



Chapter 6

Time Management

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1

Introduction

- Time management is currently the second-most difficult knowledge area on the exam.
- Many people have not learned and do not use the time management techniques.
- You should know manual methods for drawing network diagrams and scheduling.

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2

Time Management Definition

- Project Time Management includes the processes required to ensure timely completion of the project.

Processes

- **Activity Definition:** identifying the specific activities that must be performed to produce the various project deliverables.
- **Activity Sequencing:** identifying and documenting interactivity dependencies.
- **Activity Resource Estimating:** estimating resources required for each activity.
- **Activity Duration Estimating:** estimating the number of work periods that will be needed to complete individual activities.
- **Schedule Development:** analyzing activity sequences, activity durations, and resource requirements to create the project schedule.
- **Schedule Control:** controlling changes to the project schedule.

Define Activity

- Defining the schedule activities involves identifying and documenting the work that is planned to be performed.
- The Activity Definition process will identify the deliverables at the lowest level in the work breakdown structure (WBS), which is called the work package.
- Project work packages are planned (decomposed) into smaller components called schedule activities to provide a basis for estimating, scheduling, executing, and monitoring and controlling the project work.
- Implicit in this process is defining and planning the schedule activities such that the project objectives will be met.

Activity Definition Tools & Techniques

1. Decomposition

- The technique of decomposition, as it is applied to activity definition, involves subdividing the project work packages into smaller, more manageable components called schedule activities.
- The Activity Definition process defines the final outputs as schedule activities rather than as deliverables, as is done in the Create WBS process
- The activity list, WBS, and WBS dictionary can be developed either sequentially or concurrently, with the WBS and WBS dictionary being the basis for development of the final activity list.
- Each work package within the WBS is decomposed into the schedule activities required to produce the work package deliverables.
- This activity definition is often performed by the project team members responsible for the work package.

Activity Definition Tools & Techniques (cont'd)

2. Templates

- A standard activity list or a portion of an activity list from a previous project is often usable as a template for a new project.
- The related activity attributes information in the templates can also contain a list of resource skills and their required hours of effort, identification of risks, expected deliverables, and other descriptive information.
- Templates can also be used to identify typical schedule milestones.

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7

Activity Definition Tools & Techniques (cont'd)

3. Rolling Wave Planning

- Rolling wave planning is a form of progressive elaboration planning where the work to be accomplished in the near term is planned in detail at a low level of the WBS, while work far in the future is planned for WBS components that are at a relatively high level of the WBS.
- The work to be performed within another one or two reporting periods in the near future is planned in detail as work is being completed during the current period. Therefore, schedule activities can exist at various levels of detail in the project's life cycle.
- During early strategic planning, when information is less defined, activities might be kept at the milestone level.

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8

Activity attributes

- The activity attributes include: identified assumptions, constraints, person responsible for performing the work, geographic area or building where the work has to be performed ...etc.

SEQUENCE ACTIVITY - NETWORK DIAGRAM

- The network diagram shows HOW the project tasks will flow from beginning to end.
- Once estimates are available for each task, the network diagram also proves your best estimates of how long the project should take to complete.

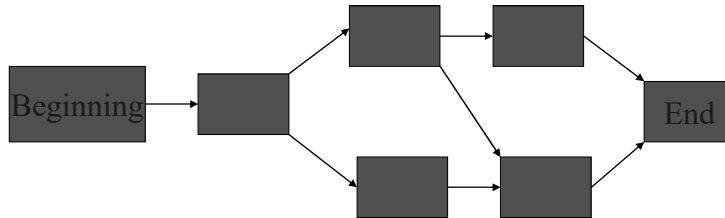
NETWORK DIAGRAM continued

- If plotted out against time (or placed against a calendar based scale) the network diagram would be a time scaled network diagram.
- A network diagram is completed after the project charter, project staffing and WBS.

NETWORK DIAGRAM continue

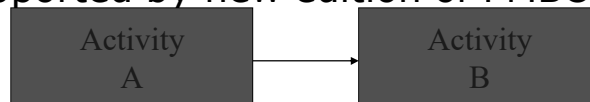
- A network diagram is created by putting the project tasks (or work packages) from the lowest level of the WBS in their order of completion from project beginning to end.
- This is called activity sequencing. The resulting diagram may look like the following one.

NETWORK DIAGRAM continue



METHODS TO DRAW NETWORK DIAGRAMS

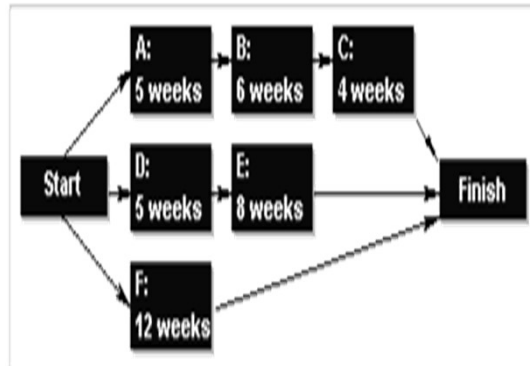
- There are two ways to draw a network diagram, activity – on - arrow or activity - on – node. Today most of us are used to be working with AON. AOA is also not supported by new edition of PMBOK.



ACTIVITY-ON-NODE (AON) OR PRECEDENCE DIAGRAMMING METHOD (PDM)

PDM

- In this method, boxes are used to represent tasks and arrows represent the logical relationship (dependencies) between tasks.



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15

AON continue

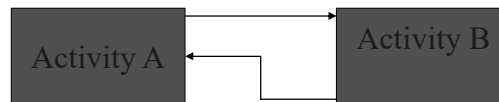
- There can be four types of relationships between tasks:
 - 1 - Finish - to - start - the initiation of the work of the successor depends upon the completion of the work of the predecessor.
 - 2 - Finish - to - finish - the completion of the work of the successor depends upon the completion of the work of the predecessor.
 - 3 - Start - to - start - the initiation of the work of the successor depends upon the initiation of the work of the predecessor.
 - 4 - Start - to - Finish - the completion of the successor is dependant upon the initiation of the predecessor.

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16

GERT

- A network diagram drawing method that allows loops between tasks. The easiest is when you have a task to design a component and then test it. After testing, it may or may not need to be redesigned.



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17

TYPES OF DEPENDENCIES

- The sequence of tasks depends on the following dependencies:
 - **MANDATORY DEPENDENCY** (Hard Logic) – Inherent in the nature of the work being done (e.g., you must design before you can construct.)

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18

TYPES OF DEPENDENCIES continue

- DISCRETIONARY DEPENDENCY (Preferred, Preferential, or Soft Logic) – Based on experience, desire, or preferences.
- EXTERNAL DEPENDENCY – Based on the needs or desires of a party outside the project (e.g. government or suppliers.)

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19

Leads & Lags

- **A lead** allows an acceleration of the successor activity. For example, a technical writing team can begin writing the second draft of a large document (the successor activity) fifteen days before they finish writing the entire first draft (the predecessor activity). This could be accomplished by a finish-to-start relationship with a fifteen-day lead time.
- **A lag** directs a delay in the successor activity. For example, to account for a ten-day curing period for concrete, a ten-day lag on a finish-to-start relationship could be used, which means the successor activity cannot start until ten days after the predecessor is completed.

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20

Estimate Activity Resource -Alternatives Analysis

- Many schedule activities have alternative methods of accomplishment. They include using various levels of resource capability or skills, different size or type of machines, different tools (hand versus automated), and make-or-buy decisions regarding the resource

Published estimating data

- Several companies routinely publish updated production rates and unit costs of resources for an extensive array of labor trades, materials, and equipment for different countries and geographical locations within countries.

ESTIMATING

- You should understand that people doing the work (not the project manager or senior managers) should create estimates.
The role of the project manager is to:
- Provide the team with enough information to properly estimate each task.
- Complete a sanity check of the estimate.
- Formulate a reserve (more on this later).

ESTIMATING continue

- “The art and science of using historical data, personal expertise, institutional memory, and the project scope statement to predict the resource expenditures, total cost, and duration of a project”
Estimates can come from any of the following:
- **Guess.** (Yes, this is okay. Remember we are estimating based on a WBS. Estimating a small task by guessing will be more accurate than doing the same for a larger task.)
- **Actual costs** – Labor, material, overhead, risk.
- **Benchmarks** – Comparing your performance to that of another company

Estimating Accuracy Depends On The Detail Of The WBS

- Top level
 - Order of Magnitude, Conceptual, “Ballpark”
 - Low accuracy
- Mid level
 - Budgetary, Proposal, Contractual
 - Better accuracy
- Work Package level
 - Definitive, Based on real work effort and resources
 - Best accuracy

Resource breakdown structure

- The RBS is a hierarchical structure of the identified resources by resource category and resource type.

Estimate Activity Duration Analogous Estimating

- Analogous estimating: (Top-Down estimating) means using the actual duration of previous, similar activity as the basis for estimating the duration of a future activity.
- It is frequently used to estimate project duration when there is a limited amount of detailed information about the project (e.g. in the early phases)

Program Evaluation and Review Technique (PERT)

- Program Evaluation and Review Technique (PERT): uses a weighted average duration estimate to calculate activity durations.

Three-point estimates

- You should remember that this method
 - Has three estimates for activity
 - ✓ Optimistic.
 - ✓ Pessimistic.
 - ✓ Most likely.
 - Can be used to estimate time or cost.
 - Can be drawn only on an activity – on – arrow (AOA) diagram.
 - Can have dummies.

ESTIMATING USING Three-point estimates

- In the form of estimating, the person estimating the task provides an optimistic, pessimistic, and most likely estimate for each task.
- You must memorize three formulas, however, there are only a few questions on the exam on this topic.

PERT formula $\frac{(P+4M+O)}{6}$	Standard deviation of a task using PERT $\frac{(P-O)}{6}$	Variance of task using PERT $[\frac{(P-O)}{6}]^2$
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Quantitatively Based Durations

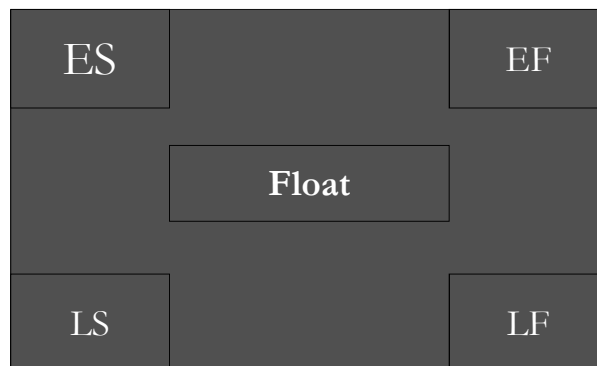
- The quantities to be performed for each specific work category.
- Expected Qty for Activity A: 10 units.
- Productivity unit rate: 2day/unit.
- Total duration: 20 days

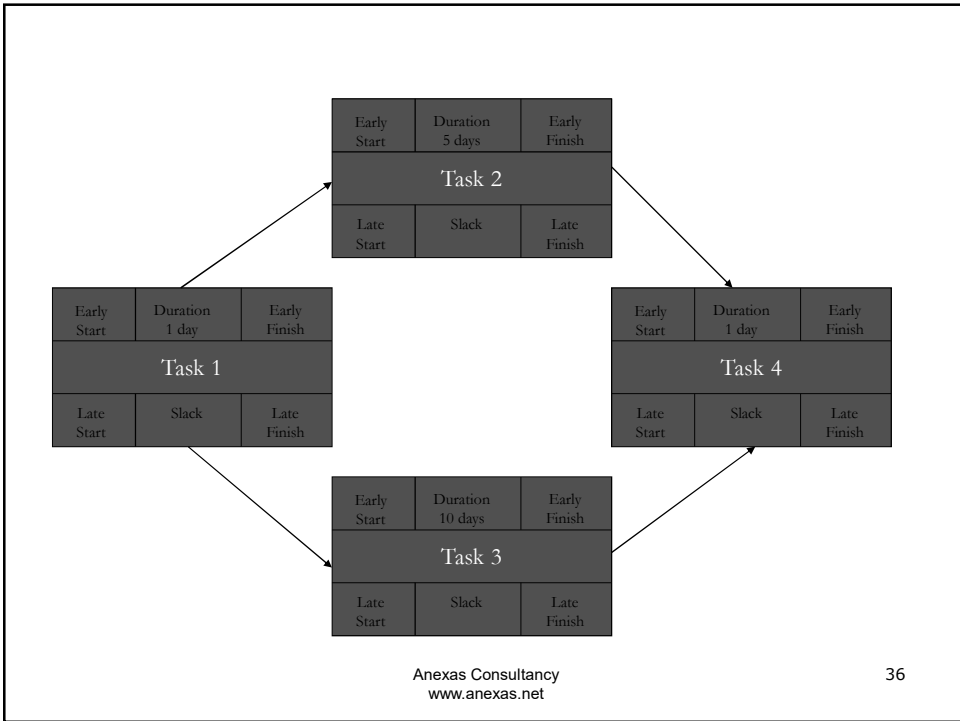
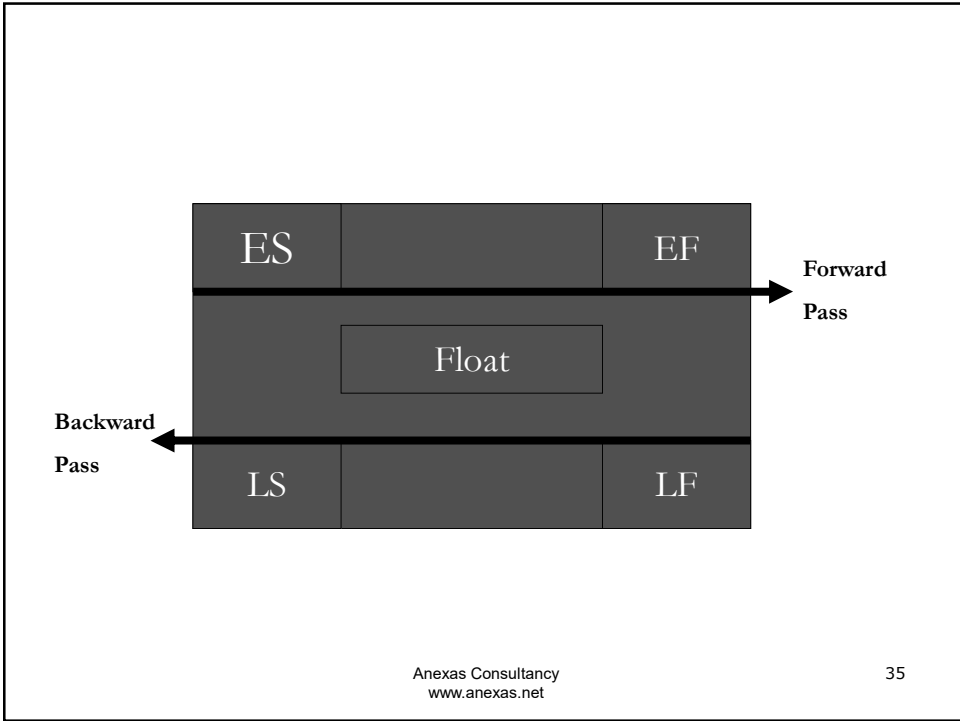
Schedule Network Analysis

- Critical Path Method
- PERT
- Schedule compression
- What-if-scenario analysis
- Resource leveling

CRITICAL PATH

- Once you create a network Diagram and estimate tasks, you can find the critical path.
- The critical path is the longest path through a network diagram and determines the earliest completion of the project.
- The easiest way to find the critical path is to add up the lengths of time for each path in a network diagram. The longest path is the critical path.
- Although the critical path may change over time, it helps prove how long the project should take and indicates to the project manager which tasks need more monitoring.
- The critical path almost has no slack (defined later).





Calculating the Forward Pass

- The start node begins with zero as the early start (ES) date for the first task.
- Add the duration of the task to calculate the early finish (EF).
- Add any *lags*, the wait time between two tasks. This yields the ES of the next or successor task.
- If there are two or multiple predecessor tasks, take the latest (which has a higher number) of the EFs of the predecessors to identify the ES of the successor.
- Continue through each path until you reach the end/finish node.
- If there are multiple activities at the end, the latest EF becomes the project duration, and the LF (late finish) is the conclusion of all the activities coming off the finish node.

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37

Calculating the Backward Pass

- Start calculating the backward pass from the end/finish node and work backward toward the start node.
- Subtract the duration from the LF. This number is the late start (LS). Subtract any lags (from the LS), and the result becomes the LF of the predecessor task.
- If there are two or multiple successor task, take the earliest LS (which has the lowest number) as the LF of the predecessor. Continue calculating the start node.
- Check for float, the difference between the ES and LS. Note that one of the paths (invariably, the longest one) will have any float—its float will be zero. This is the critical path.

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38

Float Equations

- Float or Slack = Late Start – Early Start
or
Late Finish – Early Finish
- Early Finish = Early Start + Duration
- Late Start = Late Finish - Duration

SLACK (FLOAT)

- The amount of time a task can be delayed without delaying the project. Tasks on the critical path almost always have no slack.
- Slack is extremely useful for the project manager to understand as it allows for better allocation for resources and other areas of the project.
- Slack used up, the task ends up changing the critical path and makes the project more risky.
- Such information also helps team members juggle multiple projects by telling them how much flexibility they have on each task they are working on.

SLACK continue

The general definition of slack can be defined further to the following subcategories of slack:

- 1. Free slack (float)** – the amount of time a task can be delayed without delaying the early start date of its successor, and
- 2. Total slack (float)** – the amount of time a task can be delayed without delaying the project completion date.
- 3. Project slack (float)** – the amount of time a project can be delayed without delaying the externally imposed project completion required by the customer, management, or previously committed to be the project manager.

Mathematical Analysis

- Calculating theoretical early and late start and finish dates for all project activities without any resource pool limitations. Your goal is to show dependencies on predecessor and successor tasks. The most common analysis techniques are as follows:
 - o CPM
 - o GERT
 - o PERT
 - o Monte Carlo Simulation

Critical Path Method (CPM)

- Works by making two separate paths through the network. A *forward pass* through the entire network determines the early start and early finish dates. The earliest finish date for the last task in the network establishes the earliest project end date.
- Next, CPM uses a second, *backward pass* to calculate the late start and late finish dates.
- The difference between the late date and the early date of a task is the amount of *total slack* (also called *total float*) on a task. Critical tasks have zero slack.

Graphical Evaluation and Review Technique (GERT)

- Allows for probabilistic treatment of both network logic and activity duration estimates.
- Some activities may not be performed at all.
- GERT allows for loops or conditional branches; none of the other methods permit loops. Loops might include testing, rework, and retesting.

PERT

- Uses sequential network logic and weighted-average duration estimates to calculate project duration.
- Although PERT is an older technique that is seldom used anymore, PERT-like estimates are often used in CPM calculations.
- Today's PERT-like estimates use a weighted average (mean) to estimate durations.

MONTE CARLO SIMULATION

- This method of estimating uses a computer to simulate the outcome of a project based on PERT estimates (optimistic, pessimistic, and most likely estimates) and the network diagram, but does not use the PERT formula.
- The simulation tell you:
 - The probability of completing the project on any specific day.
 - The probability of completing the project for any amount of cost.
 - The probability of any task actually being on the critical path.
 - The overall project risk.

SHORTENING THE SCHEDULE

Crashing and fast tracking are two ways to shorten the project schedule. This most often needs to happen in two circumstances.

- First, management says the project duration is too long.
- Second, a change has been made to the project, or the desired completion date changes.
- NB: Any shortening in the schedule should be done on the Critical Path

CRASHING

- Adding more resources to the critical path. This can take the form of moving resources from non – critical tasks or adding extra resources to the task from outside the project.
- Crashing almost always results in increased costs.
- It includes:
 - Multiple-shift work
 - Extended workdays
 - Using more productive equipment
 - Increasing the number of craftspeople
 - Using materials with faster installation
 - Using alternate methods

FAST TRACKING

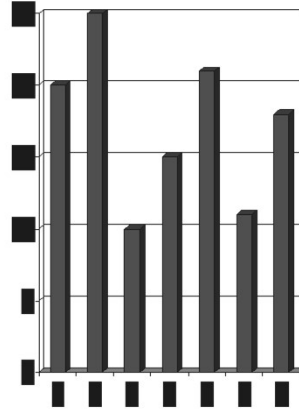
- Doing more tasks in parallel.
- Fast tracking often results in rework and usually increases risk and requires more attention to communication.
- In crashing or fast tracking, it is best to see all potential choices and then select the choice or choices that have the least impact on the project.
- If you have negative project float (the estimated completion date is after the desire date), would your first choice be to tell the customer that the date could not be met or to ask for more time?
- No, the first choice would be to crash or fast track to analyze what could be done about itself.

FAST TRACKING continue

- But if you have to choose between crashing and fast tracking, what would you do?
- Adding resources to the project would generally cost more than fast tracking and one would choose fast tracking. However, crashing can also mean moving resources around within the project.
- In this case, if making such move does not add cost, then crashing would be preferable to fast tracking as it would not affect the risk and complexity of the project.
- Think about this! In the real world many project managers use the network diagram to manage day – to – day operations of the project and to make adjustments when changes occur and dates change.

Resource Leveling

- Resource leveling is a little-used tool in project management software. You would level the resources if your project utilized 5 resources one month, 15 the next and 3 the next, or some other up and down pattern that was not an acceptable use of resources.



Resource Leveling (continue)

- It could also be used if you do not have 15 resources available and would prefer to lengthen the project, a result of leveling, instead of hiring more resources.
- Leveling allows you to level the peaks and valleys of resource use from one month to another resulting in a more stable number of resources used on your project but letting schedule and cost slip

Critical chain method

- Critical chain is another technique that modifies the project schedule to account for limited resources.
- Critical chain mixes deterministic and probabilistic approaches. Initially, the schedule network is built using activity logic, required dependencies, and defined constraints as input. Then, the critical path is calculated. After the critical path is identified, resource availability is entered and the resource driven result is determined.
- The result often alters the critical path

Schedule Management Plan

- Once the schedule is developed, the project manager can and must put in place a plan for effectively managing the project to the schedule and will manage changes. Such a plan can be formal or informal but is part of project plan.
- A schedule management plan requires that progress be measured along the way and that the measures of performance are determined in advance. How would you measure schedule performance during the project?

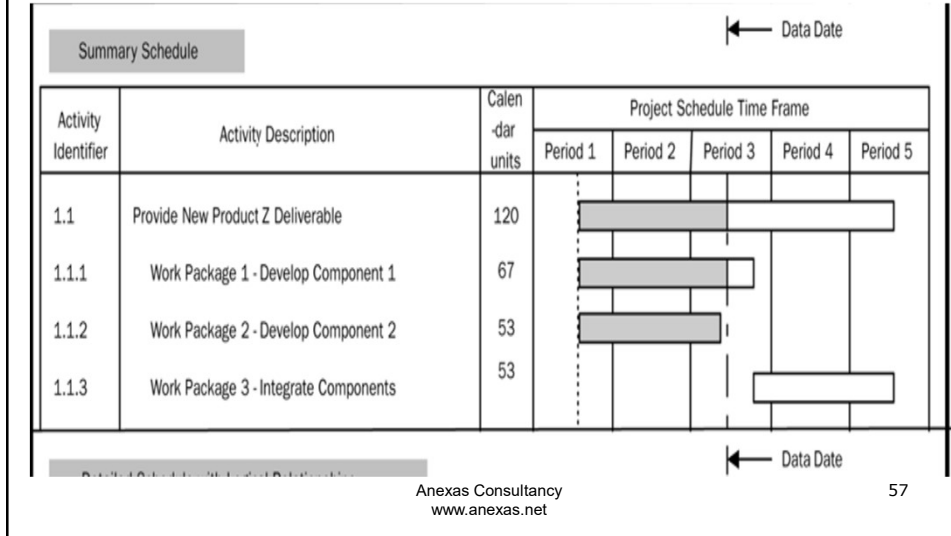
MILESTONE CHARTS

- These are similar to bar charts but only show major events.
- Remember that milestones have no duration; they are simply the completion of activities.
- Milestones may include "requirements are complete" or "design is finished" and are part of the inputs for activity sequencing.
- Milestone charts are a good tools for reporting to management and the customer.

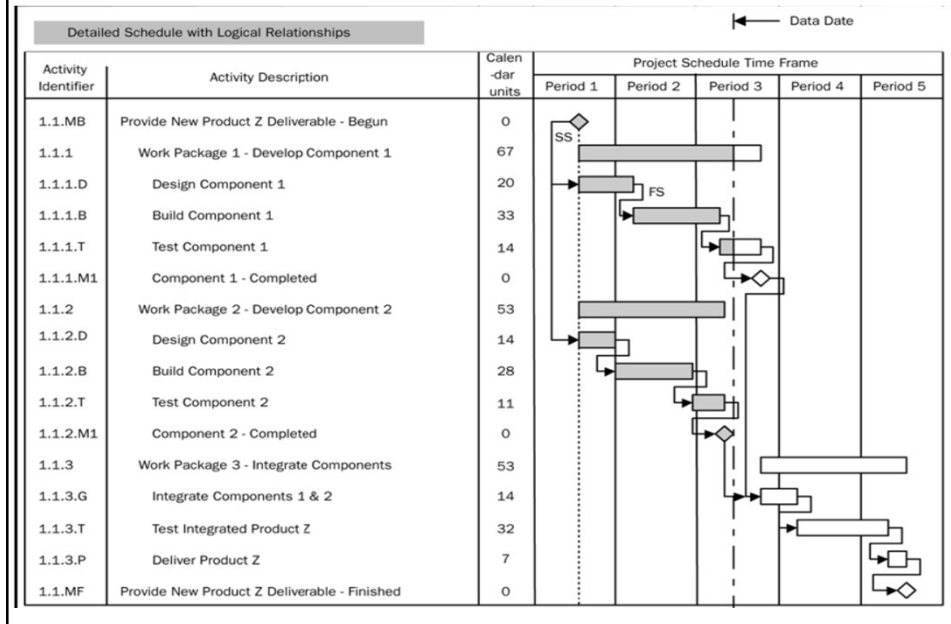
Schedule Development Outputs

Milestone Schedule								
Activity Identifier	Activity Description	Calendar units	Project Schedule Time Frame					
			Period 1	Period 2	Period 3	Period 4	Period 5	
1.1.MB	Provide New Product Z Deliverable - Begun	0	◆					
1.1.1.M1	Component 1 - Completed	0			◆			
1.1.2.M1	Component 2 - Completed	0			◆			
1.1.MF	Provide New Product Z Deliverable - Finished	0					◆	

Schedule Development Outputs



Schedule Development Outputs



Some Definitions

- **Heuristics:**
A heuristic means a rule of thumb.
Several types of heuristics exist, some are scheduling, estimating, planning and resource leveling.

Question 1

- **To control the schedule, a project manager is re-analyzing the project to predict project duration. She does this by analyzing the sequence of activities with the least amount of scheduling flexibility. What technique is she doing?**

A. Critical path
B. Flow chart
C. Precedence diagramming
D. Work breakdown structure

Answer A

- **There are only two choices related to scheduling. A and C. Choice C, however, is a diagramming technique that deals with the relationship between activities, not schedule flexibility.**

Question 2

- **A dependency requiring that design be completed before manufacturing can start is an example of a:**
 - A. Discretionary dependency
 - B. External dependency
 - C. Mandatory dependency
 - D. Scope dependency

Answer C

- **Since the dependency is required, it could not be discretionary (choice A) and therefore must be mandatory. No mention is made that the dependency comes from a source outside the project, so external (choice B) is not correct. Scope dependency (choice D) is not a defined term. The key word in this question is "requires". The question defines a mandatory dependency.**

Question 3

- **Which of the following are GENERALLY illustrated BETTER by bar charts than network diagrams?**
 - A. Logical relationships
 - B. Critical paths
 - C. Resource trade-offs
 - D. Progress or status

Answer D

- **The bar chart or (Gantt chart) is designed to show a relationship of activities to time. This is the best use when demonstrating progress or status as a factor of time.**

Question 4

- **If the optimistic estimate for an activity is 12 days, and the pessimistic estimate is 18 days, what is the standard deviation of this activity?**
- A. 1
B. 1.3
C. 6
D. 3

Answer A

- **The standard deviation is computed by $(P - O)/6$. therefore, the answer is $(18 - 12)/6 = 6/6=1$.**

Question 5

- **A heuristic is best described as a:**
 - A. Control tool.
 - B. Scheduling method.
 - C. Planning tool.
 - D. Rule of thumb.

Answer D

- **A heuristic is a rule of thumb. Examples are cost per line of code, cost per square foot of floor space, etc.**