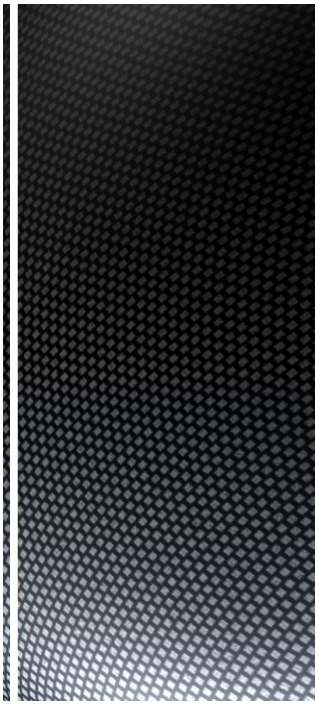

PM
(Project Management)

International Campus – Kish
Sharif University of Technology

Session#11

Course Description

- *Instructor*
  - *Omid Fatahi Valilai, Ph.D. Industrial Engineering Department, Sharif University of Technology*
  - *Email: Fvalilai@Sharif.edu , Tel: 021-6616-5706*
  - *Web site: http://sharif.edu/~fvalilai*
- *Class time*
  - *Thursday* *09:30~12:30-13:00~16:00- 16:30~19:30*
- *Course evaluation*
  - *Mid-term* *(30%)*
  - *Final exam* *(40%)*
  - *Quiz* *(10%)*
  - *Exercise* *(20%)*

Course Description *(Continued ...)*

- *Mid-term session:*
  - *23rd, Aban 1392*
- *Reference:*
  - *Kerzner, H., "Project Management—A Systems Approach to Planning, Scheduling, and Controlling, Eighth Edition", 2003, John Wiley & Sons, Inc.*
  - *Lewis, James P.; "Project planning, scheduling, and Control a hands-on guide to bringing projects in on time and on budget", 2001, McGraw-Hill*
  - *Project Management Institute; "A Guide to the Project; Management Body of Knowledge", 5th edition, 2013, Project Management Institute, Inc.*

Course Description *(Continued…)*

- *Course Calendar:*

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								W1																							
		Mo	Tu	We	Th	Fr	Sa	Su	Mo	Tu	We	Th	Fr	Sa	Su	Mo	Tu	We	Th	Fr	Sa	Su	Mo	Tu	We	Th	Fr	Sa	Su	Mo	Tu	
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9	Sep	23	24	25	26	27	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Oct	10
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						W5																									
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12	Dec	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Jan	1
	2014																													2014	

Course Description *(Continued..)*

- *Contents:*
  - *Chapter 1 - Overview*
  - *Chapter 2 - Project Management Growth—Concepts and Definitions*
  - *Chapter 3 - Organizational Structures*
  - *Chapter 4 - Organizing and Staffing the Project Office and Team*
  - *Chapter 5 - Management Functions*
  - *Chapter 6 - Time Management and Stress*
  - *Chapter 7 - Conflicts*
  - *Chapter 8 - Special Topics*
  - *Chapter 9 - The Variables for Success*
  - *Chapter 10 - Working with Executives*
  - *Chapter 11 - Planning*

Course Description *(Continued..)*

- *Contents:*
  - *Chapter 12 - Network Scheduling*
  - *Chapter 13 - Project Graphics*
  - *Chapter 14 - Pricing and Estimating*
  - *Chapter 15 - Cost Control*
  - *Chapter 16 - Trade-off Analysis in a Project Environment*
  - *Chapter 17 - Risk Management*
  - *Chapter 18 - Learning Curves*
  - *Chapter 19 - Modern Developments in Project Management*
  - *Chapter 20 - Quality Management*
  - *Chapter 21 - Contracts and Procurement*
  - *Chapter 22 - Critical Chain Project Management*

Chapter 12 – Network scheduling

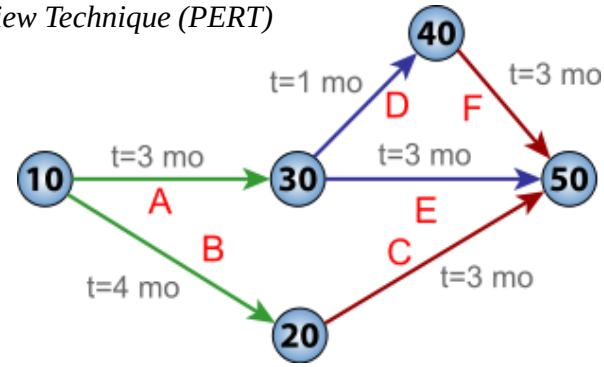
- *Introduction*
  - *A critical tool employed by a project manager is configuration management or configuration change control.*
  - *As projects progress downstream through the various life-cycle phases, the cost of engineering changes can grow boundlessly.*
  - *Configuration management is a control technique, through an orderly process, for formal review and approval of configuration changes. If properly implemented, configuration management provides*
    - *Appropriate levels of review and approval for changes*
    - *Focal points for those seeking to make changes*
    - *A single point of input to contracting representatives in the customer's and contractor's office for approved changes*

Chapter 12 – Network scheduling

- *Introduction*
  - *Management is continually seeking new and better control techniques to cope with the complexities, masses of data, and tight deadlines that are characteristic of highly competitive industries. Managers also want better methods for presenting technical and cost data to customers.*
  - *Scheduling techniques help achieve these goals. The most common techniques are:*
    - *Gantt or bar charts*
    - *Milestone charts*
    - *Networks*
    - *Program Evaluation and Review Technique (PERT)*
    - *Arrow Diagram Method (ADM) [Sometimes called the Critical Path Method (CPM)]*
    - *Precedence Diagram Method (PDM)*
    - *Graphical Evaluation and Review Technique (GERT)*

Chapter 12 – Network scheduling

- *Program Evaluation and Review Technique (PERT)*

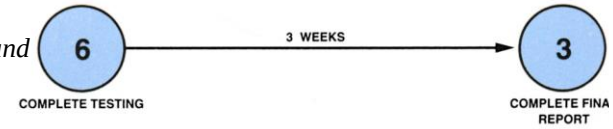


Chapter 12 – Network scheduling

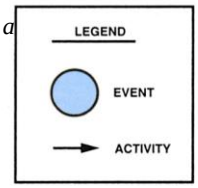
- *Program Evaluation and Review Technique (PERT)*
  - *A big advantage of PERT lies in its extensive planning.*
    - *PERT therefore determines where the greatest effort should be made to keep a project on schedule.*
  - *The second advantage of PERT is that one can determine the probability of meeting deadlines by development of alternative plans.*
    - *If the decision maker is statistically sophisticated, he can examine the standard deviations and the probability of accomplishment data.*
  - *A third advantage is the ability to evaluate the effect of changes in the program.*
    - *PERT can evaluate the effect of a contemplated shift of resources from the less critical activities to the activities identified as probable bottlenecks.*
  - *Finally, PERT allows a large amount of sophisticated data to be presented in a well-organized diagram from which contractors and customers can make joint decisions.*

Chapter 12 – Network scheduling

- *Network fundamentals*
  - *Interdependencies are shown through the construction of networks. Network analysis can provide valuable information for planning, integration of plans, time studies, scheduling, and resource management.*

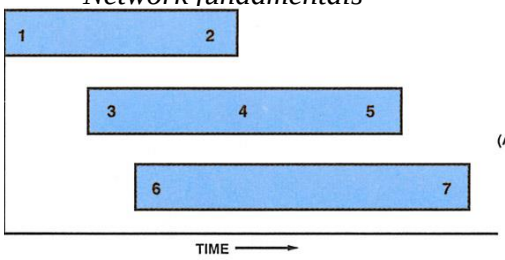


  - *Networks are composed of events and activities.*
    - *An event is defined as the starting or ending point for a group of activities, and*
    - *An activity is the work required to proceed from one event or point in time to another.*

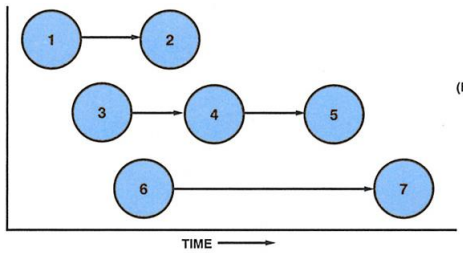


Chapter 12 – Network scheduling

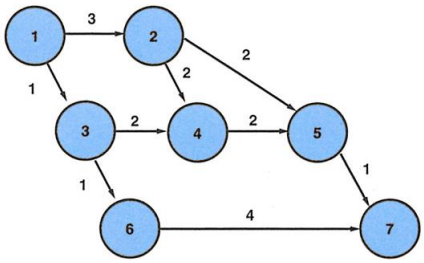
- *Network fundamentals*



(A) GANTT CHART



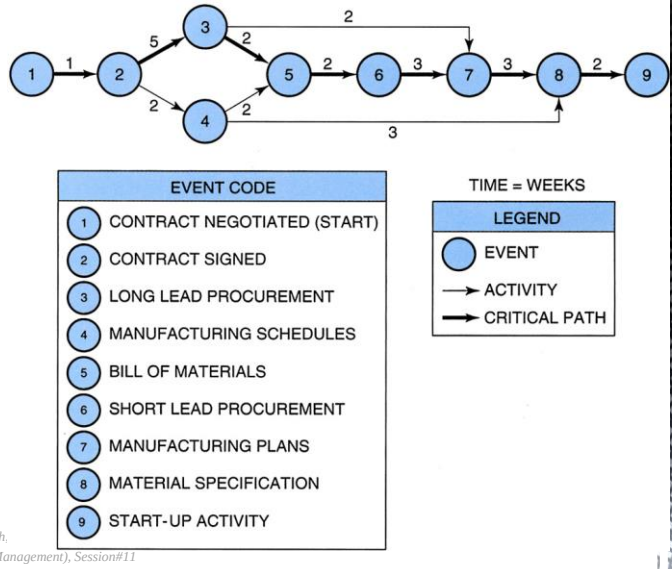
(B) MILESTONE CHAR



(C) PERT CHART

Chapter 12 – Network scheduling

SEQUENCE OF EVENTS			
Activity	*Title*	*Immediate Predecessors*	*Activity Time, Weeks*
1-2	*A*	—	*1*
2-3	*B*	*A*	*5*
2-4	*C*	*A*	*2*
3-5	*D*	*B*	*2*
3-7	*E*	*B*	*2*
4-5	*F*	*C*	*2*
4-8	*G*	*C*	*3*
5-6	*H*	*D,F*	*2*
6-7	*I*	*H*	*3*
7-8	*J*	*E,I*	*3*
8-9	*K*	*G,J*	*2*

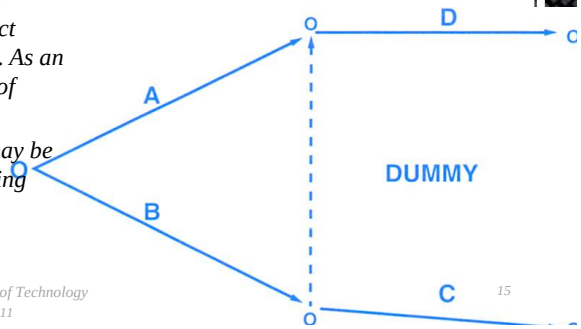


Chapter 12 – Network scheduling

- *Graphical evaluation and review technique (GERT)*
  - *Graphical evaluation and review techniques are similar to PERT but have the distinct advantages of allowing for looping, branching, and multiple project end results.*
  - *With PERT one cannot easily show that if a test fails, we may have to repeat the test several times.*
    - *With PERT, we cannot show that, based upon the results of a test, we can select one of several different branches to continue the project. These problems are easily overcome using GERT.*

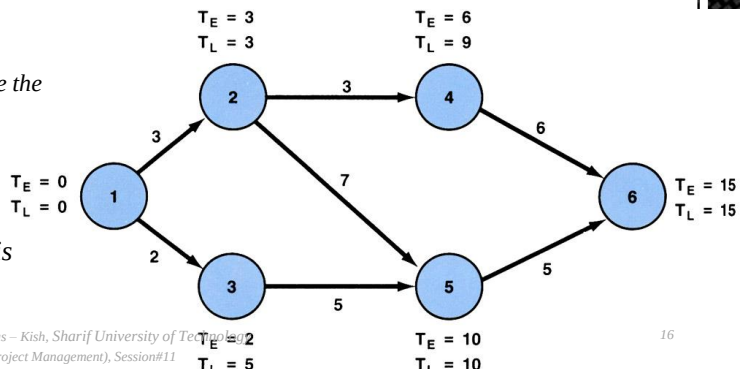
Chapter 12 – Network scheduling

- *Graphical evaluation and review technique (GERT)*
  - *There are three basic types of interrelationships or dependencies:*
    - *Mandatory dependencies (i.e., hard logic): These are dependencies that cannot change, such as erecting the walls of a house before putting up the roof.*
    - *Discretionary dependencies (i.e., soft logic): These are dependencies that may be at the discretion of the project manager or may simply change from project to project. As an example, one does not need to complete the entire bill of materials prior to beginning procurement.*
    - *External dependencies: These are dependencies that may be beyond the control of the project manager such as having contractors sit on your critical path.*



Chapter 12 – Network scheduling

- *Graphical evaluation and review technique (GERT)*
  - *Since there exists only one path through the network that is the longest, the other paths must be either equal in length to or shorter than that path.*
    - *Therefore, there must exist events and activities that can be completed before the time when they are actually needed.*
  - *The time differential between the scheduled completion date and the required date to meet critical path is referred to as the slack time*

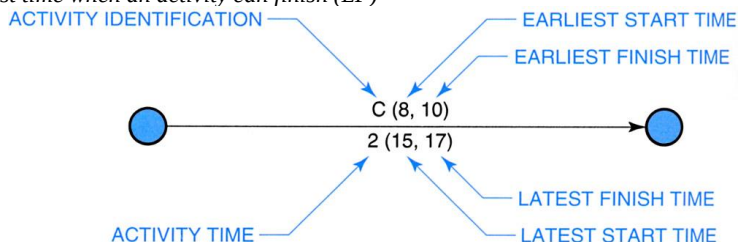


Chapter 12 – Network scheduling

- *Graphical evaluation and review technique (GERT)*
  - *Slack can be defined as the difference between the latest allowable date and the earliest expected date based on the nomenclature below:*
  - T_E *= the earliest time (date) on which an event can be expected to take place*
  - T_L *= the latest date on which an event can take place without extending the completion date of the project*
  - *Slack time =* $T_L - T_E$

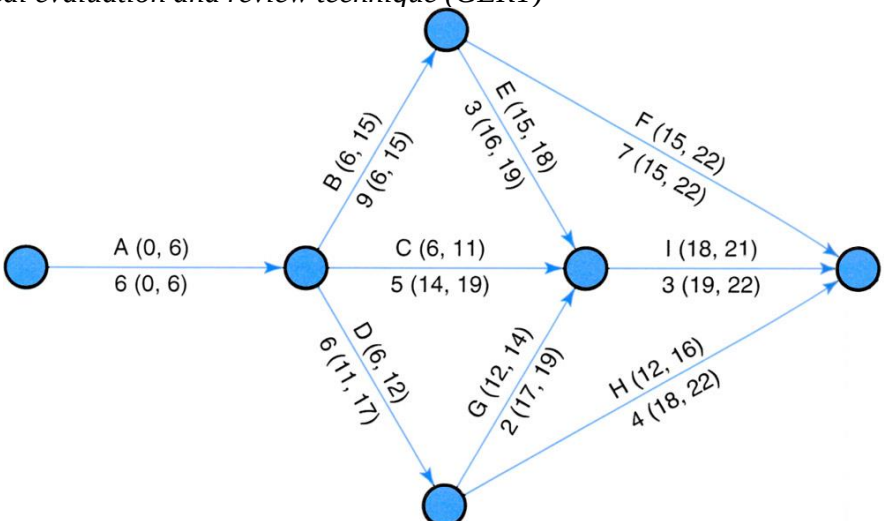
Chapter 12 – Network scheduling

- *Graphical evaluation and review technique (GERT)*
  - *Some people prefer to calculate the earliest and latest times for each activity instead. Also, the earliest and latest times were identified simply as the time or date when an event can be expected to take place. To make full use of the capabilities of PERT/CPM, we could identify four values:*
    - *The earliest time when an activity can start (ES)*
    - *The earliest time when an activity can finish (EF)*
    - *The latest time when an activity can start (LS)*
    - *The latest time when an activity can finish (LF)*



Chapter 12 – Network scheduling

- *Graphical evaluation and review technique (GERT)*



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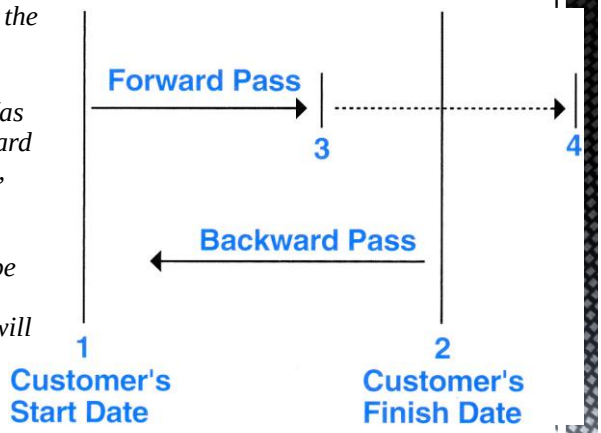
Chapter 12 – Network scheduling

- *Slack time*
  - *When performing a forward pass through a network, we work from left to right beginning at the customer's starting milestone (position 1).*
  - *The backward pass, however, begins at the customer's end date milestone (position 2), not (as is often taught in the classroom) where the forward pass ends. If the forward pass ends at position 3, which is before the customer's end date, it is possible to have slack on the critical path.*
  - *This slack is often called reserve time and may be added to other activities or filled with activities such as report writing so that the forward pass will extend to the customer's completion date.*



Chapter 12 – Network scheduling

- *Slack time*
  - *Negative slack usually occurs when the forward pass extends beyond the customer's end date.*
  - *However, the backward pass is still measured from the customer's completion date, thus creating negative slack.*
  - *This is most likely to result when:*
    - *The original plan was highly optimistic, but unrealistic*
    - *The customer's end date was unrealistic*
    - *One or more activities slipped during project execution*
    - *The assigned resources did not possess the correct skill levels*
    - *The required resources would not be available until a later date*

Chapter 12 – Network scheduling

- *Estimating activity time*
  - *Determining the elapsed time between events requires that responsible functional managers evaluate the situation and submit their best estimates.*
  - *The calculations for critical paths and slack times in the previous sections were based on these best estimates.*
  - *Many programs, however, include events and activities that are non-repetitive. In this case, the functional managers must submit their estimates using three possible completion assumptions:*
    - *Most optimistic completion time. This time assumes that everything will go according to plan and with minimal difficulties. This should occur approximately 1 percent of the time.*
    - *Most pessimistic completion time. This time assumes that everything will not go according to plan and maximum difficulties will develop. This should also occur approximately 1 percent of the time.*
    - *Most likely completion time. This is the time that, in the mind of the functional manager, would most often occur should this effort be reported over and over again*

Chapter 12 – Network scheduling

- *Estimating activity time*
  - *Before these three times can be combined into a single expression for expected time, two assumptions must be made.*
    - *The first assumption is that the standard deviation, σ, is one-sixth of the time requirement range. This assumption stems from probability theory, where the end points of a curve are three standard deviations from the mean.*
    - *The second assumption requires that the probability distribution of time required for an activity be expressible as a beta distribution.*

$$
\begin{aligned}
f(x;\alpha,\beta) &= \text{constant} \cdot x^{\alpha-1}(1-x)^{\beta-1} \\
&= \frac{x^{\alpha-1}(1-x)^{\beta-1}}{\int_0^1 u^{\alpha-1}(1-u)^{\beta-1}\,du} \\
&= \frac{\Gamma(\alpha+\beta)}{\Gamma(\alpha)\Gamma(\beta)}\,x^{\alpha-1}(1-x)^{\beta-1} \\
&= \frac{1}{\mathrm{B}(\alpha,\beta)}\,x^{\alpha-1}(1-x)^{\beta-1}
\end{aligned}
$$

Chapter 12 – Network scheduling

- *Estimating activity time*
  - *Before these three times can be combined into a single expression for expected time, two assumptions must be made.*
    - *The first assumption is that the standard deviation, σ, is one-sixth of the time requirement range. This assumption stems from probability theory, where the end points of a curve are three standard deviations from the mean.*
    - *The second assumption requires that the probability distribution of time required for an activity be expressible as a beta distribution.*

  - *The expected time between events can be found from the expression:*

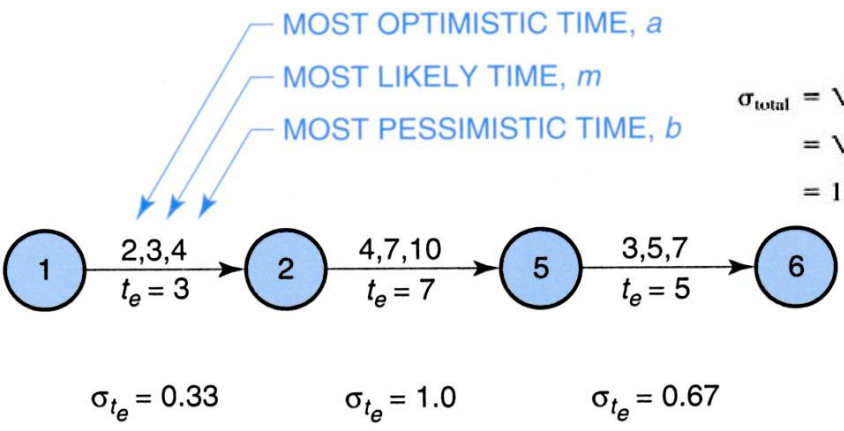
$$t_e = \frac{a + 4m + b}{6}$$

  - *where te = expected time, a = most optimistic time, b = most pessimistic time, and m = most likely time.*

Chapter 12 – Network scheduling

- *Estimating total program time*
  - *In order to calculate the probability of completing the project on time, the standard deviations of each activity must be known. This can be found from the expression:*

$$\sigma_{t_e} = \frac{b - a}{6}$$



$$\sigma_{\text{total}} = \sqrt{\sigma_{1\text{–}2}^2 + \sigma_{2\text{–}5}^2 + \sigma_{5\text{–}6}^2}$$
$$= \sqrt{(0.33)^2 + (1.0)^2 + (0.67)^2}$$
$$= 1.25$$

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Chapter 12 – Network scheduling

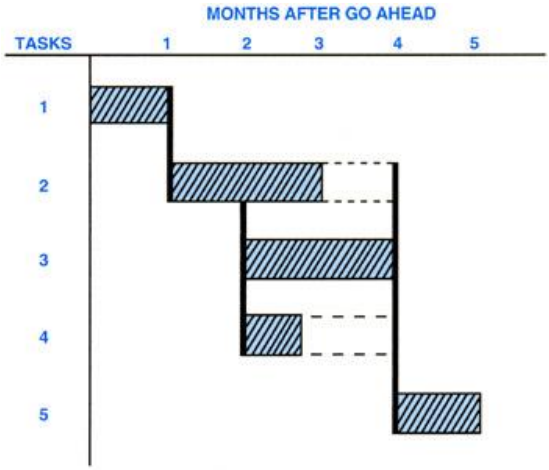
- *Total PERT/CPM planning*
  - *PERT scheduling is a six-step process.*
    - *Steps one and two begin with the project manager laying out a list of activities to be performed and then placing these activities in order of precedence, thus identifying the interrelationships. These charts drawn by the project manager are called either logic charts, arrow diagrams, work flow, or simply networks.*
      - *The activity time is not identified, and neither is the critical path.*
    - *Step three is reviewing the arrow diagrams with the line managers (i.e., the true experts) in order to obtain their assurance that neither too many nor too few activities are identified, and that the interrelationships are correct.*
    - *In step four the functional manager converts the arrow diagram to a PERT chart by identifying the time duration for each activity.*
      - *It should be noted here that the time estimates that the line managers provide are based on the assumption of unlimited resources because the calendar dates have not yet been defined.*

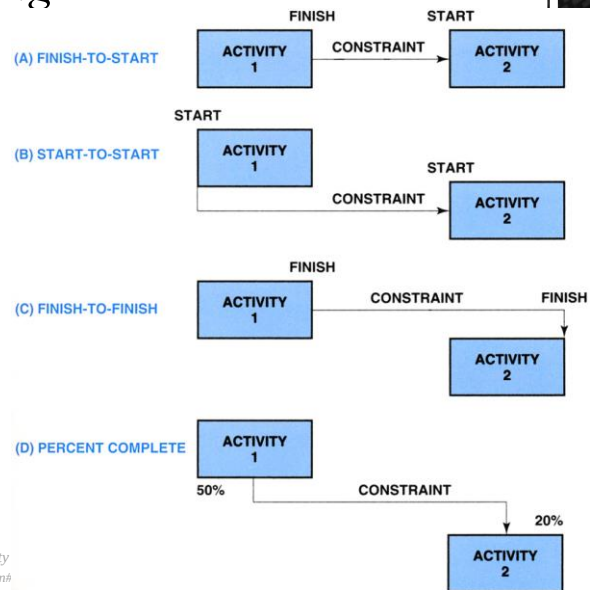
Chapter 12 – Network scheduling

- *Total PERT/CPM planning*
  - *PERT scheduling is a six-step process.*
    - *Step five is the first iteration on the critical path. It is here that the project manager looks at the critical calendar dates in the definition of the project's requirements.*
      - *If the critical path does not satisfy the calendar requirements, then the project manager must try to shorten the critical path using methods or by asking the line managers to take the "fat" out of their estimates.*
    - *Step six is often the most overlooked step. Here the project manager places calendar dates on each event in the PERT chart, thus converting from planning under unlimited resources to planning with limited resources.*
      - *If the line manager cannot commit to the calendar dates, then replanning will be necessary.*

Chapter 12 – Network scheduling

- *Precedence networks*





Chapter 12 – Network scheduling

- *Lag*
  - *The time period between the early start or finish of one activity and the early start or finish of another activity in the sequential chain is called lag.*
    - *Lag is most commonly used in conjunction with precedence networks*