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# ENGINEERING PROJECT 1

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## INTRODUCTION TO PROJECT MANAGEMENT

By Hazizulden Abdul Aziz

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## Objectives and Outcomes

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- ✦ Objectives
  - ✦ To provide basic knowledge needed to manage an Engineering Design Project
- ✦ Learning outcomes
  - ✦ Can generate project plan, schedule & monitoring reports

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# Topics

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- ✦ Project Management Principles
- ✦ Project Life-Cycles
- ✦ Project Planning
- ✦ Network Scheduling Techniques
- ✦ Project Monitoring and Control
- ✦ Reporting Progress
- ✦ Project Closure
- ✦ Project Management BOK

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# Introduction

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- ✦ Project and Engineer
- ✦ Definition of a project
  - ✦ Specific outcomes
  - ✦ Defined start and end date
  - ✦ Established resources

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## Engineering Projects

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- ✦ Military Development Projects
- ✦ Construction and Infrastructure Projects
- ✦ Product Development Projects
- ✦ Installation and Commissioning Projects
- ✦ Shut-Down and Maintenance Projects
- ✦ Software Development Projects
- ✦ Research & Development Project

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## Define Project Management

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- ✦ A process of guiding a project from its beginning, through its execution to its end
- ✦ Basic principles of planning, organizing and controlling works
- ✦ Methodology for ensuring project success

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## Defining Project Success

- ✦ Accepted by CUSTOMER
- ✦ Within time & cost limitation
- ✦ At desired performance level
- ✦ With minimum scope changes
- ✦ Effective & efficient use of resources
- ✦ Without disturbing the organization main work flow
- ✦ Without changing corporate culture

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## Project vs. Process vs. Program

- |   |                             |
|---|-----------------------------|
| ✦ Process   | ✦ Program                   |
| ✦ A routine   | ✦ Long range goals          |
| ✦ Series of steps on how to perform a particular activity | ✦ Have no specific outcomes |

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# Project Life-Cycle

- ✦ The 5 phases of Project Life-Cycle
  - ✦ Conceiving an idea
  - ✦ Define and Plan
  - ✦ Mobilization
  - ✦ Implementation
  - ✦ Closing

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## Ph 1 – Conceiving an Idea

- ✦ Answer the two questions:
  - ✦ Should I do it?
  - ✦ Can I do it?
- ✦ Conduct feasibility studies
- ✦ Include a cost-benefit analysis

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## Ph 2 – Define and Plan

- ✦ Statement of Work
- ✦ Work Breakdown Structure
- ✦ Project Schedule
- ✦ Resources needed & cost estimation
- ✦ Validated Assumptions & Risk Analysis
- ✦ Organizational roles and responsibilities

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## Ph 3 – Mobilization

- ✦ Get the resources needed
- ✦ Set-up tracking & information system
  - ✦ Schedule, financial, communication, etc etc
- ✦ Assigned roles and responsibilities
- ✦ Explain task to Project Team

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## Ph 4 – Implementation

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- ✦ Do the tasks
- ✦ Monitor performance
- ✦ Compare performance against plan
- ✦ Fixed any discrepancies & make adjustment
- ✦ Keep everybody informed

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## Ph 5 – Closing

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- ✦ Get approvals of final results
- ✦ Close all project documentation
- ✦ Hold post-project evaluation – lesson learned

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## Pitfalls

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- ✦ Skip planning and closing phases
- ✦ Vague objectives
- ✦ Incomplete or inaccurate project schedule
- ✦ Inadequate resources identification
- ✦ Bad assumption
- ✦ Inaccurate project monitoring
- ✦ Under estimate cost, uncertainty & risk

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## Planning for a Project

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Phase 2: Define and Plan

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## Define and Plan

- ✦ Define Statement of Work
- ✦ Develop Work Breakdown Structure
- ✦ Develop Network Diagram
- ✦ Identify Critical Path
- ✦ Generate Project Schedule

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## Statement of Work

- ✦ Written confirmation of the project outcomes
- ✦ Include terms and conditions
- ✦ Agreed upon by both parties
- ✦ Must have:
  - ✦ Purpose and Objectives
  - ✦ Constraints and Assumptions
- ✦ Can be in many forms:
  - ✦ Work Order, RFP/RFQ, Contract etc

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## How to define Statement of Work

- ✦ Identify the real needs (client and users)
- ✦ Develop the goals and objectives
  - ✦ Specification, results or deliverables
- ✦ Identify limitation
  - ✦ Time, resources and performance
- ✦ Define assumption
- ✦ Write them and get approval from client

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## Work Breakdown Structure (WBS)

- ✦ Hierarchic breakdown of a major activity into its sub-activities and sub-sub-activities
- ✦ Purpose
  - ✦ To identify ALL works to be performed

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## How to develop WBS

- ✦ Top-Down vs. Brainstorming approaches
- ✦ List all major activities
- ✦ Brainstorm all sub-activities & sub-sub activities
- ✦ Determine predecessor(s) for each activity
- ✦ Determine duration for each activity
  - ✦ *Estimating activity duration*
- ✦ Assign code for each activity

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## WBS – detail breakdown?

- ✦ Can I accurately estimate detail of “resources” required?
- ✦ Can I accurately estimate the time required to complete the task?
- ✦ Will others understand what to do?

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## Example of simplified WBS Table

Project Name Engineering Product Design (Prototype Development)

Activity ID	Activity Description	Duration (wk)	Predecessor
A	Market Research	3	None
B	Preliminary Design	1	A
C	Detailed Design (Mech)	1	B
D	Detailed Design (Elect)	2	B
E	Design Review	1	C&D
F	Make Prototype	5	E
G	Prototype Test	1	F
H	Prepare documentation	1	G
I	Design Review & Approval	1	G
		16	

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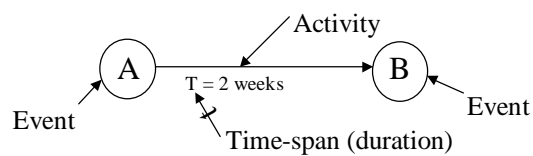
## Network Diagram

- ✦ Graphical representation of project activities
- ✦ Show all activities and their sequence, duration and interdependency
- ✦ Contains three elements
  - ✦ Event – Activity – duration(time-span)
- ✦ Two methods
  - ✦ Activity-on-the-arrow (PERT chart)
  - ✦ Activity-in-the-box (CPM/ADM chart)

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# PERT

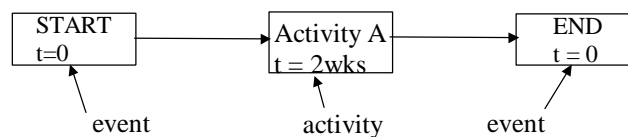
- ✦ PERT = Program Evaluation & Review Technique
- ✦ Use for projects where activity duration can not be estimated.
- ✦ Use statistical probability to estimate duration



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# CPM/ADM

- ✦ CPM = Critical Path Method
- ✦ ADM = Arrow Diagram Method
- ✦ Use for projects where activity duration can be estimated



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## How to develop Network Diagram

- ✦ Start with activities with NO predecessors
- ✦ Identify immediate successors to above activities
- ✦ Continue with all subsequent activities in WBS

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## Critical Path Analysis

- ✦ Critical Path
  - ✦ Longest PATH through the network
    - ✦ PATH = total time-span from start to end
  - ✦ Sequence of activities with longest time to complete
- ✦ Time span of critical path define the project duration

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## Finding Critical Path (some definition)

- ⊕ Early Start (ES) = earliest time an activity can start
- ⊕ Early Finish (EF) = earliest time an activity can be completed.
  - ⊕  $EF = ES + \text{time-span}$
- ⊕ Latest Finish (LF) = latest time an activity can be completed
- ⊕ Latest Start (LS) = latest time to start an activity.
  - ⊕  $LS = LF - \text{time-span}$
- ⊕ Slack time = maximum time delay for an activity
  - ⊕  $\text{Slack time} = (LS - ES) \text{ or } (LF - EF)$

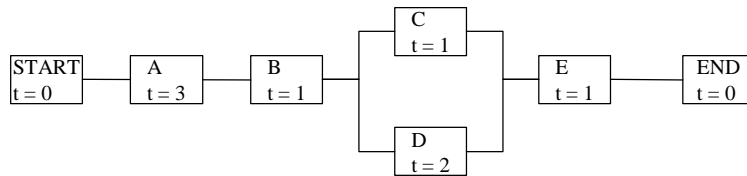
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## Finding Critical Path

- ⊕ Do the forward pass
  - ⊕ calculate ES & EF for each activity
- ⊕ Do the backward pass
  - ⊕ calculate LS & LF for each activity
- ⊕ Calculate the slack time for each activity
- ⊕ Activities on the critical path if slack time = 0

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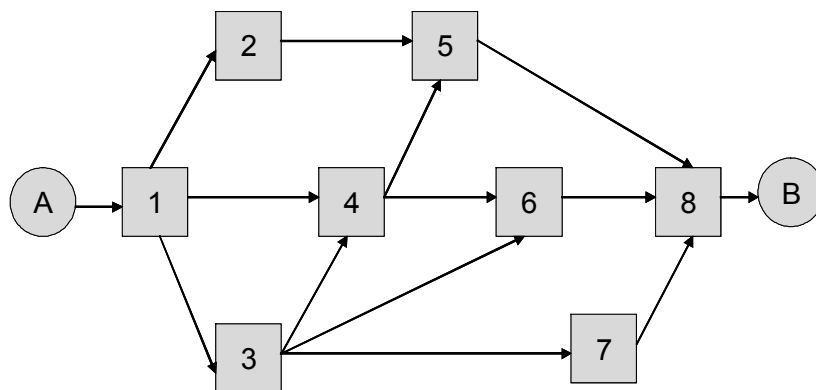
## Finding Critical Path (Example)



- ✦ Path A-B-C-E: duration =
- ✦ Path A-B-D-E: duration =
- ✦ Critical path is

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## What if the Network Diagram looks like this?



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## WBS Table (Revisit)

Project Name Engineering Product Design (Prototype Development)								
Activity ID	Activity Description	Duration (wk)	Predecessor	ES	EF	LS	LF	Slack-Time
A	Market Research	3	None					
B	Preliminary Design	1	A					
C	Detailed Design (Mech)	1	B					
D	Detailed Design (Elect)	2	B					
E	Design Review	1	C&D					
F	Make Prototype	5	E					
G	Prototype Test	1	F					
H	Prepare documentation	1	G					
I	Design Review & Approval	1	G					

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## The Critical Path

- ✦ Can have more than one critical path
- ✦ Delay in starting and/or completing activity in critical path will delay the project
- ✦ Critical path can change throughout project execution

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## What's next?

- ✦ Determine actual calendar date for each activity
  - ✦ Start date – milestones – dateline
- ✦ Project duration meet all dates required?
- ✦ NO!
  - ✦ It's time for CRITICAL PATH ANALYSIS

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## Meeting the time constraint

- ✦ Focus on activities in the critical path
  - ✦ Aims to reduce time-span in critical path
- ✦ Recheck duration estimate
  - ✦ Time: human – machine – processing – waiting
- ✦ Consider using more resources
- ✦ Consider different strategy
- ✦ Consider parallel activities

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## Avoid pitfall of “backing in”

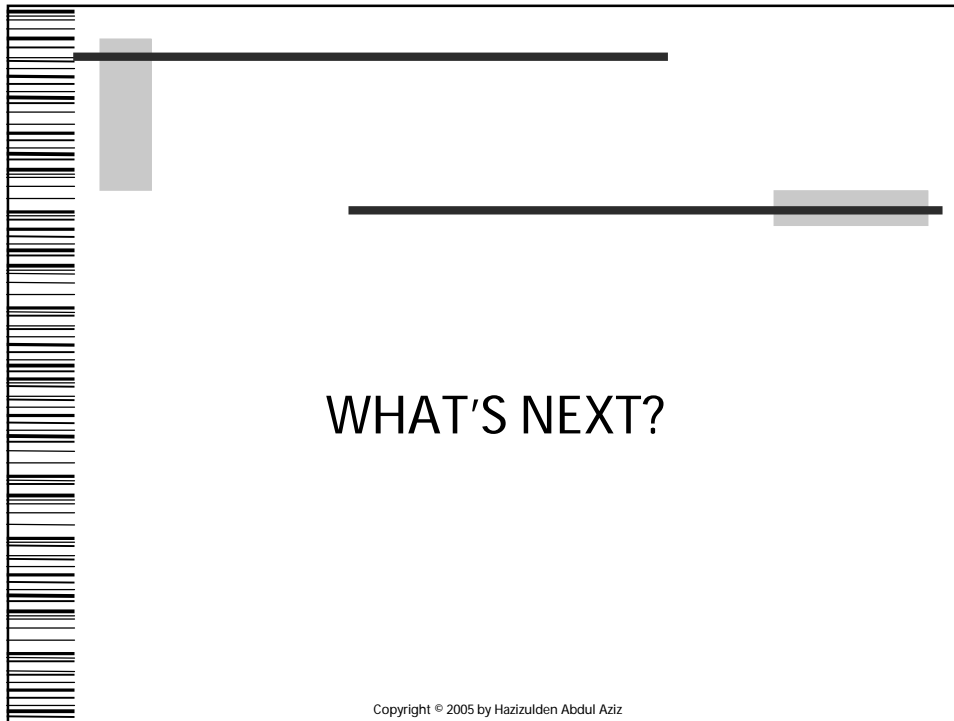
- ✦ “backing in” - working backward to meet schedule
- ✦ Potential pitfalls
  - ✦ Miss one or more important activities
  - ✦ Unrealistic time estimate
  - ✦ Ineffective or illogical sequence of activities
  - ✦ Unrealistic assumption

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## WBS Table ==> Project Schedule

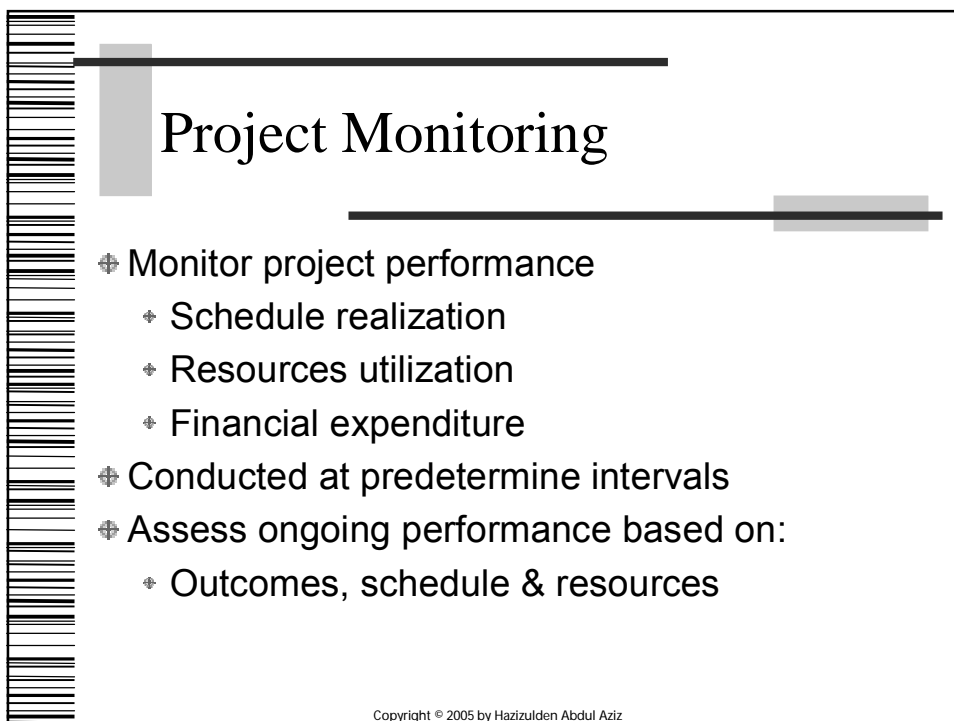
Project Name Engineering Product Design (Prototype Development)					
Activity ID	Duration (wk)	ES	EF	LS	LF
A	3	Dec 27, 05	Jan 15, 06	Dec 27, 05	Jan 15, 06
B	1	Jan 16, 06	Jan 22, 06	Jan 16, 06	Jan 22, 06
C	1	Jan 23, 06	Jan 29, 06	Jan 30, 06	Feb 5, 06
D	2	Jan 23, 06	Feb 5, 06	Jan 23, 06	Feb 5, 06
E	1	Feb 6, 06	Feb 12, 06	Feb 6, 06	Feb 12, 06
F	5	Feb 13, 06	Mar 19, 06	Feb 13, 06	Mar 19, 06
G	1	Mar 20, 06	Mar 26, 06	Mar 20, 06	Mar 26, 06
H	1	Mar 27, 06	Apr 2, 06	Mar 27, 06	Apr 2, 06
I	1	Apr 3, 06	Apr 9, 06	Apr 3, 06	Apr 9, 06

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# WHAT'S NEXT?

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## Project Monitoring

- ✦ Monitor project performance
  - ✦ Schedule realization
  - ✦ Resources utilization
  - ✦ Financial expenditure
- ✦ Conducted at predetermine intervals
- ✦ Assess ongoing performance based on:
  - ✦ Outcomes, schedule & resources

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## Project Information System

- ✦ Establish a system for data collection
- ✦ Performance data
  - ✦ Schedule – actual start & end of an activity
  - ✦ Resources – actual work hours
  - ✦ Expenditure – purchases & payments
- ✦ Data collection method
  - ✦ Recording the measurement
  - ✦ Frequency of measurement

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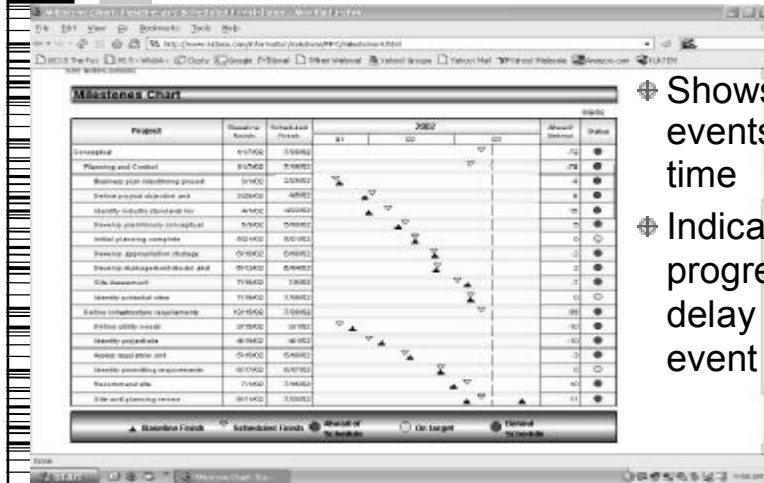
## Project Control

- ✦ For each performance evaluation cycle:
  - ✦ Reconfirm plan – things to do & achieve
  - ✦ Assess performance – actual vs. plan
  - ✦ Take corrective action
    - ✦ Bring project to plan
    - ✦ Make changes to reflect new expectation
  - ✦ Update on progress
    - ✦ Achievement, problem & future plan

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# Milestone Chart

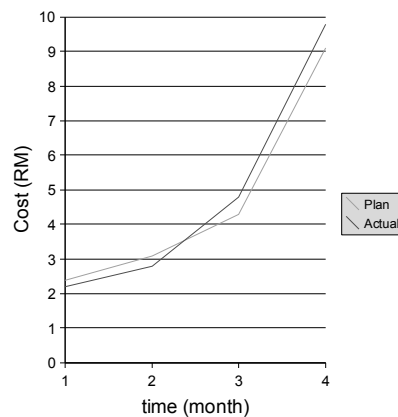


- Shows key events against time
- Indicate progress or delay of an event

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# Trend Line Chart

- Track performance against time
- Use to track
  - Resource utilization
  - Consumption or expenditure
  - Cost



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## Project Closure

- ✦ What to do?
  - ✦ Complete all activities
  - ✦ Get all required approval/acceptance
  - ✦ Evaluate results vs. expectation
- ✦ Create project closure checklist
  - ✦ Results to achieve
  - ✦ Acceptance or approval requirement
  - ✦ Report to be submitted
- ✦ LESSON LEARNED?

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## Project Management vs. Project Engineering

- ✦ Project Engineering
  - ✦ Technical Matters – Planning, Control, Monitoring, Specification, Configuration, Fabrication, Production, testing and Logistic
- ✦ Project Management
  - ✦ Technical Matters + Contract, Reporting, Procurement, Staffing, Prioritization

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## Project Manager BOK & Skills

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- ✦ Planning
- ✦ Risk
- ✦ Cost
- ✦ Integration
- ✦ Scope
- ✦ Procurement
- ✦ Quality
- ✦ HR
- ✦ Communication
- ✦ Time
- ✦ Leadership
- ✦ Team building
- ✦ Conflict resolution
- ✦ Organization
- ✦ Administrative
- ✦ Entrepreneur  
[Technopreneur]

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## Additional Readings

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- ✦ Project Management for Dummies by Stanley E. Portny
- ✦ Project Management by Harold Kerzner

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