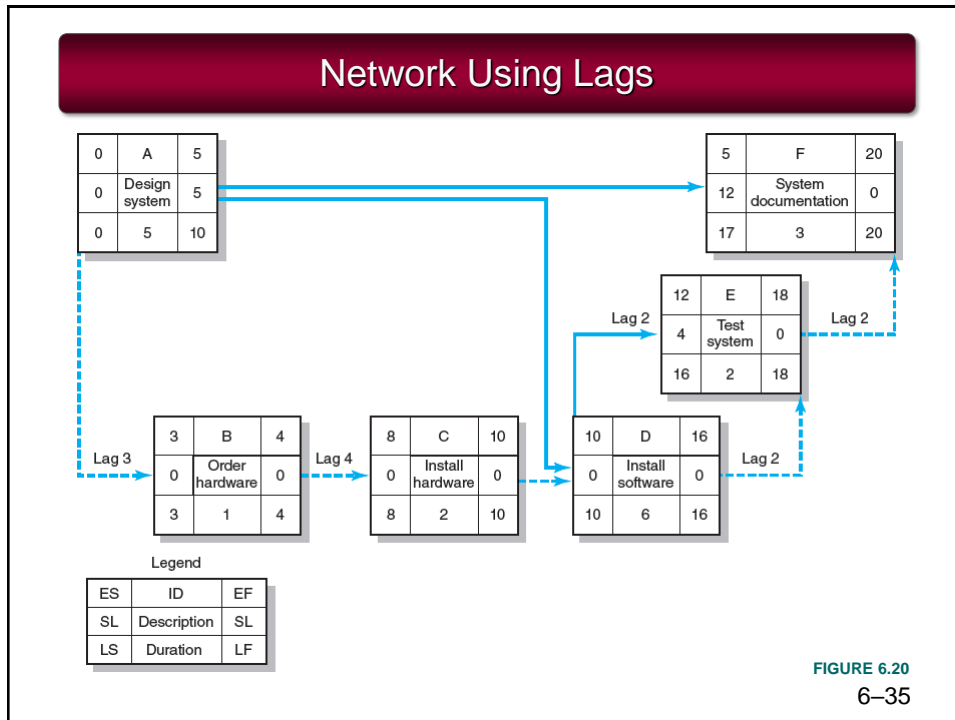
FIGURE 6.14
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Use of Lags Cont'd

Use of Lags to Reduce Project Duration

FIGURE 6.15
6-32





Hammock Activities

• Hammock Activity

- Spans over a segment of a project.
- Has a duration that is determined after the network plan is drawn.
- Is used to aggregate sections of the project to facilitate getting the right amount of detail for specific sections of a project.
- Is very useful in assigning and controlling indirect project costs.

Hammock Activity Example

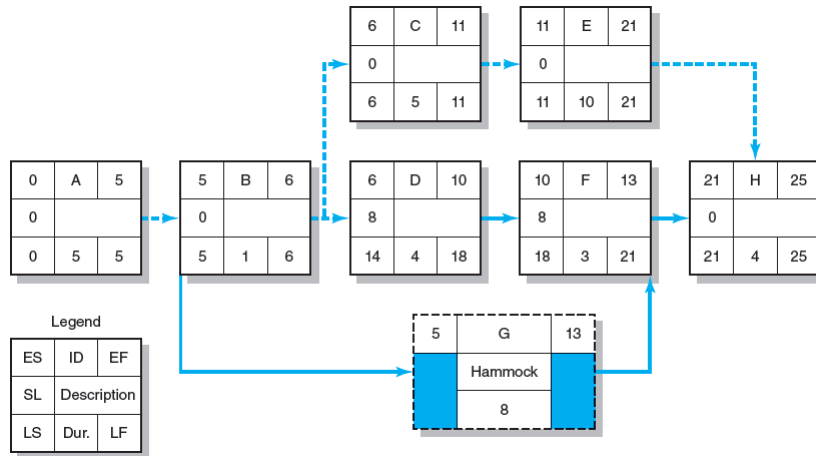


FIGURE 6.21
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