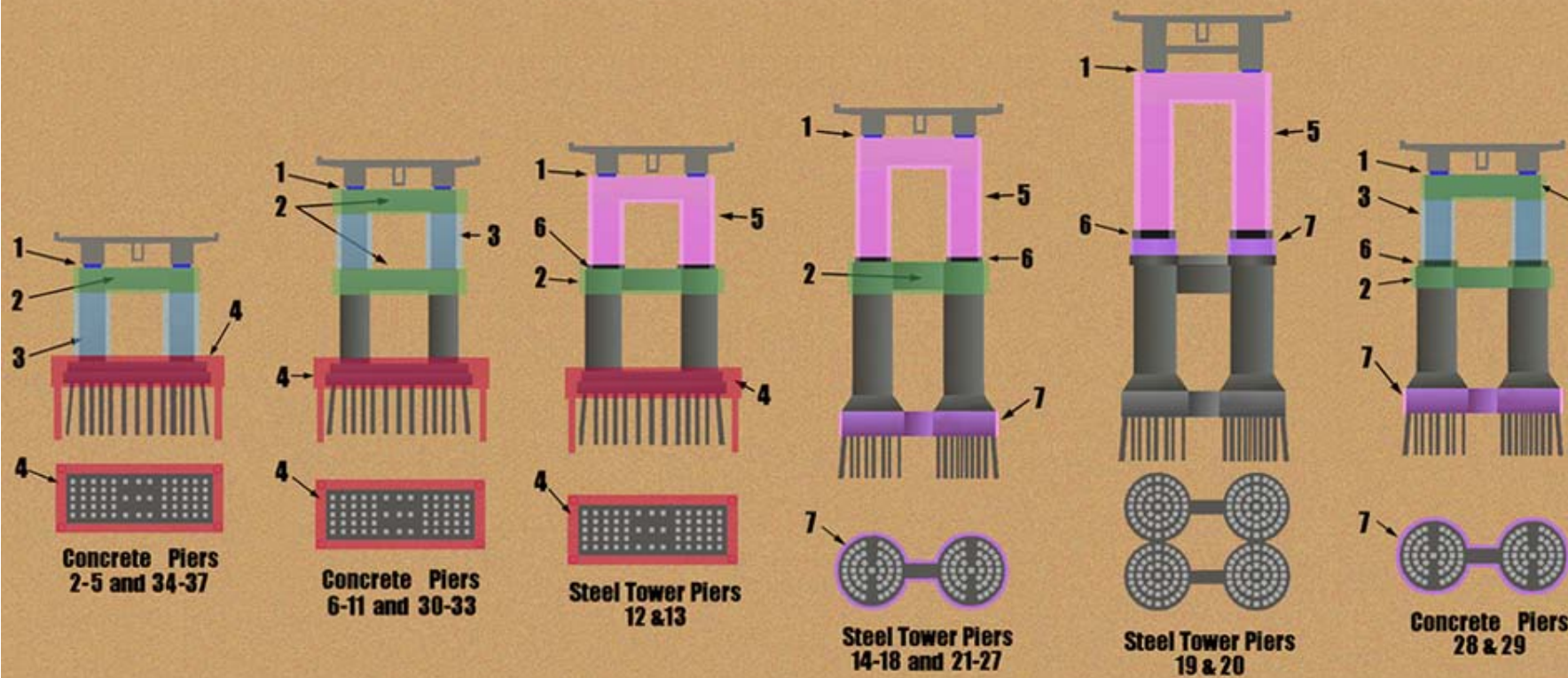


Scheduling Techniques for Construction Projects

Chapter 4



Planning and Scheduling Objectives

Objectives include:

- The ability to create a simple bar chart and a simple CPM logic network**
- An understanding of how to use a CPM for determining project status and in identifying float**

Planning and Scheduling Objectives

Objectives include:

- **The ability to calculate resource needs and an understanding of resource leveling strategies**
- **The ability to create a velocity diagram**
- **The ability to develop a linear schedule**

Planning and Scheduling

- A common technique used to understand and organize complex undertaking is to **divide the problem into smaller subparts**
- In construction this technique is applied in both estimating and **planning**

Planning and Scheduling

- **The critical path method (CPM) is a planning and control technique that provides an accurate, timely, and easily understood picture of the project**
- **The logic diagram graphically portrays the relationships between project activities.**

Management Principles

- **Clearly defined policies understood by everyone on the team**
- **Unity of purpose throughout an organization**
- **Subdivision of work *systematically planned and programmed***

Management Principles

- **Specific assignment of tasks and an assurance that subordinates clearly understand the tasks**
- **Clear authority relationships**
- **Delegation of authority equal to the level of responsibility**

Management Principles

- **Adequate allocation of resources**
- **Continuous accountability for the use of resources and production results**
- **Coordination of all individual and group efforts**

Management Principles

Management includes:

- **Planning**
- **Scheduling**
- **Controlling**



Planning

- **Planning creates an orderly sequence of events. It serves the manager by:**
 - **pointing out the things to be done**
 - **their sequence**
 - **how long each task should take**
 - **who is responsible for which tasks or actions**

The Planning Process

- **Assumptions based on facts**
- **Alternative courses of action**
- **Select the course of action –**

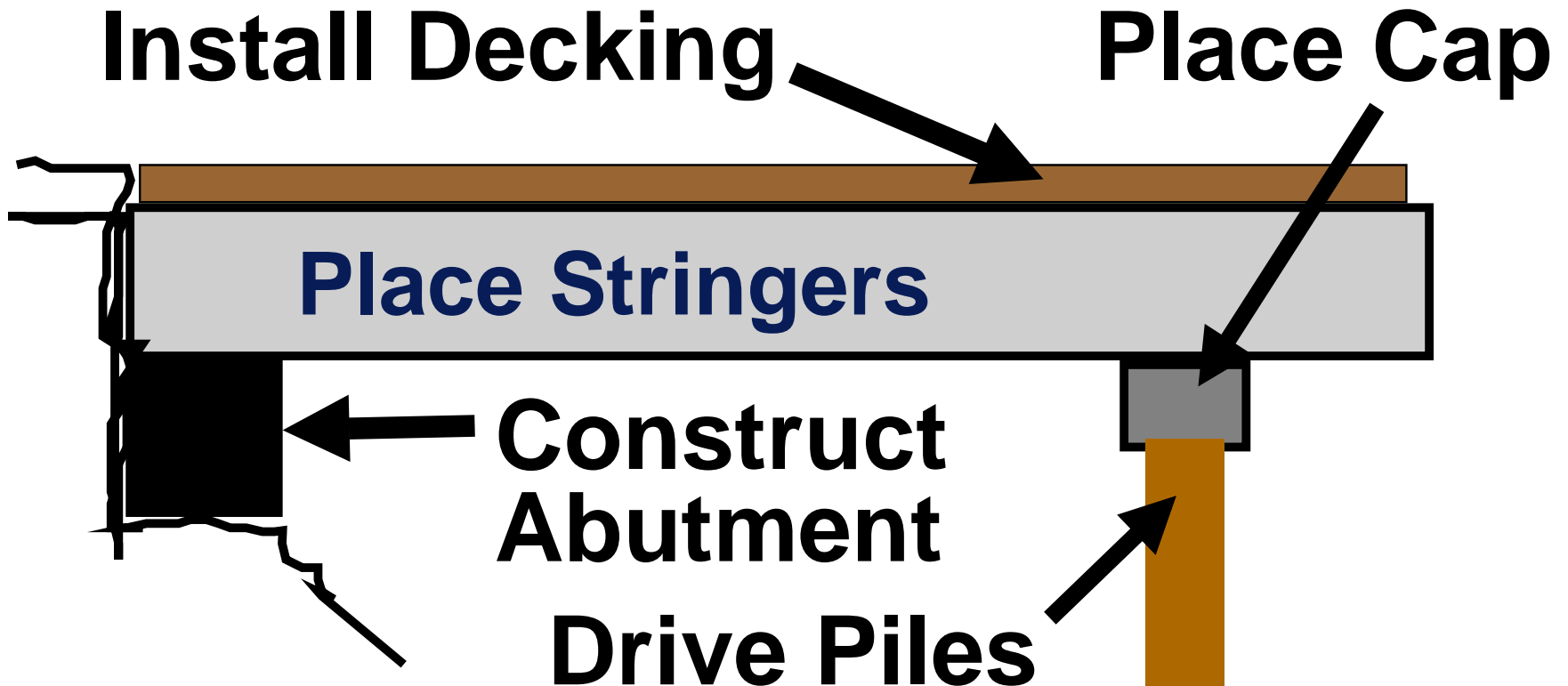
The Planning Process

Course of action – including:

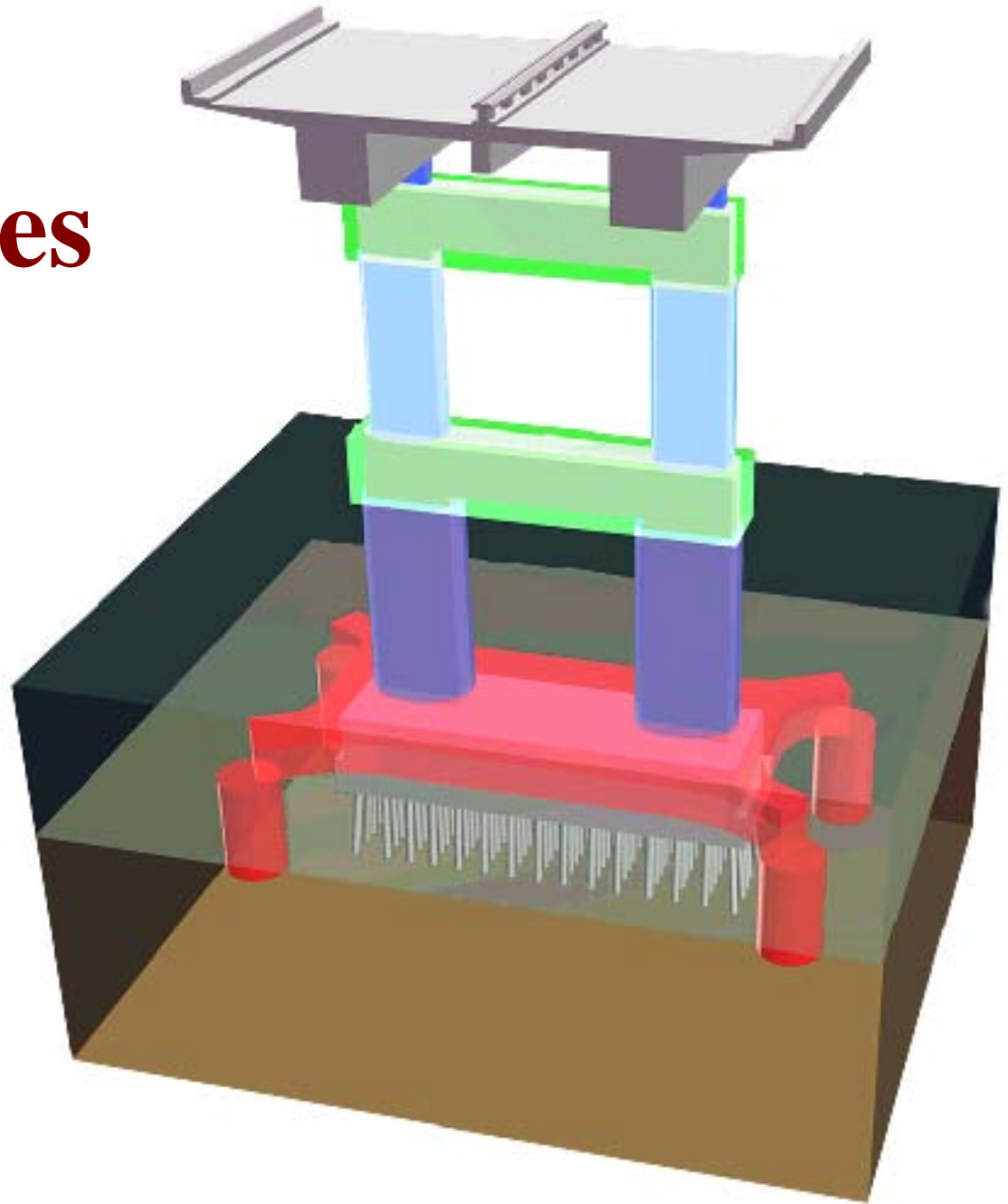
- **Moving onto the jobsite**
- **Bringing in supplies & equipment**
- **Obtaining & using natural resources**
- **Planning for inclement weather**
- **Providing for adequate construction site drainage**

Activities

A time consuming, definable task.



Activities

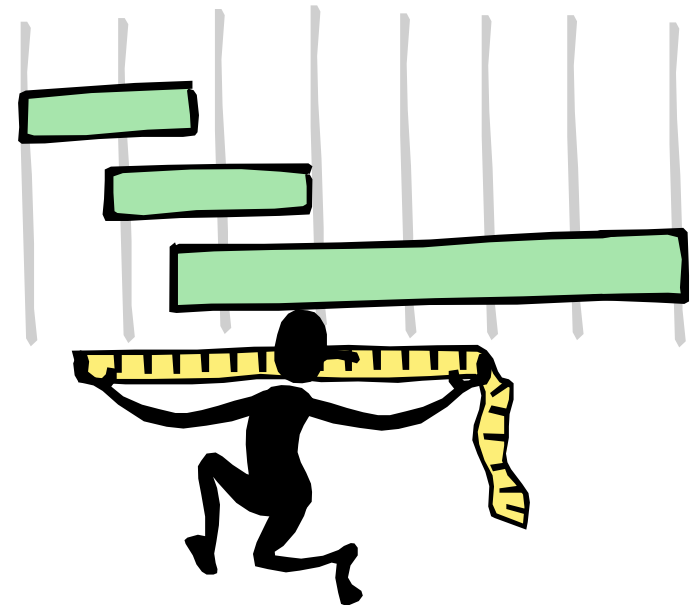


Activities

- **Activities consume time**
- **Activities *usually* consume physical resources**
- **Activities have definable start and finish points**
- **Activities are assignable**
- **Activities are measurable**

Scheduling

- **Barcharts (Gantt Chart)**



- **CPM – Critical Path Method**

Bar Chart

- **The bar chart is widely used as a construction-scheduling tool because of its simplicity, ease of preparation, and understandable format**
- **Normally the activities are listed in chronological order according to their start date**

Bar Chart

- **Discontinuous bars are sometimes used on hand drawn bar charts to represent interruptions of activities**

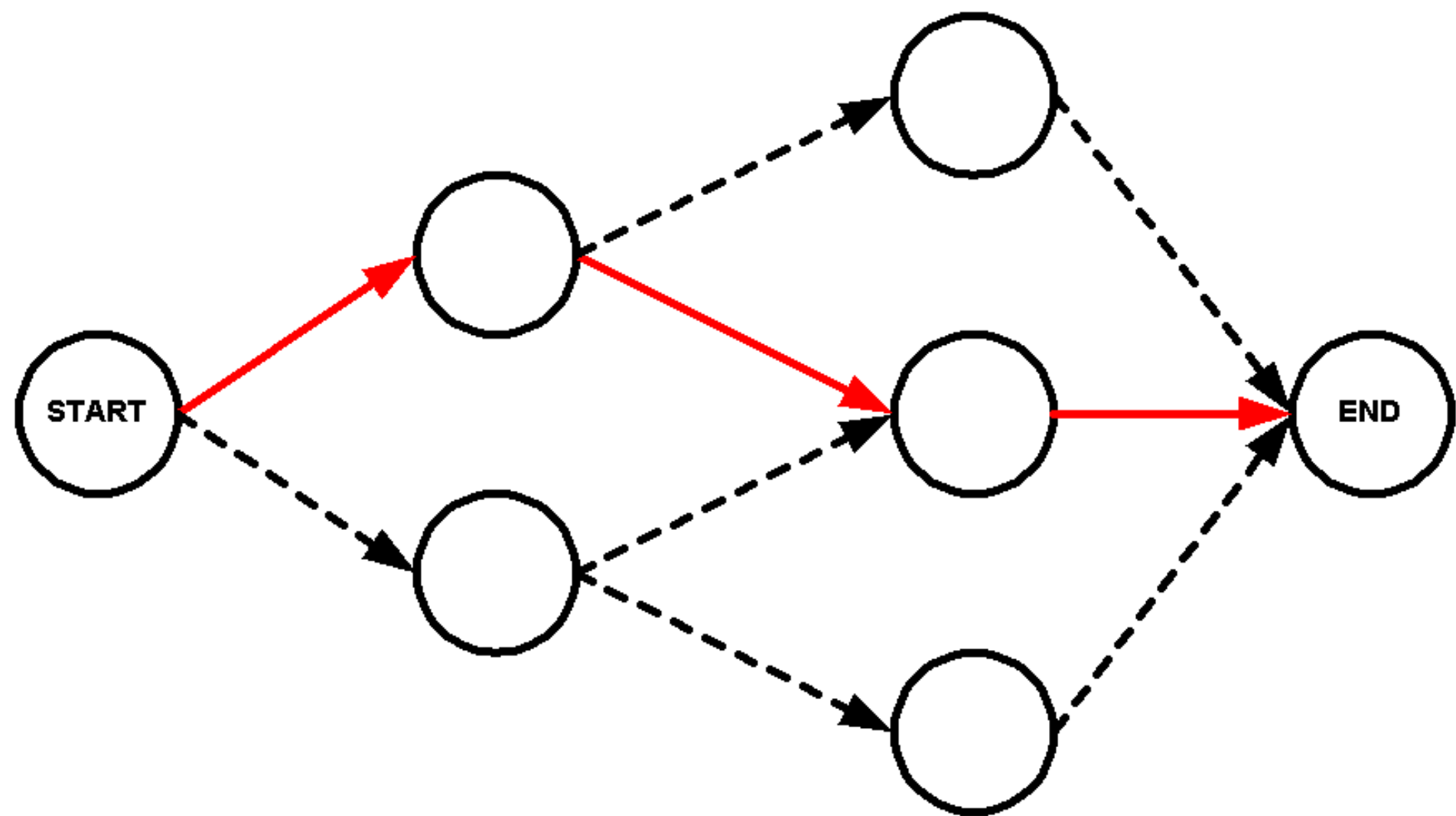
Bar Chart - Disadvantages

- It does not clearly show the detailed sequence of the activities
- It does not show which activities are *critical* to the successful, timely completion of the project

Critical Path Method

- **The logic diagram graphically portrays the relationships between project activities**
- **With this information, it is easier to *plan, schedule, & control* the project**
- **The CPM is a *tool* that assists the planning, scheduling, & controlling of the project.**

← OVERALL PROJECT DURATION →



Critical Path Method

Before the diagram can be developed, the project must first be constructed mentally to determine activity relationships

Critical Path Method

For each activity ask:

- Can this activity start at the beginning of the project? (Start activities)**
- Which activities must be finished before this one begins? (Precedence)**

Critical Path Method

For each activity ask:

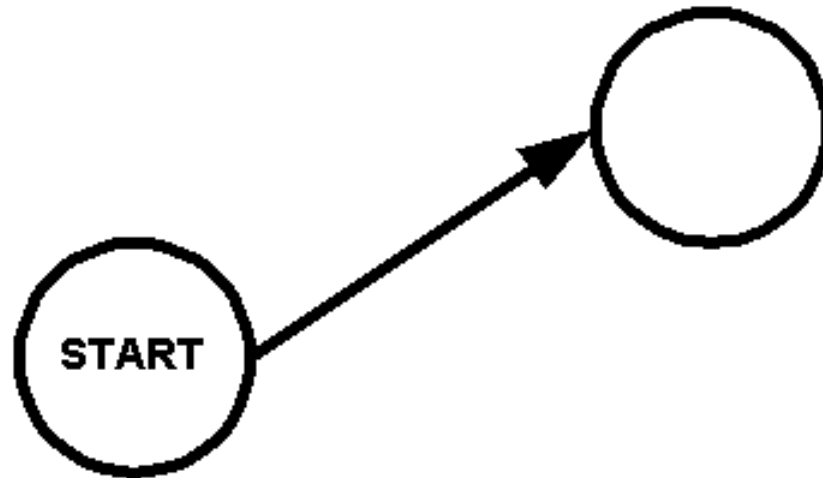
- **Which activities may either start or finish at the same time this one does? (Concurrence)**
- **Which activities cannot begin until this one is finished? (Succession)**

Example

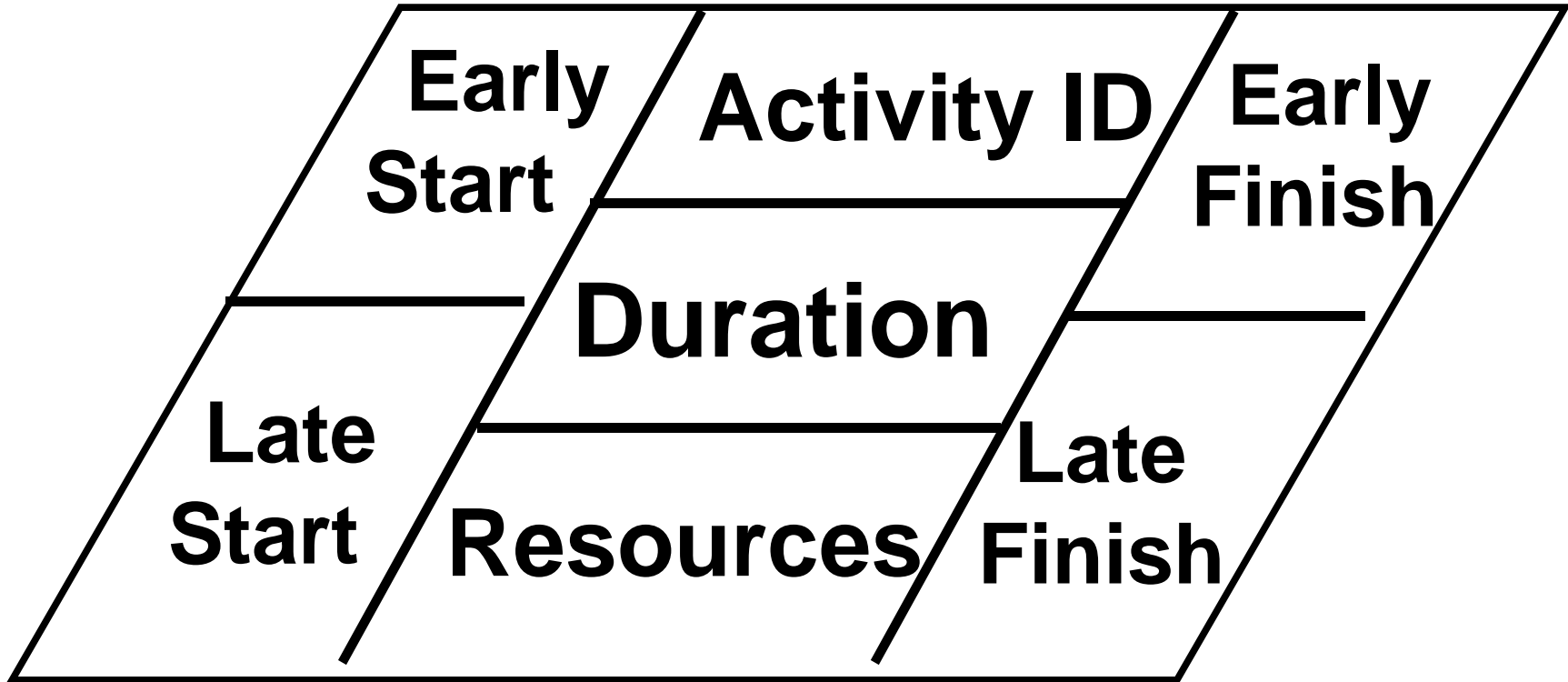
- **Our daily schedule of morning activities includes six activities; wake up, take shower, leave house, drive to work, start car, and get dressed**
- **Use the "Preceded Immediately By (PIB)." method to organize these activities for a CPM schedule**

Critical Path Method

- The two basic logic symbols on the precedence diagram are the *node* and the *precedence arrow*



Critical Path Method



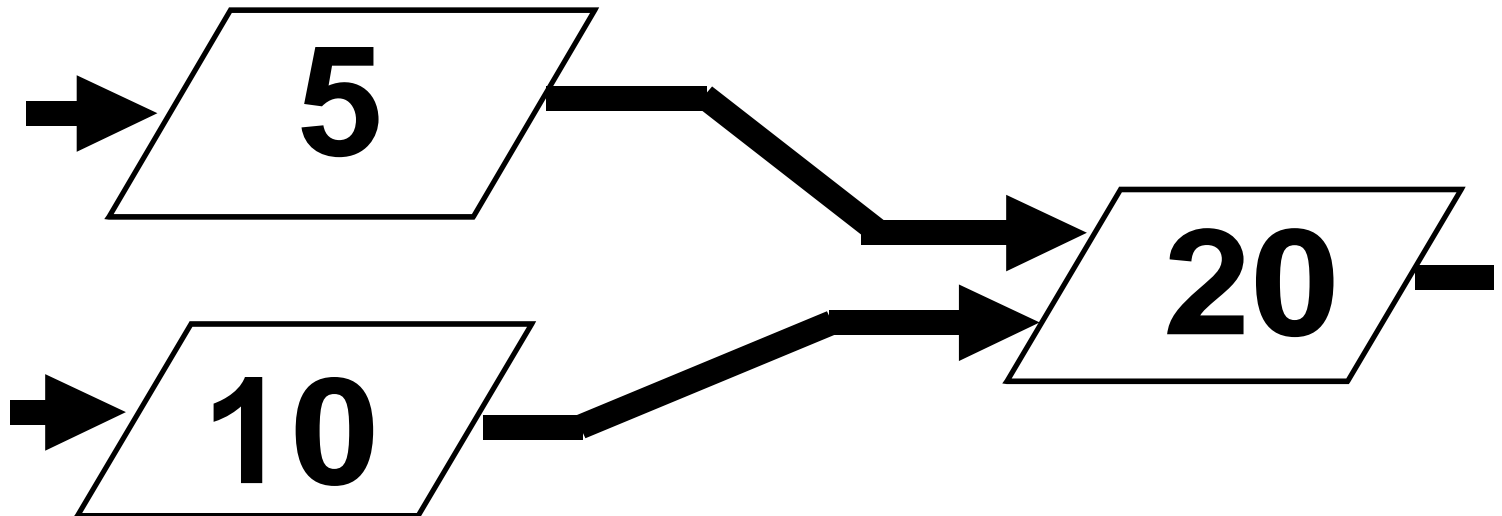
Schedule Calculations

- **Sequential Logic**
 - **Activity 20 cannot start until activity 10 is completed**



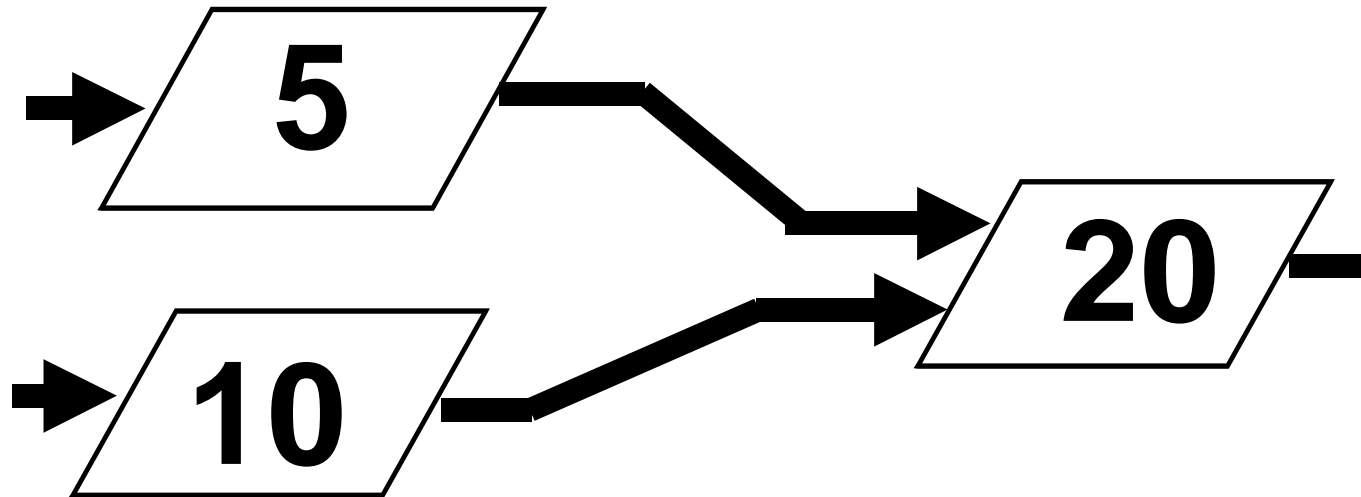
Schedule Calculations

- **Concurrent Logic**
 - **Activities 5 and 10 can proceed concurrently**



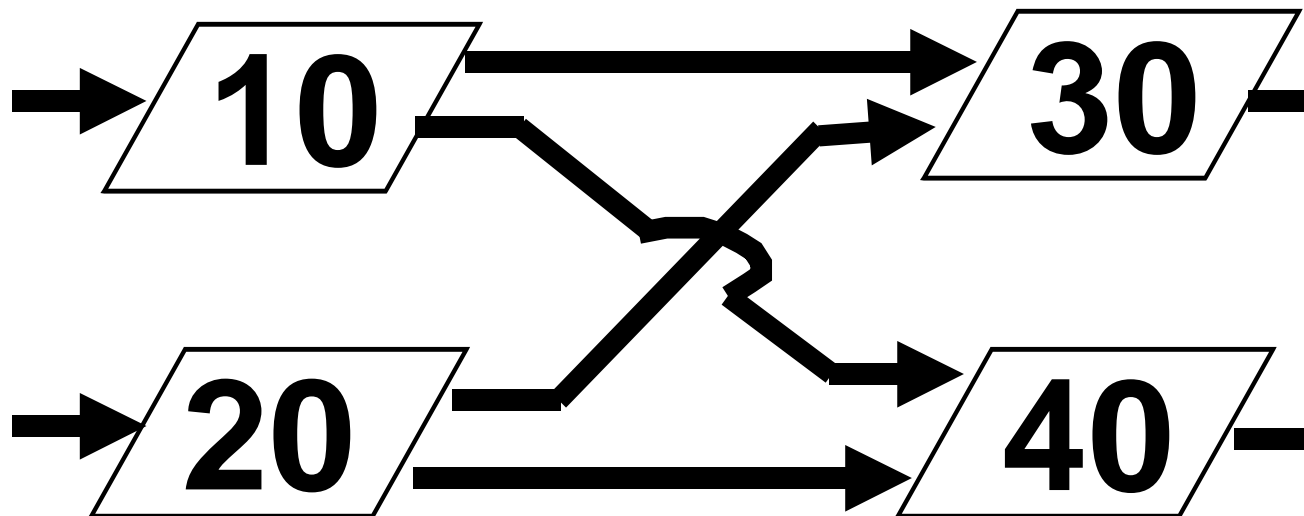
Schedule Calculations

- **Multiple Predecessor Logic**
 - **Activity 20 cannot start until both activities 5 and 10 are completed**



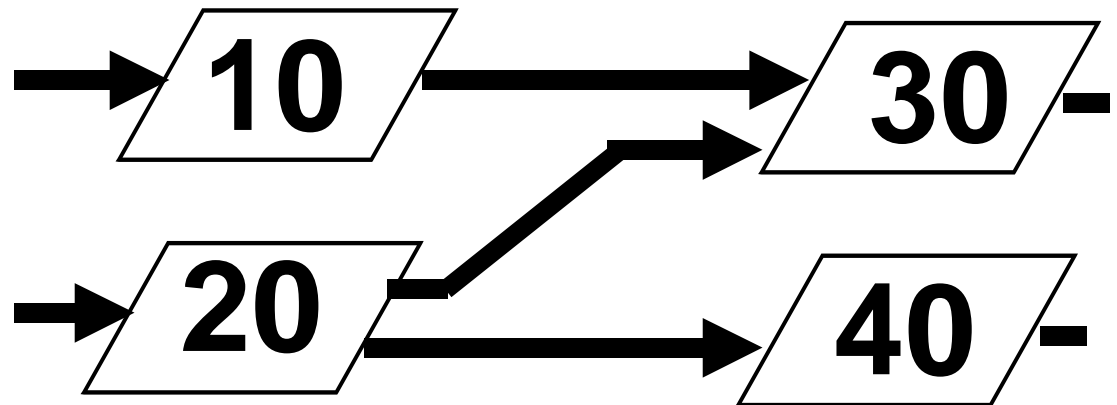
Schedule Calculations

- **Multiple Predecessor Logic**
 - **Activity 30 & 40 cannot start until both activities 10 & 20 are completed**



Schedule Calculations

- **Multiple Successor Logic**
 - Activity 20 must be complete before either 30 or 40 can start, 30 can start only after 10 and 20 are completed
40 can start immediately after 20 is completed



Practical Exercise #1,



Develop a logic network for the Sequence listed as PE # 1.

PE #1

ACTIVITY PIB

5	NONE
10	NONE
15	5
20	5
25	10
30	15
35	25
40	20, 30, 35

Step # 1: Draw **start** node.

Step # 2: Draw all activity nodes

Preceded

Immediately by

“NONE.”

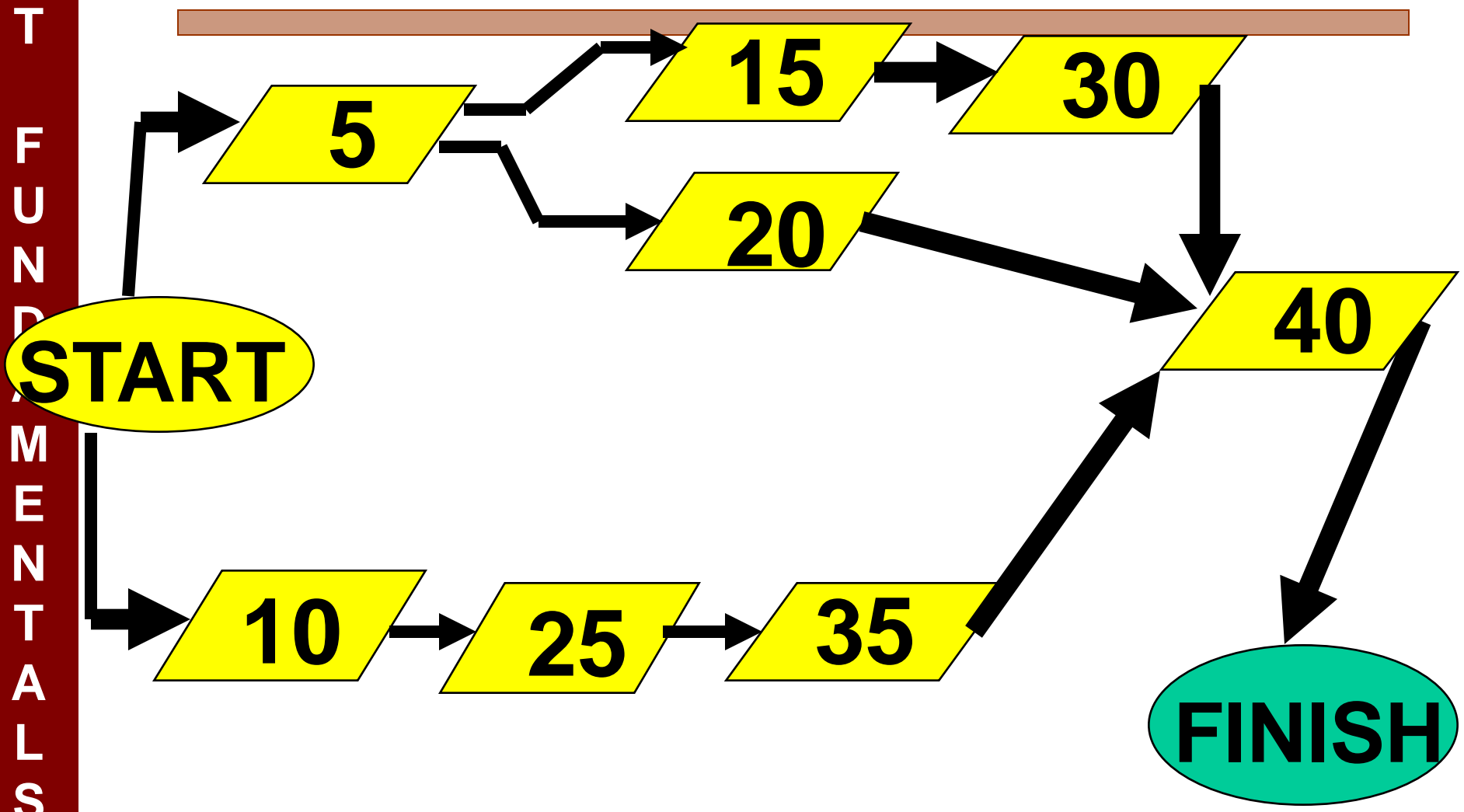
PE #1

Step # 3: Draw in activity nodes
Preceded Immediately by **One**
activity.

Step # 4: Draw in activity nodes
Preceded Immediately by **two or
more** activities.

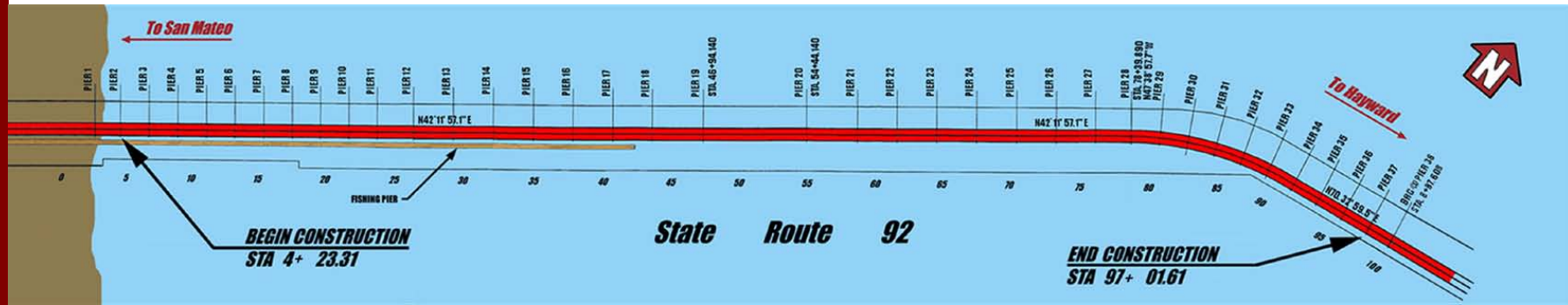
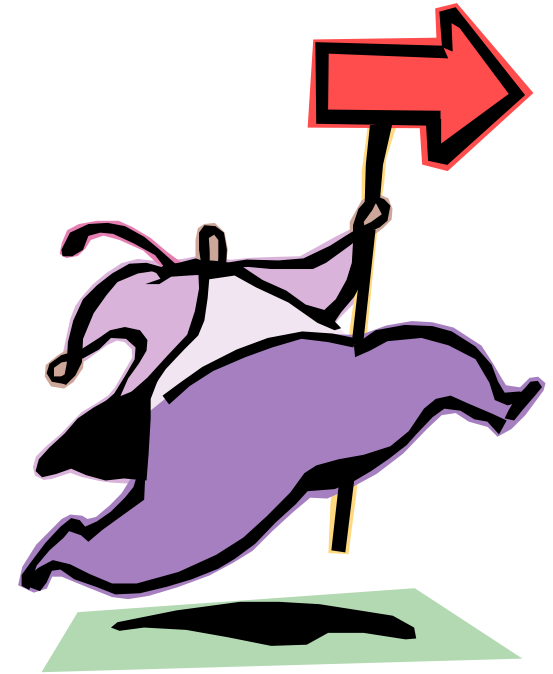
Step # 5: Draw **Finish** node.

PE #1



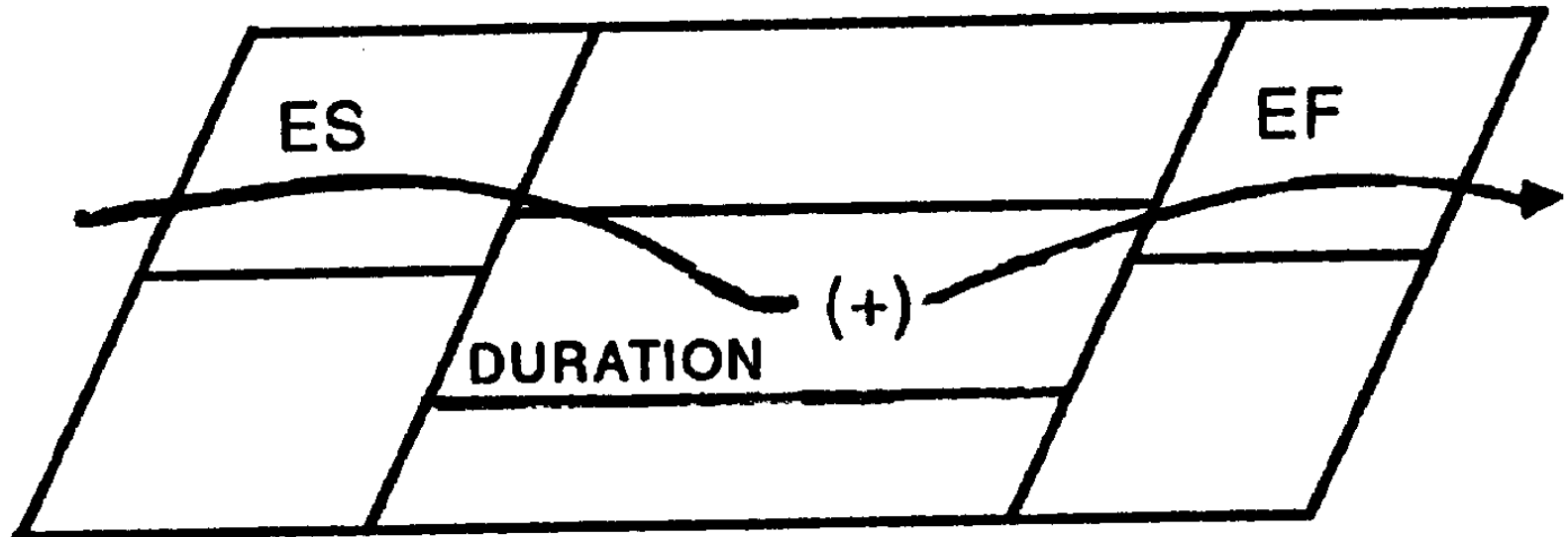
Forward Pass

- The earliest time each activity in the network can start and finish
- The minimum overall duration of the project



Forward Pass

- $\text{Early Finish}_n = \text{Early Start}_n + \text{Duration}_n$



Early start/early finish

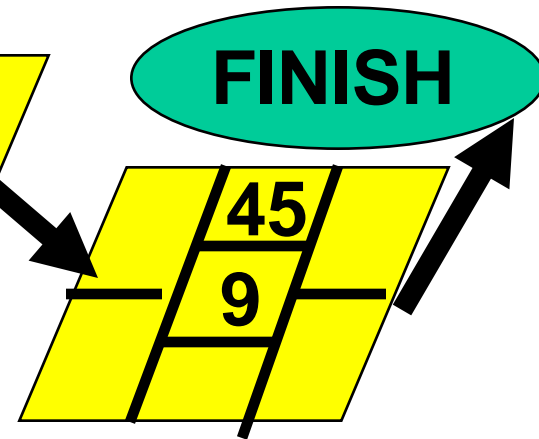
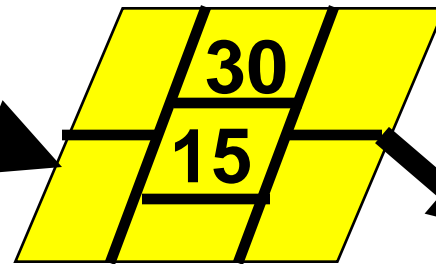
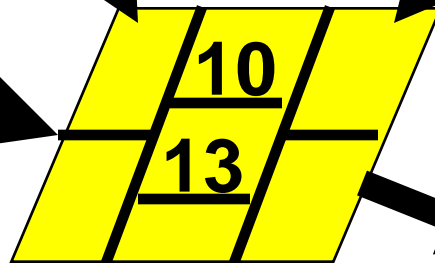
- *Early start time* (ES) of an activity is the earliest point in time, taking into account the network logic, that an activity may start
- *Early finish time* (EF) is the earliest time the activity may finish

ACTIVITY ON THE NODE TIME ANALYSIS

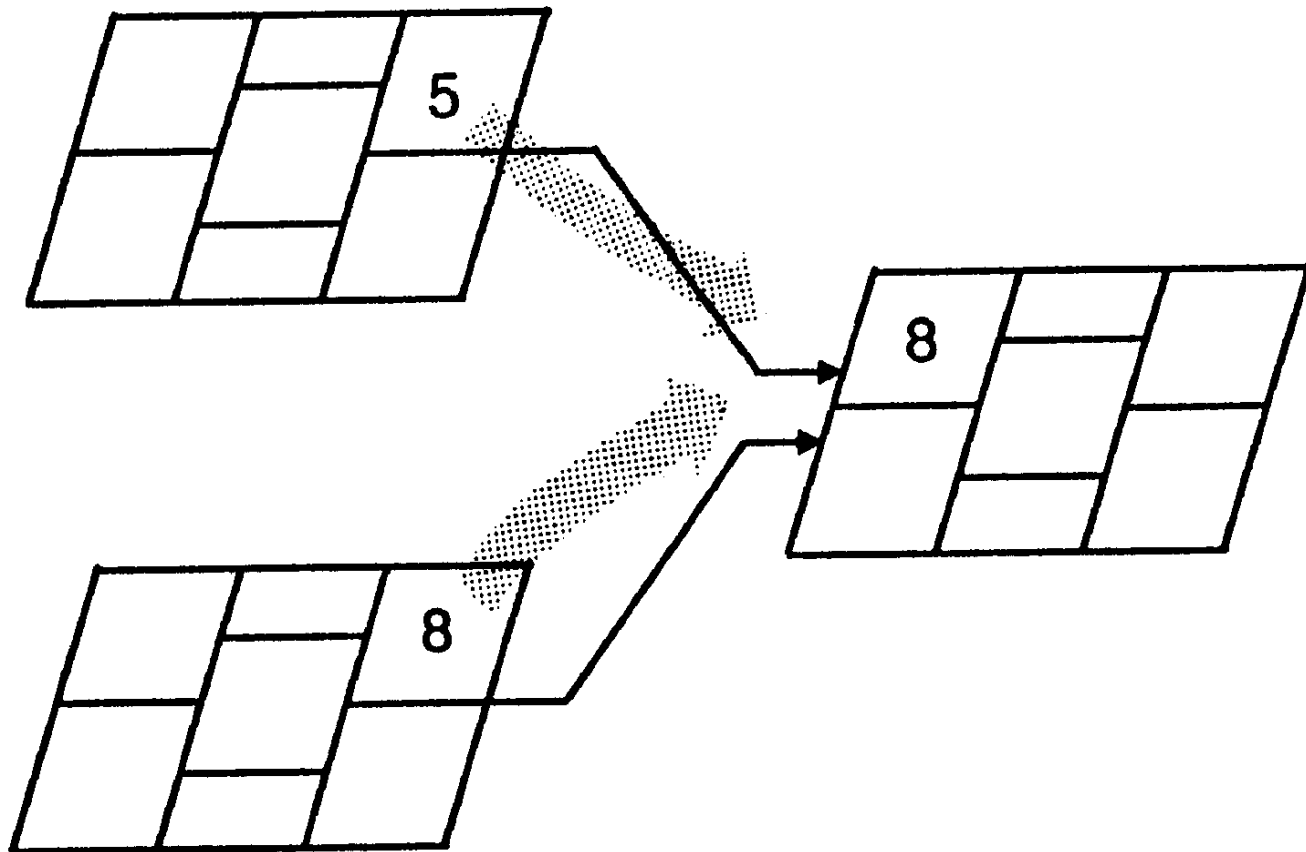
Early Start

Early Finish

START 0

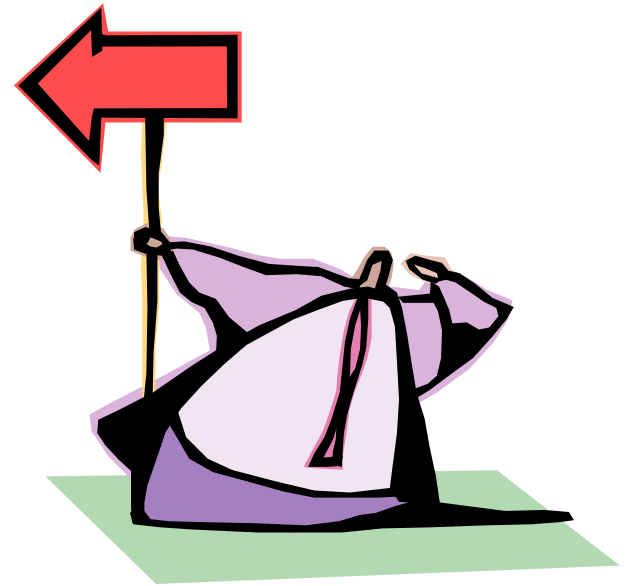


Early start



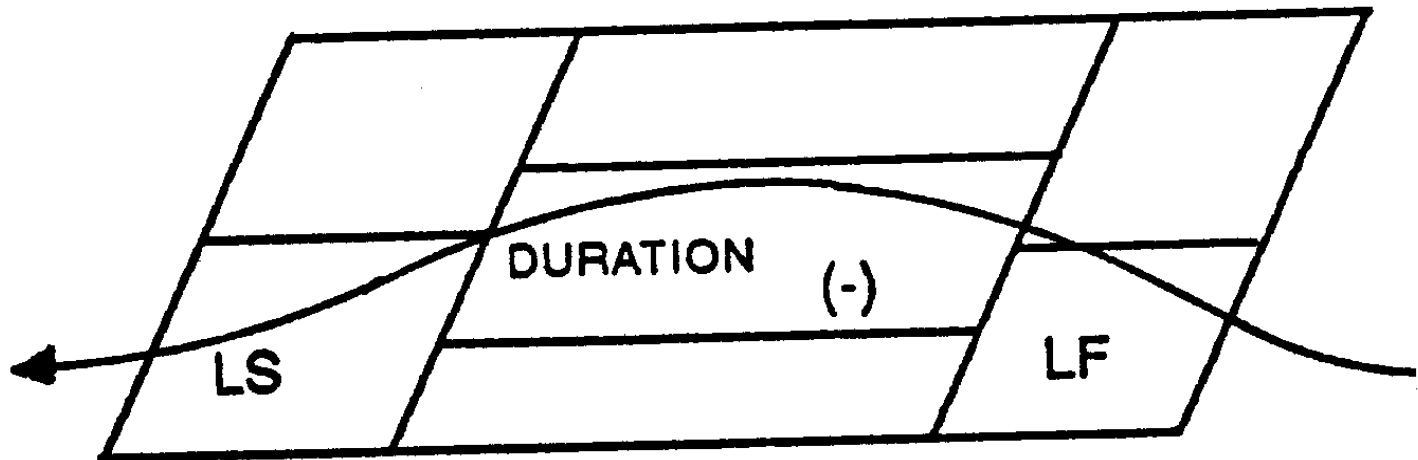
Backward Pass

- **A backward pass through the logic network will produce the latest point in time that each network activity can start and finish, and still maintain the minimum overall project duration**

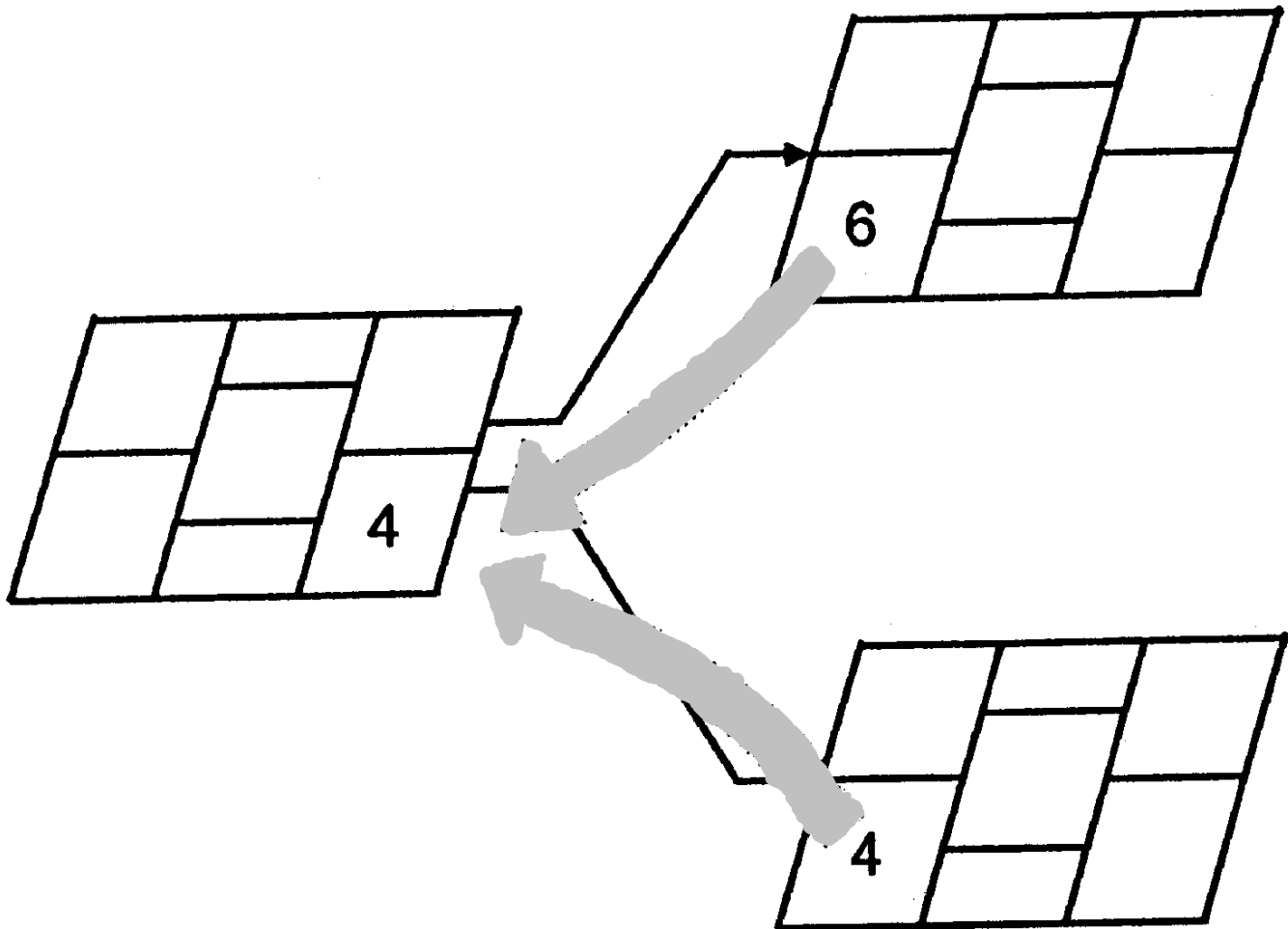


Late finish/late start

- *Late finish time (LF)* is the latest time that an activity may finish without delaying the entire project



Late finish/late start



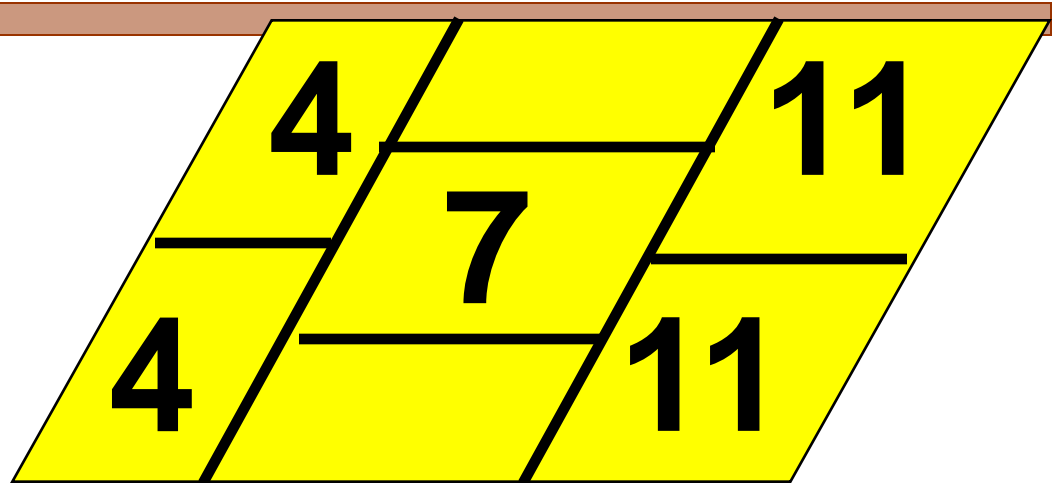
Critical Path and Critical Activities

- **A critical activity can be determined from the logic network by applying either of the following rules:**
 - **The early start and late start times for a particular activity are the same**
 - **The early finish and late finish time for a particular activity are the same**

CRITICAL PATH

1. $ES = LS$

2. $EF = LF$



The duration must be equal to the difference between the ES and the EF or the difference between the LS and the LF.

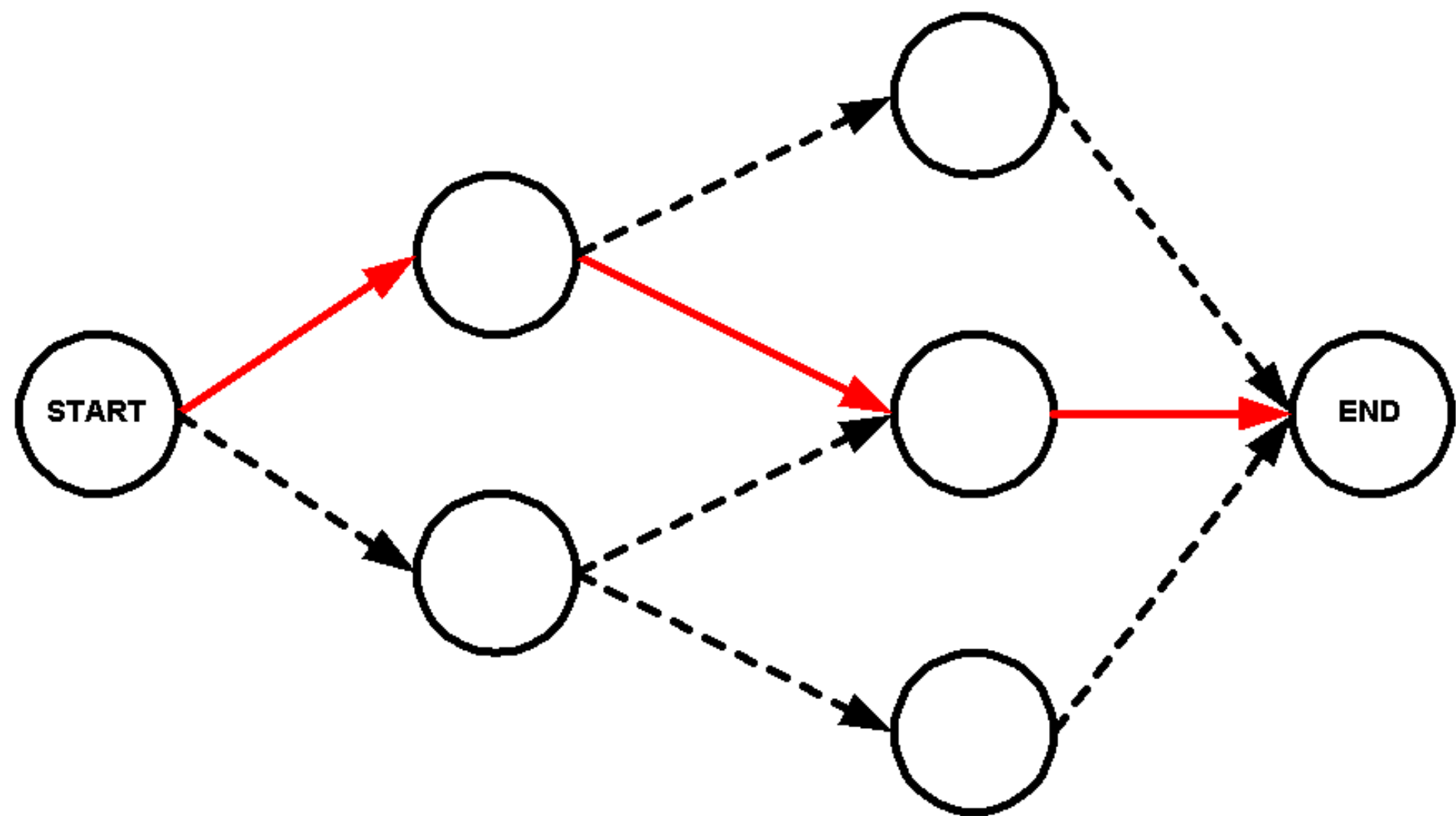
$$EF - ES = \text{Duration } or$$

$$LF - LS = \text{Duration}$$

Critical Path and Critical Activities

- **Critical activities are linked together forming a path from the start activity to the finish activity called a *critical path*.**

← OVERALL PROJECT DURATION →



Total Float

***Total float* (TF) is the amount of time that an activity may be delayed without delaying the project's estimated completion time**

Total float assumes that all preceding activities are finished as early as possible and all succeeding activities are started as late as possible

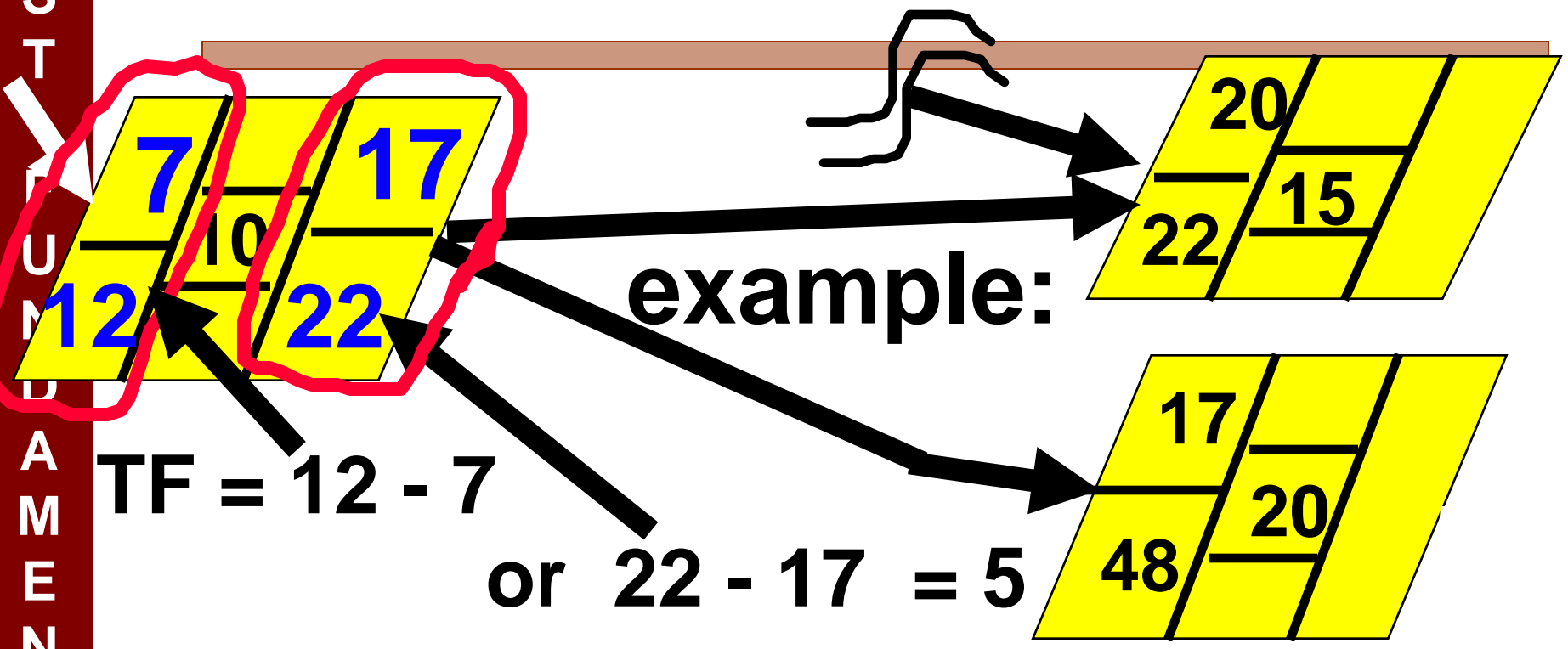
Total Float

- **Total Float = Late Start – Early Start**
- **Total Float = Late Finish – Early Finish**

Both equations will yield the same answer

An activity can take place at any time within the interval defined by its early start and late finish dates, and still not delay the project

TIME ANALYSIS



$$TF = 12 - 7$$

$$\text{or } 22 - 17 = 5$$

TOTAL FLOAT (TF)

= LATE START(LS) - EARLY START(ES)

or LATE FINISH(LF) - EARLY FINISH(EF)

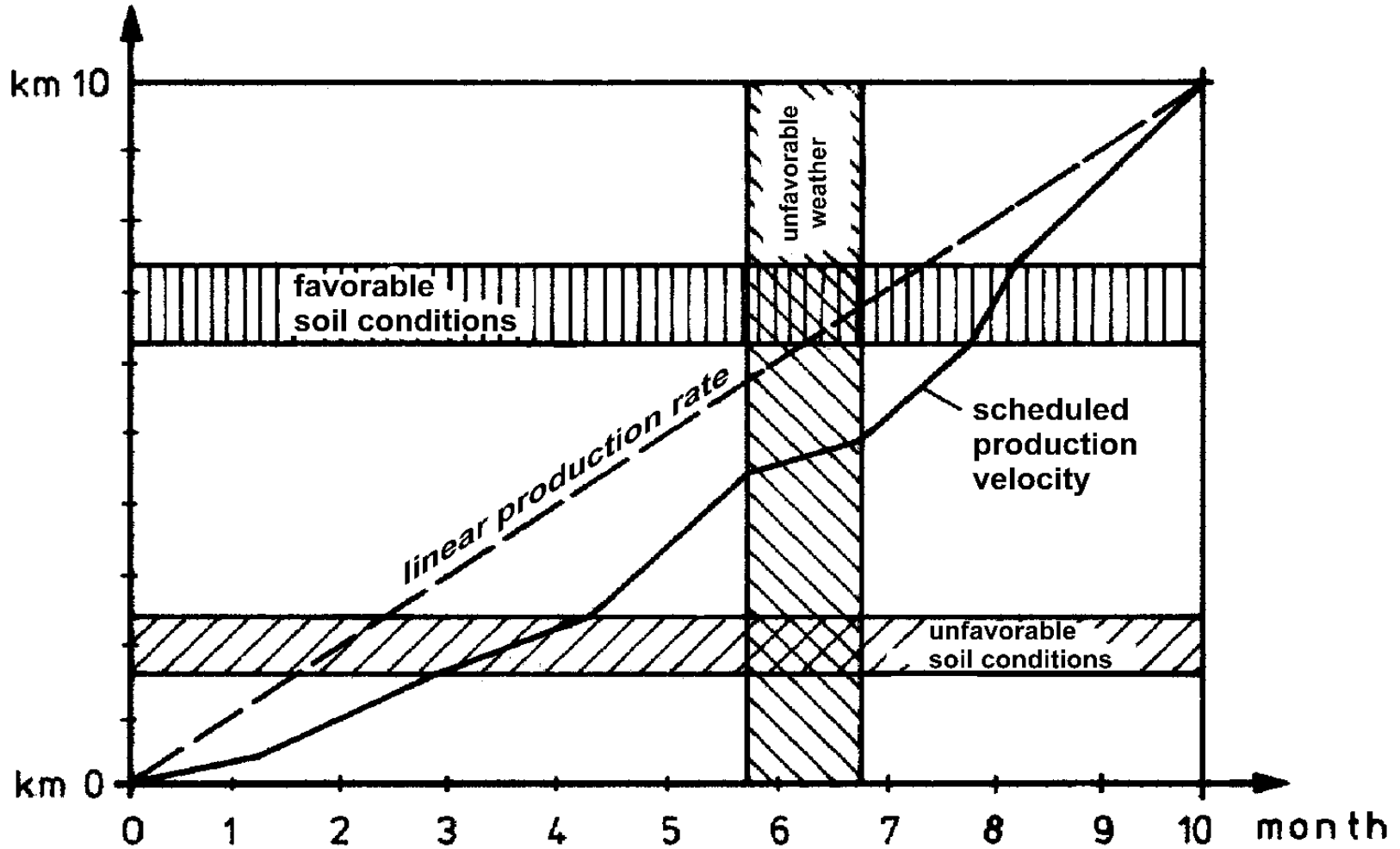
Velocity Diagram

Velocity diagrams present a graphical picture of the relationship between time and the accomplishment of an activity.

Velocity Diagram

- **The vertical axis of the diagram represents accomplishment of a work task; cubic yards excavated, miles of road built, kilometers of pipeline constructed**
- **The horizontal axis presents construction time**

Velocity Diagram



Chapter 4 Homework

- Due next class

-4.7

-4.13

