

Cost Estimation Process

Step 1: Define Project Scope

- Clearly articulate project objectives
- Identify deliverables and milestones
- Establish project boundaries and constraints
- Document assumptions and exclusions

Step 2: Develop Work Breakdown Structure (WBS)

- Decompose project into manageable work packages
- Organize hierarchically from major deliverables to activities
- Ensure completeness (100% rule)
- Assign unique identifiers to each element

Step 3: Identify Resources

- Human resources (labor categories and quantities)
- Materials and equipment
- Subcontractors and vendors
- Facilities and utilities

Step 4: Estimate Costs for Each WBS Element

- Apply appropriate estimation technique
- Consider direct and indirect costs
- Account for productivity factors
- Document basis of estimate

Step 5: Aggregate Costs

- Roll up costs from lowest to highest WBS level
- Ensure no duplication or omission
- Create cost baseline

Step 6: Add Contingency Reserves

- Identify known risks and uncertainties
- Calculate contingency percentage based on risk analysis
- Separate contingency from base estimate

Step 7: Review and Validate

Conduct peer reviews

Compare with similar projects

Verify against market rates

Obtain stakeholder approval

Step 8: Document and Communicate

Prepare detailed cost estimate report

Include assumptions, exclusions, and basis

Present to stakeholders

Establish change control process

Estimation Techniques and Methods

1 Analogous Estimating (Top-Down)

Uses historical data from similar projects as basis for estimation.

Advantages: Quick, requires minimal detail

Disadvantages: Less accurate, depends on similarity of projects

2 Parametric Estimating

Uses statistical relationships between historical data and variables.

Formula: Cost = Unit Rate \times Quantity **Example:** ₹12,000 per square meter \times 5,000 sqm = ₹6 crore

Advantages: More accurate than analogous, scalable

Disadvantages: Requires reliable data, may not capture unique aspects

3 Bottom-Up Estimating

Estimates individual work packages and aggregates upward.

Advantages: Most accurate, detailed

Disadvantages: Time-consuming, requires detailed information

4 Three-Point Estimating

Uses optimistic, most likely, and pessimistic estimates.

PERT Formula: Expected Cost = $(\text{Optimistic} + 4 \times \text{Most Likely} + \text{Pessimistic}) / 6$

Advantages: Accounts for uncertainty, probabilistic

Disadvantages: Subjective, requires expertise

5 Reserve Analysis

Adds contingency for identified risks and management reserve for unknown risks.

Contingency Reserve: 5-15% for known risks **Management Reserve:** 5-10% for unknown risks

Cost Components and Structure

1 Direct Costs

Costs directly attributable to project deliverables:

Labor costs (wages, benefits)

Materials and supplies

Equipment rental or purchase

Subcontractor fees

Travel and transportation

2 Indirect Costs

Costs not directly tied to specific deliverables:

Administrative overhead

Utilities and facilities

Insurance and permits

Quality assurance

Project management

Fixed vs. Variable Costs

Fixed Costs: Remain constant regardless of project scale (permits, insurance)

Variable Costs: Change with project scope (materials, labor hours)

Capital vs. Operating Costs

Capital Expenditure (CapEx): One-time investments (construction, equipment)

Operating Expenditure (OpEx): Recurring costs (maintenance, utilities)

Generative AI in the Agile Context

What is Generative AI?

Generative AI systems
(ChatGPT, Copilot,
Gemini):

- ▶ Generate text, code, test cases, reports
- ▶ Analyze project data
- ▶ Assist in decision-making
- ▶ Automate routine Agile tasks



GenAI as an Agile Enabler

GenAI acts as:

- ▶ Virtual Scrum Assistant
- ▶ Productivity Booster
- ▶ Decision Support System
- ▶ Continuous Improvement Engine



Role of GenAI Across Agile Lifecycle

GenAI supports every phase of Agile:

- ▶ Backlog & Requirements
- ▶ Sprint Planning & Estimation
- ▶ Daily Stand-ups
- ▶ Development & Testing
- ▶ Sprint Reviews & Retrospectives
- ▶ Risk Management



A photograph showing two people in a professional setting. One person is pointing at a tablet screen, which displays a document with the word 'On' visible. The other person is listening attentively. A coffee cup is on the table. The background is blurred.

Product Backlog & Requirement Management

GenAI Supports:

- ▶ Business ideas to user stories
- ▶ Writing acceptance criteria
- ▶ Detecting ambiguity & duplicates
- ▶ Suggesting epics and features

Example: Banking App →
25+ User Stories



Benefits of GenAI in Backlog

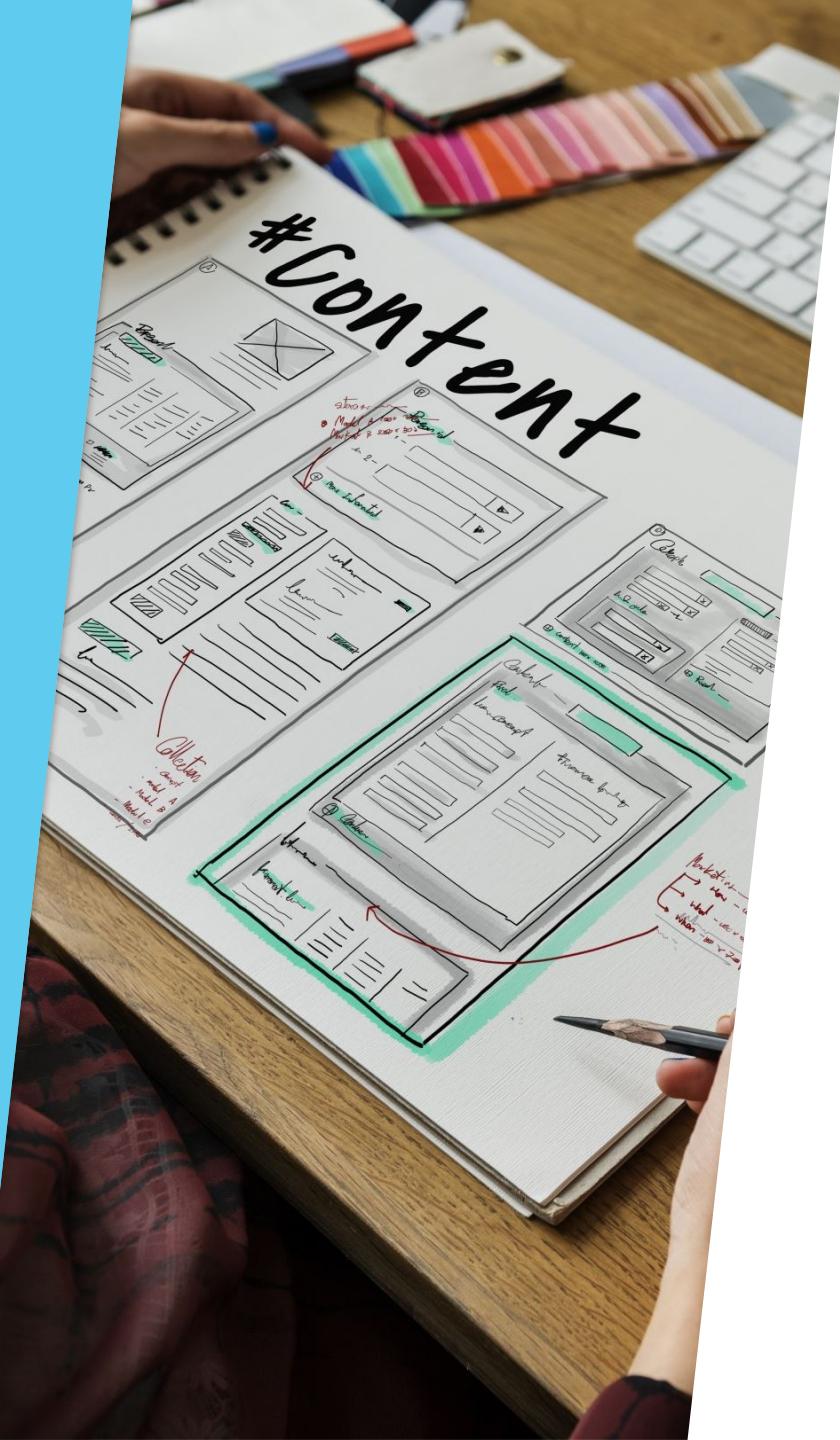
- ▶ • Faster backlog creation
- ▶ • Better requirement clarity
- ▶ • Reduced manual documentation



Sprint Planning & Estimation

GenAI Supports:

- ▶ Predicting story points
- ▶ Suggesting sprint capacity
- ▶ Task breakdown recommendation
- ▶ Detecting overloaded sprint plans



Sprint Planning Benefits

- ▶ More accurate sprint commitments
- ▶ Reduced planning bias
- ▶ Better velocity forecasting



Daily Stand-ups & Collaboration

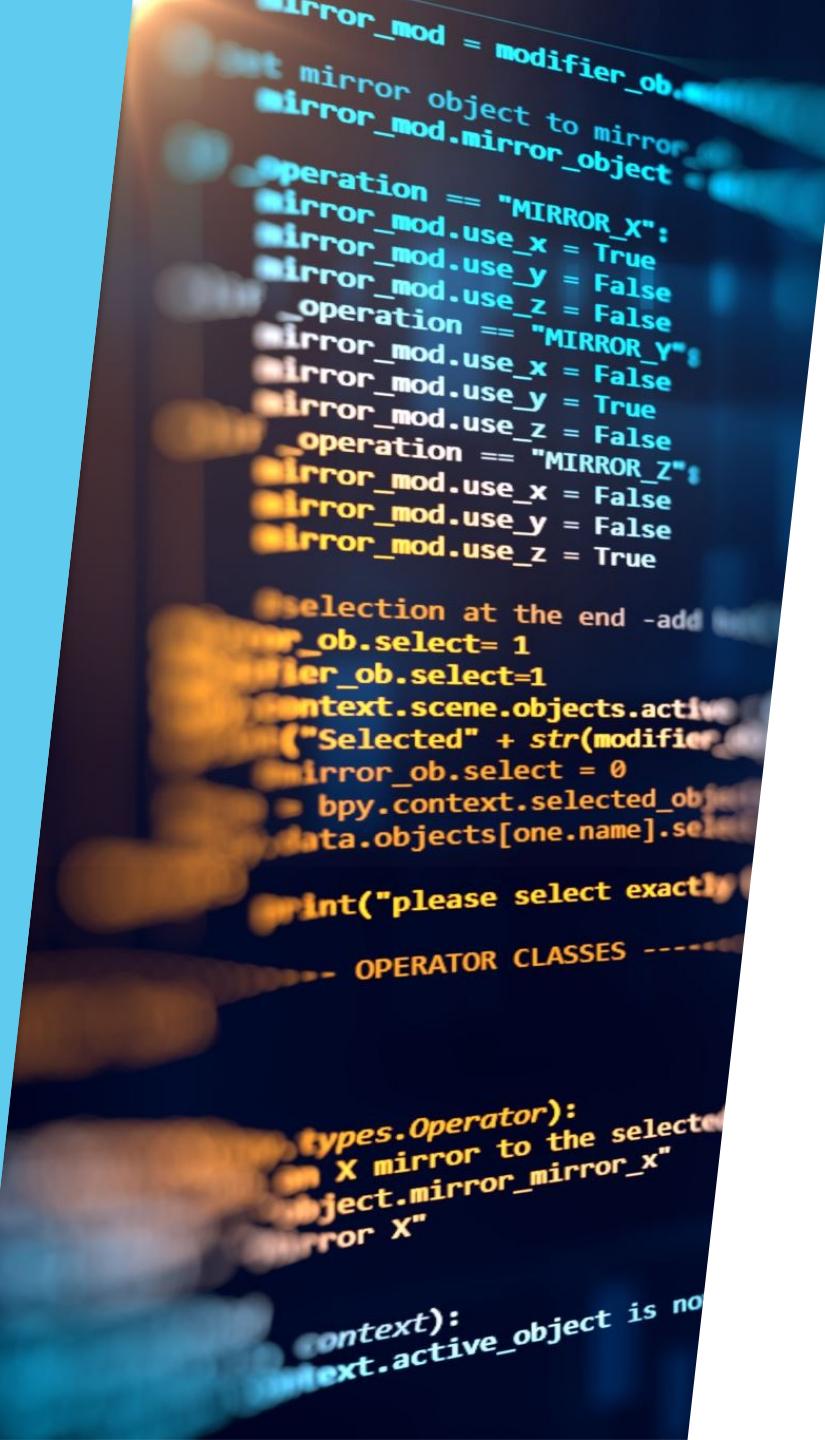
GenAI Supports:

- ▶ Stand-up summary generation
- ▶ Chat to action conversion
- ▶ Status dashboards



Daily Collaboration Benefits

- ▶ Time-saving meetings
- ▶ Improved transparency
- ▶ Better remote team coordination



Development Support (GenAI + DevOps)

GenAI Helps:

- ▶ Code generation
- ▶ Code reviews
- ▶ Refactoring
- ▶ Test case generation

A close-up photograph of a motorcycle's handlebar area. On the left, a chrome side-view mirror is mounted on the handlebar. Below it, a black handgrip is attached. To the right of the handlebar, a silver bell is mounted. The background is blurred, showing the side of a red motorcycle.

Development Benefits

- ▶ Faster development cycles
- ▶ Reduced defects
- ▶ Improved code quality



Testing & Quality Assurance

GenAI Auto-Generates:

- ▶ Unit tests
- ▶ Regression scripts
- ▶ Edge case scenarios
- ▶ Identifies high-risk defect areas



Testing Benefits

- ▶ Faster test creation
- ▶ Better coverage
- ▶ Early bug detection



Sprint Reviews & Retrospectives

GenAI Supports:

- ▶ Sprint performance analysis
- ▶ Bottleneck detection
- ▶ Velocity drop analysis
- ▶ Process improvement suggestions

Retrospective Benefits



DATA-DRIVEN
REVIEWS



CONTINUOUS
IMPROVEMENT



REDUCED
SUBJECTIVE BIAS

Risk Management & Decision Support

GenAI Helps:

- ▶ Sprint risk prediction
- ▶ Delivery delay forecasting
- ▶ Resource gap analysis
- ▶ What-if simulations

Risk Management Benefits



Proactive mitigation



Better leadership decisions



Higher project success rate

GenAI for Agile Roles



Product Owner - Stories, prioritization



Scrum Master - Planning



Developers - Coding, debugging



Testers - Automated tests



Project Manager - Risks & reporting

A photograph of a wooden desk with a calculator, a spiral notebook, and a pen. A large sheet of paper with various charts and data tables is resting on the desk. The charts include a bar chart showing a general upward trend, a pie chart, and a table with numerical data. The overall theme is business and data analysis.

Business Benefits of GenAI

- ▶ 30-50% faster documentation
- ▶ 20-40% productivity improvement
- ▶ Reduced errors
- ▶ Faster sprint cycles
- ▶ Predictive decision making
- ▶ Cost optimization
- ▶ Enhanced innovation



Challenges & Limitations

- ▶ Data privacy risks
- ▶ AI hallucinations
- ▶ Over-reliance on automation
- ▶ Human validation required
- ▶ Tool integration challenges

GenAI Tools Used in Agile



- ChatGPT / Gemini - Documentation & retrospectives



- GitHub Copilot - Coding



- Jira AI - Sprint insights



- Azure DevOps AI - Deployment intelligence



- Tabnine - Code suggestions

Future of GenAI in Agile



- Autonomous Sprint Planning



- AI-driven Product Owners



- Self-optimizing Agile Teams



- Predictive Roadmaps



- AI-generated compliance reports

JIRA in AGILE Environmen t



Introduction to JIRA

- Jira is a **project management tool** used by **agile teams**.
- Launched in 2002
- **Website** – www.atlassian.com/software/jira

Important features

- Agile reporting
- Rich toolkit for developers
- Bug tracking
- Integration with other tools
- Mobile apps
- Customizable workflows

Agile

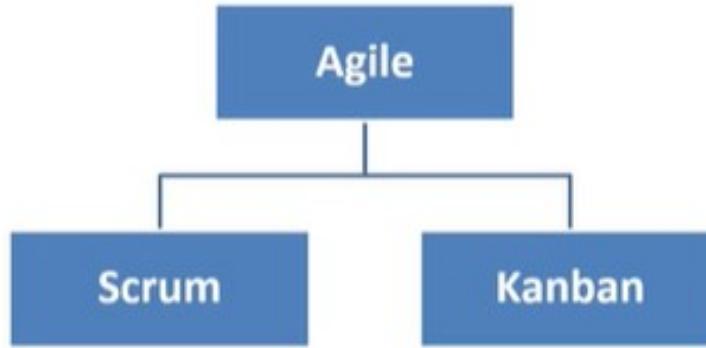
- Agile is a software development methodology that focuses on assisting teams in getting more work done by allowing them to organize their work.
- Agile is constantly growing and evolving. It's all about continuously improving as a team.

Agile board

The agile board is a visual framework for displaying and synchronizing tasks as they move through various stages.



Basics of Agile methodology



Scrum has sprints. Kanban does not.

Sprint

A sprint is a pre-determined amount of time where teams determine the work to get done.

Key-points

- Kanban and Scrum are two approaches to putting in place an agile development or project management system.
- **Scrum** is built on short and controlled work sprints.
- **Kanban** methodologies are continuous and more fluid.

IMPORTANT Terminologi es in JIRA Tool

User story

- A user story is a brief and simplified explanation of a feature in a system that is currently being developed.
- The most significant aspect of user stories is that they are conveyed from the viewpoint of the user or the person who will utilize the feature.

Epic

An epic is a story that is too big for a single sprint. It's divided into multiple user stories.

Issues

- Issues are containers for fields that contain your data. Examples of fields- Summary, assignee, due date, description.
- Issues are the building blocks of any project.
- Stories, epics and bugs are types of issues in Jira.

Projects

Projects are containers for issues.

Your work

Recent projects



ProjectSample

Team-managed software

QUICK LINKS

My open issues

0

Done issues

1 board

Worked on

Viewed

Assigned to me

0

Starred



Jira Software

Your work ▾

Projects ▾

Filters ▾

Dashboards ▾

People ▾

Switch to

Atlassian Start 



Jira Software

sample1project12345



Administration



DISCOVER



Confluence

TRY

Document collaboration

Your work

Recent projects



Project Sample
Team-managed software

QUICK LINKS

My open issues

0

Done issues

1 board

Assigned to me Recent Boards



You have no open issues assigned to you

Go to Your Work page



ProjectSample
Software project



Roadmap



Board



Code



Project pages



Add shortcut



Project settings

Projects / ProjectSample

PROJ board



SR



TO DO

+ Create issue

IN PROGRESS

DONE ✓

ProjectSample
Software project

Roadmap

Board

Code

Project pages

Add shortcut

Project settings

Projects / Project
PROJ board

Search

TO DO

+ Create issue



Search for issues across all projects and save
them as filters.

[Learn more](#)

[View all filters](#)

[Advanced issue search](#)

DONE ✓

Ware

Your work

Projects

Filters

Dashboards

People

More

Create

Search

Projects / ProjectSample

PROJ board



SR

TO DO

+ Create issue



Create a dashboard to track the status of
your projects.
[Learn more](#)

[View all dashboards](#)

[Create dashboard](#)

DONE ✓

-  ProjectSample
Software project
-  Roadmap
-  **Board**
-  Code
-  Project pages
-  Add shortcut
-  Project settings

Projects / ProjectSample

PROJ board



SR



TO DO

+ Create issue

YOUR COLLABORATORS Invite a teammate**YOUR TEAMS** Start a team

Search people and teams

ware

Your work

Projects

Filters

Dashboards

People

More

Create

Search



le
1

Projects / ProjectSample

PROJ board



SR



TO DO

+ Create issue

IN PROGRESS

Settings

ATLASSIAN ADMIN

User management

Add users, groups, and manage access requests.

Billing

Update your billing details, manage your subscriptions and more.

JIRA SETTINGS

System

Manage your general configuration, global permissions, look and feel and more.

Products

Manage your Jira products' settings and integrations.

Projects

Manage your project settings, categories, and more.

ware

Your work

Projects

Filters

Dashboards

People

More

Create

Q: Search



Help

Projects / ProjectSample

PROJ board



SR



GROUP BY

None

TO DO

+ Create issue

IN PROGRESS

DO

What is the board?

Read more about how the board works with different agile features in your team-managed project, and how to use the board to run your team's defined process.

Create custom fields for your issues

Find out how to customize your issues so you can capture the information your team needs to complete their tasks.

Choose the best view for your board

Do you have a lot of cards on your board? Learn how to filter or group your board's cards so you know exactly what to work on.



Projects / ProjectSample

PROJ board



SR



TO DO

[+ Create issue](#)

IN PROGRESS

Notifications

Only show unread [Direct](#) [Watching](#)

You have no notifications from the

I works with
team-managed
'd to run your

sues

issues so you
r team needs to

board

ur board? Learn

Team-managed vs company-managed projects in Jira

Team-managed projects

- Used to be called “**Next-gen-projects**”
- Renamed to “**Team-managed projects**” in 2021
- **Do not require** admin permissions to create
- **Fast and easy** to set up and maintain.

Company-managed projects

- Used to be called “**Classical projects**”
- Renamed to “**Company-managed projects**” in 2021
- **Require admin permission** to create
- **Complicated** to set up and maintain.

Projects ▾

Filters ▾

Dashboards ▾

People ▾

More ▾

Create

RECENT



ProjectSample (PROJ)

Software project

[View all projects](#)

[Create project](#)



Project templates

Software development

Service management

Work management

Marketing

Human resources

Finance

Design

Personal

Operations

Project templates

Software development

Plan, track and release great software. Get up and running quickly with templates that suit the way your team works. Plus, teams that want to connect work across their entire toolchain.



Kanban LAST CREATED

Visualize and advance your project forward using issues on a powerful board.



Scrum

Sprint toward your project goals with a board, backlog, and roadmap.



Bug tracking

Manage a list of development tasks and bugs.

Project templates / Software development

Kanban

Use template X

Kanban (the Japanese word for “visual signal”) is all about helping teams visualize their work, limit work currently in progress, and maximize efficiency. Use the Kanban template to increase planning flexibility, reduce bottlenecks and promote transparency throughout the development cycle.

PRODUCT

Jira Software

RECOMMENDED FOR

Teams that control work volume from a backlog

DevOps teams that want to connect work across their tools

ISSUE TYPES

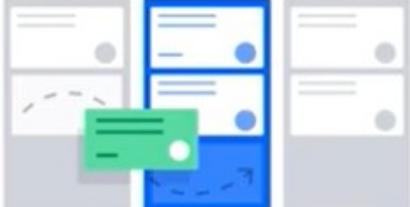
Epic

Track work using a simple board

Work items are represented visually on your kanban board, allowing teams to track the status of work at any time. The columns on your board represent each step in your team’s workflow, from to-do to done.

[Learn more about kanban boards](#)

Next: Select a project type [Use template](#)



[← Back to project templates](#)

1 Project template



Kanban

Visualize and advance your project forward using issues on a powerful board.

[Change template](#)

2 Choose a project type



You'll need to create a new project if you decide to switch project types later.

Team-managed

Set up and maintained by your team.

[Select a team-managed project](#)

Company-managed

Set up and maintained by your Jira admins

[Select a company-managed project](#)

[← Back to project templates](#)

② Choose a project type



You'll need to create a new project if you decide to switch project types later.

Team-managed

Set up and maintained by your team.

For teams who want to control their own working processes and practices in a self-contained space. Mix and match agile features to support your team as you grow in size and complexity.

Simplified configuration

Select a team-managed project

Company-managed

Set up and maintained by your Jira admins

For teams who want to work with other teams across many projects in a standard way. Encourage and promote organizational best practices and processes through a shared configuration.

Expert configuration

Select a company-managed project

Switching from Team to company managed is not allowed but switching between templates allowed that is kanban to scrum etc.

2 Choose a project type

 You'll need to create a new project if you decide to switch project types later.

Team-managed

Set up and maintained by your team

For teams who want to control their own working processes and practices in a self-contained space. Mix and match agile features to support your team as you grow in size and complexity.

Simplified configuration



Select a team-managed project

The last project you created was a team-managed project

Company-managed

Set up and maintained by your Jira admins

For teams who want to work with other teams across many projects in a standard way. Encourage and promote organizational best practices and processes through a shared configuration.

Expert configuration



Select a company-managed project

Set up and maintained by your team

For teams who want to control their own working processes and practices in a self-contained space. Mix and match agile features to support your team as you grow in size and complexity.

Simplified configuration



Get up and running quickly, with simplified configuration.

Anyone on your team can set up and maintain

Settings do not impact other projects

Select a team-managed project

Set up and maintained by your Jira admins

For teams who want to work with other teams across many projects in a standard way. Encourage and promote organizational best practices and processes through a shared configuration.

Expert configuration



Benefit from complete control with expert configuration, customization and flexibility.

Set up and maintained by your Jira admins

Standardized configuration shared across projects

Select a company-managed project

Choose a project type

Add project details

You can change these details anytime in your project settings.

Name *

Try a team name, project goal, milestone...

Access *

Choose an access level

Key  *

Connect repositories, documents, and more

Sync your team's work from other tools with this project for better visibility, access, and automation.

Template



Kanban

Visualize and advance your project forward using issues on a powerful board.

Type



Team-managed

Control your own working processes and practices in a self-contained space.

Change template



Change template

Cancel

Create project

Add project details

You can change these details anytime in your project settings.

Name *

Project Sample 1

Access *

Choose an access level

Key  *

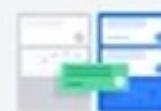
PS1

Connect repositories, documents, and more

Sync your team's work from other tools with this project for better visibility, access, and automation.

Template

Change template



Kanban

Visualize and advance your project forward using issues on a powerful board.

Type

Change type



Team-managed

Control your own working processes and practices in a self-contained space.

Cancel

Create project

Add project details

You can change these details anytime in your project settings.

Name *

Project Sample 1

Access *

Choose an access level

Private

 Only admins and people you add to the project can search for, view, create, or edit its issues.

Limited

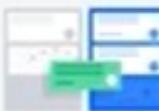
 Anyone with  access to the "sample1project12345" Jira site can search for, view, and comment on this project's issues. Only people you add to the project can create and edit its issues.

Open

 Anyone with access to the "sample1project12345" Jira site can search for, view, create and edit this project's issues.

Template

Change template



Kanban

Visualize and advance your project forward using issues on a powerful board.

Type

Change type



Team-managed

Control your own working processes and practices in a self-contained space.

Cancel

Create project

Add project details

You can change these details anytime in your project settings.

Name *

Project Sample 1

Access *

 Private



Key  *

PS1



Connect repositories, documents, and more

Sync your team's work from other tools with this project for better visibility, access, and automation.

Your work ▾ Projects ▾ Filters ▾ Dashboards ▾ People ▾ Plans ▾ More ▾ **Create**   

Projects / Project Sample 1

PS1 board

  GROUP BY 

TO DO	IN PROGRESS	DONE ✓



Jira Software Your work Projects Filters Dashboards People More Create Search

Project Sample 1 Software project

Roadmap

Board

Code

Project pages

Add shortcut

Project settings

Projects / Project Sample 1

PS1 board

TO DO IN PROGRESS DONE

+ Create issue

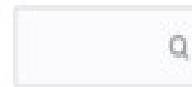
Create column +

ADD More column through that + sign

 Project Sample 1
Software project

Projects / Project Sample 1

PS1 board



SR



TO DO

+ Create issue

IN PROGRESS

 Project Sample 1
Software project

Roadmap

Board

Code

Project pages

Add shortcut

Project settings

Projects / Project Sample 1

PS1 board



SR



TO DO 1 ISSUE

Task 1 Website 2.0

 PS1-3

What needs to be done?

I

TO DO 2 ISSUES

- Task 1 Website 2.0  
- PS1-3

- Task 2 
- PS1-4

What needs to be done?

-



Projects / Project Sample 1

PS1 board

TO DO 2 ISSUES

- Task 2 
- PS1-4

IN PROGRESS

- Task 1 Website 2.0 
- PS1-3

What needs to be done?

-



Software

Your work

Projects

Filters

Dashboards

People

More

Create

Search

Sample 1
Project

Projects / Project Sample 1

PS1 board



SR



TO DO

+ Create issue

IN PROGRESS 1 ISSUE

Task 1 Website 2.0

PS1-3

DONE 1 ISSUE ✓

Task 2

PS1-4

+ Create issue

[Projects](#) / Project Sample 1

PS1 board



SR

GROUP BY [None](#)

IN PROGRESS 1 ISSUE

Task 1 Website 2.0

 PS1-3

DONE 1 ISSUE ✓

Task 2

 PS1-4

QA

New box added for

Project Sample 1

Software project

Roadmap

Board

Code

Project pages

Add shortcut

Project settings

Projects / Project Sample 1

PS1 board

SEARCH  GROUP BY **None**

IN PROGRESS 1 ISSUE

Task 1 Website 2.0

PS1-3

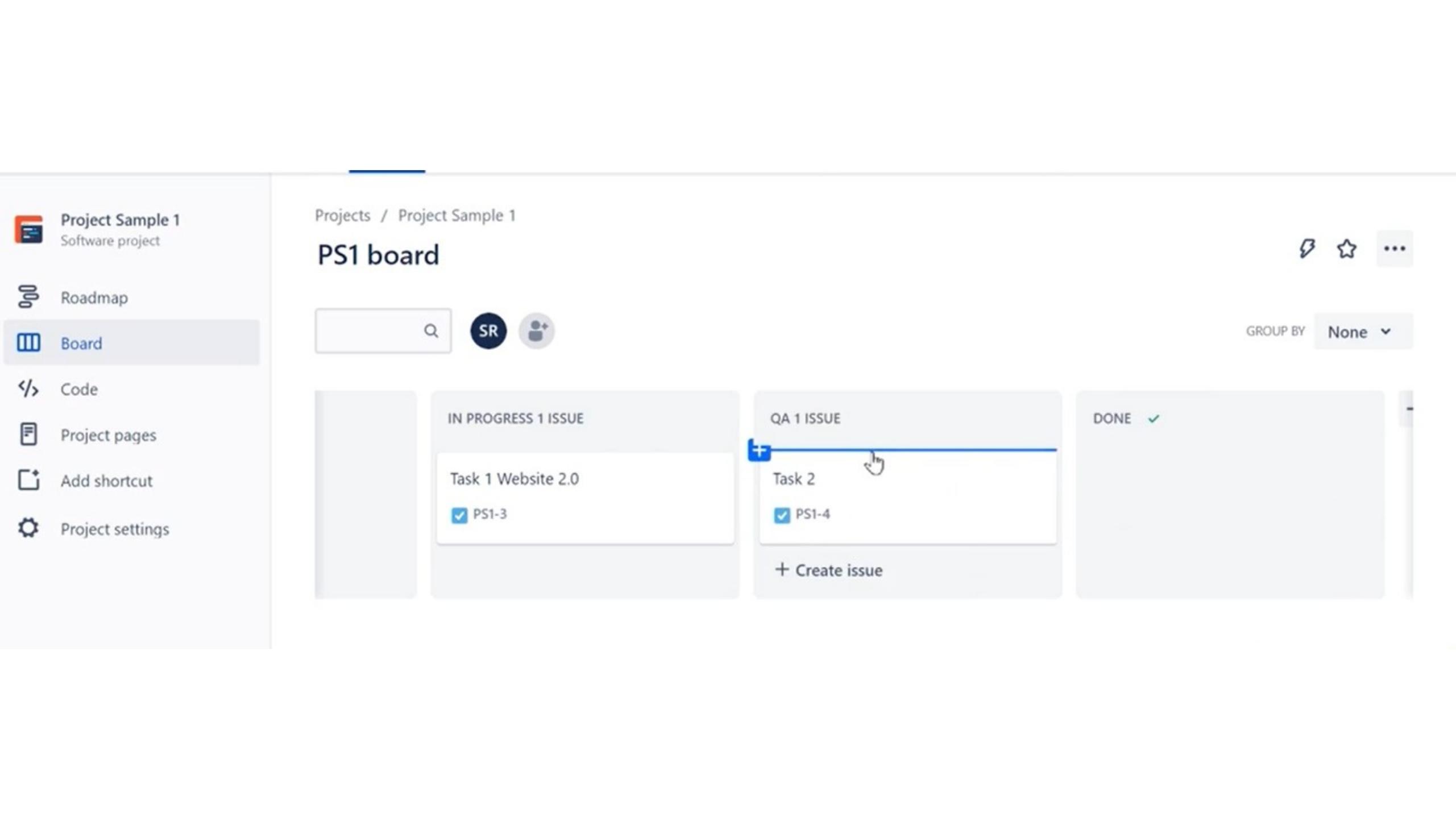
QA 1 ISSUE

Task 2

PS1-4

+ Create issue

DONE ✓



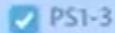
The screenshot shows the Jira Software interface. On the left, a sidebar menu is open with the following options: Project Sample 1 (Software project), Roadmap, Board (selected), Code, Project pages, Add shortcut, and Project settings. The main area is titled 'PS1 board' and shows a board with one card: 'IN PROGRESS 1 ISSUE' (Task 1 Website 2.0, checked: PS1-3). Above the board, there is a search bar, a 'SR' user icon, and a 'Add people' button. To the right of the board, there is a 'GROUP BY' dropdown menu with the following options: None (selected), Assignee, and Subtask. A blue arrow points from the 'Add people' button to the text 'Add people to work on the task'. Another blue arrow points from the 'None' option in the 'GROUP BY' menu to the text 'Task assigned'.

Add people to
work on the
task

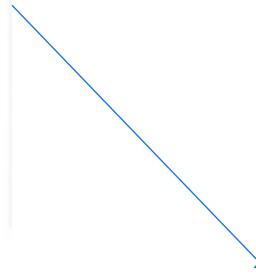
Task assigned

IN PROGRESS 1 ISSUE

Task 1 Website 2.0



PS1-3



Add epic / PS1-3



Task 1 Website 2.0



Description

Add a description...

Activity

Show: All **Comments** History



Newest first



Add a comment...

Pro tip: press **M** to comment

In Progress

Pinned fields



Click on the next to a field label to start pinning.

Details



Assignee



Unassigned

Labels

None

Reporter



Shantnu Rana

Created 1 minute ago

Updated 59 seconds ago

Configure

/ PS1-3



0 1



Issue 2.0

Add a child issue

Link issue



In Progress

Pinned fields

Click on the next to a field label to start pinning

Details

Assignee



Unassigned

Labels



Assignment

Reporter



Automatic

Created 1 minute ago

Config

Updated 1 minute ago

Comments

History

comment...

99 to comment

Newest first 47

Jira Software

Project Sample 1

Roadmap

Board

Code

Project pages

Add shortcut

Project settings

Projects / Project Sample 1

PS1 board

TO DO

IN PROGRESS 1 ISSUE

QA 1 ISSUE

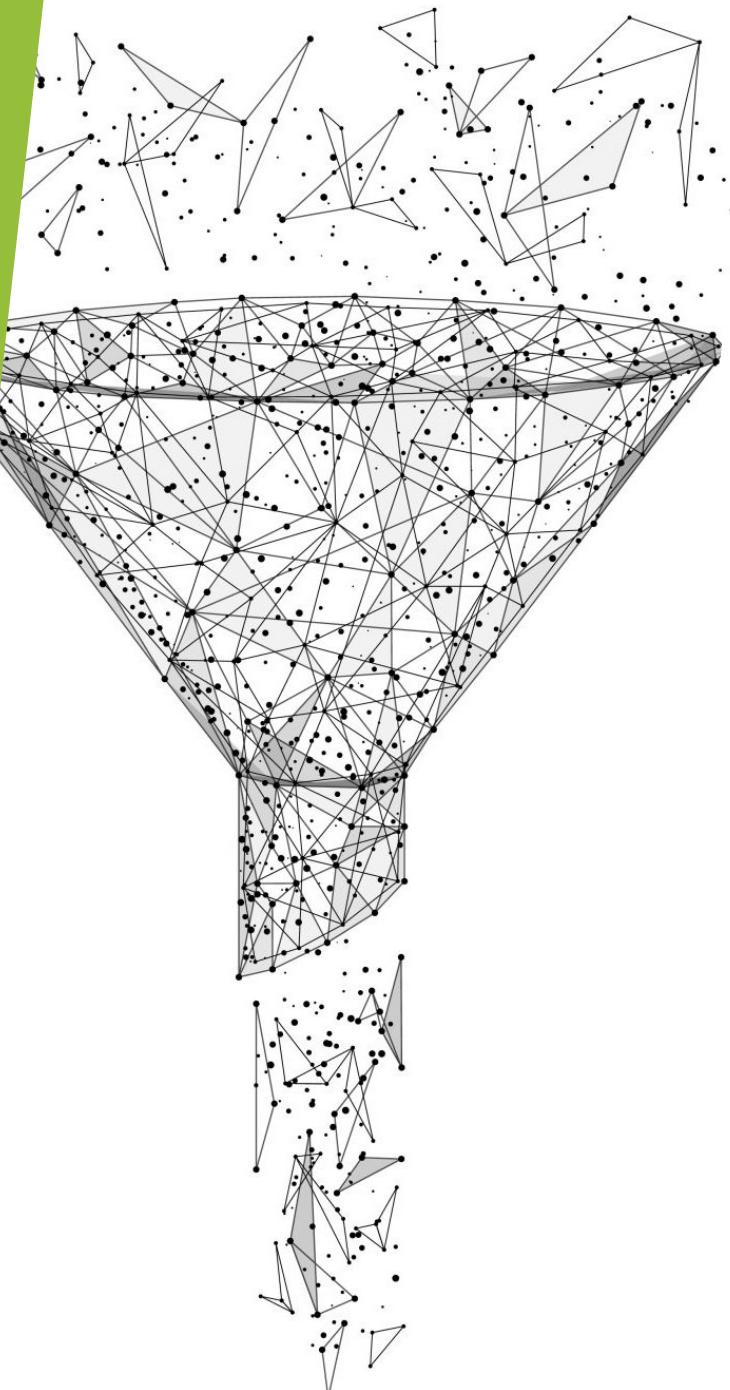
Shantnu Rana 2 issues

Unassigned no issues

+ Create issue

+ Create issue

Issue Creation

A large, abstract network diagram is positioned on the left side of the slide. It consists of numerous small, black, irregularly shaped clusters of points and lines, resembling a complex web or a collection of small triangles. These clusters are interconnected by a larger, more continuous network of lines and points, forming a funnel-like shape that tapers towards the bottom. The overall effect is one of a dynamic, interconnected system.

Project Network Management: Resource Levelling and Crashing

Introduction to Project Network Management

- ▶ Project Network Management focuses on planning, scheduling, and controlling project activities to meet time, cost, and resource constraints.
- ▶ Two major techniques for optimization:
 - ▶ 1. Resource Levelling - optimizing resource usage
 - ▶ 2. Project Crashing - reducing project duration cost-effectively

Recap: Network Scheduling

► Basics

Key methods used in scheduling:

- ▶ • Critical Path Method (CPM)
- ▶ • Program Evaluation and Review Technique (PERT)
- ▶ Terminology:
 - ▶ • Activity: Defined task in the project.
 - ▶ • Duration: Time required to complete activity.
 - ▶ • Dependencies: Predecessor-successor relationships.
 - ▶ • Critical Path: Longest path determining project duration.
 - ▶ • Float (Slack): Time an activity can be delayed without affecting total project duration.

What is Resource Levelling?

- ▶ Resource Levelling is the process of adjusting project schedules to minimize fluctuations in resource usage.
- ▶ Goal: Achieve a smooth resource utilization profile without exceeding resource limits.

Need for Resource Levelling

- ▶ • Limited availability of key resources (labor, equipment, budget).
- ▶ • Avoid resource overallocation.
- ▶ • Improve team efficiency and morale.
- ▶ • Balance workload across project timeline.
- ▶ • Maintain stable resource demand curves.

Key Principles of Resource Levelling

- ▶ 1. Identify overallocated resources.
- ▶ 2. Delay non-critical activities within available float.
- ▶ 3. Maintain project deadline (if possible).
- ▶ 4. Reallocate resources from low-priority to high-priority tasks.
- ▶ 5. Evaluate impact on overall project duration.

Methods of Resource Levelling

- ▶ 1. Manual Adjustment - Shifting activities manually within float.
- ▶ 2. Heuristic Methods - Rule-based approaches (e.g., minimum slack first, shortest duration first).
- ▶ 3. Optimization Algorithms - Linear programming or integer programming models for automation.
- ▶ 4. Software Tools - MS Project, Primavera, etc., perform automatic levelling.

Example: Resource Levelling

- ▶ Example Scenario:
 - ▶ - Project with 5 activities (A-E), each needing manpower.
 - ▶ - Activities B and C overallocation detected.
- ▶ Solution:
 - ▶ - Delay activity C by 2 days (within float).
 - ▶ - Result: Resource usage smoothed, no change to project completion date.

Resource Smoothing vs. Resource Levelling

- ▶ Resource Smoothing:
 - Adjust activities within float.
 - Project duration unchanged.
 - Goal: Optimize resource usage without delay.
- ▶ Resource Levelling:
 - Adjust start times beyond float.
 - May extend project duration.
 - Goal: Resolve resource overallocation.

What is Project Crashing?

- ▶ Project Crashing is the process of reducing total project duration by allocating additional resources at additional cost.
- ▶ Objective: Achieve the shortest possible duration at the least incremental cost.

When to Apply Crashing

- ▶ • Deadline constraints require earlier completion.
- ▶ • Late schedule threatens penalties or lost opportunities.
- ▶ • Resource availability allows acceleration.
- ▶ • Management desires time-cost optimization.

Crashing Assumptions

- ▶ • Activity duration can be reduced with extra cost.
- ▶ • Relationship between time and cost is linear.
- ▶ • Quality of work is not compromised.
- ▶ • Activities on the critical path are candidates for crashing only.

Key Concepts: Normal vs Crash Parameters

- ▶ For each activity:
 - ▶ • Normal Time (NT): Standard completion time.
 - ▶ • Normal Cost (NC): Cost associated with NT.
 - ▶ • Crash Time (CT): Minimum achievable duration.
 - ▶ • Crash Cost (CC): Cost associated with CT.
 - ▶ • Cost Slope = $(CC - NC) / (NT - CT)$ = Cost per unit time saved.

Steps in Project Crashing

- ▶ 1. Identify the critical path.
- ▶ 2. Compute cost slope for all activities.
- ▶ 3. Select cheapest activity on the critical path to crash.
- ▶ 4. Reduce duration and update network.
- ▶ 5. Recompute new critical path.
- ▶ 6. Repeat until target duration or minimum cost achieved.

Example: Crashing Calculation

- ▶ Activity A: NT=8 days, NC=\$8,000; CT=6 days, CC=\$9,200
- ▶ Cost Slope = $(9200-8000)/(8-6) = \$600$ per day.
- ▶ Interpretation: Crashing A by 1 day adds \$600 to project cost.
- ▶ Decision depends on whether benefit > added cost.

Graphical Representation of Crashing

- ▶ The Time-Cost Tradeoff Curve:
 - ▶ • Downward sloping curve showing reduction in duration as cost increases.
 - ▶ • Point of optimal crashing = lowest total project cost (direct + indirect costs).

Comparing Levelling and Crashing

- ▶ | Aspect | Resource Levelling | Project Crashing |
- ▶ | ----- | ----- | ----- |
- ▶ | Objective | Smooth resource use | Reduce project duration |
- ▶ | Effect on Duration | May increase | Decreases |
- ▶ | Effect on Cost | Neutral | Increases |
- ▶ | Main Constraint | Resource limits | Cost limits |
- ▶ | Focus | Resource optimization | Time-cost optimization |

Challenges in Levelling and Crashing

- ▶ • Limited data accuracy on resource productivity.
- ▶ • Conflicts between time, cost, and quality.
- ▶ • Multiple critical paths complicate analysis.
- ▶ • Risk of burnout from excessive crashing.
- ▶ • Dependency management becomes complex.

Best Practices

- ▶ • Maintain updated resource calendars.
- ▶ • Use project management software for simulations.
- ▶ • Evaluate trade-offs with management approval.
- ▶ • Document all adjustments and assumptions.
- ▶ • Balance technical feasibility with team capacity.
- ▶ • Monitor performance post-adjustment.

Case Example: Combined Levelling and Crashing

- ▶ A construction project exceeded resource capacity during foundation work.
- ▶ Steps taken:
 - ▶ 1. Levelled resource load by delaying non-critical electrical work.
 - ▶ 2. Crashed concrete curing activity by adding night shift labor.
- ▶ Outcome: Project completed 5 days earlier with controlled cost rise.

Conclusion

- ▶ Levelling and Crashing are complementary project optimization techniques.
- ▶ Levelling focuses on resource balance, Crashing on time reduction.
- ▶ Effective project managers use both judiciously to achieve optimal time-cost-resource balance.

RISK and Project Network analysis

Risk Management Process

Risk Defined:

- An uncertain event or condition that, if it occurs, has a positive or negative effect on project objectives.
- No amount of planning can overcome or control risk.

Risk Management Defined:

An attempt to recognize and manage potential and unforeseen trouble spots that may occur when the project is implemented.

- What can go wrong (risk event)?
- How to minimize the risk event's impact (consequences)?
- What can be done before an event occurs (anticipation)?
- What to do when an event occurs (contingency plans)?

Risk Event Graph

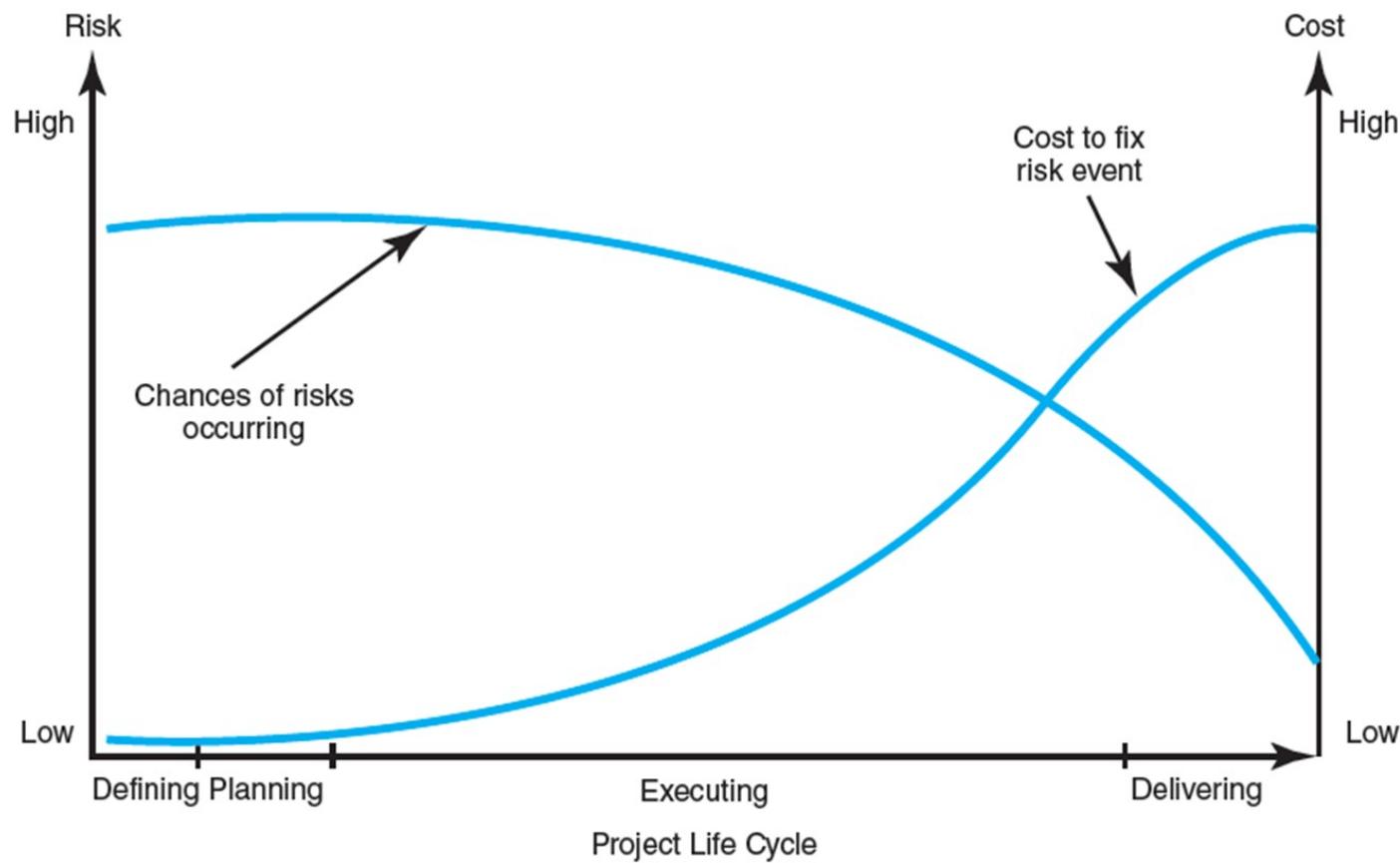


FIGURE 7.1

Benefits of Risk Management

- A proactive rather than reactive approach.
- Reduces surprises and negative consequences.
- Prepares the project manager to take appropriate action.
- Provides better control over the future.
- Improves chances of reaching project objectives on time, within budget, and of meeting required performance.

The Risk Management Process



FIGURE 7.2

7.2 Step 1: Risk Identification

- Generate a list of all the possible risks that could affect the project through brainstorming and other problem identifying techniques.
- Focus on the events that could produce consequences, not on project objectives.
- Use risk breakdown structure (RBS) in conjunction with work breakdown structure (WBS) to identify and analyze risks.
- Identify the macro risks first then specific areas can be checked.
- Use risk profile (a list of questions) to address traditional areas of uncertainty on a project.

The Risk Breakdown Structure (RBS)

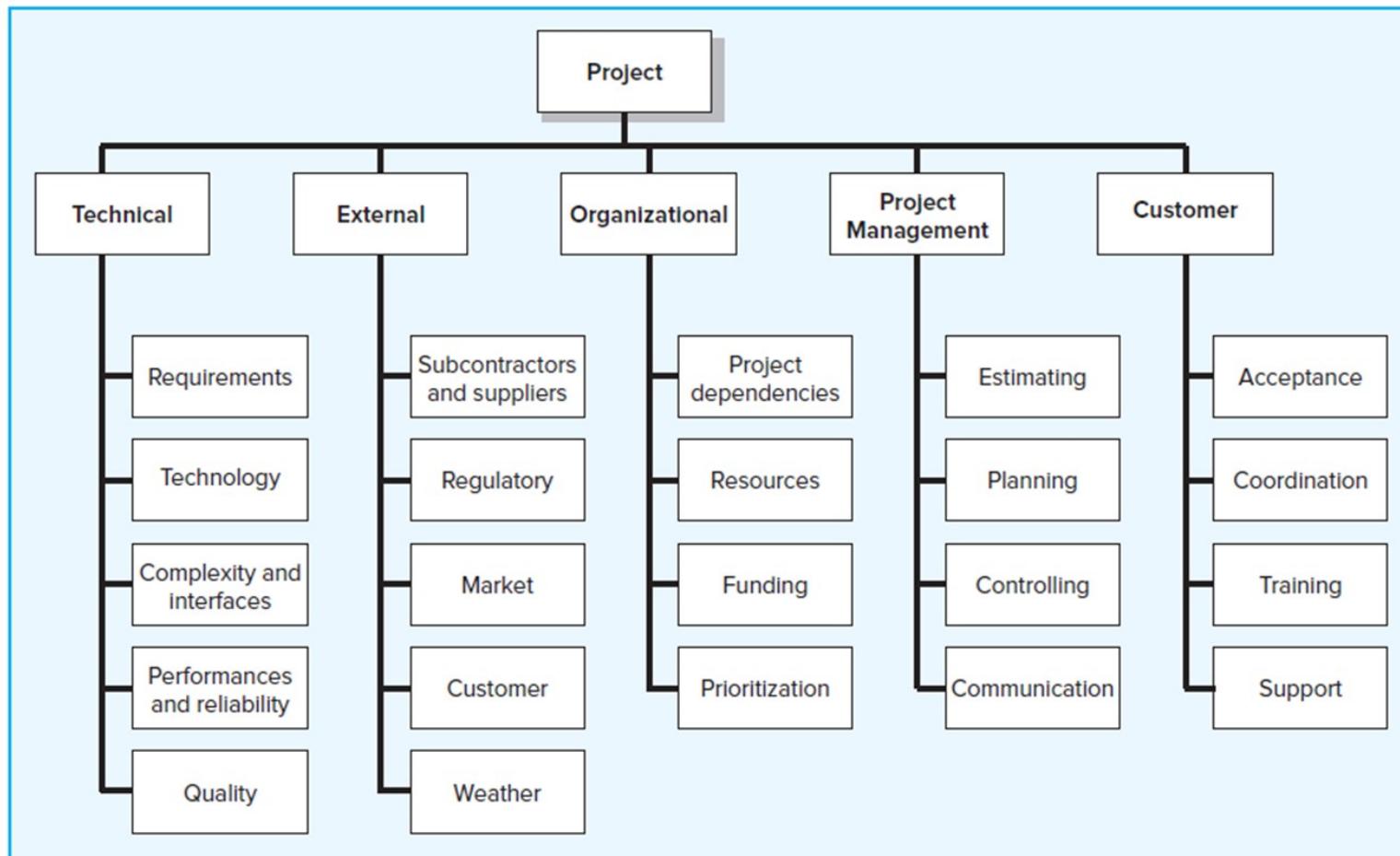


FIGURE 7.3

Partial Risk Profile for Product Development Project

Technical Requirements:

Are the requirements stable?

Design:

Does the design depend on unrealistic or optimistic assumptions?

Testing:

Will testing equipment be available when needed?

Development:

Is the development process supported by a compatible set of procedures, methods, and tools?

Schedule:

Is the schedule dependent upon the completion of other projects?

Budget:

How reliable are the cost estimates?

Quality:

Are quality considerations built into the design?

Management:

Do people know who has authority for what?

Work Environment:

Do people work cooperatively across functional boundaries?

Staffing:

Is staff inexperienced or understaffed?

Customer:

Does the customer understand what it will take to complete the project?

Contractors:

Are there any ambiguities in contractor task definitions?

FIGURE 7.4

7.3 Step 2: Risk Assessment

Scenario analysis assesses the significance of each risk event in terms of probability and impact.

Risk assessment form evaluates the severity, and probability of risk events and their detection difficulty.

Risk severity matrix prioritizes which risks to address.

- **Failure Mode and Effects Analysis (FMEA)** extends the risk severity matrix by including ease of detection in the equation:

$$\text{Risk Value} = \text{Impact} \times \text{Probability} \times \text{Detection}$$

Probability analysis uses statistical techniques in assessing project risk.

- Decision trees, net present value (NPV), program evaluation and review technique (PERT), PERT simulation.

Defined Conditions for Impact Scales of a Risk on Major Project Objectives (examples for negative impacts only)

Relative or Numeric Scale					
Project Objective	1 Very Low	2 Low	3 Moderate	4 High	5 Very High
Cost	Insignificant cost increase	<10% cost increase	10% to 20% cost increase	20% to 40% cost increase	>40% cost increase
Time	Insignificant time increase	<5% time increase	5% to 10% time increase	10% to 20% time increase	>20% time increase
Scope	Scope decrease barely noticeable	Minor areas of scope affected	Major areas of scope affected	Scope reduction unacceptable to sponsor	Project end item is effectively useless
Quality	Quality degradation barely noticeable	Only very demanding applications are affected	Quality reduction requires sponsor approval	Quality reduction unacceptable to sponsor	Project end item is effectively useless

FIGURE 7.5

Risk Assessment Form

Risk Event	Likelihood	Impact	Detection Difficulty	When
Interface problems	4	4	4	Conversion
System freezing	2	5	5	Start-up
User backlash	4	3	3	Postinstallation
Hardware malfunctioning	1	5	5	Installation

FIGURE 7.6

Risk Severity Matrix

Failure Mode and Effects Analysis (FMEA)
Impact × Probability × Detection = Risk Value

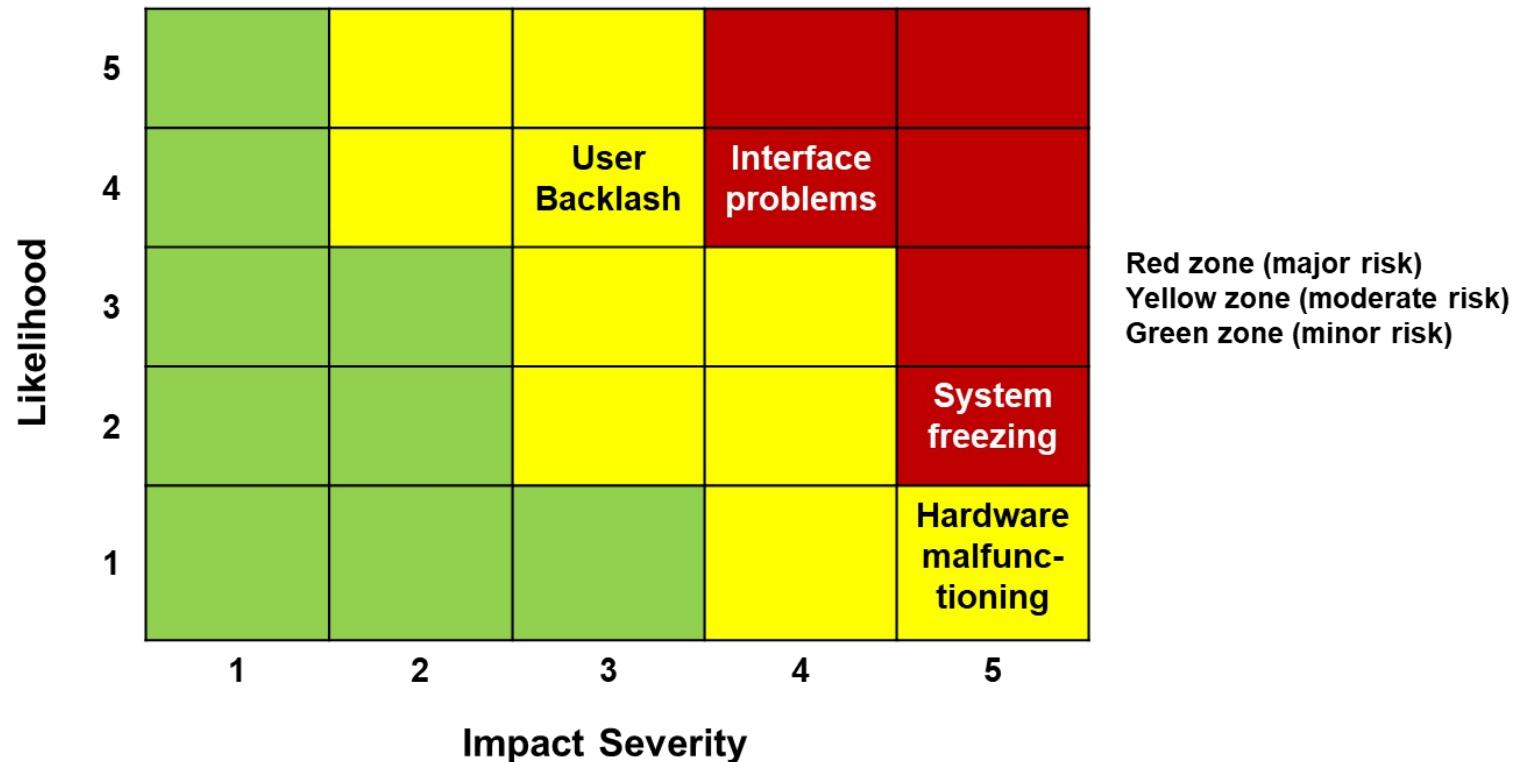


FIGURE 7.7

[Access the text alternative for slide images.](#)

7.4 Step 3: Risk Response Development

Mitigating Risk:

- Reducing the likelihood that the event will occur.
- Reducing the impact that the adverse event would have on the project.

Avoiding Risk:

- Changing the project plan to eliminate the risk or condition.

Transferring Risk:

Passing risk to another party.

- Examples: Fixed-price contracts, insurance, Build-Own-Operate-Transfer (BO OT) provisions.

Escalating Risk:

- Notifying the appropriate people within the organization of the threat.

Retaining Risk:

- Making a conscious decision to accept the risk of an event occurring.

7.5 Contingency Planning

Contingency Plan Defined:

- Is an alternative plan that will be used if a possible foreseen risk event becomes a reality.
- Is a plan of action that will reduce or mitigate the negative impact of the risk event.
- Is not a part of the initial implementation plan and only goes into effect after the risk event is recognized.

Consequences of the absence of a contingency plan:

- Cause a manager to delay or postpone the decision to implement a remedy.
- Lead to panic and acceptance of the first remedy suggested.
- Make the decision making under pressure which can be dangerous and costly.

Risk Response Matrix

Risk Event	Response	Contingency Plan	Trigger	Who Is Responsible
Interface problems	Mitigate: Test prototype	Work around until help comes	Not solved within 24 hours	Nils
System freezing	Mitigate: Test prototype	Reinstall OS	Still frozen after one hour	Emmylou
User backlash	Mitigate: Prototype demonstration	Increase staff support	Call from top Management	Eddie
Equipment malfunctions	Mitigate: Select reliable vendor Transfer: Warranty	Order replacement	Equipment fails	Jim

FIGURE 7.8

Risk and Contingency Planning

Technical Risks:

- Backup strategies if chosen technology fails.
- Assess whether technical uncertainties can be resolved.

Schedule Risks:

- Expedite or “crash” the project to get it back on track.
- Schedule activities in parallel or use start-to-start lag relationships.
- Use the best people for high-risk tasks.

Cost Risks:

- Review price to avoid the trap of using one lump sum to cover price risks.

Funding Risks:

- Evaluate the risk of reductions in funding—a cut in the project.

7.6 Opportunity Management

An **opportunity** is an event that can have positive impact on project objectives.

Exploit:

- Seek to eliminate the uncertainty associated with an opportunity to ensure that it definitely happens.

Share:

- Allocate some or all of the ownership of an opportunity to another party who is best able to capture the opportunity for the benefit of the project.

Enhance:

- Take action to increase the probability and/or the positive impact of an opportunity.

Escalate:

- Notify the appropriate people within the organization of the opportunity.

Accept:

- Be willing to take advantage of the opportunity if it occurs, but not taking action to pursue it.

7.7 Contingency Funding and Time Buffers

Contingency Funds (To manage budget risks):

Are funds to cover project risks—identified and unknown.

For control purposes, contingency funds are divided into:

- Contingency reserves—cover identified risks and are allocated to specific segments or deliverables of the project.
- Management reserves—cover unidentified risks and are allocated to risks associated with the total project.

Time Buffers (To manage schedule risks):

Are amounts of time used to cushion against potential delays in the project.

- Add to activities with severe risks.
- Add to merge activities that are prone to delays.
- Add to noncritical activities to reduce the likelihood that they will create another critical path.
- Add to activities that require scarce resources.

Budget Estimate

Activity	Budget Baseline	Contingency Reserve	Project Budget
Design	\$500,000	\$15,000	\$515,000
Code	900,000	80,000	980,000
Test	20,000	2,000	22,000
Subtotal	\$1,420,000	\$97,000	\$1,517,000
Management reserve	—	—	50,000
Total	\$1,420,000	\$97,000	\$1,567,000

TABLE 7.1

7.4 Step 4: Risk Response Control

Risk Register:

- Details all identified risks, including descriptions, category, probability of occurring, impact, responses, contingency plans, owners, and current status.

Risk Control involves:

- Executing the risk response strategy.
- Monitoring triggering events.
- Initiating contingency plans.
- Watching for new risks.

Establishing a Change Management System:

- Monitoring, tracking, and reporting risk.
- Fostering an open organization environment.
- Repeating risk identification/assessment exercises.
- Assigning and documenting responsibility for managing risk.

7.9 Change Control Management

Sources of Change:

- Project scope changes.
- Implementation of contingency plans.
- Improvement changes.

Change Management Systems:

1. Identify proposed changes.
2. List expected effects of proposed change(s) on schedule and budget.
3. Review, evaluate, and approve or disapprove of changes formally.
4. Negotiate and resolve conflicts of change, conditions, and cost.
5. Communicate changes to parties affected.
6. Assign responsibility for implementing change.
7. Adjust the master schedule and budget.
8. Track all changes that are to be implemented.

Change Control Process

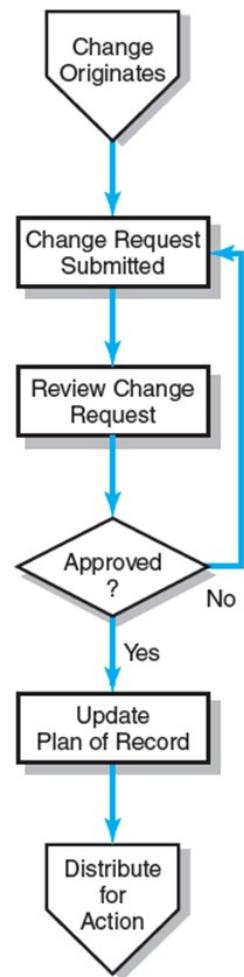


FIGURE 7.9

[Access the text alternative for slide images.](#)

Benefits of Change Control Systems

1. Inconsequential changes are discouraged by the formal process.
2. Costs of changes are maintained in a log.
3. Integrity of the WBS and performance measures is maintained.
4. Allocation and use of contingency and management reserves are tracked.
5. Responsibility for implementation is clarified.
6. Effect of changes is visible to all parties involved.
7. Implementation of change is monitored.
8. Scope changes will be quickly reflected in baseline and performance measures.

Sample Change Request

Project name <u>Irish/Chinese culture exchange</u>	Project sponsor <u>Irish embassy</u>	
Request number <u>12</u>	Date <u>June 6, 2xxx</u>	
Originator <u>Jennifer McDonald</u>	Change requested by <u>Chinese culture office</u>	
Description of requested change <i>1. Request river dancers to replace small Irish dance group. 2. Request one combination dance with river dancers and China ballet group.</i>		
Reason for change <i>River dancers will enhance stature of event. The group is well known and loved by Chinese people.</i>		
Areas of impact of proposed change—describe each on separate sheet <input checked="" type="checkbox"/> Scope <input checked="" type="checkbox"/> Cost <input type="checkbox"/> Other _____ <input type="checkbox"/> Schedule <input type="checkbox"/> Risk		
Disposition <input type="checkbox"/> Approve <input checked="" type="checkbox"/> Approve as amended <input type="checkbox"/> Disapprove <input type="checkbox"/> Deferred	Priority <input type="checkbox"/> Emergency <input checked="" type="checkbox"/> Urgent <input type="checkbox"/> Low	Funding Source <input type="checkbox"/> Mgmt. reserve <input type="checkbox"/> Budget reserve <input checked="" type="checkbox"/> Customer <input type="checkbox"/> Other
Sign-off Approvals		
Project manager <u>William O'Mally</u>	Date <u>June 12, 2xxx</u>	
Project sponsor <u>Kenneth Thompson</u>	Date <u>June 13, 2xxx</u>	
Project customer <u>Hong Lee</u>	Date <u>June 18, 2xxx</u>	
Other _____	Date _____	

FIGURE 7.10

[Access the text alternative for slide images.](#)

Change Request Log

Owner Requested Change Status Report—Open Items

OSU—Weatherford

Rc#	Description	Reference Document	Dates				Status	Comments
			Date Rec'd	Date Submit	Amount			
51	Sewer work offset				-188,129	OPEN	FUNDING FROM OTHER SOURCE	
52	Stainless Plates at restroom Shower Valves	ASI 56	1/5/2013	3/30/2013	9,308	APPROVED		
53	Waterproofing Options	ASI 77	1/13/2013		169,386	OPEN		
54	Change Electrical floor box spec change	RFI 113	12/5/2013	3/29/2013	2,544	SUBMIT		
55	VE Option for Style and rail doors	Door samples	1/14/2013		-20,000	ROM		
56	Pressure Wash C tower	Owner request	3/15/2013	3/30/2013	14,861	SUBMIT		
57	Fire Lite glass in stairs	Owner request			8,000	QUOTE	ROM BASED ON FIRELITE NT	
58	Cyber Café added tele /OFOI equipment	ASI 65	1/30/2013	3/29/2013	4,628	APPROVED		
59	Additional Dampers in C wing	ASI 68	2/4/2013	3/29/2013	1,085	SUBMIT		
60	Revise Corridor ceilings	ASI 72	2/13/2013	3/31/2013	-3,755	SUBMIT		

OPEN—Requires estimate.

ROM—Rough order magnitude.

QUOTE—Subcontractor quotes.

SUBMIT—RC letter submitted.

APPROVED—RC letter approved.

REVISE—RC letter to be reviewed.

ASI—Architect's supplemental instructions.

RFI—Request for information.

FIGURE 7.11

Key Terms

- Avoiding risk.
- Change management system.
- Contingency plan.
- Contingency reserves.
- Escalating risk.
- Management reserves.
- Mitigating risk.
- Opportunity.
- Retaining risk.
- Risk.
- Risk breakdown structure (RBS).
- Risk profile.
- Risk register.
- Risk severity matrix.
- Scenario analysis.
- Time buffer.
- Transferring risk.

PERT—Program Evaluation and Review Technique

Assumes each activity duration has a range that statistically follows a beta distribution.

Uses three time estimates for each activity: optimistic, pessimistic, and a most likely time estimate to represent activity durations.

- From these three time estimates, a weighted average time estimate and a variance is calculated.
- Knowing the weighted average and variances for each activity allows the project planner to compute the probability of meeting different project durations.
- The longer the project duration is, the higher is the probability of meeting that duration.

Activity and Project Frequency Distributions

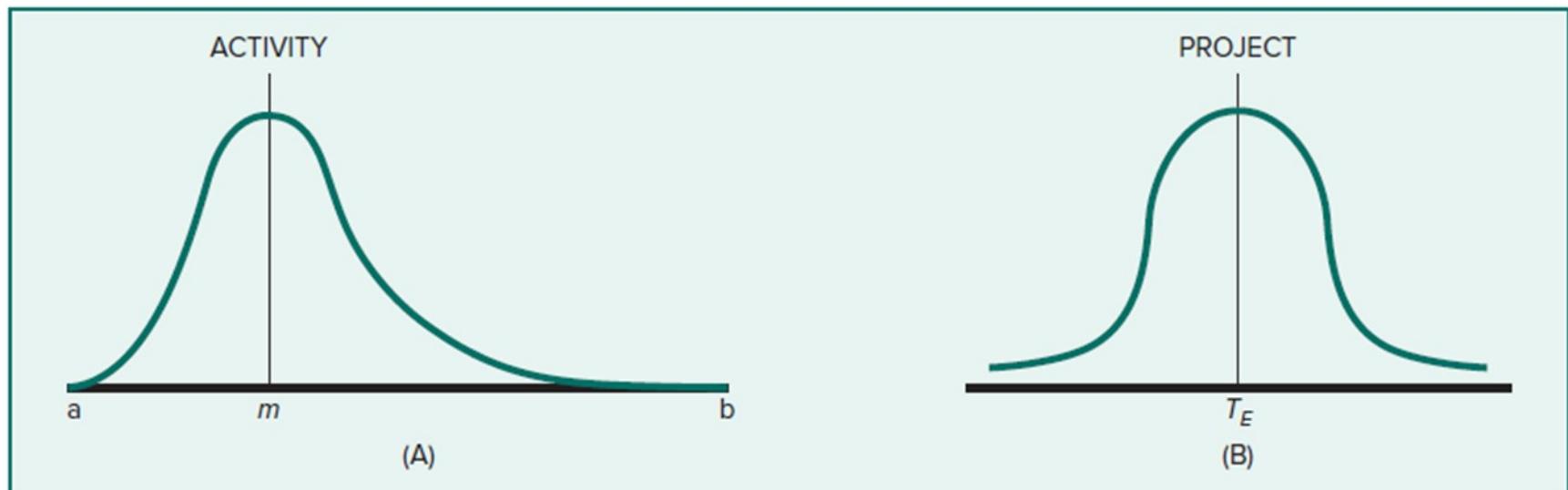


FIGURE A7.1

[Access the text alternative for slide images.](#)

Activity Time Calculations

The weighted average activity time is computed by the following formula:

$$t_e = \frac{a + 4m + b}{6} \quad (7.1)$$

where t_e = weighted average activity time.

a = optimistic activity time (1 chance in 100 of completing the activity earlier under *normal* conditions).

b = pessimistic activity time (1 chance in 100 of completing the activity later under *normal* conditions).

m = most likely activity time.

Activity Time Calculations 2

The variability in the activity time estimates is approximated by the following equations:

The standard deviation for the *activity*.

$$\sigma_{t_e} = \left(\frac{b - a}{6} \right) \quad (7.2)$$

The standard deviation for the *project*.

$$\sigma_{T_E} = \sqrt{\sum \sigma_{t_e}^2} \quad (7.3)$$

The above formula is just the square root of the sum of the variances of all critical tasks.

Activity Times and Variances

Node	Activity	<i>a</i>	<i>m</i>	<i>b</i>	<i>t_e</i>	$[(b-a)/6]^2$
1 to 2	A	17	29	47	30	25
2 to 3	B	6	12	24	13	9
2 to 4	C	16	19	28	20	4
3 to 5	D	13	16	19	16	1
4 to 5	E	2	5	14	6	4
5 to 6	F	2	5	8	5	1

TABLE A7.1

Probability of Completing the Project

The equation below is used to compute the “Z” value found in statistical tables (Z = number of standard deviations from the mean), which, in turn, tells the probability of completing the project in the time specified.

$$Z = \frac{T_S - T_E}{\sqrt{\sum \sigma_{t_e}^2}} \quad (7.4)$$

where T_E = critical path duration.

T_S = scheduled project duration.

Z = probability (of meeting scheduled duration) (see statistical Table A7.2).

Hypothetical Network

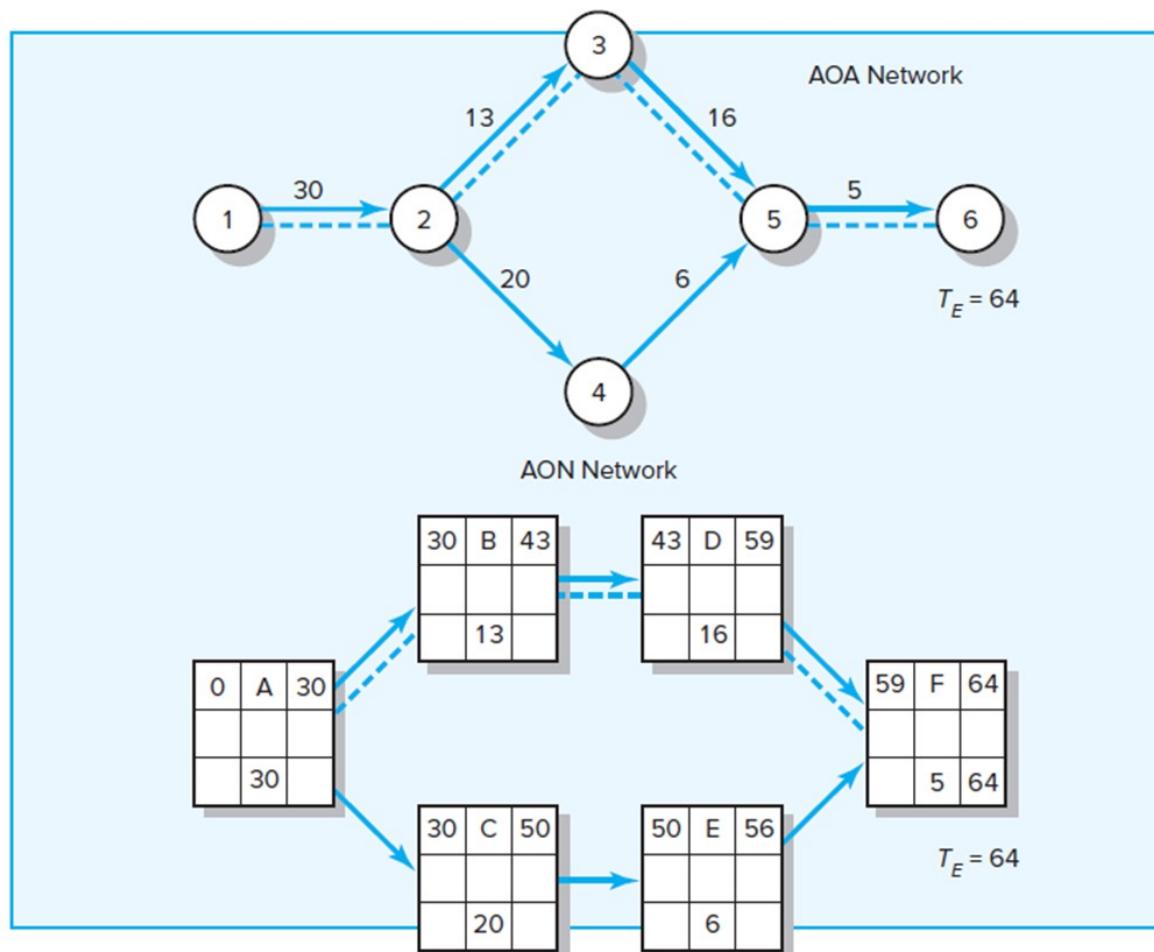


FIGURE A7.2

[Access the text alternative for slide images.](#)

Possible Project Durations

Probability project is completed before scheduled time (T_s) of 67 units.

$$\begin{aligned} Z &= \frac{T_s - T_E}{\sqrt{\sum \sigma_{t_e}^2}} \\ &= \frac{67 - 64}{\sqrt{25 + 9 + 1 + 1}} \\ &= \frac{+3}{\sqrt{36}} \\ &= +0.50 \\ P &= .69 \end{aligned}$$

Probability project is completed by the 60th unit time period (T_s).

$$\begin{aligned} Z &= \frac{60 - 64}{\sqrt{25 + 9 + 1 + 1}} \\ &= \frac{-4}{\sqrt{36}} \\ &= -0.67 \\ P &\approx .26 \end{aligned}$$

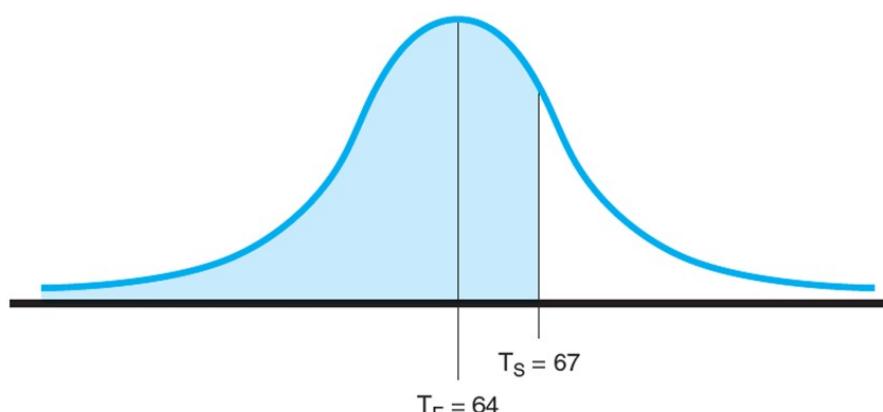


FIGURE A7.3

[Access the text alternative for slide images.](#)

Z Values and Probabilities

Z Value	Probability	Z Value	Probability
-3.0	.001	+0.0	.500
-2.8	.003	+0.2	.579
-2.6	.005	+0.4	.655
-2.4	.008	+0.6	.726
-2.2	.014	+0.8	.788
-2.0	.023	+1.0	.841
-1.8	.036	+1.2	.885
-1.6	.055	+1.4	.919
-1.4	.081	+1.6	.945
-1.2	.115	+1.8	.964
-1.0	.159	+2.0	.977
-0.8	.212	+2.2	.986
-0.6	.274	+2.4	.992
-0.4	.345	+2.6	.995
-0.2	.421	+2.8	.997
0.0	.500	+3.0	.999

TABLE A7.2

Software Project Management: The Scrum Framework

Dr Samyadip Chakraborty

Introduction to Scrum

- ▶ Scrum is an agile framework for managing software development projects that emphasizes iterative progress, collaboration, and continuous improvement.
- ▶ Work is divided into small increments called Sprints, enabling adaptability to change and incremental delivery of value.

Scrum Roles Overview

Scrum defines three key roles:

- ▶ 1. Product Owner
- ▶ 2. Scrum Master
- ▶ 3. Development Team

Product Owner

- ▶ • Maximizes product value and manages the Product Backlog.
- ▶ • Defines and prioritizes product features.
- ▶ • Manages stakeholder expectations.
- ▶ • Ensures team understands backlog items.
- ▶ • Accepts or rejects completed work.

Scrum Master

- ▶ • Facilitator and coach for the team.
- ▶ • Removes impediments.
- ▶ • Promotes adherence to Scrum principles.
- ▶ • Protects team from external interruptions.
- ▶ • Encourages continuous improvement.

Development Team

- ▶ • Cross-functional, self-organizing professionals (5-9 members).
- ▶ • No sub-teams or hierarchies.
- ▶ • Responsible for delivering increments.
- ▶ • Includes developers, testers, and designers.

Scrum Artifacts Overview

- ▶ Three main artifacts track Scrum progress:
- ▶ 1. Product Backlog
- ▶ 2. Sprint Backlog
- ▶ 3. Product Increment

Product Backlog

- ▶ • Ordered list of everything needed in the product.
- ▶ • Dynamic, evolving, and prioritized by value.
- ▶ • Written as user stories with acceptance criteria.
- ▶ • Estimated using story points or time.

Sprint Backlog

- ▶ • Subset of Product Backlog selected for current Sprint.
- ▶ • Includes tasks, estimates, and ownership.
- ▶ • Updated daily and visible to all team members.

Product Increment and Definition of Done

- ▶ • Sum of all completed Product Backlog items.
- ▶ • Must meet Definition of Done and be potentially shippable.
- ▶ • Definition of Done includes coding, testing, documentation, and acceptance by Product Owner.

Scrum Ceremonies Overview

- ▶ Four core ceremonies ensure transparency and inspection:
- ▶ 1. Sprint Planning
- ▶ 2. Daily Scrum
- ▶ 3. Sprint Review
- ▶ 4. Sprint Retrospective

Sprint Planning

- ▶ • Defines work for the Sprint (2-4 hours for a 2-week Sprint).
- ▶ • Determines 'What' and 'How'.
- ▶ • Outputs Sprint Goal and Sprint Backlog.

Daily Scrum (Stand-up)

- ▶ • 15-minute daily meeting.
- ▶ • Each member answers:
 - ▶ - What did I do yesterday?
 - ▶ - What will I do today?
 - ▶ - Any impediments?
- ▶ • Promotes coordination and quick decisions.

Sprint Review

- ▶ • Inspect the Increment and adapt Product Backlog.
- ▶ • Product demonstration to stakeholders.
- ▶ • Collects feedback and revises backlog accordingly.

Sprint Retrospective

- ▶ • Reflect on process and team performance.
- ▶ • Discuss what went well and what to improve.
- ▶ • Identify actionable improvements for next Sprint.

Sprint Cycle Overview

- ▶ A Sprint is a 1-4 week time-boxed iteration producing a potentially releasable increment.

Sprint Stages in Detail

- ▶ 1. Pre-Sprint: Backlog refinement
- ▶ 2. Sprint Planning
- ▶ 3. Sprint Execution
- ▶ 4. Sprint Completion
- ▶ 5. Sprint Review
- ▶ 6. Sprint Retrospective
- ▶ 7. Sprint Transition

Scrum Metrics and Tracking

- ▶ Common metrics include:
 - ▶ • Velocity - work completed per Sprint.
 - ▶ • Burndown Chart - work remaining over time.
 - ▶ • Cumulative Flow Diagram - workflow visualization.
 - ▶ • Sprint Health - reliability, defects, happiness, and cycle time.

Common Scrum Challenges and Solutions

- ▶ 1. Scope Creep - Reinforce fixed Sprint Backlog.
- ▶ 2. Incomplete Stories - Improve estimation, break work down.
- ▶ 3. Ineffective Daily Scrums - Stay focused and time-boxed.
- ▶ 4. Low Stakeholder Engagement - Conduct engaging reviews.
- ▶ 5. Resistance to Change - Pilot teams, training, coaching.

Scaling Scrum Frameworks

- ▶ For multiple teams working on one product:
 - ▶ • Scrum of Scrums - coordination meeting.
 - ▶ • SAFe - Scaled Agile Framework, adds layers (Program, Portfolio).
- ▶ • LeSS - Large-Scale Scrum, one Product Owner and shared backlog.
- ▶ • Scrum@Scale - extends Scrum principles across organization.

Best Practices for Scrum Success

- ▶ • Maintain consistent Sprint cadence.
- ▶ • Keep Product Backlog refined and transparent.
- ▶ • Foster self-organization.
- ▶ • Focus on delivering business value.
- ▶ • Encourage sustainable pace and continuous learning.

Highlight & Conclusion

- ▶ Scrum provides an iterative, flexible approach to managing complex software projects.
- ▶ Success depends on transparency, collaboration, and commitment to continuous improvement.
- ▶ Proper implementation improves productivity, product quality, and stakeholder satisfaction.

Project Management

INTRODUCTION: Session 1

Learning Objectives

- Understand why project management (PM) is crucial in today's world.
- Distinguish a project from routine operations.
- Identify the different stages of a project life cycle.
- Describe how Agile PM is different from traditional PM.
- Understand that managing projects involves balancing the technical and sociocultural dimensions of the project.

Outline

- 1.1 What Is a Project?
- 1.2 Agile Project Management.
- 1.3 Current Drivers of Project Management.
- 1.4 Project Management Today: A Socio-Technical Approach.

What Is a Project?

Project Defined (according to PMI):

- A temporary endeavor undertaken to create a unique product, service, or result.

Major Characteristics of a Project:

- Has an established objective.
- Has a defined lifespan with a beginning and an end.
- Involves several departments and professionals.
- Involves doing something never done before.
- Has specific time, cost, and performance requirements.

Program versus Project

Program Defined:

- A group of related projects designed to accomplish a common goal over an extended period of time.

Program Management Defined:

- A process of managing a group of ongoing, interdependent, related projects in a coordinated way to achieve strategic objectives.

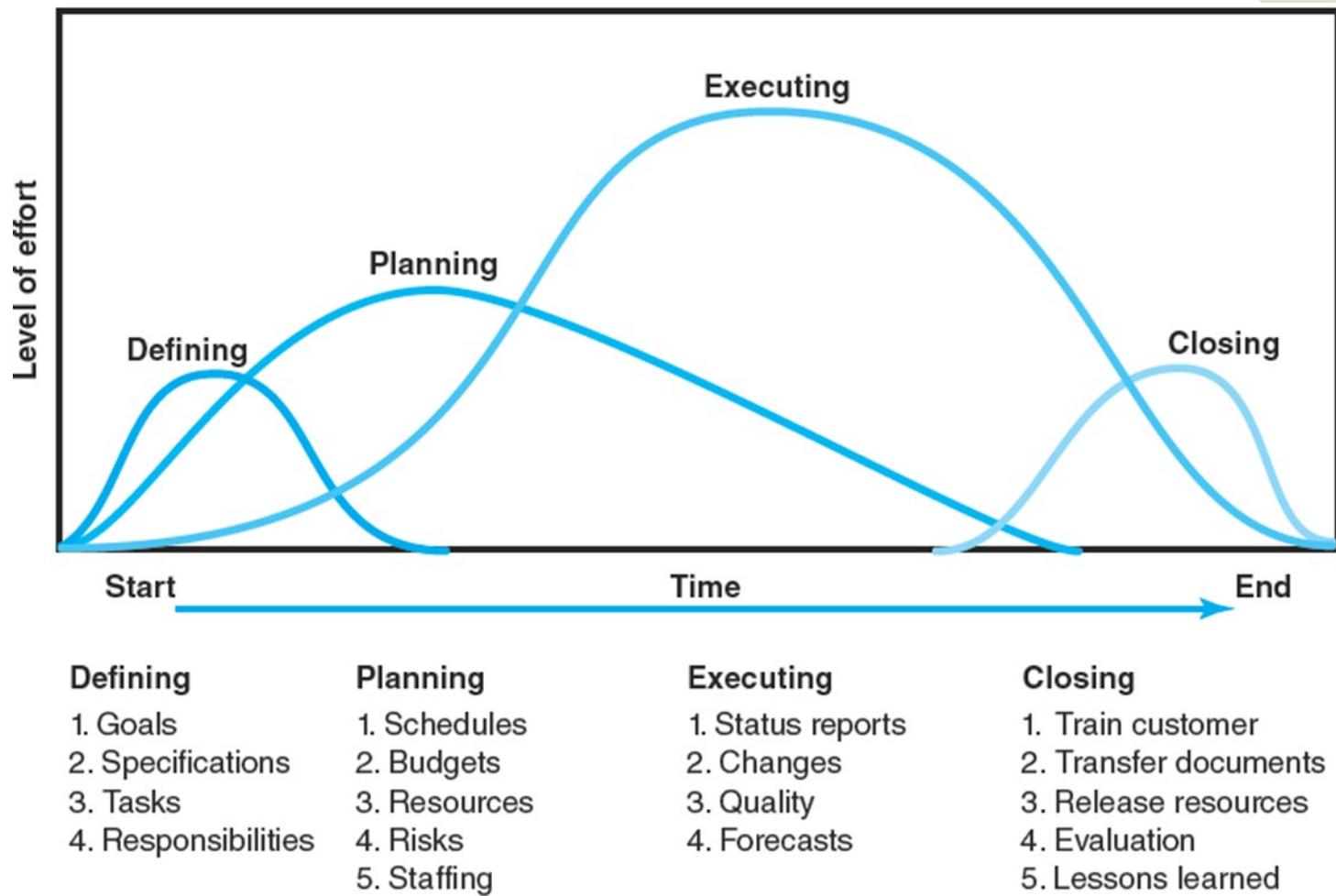
Examples:

- Project: completion of a required course in project management.
- Program: completion of all courses required for a business major.

Comparison of Routine Work with Projects

Routine, Repetitive Work	Projects
Taking class notes	Writing a term paper
Daily entering sales receipts into the accounting ledger	Setting up a sales kiosk for a professional accounting meeting
Responding to a supply-chain request	Developing a supply-chain information system
Practicing scales on the piano	Writing a new piano piece
Routine manufacture of an Apple iPod	Designing an iPod that is approximately 2 × 4 inches, interfaces with PC, and stores 10,000 songs
Attaching tags on a manufactured product	Wire-tag projects for GE and Walmart

Project Life Cycle



The Challenge of Project Management

The Project Manager:

- Manages temporary, nonrepetitive activities and frequently acts independently of the formal organization.
- Marshals resources for the project.
- Is the direct link to the customer.
- Works with a diverse troupe of characters.
- Provides direction, coordination, and integration to the project team.
- Is responsible for performance and success of the project.
- Must induce the right people at the right time to address the right issues and make the right decisions.

Agile Project Management

Agile Project Management (Agile PM):

- Is a methodology emerged out of frustration with using traditional project management processes to develop software.
- Is now being used across industries to manage projects with high levels of uncertainty.
- Employs an incremental, iterative process sometimes referred to as a “rolling wave” approach to complete projects.
- Focuses on active collaboration between the project and customer representatives, breaking projects into small functional pieces, and adapting to changing requirements.
- Is often used up front in the defining phase to establish specifications and requirements, and then traditional methods are used to plan, execute, and close the project.
- Works best in small teams of four to eight members.

Rolling Wave Development



- Iterations typically last from one to four weeks.
- The goal of each iteration is to make tangible progress such as define a key requirement, solve a technical problem, or create desired features to demonstrate to the customer.
- At the end of each iteration, progress is reviewed, adjustments are made, and a different iterative cycle begins.
- Each new iteration subsumes the work of the previous iterations until the project is completed, and the customer is satisfied.

Current Drivers of Project Management

Factors leading to the increased use of project management:

- Compression of the product life cycle.
- Knowledge explosion.
- Triple bottom line (planet, people, profit).
- Increased customer focus.
- Small projects represent big problems.

Project Management Today: A Socio-Technical Approach

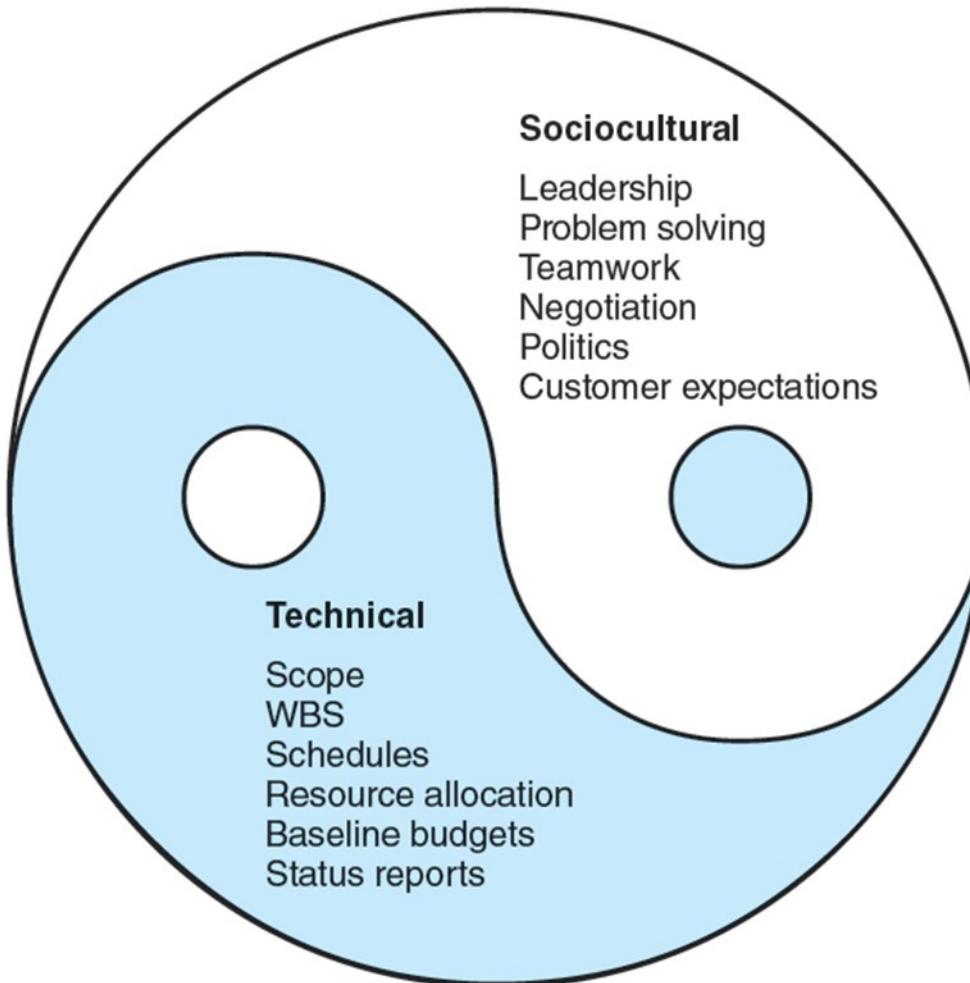
The Technical Dimension (The “Science”):

- Consists of the formal, disciplined, purely logical parts of the process.
- Includes planning, scheduling, and controlling projects.

The Sociocultural Dimension (The “Art”):

- Involves the contradictory and paradoxical world of implementation.
- Centers on creating a temporary social system within a larger organizational environment that combines the talents of a divergent set of professionals working to complete the project.

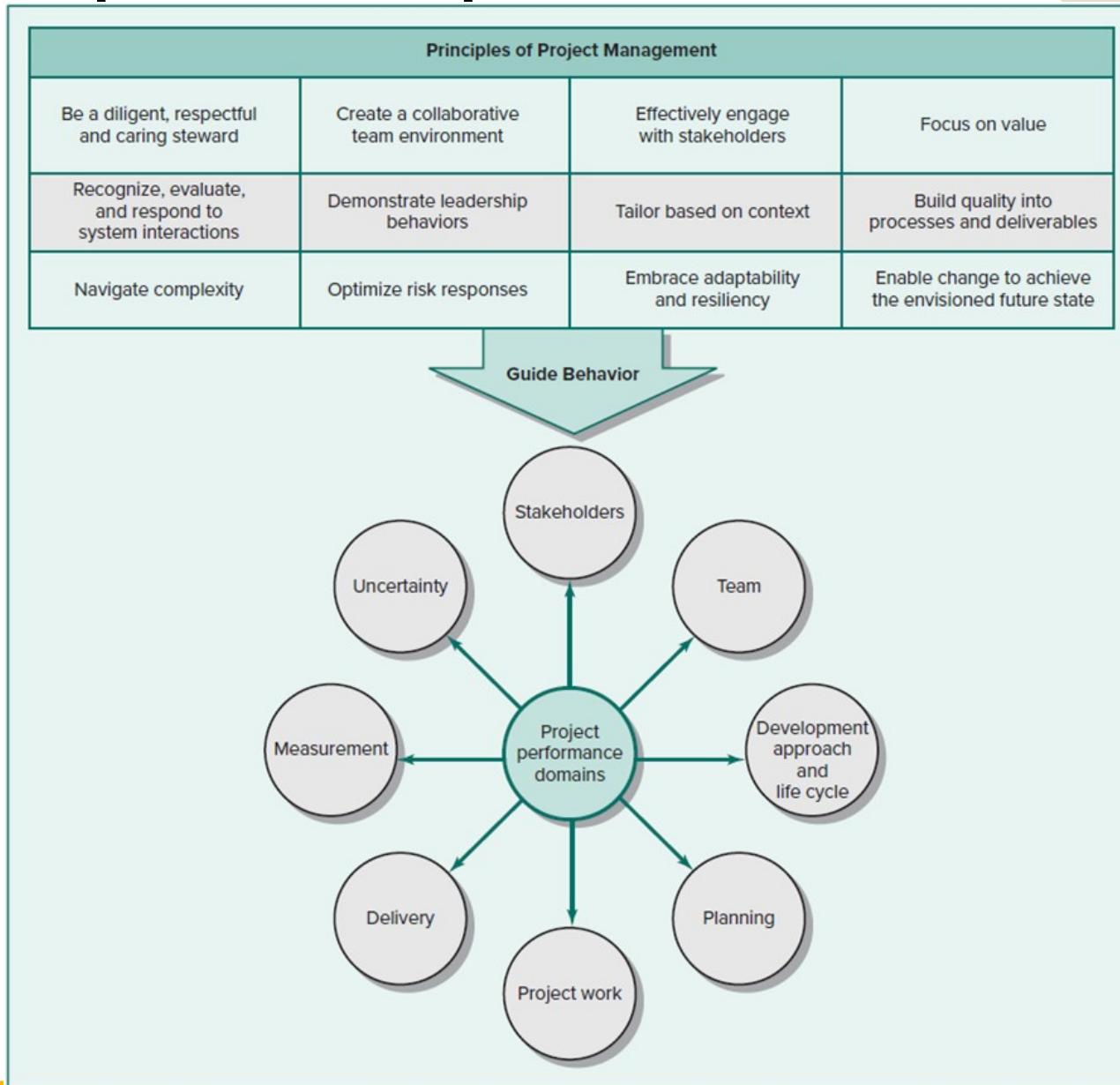
A Socio-Technical Approach to Project Management



Key Terms

- Agile Project Management (Agile PM).
- Program.
- Project.
- Project life cycle.
- Project Management Professional (PMP).

Relationship between 12 Project Management Principles and Project Performance Domains



Session 2: Organization Strategy and Project Selection

Learning Objectives

Explain	2-1: Explain why it is important for project managers to understand their organization's strategy.
Identify	2-2: Identify the significant role projects contribute to the strategic direction of the organization.
Understand	2-3: Understand the need for a project priority system.
Distinguish	2-4: Distinguish among three kinds of projects.
Describe	2-5: Describe how the phase gate model applies to project management.
Apply	2-6: Apply financial and nonfinancial criteria to assess the value of projects.
Understand	2-7: Understand how multi-criteria models can be used to select projects.
Apply	2-8: Apply an objective priority system to project selection.
Understand	2-9: Understand the need to manage the project portfolio.

Why Project Managers Need to Understand Strategy

Project managers need to understand their organization's mission and strategy:

1. Make appropriate decisions and adjustments.

How a project manager would respond to a suggestion to modify the design of a product or to delays may vary depending upon strategic concerns.

2. Effective project advocates.

Demonstrate to senior management how their project contributes to the firm's mission in order to garner the continued support of management.

Explain to stakeholders why certain project objectives and priorities are critical in order to secure buy-in.

Explain why the project is important to motivate and empower the project team (Brown, Hyer, & Ettenson, 2013).

The Strategic Management Process

Strategic Management Defined:

- Assessing “what we are”
- Deciding and implementing “what we intend to be and how we are going to get there.”
- Is a continuous, iterative process aimed at developing an integrated and coordinated long-term plan of action.
- Requires strong links among mission, goals, objectives, strategy, and implementation.

Dimensions of Strategic Management:

1. Responds to changes in the external environment and allocates the firm's scarce resources to improve its competitive position.
2. Internal responses to new action programs aimed at enhancing the competitive position of the firm.

Strategic Management Process Activities

The sequence is:

1. Review and define the organizational mission.

The mission identifies “what we want to become.” Mission statements identify the scope of the organization in terms of its product and service.

2. Analyze and formulate strategies.

Formulating strategy answers the question of what needs to be done to reach objectives. Strategy formulation includes determining and evaluating alternatives that support the organization’s objectives and selecting the best alternative.

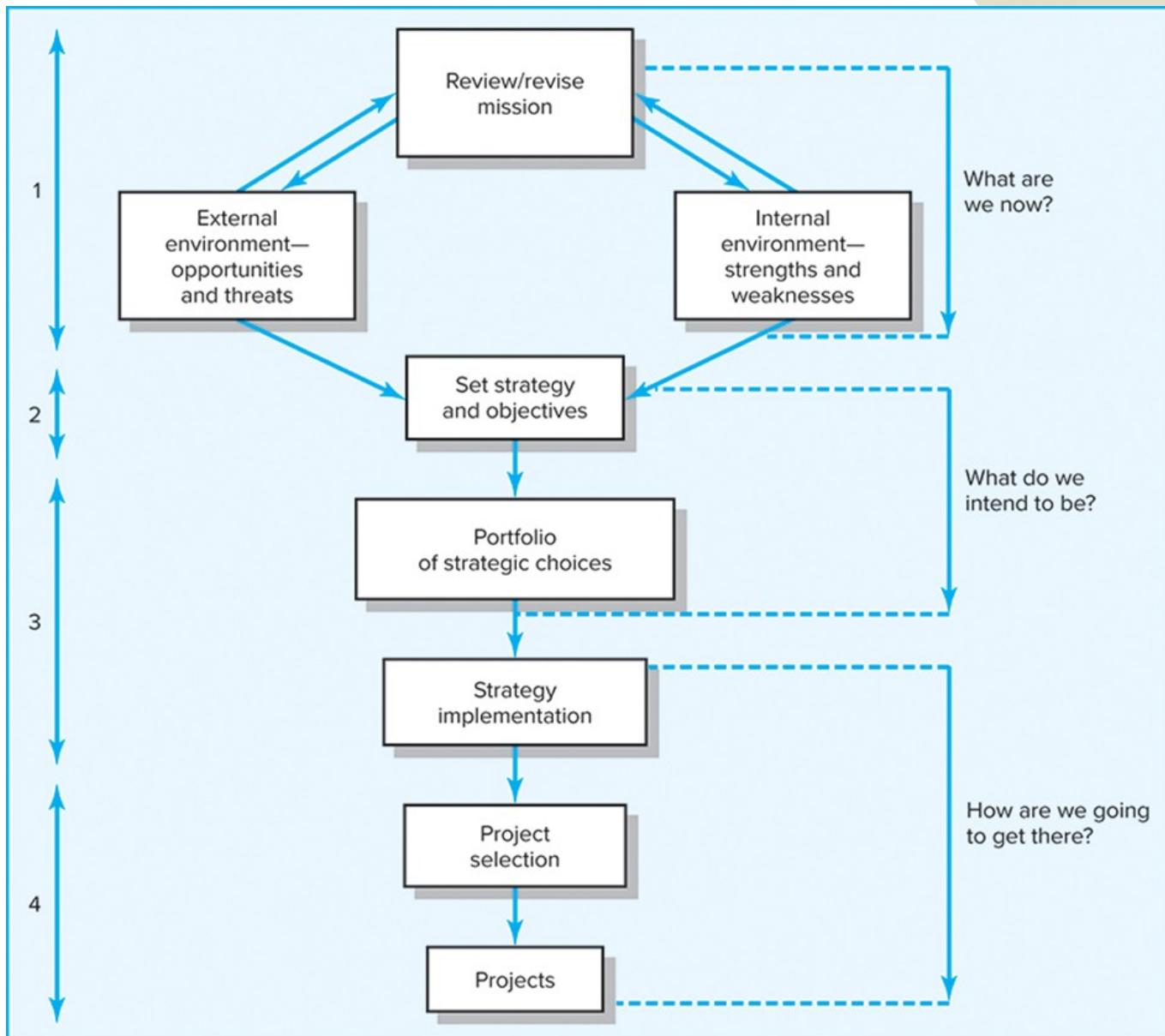
3. Set objectives to achieve strategies.

Objectives translate the organization strategy into specific, concrete, measurable terms. Objectives answer in detail where a firm is headed and when it is going to get there.

4. Implement strategies through projects.

Implementation addresses the question of how strategies will be realized, given available resources.

Strategic Management Process



Characteristics of Objectives

S	Specific	Be specific in targeting an objective
M	Measurable	Establish a measurable indicator(s) of progress
A	Assignable	Make the objective assignable to one person for completion
R	Realistic	State what can realistically be done with available resources
T	Time related	State when the objective can be achieved, that is, duration

Need for a Project Priority System

Implementation of projects without a strong priority system linked to strategy create problems.

Problem 1: Behavioral Biases.

- Two predispositions are optimism bias (overly positive about the outcomes of planned activities) and uniqueness bias (individuals see themselves as more singular than they are).

Problem 2: The Implementation Gap.

- The implementation gap is the lack of understanding and consensus of organization strategy among top and middle-level managers.

Problem 3: Organization Politics.

- Project selection may be based not so much on facts and sound reasoning as on the persuasiveness and power of people advocating projects.
- The term *sacred cow* is often used to denote a project that a powerful, high-ranking official is advocating.

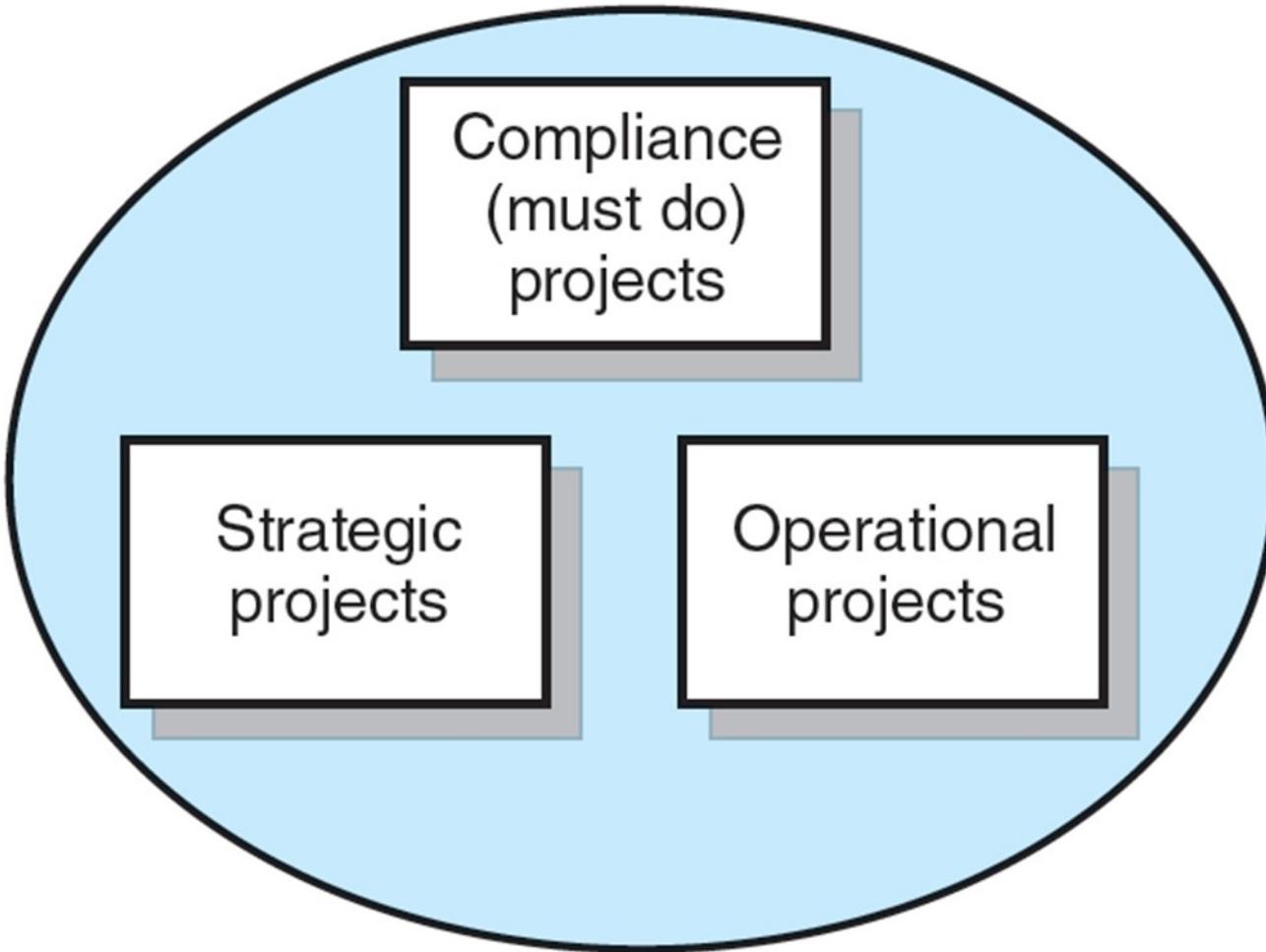
Problem 4: Resource Conflicts and Multitasking.

- A multi-project environment creates the problems of project interdependency and the need to share resources. Resource sharing leads to multitasking—Involves starting and stopping work on one task to go and work on another project, then returning to the work on the original task.

Benefits of Project Portfolio Management

- **Builds discipline into project selection process.**
- Links project selection to strategic metrics.
- Prioritizes project proposals across a common set of criteria, rather than on politics or emotion.
- Allocates resources to projects that align with strategic direction.
- Balances risk across all projects.
- Justifies killing projects that do not support organization strategy.
- Improves communication and supports agreement on project goals.

Project Classification

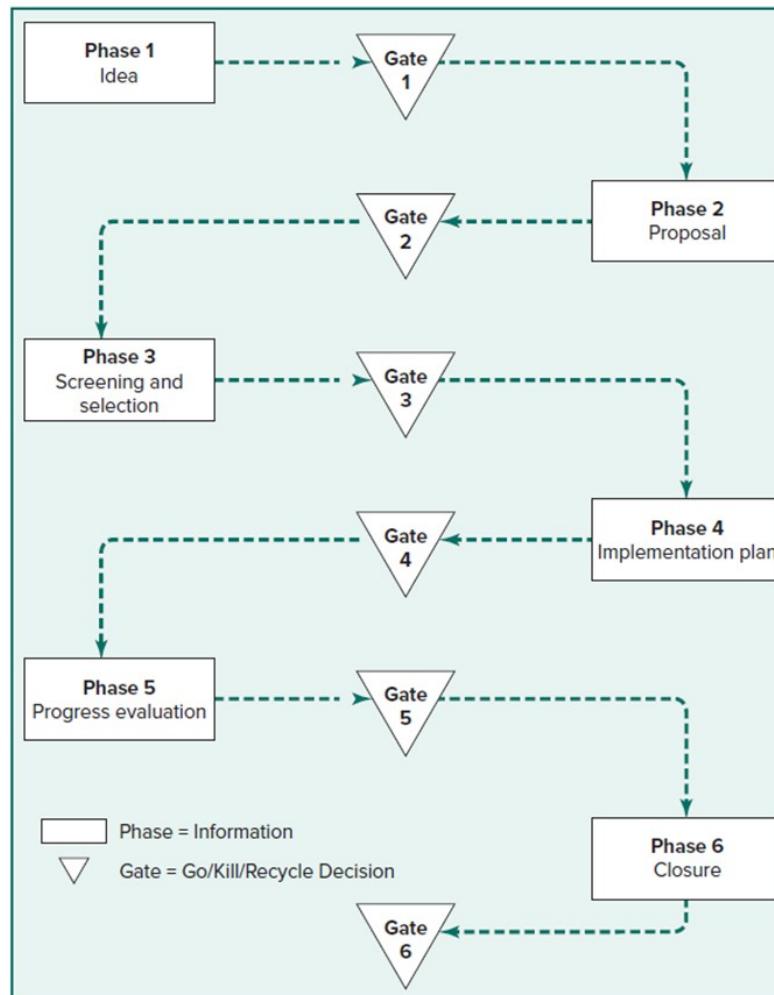


Phase Gate Model

Phase Gate Model:

- Is a series of gates that a project must pass through in the order to be completed.
- Its purpose is to ensure that the organization is investing time and resources on worthwhile projects that contribute to its mission and strategy.
- Each gate is associated with a project phase and represents a decision point.
- A gate can lead to three possible outcomes: go (proceed), kill (cancel), or recycle (revise and resubmit).

Phase Gate Process Diagram



Selection Criteria

Financial Criteria:

- Payback.
- Net present value (NPV).

Nonfinancial Criteria:

- Projects of strategic importance to the firm.

Two Multi-Criteria Selection Models:

- Checklist Models.
- Multi-Weighted Scoring Models.

Financial Criteria: The Payback Model

The Payback Model:

- Measures the time the project will take to recover the project investment.
- Desires shorter paybacks.
- Is the simplest and most widely used model.
- Emphasizes cash flows, a key factor in business.

Limitations of the Payback Method:

- Ignores the time value of money.
- Assumes cash inflows for the investment period (and not beyond).
- Does not consider profitability.

The Payback Formula Is:

$$\text{Payback period (yrs)} = \frac{\text{Estimated project cost}}{\text{Annual savings}}$$

Example Comparing Two Projects Using Payback Method

	A	B	C	D	E	F	G	H	I	J	K	L	M	
1					Exhibit 2.3A									
2														
3					Example Comparing Two Projects Using the Payback Method									
4														
5					Project A		Project B		Formulas					
6														
7														
8	Investment		\$700,000		\$400,000								Project A: Payback = (D8/D9)	
9	Annual savings		\$225,000		\$110,000								Project B: Payback = (F8/F9)	
10														
11	Payback period*		3.1 years		3.6 years									
12														
13	Rate of return **		32.1%		27.5%								Project A: Rate of return = (D9/D8)	
14													Project B: Rate of return = (F9/F8)	
15	Project A: Accept. Less than 5 years and exceeds 15% desired rate.													
16														
17	Project B: Accept. Less than 5 years and exceeds 15% desired rate.													
18														
19	* Note: Payback does not use the time value of money.													
20	** Note: Rate of return is reciprocal of Payback.													
21														

Financial Criteria: Net Present Value (NPV)

Net Present Value (NPV):

- Uses management's minimum desired rate of return (discount rate) to compute the present value of all net cash inflows.
- Prefers positive NPV to negative NPV.
- Desires higher positive NPVs.
- Is more realistic because it considers the time value of money, cash flows, and profitability.

The NPV Formula Using Microsoft Excel is,

$$\text{Project NPV} = I_0 + \sum_{t=1}^n \frac{F_t}{(1+k)^t}$$

where

I_0 = Initial investment (since it is an outflow, the number will be negative).

F_t = Net cash inflow for period t .

k = Required rate of return.

n = Number of years.

Example Comparing Two Projects Using Net Present Value Method

	A	B	C	D	E	F	G	H	I	J	K	L	M	
1														
2														
3														
4	Example Comparing Two Projects Using NPV													
5	Project A		Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Total					
6	Required	15%												
7	Outflows		\$700,000											
8	Inflows			\$225,000	\$225,000	\$225,000	\$225,000	\$225,000	\$1,125,000					
9	Net inflows			\$225,000	\$225,000	\$225,000	\$225,000	\$225,000	\$425,000	Project A: =C7+NPV(B6,D9:H9)				
10	NPV		\$54,235											
11														
12														
13	Project B													
14	Required	15%												
15	Outflows		\$400,000											
16	Inflows			\$110,000	\$110,000	\$110,000	\$110,000	\$110,000	\$550,000					
17	Net inflows			\$110,000	\$110,000	\$110,000	\$110,000	\$110,000	\$150,000	Project B: =C15+NPV(B14,D17:H17)				
18	NPV		-\$31,263											
19														
20														
21														
22	NPV comparison: Accept Project A---NPV is positive.													
23	Reject Project B---NPV is negative.													

Nonfinancial Criteria

Examples of strategic objectives are:

- To capture larger market share.
- To make it difficult for competitors to enter the market.
- To develop an enabler product, which by its introduction will increase sales in more profitable products.
- To develop core technology that will be used in next-generation products.
- To reduce dependency on unreliable suppliers.
- To prevent government intervention and regulation.

Two Multi-Criteria Selection Models

Checklist Models:

- Use a list of questions to review potential projects and to determine their acceptance or rejection.
- Allow greater flexibility in selecting among many different types of projects and are easily used across different divisions and locations.
- Fail to answer the relative importance or value of a potential project to the organization and does not allow for comparison with other potential projects.

Multi-Weighted Scoring Models:

- Use several weighted selection criteria to evaluate project proposals.
- Include qualitative and/or quantitative criteria.
- Allow for comparison with other potential projects.

Checklist Models: Sample Selection Questions Used in Practice

Topic	Question
Strategy/alignment	What specific organization strategy does this project align with?
Driver	What business problem does the project solve?
Sponsorship	Who is the project sponsor?
Risk	What is the impact of not doing this project?
Risk	How risky is the project?
Benefits, value, ROI	What is the value of the project to this organization?
Benefits, value, ROI	When will the project show results?
Objectives	What are the project objectives?
Organization culture	Is our organizational culture right for this type of project?
Resources	Will internal resources be available for this project?
Schedule	How long will this project take?
Finance/portfolio	What is the estimated cost of the project?
Portfolio	How does this project interact with current projects?

Multi-Weighted Scoring Models: Project Screening Matrix

Criteria Weight	Stay within core competencies	Strategic fit	Urgency	25% of sales from new products	Reduce defects to less than 1%	Improve customer loyalty	ROI of 18% plus	Weighted total
	2.0	3.0	2.0	2.5	1.0	1.0	3.0	
Project 1	1	8	2	6	0	6	5	66
Project 2	3	3	2	0	0	5	1	27
Project 3	9	5	2	0	2	2	5	56
Project 4	3	0	10	0	0	6	0	32
Project 5	1	10	5	10	0	8	9	102
Project 6	6	5	0	2	0	2	7	55
:								
Project <i>n</i>	5	5	7	0	10	10	8	83

2.7 Applying a Selection Model

Project Classification:

Deciding whether the project fits with the organization strategy.

Selecting a Model.

- Weighted scoring criteria seem the best alternative because:
 - They reduce the number of wasteful projects using resources.
 - They help to identify project goals that can be communicated using the selection criteria as corroboration.
 - They help project managers understand how their project was selected, how their project contributes to organization goals, and how it compares with other projects.

A Proposal Form for an Automatic Vehicular Tracking (AVL) Public Transportation Project

Project Proposal Form			
Date: Jan 22, 2xxx	Proposal # 11	Sponsor J. Moran	
Project classification?			
Strategic	Operational	<input checked="" type="checkbox"/>	Compliance
What business problem does the project solve?			
Increase customer satisfaction through kiosk and website for bus, streetcar, and fast rail			Enhance driver and traveler safety
			Hyperlink to: AVL.tri-met.org
How does this project align with our organization strategy?			
Increase customer ridership through better passenger travel planning & scheduling decisions			Faster response to accidents
What are the major deliverables of the project?			
GPS vehicle tracking system, Internet access, schedule screen			
What is the impact of not doing this project?			
Not meeting ridership goals			
What are the three major risks for this project?			
Cost overruns	Integration of fast rail, bus, and streetcar systems	Hacking system	
How will we measure success?			
Increased ridership			Customer satisfaction
Meeting budget and schedule			
Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> Will this project require internal resources?			
Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> Available?			
What is the estimated cost of the project? \$10 million			
How long will this project take? 22 Weeks			
Oversight action: Accept <input checked="" type="checkbox"/> Return <input type="checkbox"/>			
Signature XXXXXX			Date: Feb. 7, 2xxx

Risk Analysis for a 500-Acre Wind Farm

Brief Risk Assessment

Purpose: To draw attention to apparent project risks that will need management attention.

What are the four major risks of this project?

1. *Government incentives curtailed*
2. *Land use injunction*
3. *Energy price decrease*
4. *New import tax*

Rank risks above by “probability” and “impact” on the chart below by High, Medium or Low.

Risk Intensity Rating

Risk	Probability	Impact
1. <i>Government incentives curtailed</i>	High	High
2. <i>Land use injunction</i>	Medium	High
3. <i>Energy price decrease</i>	Medium	Medium
4. <i>New import tax</i>	Low	High

Check other project risk factors:

Complexity

Low

Average

High

Resource skills

Good

Okay

Lacking

Technology

Low

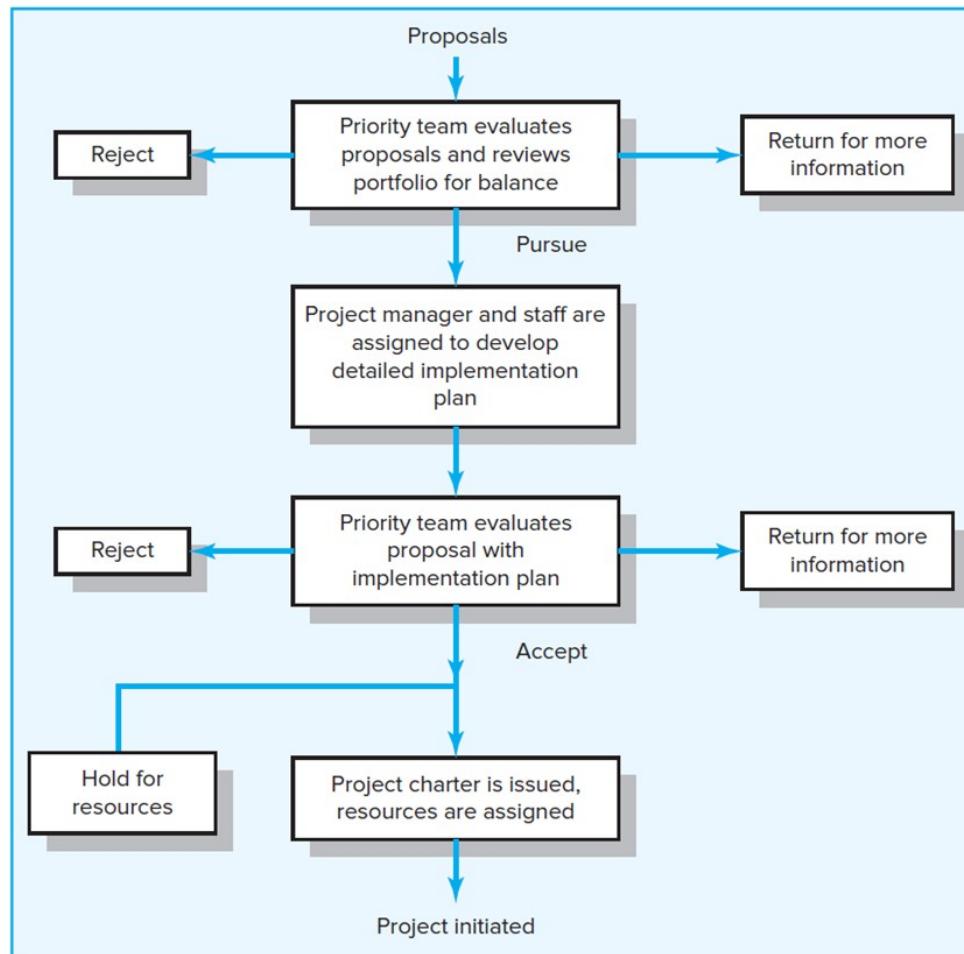
Average

High

Reviewed by Rachel

Date April 1, 2xxx

Project Screening Process



Priority Screening Analysis

Must objectives		Must meet if impacts	...26	27	28	29	Project number		
All activities meet current legal, safety, and environmental standards		Yes-Meets objective No-Does not meet obj N/A-No impact	N/A						
All new products will have a complete market analysis		Yes-Meets objective No-Does not meet obj N/A-No impact	Yes						
Want objectives		Relative Importance 1-100	Single project Impact definitions		Weighted score	Weighted score	Weighted score		
Provides immediate response to field problems		99	0 = Does not address 1 = Opportunity to fix 2 = Urgent problem		99				
Create \$5 million in new sales by 20xx		88	0 < \$100,000 1 = \$100,000–500,000 2 > \$500,000		0				
Improve external customer service		83	0 = Minor impact 1 = Significant impact 2 = Major impact		166				
↓									
Total weighted score									
Priority									

Managing the Portfolio System

Senior Management Input:

- Provides guidance in establishing selection criteria that strongly align with the current organization strategies.
- Annually decides how to balance the available organizational resources (people and capital) among the different types of projects.

Governance Team Responsibilities:

- Publish the priority of every project.
- Ensure the selection process is open and free of power politics.
- Evaluate the progress of current projects.
- Constantly scan the external environment to determine if organization focus and/or selection criteria need to be changed.

Balancing the Portfolio for Risks and Types of Projects

David and Jim Matheson studied R&D organizations and developed a classification scheme that could be used for assessing a project portfolio. They separated projects in terms of degrees of difficulty and commercial value. The four basic types of projects are:

- **Bread-and-butter** projects involve evolutionary improvements to current products and services.
- **Pearls** represent revolutionary commercial advances using proven technology.
- **Oysters** involve technological breakthroughs with tremendous commercial potential.
- **White elephants** showed promise at one time but are no longer viable.

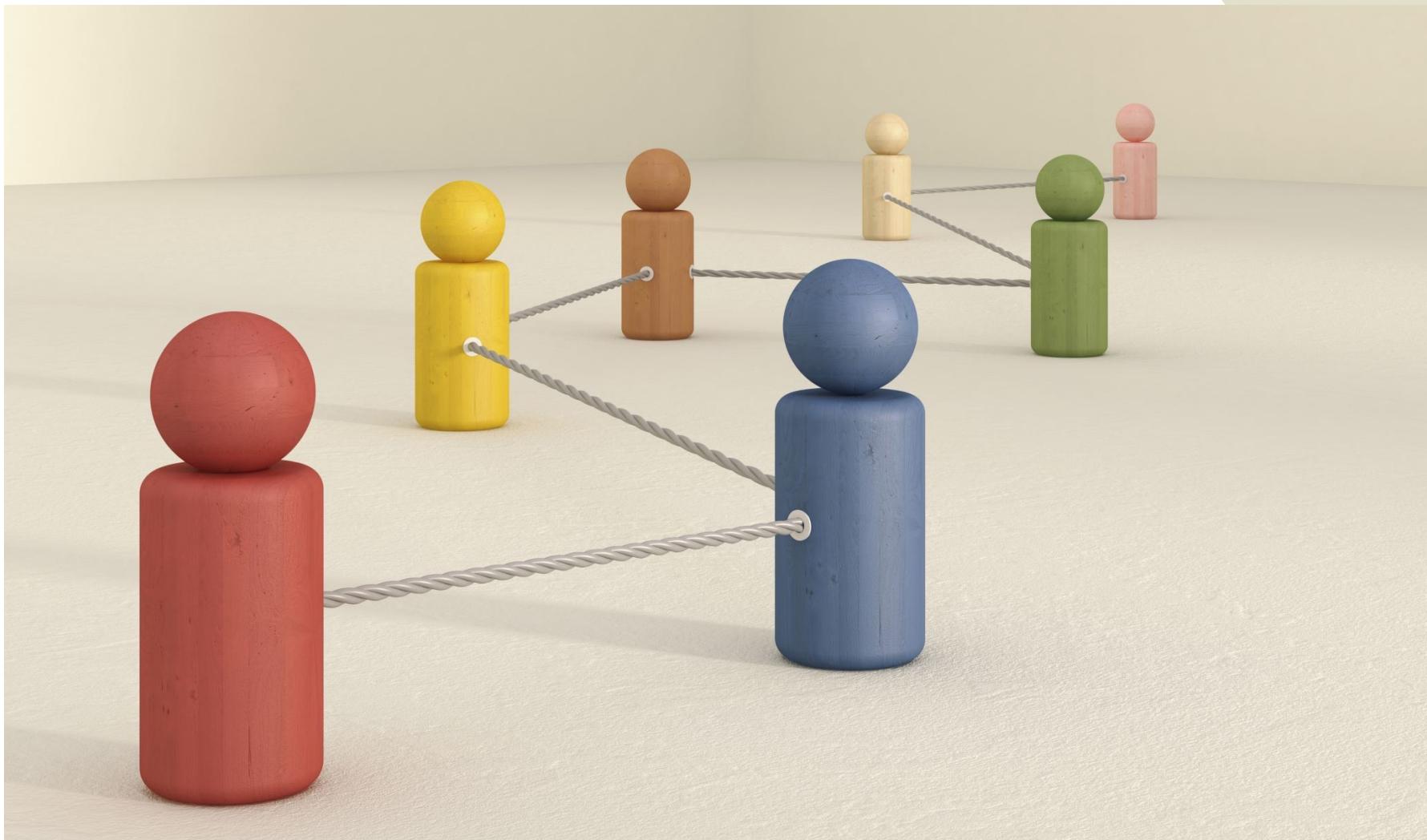
Discussion Topics

- Implementation gap.
- Net present value (NPV).
- Optimism bias.
- Organization politics.
- Payback.
- Phase gate model.
- Priority system.
- Priority team.
- Project portfolio.
- Project sponsor.
- Sacred cow.
- Strategic management.
- Uniqueness bias.

Activities

- Aligning strategy to projects and operations
- Understanding RCA and Business problem
- Understanding and Developing the NTCP framework

Session 3 & 4: Project management structures & organizational culture



Objectives

- Identify different project management structures and understand their strengths and weaknesses.
- Distinguish three different types of matrix structures and understand their strengths and weaknesses.
- Describe how project management offices (PMO's) can support and improve project execution.
- Understand organizational and project considerations that should be considered in choosing an appropriate project management structure.
- Appreciate the significant role that organizational culture plays in managing projects. Interpret the culture of an organization.
- Understand the interaction between project management structure and the culture of an organization.

Project Management Structures

Three different project management structures are:

1. Functional organization.
2. Dedicated project teams.
3. Matrix structure.

Weak matrix.

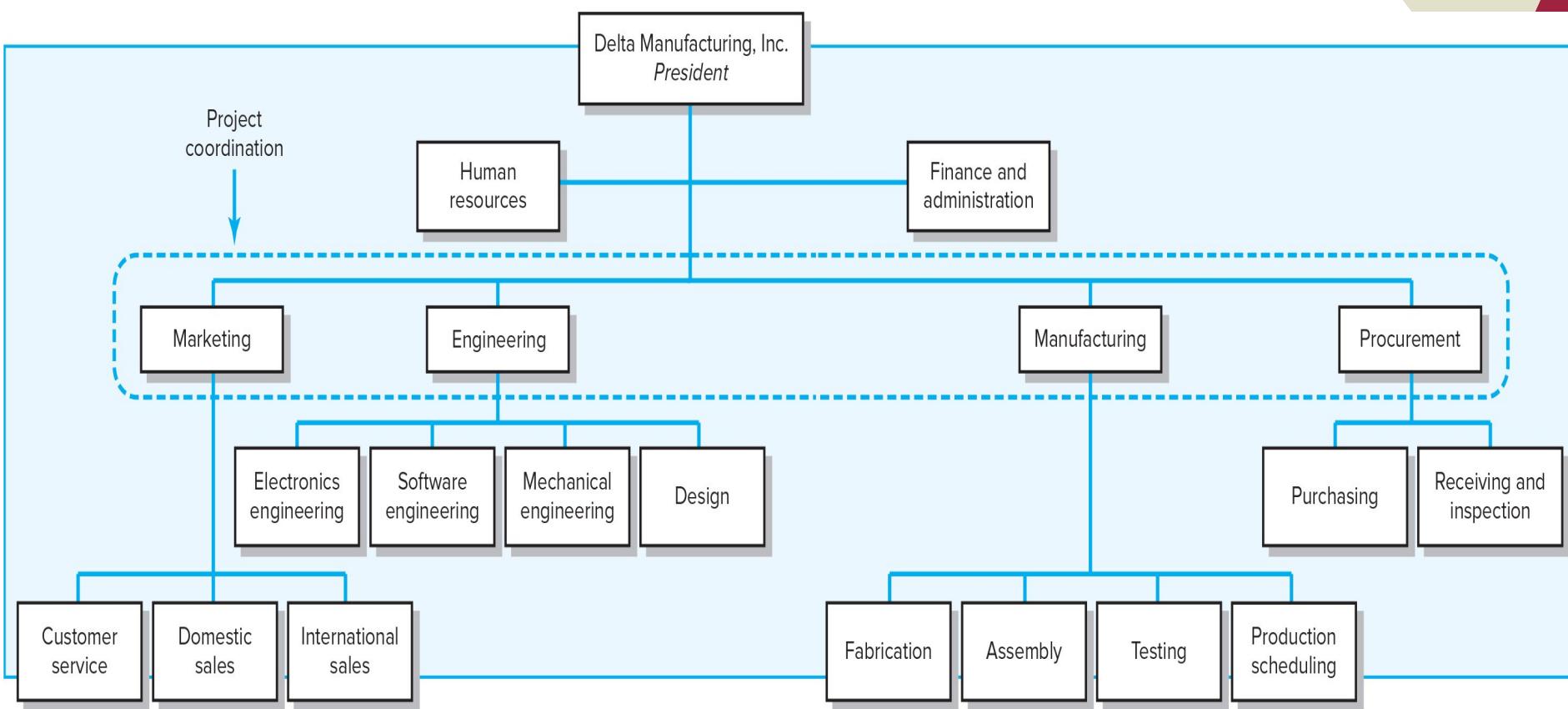
Balanced matrix.

Strong matrix.

Organizing Projects within the Functional Organization

- Top management decides to implement the project, and different segments of the project are distributed to appropriate functional areas.
- Coordination is maintained through normal management channels.
- It is commonly used when one functional area plays a dominant role in completing the project or has a dominant interest in the success of the project.

Functional Organizations



Advantages and Disadvantages of Using Functional Organization to Administer and Complete Projects

Advantages:

1. No change.
2. Flexibility.
3. In-depth expertise.
4. Easy post-project transition.

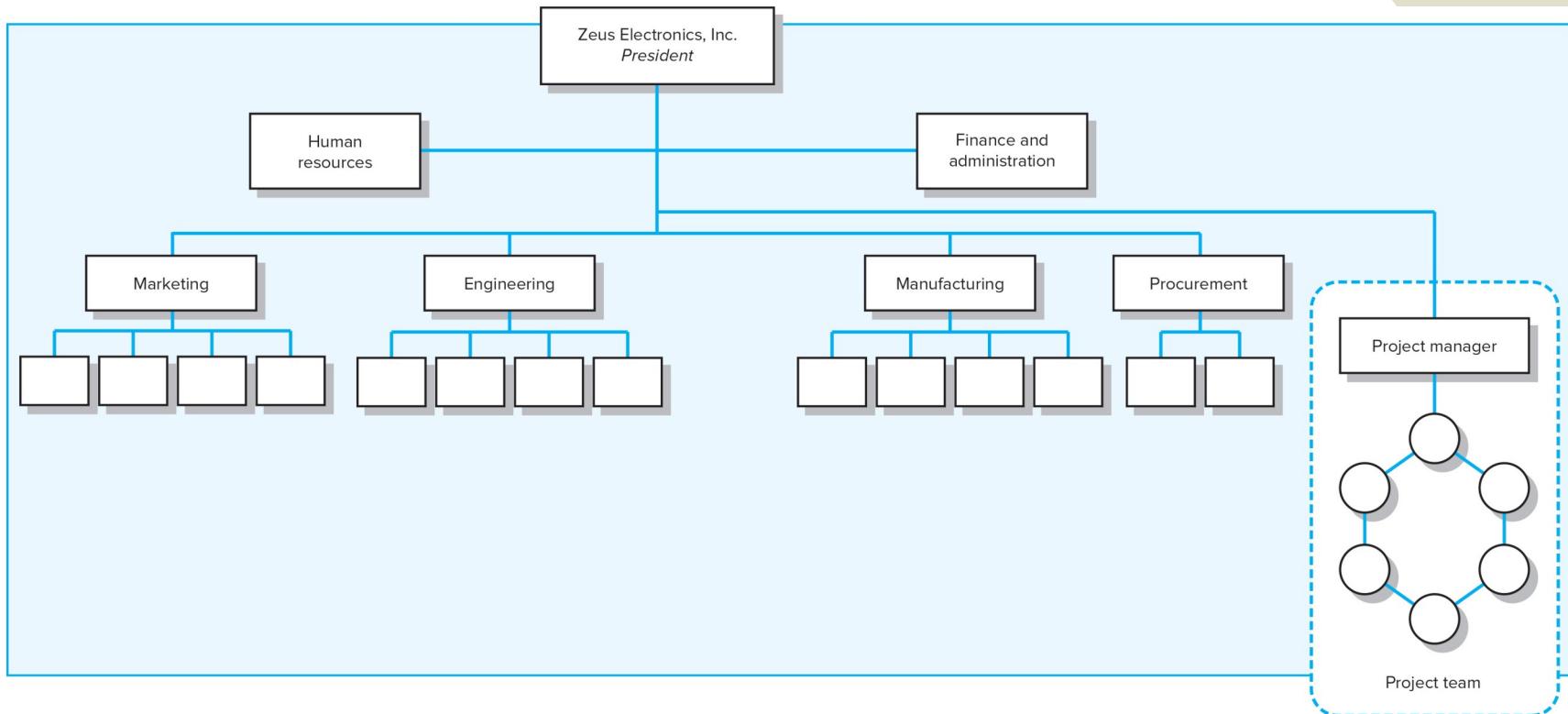
Disadvantages:

1. Lack of focus.
2. Poor integration.
3. Slow.
4. Lack of ownership.

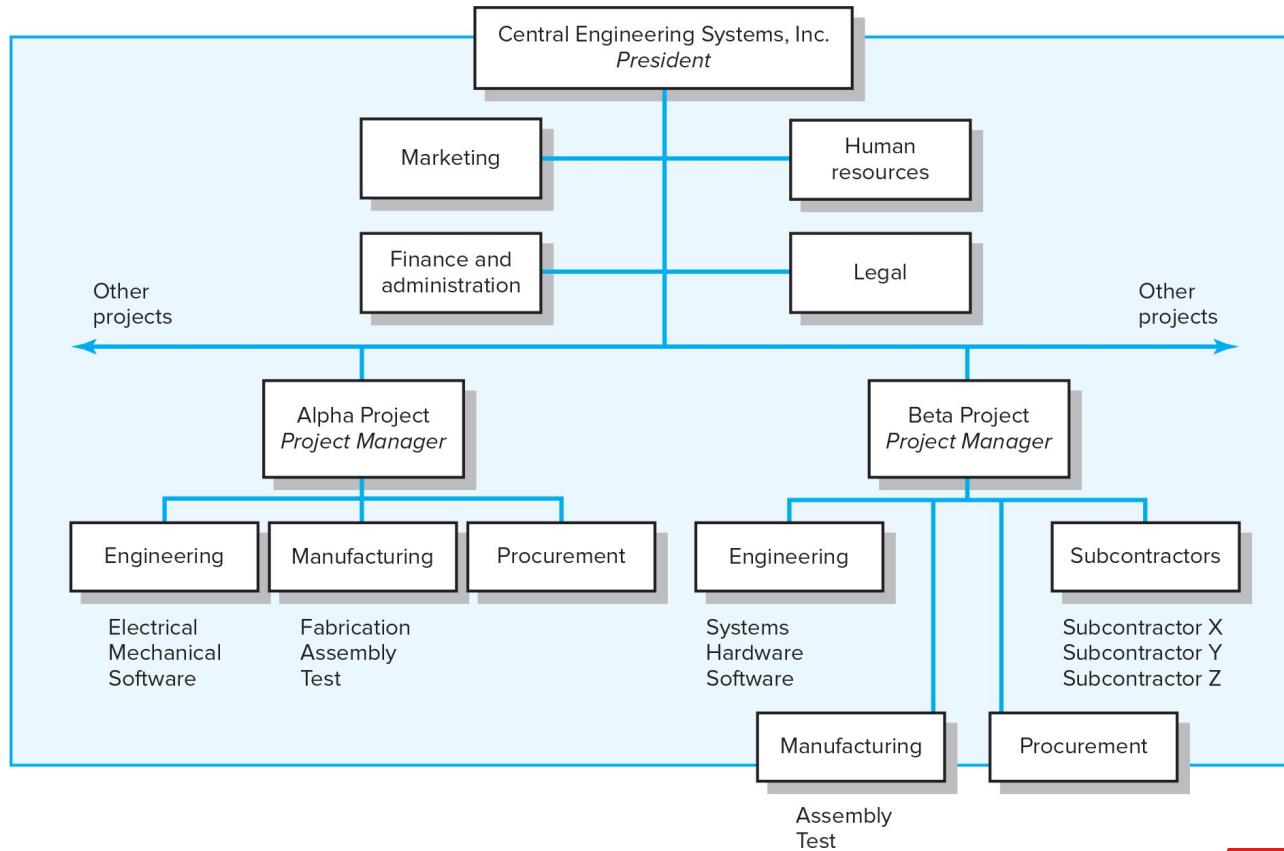
Organizing Projects as Dedicated Teams

- Dedicated project teams operate as units separate from the rest of the parent organization.
- A full-time project manager is designated to pull together a core group of specialists who work full time on the project.
- The project manager recruits necessary personnel from both within and outside the parent company.
- In a projectized organization where projects are the dominant form of business, the entire organization is designed to support project teams.
- “Projectitis” is referred to as a negative dimension to dedicated project teams. A we–they attitude can emerge between project team members and the rest of the organization.

Dedicated Project Team



Projectized Organization Structure



Strengths and Weaknesses of the Dedicated Project Team Approach and Projectized Organizations

Strengths:

1. Simple.
2. Fast.
3. Cohesive.
4. Cross-functional integration.

Weaknesses:

1. Expensive.
2. Internal strife.
3. Limited technological expertise.
4. Difficult post-project transition.

Organizing Projects within a Matrix Arrangement

Matrix management is a hybrid organizational form in which horizontal project management structure is overlaid on the normal functional hierarchy.

There are usually two chains of command, one along functional lines and the other along project lines.

Project participants report simultaneously to both functional and project managers.

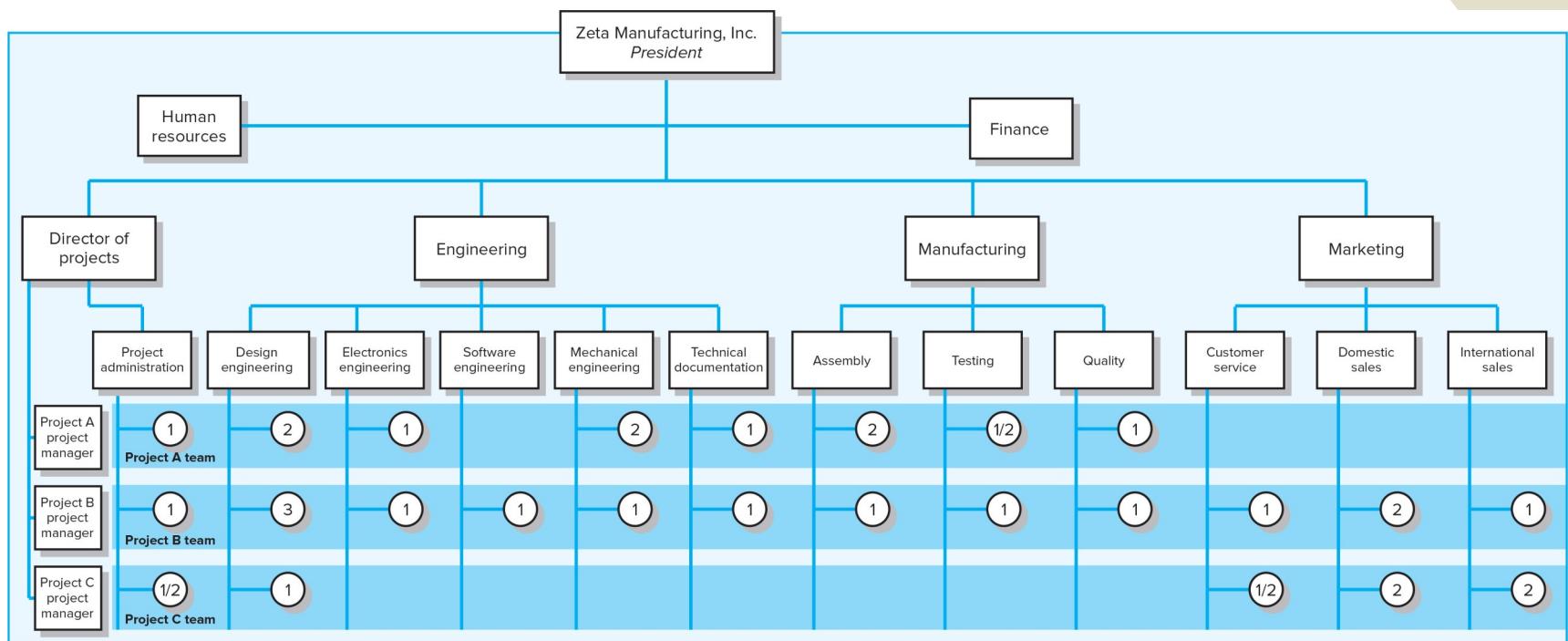
The matrix structure is designed to utilize resources optimally through sharing of resources.

Individuals work on multiple projects as well as being capable of performing normal functional duties.

It attempts to achieve greater integration by creating and legitimizing the authority of a project manager.

It provides dual focus between functional/technical expertise and project requirements.

Matrix Organization Structure



Division of Project Manager and Functional Manager Responsibilities in a Matrix Structure

Project Manager	Negotiated Issues	Functional Manager
What has to be done?	Who will do the task?	How will it be done?
When should the task be done?	Where will the task be done?	
How much money is available to do the task?	Why will the task be done?	How will the project involvement impact normal functional activities?
How well has the total project been done?	Is the task satisfactorily completed?	How well has the functional input been integrated?

Different Matrix Forms 1

Weak Matrix:

This form is very similar to a functional approach with the exception that there is a formally designed project manager responsible for coordinating project activities.

Functional managers are responsible for managing their segment of the project.

The project manager acts as a staff assistant who draws the schedules and checklists, collects information on the status of the work, and facilitates project completion.

Different Matrix Forms 2

Balanced Matrix:

The project manager is responsible for defining what needs to be accomplished. The project manager establishes the overall plan for completing the project, integrates the contribution of the different disciplines, sets schedules, and monitors progress.

The functional managers are concerned with how it will be accomplished. The functional managers are responsible for assigning personnel and executing their segment of the project according to the standards and schedules set by the project manager.

Different Matrix Forms 3

Strong Matrix:

The project manager controls most aspects of the project, including scope trade-offs and assignment of functional personnel. The project manager controls when and what specialists do and has final say on major project decisions.

The functional managers have title over their people and are consulted on a need basis. The functional managers serve as subcontractors for the project.

Advantages and Disadvantages of Matrix Management

Advantages:

- Efficient.
- Strong project focus.
- Easier post-project transition.
- Flexible.

Disadvantages:

1. Dysfunctional conflict.
2. Infighting.
3. Stressful.
4. Slow.

Project Management Office (PMO)

Is a centralized unit within an organization or a department that oversees and supports the execution of projects.

Plays a critical role in helping matrix systems mature into more effective project delivery platforms.

Can be characterized in different kinds:

- **Weather station**—tracks and monitors project performance.
- **Control tower**—improves project execution.
- **Resource pool**—provides the organization with a cadre of trained project managers and professionals.
- **Command and control center**—has direct authority over the project.

What is the Right Project Management Structure?

Organization Considerations:

How important is the project management to the success of the firm?

What percentage of core work involves projects?

What level of resources are available?

Project Considerations:

- Size of project.
- Strategic importance.
- Novelty and need for innovation.
- Need for integration (number of departments involved).
- Environmental complexity (number of external interfaces).
- Budget and time constraints.
- Stability of resource requirements.

Organizational Culture

Organizational Culture:

Is a system of shared norms, beliefs, values, and assumptions that binds people together, thereby creating shared meanings.

Reflects the “personality” of the organization.

Performs several important functions in organizations.

Provides a sense of identity for its members.

Helps legitimize the management system.

Clarifies and reinforces standards of behavior.

Helps create social order.

Key Dimensions Defining an Organization's Culture



Identifying Cultural Characteristics

- Study the physical characteristics of an organization.
- Read about the organization.
- Observe how people interact within the organization.
- Interpret stories and folklore surrounding the organization.

Organizational Culture Diagnosis

Worksheet

Power Corp.

1. Physical Characteristics:

Architecture, office layout, décor, attire.

Corporate HQ is a 20-story modern building—president on top floor. Offices are bigger in the top floors than lower floors. Formal business attire (white shirts, ties, power suits, . . .). Power appears to increase the higher up you are.

2. Public Documents:

Annual reports, internal newsletters, vision statements.

At the heart of the Power Corp. way is our vision . . . to be the global energy company most admired for its people, partnership, and performance.

Integrity. We are honest with others and ourselves. We meet the highest ethical standards in all business dealings. We do what we say we will do.

Organizational Culture Diagnosis Worksheet

3. Behavior:

Pace, language, meetings, issues discussed, decision-making style, communication patterns, rituals.

Hierarchical decision making, pace brisk but orderly, meetings start on time and end on time, subordinates choose their words very carefully when talking to superiors, people rarely work past 6:00 p.m., president takes top-performing unit on a boat cruise each year. . . .

4. Folklore:

Stories, anecdotes, heroines, heroes, villains.

Young project manager was fired after going over their boss's head to ask for additional funds.

Stephanie C. was considered a hero for taking complete responsibility for a technical error.

Jack S. was labeled a traitor for joining chief competitor after working for Power Corp. for 15 years.

Implications of Organizational Culture for Organizing Projects

Project managers interact with:

The culture of their parent organizations as well as the subcultures of various departments.

The project's clients or customer organizations.

Other organizations connected to the project such as suppliers and vendors, subcontractors, consulting firms, government and regulatory agencies, and community groups.

A “riverboat trip” is a metaphor describing the relationship between organizational culture and project management. Culture is the river and the project is the boat.

Discussion Topic

Project Vs Program Vs Portfolio

SWOT in PJM

Cultural Alignment and Project
Environment

Session 5: Defining Projects, PLC and Scope

Learning Objectives

- Identify key elements of a project scope statement and understand why a complete scope statement is critical to project success.
- Describe the causes of scope creep and ways to manage it.
- Understand why it is important to establish project priorities in terms of cost, time, and performance.
- Demonstrate the importance of a work breakdown structure (WBS) to the management of projects and how it serves as a database for planning and control.
- Demonstrate how the organization breakdown structure (OBS) establishes accountability to organization units.
- Describe a process breakdown structure (PBS) and when to use it
- Create responsibility matrices for small projects.
- Create a communication plan for a project.

Five General Steps for Collecting Project Information

Step 1: Defining the Project Scope.

Step 2: Establishing Project Priorities.

Step 3: Creating the Work Breakdown Structure.

Step 4: Integrating the WBS with the Organization.

Step 5: Coding the WBS for the Information System.

Step 1: Defining the Project Scope

Project Scope Defined:

- Is a definition of the end result or mission of your project—a product or service for your client/customer.
- Defines the results to be achieved in specific, tangible, and measurable terms.

Purposes of the Project Scope Statement:

- To clearly define the deliverable(s) for the end user.
- To direct focus on the project purpose throughout the life of the project for the customer and project participants.
- To be published and used by the project owner and project participants for planning and measuring project success.

Project Scope Checklist

1. Project objective.
2. Product scope description.
3. Justification.
4. Deliverables.
5. Milestones.
6. Technical requirements.
7. Limits and exclusions.
8. Acceptance criteria.

Project Scope: Terms and Definitions

Scope Statements:

- Is a short, one- to two-page summary of key elements of the scope, followed by extended documentation of each element.
- Is also referred to as “statements of work (SOW’s).”

Project Charter:

- Is a documentation that authorizes the project manager to initiate and lead the project.
- Often includes a brief scope description as well as such items as risk limits, business case, spending limits, and even team composition.

Scope Creep:

- Is the tendency for the project scope to expand over time—usually by changing requirements, specifications, and priorities.

Six of the Most Common Causes of Scope Creep

- Poor requirement analysis.
- Not involving users early enough.
- Underestimating project complexity.
- Too many decision-makers.
- Lack of change control.
- Gold plating.

Establishing Project Priorities

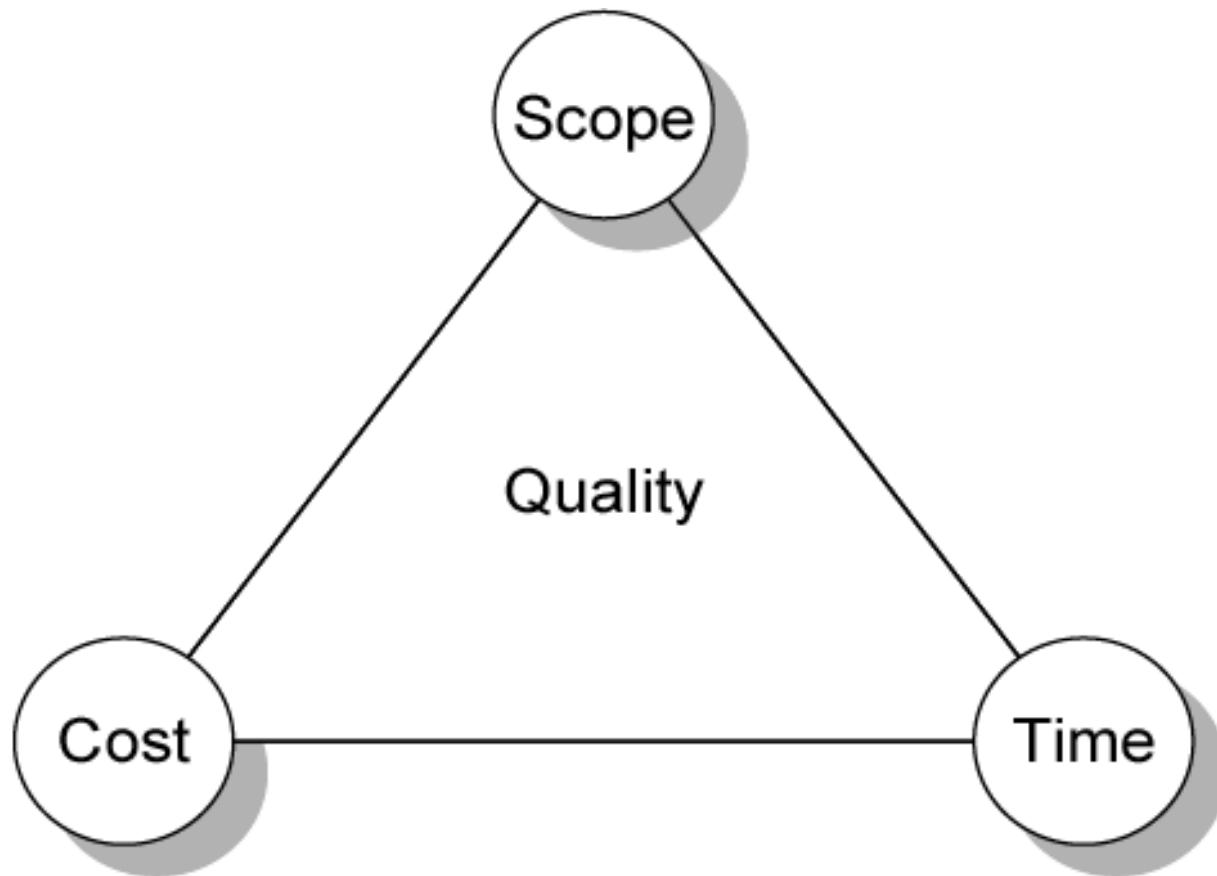
Three major criteria (trade-offs) that a project manager has to manage are:

- Cost (budget).
- Time (schedule).
- Performance (scope).

A project manager can manage the project trade-offs by completing a priority matrix for the project and identifying which criterion is:

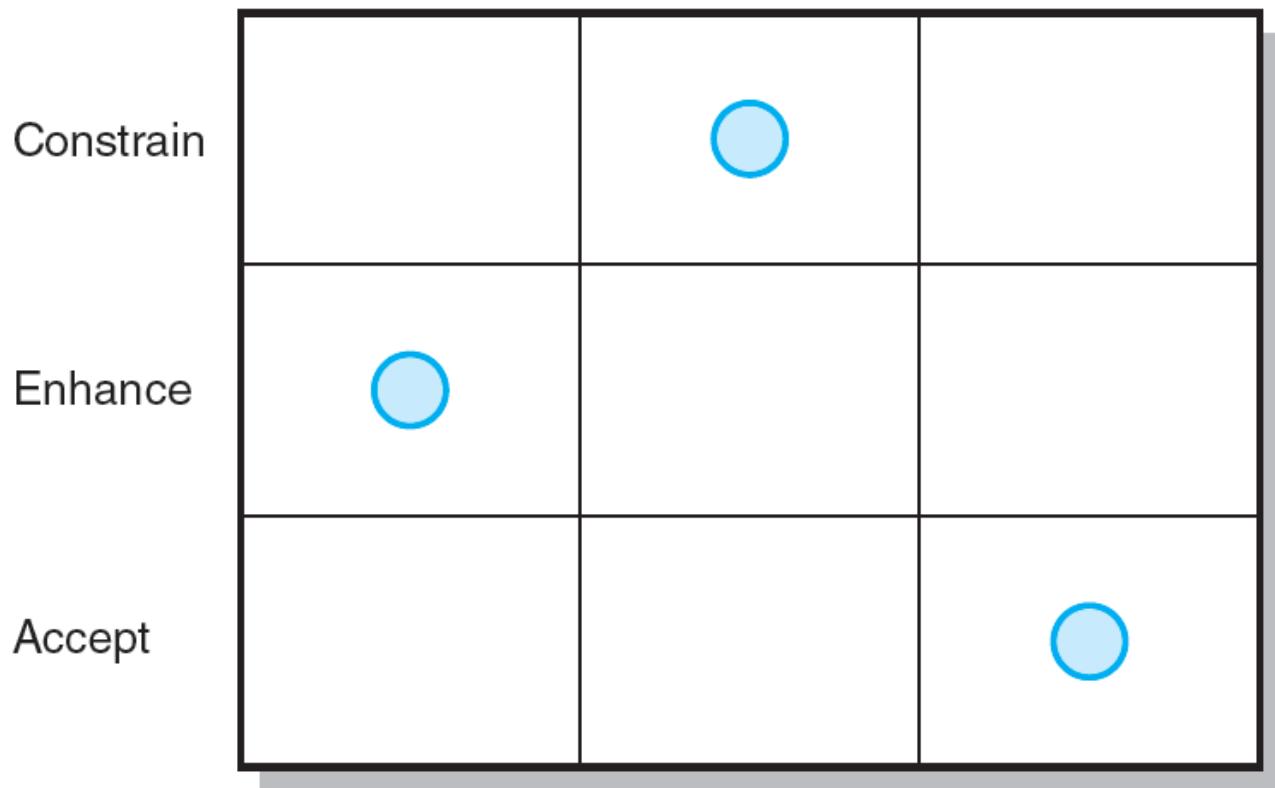
- Constrain—original parameter is fixed.
- Enhance—a criterion should be optimized.
- Accept—a criterion is tolerable not to meet the original parameter.

Project Management Trade-offs



Project Priority Matrix for the Development of a New Wireless Router

Time Performance Cost

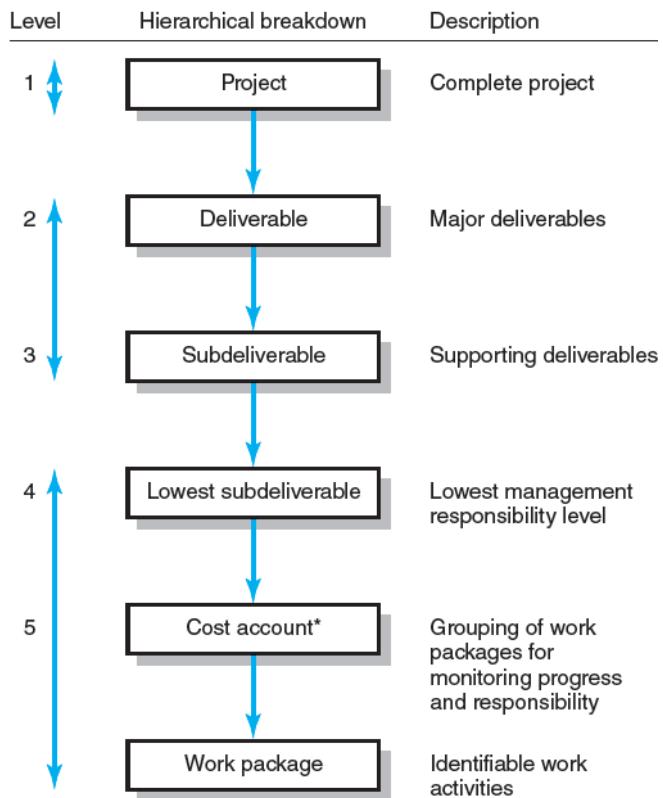


Step 3: Creating the Work Breakdown Structure

Work Breakdown Structure (WBS):

- Is a hierarchical outline of the project with different levels of detail.
- Identifies the products and work elements involved in a project.
- Defines the relationship of the final deliverable (the project) to its sub-deliverables, and, in turn, their relationships to work packages.
- Serves as a framework for tracking cost and work performance.
- Is best suited for design and build projects that have tangible outcomes rather than process-oriented projects.

Hierarchical Breakdown of the WBS



* This breakdown groups work packages by type of work within a deliverable and allows assignment of responsibility to an organizational unit. This extra step facilitates a system for monitoring project progress (discussed in Chapter 13).

How WBS Helps the Project Manager

- Assures project managers that all products and work elements are identified, to integrate the project with the current organization, and to establish a basis for control.
- Facilitates the evaluation of cost, time, and technical performance at all levels in the organization over the life of the project.
- Provides management with information appropriate to each organizational level.
- Helps project managers to plan, schedule, and budget the project.
- Helps in the development of the organization breakdown structure (OBS), which assigns project responsibilities to organization units and individuals.
- Provides the opportunity to “roll up” (sum) the budget and actual costs of the smaller work packages into larger work elements.
- Defines communication channels and assists in understanding and coordinating many parts of the project.

A Work Package

- Is the lowest level of the WBS.
- Is a short-duration task that has a definite start and stop point, consumes resources, and represents cost.
- Should not exceed 10 workdays or one reporting period.
- Should be as independent of other work packages of the project as possible.
- Is the basic unit used for planning, scheduling, and controlling the project.

Each Work Package in the WBS

- Defines work (what).
- Identifies time to complete a work package (how long).
- Identifies a budget to complete a work package (cost).
- Identifies resources needed to complete a work package (how much).
- Identifies a single person responsible for units of work (who).
- Identifies monitoring points for measuring progress (how well).

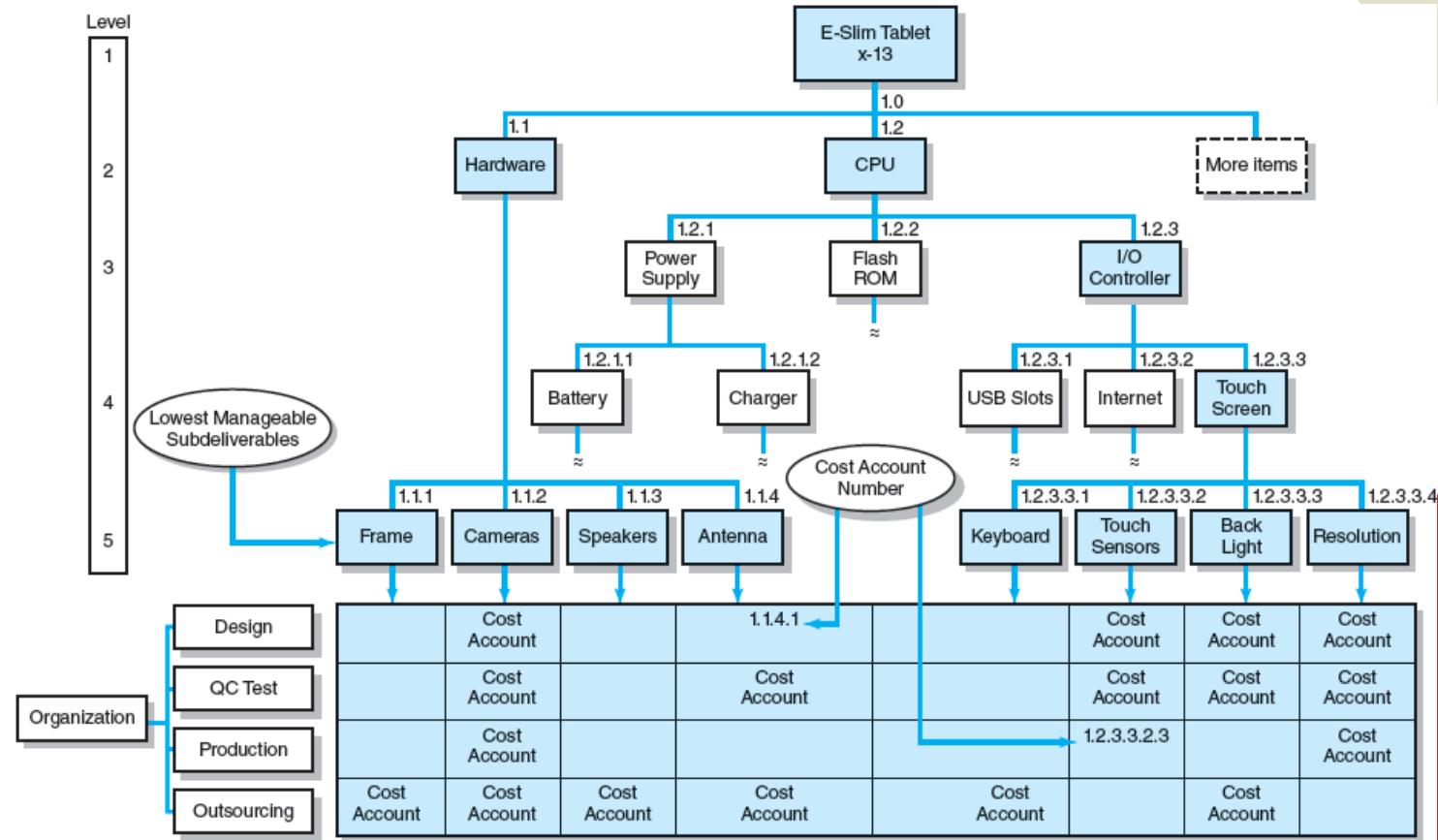
Step 4: Integrating the WBS with the Organization

Organization Breakdown Structure (OBS):

- Depicts how the firm has organized to discharge work responsibility.
- Provides a framework to summarize organization unit work performance.
- Identifies the organization units responsible for work packages.
- Ties the organizational unit to cost control accounts.

The intersection of work packages and the organization unit creates a project cost point or cost account that integrates work and responsibility.

Integration of WBS and OBS



4.5 Step 5: Coding the WBS for the Information System

WBS Coding System:

Defines.

Levels and elements in the WBS.

Organization elements.

Work packages.

Budget and cost information.

Allows reports to be consolidated at any level in the structure.

WBS Dictionary:

Provides detailed information about each element in the WBS.

Coding the WBS

	Task Mode	WBS	Task Name
1	→	1	▪ E-Slim Tablet x-13 Prototype
2	→	1.1	▪ Hardware
3	→	1.1.1	Frame
4	→	1.1.2	Cameras
5	→	1.1.3	Speakers
6	→	1.1.4	Antenna
7	→	1.2	▪ CPU
8	→	1.2.1	▪ Power Supply
9	→	1.2.1.1	Battery (more items)
10	→	1.2.1.2	Charger (more items)
11	→	1.2.2	Flash ROM
12	→	1.2.3	▪ I/O Controller
13	→	1.2.3.1	USB Slots (more items)
14	→	1.2.3.2	Internet (more items)
15	→	1.2.3.3	▪ Touch Screen
16	→	1.2.3.3.1	▪ Keyboard
17	→	1.2.3.3.1.1	Work package K1
18	→	1.2.3.3.2	▪ Touch Sensors
19	→	1.2.3.3.2.1	Work package TS1
20	→	1.2.3.3.2.2	Work package TS2
21	→	1.2.3.3.2.3	Work package TS3
22	→	1.2.3.3.3	Back Light (more items)
23	→	1.2.3.3.4	Resolution (more items)

Process Breakdown Structure

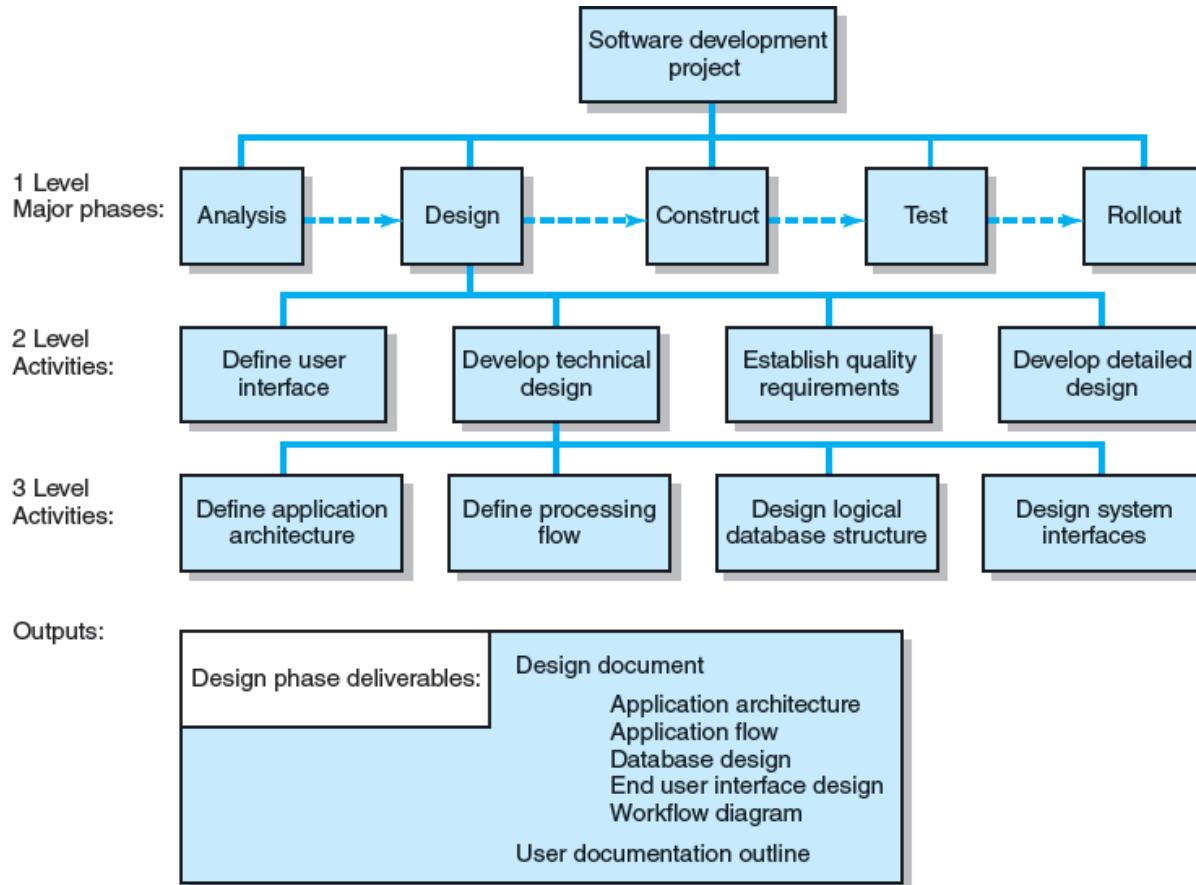
Process Breakdown Structure (PBS):

- Is used for process-oriented projects.
- Is often referred to as the “waterfall method” in the software industry.

Process-Oriented Project:

- Is a project that the final outcome is a product of a series of steps and phases.
- Is a project that evolves over time with each phase affecting the next phase.
- Is a project that is driven by performance requirements, not by plans/blueprints.

PBS for Software Development Project



Responsibility Matrices

Responsibility Matrix (RM):

- Is also called a linear responsibility chart.
- Summarizes the tasks to be accomplished and who is responsible for what on the project.
- Lists all the project activities and the participants responsible for each activity.
- Clarifies interfaces between units and individuals that require coordination.
- Provides a means for all participants in a project to view their responsibilities and agree on their assignments.
- Clarifies the extent or type of authority exercised by each participant.

Responsibility Matrix for a Market Research Project

Task	Project Team				
	Richard	Dan	Dae	Linda	Elizabeth
Identify target customers	R	S		S	
Develop draft questionnaire	R	S	S		
Pilot-test questionnaire			R		S
Finalize questionnaire	R	S	S	S	
Print questionnaire					R
Prepare mailing labels					R
Mail questionnaire					R
Receive and monitor returned questionnaires				R	S
Input response data			R		
Analyze results		R	S	S	
Prepare draft of report	S	R	S	S	
Prepare final report	R		S		

R = Responsible.
S = Supports/assists.

Responsibility Matrix for the Conveyor Belt Project

Deliverables	Organization							
	Design	Development	Documentation	Assembly	Testing	Purchasing	Quality Assur.	Manufacturing
Architectural designs	1	2			2		3	3
Hardware specifications	2	1				2	3	
Kernel specifications	1	3						3
Utilities specifications	2	1			3			
Hardware design	1			3		3		3
Disk drivers	3	1	2					
Memory management	1	3			3			
Operating system documentation	2	2	1					3
Prototypes	5		4		3	3	3	4
Integrated acceptance test	5	2	2	1	1		5	5

1. Responsible.
2. Support.
3. Consult.
4. Notification.
5. Approval.

RACI Matrix

Project tasks	Senior Analyst	Project Manager	Head of Design	SVP Finance	SEO Lead	Sales Director	Senior Management
Phase 1: Research							
Econometric model	R	I	I	A	C	I	I
Strategic framework	A	I	I	R	I	I	C
Risk factors	R	I	I	A	I	I	I
Phase 2: Structure							
Product specs	I	A	R	I	C	C	C
Design wireframe	I	C	R	I	C	I	C
User journey	I	C	R	I	C	C	C
User experience testing	I	C	R	I	C	C	C
Evaluation framework	I	R	C	I	C	I	C
Development backlog	I	R	C	I	C	I	C
Delivery roadmap	C	R	A	C	C	C	I

Project Communication Plan

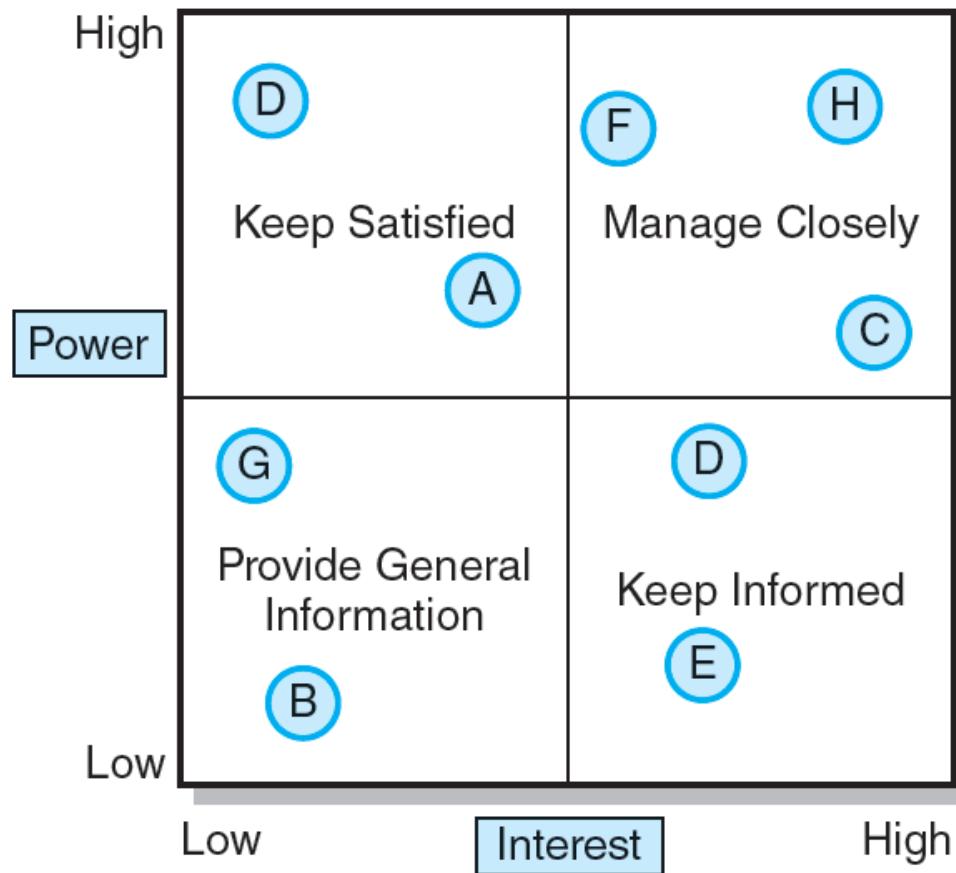
Project communication plans address the following questions:

- What information needs to be collected and when?
- Who will receive the information?
- What methods will be used to gather and store information?
- What are the limits, if any, on who has access to certain kinds of information?
- When will the information be communicated?
- How will it be communicated?

Steps for Developing a Communication Plan

1. Stakeholder analysis—identify the target groups.
2. Information needs—project status reports, deliverable issues, changes in scope, team status meetings, gating decisions, accepted request changes, action items, milestone reports, and so on.
3. Sources of information—where does the information reside?
4. Dissemination modes—hardcopy, e-mail, teleconferencing, SharePoint, and a variety of database sharing programs.
5. Responsibility and timing—determine who will send out the formation and when.

Stakeholder Communications



Shale Oil Research Project Communication Plan

What Information	Target Audience	When?	Method of Communication	Provider
Milestone report	Senior management and project manager	Bimonthly	E-mail and hardcopy	Project office
Project status reports and agendas	Staff and customer	Weekly	E-mail and hardcopy	Project manager
Team status reports	Project manager and project office	Weekly	E-mail	Team recorder
Issues report	Staff and customer	Weekly	E-mail	Team recorder
Escalation reports	Staff and customer	When needed	Meeting and hardcopy	Project manager
Outsourcing performance	Staff and customer	Bimonthly	Meeting	Project manager
Accepted change requests	Project office, senior management, customer, staff, and project manager	Anytime	E-mail and hardcopy	Design department
Oversight gate decisions	Senior management and project manager	As required	E-mail meeting report	Oversight group or project office

Key Terms

- Acceptance criteria.
- Cost account.
- Gold plating.
- Milestone.
- Organization breakdown structure (OBS).
- Priority matrix.
- Process breakdown structure (PBS).
- Product scope description.
- Project charter.
- Responsibility matrix.
- Scope creep.
- Scope statement.
- WBS dictionary.
- Work breakdown structure (WBS).
- Work package.

Session 5 & 6: Defining Projects, PLC and Scope

Learning Objectives

- Identify key elements of a project scope statement and understand why a complete scope statement is critical to project success.
- Describe the causes of scope creep and ways to manage it.
- Understand why it is important to establish project priorities in terms of cost, time, and performance.
- Demonstrate the importance of a work breakdown structure (WBS) to the management of projects and how it serves as a database for planning and control.
- Demonstrate how the organization breakdown structure (OBS) establishes accountability to organization units.
- Describe a process breakdown structure (PBS) and when to use it
- Create responsibility matrices for small projects.
- Create a communication plan for a project.

Five General Steps for Collecting Project Information

Step 1: Defining the Project Scope.

Step 2: Establishing Project Priorities.

Step 3: Creating the Work Breakdown Structure.

Step 4: Integrating the WBS with the Organization.

Step 5: Coding the WBS for the Information System.

Step 1: Defining the Project Scope

Project Scope Defined:

- Is a definition of the end result or mission of your project—a product or service for your client/customer.
- Defines the results to be achieved in specific, tangible, and measurable terms.

Purposes of the Project Scope Statement:

- To clearly define the deliverable(s) for the end user.
- To direct focus on the project purpose throughout the life of the project for the customer and project participants.
- To be published and used by the project owner and project participants for planning and measuring project success.

Project Scope Checklist

1. Project objective.
2. Product scope description.
3. Justification.
4. Deliverables.
5. Milestones.
6. Technical requirements.
7. Limits and exclusions.
8. Acceptance criteria.

Project Scope: Terms and Definitions

Scope Statements:

- Is a short, one- to two-page summary of key elements of the scope, followed by extended documentation of each element.
- Is also referred to as “statements of work (SOW’s).”

Project Charter:

- Is a documentation that authorizes the project manager to initiate and lead the project.
- Often includes a brief scope description as well as such items as risk limits, business case, spending limits, and even team composition.

Scope Creep:

- Is the tendency for the project scope to expand over time—usually by changing requirements, specifications, and priorities.

Six of the Most Common Causes of Scope Creep

- Poor requirement analysis.
- Not involving users early enough.
- Underestimating project complexity.
- Too many decision-makers.
- Lack of change control.
- Gold plating.

Establishing Project Priorities

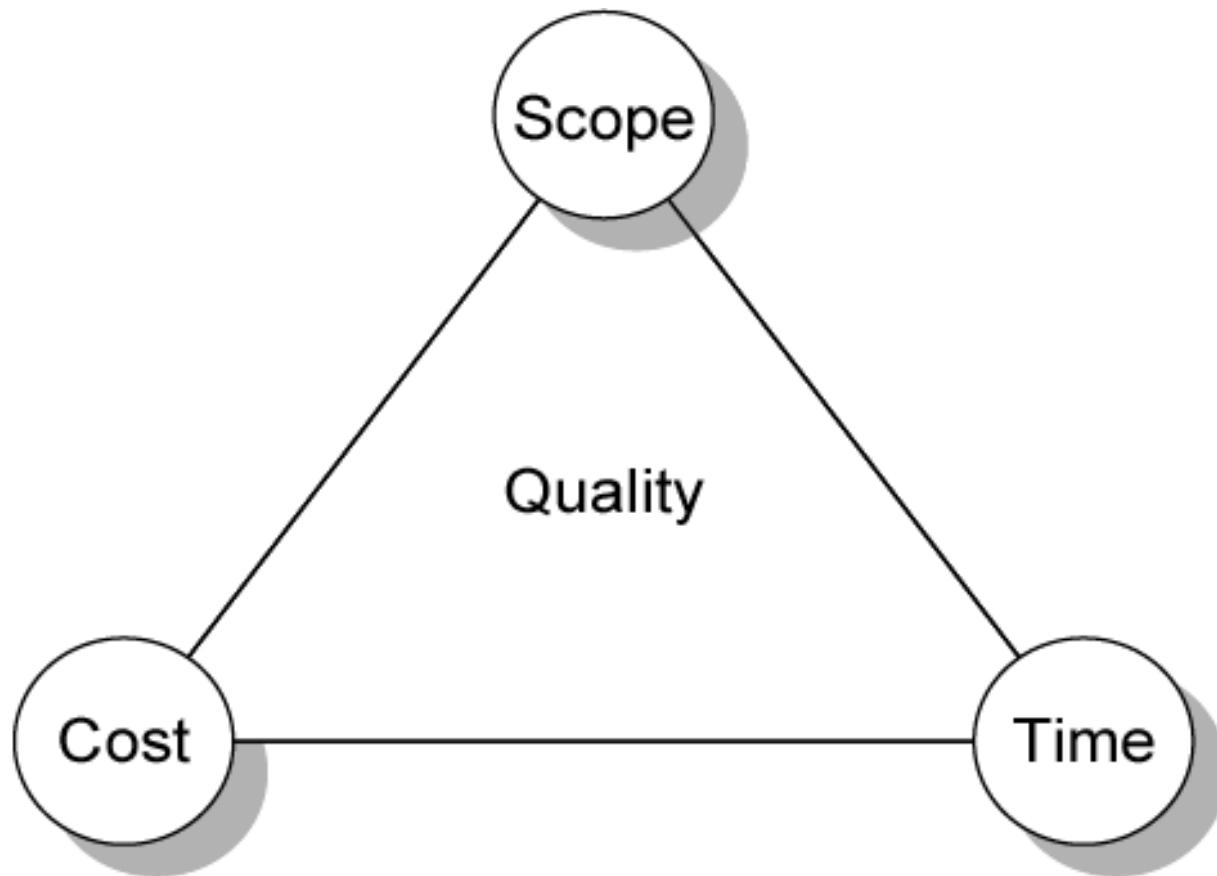
Three major criteria (trade-offs) that a project manager has to manage are:

- Cost (budget).
- Time (schedule).
- Performance (scope).

A project manager can manage the project trade-offs by completing a priority matrix for the project and identifying which criterion is:

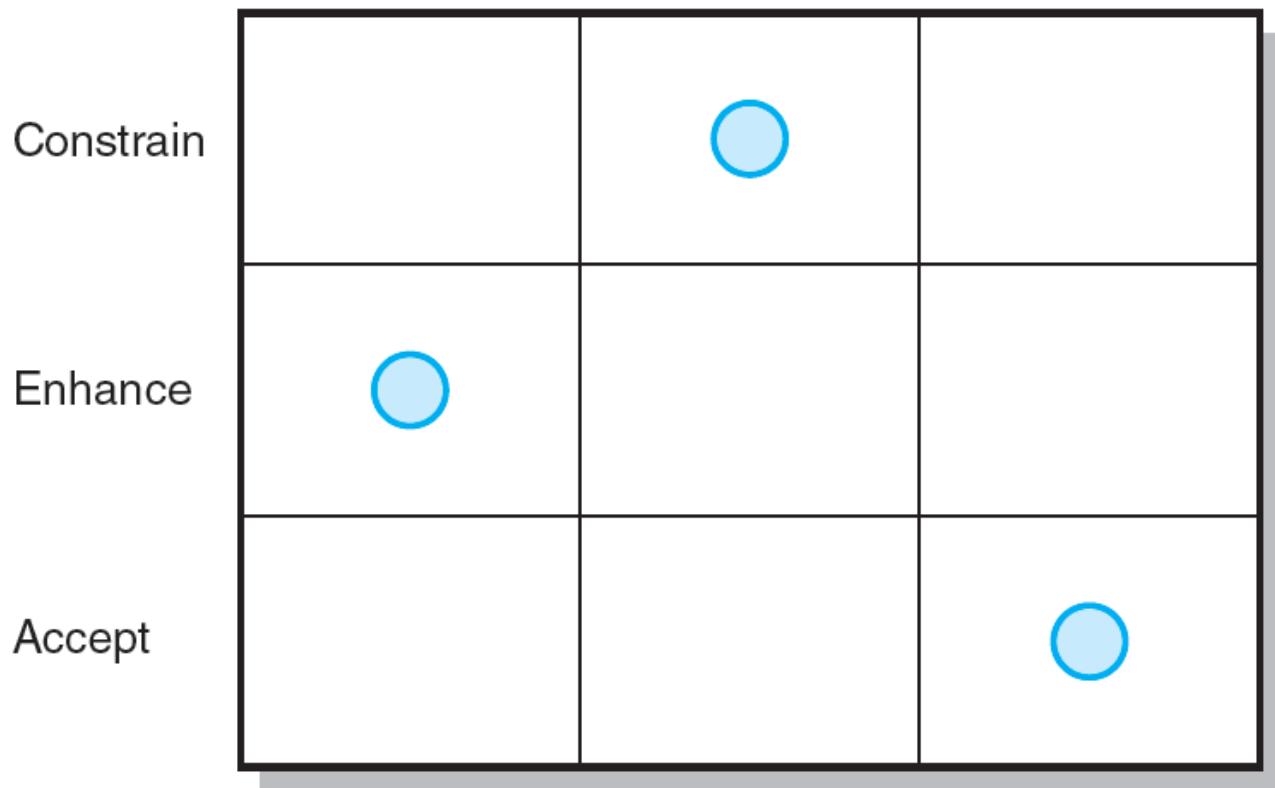
- Constrain—original parameter is fixed.
- Enhance—a criterion should be optimized.
- Accept—a criterion is tolerable not to meet the original parameter.

Project Management Trade-offs



Project Priority Matrix for the Development of a New Wireless Router

Time Performance Cost

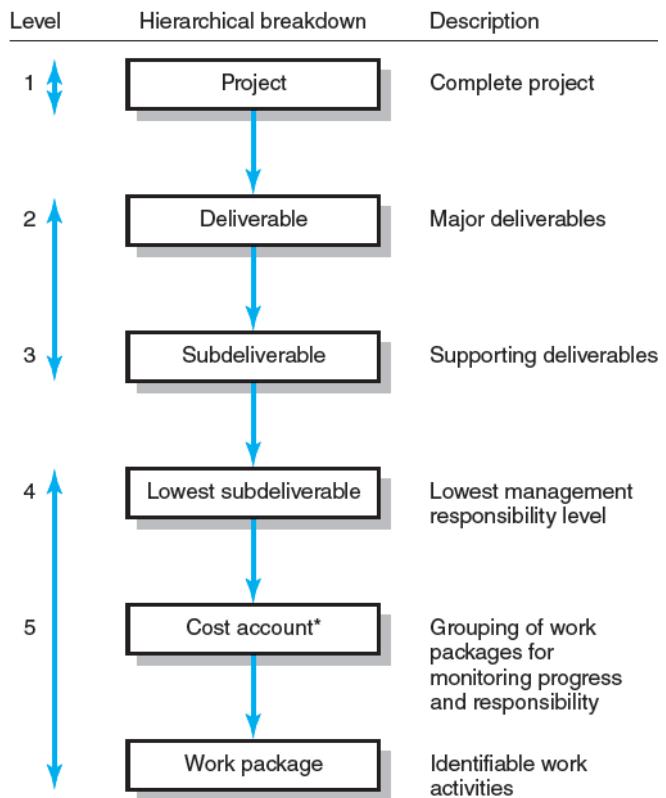


Step 3: Creating the Work Breakdown Structure

Work Breakdown Structure (WBS):

- Is a hierarchical outline of the project with different levels of detail.
- Identifies the products and work elements involved in a project.
- Defines the relationship of the final deliverable (the project) to its sub-deliverables, and, in turn, their relationships to work packages.
- Serves as a framework for tracking cost and work performance.
- Is best suited for design and build projects that have tangible outcomes rather than process-oriented projects.

Hierarchical Breakdown of the WBS



* This breakdown groups work packages by type of work within a deliverable and allows assignment of responsibility to an organizational unit. This extra step facilitates a system for monitoring project progress (discussed in Chapter 13).

How WBS Helps the Project Manager

- Assures project managers that all products and work elements are identified, to integrate the project with the current organization, and to establish a basis for control.
- Facilitates the evaluation of cost, time, and technical performance at all levels in the organization over the life of the project.
- Provides management with information appropriate to each organizational level.
- Helps project managers to plan, schedule, and budget the project.
- Helps in the development of the organization breakdown structure (OBS), which assigns project responsibilities to organization units and individuals.
- Provides the opportunity to “roll up” (sum) the budget and actual costs of the smaller work packages into larger work elements.
- Defines communication channels and assists in understanding and coordinating many parts of the project.

A Work Package

- Is the lowest level of the WBS.
- Is a short-duration task that has a definite start and stop point, consumes resources, and represents cost.
- Should not exceed 10 workdays or one reporting period.
- Should be as independent of other work packages of the project as possible.
- Is the basic unit used for planning, scheduling, and controlling the project.

Each Work Package in the WBS

- Defines work (what).
- Identifies time to complete a work package (how long).
- Identifies a budget to complete a work package (cost).
- Identifies resources needed to complete a work package (how much).
- Identifies a single person responsible for units of work (who).
- Identifies monitoring points for measuring progress (how well).

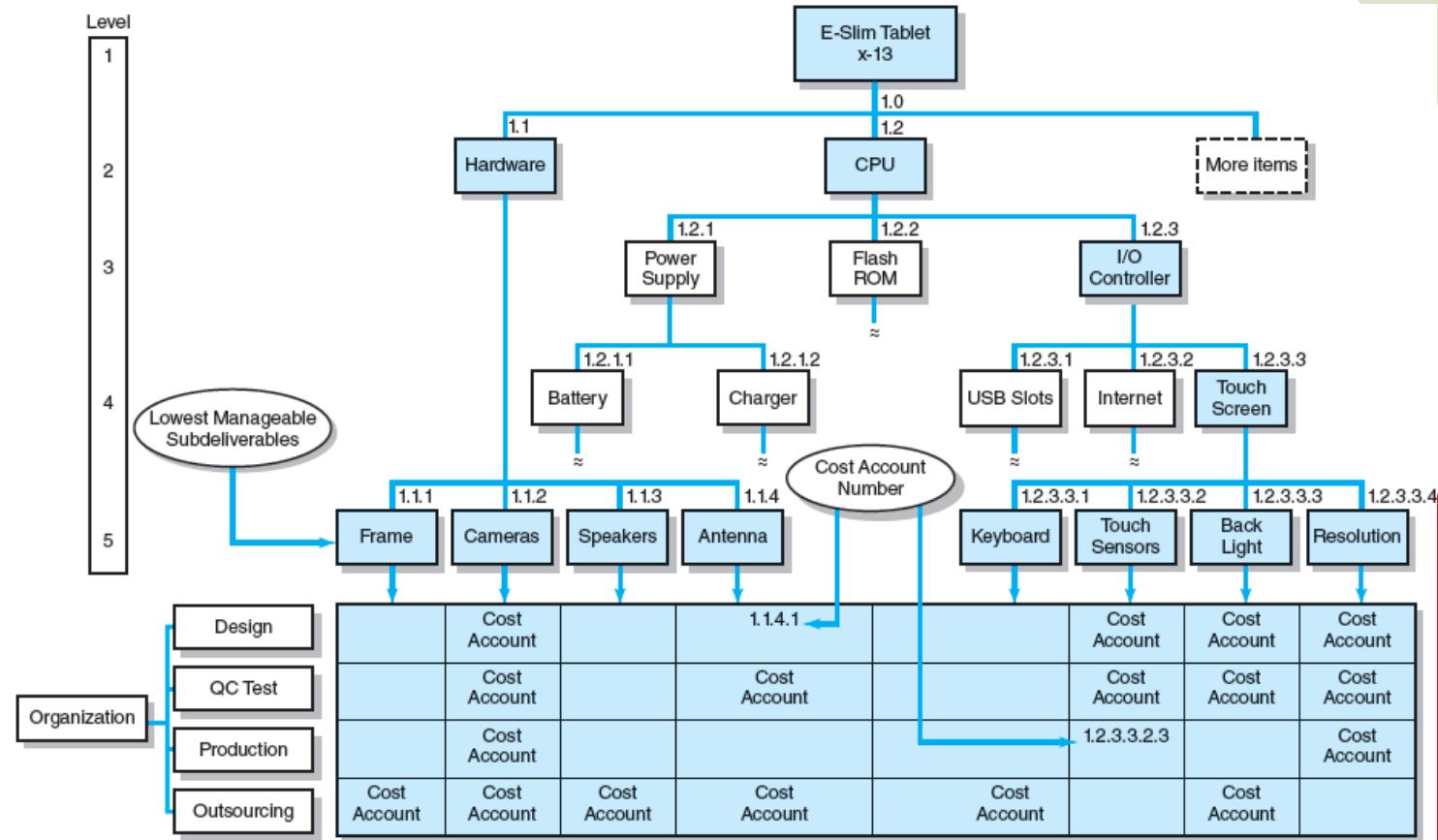
Step 4: Integrating the WBS with the Organization

Organization Breakdown Structure (OBS):

- Depicts how the firm has organized to discharge work responsibility.
- Provides a framework to summarize organization unit work performance.
- Identifies the organization units responsible for work packages.
- Ties the organizational unit to cost control accounts.

The intersection of work packages and the organization unit creates a project cost point or cost account that integrates work and responsibility.

Integration of WBS and OBS



Step 5: Coding the WBS for the Information System

WBS Coding System:

Defines.

Levels and elements in the WBS.

Organization elements.

Work packages.

Budget and cost information.

Allows reports to be consolidated at any level in the structure.

WBS Dictionary:

Provides detailed information about each element in the WBS.

Coding the WBS

	Task Mode	WBS	Task Name
1	→	1	▪ E-Slim Tablet x-13 Prototype
2	→	1.1	▪ Hardware
3	→	1.1.1	Frame
4	→	1.1.2	Cameras
5	→	1.1.3	Speakers
6	→	1.1.4	Antenna
7	→	1.2	▪ CPU
8	→	1.2.1	▪ Power Supply
9	→	1.2.1.1	Battery (more items)
10	→	1.2.1.2	Charger (more items)
11	→	1.2.2	Flash ROM
12	→	1.2.3	▪ I/O Controller
13	→	1.2.3.1	USB Slots (more items)
14	→	1.2.3.2	Internet (more items)
15	→	1.2.3.3	▪ Touch Screen
16	→	1.2.3.3.1	▪ Keyboard
17	→	1.2.3.3.1.1	Work package K1
18	→	1.2.3.3.2	▪ Touch Sensors
19	→	1.2.3.3.2.1	Work package TS1
20	→	1.2.3.3.2.2	Work package TS2
21	→	1.2.3.3.2.3	Work package TS3
22	→	1.2.3.3.3	Back Light (more items)
23	→	1.2.3.3.4	Resolution (more items)

Process Breakdown Structure

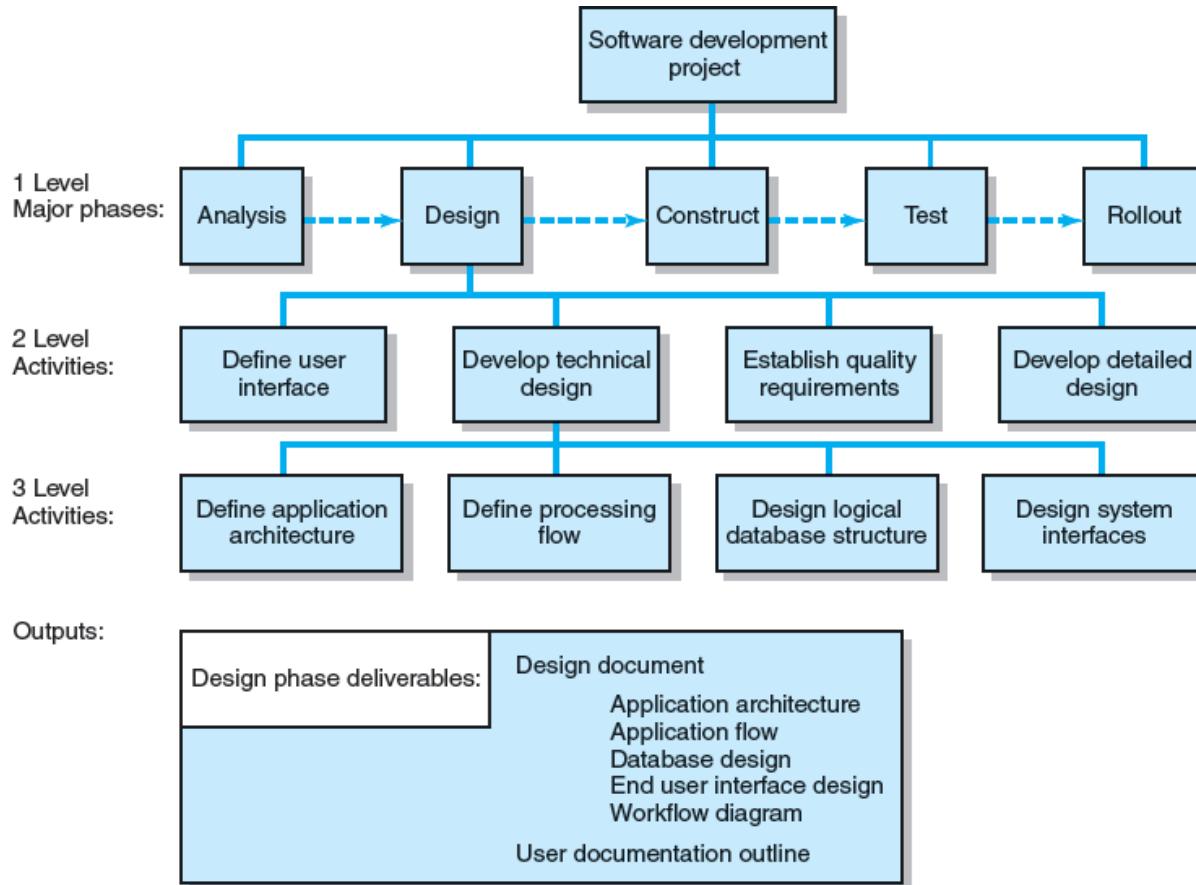
Process Breakdown Structure (PBS):

- Is used for process-oriented projects.
- Is often referred to as the “waterfall method” in the software industry.

Process-Oriented Project:

- Is a project that the final outcome is a product of a series of steps and phases.
- Is a project that evolves over time with each phase affecting the next phase.
- Is a project that is driven by performance requirements, not by plans/blueprints.

PBS for Software Development Project



Responsibility Matrices

Responsibility Matrix (RM):

- Is also called a linear responsibility chart.
- Summarizes the tasks to be accomplished and who is responsible for what on the project.
- Lists all the project activities and the participants responsible for each activity.
- Clarifies interfaces between units and individuals that require coordination.
- Provides a means for all participants in a project to view their responsibilities and agree on their assignments.
- Clarifies the extent or type of authority exercised by each participant.

Responsibility Matrix for a Market Research Project

Task	Project Team				
	Richard	Dan	Dae	Linda	Elizabeth
Identify target customers	R	S		S	
Develop draft questionnaire	R	S	S		
Pilot-test questionnaire			R		S
Finalize questionnaire	R	S	S	S	
Print questionnaire					R
Prepare mailing labels					R
Mail questionnaire					R
Receive and monitor returned questionnaires				R	S
Input response data			R		
Analyze results		R	S	S	
Prepare draft of report	S	R	S	S	
Prepare final report	R		S		

R = Responsible.
S = Supports/assists.

Responsibility Matrix for the Conveyor Belt Project

Deliverables	Organization							
	Design	Development	Documentation	Assembly	Testing	Purchasing	Quality Assur.	Manufacturing
Architectural designs	1	2			2		3	3
Hardware specifications	2	1				2	3	
Kernel specifications	1	3						3
Utilities specifications	2	1			3			
Hardware design	1			3		3		3
Disk drivers	3	1	2					
Memory management	1	3			3			
Operating system documentation	2	2	1					3
Prototypes	5		4		3	3	3	4
Integrated acceptance test	5	2	2	1	1		5	5

1. Responsible.
2. Support.
3. Consult.
4. Notification.
5. Approval.

RACI Matrix

RACI CHART EXAMPLE

Project tasks	Senior Analyst	Project Manager	Head of Design	SVP Finance	SEO Lead	Sales Director	Senior Management
Phase 1: Research							
Econometric model	R	I	I	A	C	I	I
Strategic framework	A	I	I	R	I	I	C
Risk factors	R	I	I	A	I	I	I
Phase 2: Structure							
Product specs	I	A	R	I	C	C	C
Design wireframe	I	C	R	I	C	I	C
User journey	I	C	R	I	C	C	C
User experience testing	I	C	R	I	C	C	C
Evaluation framework	I	R	C	I	C	I	C
Development backlog	I	R	C	I	C	I	C
Delivery roadmap	C	R	A	C	C	C	I

Project Communication Plan

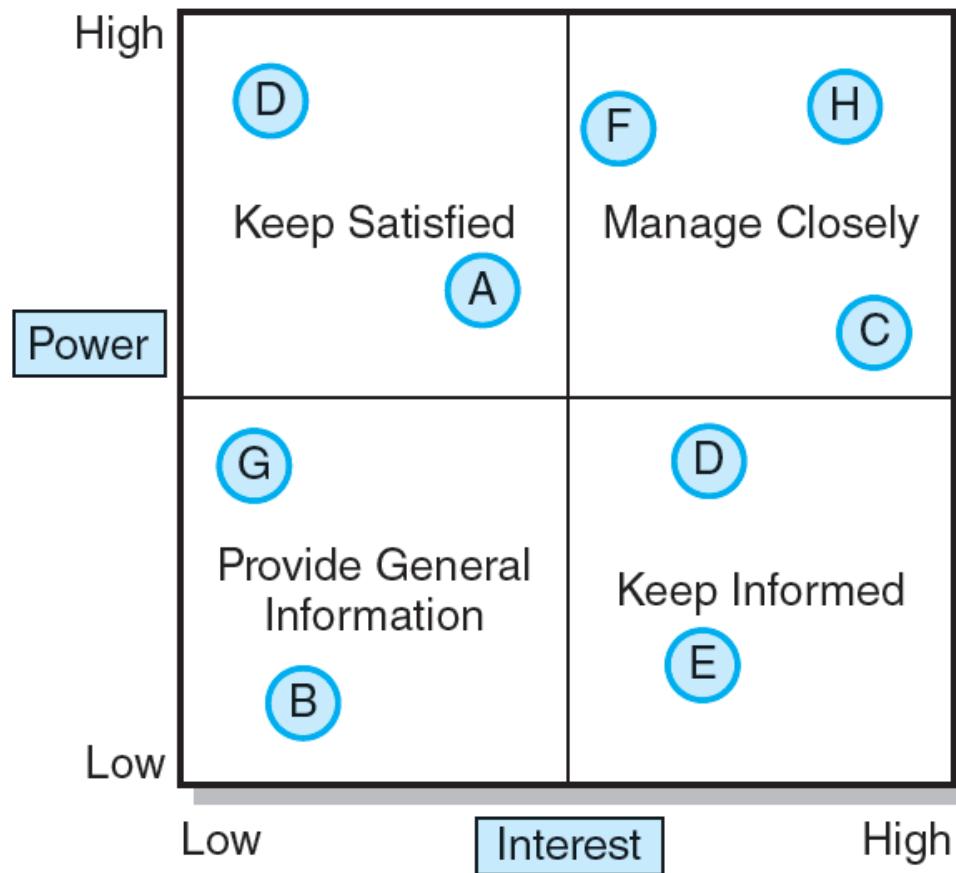
Project communication plans address the following questions:

- What information needs to be collected and when?
- Who will receive the information?
- What methods will be used to gather and store information?
- What are the limits, if any, on who has access to certain kinds of information?
- When will the information be communicated?
- How will it be communicated?

Steps for Developing a Communication Plan

1. Stakeholder analysis—identify the target groups.
2. Information needs—project status reports, deliverable issues, changes in scope, team status meetings, gating decisions, accepted request changes, action items, milestone reports, and so on.
3. Sources of information—where does the information reside?
4. Dissemination modes—hardcopy, e-mail, teleconferencing, SharePoint, and a variety of database sharing programs.
5. Responsibility and timing—determine who will send out the formation and when.

Stakeholder Communications



Shale Oil Research Project Communication Plan

What Information	Target Audience	When?	Method of Communication	Provider
Milestone report	Senior management and project manager	Bimonthly	E-mail and hardcopy	Project office
Project status reports and agendas	Staff and customer	Weekly	E-mail and hardcopy	Project manager
Team status reports	Project manager and project office	Weekly	E-mail	Team recorder
Issues report	Staff and customer	Weekly	E-mail	Team recorder
Escalation reports	Staff and customer	When needed	Meeting and hardcopy	Project manager
Outsourcing performance	Staff and customer	Bimonthly	Meeting	Project manager
Accepted change requests	Project office, senior management, customer, staff, and project manager	Anytime	E-mail and hardcopy	Design department
Oversight gate decisions	Senior management and project manager	As required	E-mail meeting report	Oversight group or project office

Key Terms

- Acceptance criteria.
- Cost account.
- Gold plating.
- Milestone.
- Organization breakdown structure (OBS).
- Priority matrix.
- Process breakdown structure (PBS).
- Product scope description.
- Project charter.
- Responsibility matrix.
- Scope creep.
- Scope statement.
- WBS dictionary.
- Work breakdown structure (WBS).
- Work package.

Session 7-8

Estimating Projects

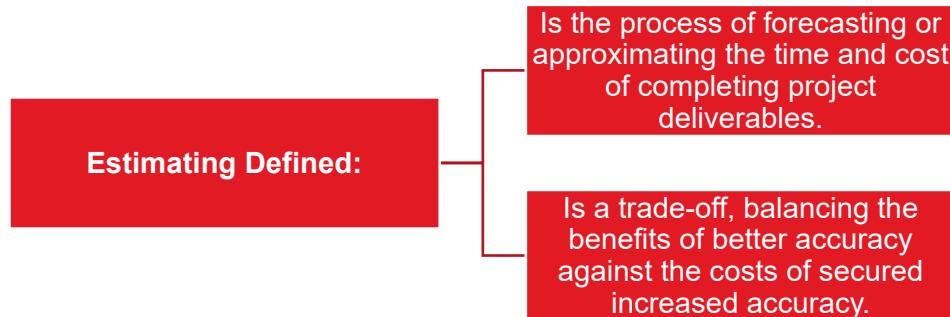
Learning Objectives

- Understand estimating project times and costs is the foundation for project planning and control.
- Identify different aspects of estimating.
- Describe guidelines for estimating time, costs, and resources.
- Describe the methods, uses, and advantages and disadvantages of top-down and bottom-up estimating methods.
- Distinguish different kinds of costs associated with a project.
- Suggest a scheme for developing an estimating database for future projects.
- Understand the challenge of estimating mega projects and describe steps that lead to better informed decisions.
- Define a “white elephant” in project management and provide examples.

Highlights

- Factors Influencing the Quality of Estimates.
- Estimating Guidelines for Times, Costs, and Resources.
- Top-Down versus Bottom-Up Estimating.
- Methods for Estimating Project Times and Costs.
- Level of Detail.
- Types of Costs.
- Refining Estimates.
- Creating a Database for Estimating.
- Mega Projects: A Special Case.

Project Estimating



Types of Estimates:

- Top-down (macro) estimates—analogy, group consensus, or mathematical relationships.
- Bottom-up (micro) estimates—based on estimates of elements found in the work breakdown structure.

Why Estimating Time and Cost is Important

Estimates are needed to support good decisions.

Estimates are needed to schedule work.

Estimates are needed to determine how long the project should take and its cost.

Estimates are needed to determine whether the project is worth doing.

Estimates are needed to develop cash flow needs.

Estimates are needed to determine how well the project is progressing.

Four Aspects of Estimating



Range—the number of potential outcomes that could be expected to occur.



Accuracy—the correctness of an estimate.



Precision—the degree of exactness associated with the estimate.



Confidence—the degree of trust one has in the estimate.

Factors Influencing the Quality of Estimates

- Planning Horizon.
- Project Complexity.
- People.
- Project Structure and Organization.
- Padding Estimates.
- Organizational Culture.
- Other Factors.

Estimating Guidelines for Times, Costs, and Resources

1. Responsibility.
2. The use of several people to estimate.
3. Normal conditions.
4. Time units.
5. Independence.
6. Contingencies.
7. Risk assessment added to the estimate to avoid surprises to stakeholders.

Top-Down versus Bottom-Up Estimating

Top-Down Estimates:

- Are usually derived from someone who uses experience and/or information to determine the project duration and total cost.
- Are sometimes made by top managers who have very little knowledge of the component activities used to complete the project.

Bottom-Up Estimates:

- Can take place after the project has been defined in detail.
- Can serve as a check on cost elements in the WBS by rolling up the work packages and associated cost accounts to major deliverables.
- Provide the customer with an opportunity to compare the low-cost, efficient method approach with any imposed restrictions.

Conditions for Preferring Top-Down or Bottom-Up Time and Cost Estimates

Condition	Top-Down Estimates	Bottom-Up Estimates
Strategic decision making	X	
Cost and time important		X
High uncertainty	X	
Internal, small project	X	
Fixed-price contract		X
Customer wants details		X
Unstable scope	X	

The Preferred Approach in Defining the Project

- Make rough top-down estimates.
- Develop the WBS/OBS.
- Make bottom-up estimates.
- Develop schedules and budgets.
- Reconcile differences between top-down and bottom-up estimates.

5.4 Methods for Estimating Project Times and Costs

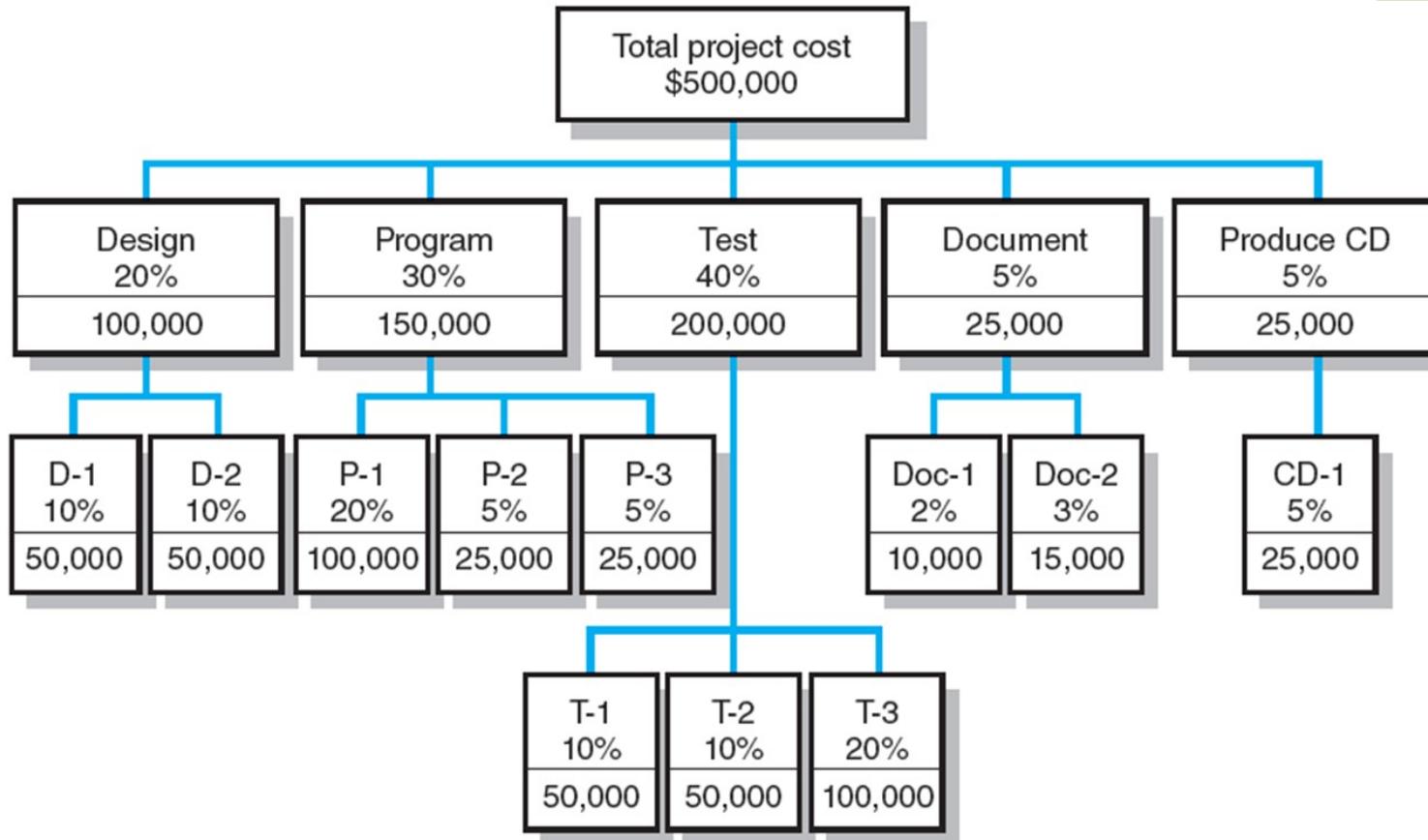
Top-Down Approaches:

- Consensus Method.
- Ratio Method.
- Apportion Method.
- Function Point Methods for Software and System Projects.
- Learning Curves.

Bottom-Up Approaches:

- Template Method.
- Parametric Procedures Applied to Specific Tasks.
- Range Estimating.

Apportion Method of Allocating Project Costs Using the WBS



Simplified Basic Function Point Count Process for a Prospective Project or Deliverable

Complexity Weighting

Element	Low	Average	High	Total
Number of <i>inputs</i>	_____ × 2 +	_____ × 3 +	_____ × 4	= _____
Number of <i>outputs</i>	_____ × 3 +	_____ × 6 +	_____ × 9	= _____
Number of <i>inquiries</i>	_____ × 2 +	_____ × 4 +	_____ × 6	= _____
Number of <i>files</i>	_____ × 4 +	_____ × 8 +	_____ × 12	= _____
Number of <i>interfaces</i>	_____ × 5 +	_____ × 10 +	_____ × 15	= _____

Example: Function Point Count Method

Software Project 13: Patient Admitting and Billing

15	Inputs	Rated complexity as low	(2)
5	Outputs	Rated complexity as average	(6)
10	Inquiries	Rated complexity as average	(4)
30	Files	Rated complexity as high	(12)
20	Interfaces	Rated complexity as average	(10)

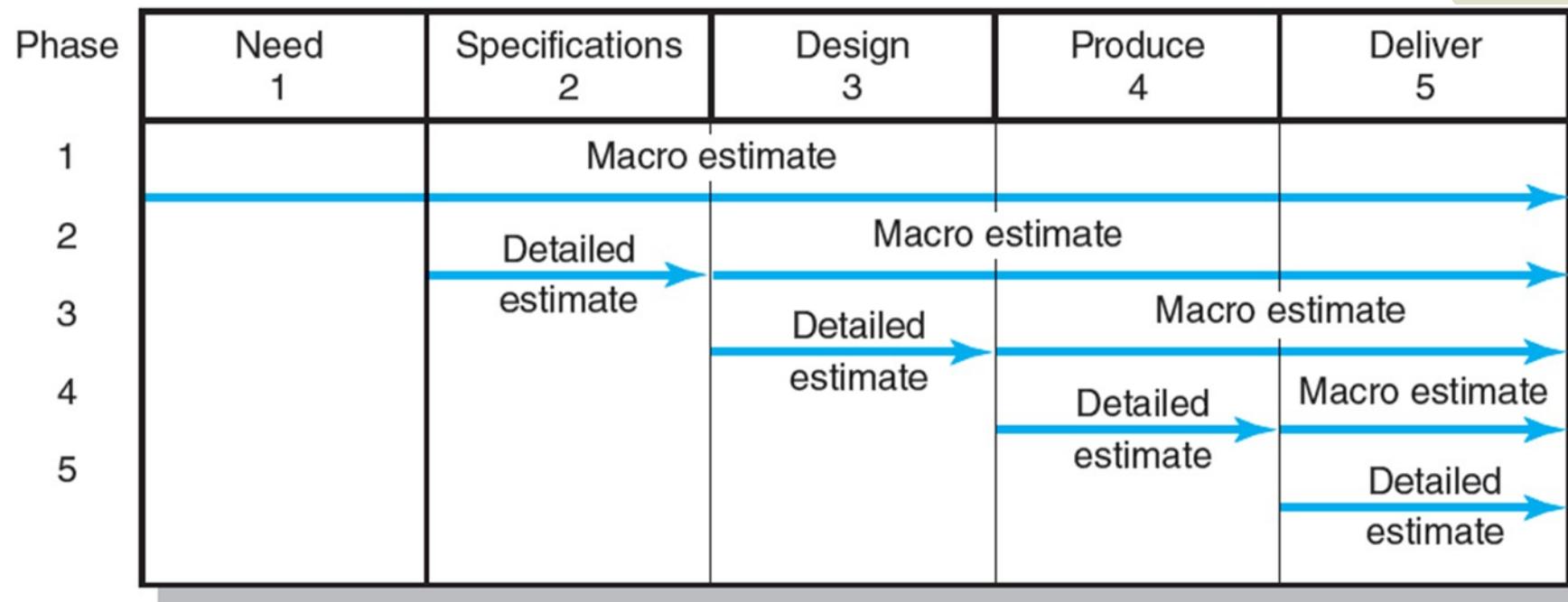
Application of Complexity Factor

Element	Count	Low	Average	High	Total
Inputs	15	× 2			= 30
Outputs	5		× 6		= 30
Inquiries	10		× 4		= 40
Files	30			× 12	= 360
Interfaces	20		× 10		<u>= 200</u>
				Total	660

Range Estimating Template

	A	B	C	D	E	F	G	H
1	Project number:	18			Project Manager:	Dawn O'Connor		
2	Project description:	New Organic Wine Launch			Date:	2/17/2xxx		
3	Organic Wine Launch Project							
4	Range Estimates							
5								
6	WBS	Description	Low	Average	High	Range		
7	ID		Estimate	Estimate	Estimate			
8			Days	Days	Days	Days		
9								
10	102	Approval	1	1	3	2	low	
11	103	Design packaging	4	7	12	8	medium	
12	104	ID potential customers	14	21	35	21	high	
13	105	Design bottle logo	5	7	10	5	low	
14	106	Contract kiosk space	8	10	15	7	medium	
15	107	Construct kiosk	4	4	8	4	medium	
16	108	Design fair brochure	6	7	12	6	high	
17	109	Trade journal advertising	10	12	15	5	medium	
18	110	Production test	10	14	20	10	high	
19	111	Produce to inventory	5	5	10	5	high	
20	112	Business card scanner hookup	1	2	3	2	low	
21	113	Video hook up	2	2	4	2	medium	
22	114	Event rehearsal	2	2	5	3	high	

A Hybrid: Phase Estimating



Top-Down and Bottom-Up Estimates

Top-Down Estimates	Bottom-Up Estimates
Intended Use Feasibility/conceptual phase Rough time/cost estimate Fund requirements Resource capacity planning	Intended Use Budgeting Scheduling Resource requirements Fund timing
Preparation Cost 1/10 to 3/10 of a percent of total project cost	Preparation Cost 3/10 of a percent to 1.0 percent of total project cost
Accuracy Minus 20%, to plus 60%	Accuracy Minus 10%, to plus 30%
Method Consensus Ratio Apportion Function point Learning curves	Method Template Parametric WBS packages Range estimates

Level of Detail

The level of detail in the WBS varies with:

- The complexity of the project;
- The need for control;
- The project size, cost, and duration; and
- Other factors.

Excessive detail:

- Emphasizes departmental outcomes rather than deliverable outcomes.
- Creates more unproductive paperwork.

Inadequate detail:

- Falls short of meeting the structure's needs.

Types of Costs

Direct Costs:

Are clearly chargeable to a specific work package.

- Examples: Labor, materials, equipment, and other.

Direct Project Overhead Costs:

Can be tied to project deliverables or work packages.

- Examples: Salary of the project manager, temporary rental space for the project team, supplies, specialized machinery.

General and Administrative (G&A) Overhead Costs:

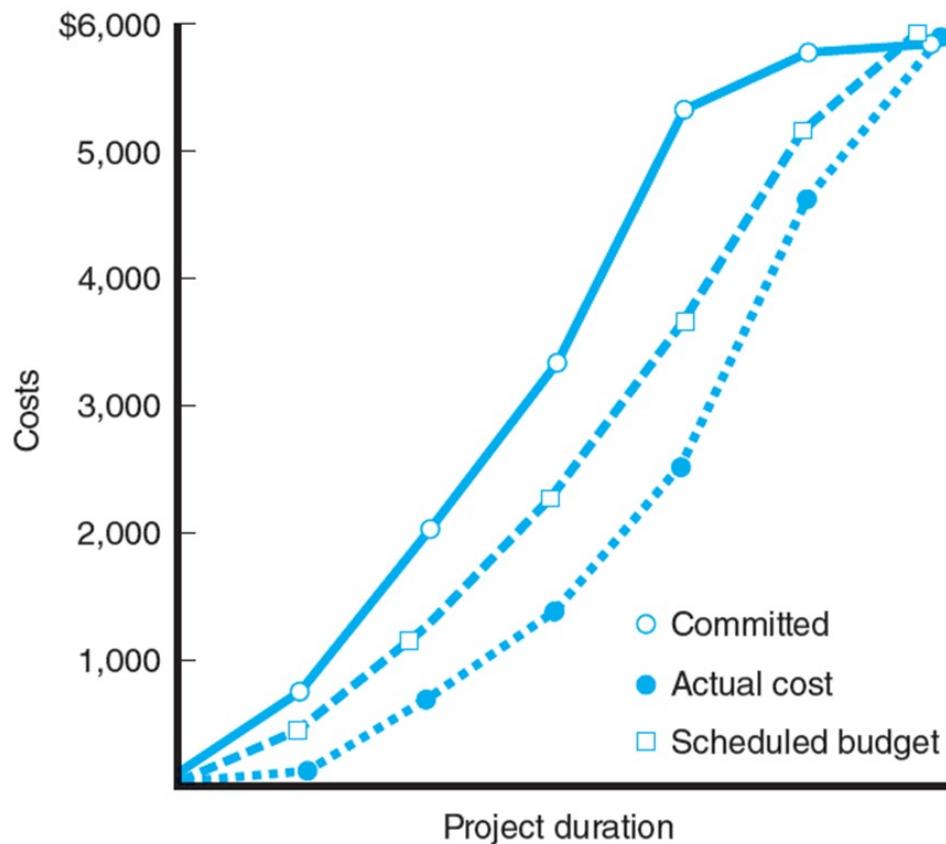
Are not directly linked to a specific project.

- Examples: Advertising, accounting, salary of senior management above the project level.

Contract Bid Summary Costs

Direct costs	\$80,000
Direct overhead	<u>\$20,000</u>
Total direct costs	\$100,000
G&A overhead (20%)	<u>\$20,000</u>
Total costs	\$120,000
Profit (20%)	<u>\$24,000</u>
Total bid	\$144,000

Three Views of Cost

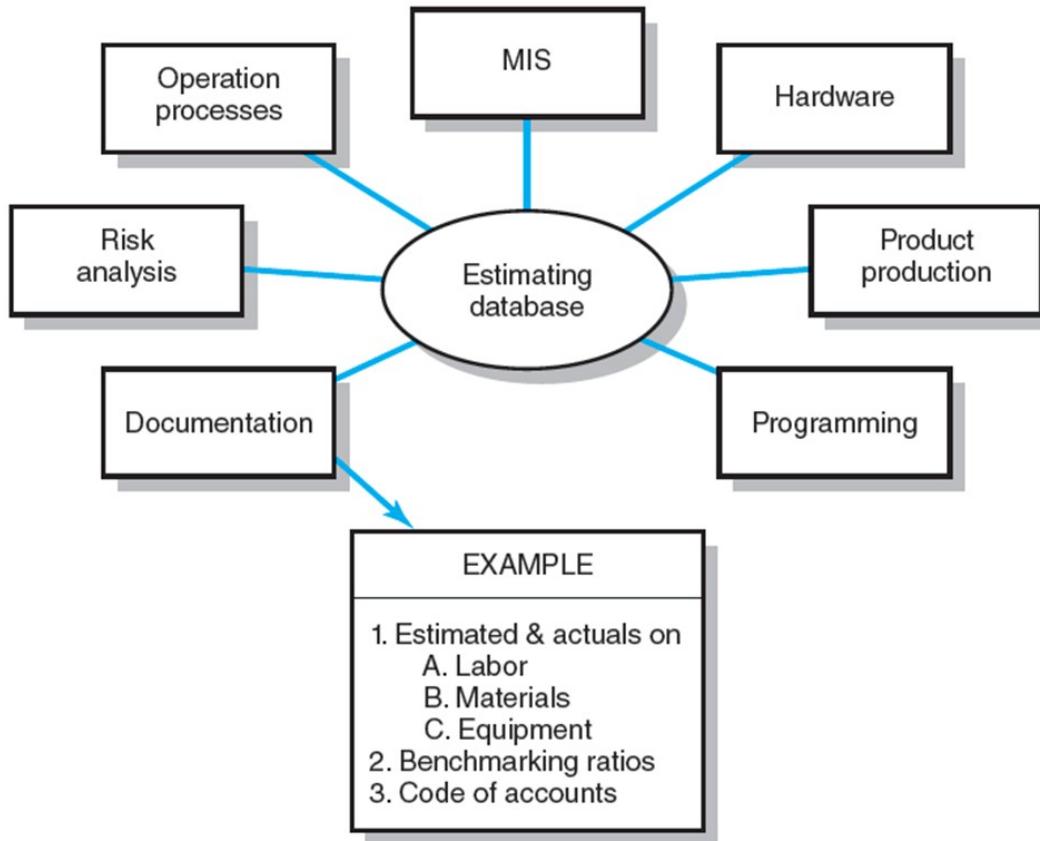


Refining Estimates

Reasons for adjusting estimates:

- Interaction costs are hidden in estimates.
- Normal conditions do not apply.
- Things go wrong on projects.
- Project scope and plans change.
- People are overly optimistic.
- People engage in strategic misrepresentation.

Creating a Database for Estimating



Mega Projects: A Special Case

Mega Projects Defined:

Are large-scale, complex ventures that typically cost \$1 billion or more, take many years to complete, and involve multiple private and public stakeholders.

- Examples: High-speed rail lines, airports, healthcare reform, the Olympics, development of new aircraft.

Often involve a double whammy.

- Projects cost much more than expected and under-deliver on benefits the projects were to provide.

Are sometimes referred to as “white elephant.”

- Projects are over budget and under value and the costs of maintaining the project exceed the benefits received.

The Reference Class Forecasting (RCF)

Three Major Steps:

1. Select a reference class of projects like your potential project.
2. Collect and arrange outcome data as a distribution. Create a distribution of cost overruns as a percentage of the original project estimate (low to high).
3. Use the distribution data to arrive at a realistic forecast. Compare the original cost estimate for the project with the reference class projects.

Benefits:

- Outside empirical data mitigate human bias.
- Politics, strategic, and promoter forces have difficulty ignoring outside RCF information.
- RCF serves as a reality check for funding large projects.
- RCF helps executives avoid unsound optimism.
- RCF leads to improved accountability.
- RCF provides a basis for project contingency funds.

Types of Cost Estimates

1 Order of Magnitude Estimate (Rough Order of Magnitude - ROM)

Accuracy Range: -25% to +75%

When Used: Initial project conception, feasibility studies

Effort Required: Minimal

Basis: Historical data, expert judgment

2 Budget Estimate (Preliminary Estimate)

Accuracy Range: -10% to +25%

When Used: Budget allocation, early planning phase

Effort Required: Moderate

Basis: Preliminary design, analogous projects

3 Definitive Estimate (Detailed Estimate)

Accuracy Range: -5% to +10%

When Used: Final approval, contract negotiations

Effort Required: Extensive

Basis: Detailed drawings, specifications, market rates

Key Terms

- Accuracy of estimate.
- Apportionment.
- Bottom-up estimates.
- Confidence in estimate.
- Delphi Method.
- Direct costs.
- Estimate.
- Function points.
- Learning curve.
- Overhead costs.
- Phase estimating.
- Precision of estimate.
- Range estimating.
- Ratio method.
- Reference class forecasting (RCF).
- Template method.
- Time and cost databases.
- Top-down estimates.
- White elephant.

The Diamond Framework – A graphical tool to analyse project gaps, potential benefits, and risk

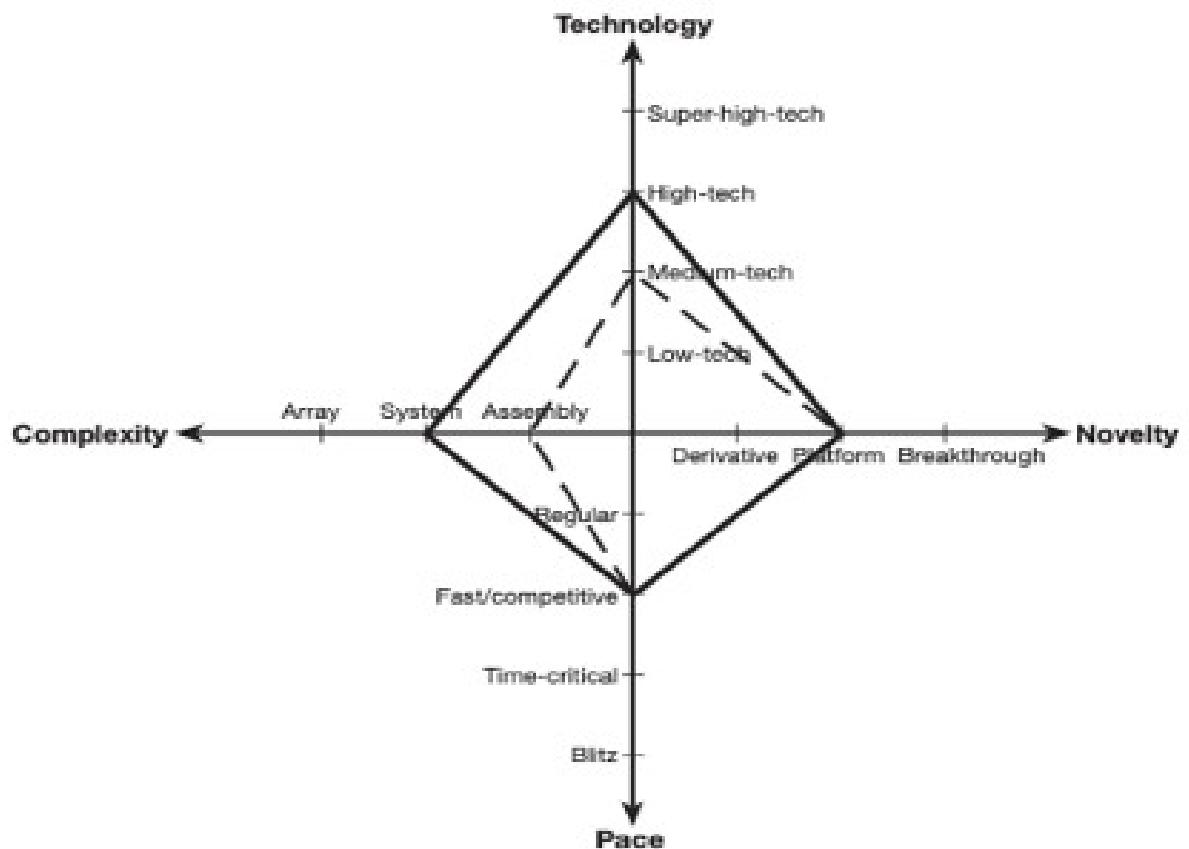
The uniqueness of each project is like dealing with an individual personality. One way of dealing with one person cannot fit all. Managers, professionals, and entrepreneurs do a great job of dealing with individuals in their own unique ways. They are aware of each person's personal interests.

A common mistake organizations make is assuming that the same methodology and general mindset can be applied to all similar projects. However, that's not true. All projects are unique in their own way. Project managers experience this all the time. Even when working on similar kinds of projects, they understand differentiation that is very well calculated in the background and might not be visible upfront.

Considering the distinctive qualities of each project, is there a one-stop solution that could be used for all kinds of projects?

Well, the answer is **NO**, but there's a method or framework shared by "**Shenhar & Dvir**" - the Diamond Framework, also known as the NTCP Model, that is used to provide a reasonable solution to each project. It's an independent framework that is not biased toward any specific industry or technology.

NTCP – Novelty, Technology, Complexity & Pace



The uniqueness of a project is determined by various factors, such as the technology utilized, risks involved, size, location, customer requirements and many other aspects. Despite each project having its

own unique characteristics, there are **common traits** that are shared among all projects, including defined goals, specific timelines, planning and the presence of a project manager.

The NTCP framework focuses on the core similarities of all projects: **the Goal, the Tasks, and the Environment.**

Understanding these three basic requirements in a project:-

The Goal provides the purpose to a project, where you decide the desired end result and its impact on all aspects of your project.

The Task includes brainstorming, planning and evaluation. During this process, you connect all the points and identify the work that needs to be done, including the level of technology required, the complexity of the work, and comparisons with previous similar tasks. Simultaneously, you work on finding a suitable solution for the current situation.

The Environment- The term environment itself gives you the picture of current situation, encompassing the prevailing market conditions, cultural factors, political landscape, and geographical considerations.

These common traits prompt you to assess your projects based on three key parameters: the **uncertainty** involved, the **complexity** of the project, and the desired **pace** of progress.

Uncertainty is a blur picture where you consider the project's goal, tasks and the perpetually evolving environment. The NTCP model divides uncertainty into two major parts, aiming to provide clarity to some extent. These are **Technological** uncertainty and market uncertainty, referred to as **Novelty**. Technological uncertainty assesses the technology required for the product, while market uncertainty evaluates how new the product is to the market.

That's how the NTCP model was formulated with four primary dimensions: **Novelty, Technology, Complexity, and Pace.**

How do you plan to utilize the NTCP model for your project?

To effectively utilize this model, it is essential to have a clear understanding of how it divides its parameters.

Novelty:

When considering **Novelty**, it is crucial to determine the correct positioning of your product within the market. Your product may belong to a new category that has never been introduced or used before, or it may be an improved version of an existing product. Novelty is categorized into three parts for accurate measurement: Derivatives, Platform, and Breakthrough.

Derivative products are the improved version of an existing product. For example, the introduction of Google search when Yahoo was the dominant search engine. **Platform** - A new generation product in our existing product line. For example, the launch of the iPod in 2001 revolutionized the era of portable MP3 players. **Breakthrough** – These products are those that are completely novel and innovative. One of the best examples of this is LinkedIn, a platform that revolutionized professional networking by introducing innovative features that allow professionals to connect and interact online.

Technology:

Technology level in a project is divided into four parts: low-tech, medium-tech, high-tech, and super-high tech.

Super-high tech projects require the development of new technologies that do not currently exist in the market, such as the Mars rover landing. **High-tech to Low-tech** projects rely on existing technologies, such as defense development, automobile, or the development of new features with the help of existing technology.

Complexity:

It is the category that defines the level of complexity of your project. Complexity is typically categorized into three levels: Assembly, System, and Array.

An **Assembly** project involves a business responsible for a single function, producing standalone products such as home appliances. **System** projects are complex collections of subsystems and multiple elements, such as building cars and computers. **Array** projects consist of a widely dispersed collection of systems that work together to achieve a common goal, such as power distribution and mass transit infrastructure.

Pace:

Understanding the importance of making decisions quickly is crucial in project management. By evaluating the time criticality of your project, you can determine the appropriate level of urgency needed. Time criticality is typically categorized into four levels: Regular, Fast/Competitive, Time Critical, and Blitz.

Regular projects are not time-sensitive and do not have an immediate impact on organizational success. **Fast/Competitive** projects are focused on seizing market opportunities. **Time critical** projects, such as the launch of a space vehicle, are extremely time-sensitive, as missing deadlines can result in project failure. The most urgent type of project is a **Blitz** project, which involves crisis situations like natural disaster rescue efforts. In these cases, decisions must be made quickly to ensure the best possible outcome.

Novelty	Technology
<p>Derivative - The improvement of an existing product. For example, the introduction of Google search when Yahoo was the dominant search engine.</p> <p>Platform - A new generation product in our existing product line. For example, the launch of the iPod in 2001 revolutionized the era of portable MP3 players.</p> <p>Breakthrough – Completely novel and innovative products. One of the best examples of this is LinkedIn, a platform that revolutionized professional networking by introducing innovative features that allow professionals to connect and interact online.</p>	<p>Super-high tech projects require the development of new technologies that do not currently exist in the market, such as the Mars rover landing.</p> <p>High-tech involves a situation where technology exist in the market and new the organization</p> <p>Medium-tech includes creating new feature with the existing technology such as innovation in appliances</p> <p>Low-tech rely on established technology without making innovation in the process such as construction projects</p>
Complexity	Pace
<p>Assembly project involves a business responsible for a single function, producing standalone products such as home appliances.</p> <p>System projects are complex collections of subsystems and multiple elements, such as building cars and computers.</p> <p>Array projects consist of a widely dispersed collection of systems that work together to achieve a common goal, such as power distribution and mass transit infrastructure.</p>	<p>Regular projects are not time-sensitive and do not have an immediate impact on organizational success.</p> <p>Fast/Competitive projects are focused on seizing market opportunities.</p> <p>Time critical projects, such as the launch of a space vehicle extremely time-sensitive, as missing deadlines can result in project failure.</p> <p>Blitz -The most urgent type of project is a Blitz project, which involves crisis situations like natural disaster rescue efforts. In these cases, decisions must be made quickly to ensure the best possible outcome.</p>

By comprehending these four parameters, we aim to develop an adaptive diamond for our project. For instance, if your product category is a **platform** in Novelty seeking to outperform competitors in the market, you might require **High-tech** technology utilized in an innovative manner. The complexity of the project would be at the **system** level, involving the integration of multiple subsystems. The pace of the project will most likely be **fast-competitive**, requiring timely delivery to stay ahead from the competitors. By utilizing this framework, project managers can effectively plan and execute projects with greater efficiency and success.

Utilization of the Diamond Framework:

The Diamond Framework can be utilized to compare the required project management style with the actual style being implemented.

One of the key advantages of using the Diamond Framework is its ability to facilitate comprehensive planning from the outset. This includes tasks such as resource allocation and determining the level of attention required for each aspect of the project.

This analysis can help determine the success or failure of a project and allow for necessary adjustments to be made in the planning process. By identifying the major benefits and risks associated with the project, stakeholders can make informed decisions to ensure project success.

In the world of project management there is no perfect tool available that fits all. Once execution start everything starts falling apart and you might have to go back to your planning. Every industry has a different profile and equipped with different consumers.

Requirement of consumer and demand changes by the time. One cannot rely on accumulated data from the past anymore. Evaluation has to be the amalgamation of the past and what could be out next in the future.

Project management is a blend of skill and art. The skill involves using and applying tools and techniques, while the art lies in managing people, including vendors, employees, stakeholders, and seniors. Project Management is not just about following a set of steps and procedures; it's about recognizing the unique challenges and opportunities of each project. The role of a project manager is to be a creative leader, finding solutions beyond the textbooks and inventing new approaches that align with the uniqueness of each project.