
Operations Management

Project Management Chapter 16

Outline

- .. Global Company Profile: Bechtel
- .. The Strategic Importance of Project Management
- .. Project Planning
 - .. The Project Manager
 - .. Work Breakdown Structure
- .. Project Scheduling
- .. Project Controlling

Outline - continued

- .. Project Management Techniques: PERT and CPM
 - .. The Framework of PERT and CPM
 - .. Activities, Events, and Networks
 - .. Dummy Activities and Events
 - .. PERT and Activity Time Estimates
 - .. Critical Path Analysis
 - .. The Probability of Project Completion
 - .. Case Study of PERT: Schwabe Foundry

Outline - continued

- .. Cost-Time Tradeoffs and Project Crashing
- .. Applying Project Scheduling to Service Firms
- .. A Critique of PERT and CPM

Learning Objectives

- .. Explain what a project is
- .. Summarize the 3 main project management activities
- .. Draw project networks
- .. Compare PERT & CPM
- .. Determine slack & critical path
- .. Compute project probabilities
- .. Critique PERT and CPM

Bechtel

- .. Asked by Kuwait to begin rebuilding after Desert Storm
- .. 650 wells ablaze, others uncapped
- .. No water, electricity, food or facilities
- .. Land mines! Bombs! Grenades!
- .. Many fires inaccessible because of oil-covered roads

Bechtel

- .. Project required:
 - .. Storage, docking, and warehousing facilities at Dubai
 - .. 125,000 tons of equipment and supplies
 - .. 150 kilometers of pipeline capable of delivering 20,000,000 gallons of water per day to the fire site
 - .. more than 200 lagoons with 1,000,000 gals of seawater

Strategic Importance of Project Management

- .. Bechtel Kuwait Project:
 - .. 8,000 workers
 - .. 1,000 construction professionals
 - .. 100 medical personnel
 - .. 2 helicopter evacuation teams
 - .. 6 full-service dining halls
 - .. 27,000 meals per day
 - .. 40 bed field hospital

Strategic Importance of Project Management - continued

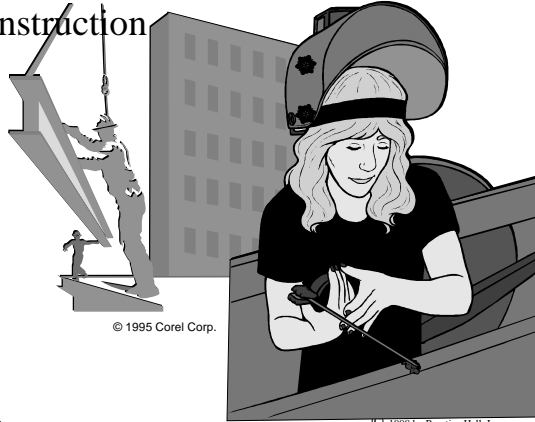
- .. Microsoft Windows 98 Project:
 - .. hundreds of programmers
 - .. millions of lines of code
 - .. millions of dollars cost
- .. Ford Redesign of Mustang Project:
 - .. 450 member project team
 - .. Cost \$700-million
 - .. 25% faster and 30% cheaper than comparable project at Ford

Project Characteristics

- .. Single unit
- .. Many related activities
- .. Difficult production planning and inventory control
- .. General purpose equipment
- .. High labor skills

An Example

“ Building construction



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An Example

“ Research project



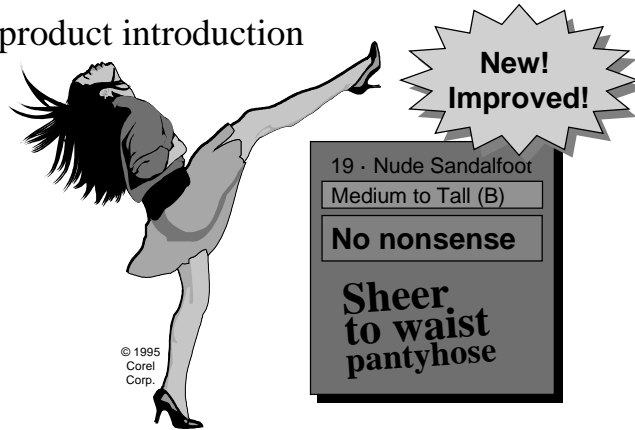
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An Example

- .. New product introduction



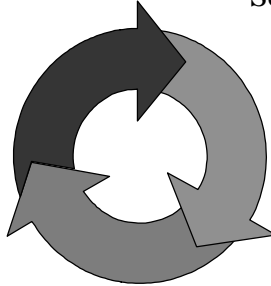
Management of Large Projects

- .. Planning - goal setting, project definition, team organization
- .. Scheduling - relating people, money, and supplies to specific activities and activities to one and other
- .. Controlling - monitoring resources, costs, quality, and budgets; revising plans and shifting resources to meet time and cost demands

Project Management Activities

Planning

- Objectives
- Resources
- Work break-down schedule
- Organization



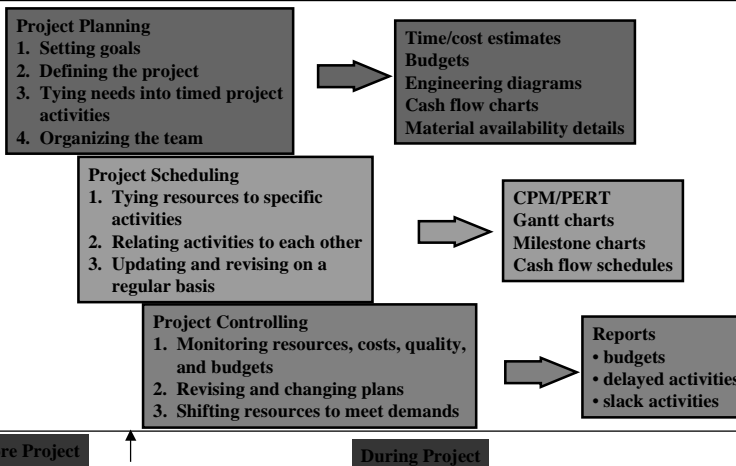
Scheduling

- Project activities
- Start & end times
- Network

Controlling

- Monitor, compare, revise, action

Project Planning, Scheduling, and Controlling



Project Planning

- .. Establishing objectives
- .. Defining project
- .. Creating work breakdown structure
- .. Determining resources
- .. Forming organization

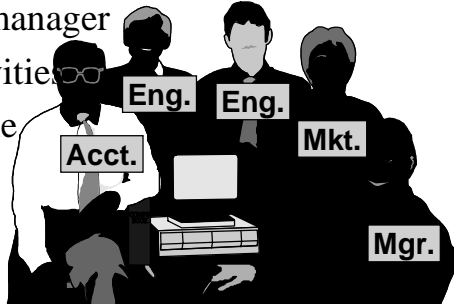


Project Organization Works Best When

- .. Work can be defined with a specific goal and deadline
- .. The job is unique or somewhat unfamiliar to the existing organization
- .. The work contains complex interrelated tasks requiring specialized skills
- .. The project is temporary but critical to the organization

Project Organization

- .. Often temporary structure
- .. Uses specialists from entire company
- .. Headed by project manager
 - .. Coordinates activities
 - .. Monitors schedule & costs
- .. Permanent structure called 'matrix organization'



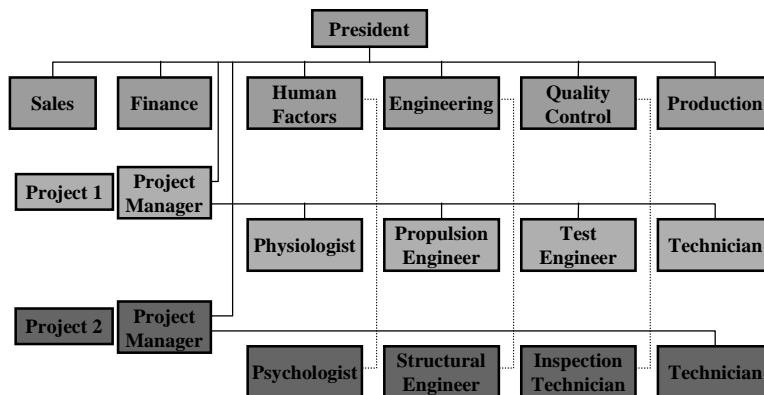
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A Sample Project Organization

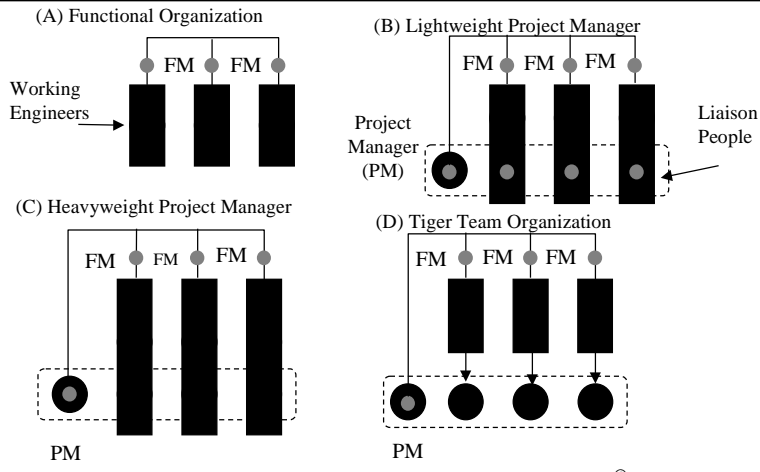


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Types of Organizations for Development Projects



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Matrix Organization

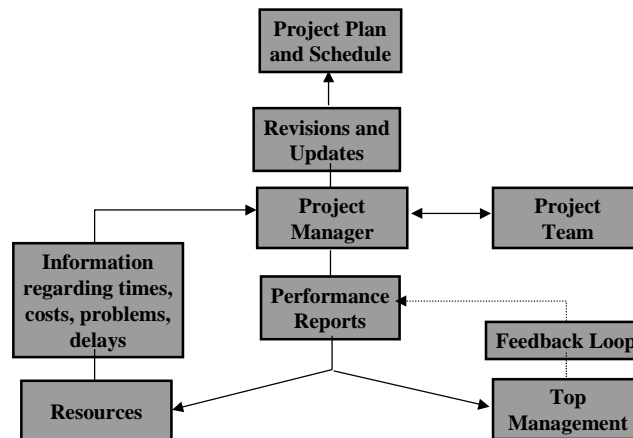
	Mkt	Oper	Eng	Fin
Project 1	☺☺		☺☺	
Project 2	☺	☺	☺	☺
Project 3		☺☺	☺	
Project 4	☺	☺☺	☺☺	

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The Role of the Project Manager



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Work Breakdown Structure

- .. 1. Project
- .. 2.. Major tasks in the project
- .. 3. Subtasks in the major tasks
- .. 4. Activities

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Project Scheduling

- .. Sequencing activities
- .. Identifying precedence relationships
- .. Determining activity times & costs
- .. Estimating material & worker requirements
- .. Determining critical activities



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Purposes of Project Scheduling

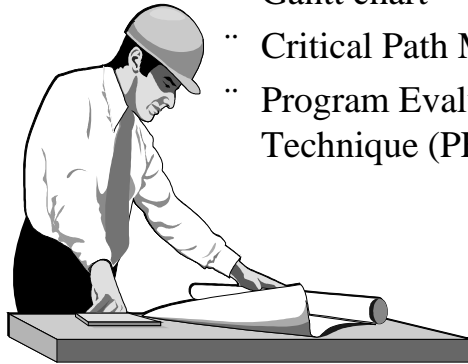
- .. Shows the relationship of each activity to others and to the project as a whole
- .. Identifies the precedence relationships among activities
- .. Encourages the setting of realistic time and cost estimates for each activity
- .. Helps make better use of people, money, and material resources by identifying critical bottlenecks

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Project Scheduling Techniques



- .. Gantt chart
- .. Critical Path Method (CPM)
- .. Program Evaluation & Review Technique (PERT)

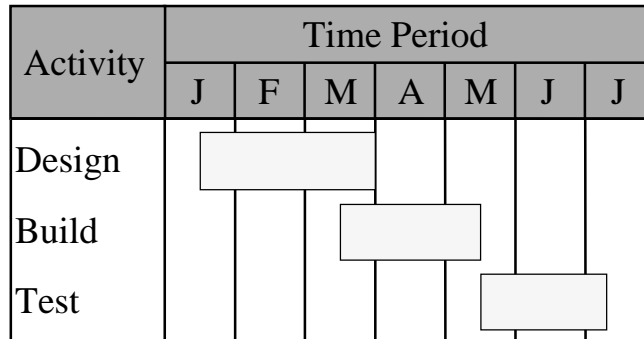
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Gantt Chart



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Project Control Reports

- .. Detailed cost breakdowns for each task
- .. Total program labor curves
- .. Cost distribution tables
- .. Functional cost and hour summaries
- .. Raw materials and expenditure forecasts
- .. Variance reports
- .. Time analysis reports
- .. Work status reports

PERT and CPM

- .. Network techniques
- .. Developed in 1950's
 - .. CPM by DuPont for chemical plants
 - .. PERT by U.S. Navy for Polaris missile
- .. Consider precedence relationships and interdependencies
- .. Each uses a different estimate of activity times

Questions Which May Be Addressed by PERT & CPM

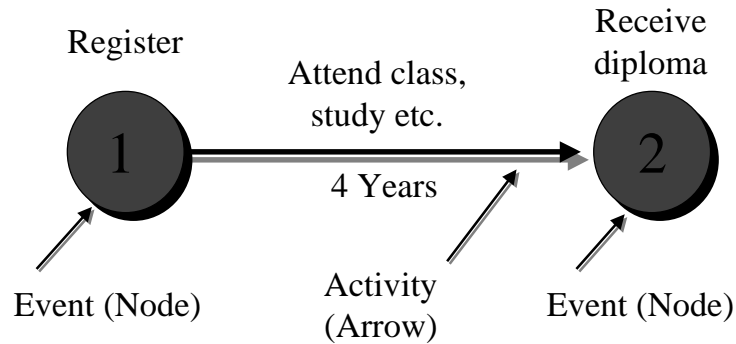
- “ Is the project on schedule, ahead of schedule, or behind schedule?
- “ Is the project over or under cost budget?
- “ Are there enough resources available to finish the project on time?
- “ If the project must be finished in less than the scheduled amount of time, what is the way to accomplish this at least cost?

The Six Steps Common to PERT & CPM

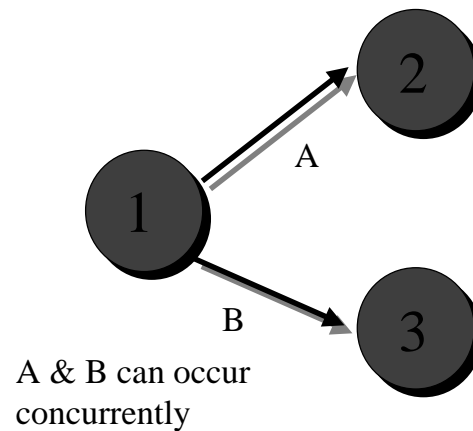
- 1 Define the project and all of its significant activities or tasks
- 2 Develop relationships among the activities. (Decide which activities must precede and which must follow others.)
- 3 Draw the network connecting all of the activities
- 4 Assign time and cost estimates to each activity
- 5 Compute the longest time path through the network. This is called the critical path
- 6 Use the network to help plan, schedule, monitor, and control the project

Network Terms

Project: Obtain a college degree (B.S.)

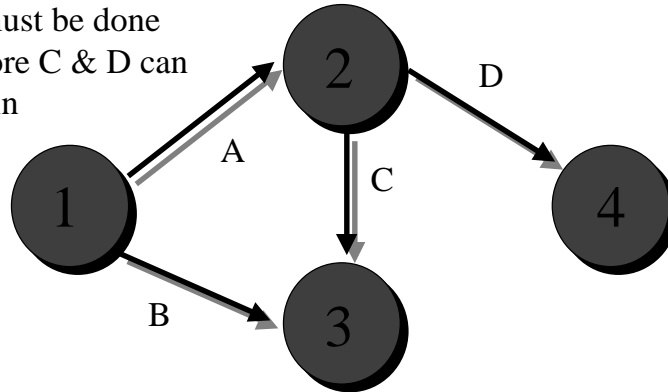


Activity Relationships

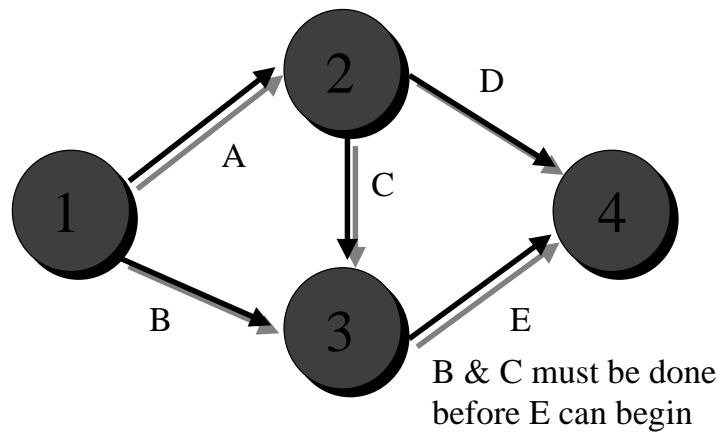


Activity Relationships

A must be done
before C & D can
begin



Activity Relationships

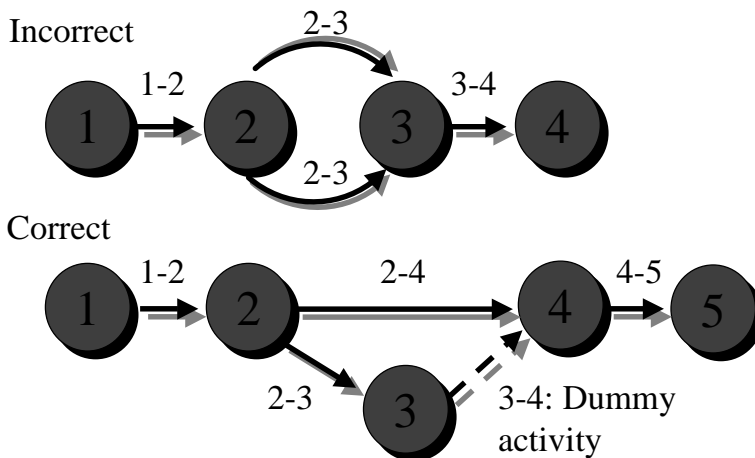


B & C must be done
before E can begin

Dummy Activities

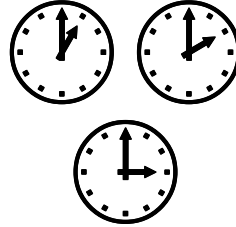
- “ Activities are defined often by beginning & ending events
 - “ Example: Activity 2-3
- “ Every activity must have unique pair of beginning & ending events
 - “ Otherwise, computer programs get confused
- “ Dummy activities maintain precedence
 - “ Consume no time or resources

Dummy Activity Example



PERT Activity Times

- .. 3 time estimates
 - .. Optimistic times (a)
 - .. Most-likely time (m)
 - .. Pessimistic time (b)
- .. Follow beta distribution
- .. Expected time: $t = (a + 4m + b)/6$
- .. Variance of times: $v = (b - a)^2/6$



Critical Path Analysis

- .. Provides activity information
 - .. Earliest (ES) & latest (LS) start
 - .. Earliest (EF) & latest (LF) finish
 - .. Slack (S): Allowable delay
- .. Identifies critical path
 - .. *Longest* path in network
 - .. *Shortest* time project can be completed
 - .. Any delay on activities delays project
 - .. Activities have 0 slack

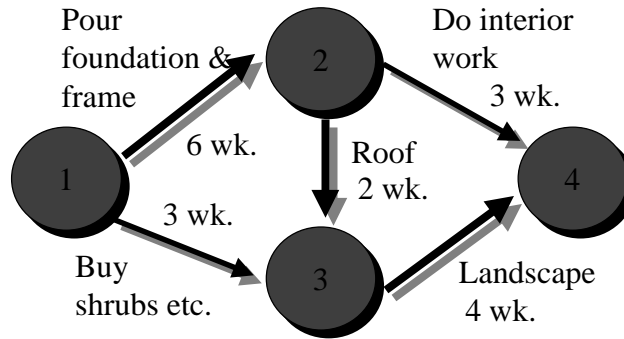
Earliest Start and Finish Steps

- .. Begin at starting event & work forward
- .. $ES = 0$ for starting activities
 - .. ES is earliest start
- .. $EF = ES + \text{Activity time}$
 - .. EF is earliest finish
- .. $ES = \text{Maximum EF of all predecessors}$ for non-starting activities

Latest Start and Finish Steps

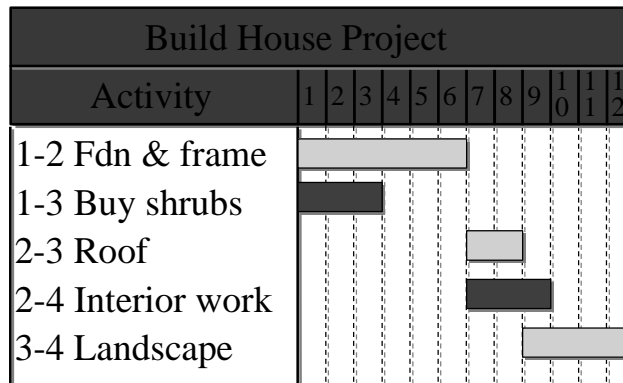
- .. Begin at ending event & work backward
- .. $LF = \text{Maximum EF}$ for ending activities
 - .. LF is latest finish; EF is earliest finish
- .. $LS = LF - \text{Activity time}$
 - .. LS is latest start
- .. $LF = \text{Minimum LS of all successors}$ for non-ending activities

Critical Path in Network

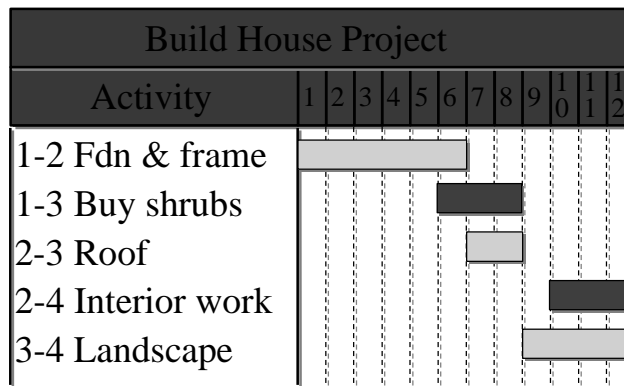


Critical path is longest path: 12 weeks.

Gantt Chart Earliest Start and Finish



Gantt Chart Latest Start and Finish



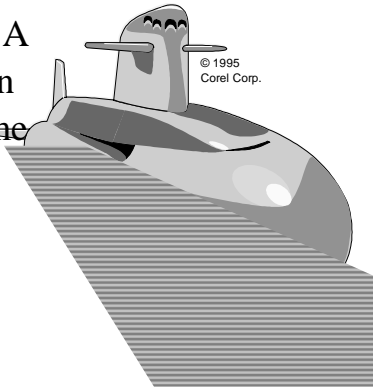
Project Times

- Expected project time (T)
 - Sum of critical path activity times, t
- Project variance (V)
 - Sum of critical path activity variances, v



PERT Probability Example

You're a project planner for General Dynamics. A submarine project has an expected completion time of 40 weeks, with a standard deviation of 5 weeks. What is the probability of finishing the sub in 50 weeks or less?



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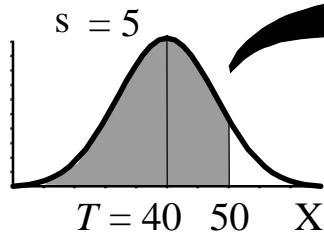
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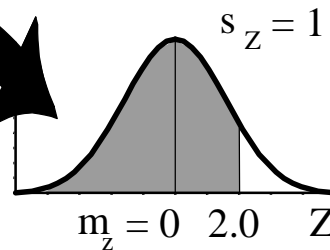
Converting to Standardized Variable

$$Z = \frac{X - T}{s} = \frac{50 - 40}{5} = 2.0$$

Normal Distribution



Standardized Normal Distribution



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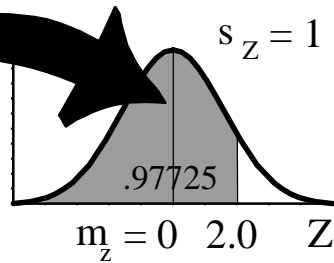
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Obtaining the Probability

Standardized Normal
Probability Table (Portion)

Z	.00	.01	.02
0.0	.50000	.50399	.50798
:	:	:	:
2.0	.97725	.97784	.97831
2.1	.98214	.98257	.98300



Probabilities in body

Benefits of PERT/CPM

- .. Useful at many stages of project management
- .. Mathematically simple
- .. Uses graphical displays
- .. Gives critical path & slack time
- .. Provides project documentation
- .. Useful in monitoring costs

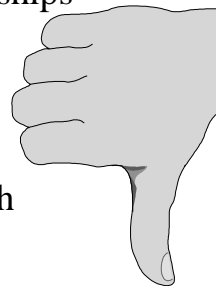


Advantages of PERT/CPM

- .. Networks generated provide valuable project documentation and graphically point out who is responsible for various project activities
- .. Applicable to a wide variety of projects and industries
- .. Useful in monitoring not only schedules, but costs as well

Limitations of PERT/CPM

- .. Assumes clearly defined, independent, & stable activities
- .. Specified precedence relationships
- .. Activity times (PERT) follow beta distribution
- .. Subjective time estimates
- .. Over-emphasis on critical path



PERT and GERT: A Comparison

- | GERT | PERT |
|--|---|
| <ul style="list-style-type: none">each activity has a probability of occurrencethe nodes indicate the nature of the branch<ul style="list-style-type: none">probabilisticdeterministic | <ul style="list-style-type: none">all activities must take placethe nodes (events) are circles and the activities are arrows |

PERT and GERT: A Comparison

- | GERT | PERT |
|--|---|
| <ul style="list-style-type: none">some activities may fail, changing the nature of the activities that followlooping back to previous activities is permitted | <ul style="list-style-type: none">all activities in the project must be successfully completedlooping back to previous activities is not permitted |