Engineering Project Management

PPT

Complied by:

Dr. Mohamed. J.A.M, PhD Eng

Introduction to Engineering Project Management

IE354

Mohamed. J.A.M,
PhD Eng Management, M.Eng. Management, B.Sc
Department of Mechanical and Industrial Engineering
College of Engineering and Technology-UDSM

2017-2018

Learning Outcomes:

- Students are able to develop and assess viability of engineering project proposals
- Students understand well key project management knowledge areas
- Students are able to apply various project management software packages
- Students understand well key concepts and principles of monitoring and evaluation
- Students have grasped various techniques and tools of monitoring and evaluation
- Students have grasped various techniques and tools of conducting impact assessment

Course objectives and Assessment

- **Thus Course Objectives**
- To introduce students to the techniques used in managing and appraising engineering project

- **Assessments**
- Group Assignment GA(25%)
- Test T(15%)
- Final examination (UE) E(60%)
- Final Result (100%) = [GA(10%)+T (30%) +E(60%)

Course content

- **Introduction to Engineering project management**
- **Engineering Project life cycle**
- **Engineering cost and Cost estimation methods**
- **Project feasibility assessment/ Appraisal** : technical, environmental, financial, economic, social, risk and sensitivity analysis, multi-criteria assessment method.
- **Project formulation, write-up and management**
  - Project initiation
  - Project Design and Engineering
  - Project organisation
  - Preparing a project proposal
  - Project time management
  - Project cost management
  - Earned Value Analysis(EVA)
  - Project Crashing
  - Project delivery methods
  - Project Resource Levelling
  - Project Monitoring and Evaluation
- **Project management information system /MS Project Applications**

Recommended References

- A guide to the project management body of Knowledge by Duncan, W.R. Project management Institute, USA-1996
- Project management : A managerial approach 4th Edition by Meredith J.R & Mantel S.J Jr, New York 2002,
- *Project Management*, *Appraisal*, *Budgeting and Implementation*, by Chandra, .P, Tata McGraw- Hill Publishing Company Limited, New Delhi 1987,
- *Projects: Planning*, *Analysis*, *Financing*, *Implementation and review* by Chandra, P. Tata McGraw-Hill, India 2004
- *Project Planning and Management: A text of Principles with a Case by* Rutebinga, P. R. & Ruzibuka, J. E. M. Research, Information and Publication Department, Institute of Development Management Mzumbe 1996

❑ Sample Engineering Projects

❑ Sample Engineering Projects

❑ Sample Engineering Projects

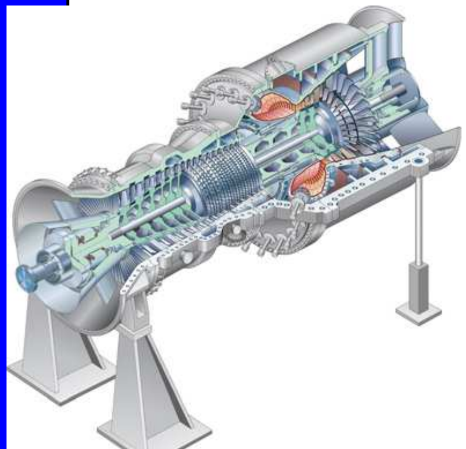
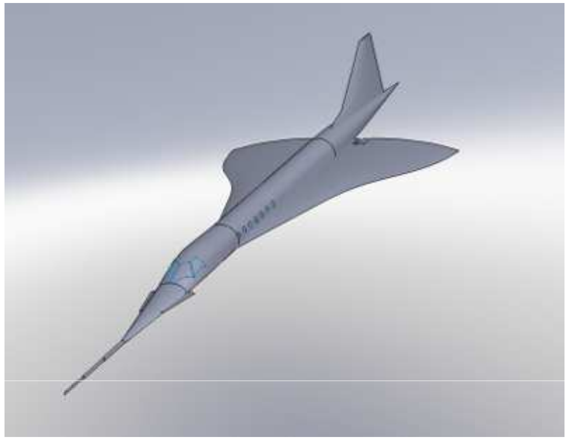
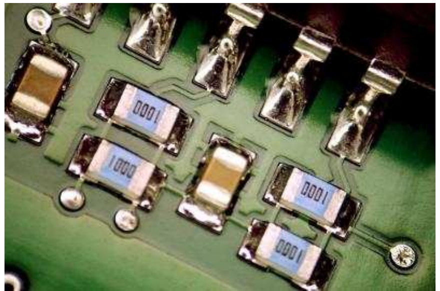
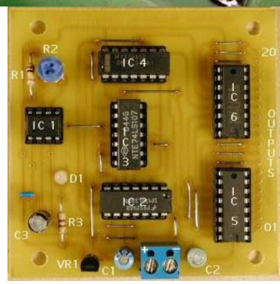


Image courtesy of Siemens Nederland NV







The number of engineering disciplines is not static. Many disciplines spawn additional sub-disciplines.

Let’s focus on the major disciplines!

Engineering Disciplines

- Aerospace
- Agricultural
- Architectural
- Biomedical
- Biological
- Chemical
- Civil
- Computer
- Electrical
- Environmental
- Industrial
- Manufacturing
- Materials
- Mechanical
- Nuclear
- Petroleum
- Software

What is Engineering?

- The profession in which a knowledge of the mathematical and natural science gained by study, experience, and practice is applied with judgement to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind

(1979, US. Engineering societies).

"**the art and science of design, construction, operation, and management of the system**

What is Management?

- A set of activities (including planning and decision making, organising, leading and control) directed at an organisation's resources (human, financial, physical and informational) with the aim of achieving organisational goals in an efficient and effective manner.

(Griffin)

Typical Engineering Activities

- Design/development of products/processes
- Project engineering/management
- Value engineering and analysis
- Technology development and applied R&D (laboratory, field)
- Production/manufacturing and construction

Engineering Management Functions

- ***Planning*** (forecasting, setting objectives, action planning, administering policies, establishing procedure)
- ***Organizing*** (selecting organizational structure, delegating, establishing working relationship)
- ***Leading/directing*** (deciding, communicating, motivating, selecting/developing people)
- ***Controlling*** (setting performance standards, evaluating/documenting/correcting performance)

Project Management is the Science and Art of Enhancing the Probability of Success by Inspired Leadership using Structured Techniques for Planning that Integrate Technical Performance, Scheduling and Budgeting (1).

Planning Activities

- Set objectives and goals
- Develop strategies
- Develop policies
- Forecast future situations
- Conduct a risk assessment
- Determine possible courses of action
- Make planning decisions
- Set procedures and rules
- Develop project plans
- Prepare budgets
- Document project plans

Organizing Activities

- Identify and group project function, activities, and tasks
- Select organizational structures
- Create organizational positions
- Define responsibilities and authority
- Establish position qualifications
- Document organizational decisions

Organizational Structure

- Conventional organization structure
  - Line organization
  - Staff organization
- Project organization structure
  - Functional
  - Project
  - Matrix
- Team Structure
  - Egoless
  - Chief programmer
  - Hierarchical

Organizing Activities

- *Identify and group project function, activities, and tasks*
- *Select organizational structures*
- Create organizational positions
- Define responsibilities and authority
- Establish position qualifications
- Document organizational decisions

Establish Position Qualifications

- Project managers
- Software system engineers
- Scientific/engineering programmers, programmer-analysts
- Verification and validation engineer
- Software quality assurance engineer

Organizing Activities

- *Identify and group project function, activities, and tasks*
- *Select organizational structures*
- *Create organizational positions*
- *Define responsibilities and authority*
- *Establish position qualifications*
- Document organizational decisions

Issues In Staffing

- Lack of project management training
- Greatly varying skills
- Inability to predict productivity of engineers
- Lack of experience
- Turnover
- Not enough software engineers
  - Most graduates are theoretical
  - Or just coders

Staffing Activities

- Fill organizational positions
- Assimilate newly assigned personnel
- Educate or train personnel
- Provide for general development
- Evaluate and appraise personnel
- Compensate
- Terminate assignments
- Document staffing decisions

Filling Positions

- Must look for
  - Education
  - Experience
  - Training
  - Motivation
  - Commitment
  - Self-motivation
  - Group affinity
  - Intelligence

Staffing Activities

- *Fill organizational positions*
- Assimilate newly assigned personnel
- Educate or train personnel
- Provide for general development
- Evaluate and appraise personnel
- Compensate
- Terminate assignments
- Document staffing decisions

Directing Activities

- Provide leadership
- Supervise personnel
- Delegate authority
- Motivate personnel
- Build teams
- Coordinate activities
- Facilitate communication
- Resolve conflicts
- Manage changes
- Document directing decisions

Providing Leadership

- Positional Power
  - Power derived from having a leadership position
  - Not always effective
- Personal Power
  - Charisma or personal charm
  - Sometimes more effective than positional power

Directing Activities

- *Provide leadership*
- Supervise personnel
- Delegate authority
- Motivate personnel
- Build teams
- Coordinate activities
- Facilitate communication
- Resolve conflicts
- Manage changes
- Document directing decisions

1. What is a project?

- Organizations perform work either as operations or projects (sometimes the two may overlap)
- operations or projects share many characteristics, they are
    - Performed by people
    - Constrained by limited resources
    - Planned, executed and controlled
- operations differs from projects as the later are temporary and unique
- ***A project*** *is therefore a complex task which in essentially non Repetitive with pre-set objectives and which uses resources such as labor, materials, equipments, technological information and Finance in a limited timed period.*

What is a project? CONT…

Attributes of projects

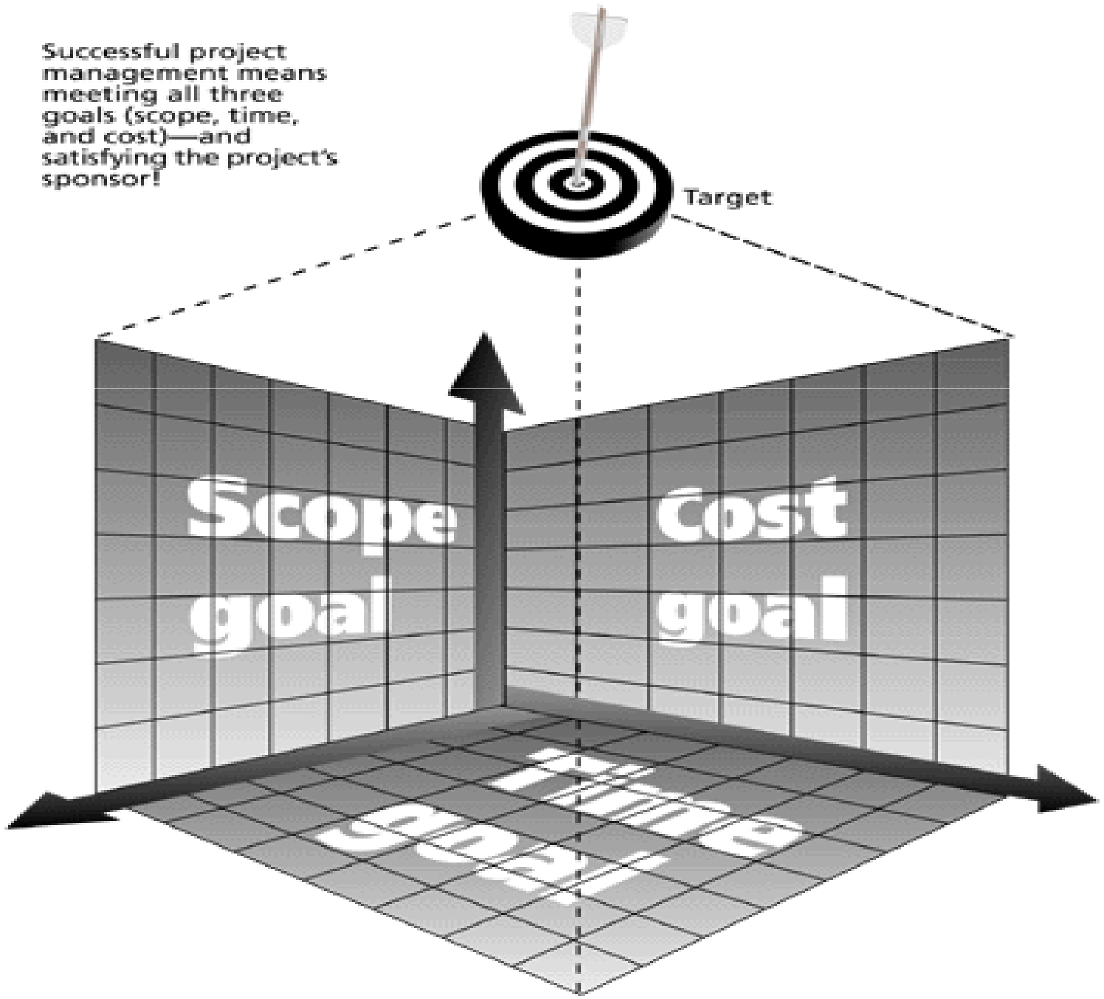
- Non-repetitive
- Has specific end objectives
- Temporary-has definite start and end dates
- unique purpose
- Passes through a series of phases, events& activities
- require resources, often from various areas
- should have a primary sponsor and/or customer
- involve uncertainty

Sample projects;

- Construction of a hydro-power plant;
- Construction of a road between two towns;
- Development of a computer software
- Undertaking a degree programme at the UDSM;
- Preparing a bachelors Degree Dissertation/project,

Eg, MG499. CP499, WR499,EL499, FB499,PD499

Triple Constraint of Project



What is Project management?

is the process of planning, organizing, Staffing, leading, controlling and coordinating human And Material resources for the execution of a facility to serve a Specific function for the purpose of meeting pre-determined Objectives within the constraints of time, cost and quality

What is Project Management?

Project management is “the application of knowledge, skills, tools, and techniques to project activities in order to meet or exceed stakeholder needs and expectations from a project” (PMI*, Project Management Body of Knowledge (PMBOK Guide), 2004, p. 6)

Why Project management?

- It facilitates the identification of problem Areas before Undertaking the project
- Helps understand the project
- Reduces project risks (e.g. financial)
- Enables resources utilization optimization
- Promotes teamwork and participation
- Effective in dealing with the ever changing environment

Motivation for Studying Engineering Project Management

- Projects have a terrible track record in Tanzania;
- Construction for example, projects take up to about 3 times longer than the planned duration;
- Budgets are not met;
- Quality is poor
- The need for projects keeps increasing;
- Companies in general are emphasizing projects

Project objectives

Breaks down your project statement into specific accomplishment

Objectives must be :

- Measurable
- Attainable
- Realistic

Specific (specify single end result)

- Achievable
- Measurable
- Fit higher level organization objectives
- Stated in terms of deliverables
- Understandable
- Realistic

Typical Stages of Engineering Projects

- Conception – realise that there is a problem that requires an engineering solution;
  - Can the problem be solved?
  - Is the solution economically viable?

    (technical and economic viability)
- Preliminary design – explore a range of feasible technical solutions to arrive at one general solution with key design parameters; includes also a full economic appraisal;
- Design or definition – produce production information for the engineering product; this includes tender documents;

- Tendering – selecting a contractor who would deliver the intended product;
- Implementation – actual delivery of the intended product;
- Commissioning – checking whether the product meets performance requirements;
- Use and maintenance for the product

Project Stakeholders …

Project Stakeholders: *Are individuals and organizations who are Actively involved in the project, or those whose interests may be positively or negatively affected as the result of project execution or successful project completion*

•*Project manager-the* individual responsible for managing the Project

•*Performing organization-The* enterprise whose employee are Mostly directly involved in doing the work of the project

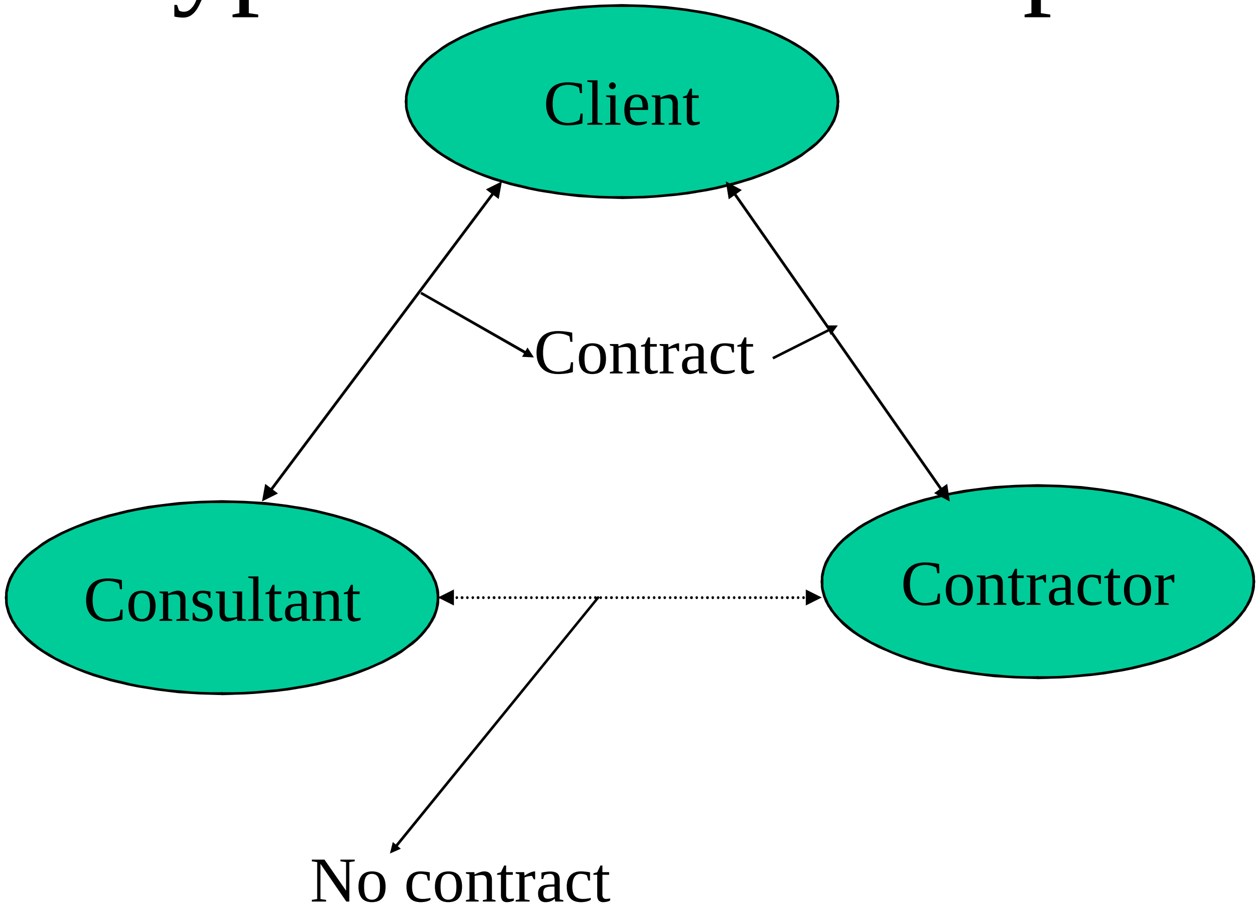
•C*ustomer/client*: The user of the project deliverables

•*sponsor*: The person/institution who orders that a project be done-provides the financial resources, in cash or kind for the project

Key actors in the engineering project processes

- Client: A person who defines what is required and generally pays for it;
- Consultant: A professional who translates the Clients requirements into product delivery information – design and drawings, tender documents;
- Contractor – A person who translates the delivery information into the actual product.

Typical Relationships



2.Types of Projects

There are number of ways by which projects can be classified: Development VS Business oriented, capital Vs non-capital, or service Vs non-service project, e.t.c

Classification developed by Robert Youker 2002.

(1) geographical location,

(2) industrial sector (Standard Industrial Classification System),

(3) stage of the project life cycle and

(4) product of the project (construction of a building or development of a new product)

Types of Projects Cont.

a list of nine different types of projects based on the product they produce *developed by Robert Youker 2002.*

Type of Project	**Product of Project (Examples)**
1.Administrative	installing a new accounting system
2.Construction	a building or road
3.Computer Software Development	a new computer program
4.Design of Plans	architectural or engineering plans
5.Equipment or System Installations	telephone system
6.Event or Relocation	a move into a new building
7.Maintenance of Process Industries	petrol-chemical plant or electric generating station
8.New Product Development	a new drug
9.Research	a feasibility study

PM Tools and Techniques

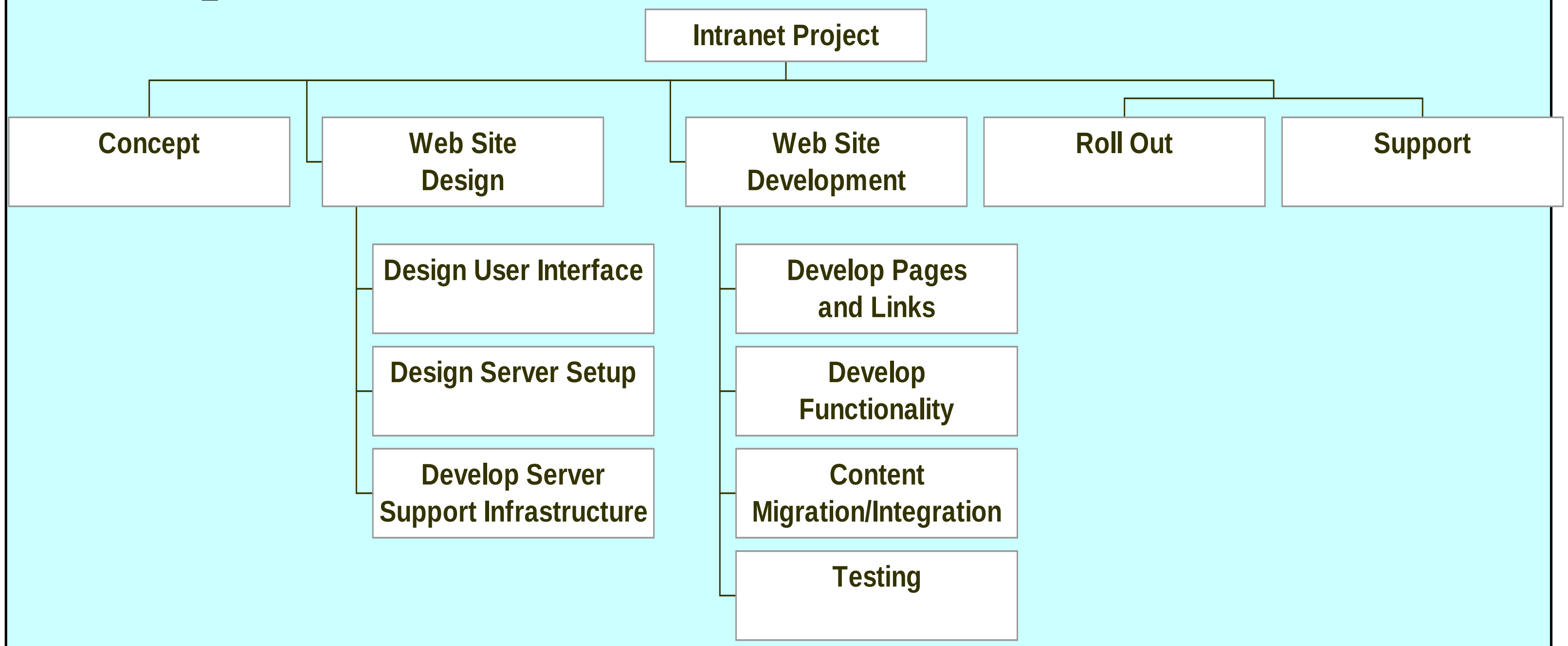
Project management tools and techniques assist project managers and their teams in various aspects/ Phases of projec management

Some specific ones include:

Brainstorming ,NPV, MCA, CBA, WBS, Action plans, stakeholders matrix, organization charts,
Project review meeting, Earned value Analysis,
Gantt charts, PERT charts, critical path analysis (time), Logframe,

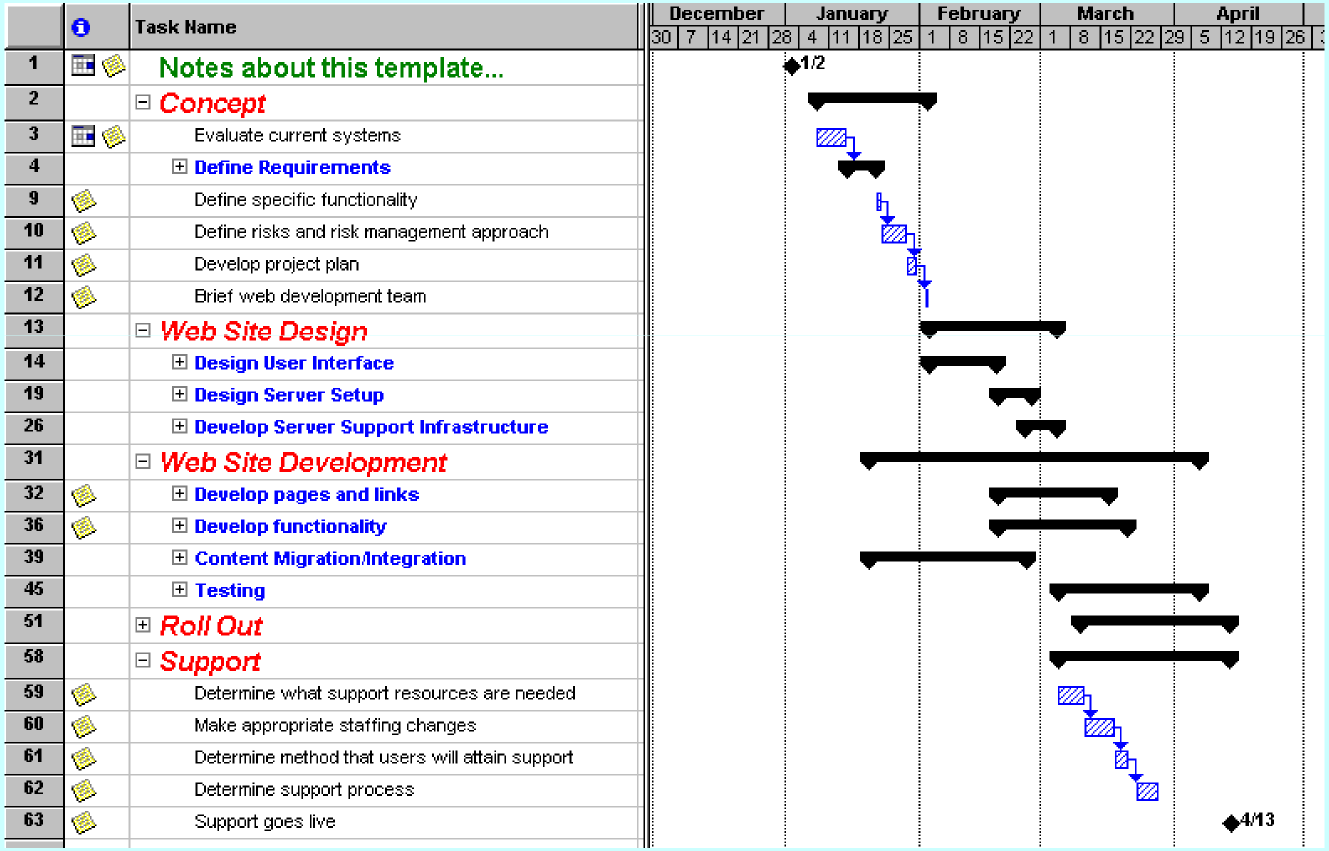
PM Tools and Techniques cont.

Sample WBS



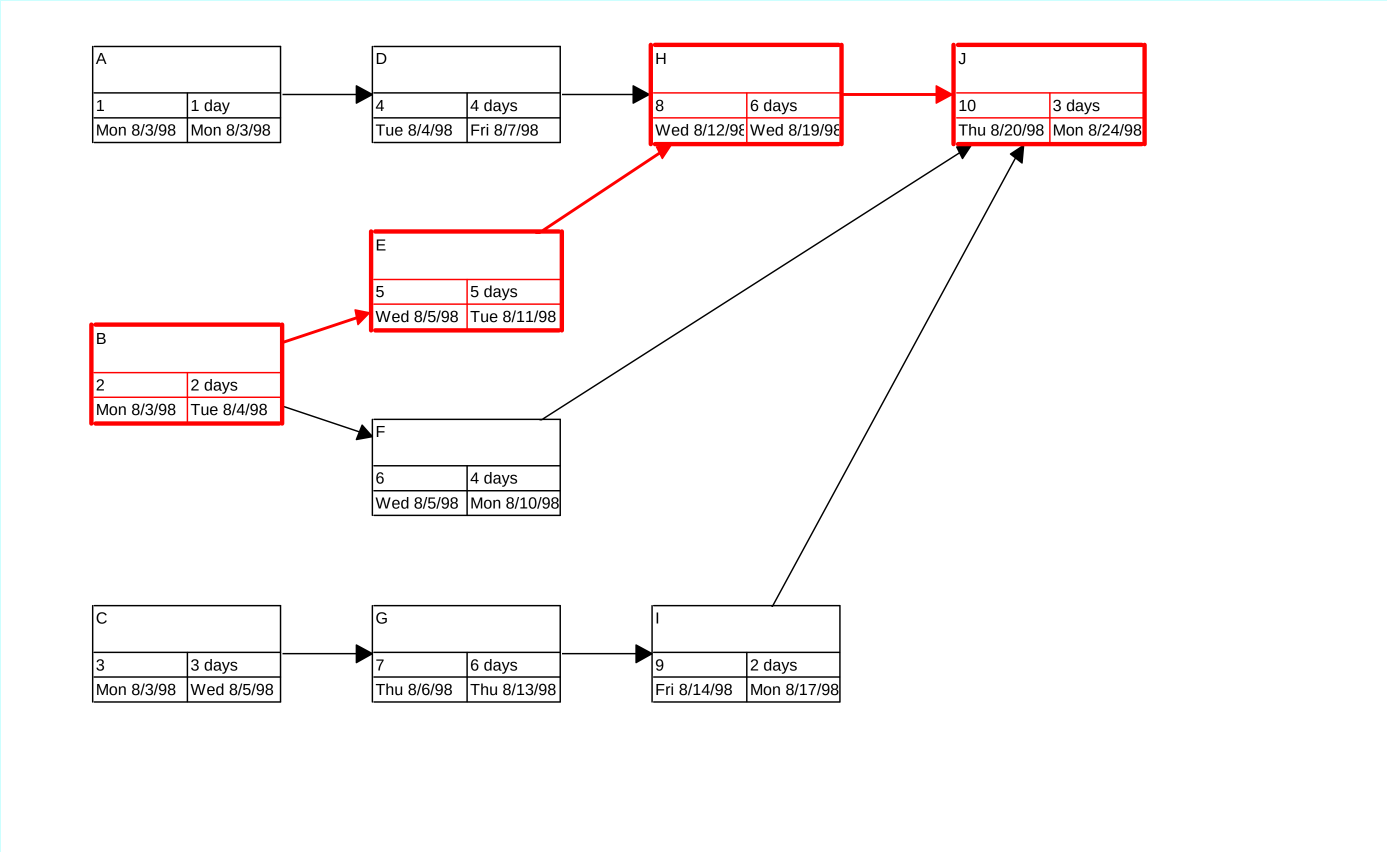
PM Tools and Techniques cont.

. Sample Gantt Chart



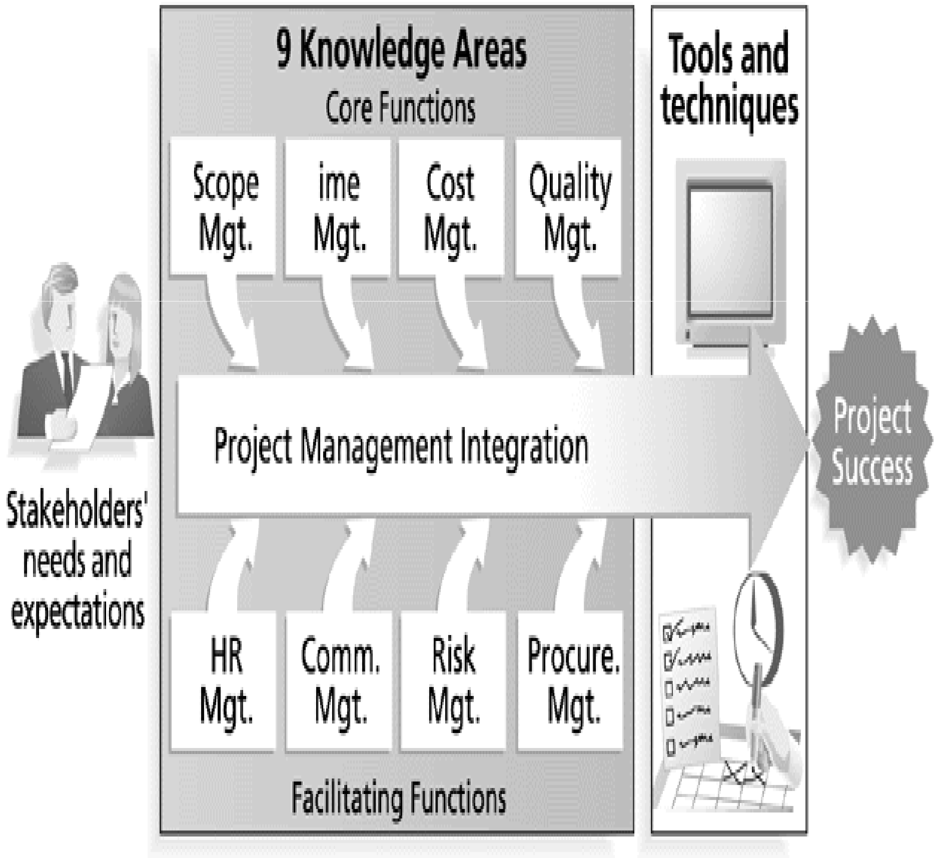
PM Tools and Techniques cont.

. Sample PERT



Project management knowledge areas

- Knowledge areas describe the key competencies that project managers must develop
  - 4 core knowledge areas lead to specific project objectives (scope, time, cost, and quality)
  - 4 facilitating knowledge areas are the means through which the project objectives are achieved (human resources, communication, risk, and procurement management)
  - 1 knowledge area (project integration management) affects and is affected by all of the other knowledge areas



Project Management (PM) VS Other Disciplines

- Much of the knowledge needed to manage projects is unique to PM
- However, project managers must also have knowledge and experience in
  - general management
  - the application area of the project
- Project managers must focus on meeting specific project objectives

Suggested Skills for a Project Manager

- Communication skills: listening, persuading
- Organizational skills: planning, goal-setting, analyzing
- Team Building skills: empathy (understanding), motivation,
- Leadership skills: sets example, energetic, vision (big picture), delegates, positive
- Coping skills: flexibility, creativity, patience, persistence (determination)
- Technological skills: experience, project knowledge

Thank You

Questions!!!!!

2.0 Engineering Project Life Cycle

IE354: Engineering Project Management

Mohamed. J.A.M,

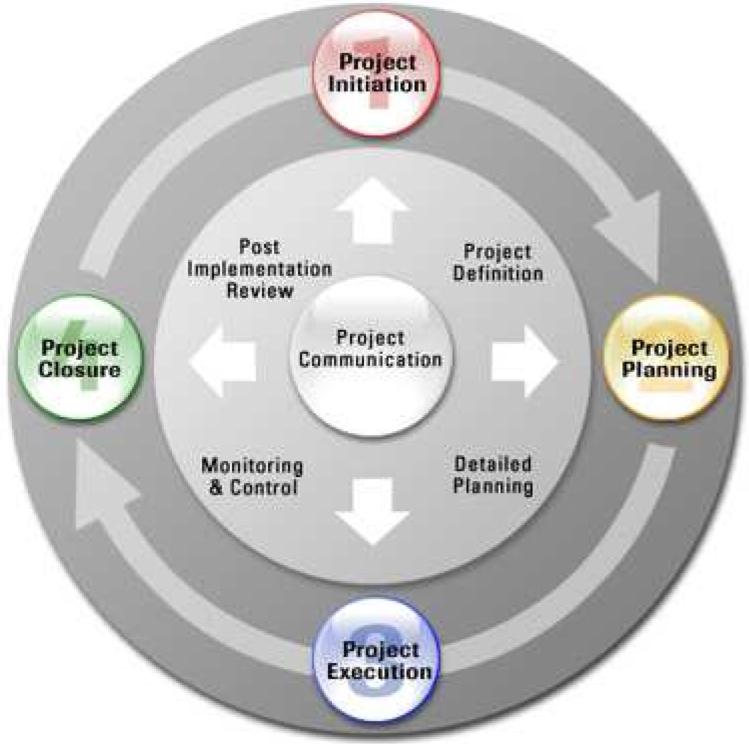
Department of Mechanical and Industrial Engineering
College of Engineering and Technology-UDSM

Outline of the Talk

- **What is Project life cycle?**
- **Phases of Project life cycle**
- **Characteristics of Project life cycle**
- **Hence, PM functions**

- A project life cycle is a collection of phases that projects go through from inception to completion
- Project phases vary by project or industry, but some general phases include
  - Initiation
  - Planning
  - Implementation
  - Closure

A project should successfully pass through each of the project phases in order to continue on to the next



Characteristics of Project phase

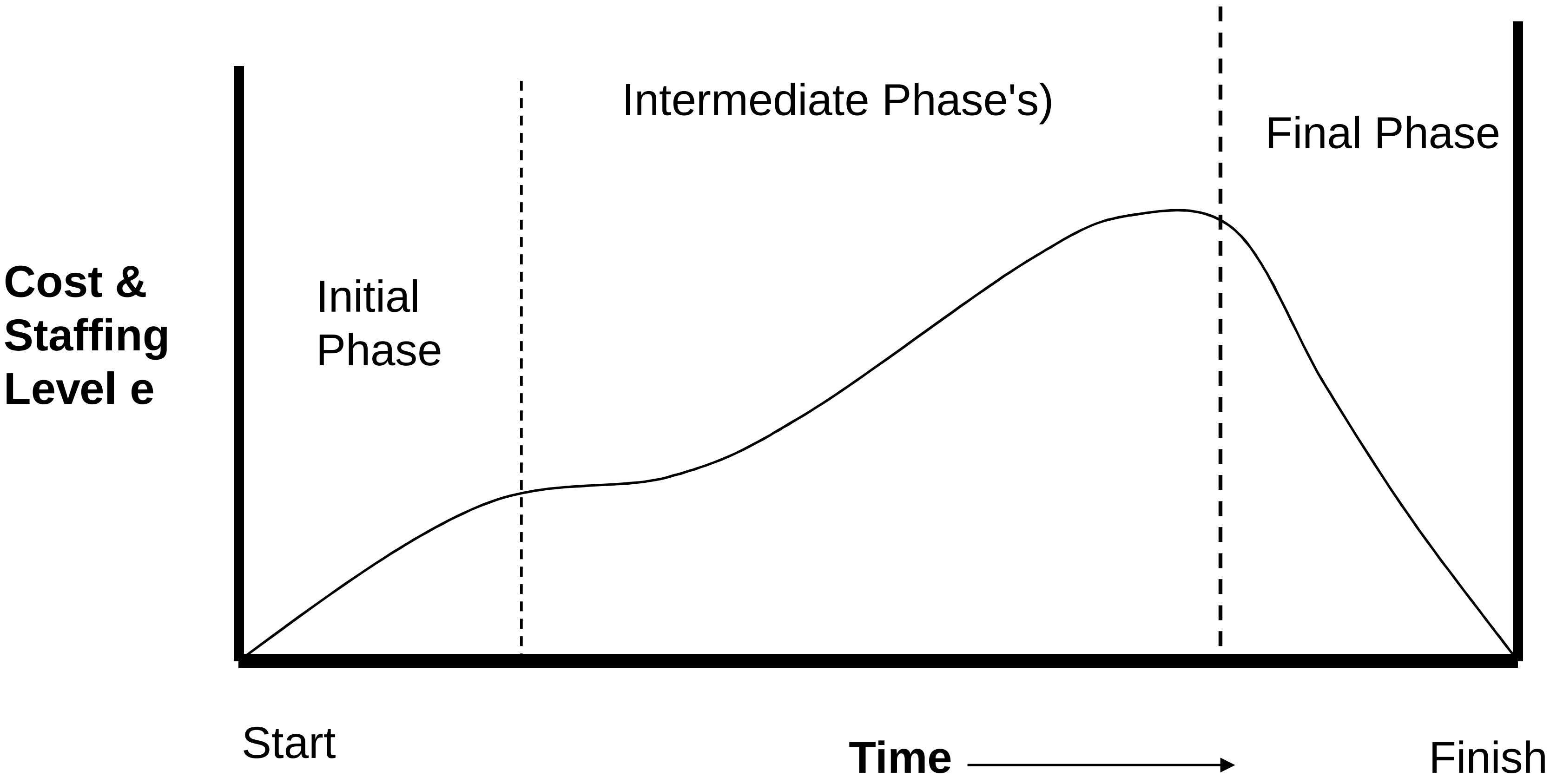
Project phase:

- Marked by completion of deliverable's –tangible verifiable work product e.g feasibility study
- Phases are part of general sequential logic of the product of the project
- Project phase is marked by deliverables and project performance – for continuation or taking corrective measures

Characteristics of project life cycle

Project life cycle

- Defines beginning and end of the project
- Defines what technical work should be done in each phase and who should be involved in each phase
- Cost and staff levels are lower at start, higher towards the end, and drop rapidly as the project draws to the conclusion
- Probability of usefully completion of the project is lowest, and hence risk and uncertainty are highest at the start of the project. Probability of usefully completion gets progressively higher as the project continues


Cost &
Staffing
Level e
Initial
Phase
Intermediate Phase's)
Final Phase
Start
Time
Finish

Initiation Phase

- Identifying needs of the client
- Conceptualization ways of satisfying the identified needs
- Feasibility studies (Technical, Operational, Financial, Socio-economical, environmental)
- Developing project objectives (TORs)
- Formulation of organization structure

Planning Phase

- Activity definition (WBS)
- Activity sequencing
- Recourses determination
- Activity duration estimation
- Time computation (Incl. Critical activities)
- Developing workplan (Working Calendar)

Implementation Phase

•Comprises procurement of material and all necessary facilities required

•Project execution

•Project progress control and reporting

Commissioning and Closing Phase

- Project progress control and reporting
- Turn project into operation unit
- Validate operational performance (Quality, Objectives)- Post implementation review
- Knowledge transfer from project team to operations team(user training)
- Project closure report
- Handing over –Start of operations phase

Relationships Among Project Process Groups, Activities, and Knowledge Areas

	Project Process Groups				
Knowledge Area	Initiating	Planning	Executing	Controlling	Closing
Integration		Project plan development	Project plan execution	Overall change control	
Scope	Initiation	Scope planning	Scope verification	Scope change control	
Time		Activity definition		Schedule control	
		Activity sequencing			
		Activity duration estimating			
		Schedule development			
Cost		Resource planning		Cost control	
		Cost estimating			
		Cost budgeting			
Quality		Quality planning	Quality assurance	Quality control	
Human resources		Organizational planning	Team development		
		Staff acquisition			
Communications		Communications planning	Information distribution	Performance reporting	Administrative closure
Risk		Risk identification		Risk response control	
		Risk quantification			
		Risk response development			
Procurement		Procurement planning	Solicitation		Contract close-out
		solicitation planning	Source selection		
			Contract administration		

Project Management Job Functions

- Define scope of project
- Identify stakeholders, decision-makers, and escalation procedures
- Develop detailed task list (work breakdown structures)
- Estimate time requirements
- Develop initial project management flow chart
- Identify required resources and budget
- Evaluate project requirements
- Identify and evaluate risks Prepare contingency plan
- Identify interdependencies
- Identify and track critical milestones
- Participate in project phase review
- Secure needed resources
- Manage the change control process
- Report project status

LIFE CYCLE OF A PROJECT

Seven Phases

Concept and Feasibility Studies

Preliminary Engineering and Design

Detailed Engineering and Design

Procurement

Construction

Start-up and Implementation

Operation or Utilization

1. Concept and Feasibility Studies

Identifying needs of the client

Forecast Future Demand

Location

Availability of Resources

Accessibility to transportation

Political and Institutional Factors

Sociological and Economic Impact on Community

Environmental Impact

Overall Technical and Economic Feasibility

Developing project objectives (TORs)

Formulation of organization structure

2. Preliminary Engineering and Design

Architectural concepts

Evaluation of technological process alternatives

Size and capacity of facility

Comparative economic studies

Reviews by regulatory bodies for compliance

Zoning regulations

Building codes

Licensing procedures

Safety standards

Environmental impact

Public Hearing

Funding cycles in Legislative and Executive Bodies

3. Detailed Engineering and Design

Design of Architectural Elements

Design of Structural Elements

Site Investigation

Foundation Design

Electrical and Mechanical Design

Preparation of Specifications and Drawings

Developing Various Plans(Time, quality, performance, quality, comm.)

Preparation of Contract Documents

3. Detailed Engineering and Design

Design of Architectural Elements

Design of Structural Elements

Site Investigation

Foundation Design

Electrical and Mechanical Design

Preparation of Specifications and Drawings

Preparation of Contract Documents

4. Procurement

Services
Equipment
Materials

Lump Sum Contract
Cost Plus Fee Contract
Negotiated Contract

5. Construction

Process whereby the Designer's Plans and Specifications are converted into Physical Structures and Facilities

Co-ordination of all resources to complete the project

On Schedule

Within Budget

According to Specified Standard of Quality and Performance

•Comprises procurement of material and all necessary facilities required

•Project execution

•Project progress control and repo

6. Start-up and Implementation

Testing of Components

Warranty Period

•Project progress control and reporting

•Turn project into operation unit

•Validate operational performance (Quality, Objectives)- Post implementation review

•Knowledge transfer from project team to operations team(user training)

•Project closure report

•Handing over –Start of operations phase

7. Operation and Utilization

Regular Maintenance of Facilities

DESIGN TEAM

Architect

Interior Designer

Landscape Architect

Civil Engineer

Environmental Engineer

Electrical Engineer

Mechanical Engineer

Chemical Engineer

Geologist

Environmental Scientist

Economist

CONSTRUCTION TEAM

General Contractor

Land Surveyor

Formwork Carpenters

Steel Fabricators

Concreters

Bricklayers

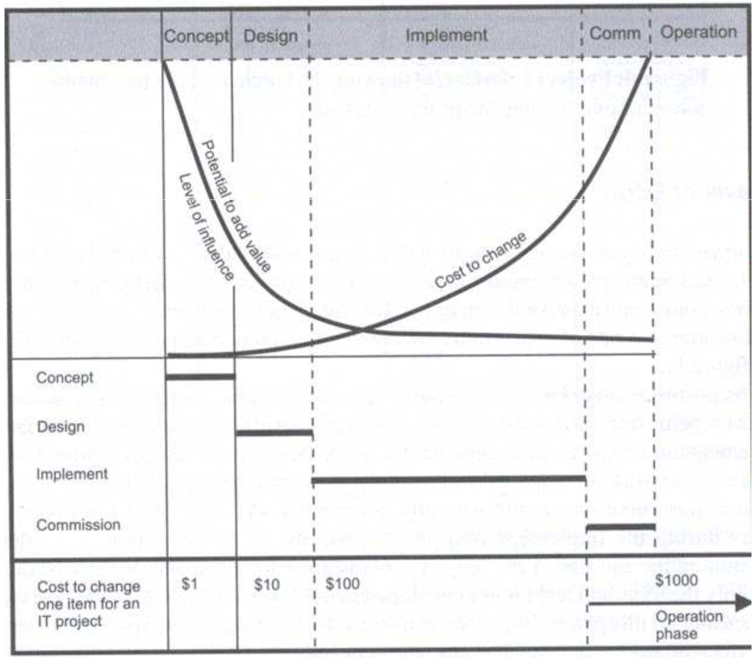
Plant and Equipment Operators

Specialist subcontractors

Suppliers

Engineering Project Life Cycle

Project Lifecycle



Lifecycle: Phases

<u>Project Phases:</u>

Concept

Design

Implementation

Handover

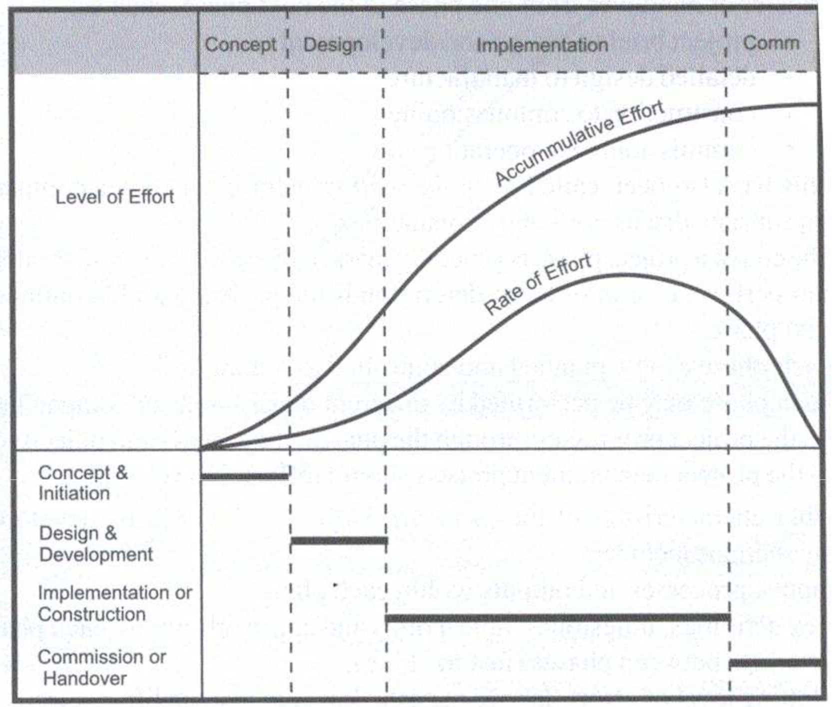
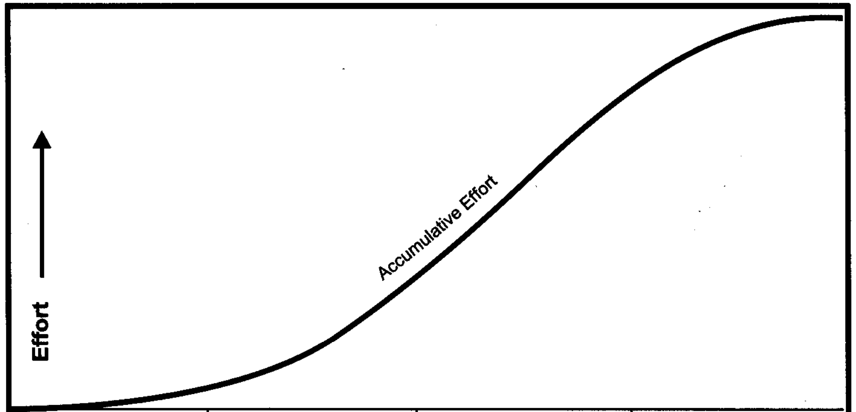


Figure 1: Project Life-Cycle (this is a typical presentation showing barchart, project phases, level of effort and level of expenditure)

Lifecycle: Phases

<u>Project Phases:</u>

Concept
Design
Implementation
Handover



Concept	Design	Implementation	Commission
Input	Input	Input	Input
Problem or opportunity, project brief, project charter	Approval to go ahead and design the product	Approval to implement project	Commissioning plan, notification of completion
Process	Process	Process	Process
Project proposal, feasibility study, identify stakeholders, cost-benefit analysis	Design product, develop detailed schedules, WBS, CPM and budgets	Award contracts and issue instructions, procure equipment and services, make the product or solve the problem	Start-up and test the product, has the problem been solved? Produce as-built drawings and operation manuals
Key Activities	Key Activities	Key Activities	Key Activities
Hold Points	Hold Points	Hold Points	Hold Points
Output	Output	Output	Output
Feasibility study report	Baseline plan (design and schedule)	Certificate of completion	Closeout Report
Approval	Approval	Approval	Approval
Go/no go decision, to proceed with design phase	To implement project	Ready to commission	Project accepted by client

Figure 2: Project Life-Cycle Components (for a typical project, using this as a standard proforma relate the components to one of your projects)

Life Cycle: Activities

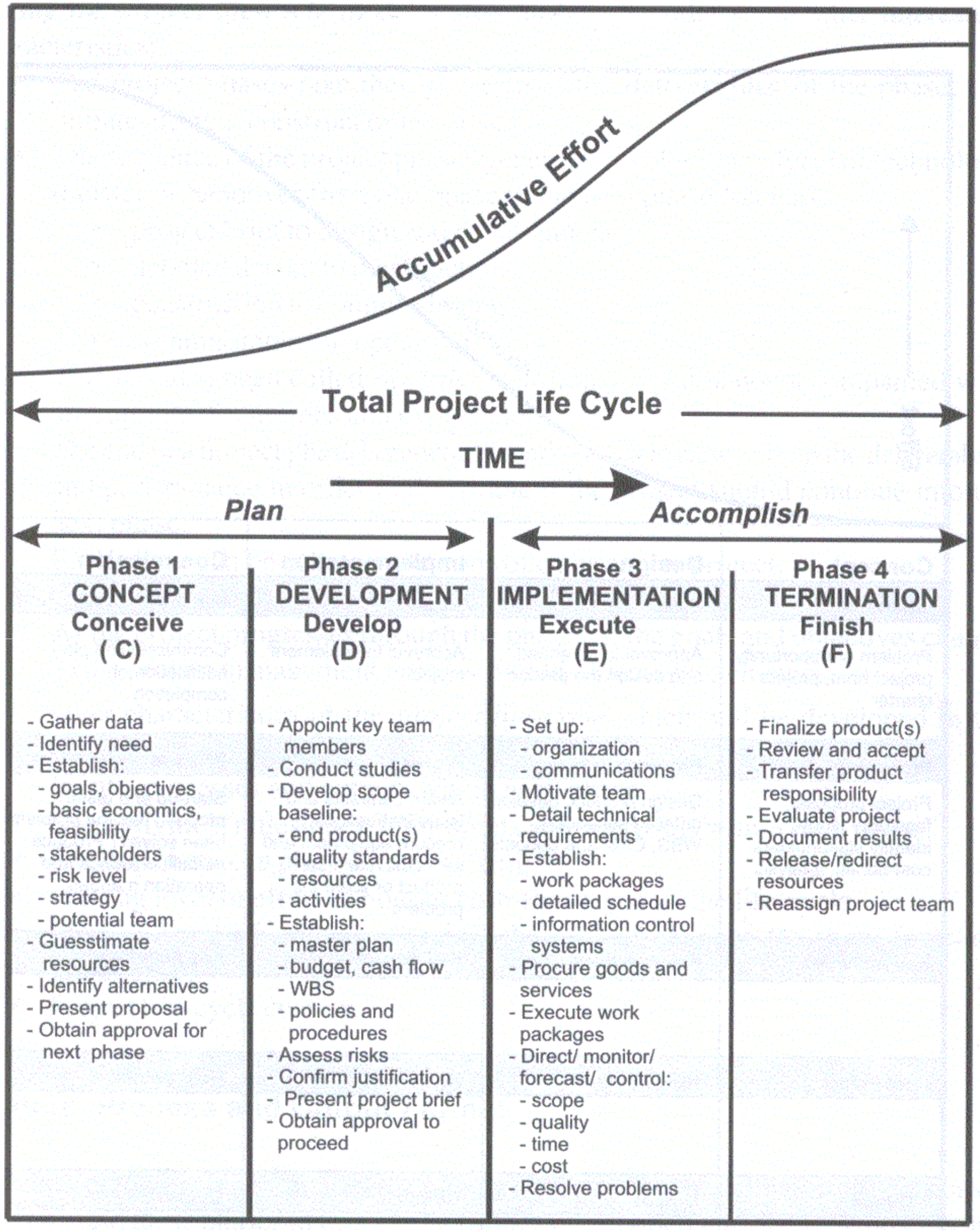


Figure 3: Project Life-Cycle [generic] (developed from the PMBOK series, volume 1, Wideman and Fellow, 1991, p.111-2)

Life Cycle: Expenditures

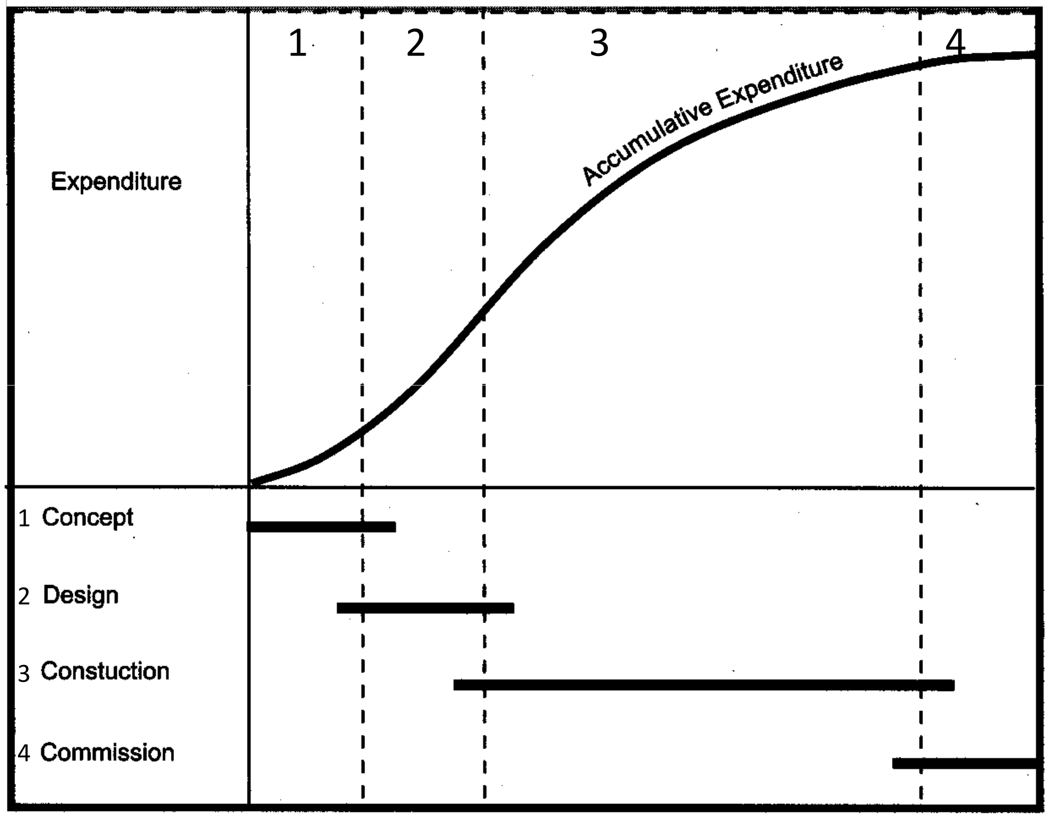


Figure 4: Project Life-Cycle (showing the barchart of the four main activities overlapping the project phases)

Life Cycle: Changes

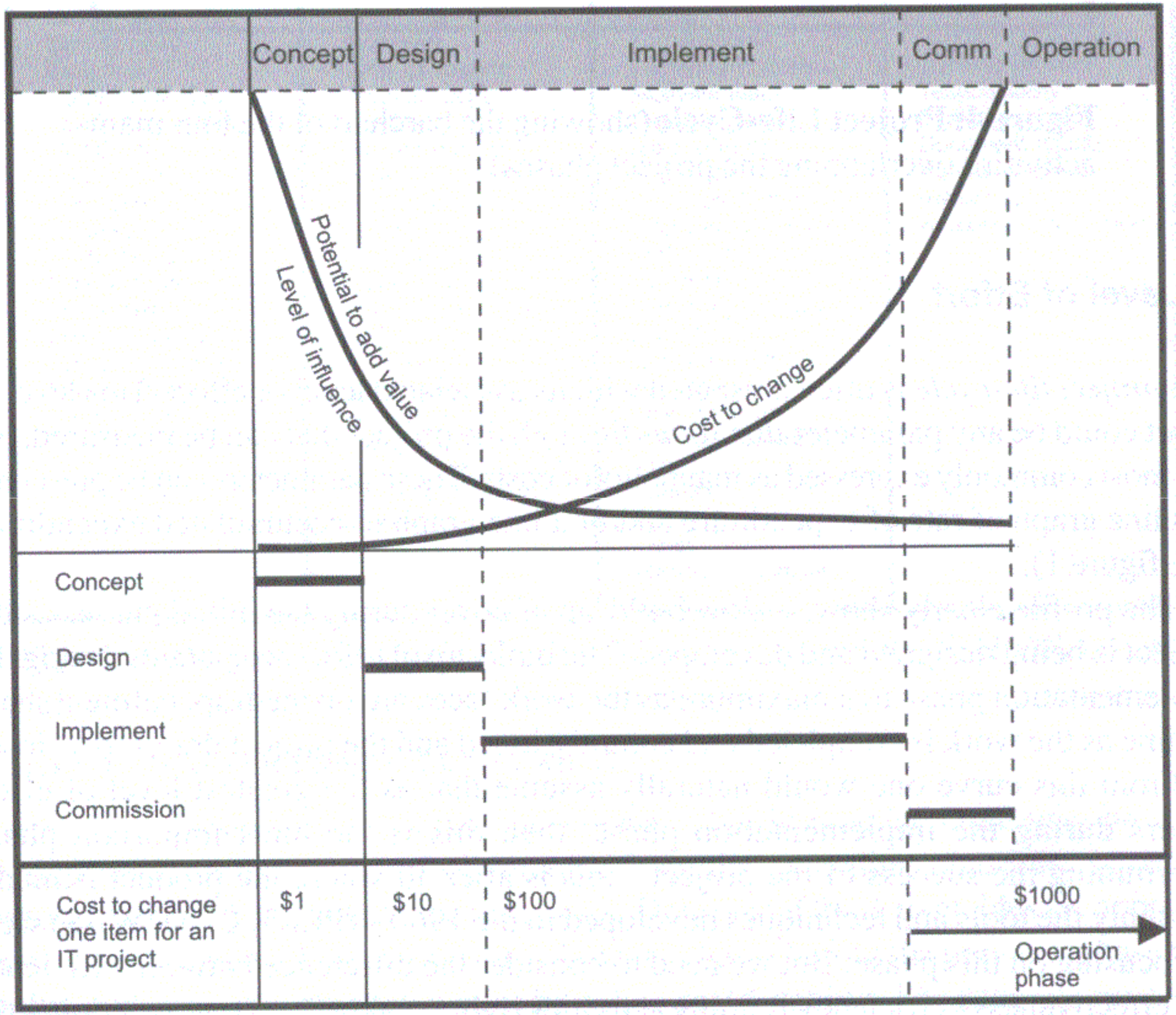


Figure 5: Potential to Add Value / Cost of Changes (showing typical cost of changes in the IT industry)

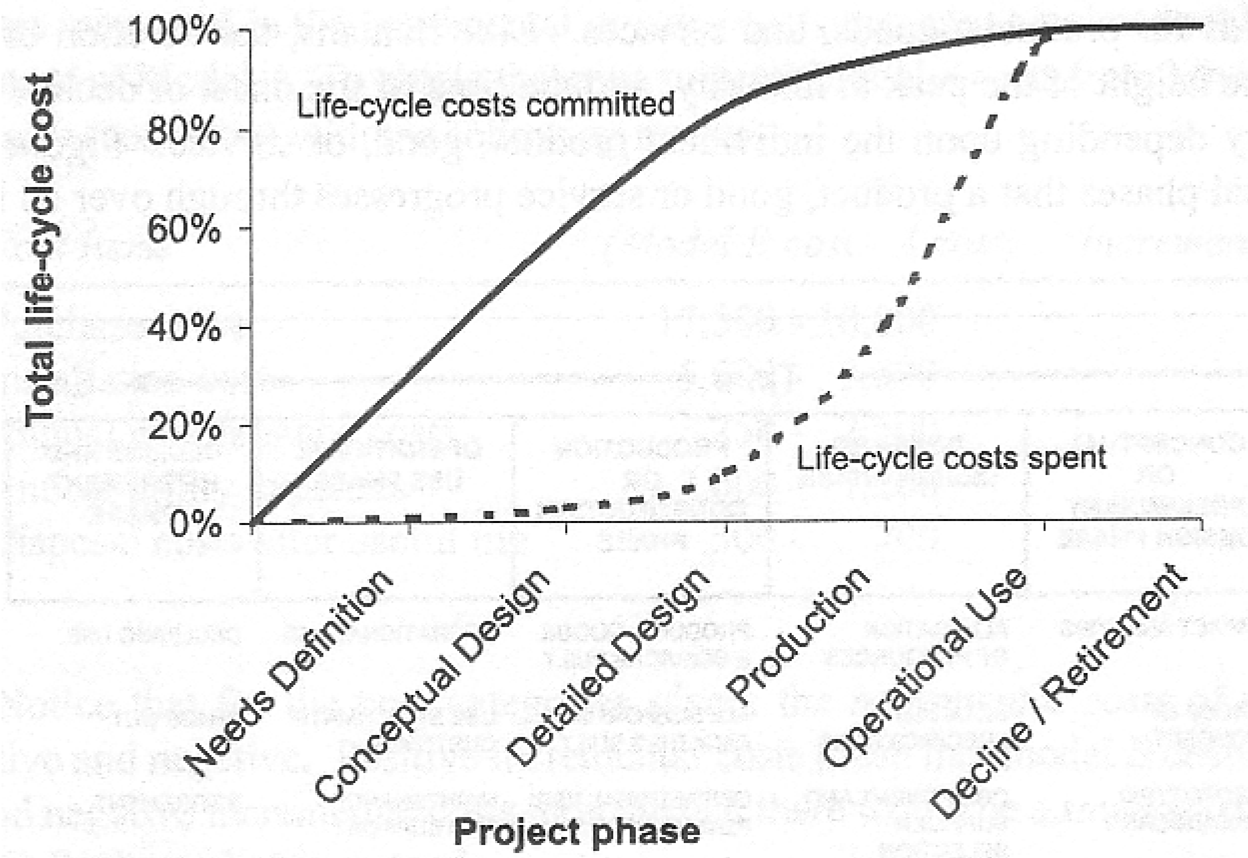
Product Life-cycle

Beginning ——— Time ———→ End

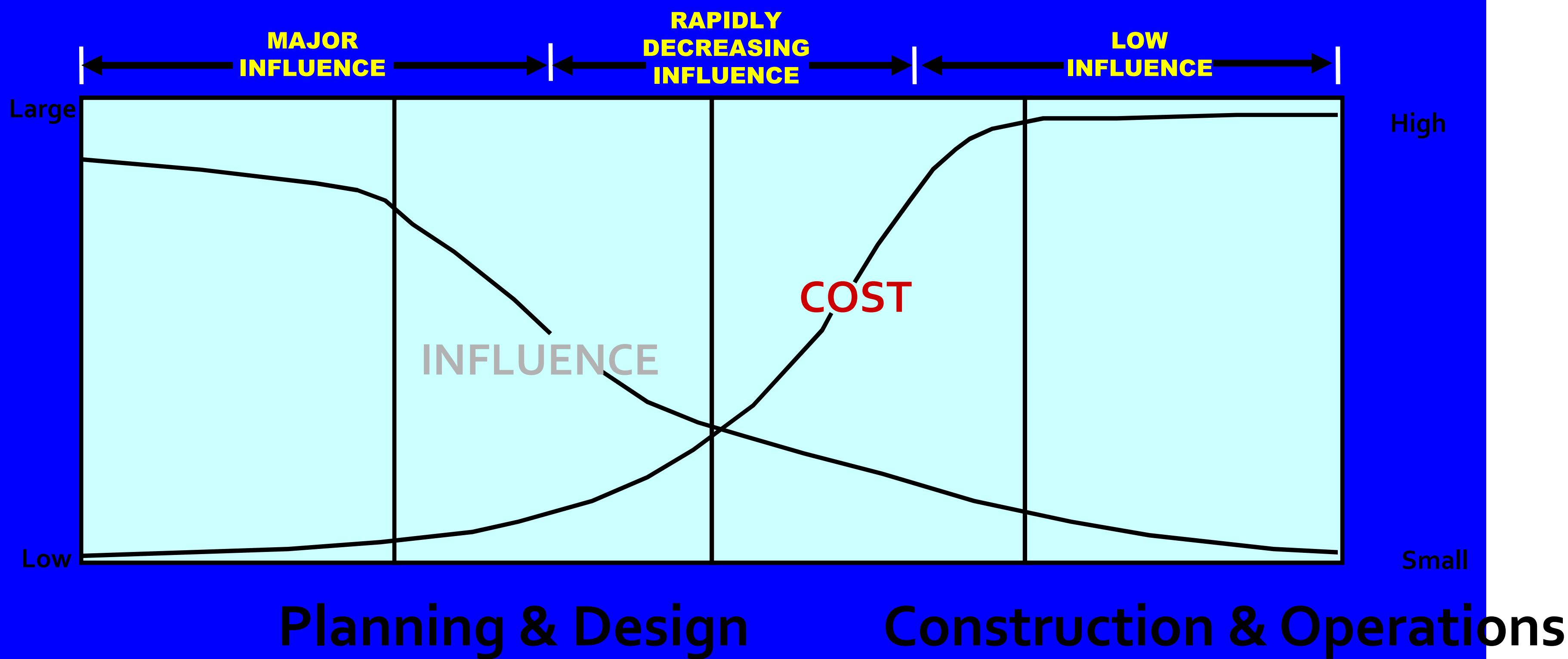
NEEDS ASSESSMENT AND JUSTIFICATION PHASE	CONCEPTUAL OR PRELIMINARY DESIGN PHASE	DETAILED DESIGN PHASE	PRODUCTION OR CONSTRUCTION PHASE	OPERATIONAL USE PHASE	DECLINE AND RETIREMENT PHASE
REQUIREMENTS	IMPACT ANALYSIS	ALLOCATION OF RESOURCES	PRODUCT, GOODS & SERVICES BUILT	OPERATIONAL USE	DECLINING USE
OVERALL FEASIBILITY	PROOF OF CONCEPT	DETAILED SPECIFICATIONS	ALL SUPPORTING FACILITIES BUILT	USE BY ULTIMATE CUSTOMER	PHASE OUT
CONCEPTUAL DESIGN PLANNING	PROTOTYPE/ BREADBOARD	COMPONENT AND SUPPLIER SELECTION	OPERATIONAL USE PLANNING	MAINTENANCE AND SUPPORT	RETIREMENT
	DEVELOPMENT AND TESTING	PRODUCTION OR CONSTRUCTION PHASE		PROCESSES, MATERIALS AND METHODS USE	RESPONSIBLE DISPOSAL
	DETAILED DESIGN PLANNING			DECLINE AND RETIREMENT PLANNING	

Figure 2-3: Typical life-cycle for products, goods and services.

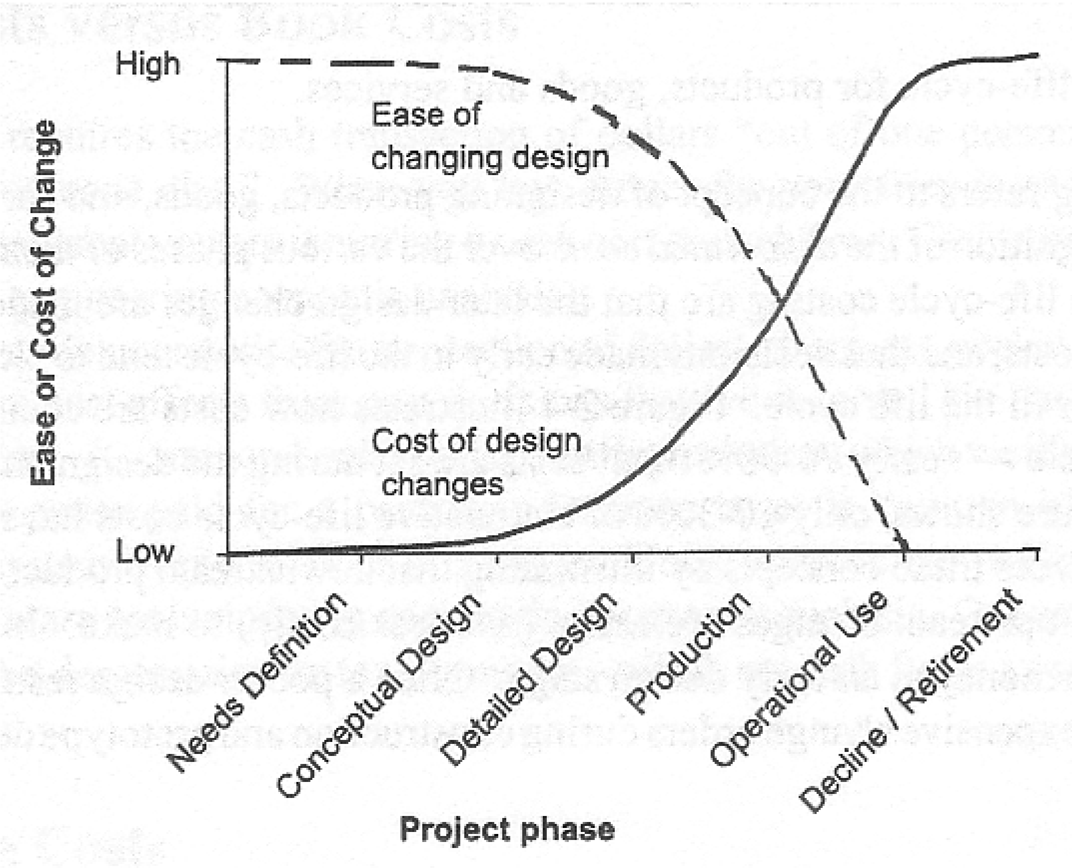
Cumulative Life-cycle Costs Committed and Dollars Spent



Influence *vs.* Cost



Life-cycle Design Change Costs and Ease of Change



Financing of Engineering projects:

- Private/Self financing;
- Financing from lending institutions;
- Financing by public funds – central government; local government authorities; Government Trading Enterprises
- Grant and credit financing facilities (bilateral donors; foundations; World Bank, ADB, etc.),
- PPP, Community Financing

Thank You

Questions!!!!!

Home work

Form Small groups and give short notes on different deliverables of Project phases

Engineering Costs and Cost Estimating

- Engineering Costs
- Cost Estimating and Estimating Models

Learning Objectives

- Understand various cost concepts
- Understand various cost estimation models
- Be able to estimate engineering costs with various models

Types of Costs

- Fixed Costs & Variable Costs
- Marginal Costs & Average Costs
- Sunk Costs & Opportunity Costs
- Recurring & Non-recurring Costs
- Incremental Costs
- Cash Costs & Book Costs
- Life-Cycle Costs

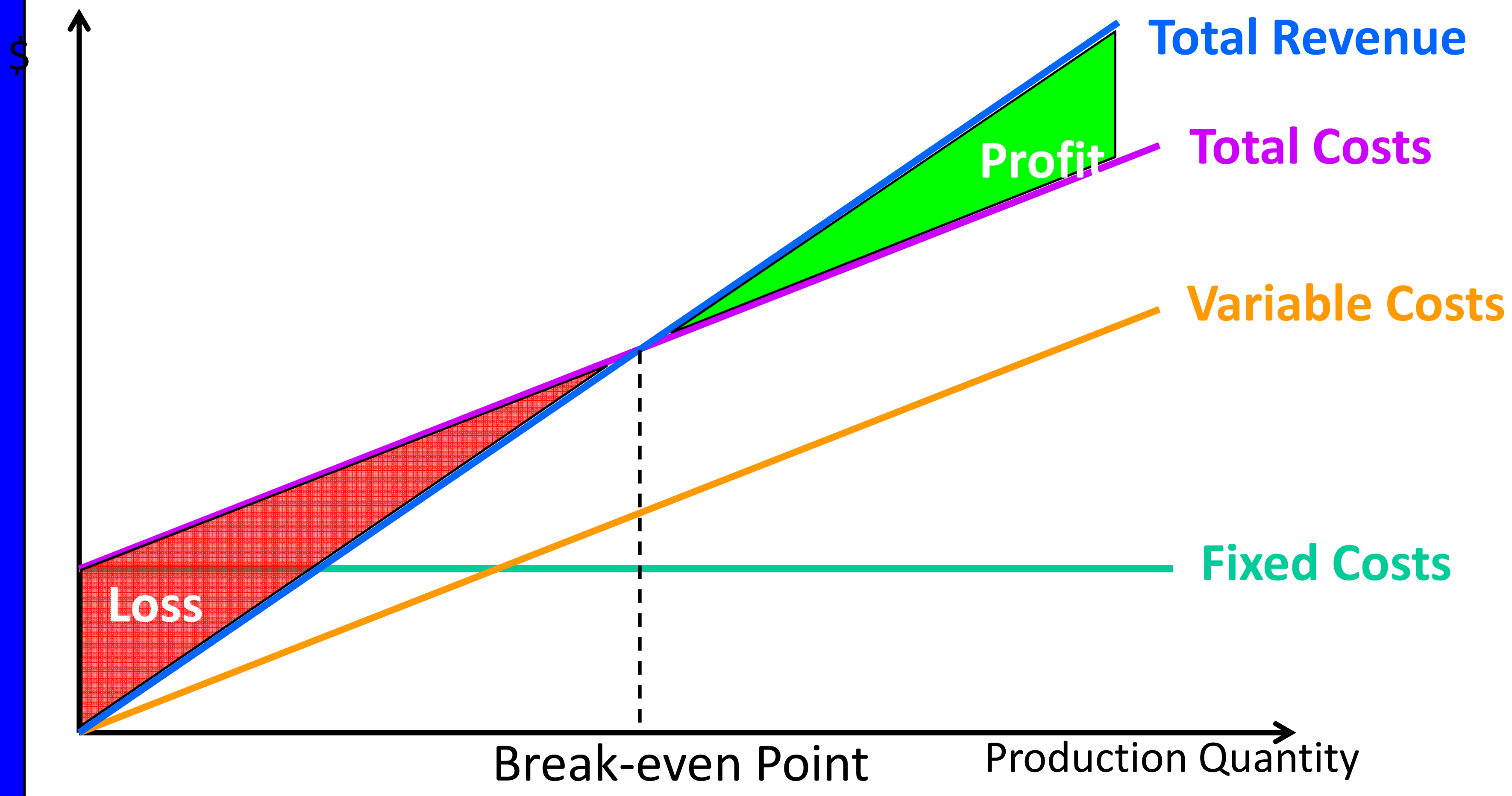
Fixed Costs and Variable Costs

- Fixed Costs: constant, independent of the output or activity level.
  - Property taxes, insurance
  - Management and administrative salaries
  - License fees, and interest costs on borrowed capital
  - Rental or lease
- Variable Costs: Proportional to the output or activity level.
  - Direct labor cost
  - Direct materials

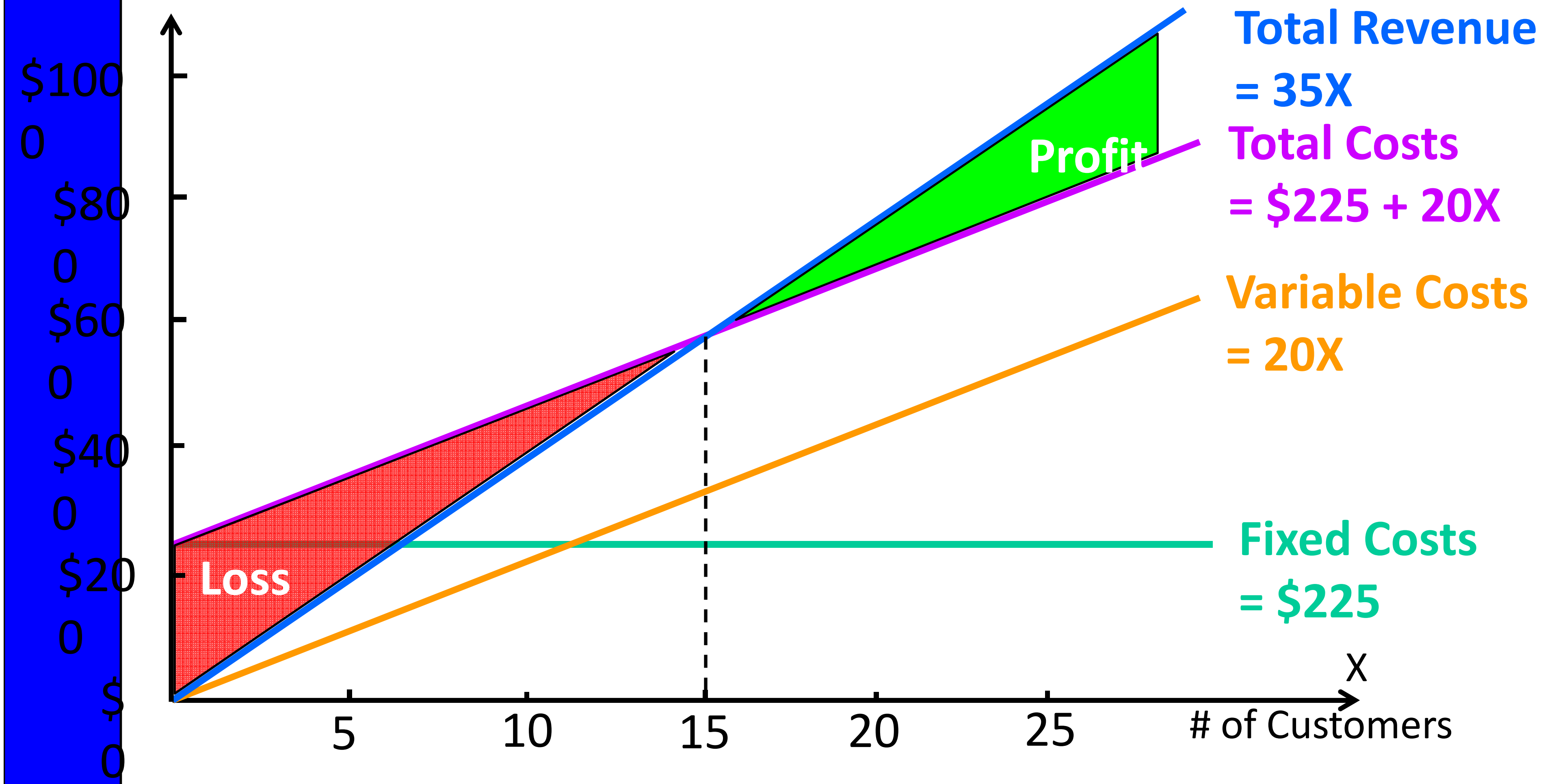
Breakeven Analysis

- Total Variable Cost = Unit Variable Cost * Quantity
- Total Cost = Fixed Cost + Total Variable Cost
- Total Revenue = Unit Selling Price * Quantity
- Breakeven point: the output level at which total revenue is equal to total cost.
- Applications of Breakeven analysis:
  - Determining minimum production quantity
  - Forecast production profit / loss

Breakeven Analysis



Example


$1000
$800
$600
$400
$200
$0
Total Revenue
= 35X
Total Costs
= $225 + 20X
Variable Costs
= 20X
Fixed Costs
= $225
Profit
Loss
X
5
10
15
20
25
# of Customers

Marginal Costs and Average Costs

- Marginal Costs: the variable cost for one more unit of output
  - Capacity Planning: excess capacity
  - Basis for last-minute pricing
- Average Costs: total cost divided by the total number of units produced.
  - Basis for normal pricing

Sunk Costs & Opportunity Costs

- Sunk Costs: Cost that has occurred in the past and has no relevance to estimates of future costs and revenues related to an alternative
  - Purchasing price of current equipment in deciding new equipment (except for capital gain/loss consideration)
- Opportunity Costs: Cost of the foregone opportunity and is hidden or implied
  - Existing equipment in replacement analysis

Recurring Costs and Non-recurring Costs

- Recurring Costs: Repetitive and occur when a firm produces similar goods and services on a continuing basis
  - Office space rental
- Non-recurring Costs: Not repetitive, even though the total expenditure may be cumulative over a period of time
  - Typically involve developing or establishing a capability or capacity to operate
  - Examples are purchase cost for real estate and the construction costs of the plant

Incremental Costs

- Incremental Costs: Difference in costs between two alternatives.
  - Suppose that A and B are mutually exclusive alternatives. If A has an initial cost of \$10,000 while B has an initial cost of \$14,000, the incremental initial cost of (B - A) is \$4,000.

Example
Choosing between Model A & B

Cost Items	Model A	Model B	Incremental Cost
Purchase Price	$10,000	$17,500	$7,500
Installation Costs	3,500	5,000	1,500
Annual Maintenance	2,500	750	-1,750
Annual Utility	1,200	2,000	800
Disposal Cost	700	500	-200

Life-Cycle Costs

- Life-Cycle Costs: Summation of all costs, both recurring and nonrecurring, related to a product, structure, system, or service during its life span.
- Life cycle begins with the identification of the economic needs or wants (the requirements) and ends with the retirement and disposal activities.

Life-cycle Costs

- **Life-cycle** - all the time from the initial conception of an idea to the death of a product (process).
- **Life-cycle costs** - sum total of all the costs incurred during the life cycle.
- **Life-cycle costing** - designing a product with an understanding of all the costs associated with a product during it's life-cycle.

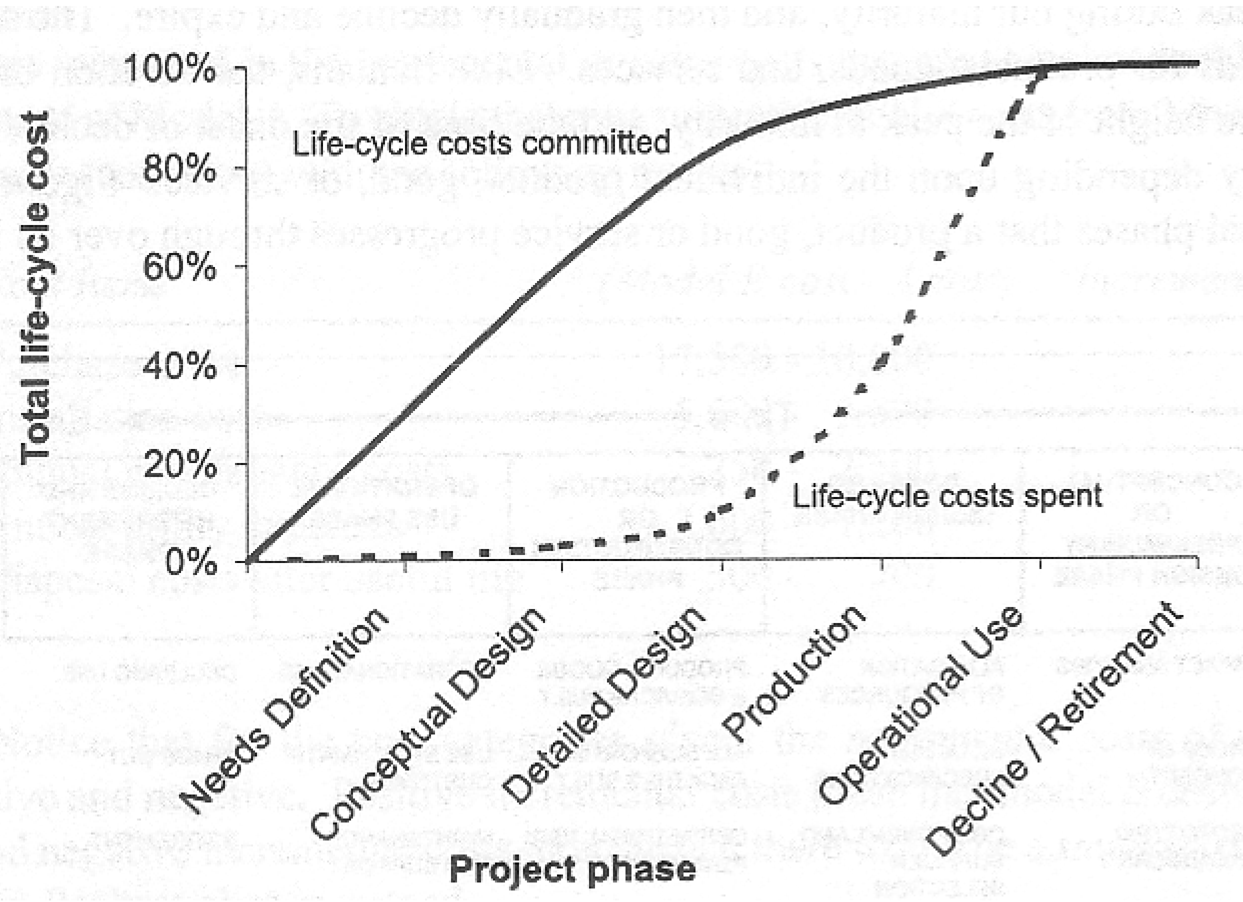
Product Life-cycle

Beginning ——— Time ———> End

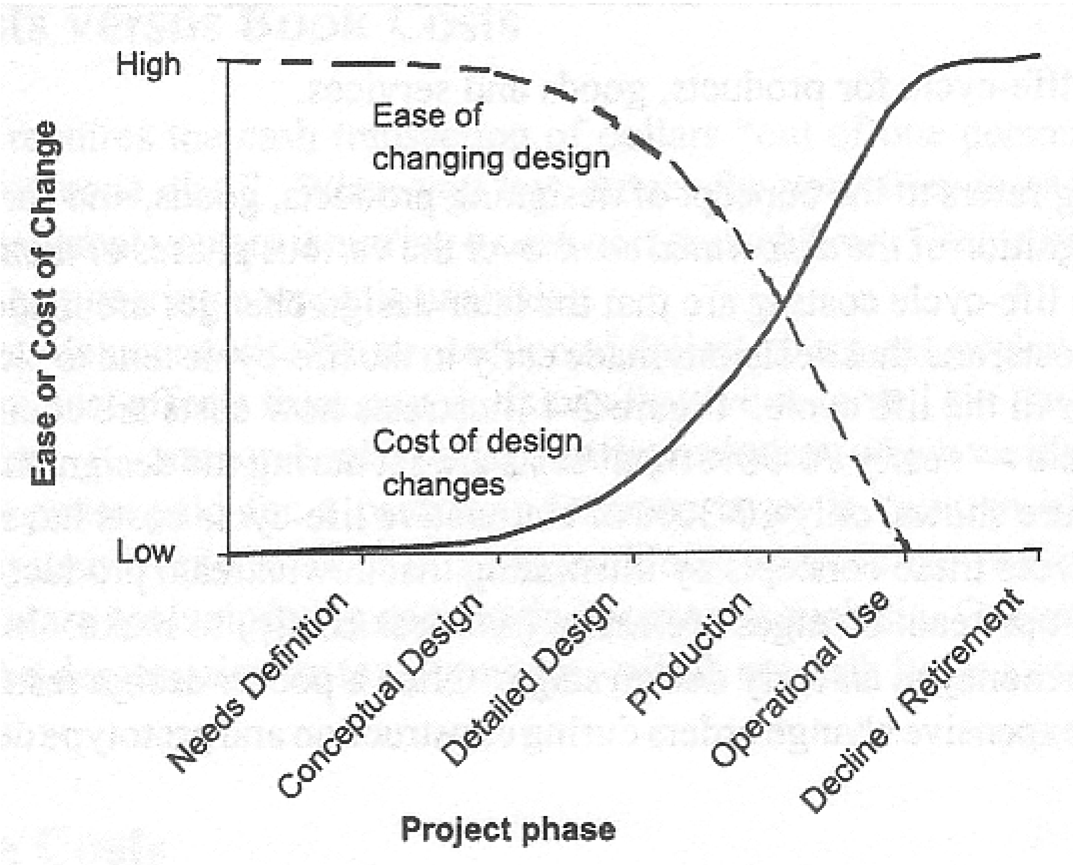
NEEDS ASSESSMENT AND JUSTIFICATION PHASE	CONCEPTUAL OR PRELIMINARY DESIGN PHASE	DETAILED DESIGN PHASE	PRODUCTION OR CONSTRUCTION PHASE	OPERATIONAL USE PHASE	DECLINE AND RETIREMENT PHASE
REQUIREMENTS	IMPACT ANALYSIS	ALLOCATION OF RESOURCES	PRODUCT, GOODS & SERVICES BUILT	OPERATIONAL USE	DECLINING USE
OVERALL FEASIBILITY	PROOF OF CONCEPT	DETAILED SPECIFICATIONS	ALL SUPPORTING FACILITIES BUILT	USE BY ULTIMATE CUSTOMER	PHASE OUT
CONCEPTUAL DESIGN PLANNING	PROTOTYPE/ BREADBOARD	COMPONENT AND SUPPLIER SELECTION	OPERATIONAL USE PLANNING	MAINTENANCE AND SUPPORT	RETIREMENT
	DEVELOPMENT AND TESTING	PRODUCTION OR CONSTRUCTION PHASE		PROCESSES, MATERIALS AND METHODS USE	RESPONSIBLE DISPOSAL
	DETAILED DESIGN PLANNING			DECLINE AND RETIREMENT PLANNING	

Figure 2-3: Typical life-cycle for products, goods and services.

Cumulative Life-cycle Costs Committed and Dollars Spent



Life-cycle Design Change Costs and Ease of Change



Cost Estimating

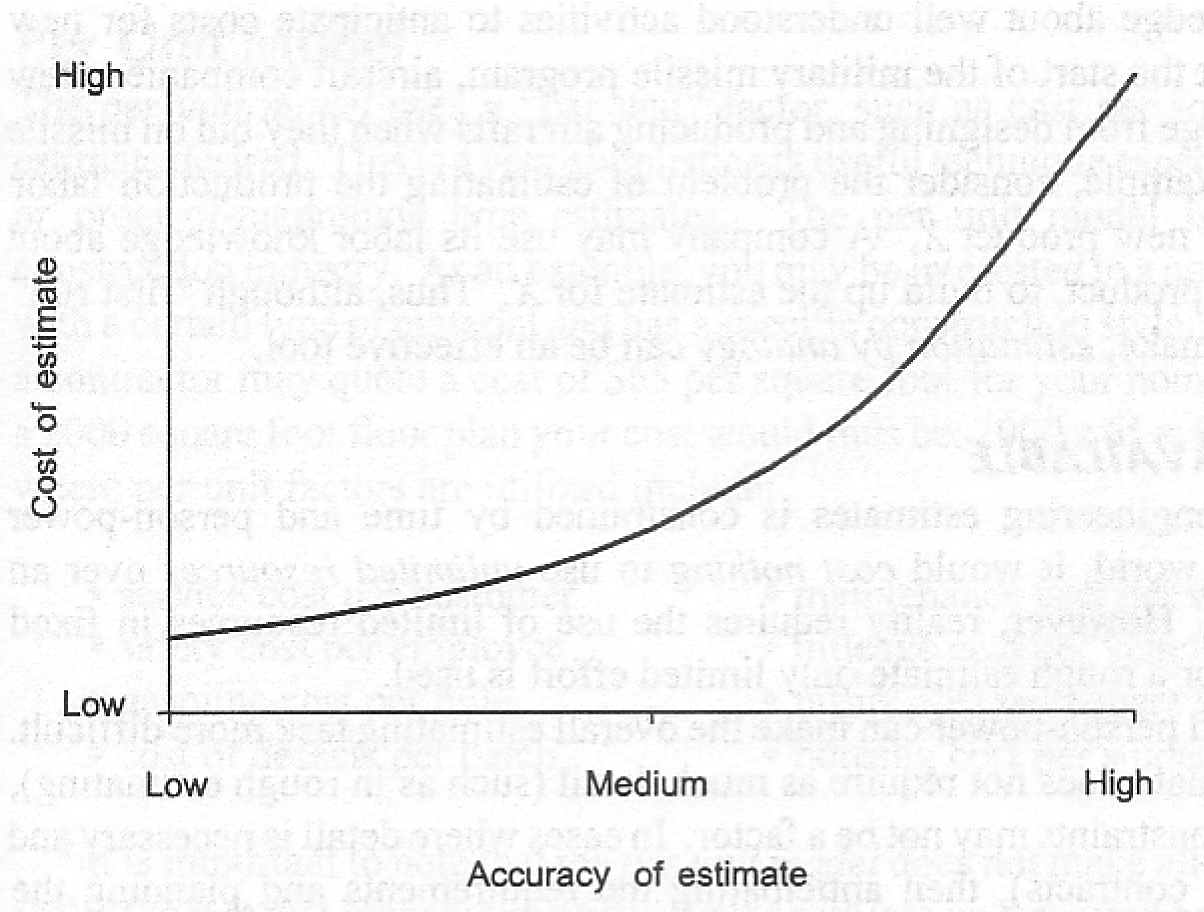
Needs for Cost Estimating

- Importance of Cost Estimating
- Types of Cost Estimating
  - Rough Estimates -30% to +60%
  - Semi-detailed Estimates -15% to +20%
  - Detailed Estimates -3% to +5%

Cost Estimating

- Economic analysis is future based
- Costs and benefits in the future require estimating.
- Estimated costs are not known with certainty.
- The more accurate the estimate, the more reliable the decision.
- Estimating is the foundation of economic analysis.

Accuracy vs. Cost Tradeoff in Estimating



Difficulties in Estimation

- One-of-a-Kind Estimates
- Time and Effort Available
- Estimator Expertise

Categories of Cost Estimating

- Capital Investment (construction, Installation, Training)
- Labor Costs (Direct and Indirect)
- Material Costs (Direct & Indirect)
- Maintenance Costs (Regular & Overhaul)
- Property Taxes and Insurance
- Operating Costs (Rental, Gas, Electricity)
- Quality Costs (Scrap, Rework, Inspection)
- Overhead Costs (Administration, Sales)
- Disposal Costs
- Revenues
- Market Values

Cost Estimating Models

- Per-Unit Model (Unit Technique)
- Segmenting Model
- Cost Indexes
- Power-Sizing Model
- Triangulation
- Improvement and the Learning Curve

Estimating Models

Model	Explanation	Examples
Per Unit	Uses a “per unit” factor. $/sq ft, Benefits/employee	Microsoft Excel Worksheet
Segmenting	Divide problem into items, estimate each & sum.	Microsoft Excel Worksheet
Cost Indexes	Index number based on historical changes in cost.	
Power Sizing	Scaling previous known costs up or down (economies of scale).	
Triangulation	Looking at costs from several perspectives.	
Learning Curve	Tracking cost improvements.	

Cost Estimating Models -- Per-Unit Model (Unit Technique)

- Per-Unit Model (Unit Technique)
  - Construction cost per square foot (building)
  - Capital cost of power plant per kW of capacity
  - Revenue / Maintenance Cost per mile (hwy)
  - Utility cost per square foot of floor space
  - Fuel cost per kWh generated
  - Revenue per customer served

Example > Cost Estimating using Per-Unit Model

Cost estimation of camping on an island for 24 students over 10 days.

Planned Activities:

- 2 days of canoeing
- 3-day hikes
- 3 days at the beach
- Nightly entertainment

Cost Data:

- Van (capacity 15) rental: $50 one way
- Camp is 50 miles away, van gets 10 miles/gallon, and gas is $1/gallon
- Each cabin holds 4 campers, rent is $10/day-cabin
- Meals are $10/day-camper
- Boat transportation is $2/camper (one way)
- Insurance/grounds fees/overhead is $1/day-camper
- Canoe (capacity 3) rentals are $5/day-canoe
- Day hikes are $2.50/camper-day
- Beach rental is $25/group-(half-day)
- Nightly entertainment is free

Solution:

- Assumption: 100% participation in all activities
- Transportation Costs:
  - Van: $50/van-trip * 2 vans * 2 trips = $200
  - Gas: $1/gallon * (50 miles / 10 miles/gallon) *2 *2 = 20
  - Boat: $2/camper-trip * 24 campers * 2 = 96
  - Subtotal $316
- Living Costs:
  - Meals: $10/day-camper * 24 campers * 10 days = $2400
  - Cabin rental: $10/day-cabin * (24/4) cabins *10 days = 600
  - Insurance: $1/day-camper * 24 campers * 10 days = 240
  - Subtotal $3240

Solution (Continued):

- Entertainment Costs:
  - Canoe rental: $5/day-canoe * 2 days * (24/3) canoes = $80
  - Beach rental: $25/group-(half-day) * (3*2) half-days = 150
  - Day hike: $2.50/camper-day* 24 campers * 3 days = 180
  - Nightly entertainment 0
  - Subtotal $410
- Total Costs: $3966

Cost Estimating Models – Segmenting Model

- Estimate is decomposed into individual components
- Estimates are made at component level
- Individual estimates are aggregated back together

Example 2-5 Cost Estimating using Segmenting Model

Cost estimate of lawn mower

A. Chassis

Cost Item	Estimate
A.1 Deck	$7.40
A.2 Wheels	10.20
A.3 Axles	4.85
Subtotal	$22.45

B. Drive Train

Cost Item	Estimate
B.1 Engine	$38.50
B.2 Starter assembly	5.90
B.3 Transmission	5.45
B.4 Drive disc assembly	10.00
B.5 Clutch linkage	5.15
B.6 Belt assemblies	7.70
Subtotal	$72.70

Example 2-5 Cost Estimating using Segmenting Model

Cost estimate of lawn mower

C. Controls

Cost Item	Estimate
C.1 Handle assembly	$3.85
C.2 Engine linkage	8.55
C.3 Blade linkage	4.70
C.4 Speed control linkage	21.50
C.5 Drive control assembly	6.70
C.6 Cutting height adjuster	7.40
Subtotal	$52.70

D. Cutting/Collection system

Cost Item	Estimate
D.1 Blade assembly	$10.80
D.2 Side chute	7.05
D.3 Grass bag & adapter	7.75
Subtotal	$25.60

Total material cost = $22.45 + $72.70 + $52.70 + $25.60 = $173.45

Cost Estimating Models – Cost Indexes

- Cost indexes reflect historical change in cost
- Cost index could be individual cost items (labor, material, utilities), or group of costs (consumer prices, producer prices)
- Indexes can be used to update historical costs

$$\frac{Cost_A}{Cost_B} = \frac{Index_A}{Index_B}$$

Example > Cost Estimating using Cost Indexes

$$\text{Labor Cost}_{\text{Now}} = \text{Labor Cost}_{\text{10yrs}}\left(\frac{\text{Index}_{\text{now}}}{\text{Index}_{\text{10yrs}}}\right)$$

$$= \$575{,}500\left(\frac{188}{124}\right) = \$871{,}800$$

$$\text{Material Cost}_{\text{Now}} = \text{Material Cost}_{\text{3yrs}}\left(\frac{\text{Index}_{\text{now}}}{\text{Index}_{\text{3yrs}}}\right)$$

$$= \$2{,}455{,}000\left(\frac{715}{544}\right) = \$3{,}227{,}000$$

Cost Estimating Models
Power-Sizing Model

$$\text{Cost}_A = \text{Cost}_B \left(\frac{\text{Size}_A}{\text{Size}_B} \right)^X$$

X = Power-sizing exponent

Equipment/Facility	X
Blower, centrifugal	0.59
Compressor	0.32
Crystallizer, vacuum	0.37
Dryer, drum	0.40
Fan, centrifugal	1.17

Equipment/Facility	X
Filter, vacuum	0.48
Lagoon, aerated	1.13
Motor	0.69
Reactor	0.56
Tank, horizontal	0.57

A. Considering Power-Sizing Index Change

$$\text{Cost}_{2500\,\text{ft}^2} = \text{Cost}_{1000\,\text{ft}^2}\left(\frac{2500\text{ft}^2}{1000\text{ft}^2}\right)^{0.55}$$

$$= \$50{,}000\left(\frac{2500}{1000}\right)^{0.55} = \$82{,}800$$

B. Considering Cost Index Change

$$\text{Cost}_{\text{Now}} = \text{Cost}_{5\,\text{yrs}}\left(\frac{\text{Index}_{\text{now}}}{\text{Index}_{5\,\text{yrs}}}\right)$$

$$= \$82{,}800\left(\frac{1487}{1306}\right) = \$94{,}300$$

Cost Estimating Models – Triangulation

- Techniques Used in Surveying: To map points of interest by using three fixed points and horizontal angular distance
- Application in Economic Analysis: To approach economic estimate from different perspectives, such as different source of data, or different quantitative models.

Cost Estimating Models – Improvement and Learning Curve

- Learning Phenomenon: As the number of repetitions increase, performance of people becomes faster and more accurate.
- Learning curve captures the relationship between task performance and task repetition.
- In general, as output doubles the unit production time will be reduced to some fixed percentage, the **learning curve percentage** or **learning curve rate**

Cost Estimating Models – Improvement and Learning Curve

Learning Curve

Let T_1 = Time to perform the 1st unit

T_N = Time to perform the Nth unit

b = Constant based on learning curve %

N = Number of completed units

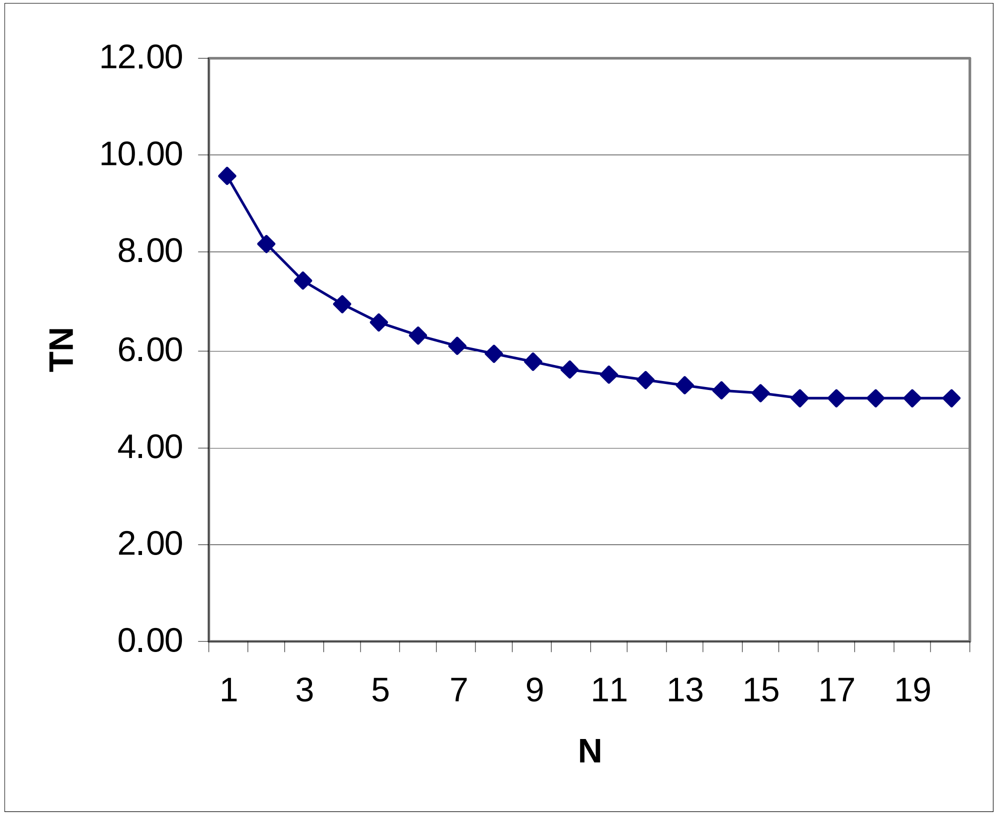
$$T_N = T_1 \cdot N^b \qquad \text{(Eq. 2-4)}$$

$$b = \frac{\log\%}{\log 2} = \frac{\ln\%}{\ln 2} \qquad \text{(Eq. 2-5)}$$

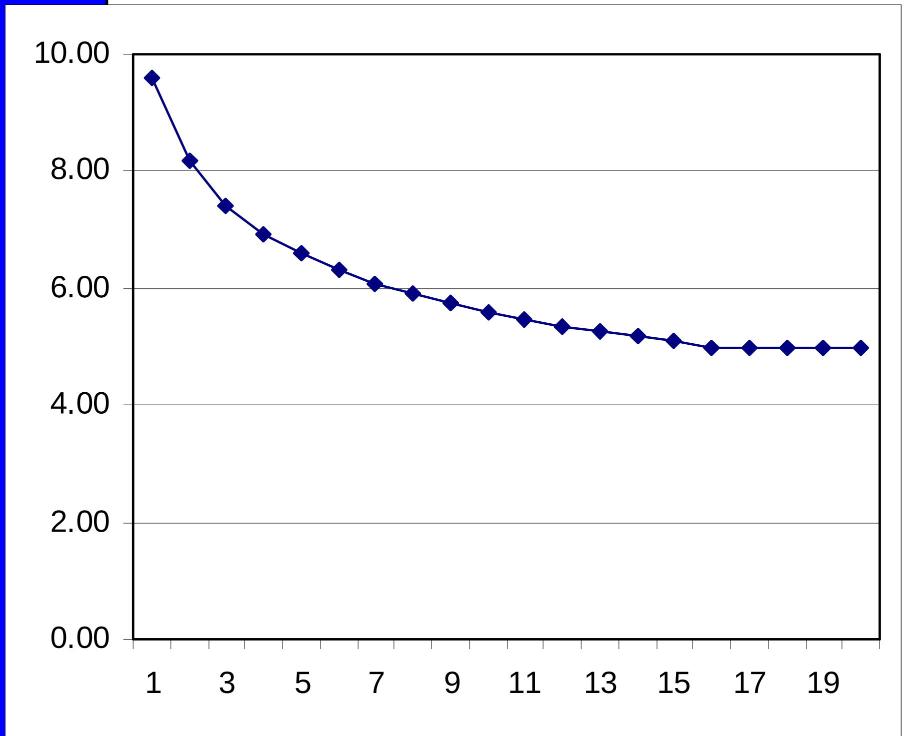
$$T_N = T_1 \cdot N^b = (9.6) \cdot N^{-0.2345}$$

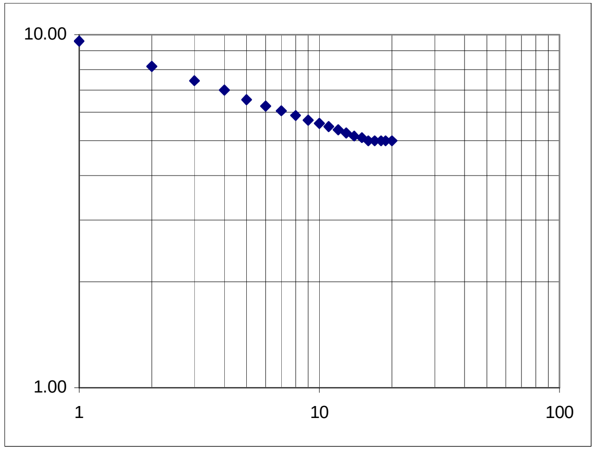
N	T_N
1	9.60
2	8.16
3	7.42
4	6.94
5	6.58
6	6.31
7	6.08
8	5.90
9	5.73
10	5.59

N	T_N
11	5.47
12	5.36
13	5.26
14	5.17
15	5.09
16	5.00
17	5.00
18	5.00
19	5.00
20	5.00



$$T_N = T_1 \cdot N^b = (9.6) \cdot N^{-0.2345}$$





Normal Scale

Log-Log Scale

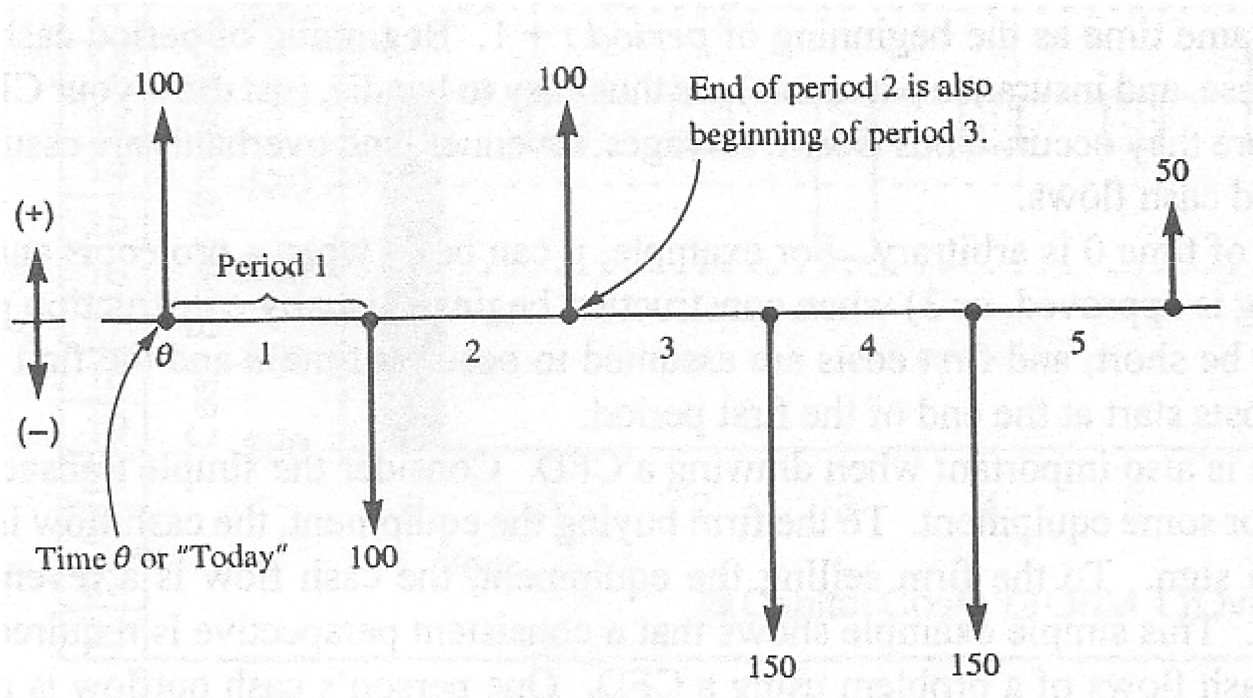
Estimating Benefits

- So far we have focused on cost terms and cost estimating.
- However, Infrastructure economists must often also estimate benefits.
- Example benefits include sales of products, revenues from bridge tolls and electric power sales, cost reductions from reduced material or labor costs, reduced time spent in traffic jams, and reduced risk of flooding.
- These benefits are the reasons that many engineering projects are undertaken.
- The cost concepts and cost estimating models can also be applied to economic benefits.

Cash Flow Diagrams

- The costs and benefits of Infrastructure projects occur over time and are summarized on a Cash Flow Diagram (CFD).
- Specifically, a CFD illustrates the size, sign, and timing of individual cash flows. In this way the CFD is the basis for engineering economic analysis.
- A Cash Flow Diagram is created by first drawing a segmented time-based horizontal line, divided into appropriate time units.
- The time units on the CFD can be years, months, quarters or any other consistent time unit.
- Then at each time when there is a cash flow, a vertical arrow is added - pointing down for costs and up for revenues or benefits.
- These cash flows are drawn to relative scale.

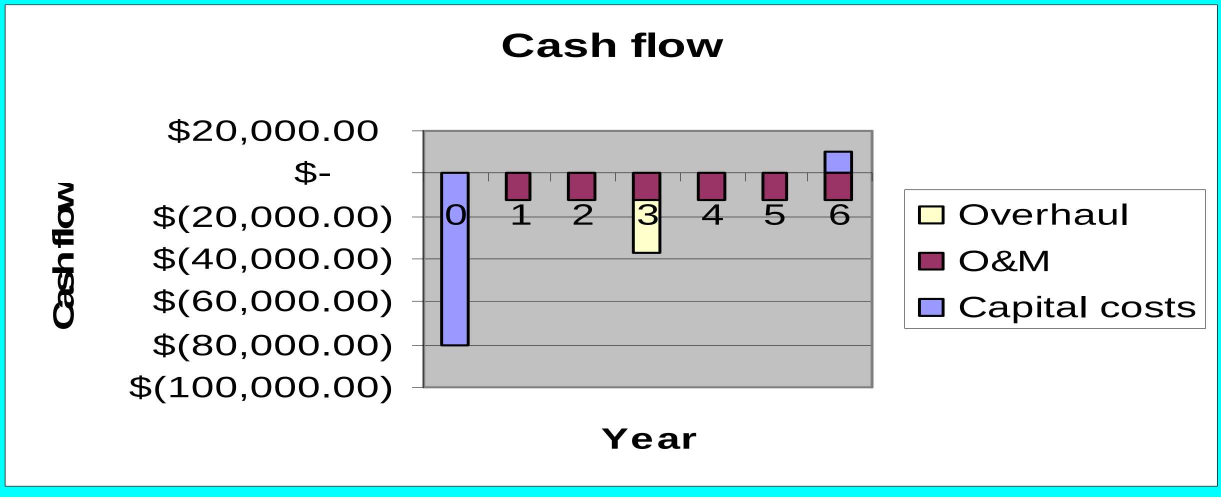
Cash Flow Diagrams



Cash Flow Diagrams

- Summarizes the flow of money over time
- Can be represented using a spreadsheet

Year	Capital costs	O&M	Overhaul	Total
0	$ (80,000.00)			$ (80,000.00)
1		$ (12,000.00)		$ (12,000.00)
2		$ (12,000.00)		$ (12,000.00)
3		$ (12,000.00)	$ (25,000.00)	$ (37,000.00)
4		$ (12,000.00)		$ (12,000.00)
5		$ (12,000.00)		$ (12,000.00)
6	$ 10,000.00	$ (12,000.00)		$ (2,000.00)



Summary

- This chapter introduced the cost concepts: fixed and variable, marginal and average, sunk, opportunity, recurring and nonrecurring, incremental, cash and book, and life-cycle.
- Fixed costs are constant and unchanging as volumes change, while variable costs change as output changes.
- Fixed and variable costs are used to find the breakeven value between costs and revenues, as well as the regions of net profit and loss.
- A marginal cost is for one more unit, while the average cost is the total cost divided by the number of units.

3. Project Initiation

Mohamed. J.A.M,

Project initiation Phase

- Outline of the talk
  - What is Project initiation?
  - Sources of project idea (project identification)
  - SWOT analysis
  - Project selection & selection methods

Project Initiation

- Initiation: beginning a project or continuing to the next phase
- Projects originate from Beneficiaries, Owners, The Government, NGOs e.t.c
- Sources:
  - strategic plan of an organization (Long-term business objectives)
  - SWOT analysis
- Reasons for project identification
  - Utilizing opportunities
  - Solving existing Problem

Project identification process

- First develop an organization strategic plan
- Then perform a business area analysis (pre-feasibility)
- Identify and define potential projects
- Then select a specific projects *(There are usually more projects than available resources)*

SWOT ANALYSIS

- **SWOT** analysis is a tool for auditing an organization and its environment.

- *SWOT* stands for **strengths, weaknesses, opportunities, and threats.**

- Strengths and weaknesses are **internal** factors. Opportunities and threats are **external** factors.

A **strength** could be:

- your marketing expertise.
- a new, innovative product or service
- quality processes and procedures

A **weakness** could be:

- lack of marketing expertise
- poor quality goods or services
- damaged reputation

An **opportunity** could be:

- a developing market such as the Internet.
- a new international market
- a market vacated by an ineffective competitor

A **threat** could be:

- a new competitor in your home market
- price wars with competitors
- a competitor has a new, innovative product or service
- competitors have superior access to channels of distribution

Project Selection (Evaluation) factors

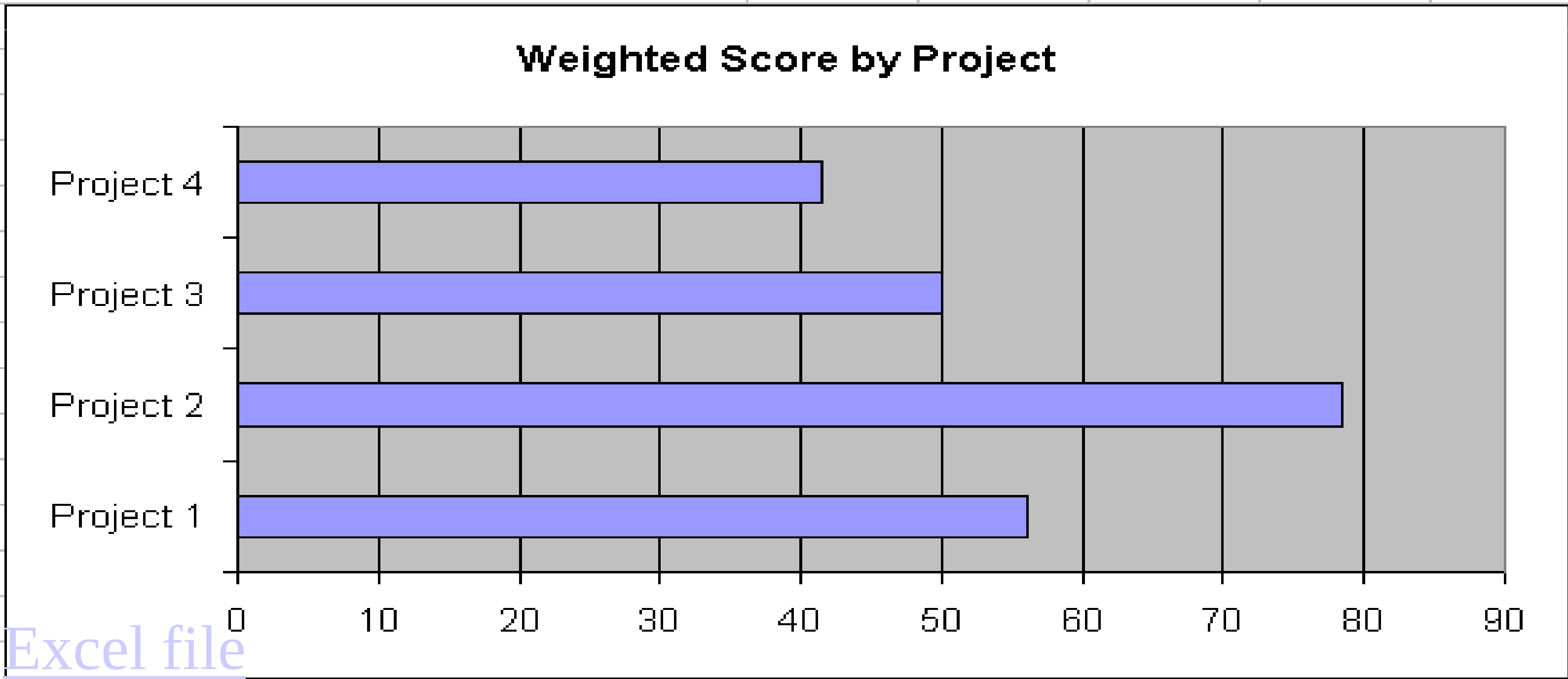
- Technical factors
- Marketing factors
- Financial factors
- Economic factors
- Environmental factors
- Others

Weighted Scoring Model

- A weighted scoring model is a tool that provides a systematic process for selecting projects based on many criteria
  - First identify criteria important to the project selection process
  - Then assign weights (percentages) to each criterion so they add up to 100%
  - Then assign scores to each criterion for each project
  - Multiply the scores by the weights and get the total weighted scores
- The higher the weighted score, the better

Figure 4-5. Sample Weighted Scoring Model for Project Selection

	A	B	C	D	E	F
1	**Criteria**	**Weight**	**Project 1**	**Project 2**	**Project 3**	**Project 4**
2	Supports key business objectives	25%	90	90	50	20
3	Has strong internal sponsor	15%	70	90	50	20
4	Has strong customer support	15%	50	90	50	20
5	Realistic level of technology	10%	25	90	50	70
6	Can be implemented in one year or less	5%	20	20	50	90
7	Provides positive NPV	20%	50	70	50	50
8	Has low risk in meeting scope, time, and cost goals	10%	20	50	50	90
9	**Weighted Project Scores**	**100%**	**56**	**78.5**	**50**	**41.5**



Excel file

Methods for Selecting Projects

- There are usually more projects than available time and resources to implement them
- Three important criteria for projects:
  - There is a *need* for the project
  - There are *funds* available
  - There's a strong *will* to make the project succeed

Tools and techniques for project selection

- Criteria for tool selection:
  - Realism
  - Capability
  - Flexibility
  - Easy to use
  - Cost

Project Selection

I. Criteria for Project Selection Models

- A. Realism
  - 1. The model should reflect the reality of the manager's decision situation, including the multiple objectives of both the firm and its managers.
  - 2. Need a common measurement system to evaluate projects.
  - 3. Must take into account the firms limitations on facilities, capital, personnel, etc.
  - 4. Should include risk factor.

Project Selection

- B. Capability
  - 1. Must deal with multiple time frames
  - 2. Must simulate various situations.
    - a) Internal situations (e.g., strikes)
    - b) External situations (e.g., interest rate changes)
  - 3. Must optimize the decision.

Project Selection

- C. Flexibility
  - – 1. Must provide valid results within range of conditions the firm might experience.
  - – 2. Should be easily modified or self-adjusting to changes in the firm's environment.

Project Selection

- D. Ease of Use
  - 1. Reasonably convenient, low execution time, easy to use and understand
  - 2. Should need no special interpretation, no hard-to-acquire data, no excessive personnel or unavailable equipment.
  - 3. Model's variables should rate one to one with real world variables that the manager finds significant to the project.
  - 4. Expected outcomes should be easily simulated

Project Selection

- E. Cost
  - 1. Data gathering and modeling costs should be low relative to the project cost.
  - 2. All costs should be considered, and their total should definitely not be greater than the potential benefits of the project.

Project Selection

- F. Easy Computerization
  - 1. Convenient to gather and store information in a computerized data base.
  - 2. Easy to manipulate the data in the model such as through a spreadsheet.

Thank You

Questions!!!!!

University of Dar es Salaam

IE 354 Engineering Project Management

Project Viability Assessment (Project Appraisal)

3.1.2. What is a PROJECT VIABILITY ASSESSMENT ?

Briefly explain how do you understand project viability assessment

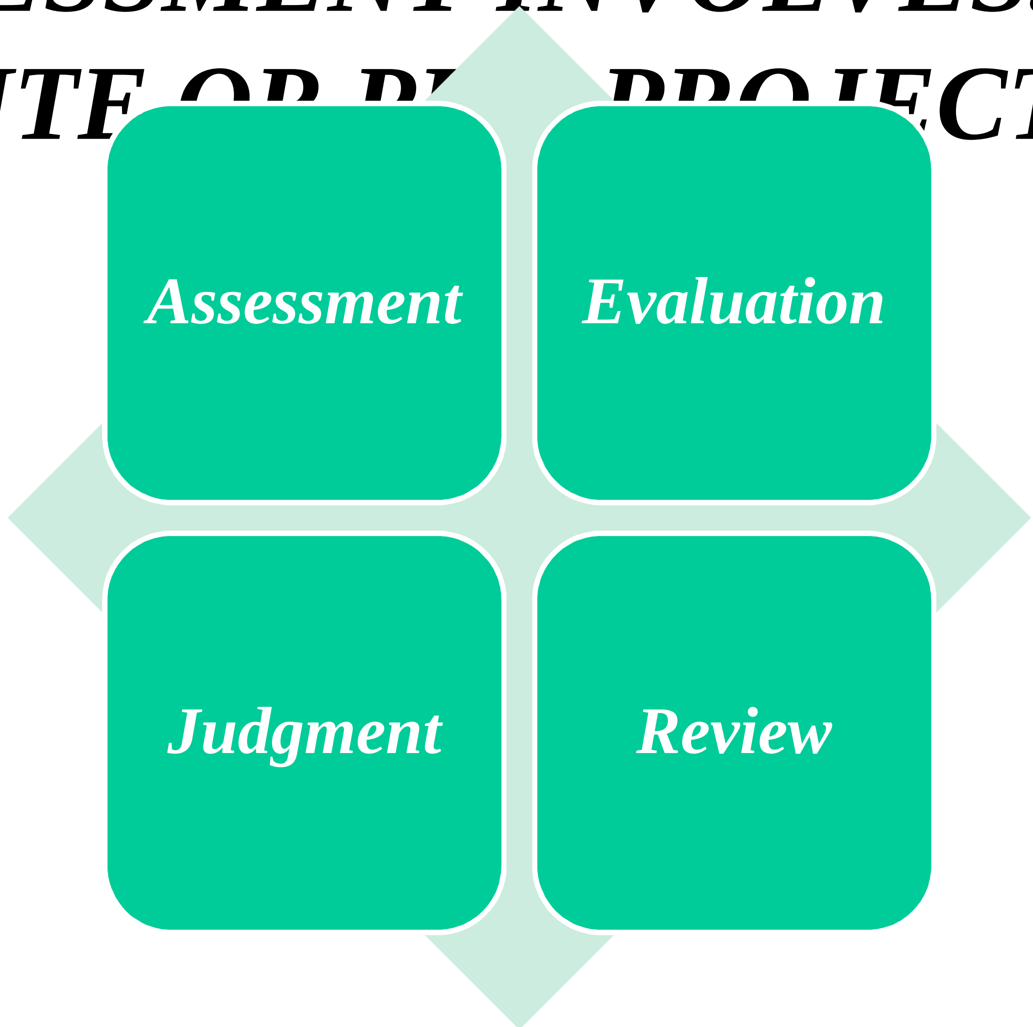
A search for project VIABILITY ASSESSMENT definition

- *"…Is a critical evaluation of project documents with the aim of establishing their effectiveness and efficiency through use of evaluation criteria…"*

- *"…Is a systematic analysis of all costs and benefits of various ways in which a project can be undertaken. The aim is to determine worthness of project…"*

- *"...the process of assessing and questioning proposals before resources are committed..."*

"…SO PROJECT VIABLITY ASSESSMENT INVOLVES. EX-ANTE OR PR PROJECT…"

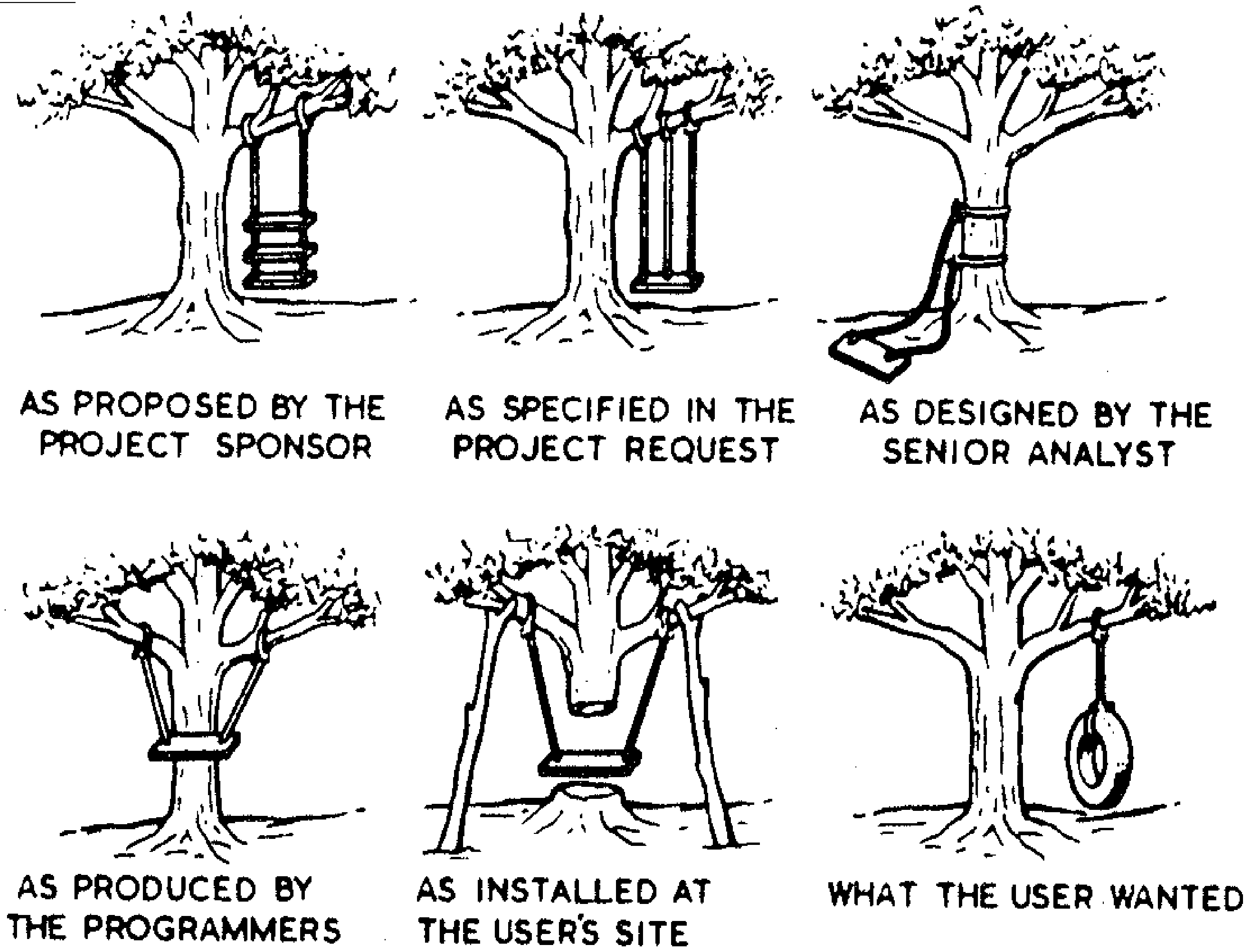


3.1.3.WHY PROJECT VIABILITY ASSESSMENT?

- To predetermine the availability of resources and technology required to carryout the project
- To establish the likely effects of the proposed project on the environment (social, economic, technological and ecological process) and to be able to develop mitigation measures
- To anticipate risks and preparing plans to reduce their effects

WHY PROJECT VIABILITY ASSESSMENT? Cont…

- To consider, evaluate and exhaust all available alternatives at early stages of decision-making
- To be able to involve public, government and private views in planning of the project
- Above all, determine benefits and costs associated with the project


AS PROPOSED BY THE PROJECT SPONSOR
AS SPECIFIED IN THE PROJECT REQUEST
AS DESIGNED BY THE SENIOR ANALYST
AS PRODUCED BY THE PROGRAMMERS
AS INSTALLED AT THE USER'S SITE
WHAT THE USER WANTED

3.1.4.TPYES OF PROJECT VIABILITY ASSESSMENT

- Project viability assessment includes:
    - Socio-environmental viability
    - Financial viability
    - Economic viability
    - Technical /Operational viability
    - Schedule viability
    - Legal and contractual viability
    - **Political viability!!!!!!!!!!**
    - Project sustainability
    - Risk considerations

types of viability assessment cont..

- Financial Viability assessment
  - Analysis seeks to ascertain whether proposed investment/project will financially in the sense of being able to meet the burden of servicing debt and whether the proposed project will satisfy the return expectations of those who provide capital.
- Economic Viability assessment
  - A process of identifying ; benefits and cost associated with project. It involves consideration of both negative and positive externalities

types of viability assessment cont..

- Environmental assessment

Focuses on assessing the likely damage to be caused by the proposed project, the environmental benefits of the project should outweigh the environmental damages (costs).

- **Technical Viability assessment**
  - A process of assessing the development organisation's ability to construct and operate a proposed system.
- **Operational Viability assessment**

The process of assessing the degree to which a proposed system solves business problem or take advantages of business opportunities.

Operational Viability assessment cont..

A measure of how well a specific solution will work in the organization. It is also a measure of how people feel about the system/project.

- Does management support the system?
- How do the end-users feel about their role in the new system?
- What end-users or managers may resist or not use the system? Can this problem be overcome? If so, how?
- Usability analysis
  - Ease of use, Ease of learning, User satisfaction

TYPES OF VIABILITY ASSESSMENT CONT..

- **Schedule Viability assessment**
  - The process of assessing the degree to which the potential time frame and completion dates for all major activities within a project meet organisational deadlines and constraints for affecting change
- **Legal & contractual assessment**
  - It is the process of assessing potential legal and contractual ramifications due the construction of a system
- **Political feasibility**
  - The process of evaluating how key stakeholders within the organization view the proposed project.

Some Internal Factors V External Factors considered

- Infrastructure
- Project scope
- Labor relations
- Project location
- Project leadership
- Organizational goal
- Management approach
- Technical manpower supply
- Resource and capital

- Public needs
- Market needs
- National goals
- Industry stability
- State of technology
- Industrial competitors
- Government regulations

3.1.5.PROJECT VIABILITY ASSESSMENT PROCESS

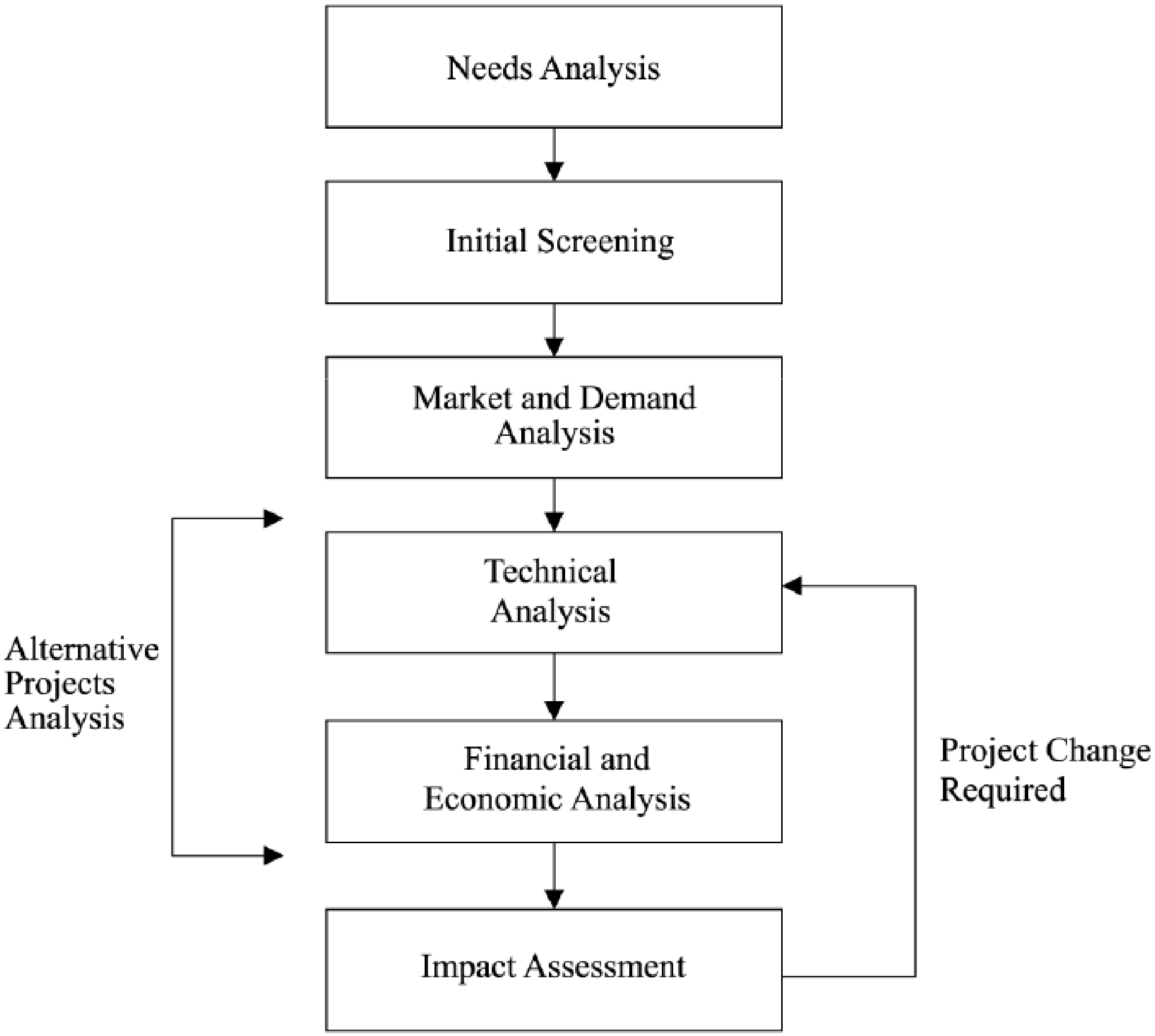
1. Identification of Problems
2. Establishing objectives /scope of the project
3. Identify major project options
4. Identify attributes/ criteria for evaluation
5. Collect relevant information
6. Conducting Project viability assessment
7. Select best option and project approval

- **Project options include:**
  - Do nothing, Optimal size of the investment, Alternative design, Lease/ build/own

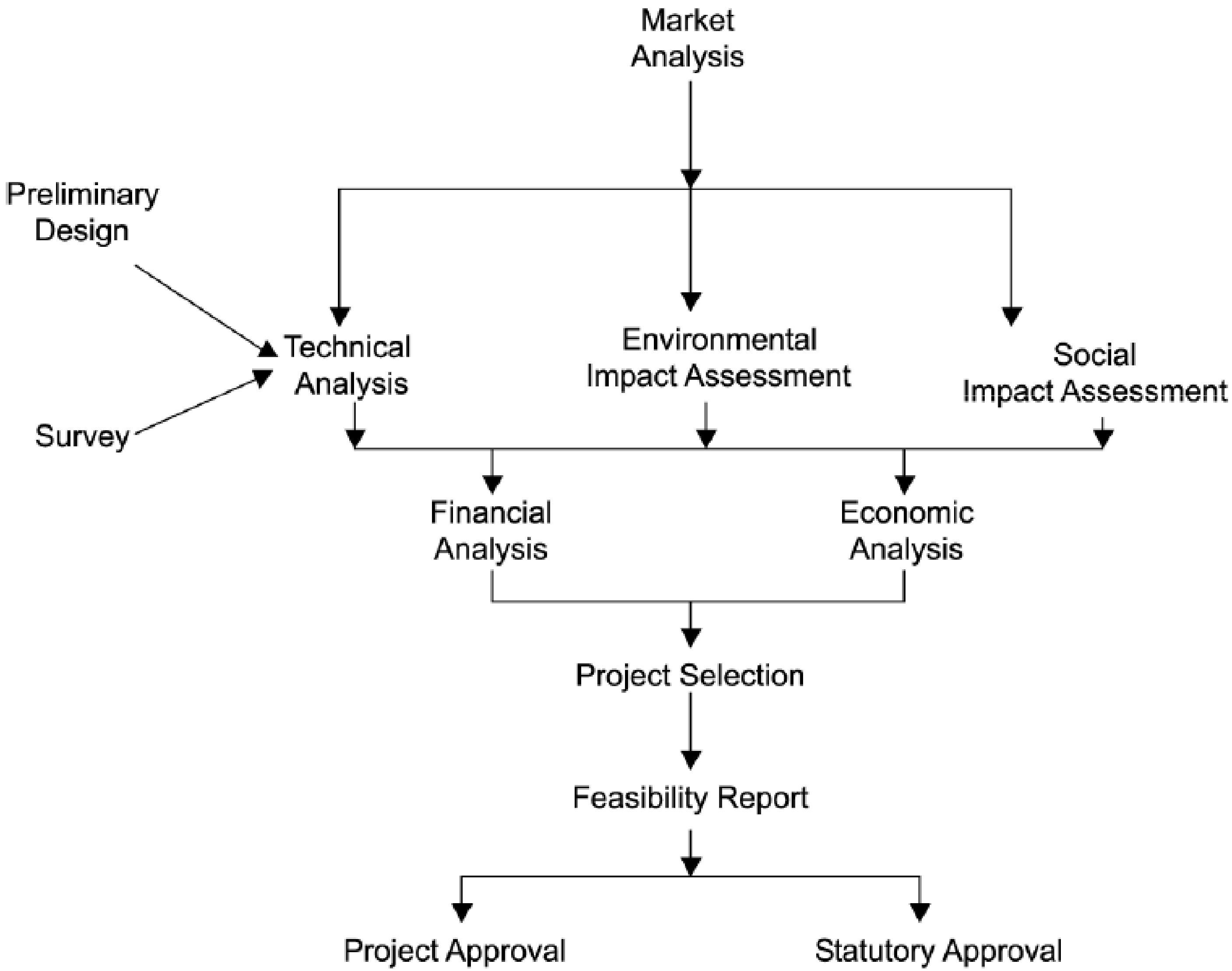
- **Conducting project viability assessment will among others include;**
  - Environmental, Financial, Economic, Sustainability analysis including Public hearings and approvals
  - Identification of measures, appropriate discount rates/ Standards Assessments/computations

Project viability assessment Models

a. Conventional Project Viability Assessment Model



b. Integrated Project Viability Assessment Model



3.1.6. Key Project viability assessment Deliverables

1.Project (Business) Case

2.Project Pre-Feasibility

3.Project Feasibility Report

4.Formal Project Proposal

5. Preliminary Scope Statement

6. **Project Charter**

Project Charter

Project Charter may contain the following:

- Project Background
- Purpose for undertaking the project
- Project Justification
- Requirements
- Stakeholder expectations from the project
- Assumptions and Constraints
- Project Organization
- Stakeholder Roles and Responsibilities
- Schedule and milestones
- Indication of budget
- Supporting infrastructure

LIMITATIONS OF PROJECT VIABILITY ASSESSMENT

- Inadequate quality information especially for new projects

- Project’s viability assessment outcomes, scope, requirements and specifications, cost, time and risks, stakeholders, resource needs etc. are often not known with a high degree of precision

Module 3.2 . Environmental Impact Assessment

Outline of the Talk

3.2.1.Introduction: Recall: What is Environment?

:What is environmental impact?

3.2.2 What is environmental Impact Assessment?

3.2.3 Historical Background of EIA

3.2.4 The Process of Environmental Impact Assessment

3.2.5. Tools and Methods

3.2.6 EIA and Project Life Cycle

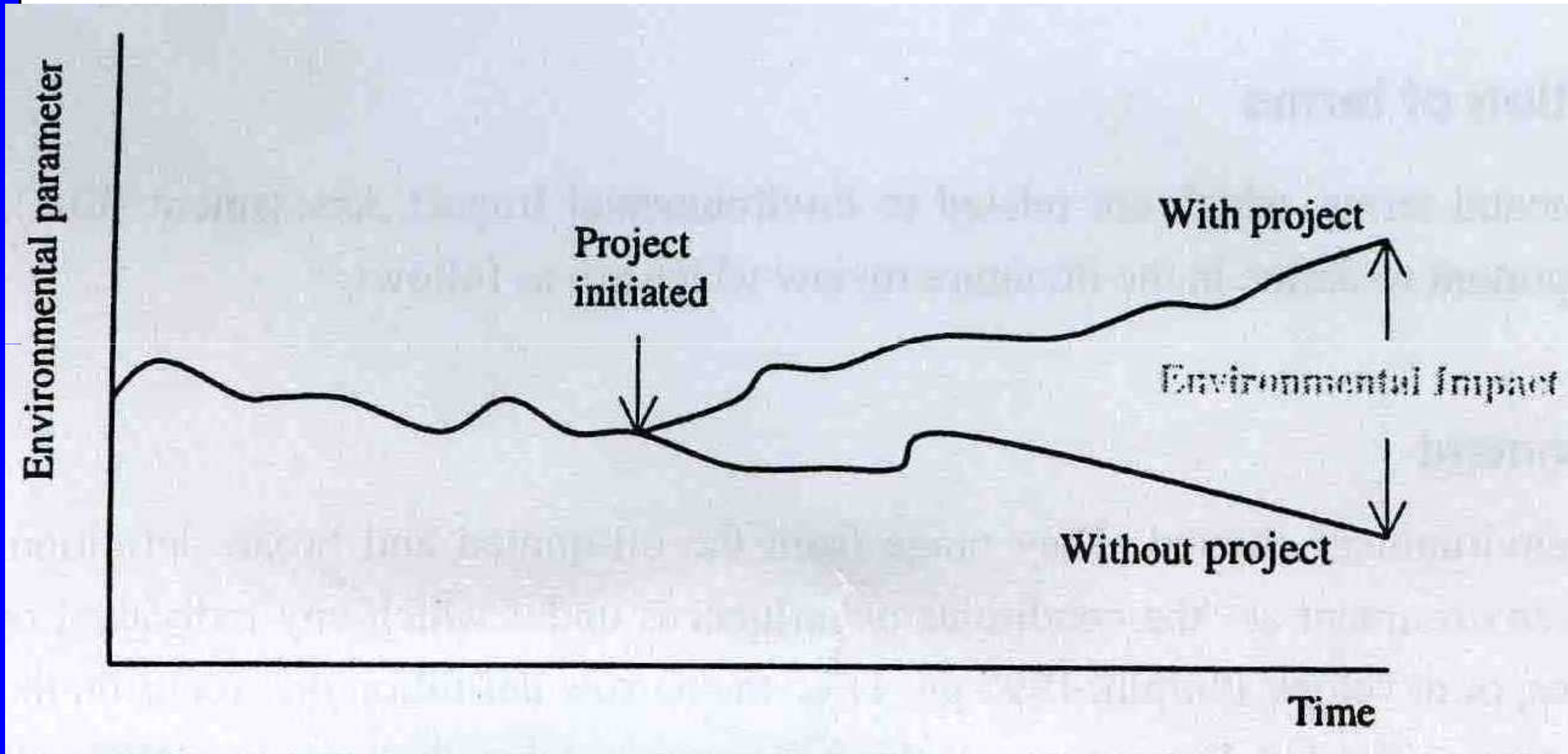
3.2.7 Environmental impact statement

3.2.8 Limitations and benefits of EIA

3.2.1What is Impact and Environmental Impact?

- An impact is the effect of one thing upon another
- change in an environmental parameter, over a specified period and within defined area, resulting from a particular activity compared with the situation which would have occurred if the activity had not been initiated
- negative or positive, direct or indirect, short term or long term, spatial or non-spatial

Nature of environmental impact



3.2.2 What is Environmental Impact Assessment?

- -the process having ultimate objective of providing decision makers with an indication of the likely consequences of their actions (Davies *et al.,* in Wathern, 1998).

- the official appraisal of the likely effects of a proposed program or project on the environment, alternatives to the proposal and measures to be adopted to protect the environment(Gilpin, 2000)

- -The process of identifying the likely consequences for the biogeochemical environment and for man's health and welfare of implementing particular activities and for conveying this information, at a stage when it can materially affect their decision, to those responsible for functioning the proposals. (Munn 1979 in Wathern, 1998).

Therefore Environmentally Impact Assessment is

A formal process for identifying:

- **likely effects of activities or projects on the environment, and on human health and welfare.**
- **means and measures to monitor & mitigate these impacts**

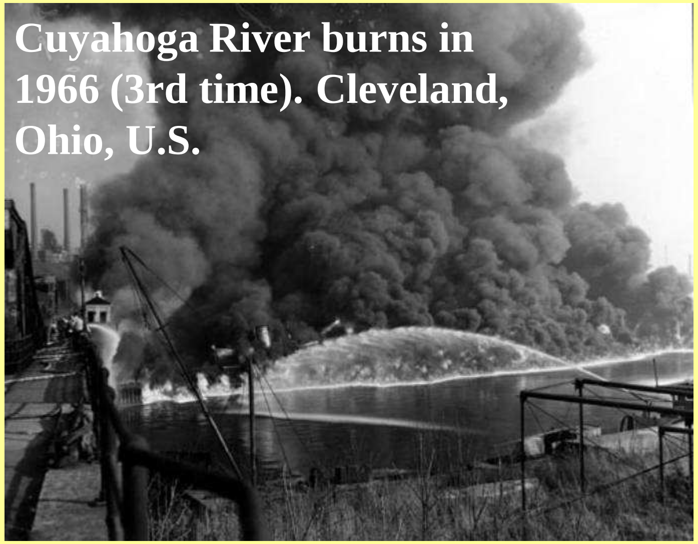
Objectives of EIA

- **Protection and management** of the environment for sustainable development;
- **Integration** of environmental management and economic decisions at an early planning stages;
- **To predict the consequences** of a proposed project in terms of environmental, social, economic and cultural and propose mitigation measures.
- **To compare available alternatives** for a particular project and determine the optimum mix of environmental and economic costs and benefits;

Elements of EIA

- **Screening**:- decide if EIA is required based on the data collected.
- **Scoping**:- identify key issues and concerns of interested parties.
- **Identifying and Evaluating Alternatives**:- list alternative sites, techniques and impacts of each.
- **Mitigating measures**:- review proposed actions to prevent/minimize the potential

3.2.3 Historical Background of EIA


Cuyahoga River burns in 1966 (3rd time). Cleveland, Ohio, U.S.

1952 "Killer fog" kills 4,000 in London

1963 *Silent Spring* documents the effects of DDT

Etc. . .

1960s & 70s: Environmental crisis affects all industrialized economies

EIA is one response:

First national EIA requirements: **1969 US National Environmental Policy Act (NEPA)** requires EIA for US

3.2.3 Historical Background of EIA CONT..

- 1972, the UN Stockholm conference on Human Environment- declaration of 26 principles on sustainable development and EIA

- The 1992, UN conference on environment and development in Rio de Janeiro. The declaration of 27 principles was endorsed whereby principle 17 is devoted to the National Instrument of EIA.

- "*Environmental Impact Assessment as a National instrument shall be undertaken for proposed activities that are likely to have a significant adverse impact on the*

3.2.4.The Process of EIA

1. **Project or Investment/Development description**
   - Describe the nature, scope and purpose of the project/investment;
   - Describe physical characteristics (size, number of employees, infrastructure required) of a project;
   - Describe operational properties (type and quantities of raw materials, energy used and other natural resources);
   - Describe nature of emissions (liquid, gaseous and solid waste).
2. **Alternative considered**
   - Describe all alternative sites and reasons for final location;
   - Focus on alternative plant design and explain reasons for final selection;
   - Describe on product and process design.

3. The Baseline Environmental Criteria

- Collect human population and their properties;
- Describe present human use of the site;
- Nature of fauna, flora and habitats;
- Explain quality and quantity of surface and groundwater;
- Air, soil quality and climatic factors;
- Explain landscape and topography of the site;
- Explain nature of the built environment;
- Any other relevant environmental features.

4. Assessment of Environmental Impact

- Assess effects on physical, social and economic;
- Assess all direct and indirect effects;
- Assess short, medium and long term effects of the proposed project;
- Assess temporary and permanent effects as well as negative and positive

5. Mitigating Measures

Could be in terms of:

- Site location and orientation;
- Type of process selected;
- Any equipment incorporated to control, contain and treat wastes;
- Any measures taken to protect surroundings.

6. Contingency Measures

- Risk assessment such as accident;
- Indicate preventive measures to be adopted in such accidents;
- Assessed in terms of technology and techniques used.

7. Assessment of Difficulties

- Offer difficulties associated in data collection and analysis, prediction of effects and assessment of risks in the whole exercise of EIA.

8. Environmental Impact Statement (EIS)

- Results of EIA are presented within EIS;
- EIS include findings of environment impact of a proposed project and/or alternatives and mitigating measures (and their assessment);
- EIS is required for discussion from both competent authorities and public.

9. Public Comments

- Invite public comments on the proposed project;
- Incorporate public opinions into the proposed project design;
- Modify the proposed project design in case of disagreements relating to development. A compromise between developers and public is vital.

10. Planning Authority

- Planning authorities have mandate to accept or reject any development based on EIA conducted;
- Bodies with such mandate in Tanzania are Local Authorities and NEMC.

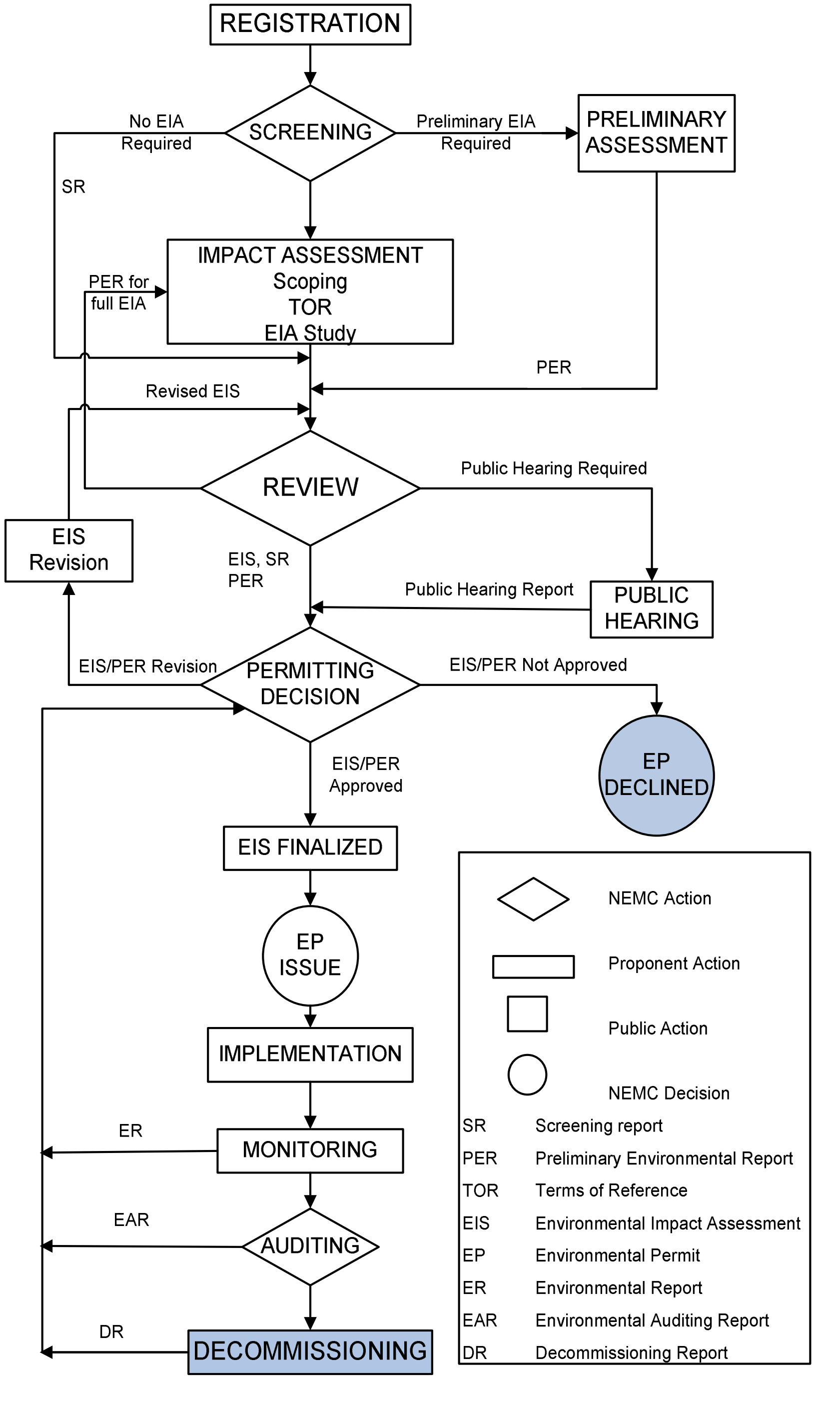


Figure 4.1 EIA Procedure in Tanzania, (NEMC)

3.2.5 EIA Tools and Methods

- Checklists,
- Matrices,
- Networks,
- Overlays (GIS-Geographical Information Systems)
- Expert systems
- Professional judgment

The choice of methodology can depend upon a number of factors including; the type and size of the project; the type and number of alternatives being considered; the nature of the likely impacts; the availability of impact identification methods; the experience of the EIA team with their use; and the resources available – cost, information, time, personnel

Checklist

- Checklists annotate the environmental features or factors that need to be addressed when identifying the impacts of projects and activities.
- Simple checklist
- Structured methodology or system
  - assign significance by scaling and weighting the impacts, such
- Sectoral checklists- certain type of projects.

Matrices

- A matrix is a grid – like table that is used to identity the interaction between project activities, which are displayed along one axis, and environmental characteristic, which are displayed along the other axis.

- impact severity = {ticks or symbols can identify impact type (such as direct indirect, cumulative) pictorially; numbers or a range of dot sizes can indicate scale; and descriptive comments }

A Sample of Impact Matrix

ACTIVITY/IMPACT	DIRECTION		DURATION		LOCATION		MAGNITUDE		EXTENT		SIGNIFICANCE	
	Pos	Neg	Long	Short	Direct	Indirect	Major	Minor	Wide	Local	Large	Small
1. Wastewater Treatment												
Odour		x		x		X		x		x		x
Solid waste		x		x		X		x		x		x
Air pollution		x	X			X	x			x		x
2. Effluent												
Water quality	x		X			X	x		x		x	
Overloading of the drainage canal		x		x	x			x	x		x	
Overloading of the Msimbazi River		x	X			X	x		x		x	

Networks

- For illustrating impacts relationships and consequences .={ the causal-effect relationships of project activities and environmental characteristic}
- Useful in identifying and depicting secondary impacts =impact hypotheses
- When used in conjunction with other methods, simplified networks help to ensure that important second-order impacts are not omitted from the investigation.
- *More detailed networks are visually complicated, time-consuming and difficult to produce unless a computer programme is used for the task.*

Overlays-GIS

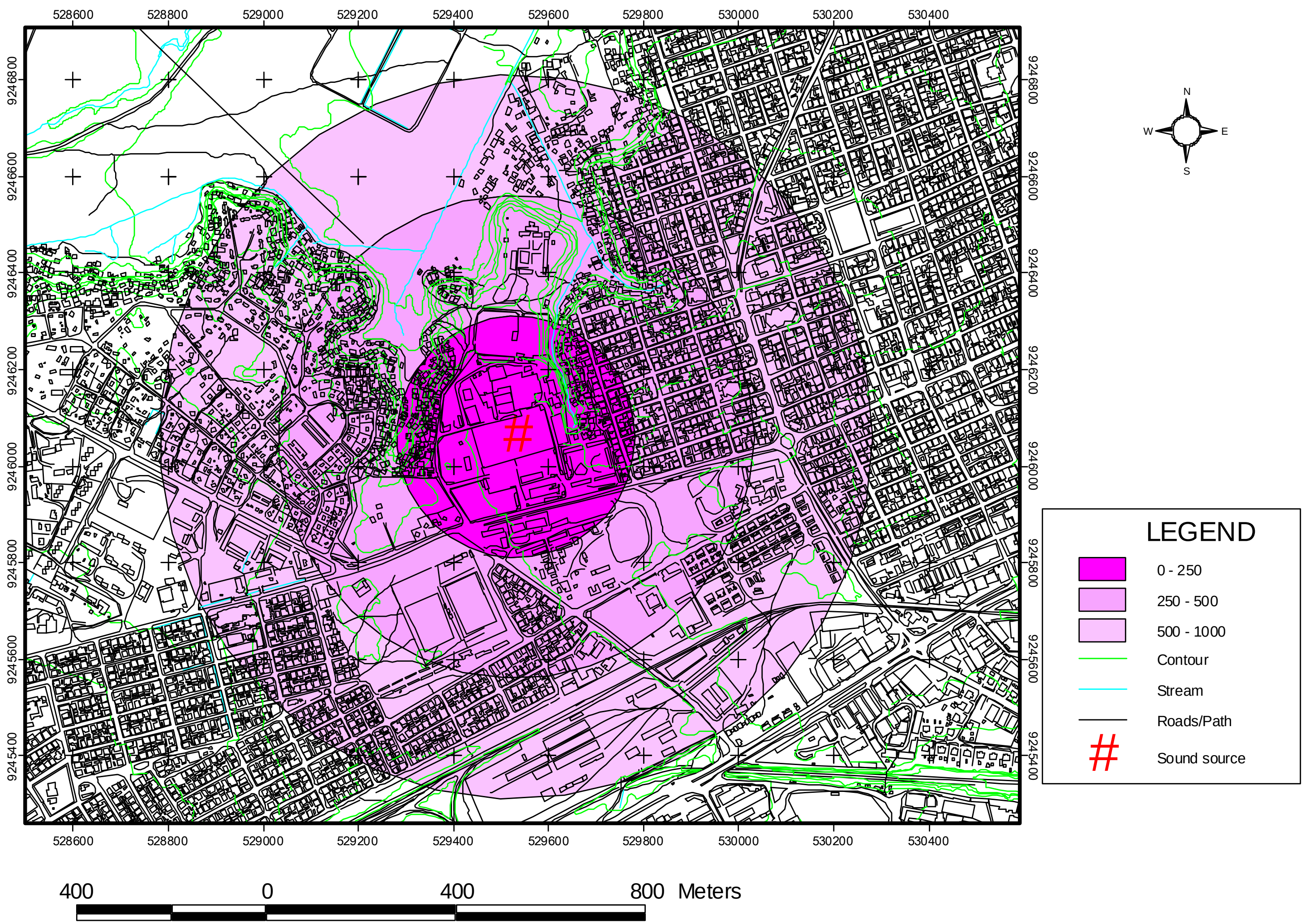
- Map impacts spatially and display then pictorially= environmental sustainability analysis

- Topographic features, ecological value and resource constraints = individual transparencies and then aggregated into a composite representation of potential impacts.

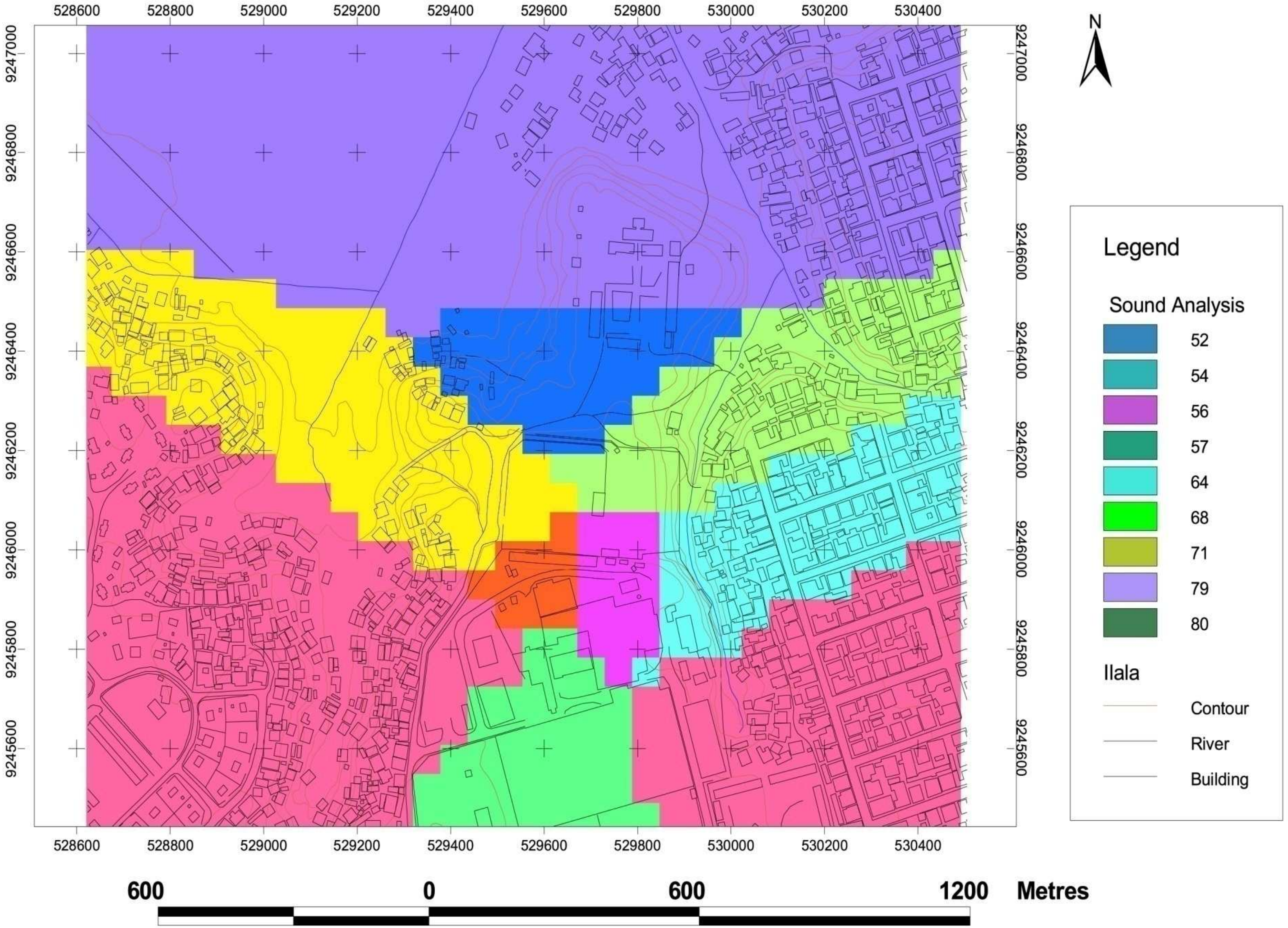
- significant for comparing site and planning alternatives, for routing linear developments to abstain environmentally sensitive areas and for landscape and habitant zoning

- GIS=The computer – based - a modern version of the overlay method. = stores, retrieves, analyzing, modeling and and displays environmental data in a spatial format.

Core impact area (CIA) & Area of Influnce (AF)



Noise Surface Map



Expert systems

- computerized knowledge-based systems, used to assist diagnosis, problem solving and decision-making
- screening and scoping procedures = automated using a number of rules and a data system that encodes expert knowledge and judgment
- The user has to answer a series of questions that have been systematically developed to identify impacts and determining their mitigability and significance
- expert systems are information – intensive, high investment method of analysis.

Professional judgment

- Professional judgment or expert opinion is widely used in EIA, although not strictly a formal method
- Knowledge and expertise gained in EIA work can be used to systematically develop data banks, technical manuals and expert systems, =assisting in future projects.
- the successful application of the formal methods of impact identification explained above rests upon profession experience and judgment.

Advantages and Disadvantages of EIA Methods

METHODOLOGY	ADVANTAGES	DISADVANTAGES
Checklists	-Easy to understand and use -Good for site selection and priority setting -Simple ranking and weighting	-Don't distinguish between direct and indirect impacts -Don't link action and impact The process of incorporation values can be controversial
Matrices	-Link action to impact -Good method for displaying EIA results	-Difficult to distinguish direct and indirect impacts -Have potential for double counting of impacts
Networks	-Link action to impact -Useful in simplified form for checking for second order impacts -Handles direct and indirect impacts	-Can be become very complex if used beyond simplified version
Overlays- GIS	-Easy to understand -Focus and display spatial impacts -Good siting	-Can be cumbersome Poorly suited to address impact duration or probability
Computer Expert system	-Excellent for impact identification and spatial analysis -Good for experimenting	-Heavy reliance on knowledge -Often complex and expensive

Resource requirements

- *Qualified multi-disciplinary staff*

skilled manager ,

trained specialists(-environmental science, development planning, economics, waste and pollution control, process engineering, landscape design, social workers, environmental information

- *Information about the environment*

Biophysical *Economic and social data*

- *Technical Guidelines*

agreed with the competent authority; for carrying out the various phases

- *Other Resources*

laboratory , library research, data manipulation and processing, administrative resources the

3.2.6 EIA AND THE PROJECT LIFE CYCLE

EIA occurs across the project lifecycle proactively

1.Implementing mitigation measures

2. Build capacity for environmentally sound operation

Feasibility → **Design** → **Construct** → **Operate** *(may include handover)* → *Reinvestment*

Environmental screening, initial assessment and scooping and detailed EIA

1. Implement & maintain proper operation

2.Environmental Monitoring and post audit

3.2.7 Environmental Impact Statement (EIS)

- = A document prepared by a proponent, consultant, or developer describing a proposed policy, program or project, alternatives to the proposal and measures to be adopted to protect the environment

- EIS is required before a new project can proceed.

- EIS for national environmental agency or authority, the donor's environmental team, environmental consultants, the implementing agency, the borrower and the general public

- EIS= maps, plans, tables, graphs diagrams = easy appreciation of contents

EIS CONTENTS-

- Executive Summary,
- Introduction,
- Compliance with policy, legal and administrative framework,
- Project description and description of the environment.
- public participation,
- Analysis of environmental impacts
- Environmental management and Monitoring plan
- Conclusion and recommendations
- References , appendices of relevant materials.

3.2.8. limitations and Benefits of Environmental impact assessment

Costs of EIA

- Scientific expertise → may not be available internally thus external expertise which is expensive
- EIA can be lengthy
- Increased costs of a project

Benefits

- Maximum environmental and financial benefits if EIA was carried out voluntarily
- Operational benefits e.g. improved environmental performance, basis for development of physical needs
- Short payback periods of the project

Questions and discussions !!!!!

Thank You

Technical Assessment of projects

Outline of the Talk

3.3.1 Introduction: Recall; Technical Assessment :Issues Considered

3.3.2 Issues under Technical Assessment

3.3.3. Objectives of TA of projects

3.3.4. Technical Assessment Criteria

3.3.5. Some Methods for TA

3.3.6 Multi-Criteria Analysis (MCA) Technique

3.3.7. Hierarchy of Criteria in Project Evaluation

3.3.1.1. Recall: Project technical viability assessment

- Assesses the development organisation’s ability to construct and operate a proposed system.

- It seeks to determine;
  - whether the prerequisites for successful commissioning of the project are available
  - the suitability of the technology selected and the adequacy of the technical investigation, and design
- It involves processes, methods, activities and tools :.

3.3.1.2. Issues under technical assessment

- Technical assessment (TA) is commonly perceived to be that of physical tools ('hardware') used for achieving any resource transformation. Very often the related know-how for either producing or using the physical tools is not realized

- TA should comprises four component;
  - Techno ware
  - Human ware
  - Info ware
  - Organ ware

WHAT IS TECHNOLGY?

- Technology - The application of knowledge to create the capability to do something entirely new or in an entirely new way.

- This can be contrasted to scientific research, which encompasses the discovery of new knowledge from which new technology id derived, and engineering which uses technology derived from this knowledge to solve specific technical problem

WHAT IS TECHNOLGY?

- A. The application of science especially to industrial or commercial objectives
- B. The entire body of methods and materials used to achieve such objectives
- C. therefore Technology Assessment is subset of technical assessment and provides substantial contribution to overall technical assessment

- **Technical hardware i.e. a specific configuration of** machinery and equipment designed to produce a good or provide a service ('techno ware');
- **Know-how i.e. scientific and technical knowledge, formal** and experience-based knowledge ('human ware');
- **Information, which may be referred to as the document embodied** form of technology ('info ware'); and
- **Organization, i.e. the production arrangements and linkages** ('organ ware').

3.3.3. OBJECTIVES OF technical Assessment of Projects

- Ensure that the project is technically feasible such that all required inputs are available
- Facilitate the most optimal formulation of project in terms of Technology, size, location and so on
- Determine appropriate technology: methods or project operations which are suitable to local, economic, social, cultural and ecological conditions.

So TECHNICAL ASSESSMENT should based on;

- *Whether the technology utilizes local raw materials?*
- *Whether the technology utilizes local man power?*
- *Whether the services and goods to be produced will cater to the basic needs?*
- *Whether the technology protects the ecological balance?*
- *Whether the technology is harmonious with social and cultural conditions ?*

3.3.4.Technical evaluation Criteria

Technical Assessment is influenced by:

- Principal inputs
  - Proximity to Raw materials
  - Man power availability
- Proximity to markets
- Capacity (plant) or size of the project
- Investment outlays and operations cost
- The use by other units

Technical evaluation Criteria cont…

- Latest development
- Easy of adoption)
- Facility location and site selection
- Public utilities (Infrastructure development)
- Government polices
- Environmental aspects and Safety
- Procurement (e.g. of plants and Machinery)
- Schedule of project implementation(CPM, PERT, Bar charts)
- Reliability

3.3.5 Some Methods for Technical assessment of Projects

- **Delphi Technique**
  - For Scanning and empirical inquiry
  - Consensus tend to stifle minority opinions;
  - Consumes Time and Resources
- **Checklist**
  - Scanning and synthetic inquiry
  - No guidelines, no cause-effect linkages
- **Benefit – cost Analysis**
  - Scanning, tracing, synthetic inquiry
  - Less participatory
  - Little consideration of Social impacts

Methods for Technical assessment of Projects cont…..

- **Matrix**
  - Scanning and synthetic inquiry
  - Bandwagon effects, biases and lengthy procedures
- **Analytical Hierarchy Process**
  - Scanning, Tracing and synthetic inquiry
  - biases and lengthy procedures
  - Consumes Time and Resources
- **Relevancy/Problem Tree**
  - tracing, priori inquiry
  - Need high knowledge of subject biases and lengthy procedures
  - Consumes Time and Resources, biases and lengthy procedures

3.3.6 Multi-Criteria Analysis (MCA) technique

- Under technical assessment many of the decision attributes involves criteria that difficulty to define or measure in monetary terms/physical units

- MCA allows such factors to be presented in a comprehensive consistence format

- MCA involves aggregating and disaggregating (decomposition)

MCA steps

- Define objectives and scope of the project
- Identify Project alternatives
- Set criteria for evaluation(refer section)
- Develop relative weights for each criterion (normalize weight)
- Develop performance rating scale e.g. 0-1, 1-3. 1-5, 1-7, 1-10, or percentage(1-100%)
- Perform evaluation: Rating of each of project options against set evaluation criteria
- Conduction computation
  - Multiply (Normalization) scores against weights for each score)
  - Determine total (weighted) score
- Select best option

Feasibility Criteria	Wt.	Candidate 1	Candidate 2	Candidate 3	Candidate ..
Operational Feasibility **Functionality**. A description of to what degree the candidate would benefit the organization and how well the system would work. **Political**. A description of how well received this solution would be from both user management, user, and organization perspective.	**30%**	Only supports Member Services requirements and current business processes would have to be modified to take advantage of software functionality **Score: 60**	Fully supports user required functionality. **Score: 100**	Same as candidate 2. **Score: 100**	
Technical Feasibility **Technology**. An assessment of the maturity, availability (or ability to acquire), and desirability of the computer technology needed to support this candidate. **Expertise**. An assessment to the technical expertise needed to develop, operate, and maintain the candidate system.	**30%**	Current production release of Platinum Plus package is version 1.0 and has only been on the market for 6 weeks. Maturity of product is a risk and company charges an additional monthly fee for technical support. Required to hire or train C++ expertise to perform modifications for integration requirements. **Score: 50**	Although current technical staff has only Powerbuilder experience, the senior analysts who saw the MS Visual Basic demonstration and presentation, has agreed the transition will be simple and finding experienced VB programmers will be easier than finding Powerbuilder programmers and at a much cheaper cost. MS Visual Basic 5.0 is a mature technology based on version number. **Score: 95**	Although current technical staff is comfortable with Powerbuilder, management is concerned with recent acquisition of Powerbuilder by Sybase Inc. MS SQL Server is a current company standard and competes with SYBASE in the Client/Server DBMS market. Because of this we have no guarantee future versions of Powerbuilder will "play well" with our current version SQL Server. **Score: 60**	
Economic Feasibility **Cost to develop:** **Payback period (discounted):** **Net present value:**	**30%**	 Approximately $350,000. Approximately 4.5 years. Approximately $210,000. **Score: 60**	 Approximately $418,040. Approximately 3.5 years. Approximately $306,748. **Score: 85**	 Approximately $400,000. Approximately 3.3 years. Approximately $325,500. **Score: 90**	
Schedule Feasibility An assessment of how long the solution will take to design and implement.	**10%**	Less than 3 months. **Score: 95**	9-12 months **Score: 80**	9 months **Score: 85**	
Ranking	**100%**	**60.5**	**92**	**83.5**	

3.3.7.Hierarchy of Criteria in Project Evaluation

- Main criteria
- **C1. Economic impacts = 60%**
- **C2. Environmental impacts = 40%**

Sub-Criteria
C1.1 Construction cost =70%
C1.2 Efficiency of construction=30%
C2.1 Noise pollution, =30%
C2.2 Air pollution= 10%
C2.3 Landscape impact= 40%
C2.4 impact on local amenities= 20%

•It allows to measure actual performance of project alternative under consideration

Questions and discussions !!!!!

Thank You

Module 3.4 . Project economic and Financial Assessment

Outline of the Talk

3.4.1 Introduction: Financial-economic a assessment

3.4.2 Steps for performing financial-economic project viability assessment

3.4.3. Traditional Financial-economic viability Indicators and Techniques

3.4.4 Questions and Discussions

3.4.1. RECALL:

- *Financial Viability assessment*

  – *Analysis seeks to ascertain whether proposed investment/project will financially be viable in the sense of being able to meet the burden of servicing debt and whether the proposed project will satisfy the return expectations of those who provide capital.*

3.4.1. RECALL CONT..

- Financial Assessment is used to evaluate the viability of a proposed project by assessing the value of net cash flows that result from its implementation

- views investment decision from the perspective of the organization undertaking the investment= measures only direct effects on cash flow of the organization of an investment decision

3.4.1. RECALL CONT..

- ***But Economic Viability assessment***

A process of identifying ALL benefits and cost associated with project. It involves consideration of both negative and positive externalities

- ECONOMIC VIABILITY = FINANCIAL VIABLITY + STAKEHOLDERS BENEFITS AND COSTS
- ***Economic assessment considers the fact that a change is good if it makes some people better off, and makes no body worse off.***

- **Thus types of project viability assessment;**
  - **Financial appraisal $\Rightarrow$ private financial costs and benefits (Partial)**
  - **Cost effective analysis $\Rightarrow$ social costs (and benefits) to find "cheapest" way of meeting a pre-determined target**
  - **Cost benefit analysis $\Rightarrow$ full social costs and benefits to find the "best" projects for the society.**

Comparison of Financial and Economic Assessment

Aspect	Financial Assessment	Economic Assessment
Focus	Net returns to equity /capital(Individual/private)	Net returns to Society
Purpose	Indicates incentives to adopt or implement	Determine if project is fulfilled on economic efficiency basis
Prices	Market or administered	May require Shadow prices
Taxes	Cost of production	Part of society benefits

3.4.2. Steps FOR assessing financial/economic VIABILITY

- Define objectives of the project
- Define the scope of the project
- Identify Project options
- Identify and measure Cash flows for each project option
    - Inflows: Revenues, subsidies, Savings, Salvage
    - Outflows: Capital, Taxes, lease, salaries, revenues loss,
- Select appropriate discount rate
- Make the computations for each alternative
- Compare the results of computations and Select best option

- Define objectives of the project
- Define the scope of the project
- identifying possible project option
- Identify quantifiable and non-quantifiable benefits and costs
- Define time period which should cover all the future costs and benefits
- Select appropriate discount rate
- Assess the net benefits
- Perform sensitivity testing
- Compare the results of computations and Select best option

Project Costs

- Cost" refers to a resource sacrificed or foregone to achieve a specific objective, or something given up in exchange.

- Capital, Taxes, lease, salaries, revenues loss

- Project costs can be Tangible or Intangible

- Costs are **usually** measured in monetary units, such as, shillings, Kwacha, Yen, dollars

- **Recurring**
  - ✓ All costs related to system operations and maintenance (**<u>O&M</u>**): lease and maintenance of site, facility, equipment and software, travel, training, supplies, security, salary and benefits, support services
- **Non-Recurring**
  - ✓ All costs related to **<u>System Development</u>:** design, development, testing, conversion, studies, procurement, implementation, new facilities and equipment

Project Benefit Elements :

- benefit is the actual or perceived beneficial effects of a project may be greater or less than revenue needed to cover project costs.
- **Quantitative**
    - ✓ Increased Revenue – i.e., collections (expected to be sufficient for the project to breakeven)
    - ✓ Reduced Costs
    - ✓ Savings
    - ✓ Salvage
    - ✓ Subsides

Qualitative

- ✓ Customer/Client Satisfaction
- ✓ Improved Morale
- ✓ Avoiding Technology Obsolescence, Etc.
- ✓ Environmental consideration
- ✓ Benefits to he broader society
- ✓ Safety
- ✓ Public returns
- ✓ Resources availability

Illustration: Port Project

<u>Economic Benefits:</u>

- (Financial Benefit) Additional port revenue from expansion in traffic.
- (Financial Benefit) Additional rental income from containers yards.
- Plus:
- Reduction in waiting time of ships.
- Reduction in animal weight loss from waiting on ship.

<u>Economic Costs:</u>

- All investment and operating costs of port, even if subsidized.

3.4.3. Traditional Financial/economic VIABILITY Indicators and Techniques

- Financial
- Payback Period
- Rate of return on investment
- Break even point
- Net Present value
- Equivalent Annual Cost
- Internal Rate of Return
- Profitability Index

- Economic
- Payback Period
- Rate of return on investment
- Break even point
- Economic Net Present value
- Equivalent Annual Cost
- Economic Internal Rate of Return
- Benefit Cost Ratio
- Cost Effectiveness Analysis/ Minimum Cost

3.4.3.1 Payback Method

- **The length of time taken to repay the initial capital cost**

$$\text{Payback} = \frac{\text{Initial Investment}}{\text{Annual Net Inflow}}$$

- Very simple to use and understand
- Useful for short-term decisions
- Does not consider time value of Money and cash flow beyond payback (Undiscounted)

Payback Period

Time period required to recover the cost of the investment from the annual cash inflow produced by the investment.

<u>Amount invested</u>

Expected annual net cash inflow

Computation of Annual Cash Inflow

Expected annual net cash inflow =

Net income	$13,000
Depreciation expense	13,000
	$26,000

Cash Payback Period

$130,000 / **$26,000** = 5 years

Payback Period – Uneven Cash Flows

Casey Co. wants to install a machine that costs $16,000 and has an 8-year useful life with zero salvage value. Annual net cash flows are:

Year	Annual Net Cash Flows	Cumulative Net Cash Flows
0	$ (16,000)	$ (16,000)
1	3,000	
2	4,000	
3	4,000	
4	4,000	
5	5,000	
6	3,000	
7	2,000	
8	2,000	

Payback Period – Uneven Cash Flows

We recover the $16,000 purchase price between years 4 and 5, about 4.2 years for the payback period.

4.2

Year	Annual Net Cash Flows	Cumulative Net Cash Flows
0	$ (16,000)	$ (16,000)
1	3,000	(13,000)
2	4,000	(9,000)
3	4,000	(5,000)
4	4,000	(1,000)
5	5,000	
6	3,000	
7	2,000	
8	2,000	

Payback = 5 years

Using the Payback Period

Payback = 3 years

Consider [illegible] projects, each with a 5-year life and each costing [illegible],000.

Year	Project One Net Cash Inflows	Project Two Net Cash Inflows
1	$ 2,000	$ 1,000
2	2,000	1,000
3	2,000	1,000
4	2,000	1,000
5	2,000	1,000,000

Would you invest in Project One just because it has a shorter payback period?

Payback Method Worked example

Cost of machine = £600,000

- Annual income streams from investment = £255,000 per year
- = 28.23 months
- (2 yrs, 6¾ months)

	Income
Year 1	255,000
Year 2	255,000
Year 3	255,000

Accounting Rate of Return

$$\frac{\textbf{Average annual operating income from asset}}{\textbf{Average amount invested in asset}}$$

- Compare accounting rate of return to company's required minimum rate of return for investments of similar risk.
- The minimum return is based on the company's *cost of capital.*

Accounting Rate of Return

Average Investment =

$$\frac{\textbf{Original Investment + Residual Value}}{\textbf{2}}$$

For Casey, average investment =

(\$130,000 + \$0)/ 2 = \$65,000

Solution to Accounting Rate of Return Problem

Average annual operating income from asset

Average amount invested in asset

$13,000 / $65,000 = 20%

Accounting Rate of Return

The decision rule is:

A project is acceptable if its rate of return is greater than management's minimum rate of return.

The higher the rate of return for a given risk, the more attractive the investment.

3.4.3.2.Rate of Return ON INVESTEMT

- A comparison of the profit generated by the investment with the cost of the investment

$$RROI = \frac{\text{Average annual return or annual profit}}{\text{Initial cost of investment}}$$

- Shows profitability
- Allows comparison between projects
- Does not consider time value of Money (Undiscounted)

3.4.3.3 A break-even point

A break-even point occurs at a point where total revenue equals total costs

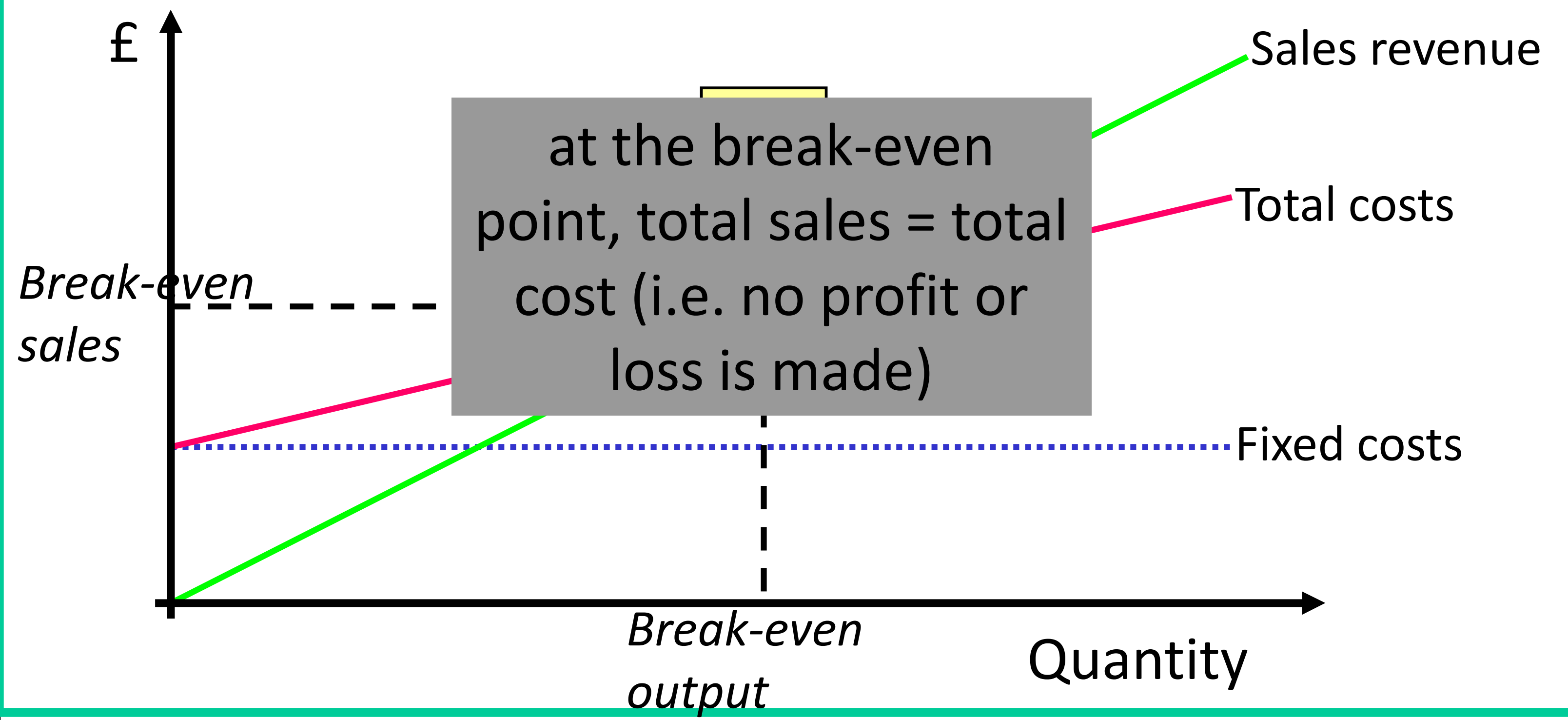
break-even analysis provides a simple means of measuring profits and losses at different levels of output

- analysis is normally done graphically using a break-even chart

Uses of break-even analysis

- to calculate the minimum amount of sales required in order to be able to break even
- to see how changes in output, selling price or costs will affect profit levels
- to calculate the level of output required to reach a certain level of profit
- to allow various scenarios (what-if) to be tested out
- to aid forecasting and planning

Drawing a break-even chart



what is profit?

- Excess of Revenue over expenses
- Antonym – Loss
- Analysed using Profit Equation

Profit Equation

Profit =(P-VC)*Q - FC

Assumptions:

1. Total cost is divided into fixed ...able costs
2. Change in level of revenue arises only because of changes in the number of units produced and sold
3. The unit selling price, unit variable cost and total fixed cost are known and constant
4. All cost can be compared and added without taking into consideration the time value of money

Contribution Margin

- Excess of Sales revenue over variable expenses

Sales Revenue – Variable Cost = Contribution Margin

Governing Equation

$$\frac{CM}{Q} = P - VC$$

- Contribution margin as a percentage of total sales

Governing Equation

CMR =CM/Sales

bep QUANTITY OR dollars?

Sales at Break Even Point

- Is the level of sales at which profit is zero

$$S_{BEP} = \frac{FC}{\frac{P - VC}{P}}$$

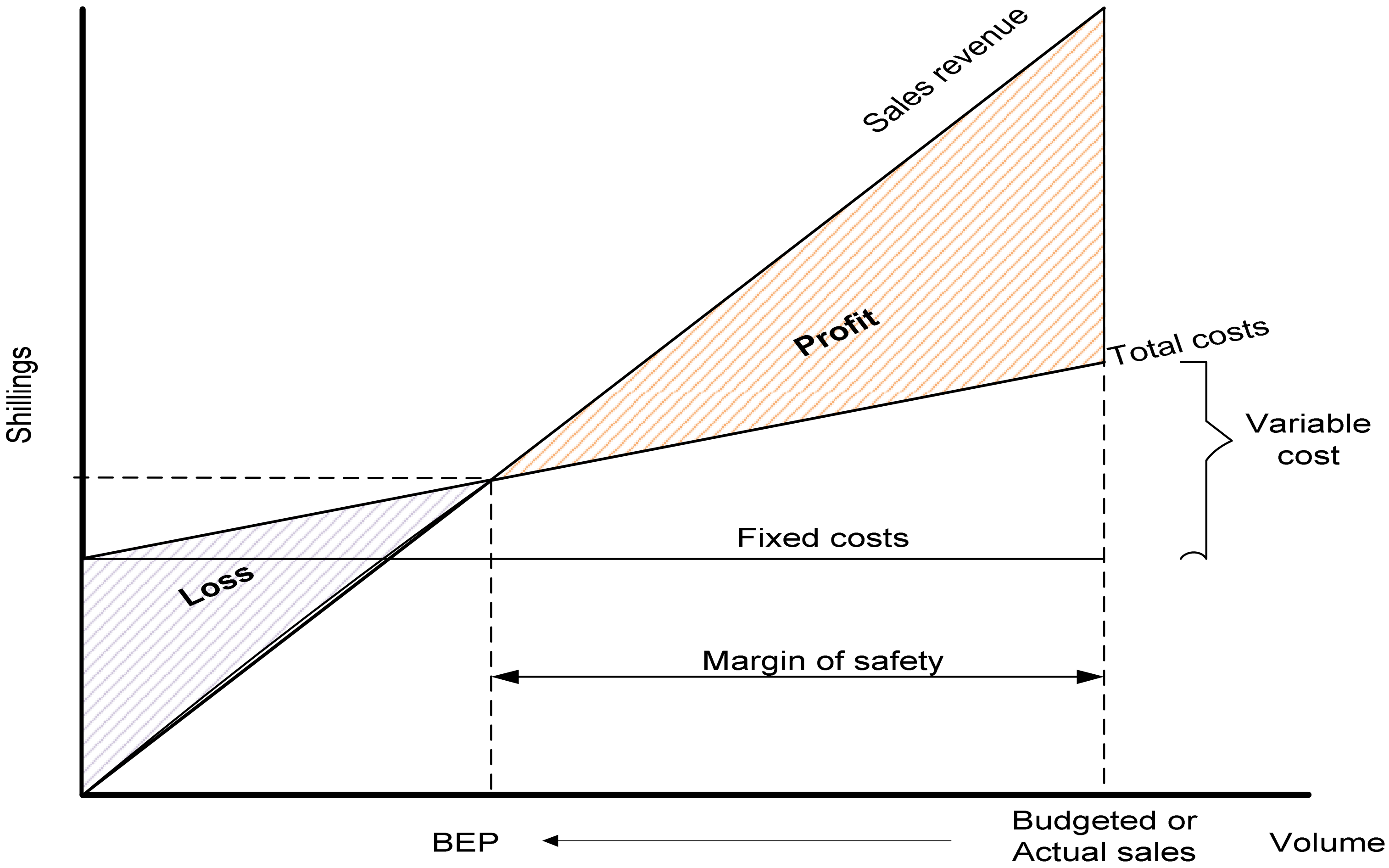
PQ = VCQ - FC

Quantity at Break Even Point

$$Q_{BEP} = \frac{FC}{P - VC}$$

where:
Q = Break-even Point, i.e., Units of production (Q),
FC = Fixed Costs,
VC = Variable Costs per Unit
UP = Unit Price

5.3 Break Even Chart



The Operating Break-even in Dollars

- We can calculate the operating break-even point in sales dollars by simply multiplying the break-even point in units by the price per unit:

$$BE\$ = Q^{*} \times p$$

- Note that we can substitute the previous definition of Q* into this equation:

$$BE\$ = \frac{FC}{p - v} p = \frac{FC}{(p - v)/p} = \frac{FC}{CM\%}$$

- Where CM% is the contribution margin as a % of the selling price

Worked example

- Suppose that a company has fixed costs of \$100,000 and variable costs of \$5 per unit. What is the break-even point if the selling price is \$10 per unit?

$$Q^* = \frac{100{,}000}{10 - 5} = 20{,}000 \text{ units}$$

Or

$$BE\$ = 20{,}000 \times 10 = \$200{,}000$$

Or

$$BE\$ = \frac{100{,}000}{(10-5)/10} = \$200{,}000$$

Advantages / Limitations of BEP

Advantages:

1. Explains cost volume profit relationship
2. Can be extended to show how changes in FC, VC, prices affect profit
3. Used in partial and capital budgeting
4. Indicate the lowest level of business activity to prevent losses

Limitations:

1. Cannot be used for multiple products

2. Difficulty of classifying cost as either all fixed or all variable

3. Tendency to continue using break even analysis even when cost and income functions have changed

3.4.3.4. Net Present Value

- To make a more informed decision, more sophisticated techniques need to be used.
- Takes into consideration of time-value of money
- Enables comparison of different interest rate to be made
- Useful for comparing similar projects with the same cost

Net Present Value

$$PV = \frac{\text{Future Value}}{(1 + i)^n}$$

Where i = discount rate

n = number of years

- Assuming compounding of interest, $1 today is worth $\$1(1+i)^n$ in *n* periods.
- Similarly, $1 received in *n* periods hence is worth $\frac{1}{(1+i)^n}$ dollars today
- Process referred to as: **Discounting**

Discounting ⇒ valuation of the future costs and benefits arising from a project in the present day

NPV WORKED EXAMPLE 1

- Cash flow x discount factor = present value
- e.g. PV of £500 in 10 years time at a rate of interest of 4.25% = 500 x .6595373 = £329.77
- 0.6595
- £329.77 is what you would have to invest today at a rate of interest of 4.25% to earn £500 in 10 years time
- PVs can be found through valuation tables (e.g. **Parry's Valuation Tables)**

Factors Affecting Discount rate

- National Economy
- Investment opportunities
- Level of risks
- Rates charged by other institutions e.g. Insurance companies

Npv worked example 2

- A firm is deciding on investing in an energy efficiency system. Two possible systems are under investigation

- One yields quicker results in terms of energy savings than the other but the second may be more efficient later

- Which should the firm invest in?

Discounted Cash Flow – System A

Year	Net Cash Flow (£)	Discount Factor (4.75%)	Present Value (£) (CF x DF)
0	- 600,000	1.00	-600,000
1	+75,000	0.9546539	71,599.04
2	+100,000	0.9113641	91,136.41
3	+150,000	0.8700374	130,505.61
4	+200,000	0.8305846	166,116.92
5	+210,000	0.7929209	166,513.39
6	+150,000	0.7569650	113,544.75
Total	**285,000**		**NPV =139,416**

Discounted Cash Flow – System B

Year	Net Cash Flow (£)	Discount Factor (4.75%)	Present Value (£) (CF x DF)
0	- 600,000	1.00	-600,000
1	+25,000	0.9546539	23,866.35
2	+75,000	0.9113641	68,352.31
3	+85,000	0.8700374	73,953.18
4	+100,000	0.8305846	83,058.46
5	+150,000	0.7929209	118,938.10
6	+450,000	0.7569650	340,634.30
Total	**285,000**		**NPV** =108,802.70

NPV WORKED EXAMPLE 3

Consider the choice between the two alternatives D & C. Both have a service life of 3 years and no salvage value at the end of the 3 years (use i = 12%). Initial investment and annual operating expenses are given below. Compare the two alternatives and recommend the best alternative

Example 1 cont---

Year	Alternative I	Alternative II
0	P = \$5000	P = \$7500
1	\$1700	\$500
2	\$2000	\$1100
3	\$2500	\$1300

12.00%									
	F/P	P/F	A/F	A/P	F/A	P/A	A/G	P/G	
n									n
1	1.1200	0.8929	1.0000	1.12	1	0.892857	0.0000	0.000	1
2	1.2544	0.7972	0.4717	0.591698	2.12	1.690051	0.4717	0.797	2
3	1.4049	0.7118	0.2963	0.416349	3.3744	2.401831	0.9246	2.221	3
4	1.5735	0.6355	0.2092	0.329234	4.779328	3.037349	1.3589	4.127	4
5	1.7623	0.5674	0.1574	0.27741	6.352847	3.604776	1.7746	6.397	5
6	1.9738	0.5066	0.1232	0.243226	8.115189	4.111407	2.1720	8.930	6
7	2.2107	0.4523	0.0991	0.219118	10.08901	4.563757	2.5515	11.644	7
8	2.4760	0.4039	0.0813	0.201303	12.29969	4.96764	2.9131	14.471	8
9	2.7731	0.3606	0.0677	0.187679	14.77566	5.32825	3.2574	17.356	9
10	3.1058	0.3220	0.0570	0.176984	17.54874	5.650223	3.5847	20.254	10
11	3.4785	0.2875	0.0484	0.168415	20.65458	5.937699	3.8953	23.129	11
12	3.8960	0.2567	0.0414	0.161437	24.13313	6.194374	4.1897	25.952	12
13	4.3635	0.2292	0.0357	0.155677	28.02911	6.423548	4.4683	28.702	13
14	4.8871	0.2046	0.0309	0.150871	32.3926	6.628168	4.7317	31.362	14
15	5.4736	0.1827	0.0268	0.146824	37.27971	6.810864	4.9803	33.920	15
16	6.1304	0.1631	0.0234	0.14339	42.75328	6.973986	5.2147	36.367	16
17	6.8660	0.1456	0.0205	0.140457	48.88367	7.11963	5.4353	38.697	17
18	7.6900	0.1300	0.0179	0.137937	55.74971	7.24967	5.6427	40.908	18
19	8.6128	0.1161	0.0158	0.135763	63.43968	7.365777	5.8375	42.998	19
20	9.6463	0.1037	0.0139	0.133879	72.05244	7.469444	6.0202	44.968	20
21	10.8038	0.0926	0.0122	0.13224	81.69874	7.562003	6.1913	46.819	21
22	12.1003	0.0826	0.0108	0.130811	92.50258	7.644646	6.3514	48.554	22
23	13.5523	0.0738	0.0096	0.12956	104.6029	7.718434	6.5010	50.178	23
24	15.1786	0.0659	0.0085	0.128463	118.1552	7.784316	6.6406	51.693	24
25	17.0001	0.0588	0.0075	0.1275	133.3339	7.843139	6.7708	53.105	25
26	19.0401	0.0525	0.0067	0.126652	150.3339	7.89566	6.8921	54.418	26
27	21.3249	0.0469	0.0059	0.125904	169.374	7.942554	7.0049	55.637	27
30	29.9599	0.0334	0.0041	0.124144	241.3327	8.055184	7.2974	58.782	28

Alternative I

- Present worth

=\$5000 +\$1700(P/F, 12%,1) +2000(P/F, 12%,2) + 2500(P/F, 12%,3)

=\$9891.83

-Annual cost

=\$9891.83(A/P, 12%,3)

=\$4118.83

=\$4119

Alternative II

-Present worth

=\$7500 +\$500(P/F, 12%,1) + \$1100(P/F, 12%,2) +\$1300(P/F, 12%,3)

=\$9748.7

Annual cost

=\$9748.7(A/P, 12%,3)

=\$4058.87

=\$4059

Conclusion: Analysis favors alternative II.

npv using excel

	A	B	C	D	E	F	G	H	I	J
2										
3	AN. INT. RATE -->	10%								
4										
5	**PROJECT 1**	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	TOTAL			
6	REVENUES	$0	$2,000	$3,000	$4,000	$5,000	$14,000			
7	COSTS	$5,000	$1,000	$1,000	$1,000	$1,000	$9,000			
8	CASH FLOW	($5,000)	$1,000	$2,000	$3,000	$4,000	**$5,000**			
9	NPV	**$2,316**								
10		Formula =npv(b3,b8:f8)								
11										
12	**PROJECT 2**	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	TOTAL			
13	REVENUES	$1,000	$2,000	$4,000	$4,000	$4,000	$15,000			
14	COSTS	$2,000	$2,000	$2,000	$2,000	$2,000	$10,000			
15	CASH FLOW	($1,000)	$0	$2,000	$2,000	$2,000	**$5,000**			
16	NPV	**$3,201**								
17		Formula =npv(b3,b15:f15)								
18										
19	RECOMMEND PROJECT 2 BECAUSE IT HAS THE HIGHER NPV.									
20										
21	IF STATEMENT -->	=IF(B9>B16,A5,A12)								
22	RESULT -->	PROJECT 2								

Notice that cash flow totals are the same, but NPVs are different.

Excel file

3.4.3.5. Internal Rate of Return

- **The IRR is the rate of interest (or discount rate) that makes the net present value = to zero**

- Allows the risk associated with an investment project to be assessed by comparing projects with different values
  - Helps measure the worth of an investment
  - Allows the firm to assess whether an investment in the machine, etc. would yield a better return based on internal standards of return
  - Allows comparison of projects with different initial outlays
  - Set the cash flows to different discount rates
  - Software or simple graphing allows the IRR to be found

Internal Rate of Return

- Interest yield of the potential investment
- The interest rate that will cause the present value of the proposed capital expenditure to equal the present value of the expected annual cash inflows.

Internal Rate of Return

- STEP 1.Compute the internal rate of return factor using this formula:

<u>Capital Investment</u>
Annual Cash Inflows

$130,000 / $26,000 = 5.0

Internal Rate of Return Method

- STEP 2. Use the factor and the present value of an annuity of 1 table to find the internal rate of return.
- Locate the discount factor that is closest to 5.0 on the line for 10 periods.

PRESENT VALUE OF AN ANNUITY OF 1								
(N) Periods	6%	7%	8%	9%	10%	12%	14%	15%
10	7.360	7.024	6.710	6.418	6.145	5.650	5.216	*5.019*

Internal Rate of Return Decision Criteria

The decision rule is:

Accept when internal rate of return is equal to or greater than the required rate of return

Reject when internal rate of return is less than required rate

Internal Rate of Return – Uneven Cash Flows

- If cash inflows are unequal, trial and error solution will result if present value tables are used.
- Use business calculators and electronic spreadsheets

IRR Example

- Consider the Cash flows of a project X (US)
- Year 0 1 2 3 4

Year	0	1	2	3	4
	(100,000)	30,000	30,000	40,000	45,000

The IRR is the Value of r which satisfies the following equation

$$100,000 = \frac{30,000}{(1+r)^1} + \frac{30,000}{(1+r)^2} + \frac{40,000}{(1+r)^3} + \frac{45,000}{(1+r)^4}$$

- Try r = 15%
- This makes the right hand side equal to: 100,802
- Try r = 16%
- This makes the right hand side equal to: 98,641
- Since the value is less than 100,000 we can conclude that the value of r lies between 15% and 16%
- For most of the purpose this indication suffices.
- If more refined estimate of r is needed, use the following procedure

1. Determine the NPV for the two closest rates of return
- (NPV/15%) = 802
- (NPV/16%)=(1,359)

2. Find the sum of the absolute values of the NPVs Obtained in Step 1
- 802 +1,359 =2161

3. Calculate the ratio of the NPV of the smaller discount rate, identified in step 1, to the sum obtained in step 2
- 802/2161 =0.37

1. Add the number obtained in step 3 to the small discount rate.

- 15 + 0.37 = 15.37

- ***Decision rule***

Accept : If the IRR is greater than Cost of Capital

Reject : If the IRR is less than the cost of capital

3.4.3.6.Profitability Index

- Allows a comparison of the costs and inflows of different projects to be assessed

$$\text{Profitability Index} = \frac{\textbf{Net Present Value}}{\textbf{Initial Capital Cost}}$$

Accept : If the PI is greater than one

Reject : If the PI is less than one

3.4.3.7 equivalent uniform annual cost

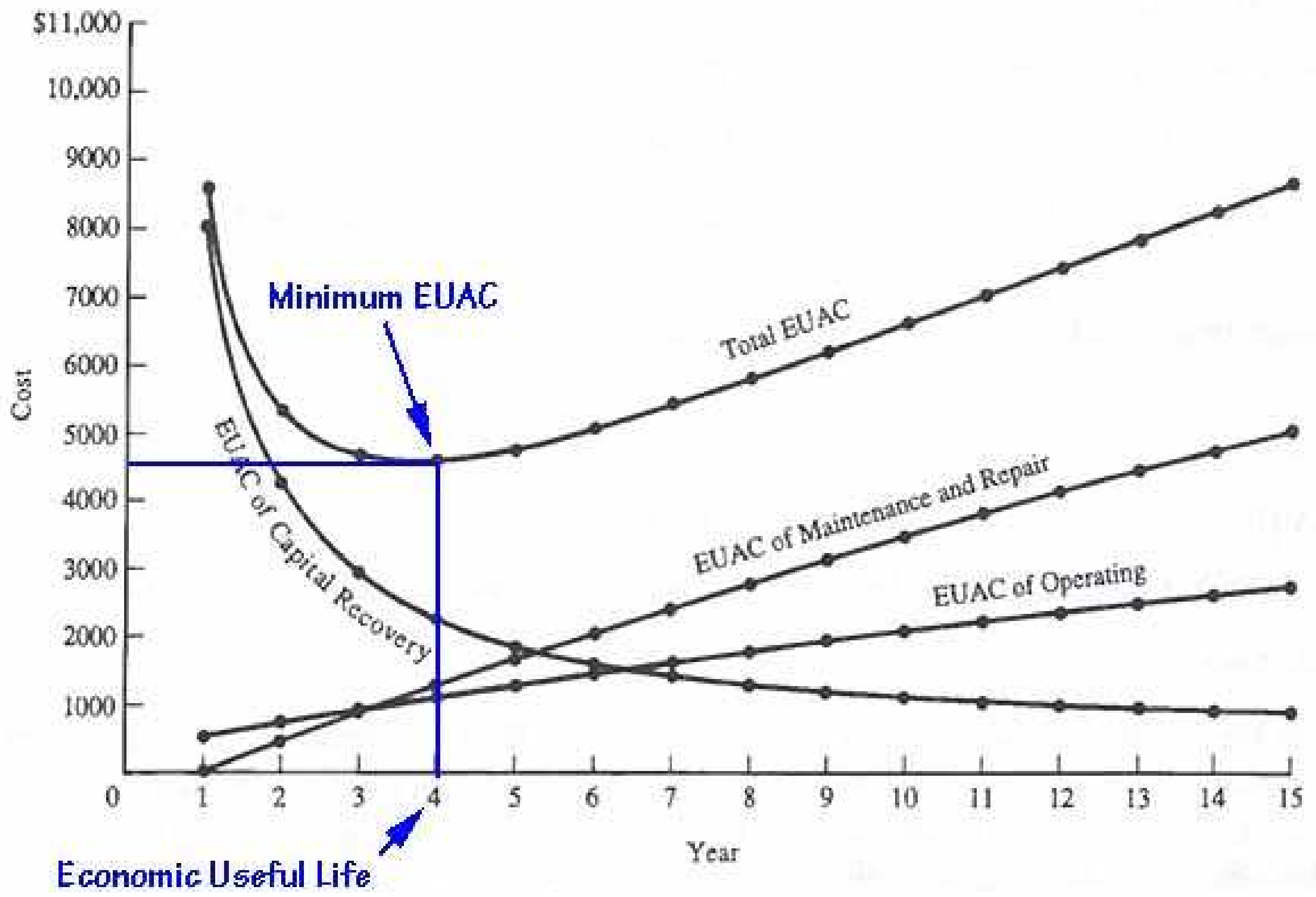
Suppose you have the following data
-$7500 initial cost (P)
-$900 arithmetic gradient maintenance cost (G)
-$500 uniform cost (A) and 400 arithmetic gradient operating cost (G)

Calculate the EUAC for each value of the useful life (e.g., n = 1, n = 2, n = 3, etc.).

Suggested solution

Year	EUAC of Capital Recovery Costs	EUAC of Maintenance and Repair Costs	EUAC of Operating Costs	EUAC Total	Interest rate
Initial year	-7500	0	-500		8%
Arithmetic gradient		-900	-400		
1	$8,100.00	$0.00	$500.00	$8,600.00	
2	$4,205.77	$432.69	$692.31	$5,330.77	
3	$2,910.25	$853.87	$879.50	$4,643.62	
4	$2,264.41	$1,263.56	$1,061.58	$4,589.55	<-----MIN
5	$1,878.42	$1,661.82	$1,238.59	$4,778.84	
6	$1,622.37	$2,048.71	$1,410.54	$5,081.62	
7	$1,440.54	$2,424.30	$1,577.47	$5,442.31	
8	$1,305.11	$2,788.67	$1,739.41	$5,833.19	
9	$1,200.60	$3,141.93	$1,896.41	$6,238.94	
10	$1,117.72	$3,484.18	$2,048.53	$6,650.43	
11	$1,050.57	$3,815.55	$2,195.80	$7,061.93	
12	$995.21	$4,136.17	$2,338.30	$7,469.68	
13	$948.91	$4,446.19	$2,476.08	$7,871.18	
14	$909.73	$4,745.75	$2,609.22	$8,264.69	
15	$876.22	$5,035.01	$2,737.78	$8,649.02	

Worked example CONT---



3.4.3.8. benefit cost ratio

- Allows a comparison of ALL costs and benefits of different projects to be assessed and thus allow decision making to be carried out

$$\mathbf{BCR} = \frac{\textbf{NPV of all Benefits}}{\textbf{NPV of all Costs}}$$

Accept : If the BCR is greater than one

Reject : If the BCR is less than one

BCR Advantages and limitations

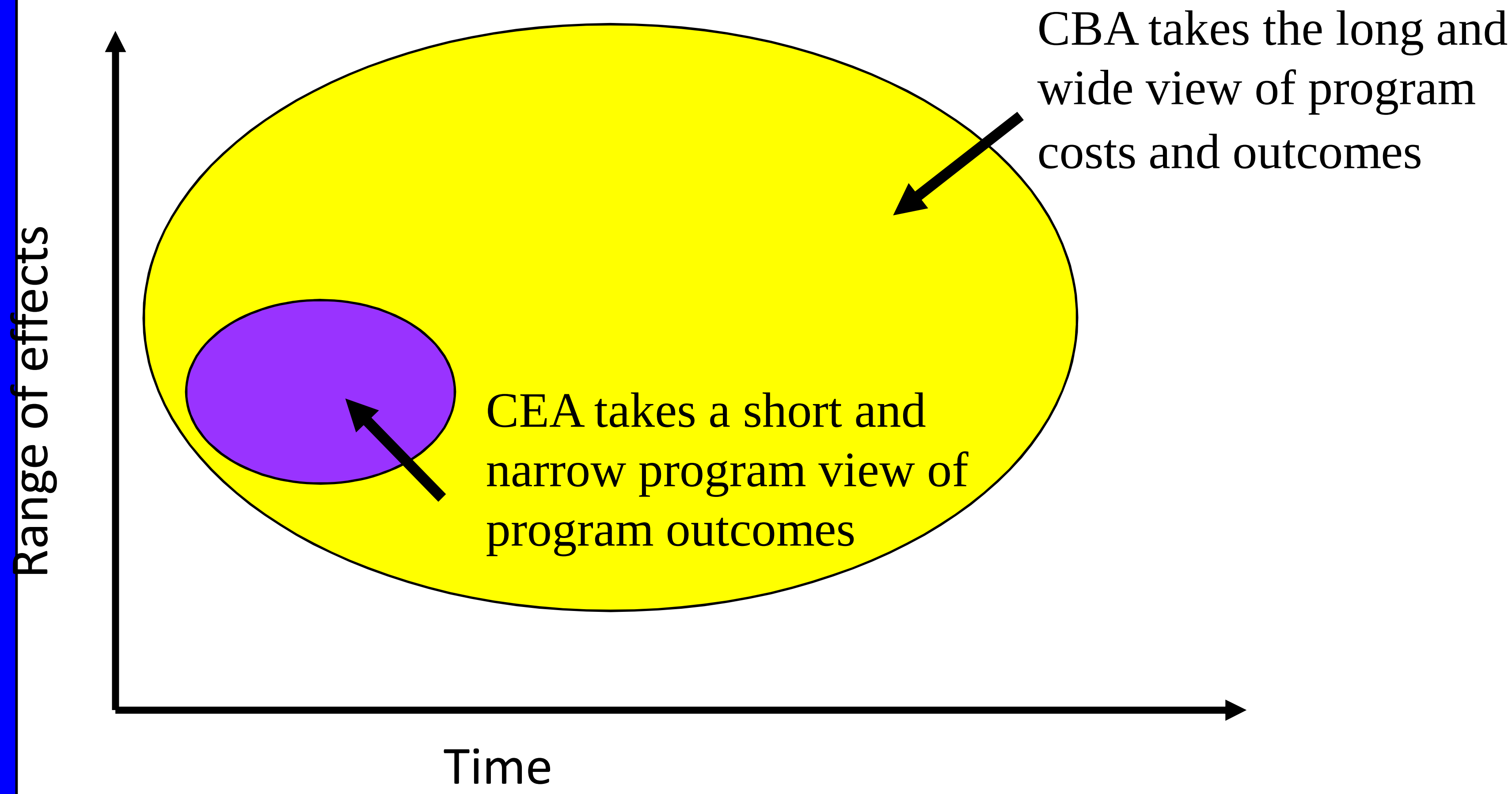
- Covers ALL social as well as private benefits/costs in each year discounted back to give the NPV.
- Use dollar values, allowing for direct comparisons and
- Use real values

- **Converting intangibles into money value** *(Many government programs deal in intangibles)*
- **Outcomes are long-term**
- **Avoiding double counting** *(Hard to do this when programs have broad social outcomes)*
- **Linking observed changes to program costs**

3.4.3.9 Cost Effectiveness Analysis (CEA)

- Finding cheapest way of accomplishing a defined project objective (Cost minimization)
- To find maximum output achievable from a given expenditure
- Because CBA compares the welfare among stakeholders, methods to translate welfare into a common denominator (i.e., money) strike many as artificial
- For this reason, CEA is conceptually and operationally simpler. It is also more applicable to evaluation and performance measurement of public programs

Scope of CEA and CBA



Comparing Methods

	Payback period	Accounting rate of return	Net present value	Internal rate of return
Basis of measurement	Cash flows	Accrual income	Cash flows Profitability	Cash flows Profitability
Measure expressed as	Number of years	Percent	Dollar Amount	Percent
Strengths	Easy to Understand Allows comparison across projects	Easy to Understand Allows comparison across projects	Considers time value of money Accommodates different risk levels over a project's life	Considers time value of money Allows comparisons of dissimilar projects
Limitations	Doesn't consider time value of money Doesn't consider cash flows after payback period	Doesn't consider time value of money Doesn't give annual rates over the life of a project	Difficult to compare dissimilar projects	Doesn't reflect varying risk levels over the project's life

Example

PLANCONSULT (T) Ltd has recently been awarded a consultancy assignment from the Ministry of Infrastructure Development to appraise two projects. The projects cost Tzs 500mil each and the required rate of return for each of the project is 12%. The projects expect net cash flows as follows:

Year	**Expected Net Cash Flows in Tzs mil**	
	Project 1	**Project 2**
0	(500)	(500)
1	325	175
2	150	175
3	150	175
4	50	175

As a project management specialist:

a) Determine the payback period for each project and recommended a best project alternative

b) Determine Net Present Value (NPV) for each project and recommended a best project alternative

c) Give short notes on the benefits and limitations of the Payback period method

a) Determine the payback period for each project and recommended a best project alternative

Solution

Payback period *is the number of years required to return the original investment from the net cash flows (net operating income after taxes plus depreciation e.t.c.)*

=

$$\frac{\textit{Initial Investment}}{\textit{Net annual cashflow}}$$

Project 1

Initial investment = Tzs500 mil

No net annual cash flow

Hence by inspection cash flow = $1^{st\ year}$ Tzs 325 mil, + 2^{nd} year Tzs 150 mil +$3r^{d}$ year Tzs 25/150 mil)(2mark)

2.17 years (

Project 2

Initial investment = Tzs 500 mil

Net annual cash flow= Tzs 175 mil/year

Payback period =

$$\frac{Tzs\,500}{Tzs\,175\ \ per\ year}$$

= 2.86 Years

***Recommendation** = Project 1 is the best alternative*

b) Determine **Net Present Value (NPV)** for each project using discount rate of 12%
and recommended a best project alternative

Solution

Net Present Value (NPV)

$$-po+\sum_{i=1}^{n}\frac{pi}{(1+r)}$$

Where –po =Initial investment

pi = Net annual inflow

r= discount rate

n= Project life time

i= time in years

Project1 *= -500 + [(325/(1.12)*^{1} *+150/(1.12)*^{2}*+150/(1.12)*^{3}*+50/(1.12)*^{4}*]*

= Tzs 48.31

Project 2*=-500 + [(175/(1.12)*^{1} *+175/(1.12)*^{2}*+175/(1.12)*^{3}*+175/(1.12)*^{4}*]*

= Tzs 31.54

- c).Give **short notes on the benefits and limitations** of the Payback period method

- ***Advantages of PB method***
  • It is very easy to calculate, but it can lead to wrong decision
  • Put more emphasis to quick return of the invested fund so that they may be put to use in other places or in meeting other needs.
  • Easy to apply (Simple to understand

- ***Limitations of the Payback Method***
- *• Does not consider post-payback cash flows*
  • Does not consider time value of money
  • Does not explicitly consider risk
  • the "acceptable" time period is arbitrary

Questions and discussions !!!!!

Thank You

Project Planning and Design

IE345: Engineering Project Management

Mohamed. J.A.M,

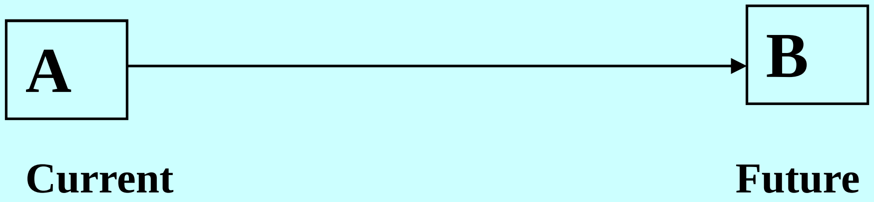
College of Engineering and Technology-UDSM

Outline of the Talk

- **Introduction**
- **Why project planning?**
- **Project Planning Processes**
- **Project planning tools and Techniques**
- **The project plan**
- **Questions and Discussion**

Introduction: Project Planning

- **Planning: Determining future course of action :The Plan**



Activity definition (WBS)

Activity sequencing

Recourses determination

Activity duration estimation

Time computation (Incl. Critical activities)

Developing workplan (Working Calendar)

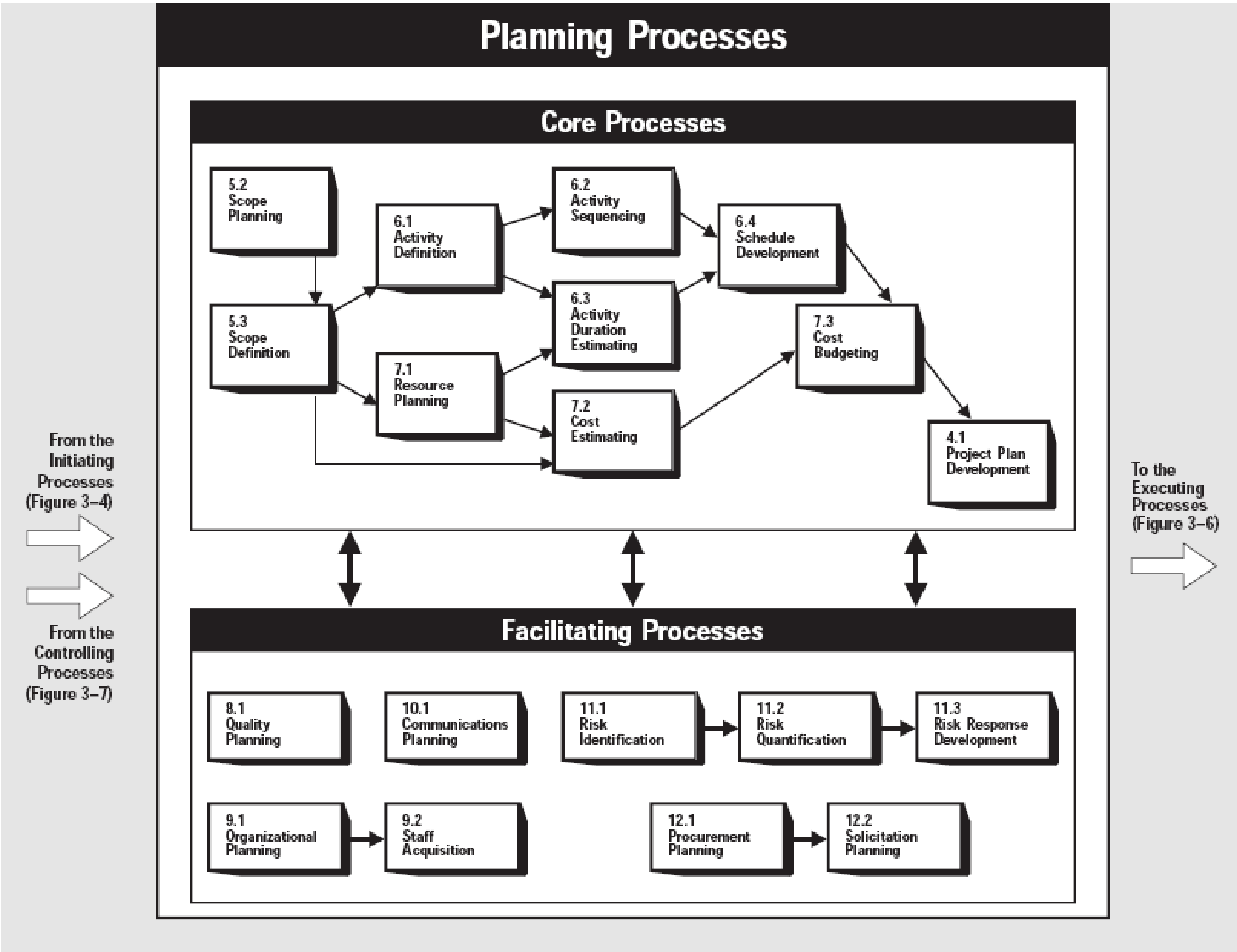
Recall: Project life cycle

Why Project Planning

- To establish set of directions (what, when, who, how)
- To guide project execution
- To minimize project risks (Things that may disrupt the project
- To provide baseline for project progress measurement and control
- To facilitate communication among project stakeholders
- To document project planning decision regarding alternative chosen

- It is a foundation document in project management because it provides the basis for planning and managing project schedules, costs, and changes

Project Planning Processes



Project Planning Techniques

- Project management techniques (PMTs) are tools and means to achieve ends by reducing uncertainty and thus improving odds of success
- They do help project managers to make decisions on the use of scarce resources as well as planning and implementing projects in an efficient and effective way.

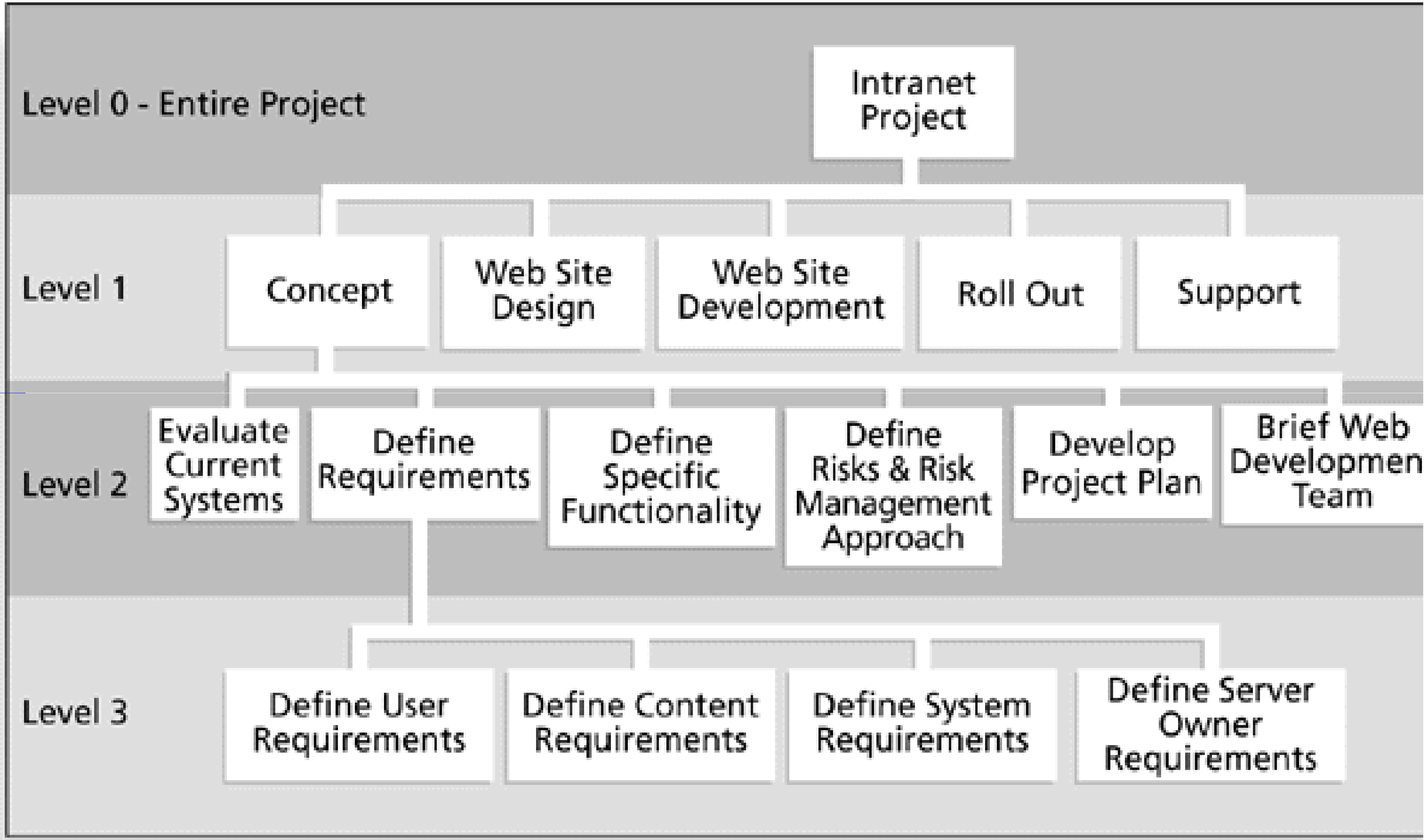
Work Breakdown Structure

- After completing scope planning, the next step is to further define the work by breaking it into manageable pieces
- Good scope definition
  - helps improve the accuracy of time, cost, and resource estimates
  - defines a baseline for performance measurement and project control
  - aids in communicating clear work responsibilities

The WBS cont…

- A work breakdown structure (WBS) is an outcome-oriented analysis of the work involved in a project that defines the total scope of the project

Sample Intranet WBS Organized by Phase



Intranet WBS in Tabular Form

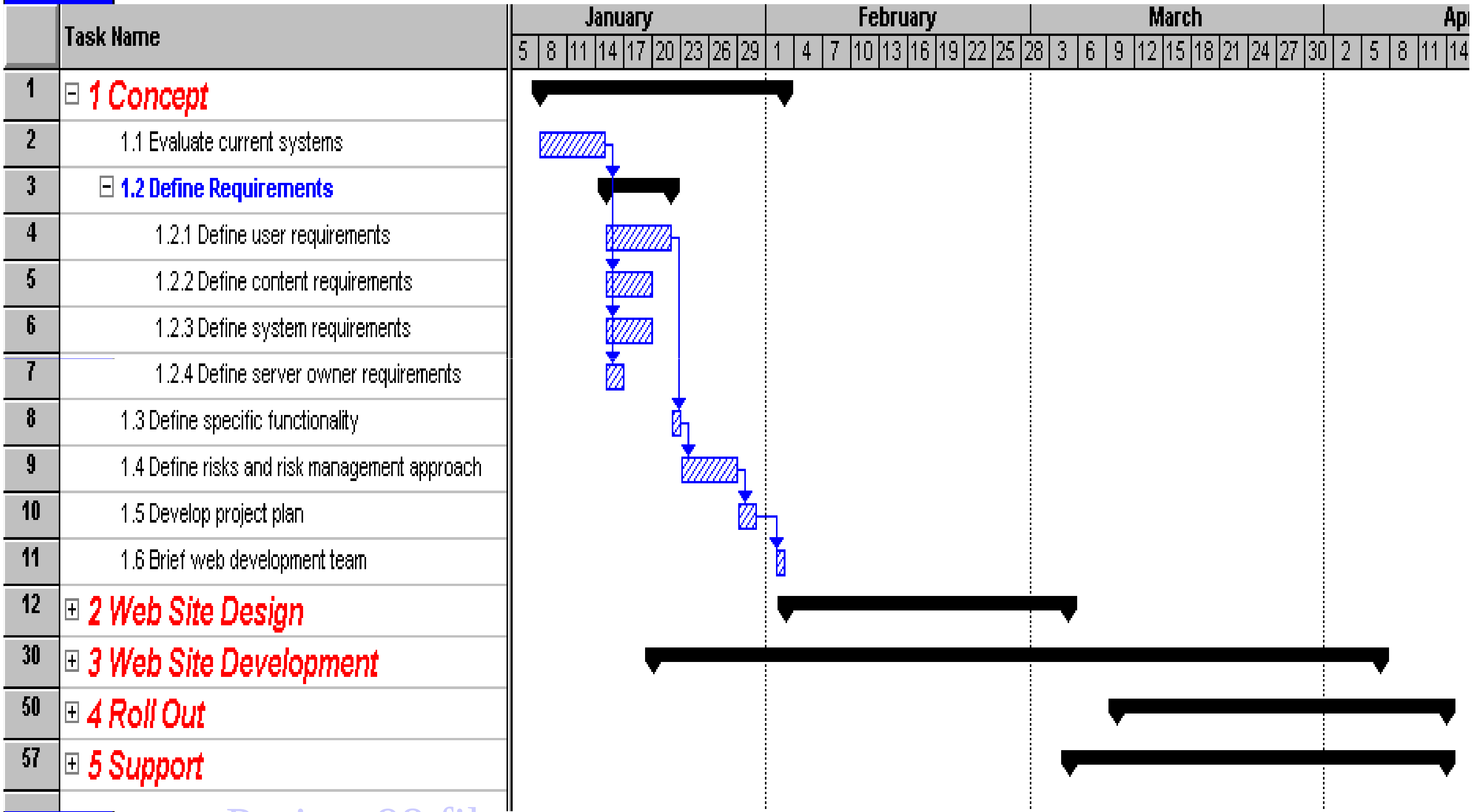
- 1.0 Concept
  - 1.1 Evaluate current systems
  - 1.2 Define Requirements
    - 1.2.1 Define user requirements
    - 1.2.2 Define content requirements
    - 1.2.3 Define system requirements
    - 1.2.4 Define server owner requirements
  - 1.3 Define specific functionality
  - 1.4 Define risks and risk management approach
  - 1.5 Develop project plan
  - 1.6 Brief web development team
- 2.0 Web Site Design
- 3.0 Web Site Development
- 4.0 Roll Out
- 5.0 Support

Gantt Chart

- Is a graphical presentation/display of schedule related information=BAR CHART
- Activities/project elements Vs respective time/ duration
- Activities are listed down on left side of the chart, dates are shown on top; horizontal bars

Intranet WBS and Gantt Chart in Project 98

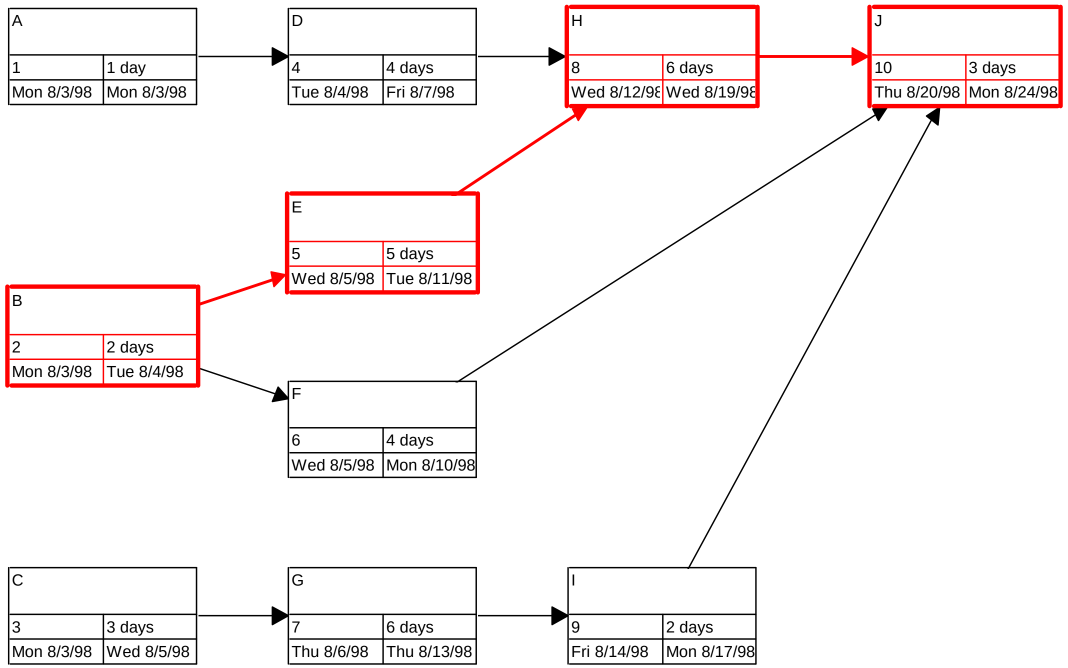
WBS **Gantt Chart**



Project 98 file

PM Tools and Techniques cont.

. Sample PERT



Action plan

- It is used to indicate project activities, responsible person to do the activity, time required to do the activity and the required resources

Project name			
Project Objectives			
Action steps *What will be done* 1. 2. 3. 4. 5.	Responsibilities *Who will do it* 1. 2. 3. 4. 5.	Resources *Funding/people /materials* 1. 2. 3. 4. 5.	Time *By when* 1. 2. 3. 4. 5

Logical Framework Analysis (LFA)

- Describes a project in a logical way so that it is well designed, described objectively, can be evaluated and clearly structured It
- The steps for using logframe include:
  - goal identification, formulation of the desired objectives in consultation with all stakeholders, determination of outputs and description of activities.
- This tool can be used in all project phases but in this study it is evaluated at formulation phase.

A logframe

Narrative summary	Verifiable indicators	Means of verification	Important assumption
Purpose			
Objective			
Outputs			
activities			
Inputs			

The Project plan

- Content:
- **Executive summary**

  Gives a brief description of the project; background, problem, objectives, activities, outputs, budget

- **Project basic data**

Name of the project, participating institutions, Contact address, brief profile, proposed duration (start and end date), source of financing

- **Project background/profile**

The plan cont..

General description of social, economic, environmental, financial benefits of the project

Needs analysis; Why, justification, project ownership

Relevance of the project in relation to wider goals of the institition

- **Project objectives**

Issues need to be achieved, general and specific objectives, activities to be performed=**Logframe**

The plan cont..

- **Project implementation plan**

Approach, contractual agreement, schedules, resource requirement, organization plan, training requirement

- **Evaluation and Monitoring**
- **Project budget**
- **Expected problems/potential problems**

Annexes

Organization structure of the company/institution, computations, project location maps, Engineering drawings

Thank You

Questions!!!!!

Project Organization

Engineering Project Management

Mohamed. J.A.M,

Feb, 11th 2017

Growth of Project Oriented Organizations

- There are many reasons for the rapid growth, but most of them can be grouped in four general areas:
  - Speed and market responsiveness have become absolute requirements for successful competition
  - The development of new products, processes, or services regularly requires input from diverse areas of specialized knowledge

Growth of Project Oriented Organizations

- Four reasons for growth (cont.)
  - Rapid expansion of technological possibilities in almost every area of enterprise tends to destabilize the structure of organizations
  - A majority of senior managers rarely feel much confidence in their understanding and control of the activities in their areas

Organisation Design

- Organisation design/structure prescribes relationships among various project (organisation), position, people and activities.
- A framework within which project managers' decision take place

It tries to ensure that:

- All activities necessary to achieve project (organisation), goals should be performed; no unnecessary activity should be performed

•There is no duplication in performing necessary activities (Optimise use of Resources)
•Various Activities are performed in a synchronised and harmonious way
•Creativity stimulation through creation various factors that determine effectiveness of organisation structure Environment, strategy, Technology, Size, people

- Organizational structure is a network of authority and activity relationships.
- It tells managers what is expected of them, to whom they are accountable and from whom to get resources and information.
- It also provides flows for authority and information.
- Organizational structure is a traditional but systematic technique of decision

- **Environment**
- Organisation/project as a system works within broader framework of the environment
- Thus there is Interaction between organisation/project and Environment.
- Environment determines the various organisational/project processes including its structure
- Design project/organisation structure which corresponds to the needs of working environmental conditions

- Structure:
- Pattern in which various parts of components are interrelated or Interconnected
- organisation structure is pattern of relationships among various components or parts of the project or organisation
- Prescribes Relationships among activities positions and people within project or organisation

- Technology

Body of particular type of knowledge and relates to direct problem solving into inventions.

It consists equipments, machines, or tools, sets of activities, methods or processes and layouts, arrangements or pattern.

- Size of Organisation/Project
- The size of Project influences its coordination, direction, control, and reporting systems and hence organisation structure

- When an project is small, interaction is confined to relatively small group, communication is simpler, less information is required for decision making and there is less need for normal structure.

- People
- Project structure is the result of conscious actions on the part who are engaged in the organisation

- Form of Project structure is expected to reflect the thinking and way of working of its framers and participants (In satisfaction or dissatisfaction for people)

- Strategy:
- The Course of action through the organisation relates itself with its environment to achieve its objectives. Organisation design according to implementation strategy

- Course of Actions: Organisation growth

- Patterns of
  - Initial expansion
  - Rationalisation of the use of resources
  - Expansion into new products and business

Mechanism for Designing Structure

- Issues
  - What should be different units of the organisation?
  - **What components should join together and what components should be kept apart?**
  - **What is the appropriate placement and relationship of different units?**
- **Answers: Managers may adopt different approaches**

Process Approach

- Designing related to identification of sequences of activities involved and then deciding various units of organisation

Results Approach

- Design on the basis of different work products

Decision Approach

Projectdesign mechanism puts certain question about the decision and the answers of these questions become the basis for designing structure.

These questions are:

What decisions are needed to obtain results for achieving organisation objectives?

What is the nature of such decisions?

At what levels of the organisation should such decisions be made?

What are the activities involved in or affected by such decisions ?

Process in design of Project Organisation Structure

1. Identification of Activities

2. Grouping of Activities. Closely are grouped into departments or divisions coordination and departmentation

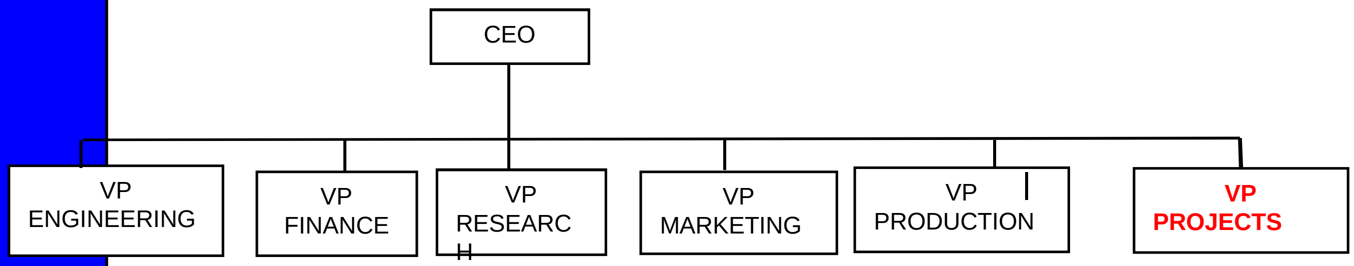
3. Delegation of Authority= the process though which a manager gives Authority to others in order to accomplish certain assignment.

Types of Project Organizations

- There are two fundamentally different ways of organizing projects within the parent organization
  - The project as part of the Functional Organization
  - The project as a free-standing part of the parent organization
- A third type, called a Matrix Organization is a hybrid of the two main types
- *However, not all of them are suitable for all situations. Their suitability depends on number of factors such as environment, size of organisation people, Technology and strategy*

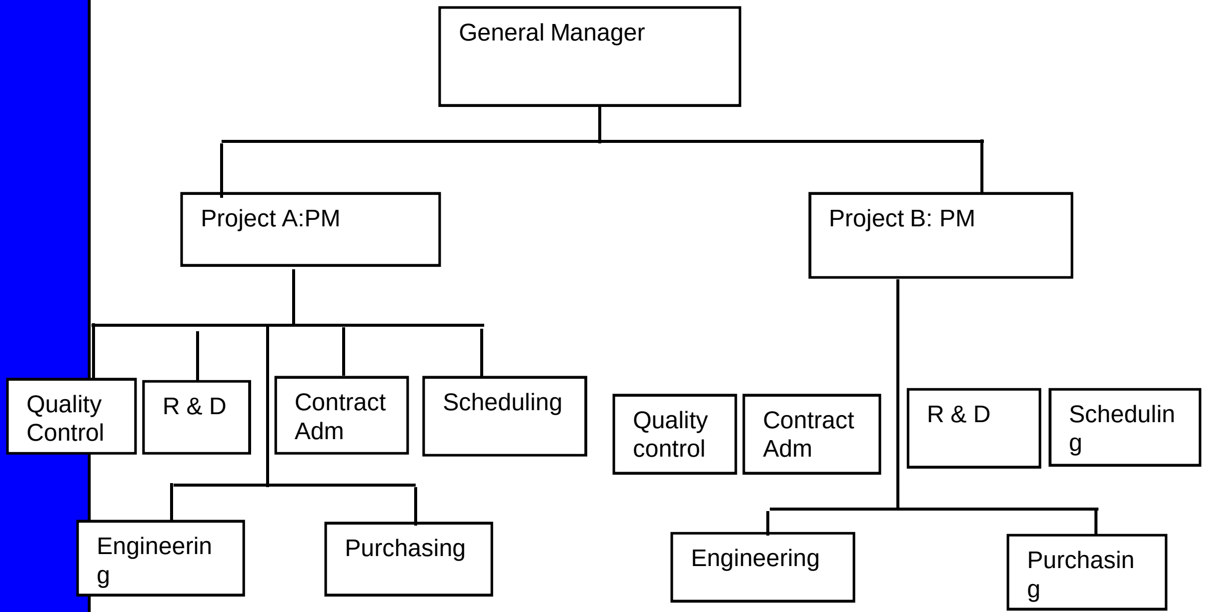
Functional Organisation Structure

- The most widely used form of organisation structure.
- This a traditional concept of organising.
- The bases for departmentation is various functions performed by an organisation.
- Both basic and secondary functions are identified.
- Characteristics
  1. Specialisation by functions
  2. Emphasis on sub goals
  3. Pyramidal growth of the organisation

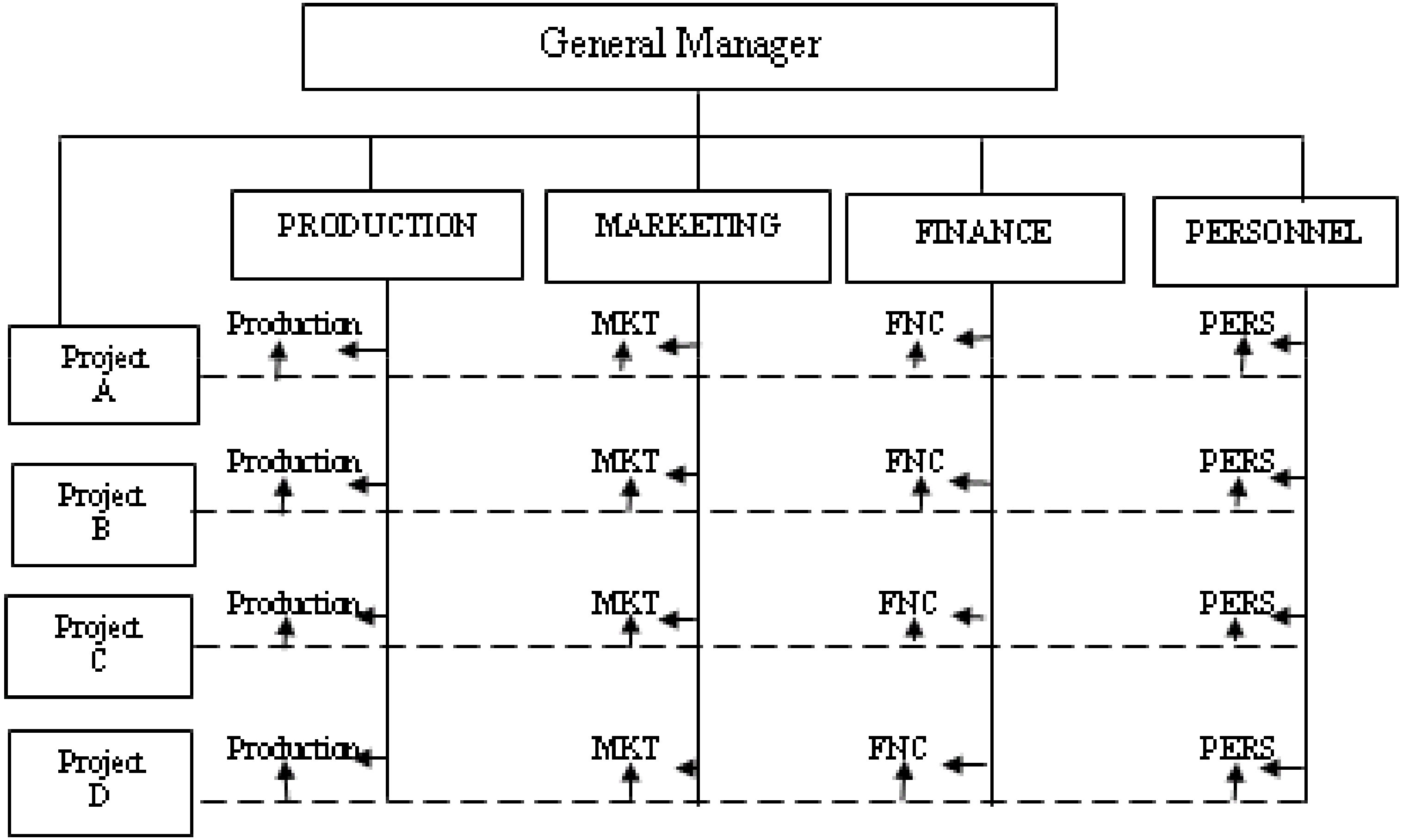

CEO
VP ENGINEERING
VP FINANCE
VP RESEARC H
VP MARKETING
VP PRODUCTION
VP PROJECTS

Project/task organisation

All Resources necessary to attain a specific objective are separated from the functional structure and set up as self contained unit headed by a project manager. The project manager is given considerable authority over the project and may acquire resources from inside or outside the overall organisation.


General Manager
Project A:PM
Project B: PM
Quality Control
R & D
Contract Adm
Scheduling
Engineerin g
Purchasing
Quality control
Contract Adm
R & D
Schedulin g
Engineering
Purchasin g

- Under Matrix Organisation
- Two complementary structure pure project structure and functional structure are emerged together to create matrix structure
- Employees a multiple commonly, dual Responsibility
- Organisation overlaps in terms of command system and organisation process and behaviour


General Manager
PRODUCTION
MARKETING
FINANCE
PERSONNEL
Project A
Project B
Project C
Project D
Production
MKT
FNC
PERS

PROS	CONS
FUNCTIONAL	
•Result into few degree of specialization. •Brings order and Clarity in organisation •Professional Achievement •Economical Resource use :no duplication.	•Generates slow decision making process •Lack responsiveness to cope with new rapid changes
PROJECT/TASK	
•More flexible for utilization of resources •Maximum use of specialised knowledge •Organisation adopt environmental . demands	•Feeling of insecurity and uncertainty among •People are not able to identify them people selves in the departments •Lack of charity among members about them role in organisation •PM faces numerous problem because he has to carry responsibility without authority
MATRIX	
•Flexible structure •Improves motivation •Provide personnel to develop and test their professional competence •when single project t permit better planning and control .to meet deadline	•Power struggle •Can develop anarchy if not managed properly Can cause delays if not managed properly

Qualities of Good Organisation Structure

- 1.Simplicity
- 2.Flexibility
- 3.Clear Line of Authority
- 4.A proper delegation of authority

Thank You

Home work:

Develop organization structure for your Group Assignment

PROJECT RISK MANAGEMENT

Compiled by Mohamed. J.A.M,
Department of Mechanical and Industrial Engineering
Division of Engineering Management
College of Engineering and Technology-UDSM

26th November , 2017

Agenda

- **What is Project Risk?**
- **Risk Management Processes : Identification, Risk Analysis, Risk Planning, Risk Control**
- **What is Sensitivity Analysis?**
- **The Purpose of Sensitivity Analysis**
- **Steps for Performing Sensitivity Analysis**
- **Sample Diagrams for Presentation of Sensitivity Analysis Results**
- **Limitations of Risk Analysis**
- **Questions and Discussions**

.What is Risk and Risk Analysis ?

- *Risk* **= some circumstances that may happen and affect (negatively) the project, the product, and/or the business . It is an event which is uncertain and may have consequences** on some endeavor
- Risk is defined as a situation in which the outcome is subject to an uncontrollable random event stemming from a ***known*** probability distribution.
  - Roll of two dice is an example since the roll can result in one of 11 possible outcomes
- Uncertainty is defined as a situation in which the outcome is subject to an uncontrollable random event stemming from an ***unknown*** probability distribution.
  - Example would be: will it rain two weeks from today?

What is Risk and Risk Analysis ? CONT…

- *Risk management* **means anticipating risks and preparing plans to reduce their effect**

- **Project risk management: Includes processes of Identifying, analyzing and responding to the project risks**

- **Risk analysis:** ***a process that uses qualitative and quantitative techniques for analyzing, quantifying and reducing uncertainty associated with project goals***

Types of Project Risk

- Project specific risk (Stand-alone risk
- Corporate risk
- Market (or beta) risk
- Others :
  - Competitive risk
  - Industrial Risk
  - International risks

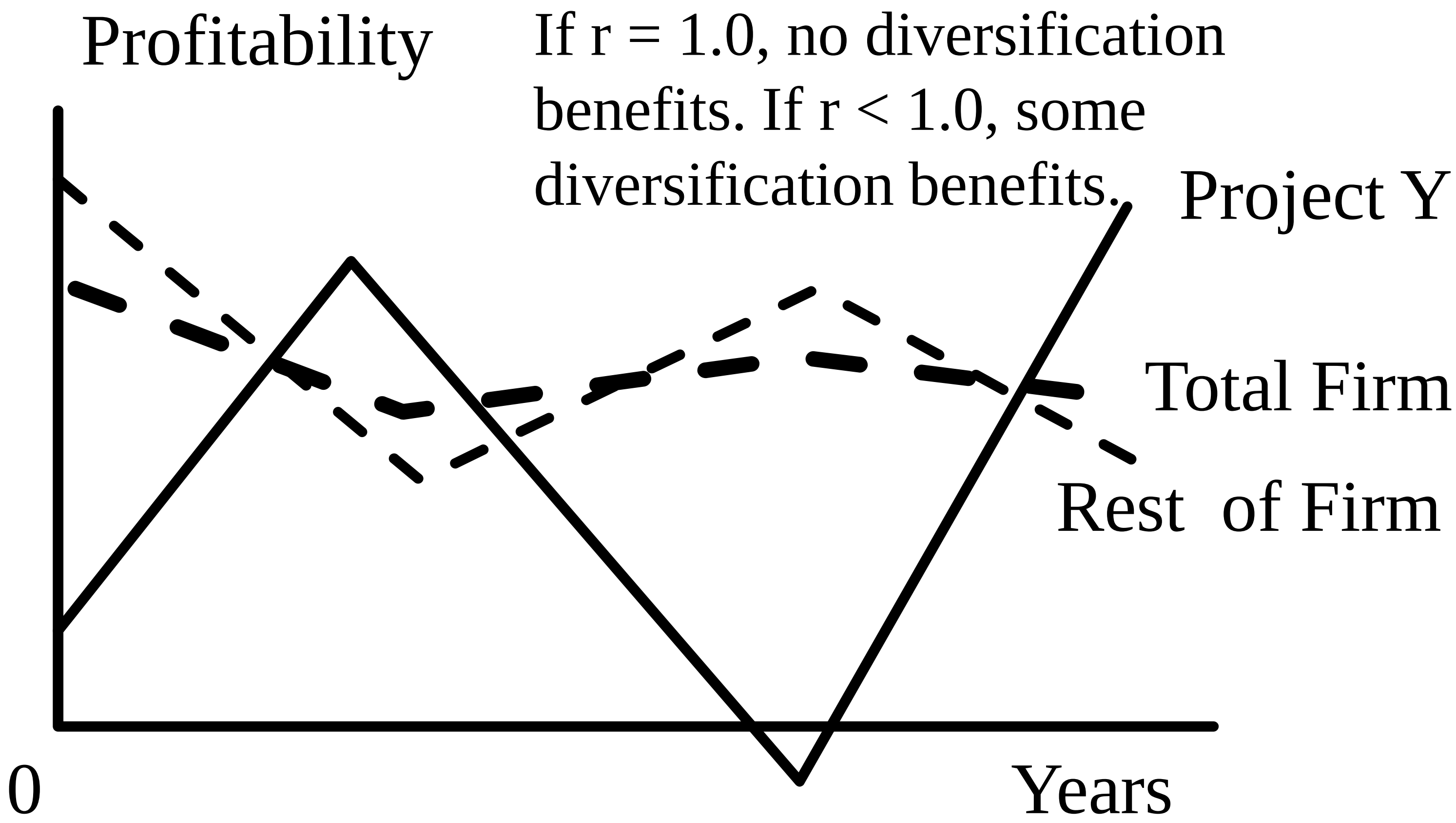
Project specific risk Stand-Alone Risk

- The project's risk if it is the firm's only asset and there are no shareholders.
- Ignores both firm and shareholder diversification.
- Measured by NPV, IRR, or MIRR.

Corporate Risk

- Reflects the project's effect on corporate earnings stability.
- Considers firm's other assets (diversification within firm).
- Depends on project and its correlation with returns on firm's other assets.
- Measured by the project's corporate beta

Project Y is negatively correlated to firm's other assets, so has big diversification benefits



Market Risk

- Reflects the project's effect on a well-diversified stock portfolio.
- Takes account of stockholders' other assets.
- Depends on project's correlation with the stock market.
- Measured by the project's market beta.

How is each type of risk used?

- Market risk is theoretically best in most situations.
- However, creditors, customers, suppliers, and employees are more affected by corporate risk.
- Therefore, corporate risk is also relevant.
- Stand-alone risk is easiest to measure, more intuitive.
- Core projects are highly correlated with other assets, so stand-alone risk generally reflects corporate risk.
- If the project is highly correlated with the economy, stand-alone risk also reflects market risk

Project Risk Factors

Main **risks** related to **project** impact:

- Failure to achieve the desired standards
- Cost overruns (operation and maintenance)

Main factors driving those risks:

- Inadequate project definition
- Hidden implementation problems (related to capacity and operating standards of the project facilities)
- Inadequate operation arrangements
- Lack of technical capacity of executing agency

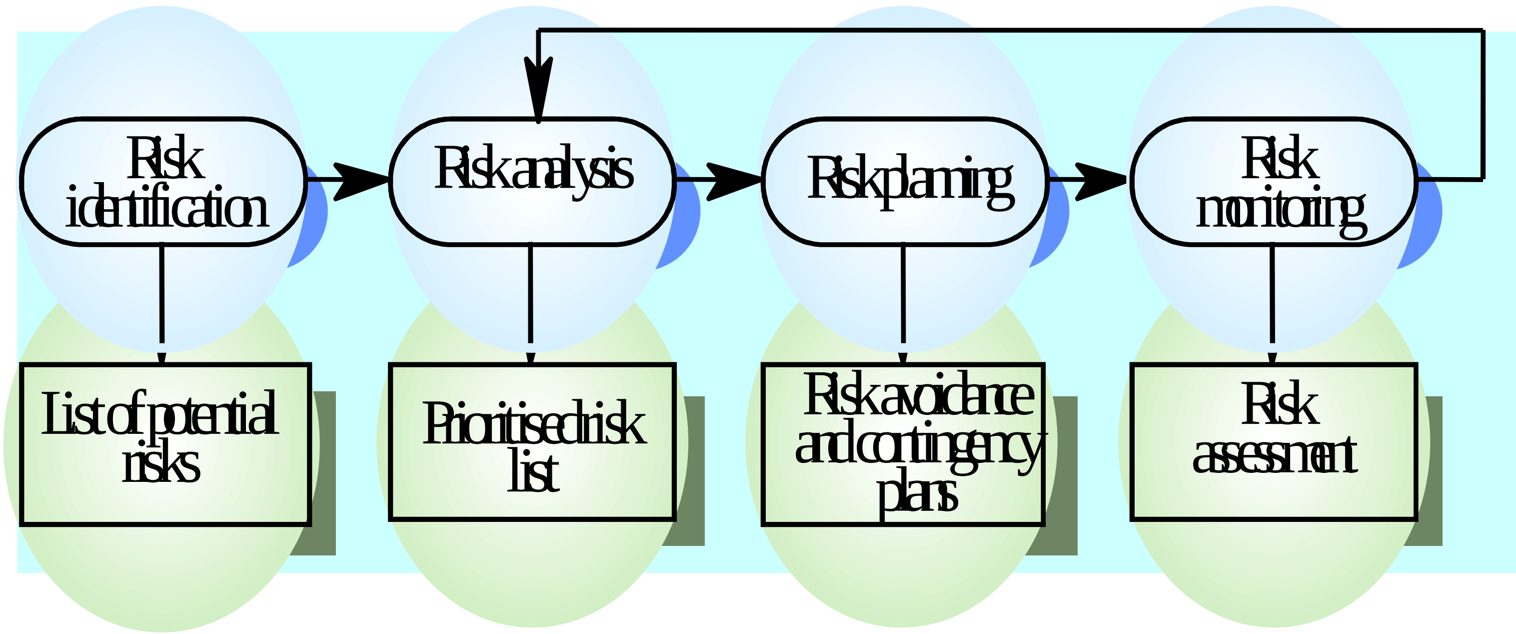
Introduction to Risk cont ……

Risk	Affects	Description
Staff turnover	Project	Experienced staff will leave the project before it is finished.
Management change	Project	There will be a change of organisational management with different priorities.
Hardware unavailability	Project	Hardware that is essential for the project will not be delivered on schedule.
Requirements change	Project and product	There will be a larger number of changes to the requirements than anticipated.
Specification delays	Project and product	Specifications of essential interfaces are not available on schedule
Size underestimate	Project and product	The size of the system has been underestimated.
Technology change	Business	The underlying technology on which the system is built is superseded by new technology.
Product competition	Business	A competitive product is marketed before the system is completed.

Project Risk Management Process

- Risk identification
  - Identify project, product and business risks;
- **Risk analysis**
  - Assess the likelihood and consequences of these risks;
- Risk planning
  - Draw up plans to avoid or minimise the effects of the risk;
- Risk monitoring and control
  - Monitor and control the risks throughout the project;

The risk management Processes



Project Risk Analysis

•**Risk Analysis** *considers the probability that changes in major quantifiable variables will actually occur*

•*Identification of the different factors that may cause the project not to be implemented as expected and/or to fail to achieve the desired impact*

Therefore Project Risk analysis is the process of assessing risks associated with a project

Risk analysis:

- **Sensitivity analysis** answers the question: What happens if the assumptions change
- ***Scenario analysis*** **:** Examines several possible situations, usually worst case, most likely case, and best case. Provides a range of possible outcomes
- **Monte Carlo Simulation** : A computerized version of scenario analysis that uses continuous probability distributions. Automatically analyzes the effect of varying inputs on outputs (models) using spreadsheet. Computer selects values for each variable based on given probability distributions.

Example *Scenario analysis*

Scenario	Probability	NPV(000)
Best	0.25	$279
Base	0.50	88
Worst	0.25	-49
		E(NPV) = $101.6

Weaknesses with scenario analysis:

- Only considers a few possible out-comes.
- Assumes that inputs are perfectly correlated—all "bad" values occur together and all "good" values occur together.
- Focuses on stand-alone risk,

Qualitative and Quantitative Risk Analysis

- **Qualitative approach** expresses probability and/or impact using an ordinal rating system to denote order
  - Adjectives: high, medium, low
  - Colors: red, yellow, green
  - **Techniques :** Probability/impact matrixes, The Top Ten Risk Item Tracking. Expert judgment
- **Quantitative approach expresses** probability and/or impact using numeric data
  - 80% probability of occurrence
  - $10,000 impact
  - Three-week delay
- **Techniques** : Scenario Analysis, EMV, Simulations, Sensitivity Analysis

Sample Probability/Impact Matrix

Probability	Low	Medium	High
High	risk 6	risk 9	risk 1 risk 4
Medium	risk 3 risk 7	risk 2 risk 5 risk 11	
Low		risk 8 risk 10	risk 12

Impact

Top Ten Risk Item Tracking

	Monthly Ranking			
Risk Item	**This Month**	**Last Month**	**Number of Months**	**Risk Resolution Progress**
Inadequate planning	1	2	4	Working on revising the entire project plan
Poor definition of scope	2	3	3	Holding meetings with project customer and sponsor to clarify scope
Absence of leadership	3	1	1	Just assigned a new project manager to lead the project after old one quit
Poor cost estimates	4	4	5	Revising cost estimates
Poor time estimates	5	5	2	Revising schedule estimates

Risk Analysis Cont………

- **Estimate risk probability:**
  - Very low (< 10%)
  - Low (10-25%)
  - Moderate (25-50%)
  - High (50-75%)
  - Very high (> 75%)

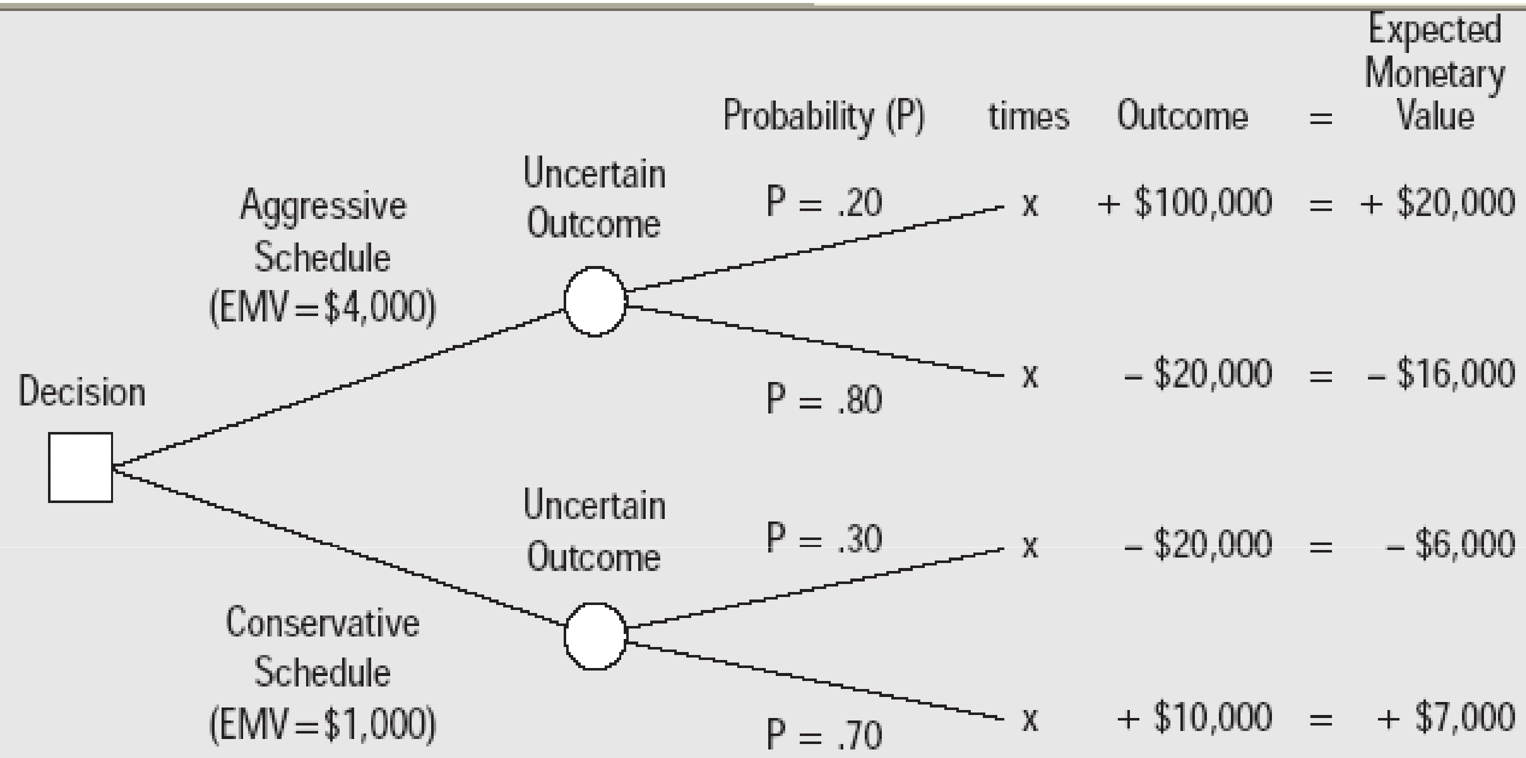
- **Establish risk seriousness:**
  - Insignificant
  - Tolerable
  - Serious
  - Catastrophic

Risk analysis (Cont..)

Risk	Probability	Effects
Organisational financial problems force reductions in the project budget.	Low	Catastrophic
It is impossible to recruit staff with the skills required for the project.	High	Catastrophic
Key staff are ill at critical times in the project.	Moderate	Serious
Software components that should be reused contain defects which limit their functionality.	Moderate	Serious
Changes to requirements that require major design rework are proposed.	Moderate	Serious
The organisation is restructured so that different management are responsible for the project.	High	Serious

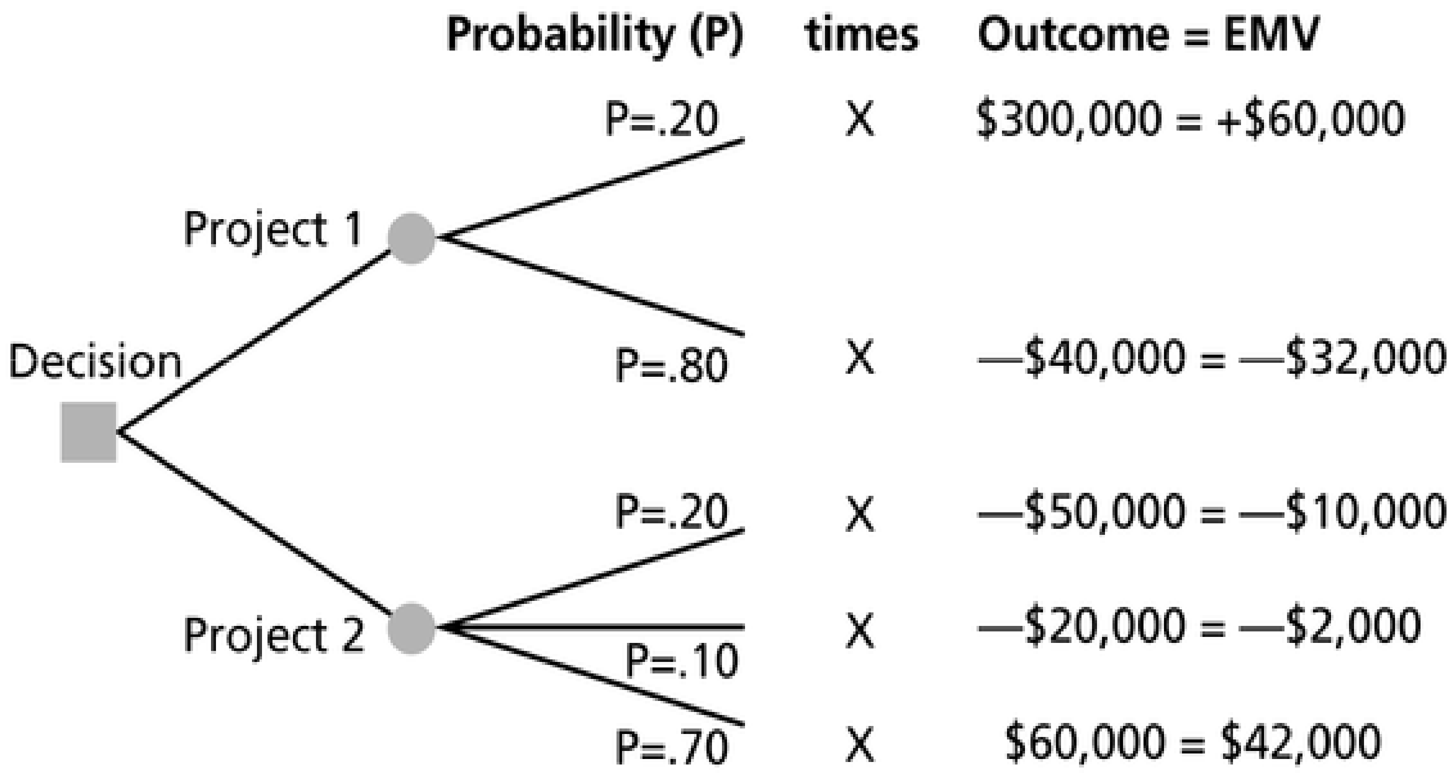
Decision Trees and Expected Monetary Value (EMV)

- A **decision tree** is a diagramming analysis technique used to help select the best course of action in situations in which future outcomes are uncertain.
- **Estimated monetary value (EMV)** is the product of a risk event probability and the risk event's monetary value.
- You can draw a decision tree to help find the EMV.



- Expected monetary value (EMV) of result = Outcome x Probability of that outcome.
- Expected monetary value of a decision = sum of EMVs of all Outcomes stemming from that decision.
- Aggressive schedule has expected monetary value of $4,000 and is "preferred" over conservative schedule with expected monetary value of $1,000.

Expected Monetary Value (EMV)



Project 1's EMV = $60,000 —32,000 = $28,000

Project 2's EMV = —$10,000 —2,000 + 42,000 = $30,000

Zoom

11.1 Risk Identification

.1 **Inputs**
- .1 Product description
- .2 Other planning outputs
- .3 Historical information

.2 **Tools and Techniques**
- .1 Checklists
- .2 Flowcharting
- .3 Interviewing

.3 **Outputs**
- .1 Sources of risk
- .2 Potential risk events
- .3 Risk symptoms
- .4 Inputs to other processes

11.2 Risk Quantification

.1 **Inputs**
- .1 Stakeholder risk tolerances
- .2 Sources of risk
- .3 Potential risk events
- .4 Cost estimates
- .5 Activity duration estimates

.2 **Tools and Techniques**
- .1 Expected monetary value
- .2 Statistical sums
- .3 Simulation
- .4 Decision trees
- .5 Expert judgment

.3 **Outputs**
- .1 Opportunities to pursue, threats to respond to
- .2 Opportunities to ignore, threats to accept

Parallels Between Qualitative and Quantitative Risk Analysis

Qualitative Analysis	Quantitative analysis
Uses ordinal rating to express probability and impact	Uses numbers to express probability and impact
Fast to calculate	More time is required
Easy to explain and use	It deals mainly on schedule and cost of the project
Not costly to produce	Costly and consumes more time
Involves simple calculations	Use computer

Risk Response Planning

- means preparing a strategy to deal with each of the risks identified
- Classes of strategies:
  - **Avoidance strategies:** the probability of the risk will be diminished
  - **Minimization strategies:** the effect of the risk will be reduced
  - **Contingency strategies:** plans for the worst case scenarios
  - Risk acceptance
  - Risk transference

Strategies for Positive Risks

- Risk exploitation
- Risk sharing
- Risk enhancement
- Risk acceptance

- **It's also important to identify residual and secondary:**
  - **Residual risks** are risks that remain after all of the response strategies have been implemented.
  - **Secondary risks** are a direct result of implementing a risk response.

Common sense Methods of dealing with Risks

- Collection of more detailed data to reduce measurement error
- Using more refined analytical techniques
- Increasing safety factors in design
- Selecting alternatives with better known performance characteristics
- Avoiding or reducing irreversible commitments
- Conduction sensitivity analysis during evaluation
- Account for decision makers’ and publics’ attitudes towards risk

Common sense Methods Cont…

- Explicitly present assumptions used in the analysis and justification for their use
- Identify all key variables : specify risk and uncertainty planning objectives
- Others include;
  - Manipulating fixed and variable cost
  - Sequential investment
  - Financial leverage : reducing dependence on debt
  - Insurance
  - Long term investments
  - Strategic alliance

Examples of risk management strategies

Risk	Strategy
Organisational financial problems	Prepare a briefing document for senior management showing how the project is making a very important contribution to the goals of the business.
Recruitment problems	Alert customer of potential difficulties and the possibility of delays, investigate buying-in components.
Staff illness	Reorganise team so that there is more overlap of work and people therefore understand each other's jobs.
Defective components	Replace potentially defective components with bought-in components of known reliability.

Risk	Strategy
Requirements changes	Derive traceability information to assess requirements change impact, maximise information hiding in the design.
Organisational restructuring	Prepare a briefing document for senior management showing how the project is making a very important contribution to the goals of the business.
Database performance	Investigate the possibility of buying a higher-performance database.
Underestimated development time	Investigate buying in components, investigate use of a program generator

Risk monitoring (Response control)

Frequently re-assess the risks

- Assess changes in risk probability and gravity
- Assess each identified risks regularly to decide whether or not it is becoming less or more probable.
- Also assess whether the effects of the risk have changed

Take into consideration risk factors

Discuss key risks at each management project progress meeting

11.3 Risk Response Development

- .1 **Inputs**
  - .1 Opportunities to pursue, threats to respond to
  - .2 Opportunities to ignore, threats to accept
- .2 **Tools and Techniques**
  - .1 Procurement
  - .2 Contingency planning
  - .3 Alternative strategies
  - .4 Insurance
- .3 **Outputs**
  - .1 Risk management plan
  - .2 Inputs to other processes
  - .3 Contingency plans
  - .4 Reserves
  - .5 Contractual agreements

11.4 Risk Response Control

- .1 **Inputs**
  - .1 Risk management plan
  - .2 Actual risk events
  - .3 Additional risk identification
- .2 **Tools and Techniques**
  - .1 Workarounds
  - .2 Additional risk response development
- .3 **Outputs**
  - .1 Corrective action
  - .2 Updates to risk management plan

What is Sensitivity Analysis ?

- Sensitivity Analysis *shows to what extent the viability of a project is influenced by variations in major quantifiable variables.*

- *A method for determining how "sensitive" your model results are to parameter values.*

- A deterministic Modeling technique used to test the impact of a change in a value of independent variable (s) **one or more** on a dependent variable . It is also called "what if analysis"

What is Sensitivity Analysis ? Cont..

- Analyzing project risks by making mechanical trial and error changes to forecast values of selected variables
- Analyzing the risks of investment projects, by changing the values of forecasted variables
- Finding the values of particular variables which give the project a Breakeven NPV of zero.

.what is Sensitivity Analysis? Cont...

- Projects do not always run to plan. Costs and benefits estimated at an early stage of a project may indicate a profitable project, but this profit could be eroded by an increase in costs or a decrease in the value of the benefits (the revenue).
- Sensitivity analysis provides a means of determining the financial impact of this type of fluctuation.
- By entering an anticipated percentage increase in costs or decrease in revenue the financial impact on the project can be identified by looking at the change to the NPV or IRR measures.

Sensitivity Analysis Cont..

- Focuses on Analyzing the effects of changes in key variables on the project's IRR or NPV the two most widely used measures of project worth. For example changes in demand : population growth, per capital consumption, tariff,

- It also assesses the relative impact of a change in a factor or variable on the project objectives for example through the use of sensitivity indicators (SI) or switching values (SV)

. The Purpose of Sensitivity Analysis

- To identify the key variables which influence the project cost and benefit streams. Such as demand, investment cost, O&M cost, financial revenues, economic benefits, financial benefits, tariffs, availability of raw materials (e.g water) and discount rates;

- To investigate the consequences of likely adverse changes in these key variables;

- To assess whether project decisions are likely to be affected by such changes;

- To identify actions that could mitigate possible adverse effects on the project.

Sensitive variables are investigated and managed in two ways:

- (1) *Ex ante;* in the planning phase; more effort is used to create better forecasts of future values. If management decides the project is too risky, it is abandoned at this stage

- (2) *Ex post*; in the project execution phase; management monitors the forecasted values. If the project is performing poorly, it is abandoned or sold off prior to its planned termination

Sensitive variables are variables having significant impacts on the NPV

. Steps of Sensitivity Analysis

1. **Identify key variables to which the project decision may be sensitive;**

Selection Criteria For sensitive variables

- *variables which may be numerically big,*
- *Variables which are very essential though may be very small e.g price*
- *Variables affected by economic changes*

Others include;

- Degree of management control.
- Management's confidence in the forecasts.
- Amount of management experience in assessing projects.
- Extrinsic variables more problematic than intrinsic variables.
- Time and cost of analyses

2. **Decide what are the key variables which need to be investigated (**The variables are ranked in the order of their monetary impact on the NPV)**;**

3. **Calculate effects of changing variables;**

- The values of the basic indicators of project viability e.g. NPV and IRR need to be recalculated for different values of key variables using sensitivity indicators (SI) or switching values (SV)

Steps of Sensitivity Analysis Cont..

- Sensitivity Indicator is the value which compares percentage change in project objectives or targets in terms of NPV or IRR with percentage change in a variable or combination of variables
- The switching value for a key variable is the maximum variation (in percentage) in the value of the variable that is permitted before the NPV (whichever is relevant for that specific key variable) turns negative OR the percentage change in a variable or combination of variables to reduce the IRR to the cut-off rate (discount rate).
- The switching value by definition is the reciprocal of the sensitivity indicator

Sensitivity Indicators and Switching Values

	Sensitivity Indicator	Switching Value
Definition	1. Towards the Net Present Value Compares percentage change in NPV with percentage change in a variable or combination of variables. 2. Towards the Internal Rate of Return Compares percentage change in IRR above the cut-off rate with percentage change in a variable or combination of variables.	1. Towards the Net Present Value The percentage change in a variable or combination of variables to reduce the NPV to zero (0). 2. Towards the Internal Rate of Return The percentage change in a variable or combination of variables to reduce the IRR to the cut-off rate (=discount rate).

Sensitivity Indicators   Switching Values

	Sensitivity Indicators	Switching Values
Expression	**1. Towards the Net Present Value** $$SI = \frac{(NPV_b - NPV_1) / NPV_b}{(X_b - X_1) / X_b}$$ where: X_b - value of variable in the base case X_1 - value of the variable in the sensitivity test NPV_b - value of NPV in the base case NPV_1 - value of the variable in the sensitivity test **2. Towards the Internal Rate of Return** $$SI = \frac{(IRR_b - IRR_1) / (IRR_b - d)}{(X_b - X_1) / X_b}$$ where: X_b - value of variable in the base case X_1 - value of the variable in the sensitivity test IRR_b - value of IRR in the base case IRR_1 Value of the variable in the sensitivity test d - discount rate	**1. Towards the Net Present Value** $$SV = \frac{(100 \text{ x } NPV_b)}{(NPV_b - NPV_1)} \text{ x } \frac{(X_b - X_1)}{X_b}$$ where: X_b - value of variable in the base case X_1 - value of the variable in the sensitivity test NPV_b – value of NPV in the base case NPV_1 – value of the variable in the sensitivity test **2. Towards the Internal Rate of Return** $$SV = \frac{(100 \text{ x } (IRR_b - d)}{(IRR_b - IRR_1)} \text{ x } \frac{(X_b - X_1)}{X_b}$$ where: X_b - value of variable in the base case X_1 - value of the variable in the sensitivity test IRR_b - value of IRR in the base case IRR_1 – value of the variable in the sensitivity test d - discount rate

	Sensitivity Indicator	Switching Value
Calculation example	**1. Towards the Net Present Value** Base Case: Price $= P_b = 300$ $NPV_b = 20{,}912$ Scenario 1: $P_1 = 270$ (10% change) $NPV_1 = 6{,}895$ $SI = \dfrac{(20{,}912 - 6{,}895) / 20{,}912}{(300 - 270) / 300} = 6.70$ **2. Towards the Internal Rate of Return** Base Case: Price $= P_b = 300$ $IRR_b = 15.87\%$ Scenario 1: $P_1 = 270$ (10% change) $IRR_1 = 13.31\%$ $d = 12\%$ $SI = \dfrac{(0.1587 - 0.1331) / (0.1587 - 0.12)}{(300 - 270) / 300}$ $= 6.61$	**1. Towards the Net Present Value** Base Case: Price $= P_b = 300$ $NPV_b = 20{,}912$ Scenario 1 $P_1 = 270$ (10% change) $NPV_1 = 6{,}895$ $SV = \dfrac{(100 \times 20{,}912)}{(20{,}912 - 6{,}895)} \times \dfrac{(300-270)}{300} = 14.9\%$ **2. Towards the Internal Rate of Return** Base Case: Price $= P_b = 300$ $IRR_b = 15.87\%$ Scenario 1: $P_1 = 270$ (10% change) $IRR_1 = 13.31\%$ $d = 12\%$ $SV = \dfrac{(100 \times (0.1587 - 0.12))}{(0.1587 - 0.1331)} \times \dfrac{(300-270)}{300}$ $= 15.1\%$

	Sensitivity Indicators	Switching Values
Interpretation	(i) percentage change in NPV respectively (ii) percentage change in IRR above the cut-off rate (12%)is larger than percentage change in variable: price is a key variable for the project.	A change of approximately 15 % in the price variable is necessary before the NPV becomes zero or before the IRR equals the cut-off rate.
Characteristic	Indicates to which variables the project result is or is not sensitive. Suggests further examination of change in variable.	Measures extent of change for a variable which will leave the project decision unchanged.

Steps of Sensitivity Analysis Cont..

4. Analyze effects of change of key variables on project objectives /targets

Consider the following example

Table 7.1 **Base Case of a Water Supply Project**

Economic statement	PV @12%	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Benefits:											
- Non-incremental water	1,674	0	225	270	315	360	405	450	450	450	450
- Incremental water	167	0	23	27	32	36	41	45	45	45	45
- Non-technical losses	263	0	35	42	50	57	64	71	71	71	71
Total	2,104	0	283	339	396	453	509	566	566	566	566
Costs:											
- Investment	1,687	1,889	0	0	0	0	0	0	0	0	0
- O&M	291	0	61	61	61	61	61	61	61	61	61
Total	1,978	1,889	61	61	61	61	61	61	61	61	61
Net cash flow	126	-1,889	222	278	335	391	448	505	505	505	505

Example cont..

- In the base case, the NPV is 126 and the IRR is 13.7 percent.

- The sensitivity of the base case NPV has been analyzed for (adverse) changes in several key variables, as follows:
  - *An increase in investment cost by 20 percent;*
  - *A decrease in economic benefits by 20 percent;*
  - *An increase in costs of operation and maintenance by 20 percent.*
  - *A delay in the period of construction, causing a delay in revenue generation by one year*.

Example cont..

- The effects of the above changes are summarized as follows;.

Table 7.2 Sensitivity Analysis: A Numerical Example					
Item	Change	NPV	IRR %	SI (NPV)	SV (NPV)
Base Case		126	13.7		
Investment	+ 20%	- 211	9.6	13.3	7.5%
Benefits	- 20%	-294	7.8	16.6	6%
O&M Costs	+ 20%	68	12.9	2.3	43.4%
Construction delays	one year	-99	10.8	NPV 178% lower	
SI = Sensitivity Indicator, SV = Switching Value					
Source: Based on the data in Table 7.1.					

Steps of Sensitivity Analysis Cont

5. Then interpret results of sensitivity analysis

Example Cont…

- **For example;** *In the case of an increase in investment costs of 20 percent, the sensitivity indicator is 13.34. This means that the change of 20 percent in the variable (investment cost) results in a change of (13.3 x 20 percent) = 266 percent in the NPV. It follows that the higher the SI, the more sensitive the NPV is to the change in the concerned variable.*

- *In the same example, the switching value is 7.5 percent which is the reciprocal value of the SI x 100. This means that a change (increase) of 7.5 percent in the key variable (investment cost) will cause the NPV to become zero. The lower the SV, the more sensitive the NPV is to the change in the variable concerned and the higher the risk with the project.*

Another Illustration: Cash Flow Impact

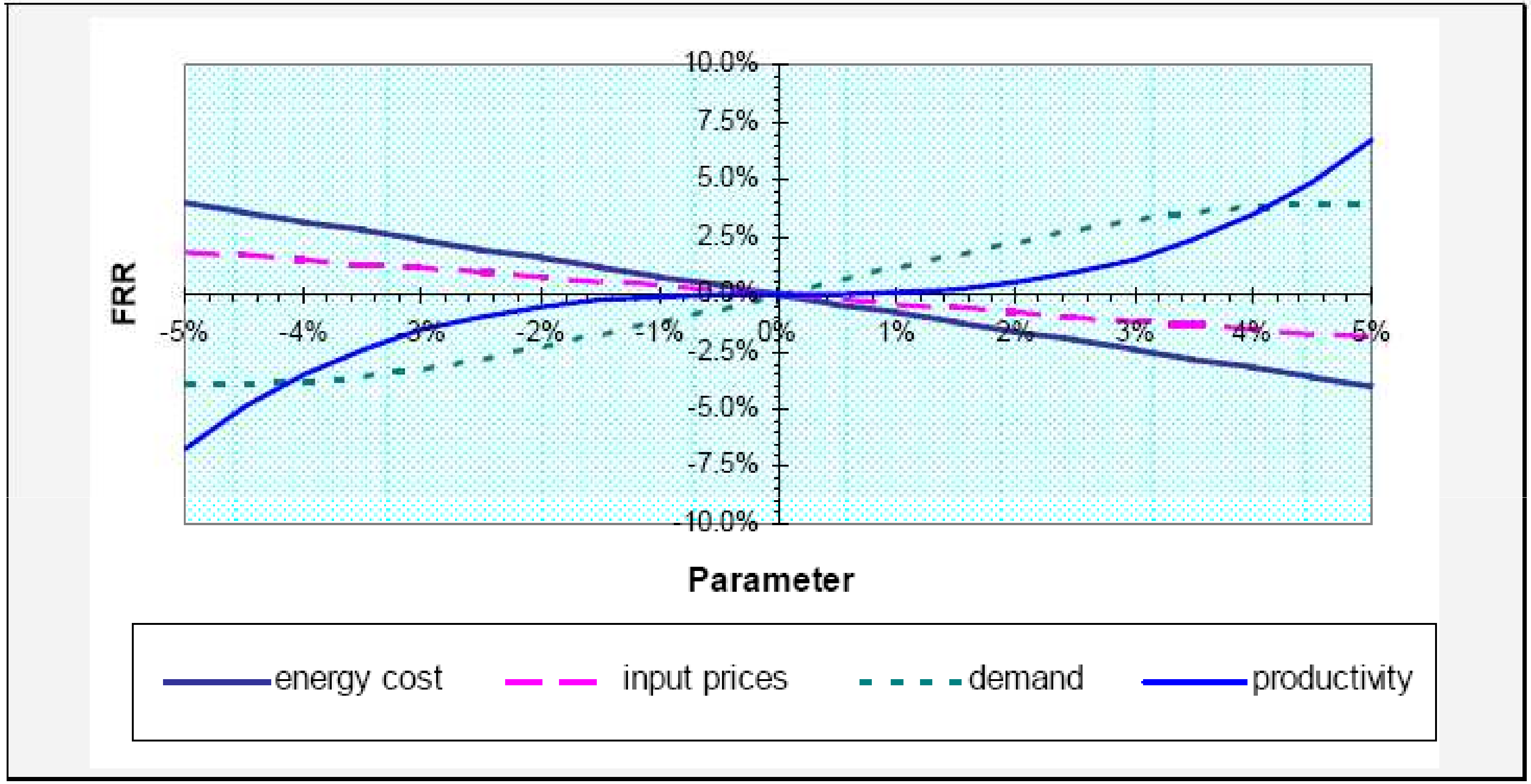
Scenario 1 – Benefits begin accruing in Year 2:

	Yr 0	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Total
Total Benefits ($m)			20	80	170	170	170	170	170	170	170	1290
Total Costs ($m)	-150	-150	-100	-60	-60	-60	-60	-60	-60	-60	-60	-880
Net Benefits ($m)	-150	-150	-80	20	110	110	110	110	110	110	110	410
NPV ($m)	$43.57											
Discount Rate	11%											

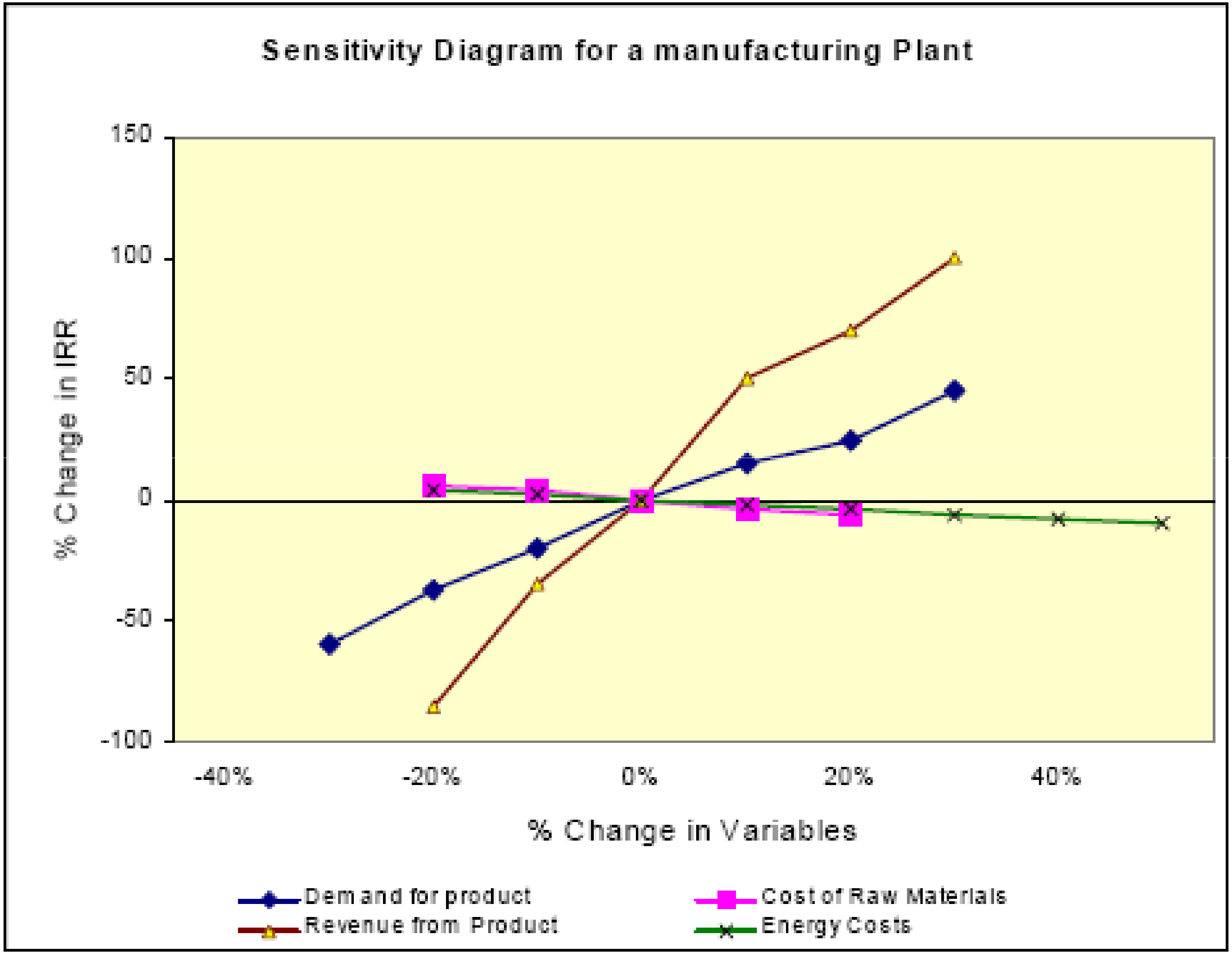
Scenario 2 – Benefits begin accruing in Year 3:

	Yr 0	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Total
Total Benefits ($m)				20	80	170	170	170	170	170	170	1120
Total Costs ($m)	-150	-150	-100	-60	-60	-60	-60	-60	-60	-60	-60	-880
Net Benefits ($m)	-150	-150	-100	-40	20	110	110	110	110	110	110	240
NPV ($m)	-$75.82											
Discount Rate	11%											

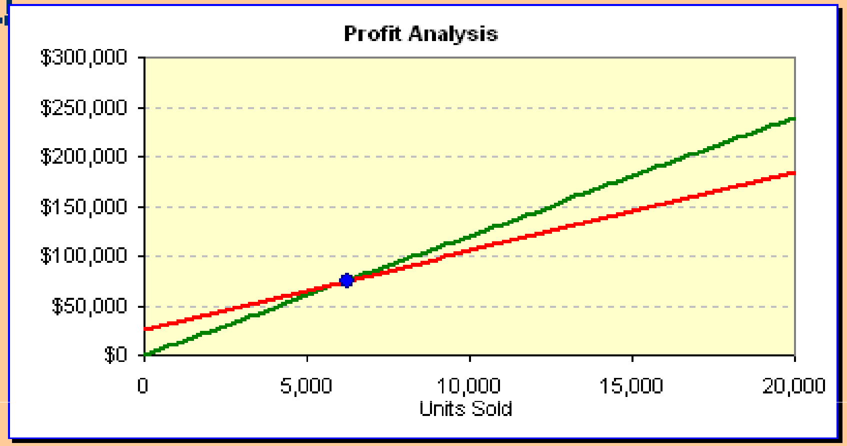
. Sample Sensitivity analysis



Source: Guide to Cost-Benefit Analysis of Investment Projects, European Commission, 2008


Sensitivity Diagram for a manufacturing Plant
150
100
50
0
-50
-100
% Change in IRR
-40%
-20%
0%
20%
40%
% Change in Variables
Demand for product
Revenue from Product
Cost of Raw Materials
Energy Costs

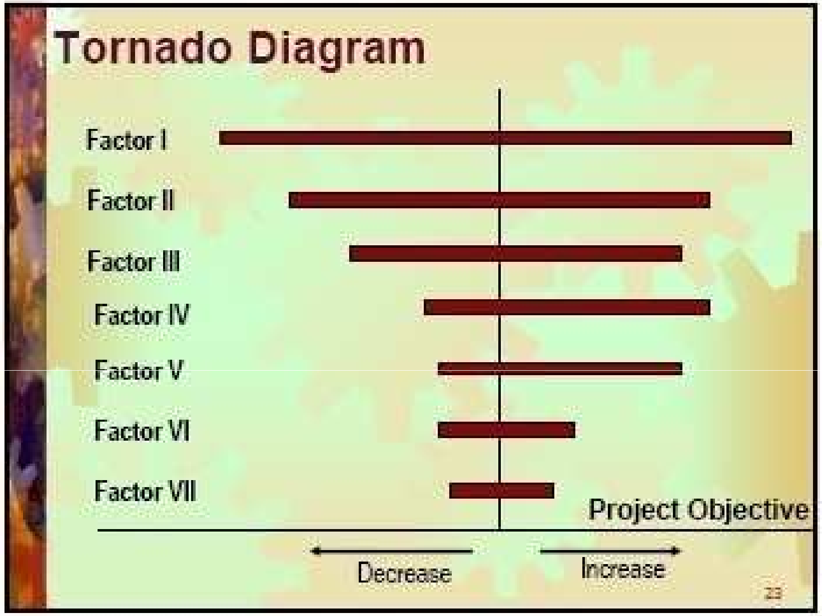
Sensitivity Analysis for Determining Break-Even Point

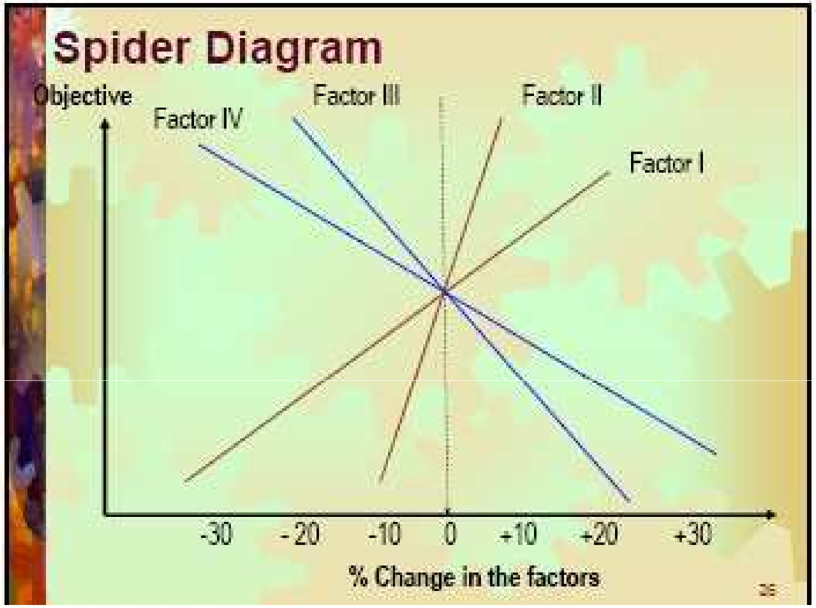


Sales Price per Unit:	$12
Manufacturing Cost per Unit:	$8
Fixed Monthly Expense:	$25,000
Break-Even Point (Units Sold):	6,250
Revenue at Break-Even Point:	$75,000

Units Sold	Revenue	Expense
0	$0	$25,000
500	6,000	29,000
1,000	12,000	33,000
1,500	18,000	37,000
2,000	24,000	41,000
2,500	30,000	45,000
3,000	36,000	49,000
3,500	42,000	53,000
4,000	48,000	57,000
4,500	54,000	61,000
5,000	60,000	65,000
5,500	66,000	69,000
6,000	72,000	73,000
6,500	78,000	77,000
7,000	84,000	81,000
7,500	90,000	85,000
8,000	96,000	89,000
8,500	102,000	93,000
9,000	108,000	97,000
9,500	114,000	101,000
10,000	120,000	105,000
10,500	126,000	109,000
11,000	132,000	113,000
11,500	138,000	117,000
12,000	144,000	121,000
12,500	150,000	125,000
13,000	156,000	129,000
13,500	162,000	133,000
14,000	168,000	137,000
14,500	174,000	141,000

Tornado Vs Spider Diagram





The longer the bar the greater the sensitivity of the project objectives to the factor

The steeper the slope of the line, the more sensitive the project objective is to the factor or variable.

Strengths and Weaknesses of Sensitivity Analysis

- Gives some idea of stand-alone risk.
- Easy to understand.
- Forces planning discipline.
- Helps to highlight risky variables.
- Relatively cheap.
- --------- --------- ---------
- Relatively unsophisticated.
- May not capture all information.
- In most cases, limited to one variable at a time.
- Ignores interdependencies (Ignores relationships between variables)

9.7. Limitations of risk analysis

The application of risk analysis to investment projects has two main limitations:

- The probability distribution for the key variables is in most cases unknown. For example, if the probability distribution for the key variables is assumed to be uniform, triangular or skewed, the results of the risk analysis will be different.

- Investment projects cannot be assimilated to stochastic processes that can be repeated an unlimited number of times so we can expect the final outcome will converge around an expected value.

- We can use risk analysis to convey an idea of overall risk or *robustness* of the NPV but no to identify individual risks and associated mitigating measures.

Thank You

Questions!!!!!

In your semester assignment, identify potential sources of project risks, develop risk management strategies and perform various sensitivity tests

Project Time Management

IE : Engineering Project Management

27th   January , 2018

Outline of the Talk

- **Introduction to Project Time Management**
- **Why Project Time management**
- **Key terms**
- **Project Time Management Processes**
- **Scheduling :The Critical Path Method (CPM), Program Evaluation and Review Technique (PERT)**
- **Similarities and Differences Between PERT and CPM**
- **Conclusion**

Introduction to Project Time Management

- **Managers often cite delivering projects on time as one of their biggest challenges**
- **All the processes required to ensure timely completion of the project**
- **Project time management involves:**
  - Activity definition
  - Activity sequencing
  - Activity duration estimation
  - Schedule development
  - Schedule control

Why Project Time Management

- **Project Managers need to find answers to the following question;**
  - What is a total time to complete a project ?
  - What are scheduled start and end dates of each activity?
  - What activities are critical and which activities are non-critical?
  - How long a non- critical activity can be delayed without affecting total Project completion time?

Key Terms

- **Activity**
  - A specific task or set of tasks that are required by the project, use up resources and take time to complete
- **Event**
  - The result of completing one or more activities
- **Network**
  - A combination of interconnected activities and events depicted with lines and nodes
- **A node**
  - An intersection of two or more lines or arrows commonly used for depicting event
- Path
  - Series of connected activities (intermediate or events) between any two events in a network
- Critical
  - Activities, events, or paths which, if delayed will delay the total completion time of the project

Project Time Management

6.1 Activity Definition

- .1 **Inputs**
  - .1 Work breakdown structure
  - .2 Scope statement
  - .3 Historical information
  - .4 Constraints
  - .5 Assumptions
- .2 **Tools and Techniques**
  - .1 Decomposition
  - .2 Templates
- .3 **Outputs**
  - .1 Activity list
  - .2 Supporting detail
  - .3 Work breakdown structure updates

6.2 Activity Sequencing

- .1 **Inputs**
  - .1 Activity list
  - .2 Product description
  - .3 Mandatory dependencies
  - .4 Discretionary dependencies
  - .5 External dependencies
  - .6 Constraints
  - .7 Assumptions
- .2 **Tools and Techniques**
  - .1 Precedence diagramming method (PDM)
  - .2 Arrow diagramming method (ADM)
  - .3 Conditional diagramming methods
  - .4 Network templates
- .3 **Outputs**
  - .1 Project network diagram
  - .2 Activity list updates

6.3 Activity Duration Estimating

- .1 **Inputs**
  - .1 Activity list
  - .2 Constraints
  - .3 Assumptions
  - .4 Resource requirements
  - .5 Resource capabilities
  - .6 Historical information
- .2 **Tools and Techniques**
  - .1 Expert judgment
  - .2 Analogous estimating
  - .3 Simulation
- .3 **Outputs**
  - .1 Activity duration estimates
  - .2 Basis of estimates
  - .3 Activity list updates

6.4
Schedule Development

.1 **Inputs**
- .1 Project network diagram
- .2 Activity duration estimates
- .3 Resource requirements
- .4 Resource pool description
- .5 Calendars
- .6 Constraints
- .7 Assumptions
- .8 Leads and Lags

.2 **Tools and Techniques**
- .1 Mathematical analysis
- .2 Duration compression
- .3 Simulation
- .4 Resource leveling heuristics
- .5 Project management software

.3 **Outputs**
- .1 Project schedule
- .2 Supporting detail
- .3 Schedule management plan
- .4 Resource requirement updates

6.5
Schedule Control

.1 **Inputs**
- .1 Project schedule
- .2 Performance reports
- .3 Change requests
- .4 Schedule management plan

.2 **Tools and Techniques**
- .1 Schedule change control system
- .2 Performance measurement
- .3 Additional planning
- .4 Project management software

.3 **Outputs**
- .1 Schedule updates
- .2 Corrective action
- .3 Lessons learned

Project Time Management Processes cont..

Defining Activities

- **Project schedules grow out of the basic document that initiate a project**
  - **Project charter includes start and end dates and budget information**
  - **Scope statement and WBS help define what will be done**
- **Activity definition involves developing a more detailed WBS and supporting explanations to understand all the work to be done**

Activity Sequencing

- Involves reviewing activities and determining dependencies
- You *must* determine dependencies in order to use critical path analysis

Project Network Diagrams

- **Project network diagrams are the preferred technique for showing activity sequencing**
- **A project network diagram is a schematic display of the logical relationships among, or sequencing of, project activities**

Figure 5-2. Task Dependency Types

Microsoft Project

Help Topics | Options | Back | Map

Task dependencies

The nature of the dependencies between linked tasks. You link tasks by defining a dependency between their finish and start dates. For example, the "Contact caterers" task must finish before the start of the "Determine menus" task. There are four kinds of task dependencies in Microsoft Project:

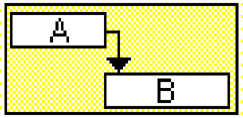
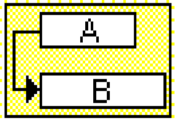
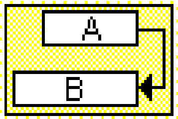
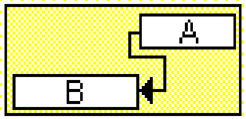
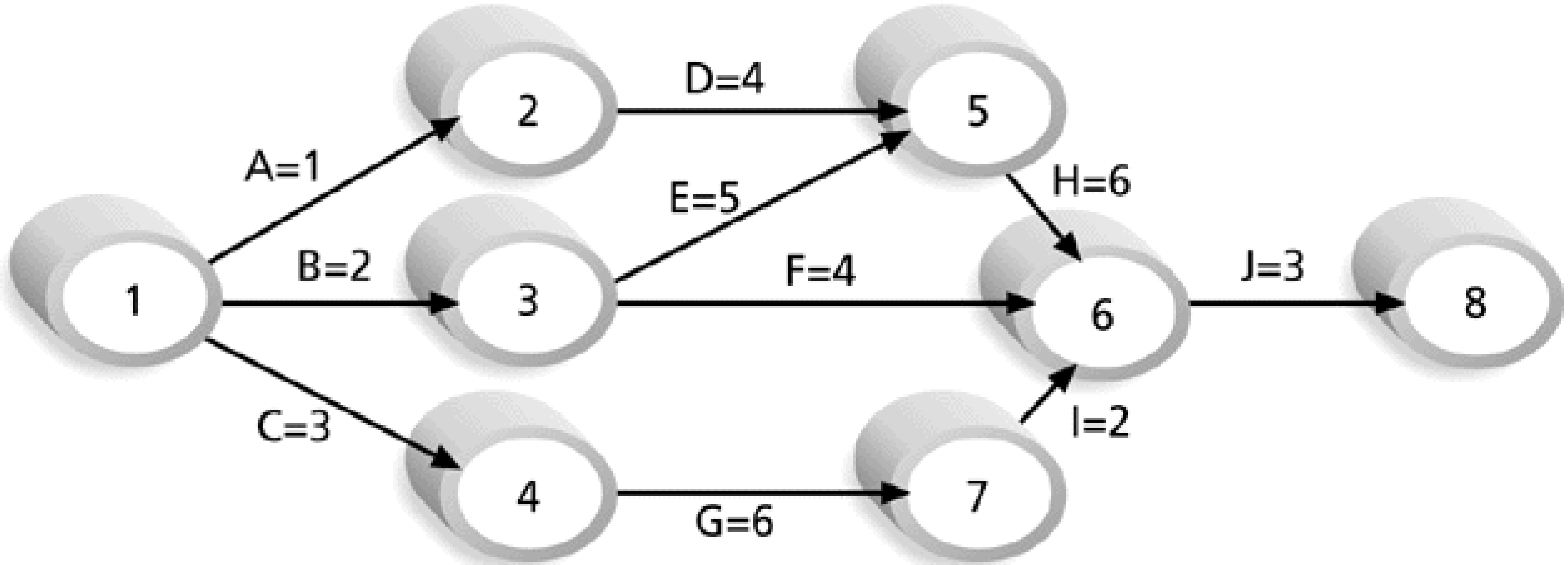
Task dependency	Example	Description
Finish-to-start (FS)		Task (B) cannot start until task (A) finishes.
Start-to-start (SS)		Task (B) cannot start until task (A) starts.
Finish-to-finish (FF)		Task (B) cannot finish until task (A) finishes.
Start-to-finish (SF)		Task (B) cannot finish until task (A) starts.

Figure 5-2. Sample Activity-on-Arrow (AOA) Network Diagram for Project X



Note: Assume all durations are in days; A=1 means Activity A has a duration of 1 day.

Activity Duration Estimating

- After defining activities and determining their sequence, the next step in time management is duration estimating
- Duration includes the actual amount of time worked on an activity *plus* elapsed time
- People doing the work should help create estimates, and an expert should review them

Schedule Development

- **Schedule development uses results of the other time management processes to determine the start and end date of the project and its activities**
- **Ultimate goal is to create a realistic project schedule that provides a basis for monitoring project progress for the time dimension of the project**
- **Important tools and techniques include Gantt charts, PERT analysis, and critical path analysis**

Critical Path Method (CPM)

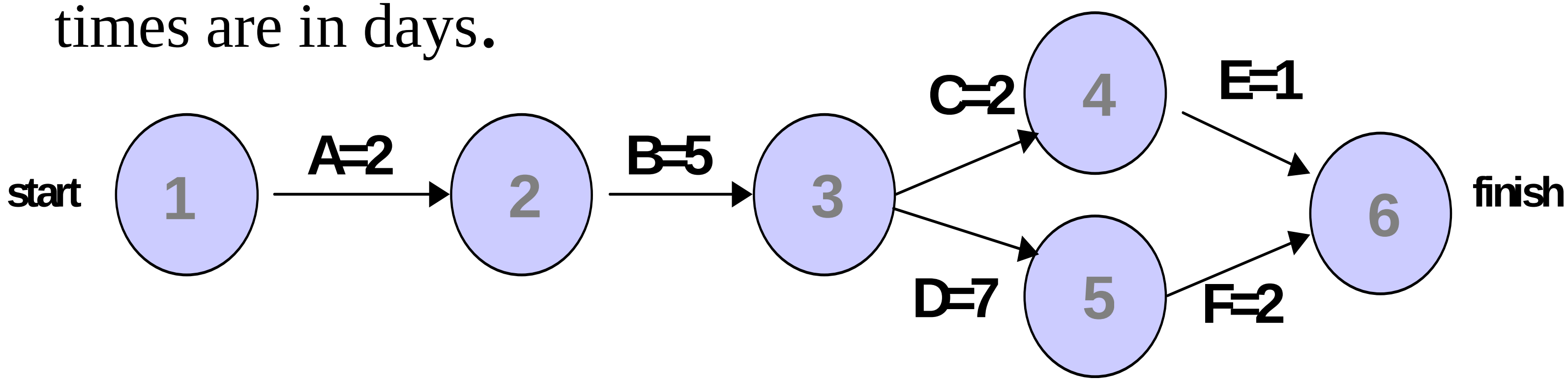
- CPM is a project network analysis technique used to predict total project duration
- A critical path for a project is the series of activities that determines the *earliest time* by which the project can be completed
- The critical path is the *longest path* through the network diagram and has the least amount of slack or float

Finding the Critical Path

- **First develop a good project network diagram**
- **Add the durations for all activities on each path through the project network diagram**
- **The longest path is the critical path**

Simple Example of Determining the Critical Path

- Consider the following project network diagram. Assume all times are in days.



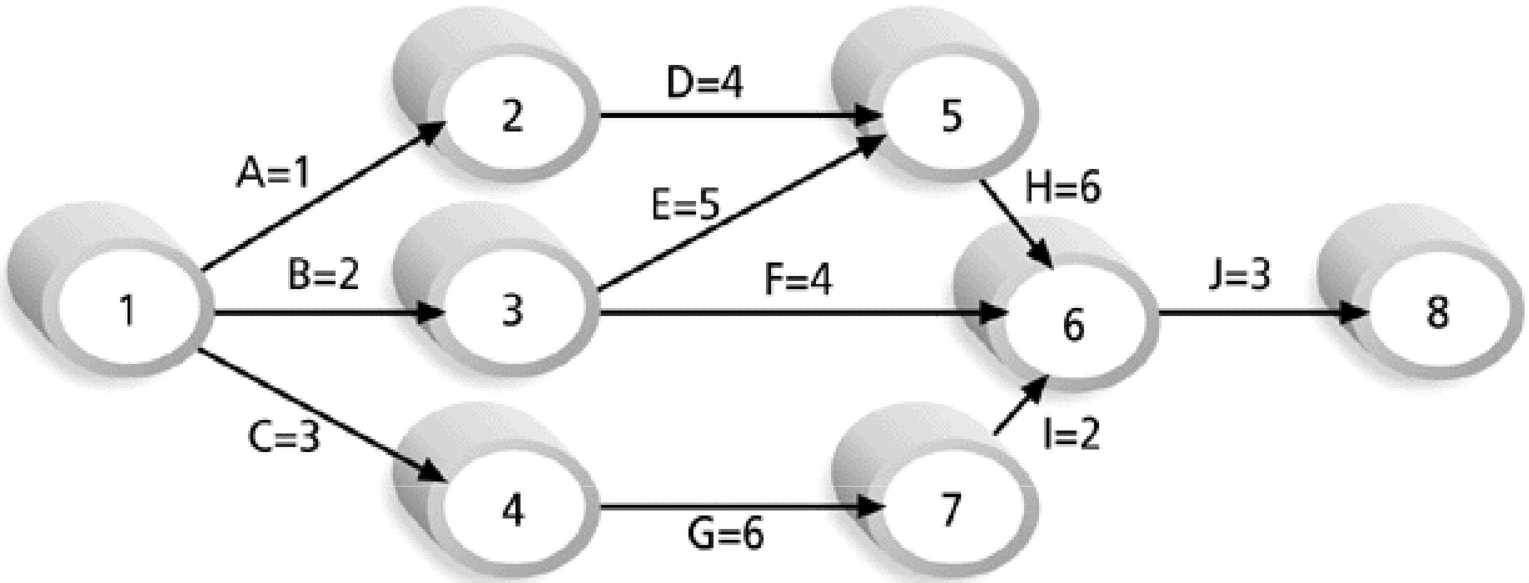
a. How many paths are on this network diagram?

b. How long is each path?

c. Which is the critical path?

d. What is the shortest amount of time needed to complete this project?

Figure 5-8. Determining the Critical Path for



Note: Assume all durations are in days.

Path 1:	A-D-H-J	Length = 1+4+6+3 = 14 days
Path 2:	**B-E-H-J**	**Length = 2+5+6+3 = 16 days**
Path 3:	B-F-J	Length = 2+4+3 = 9 days
Path 4:	C-G-I-J	Length = 3+6+2+3 = 14 days

Since the critical path is the longest path through the network diagram, Path 2, B-E-H-J, is the critical path for Project X.

Program Evaluation and Review Technique (PERT)

- PERT is a network analysis technique used to estimate project duration when there is a high degree of uncertainty about the individual activity duration estimates
- PERT uses probabilistic time estimates based on using optimistic, most likely, and pessimistic estimates of activity durations

PERT Formula and Example

- **PERT weighted average** formula:

$$\frac{\text{optimistic time} + 4X \text{ most likely time} + \text{pessimistic time}}{6}$$

- Example:

PERT weighted average =

$$\frac{8 \text{ workdays} + 4 \text{ X } 10 \text{ workdays} + 24 \text{ workdays}}{6} = 12 \text{ days}$$

where 8 = optimistic time, 10 = most likely time, and 24 = pessimistic time

Example

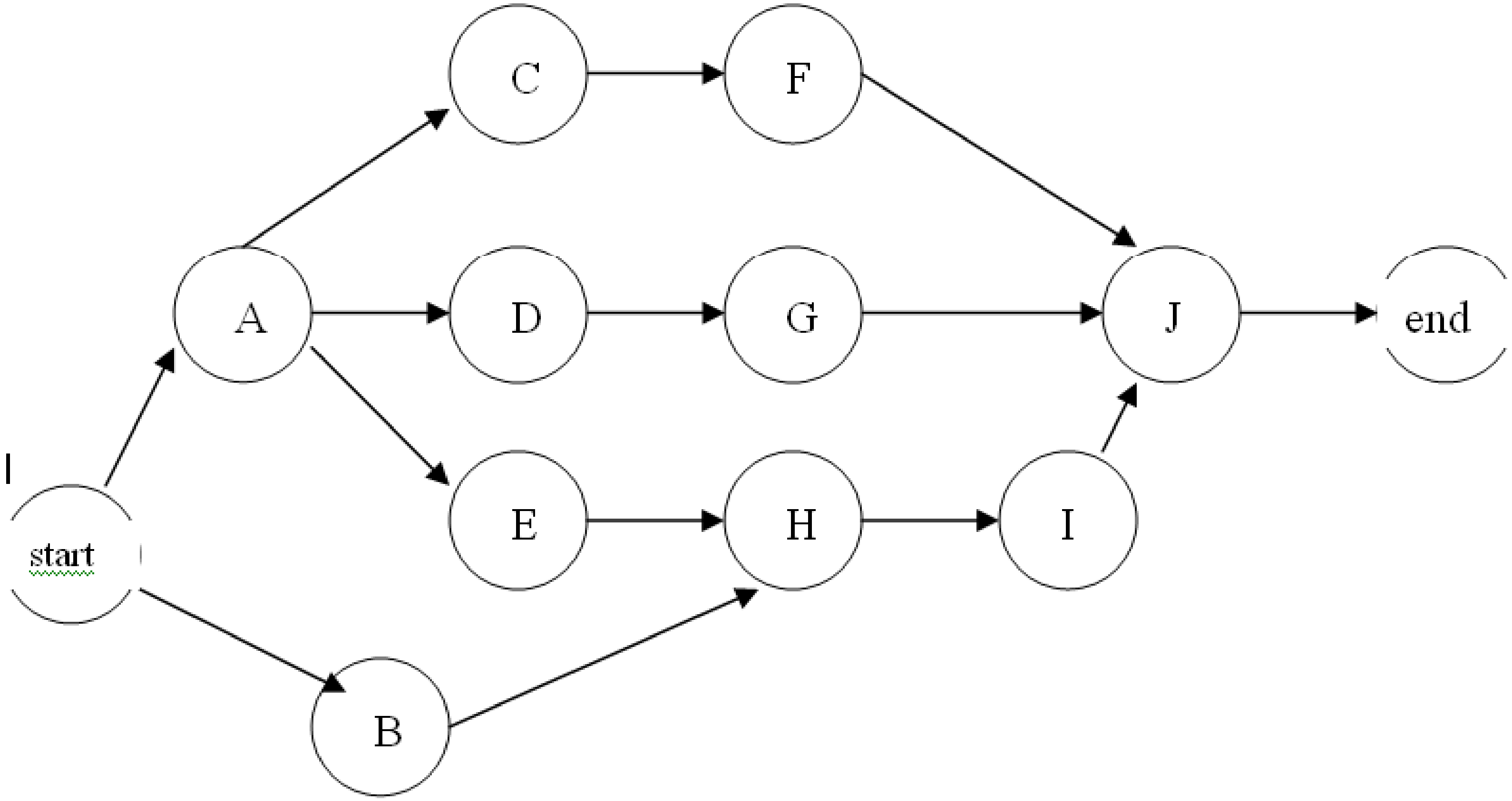
The following information has been extracted from the product design project of the J'S manufacturing company ltd.

Activity	*Description*	*Time in Months*			*Immediate predecessor*
		Optimistic	*Most likely*	*pessimistic*	
A	Develop product design	4	5	12	-
B	Plan market research	1	1.5	5	-
C	Prepare routing(Manufacturing Engineering)	2	3	4	A
D	Build prototype model	3	4	11	A
E	Prepare marketing brochure	2	3	4	A
F	Prepare cost estimates(Industrial Engineering)	1.5	2	2.5	C
G	Do preliminary product testing	1.5	3	4.5	D
H	Complete market survey	2.5	3.5	7.5	B,E
I	Prepare pricing and forecasting report	1.5	2	2.5	H
J	Prepare final report	1	2	3	F, G, I

- i. Develop network diagram using Precedence Diagramming Method (PDM) to represent the above project information
- ii. Determine the total float associated with each of the non-critical activities
- iii. Determine the ***minimum*** project completion time and identify the critical path
- iv. Compute the probability of completing the project in 20 months
- v. Determine the completion time corresponding to 95% probability
- vi. If the project must be completed within one and half years do you anticipate any problem
- vi. What effect, if any, will each of the following changes have on the completion time of the project:
  - Activity D is delayed by 4 months
  - Activity E is delayed by 3 months;
  - Activity C is finished 1 month early.
  - Activity E is finished 1 month early

Solutions:

i. Develop network diagram using Precedence Diagramming Method (PDM) to represent the above project



ii. Determine the total float associated with each of the non-critical activities

Activity	***Time in Months***			***Immediate predecessor***	***Expected time(TE) Months***	***Variance***
	Optimistic	***Most likely***	***pessimistic***			
A	4	5	12	-	6	1.78
B	1	1.5	5	-	2	0.44
C	2	3	4	A	3	0.11
D	3	4	11	A	5	1.78
E	2	3	4	A	3	0.11
F	1.5	2	2.5	C	2	0.03
G	1.5	3	4.5	D	3	0.25
H	2.5	3.5	7.5	B,E	4	0.69
I	1.5	2	2.5	H	2	0.03
J	1	2	3	F, G, I	2	0.11

$$\textbf{TE} = \frac{\text{optimistic time} + 4\text{X most likely time} + \text{pessimistic time}}{6}$$

$$\textbf{Variance} = \frac{[\text{pessimistic time} - \text{optimistic time}]^2}{36}$$

Activity	*TE (Expected Time) in months*	*EST*	*EFT*	*LST*	*LFT*	*Slack*	*Critical Path*
A	6	*0*	*6*	*0*	*6*	*0*	*yes*
B	2	*0*	*2*	*7*	*9*	*7*	*no*
C	3	*6*	*9*	*10*	*13*	*4*	*no*
D	5	*6*	*11*	*7*	*12*	*1*	*no*
E	3	*6*	*9*	*6*	*9*	*0*	*yes*
F	2	*9*	*11*	*13*	*15*	*4*	*no*
G	3	*11*	*14*	*12*	*15*	*1*	*no*
H	4	*9*	*13*	*9*	*13*	*0*	*yes*
J	2	*13*	*15*	*13*	*15*	*0*	*yes*
J	2	*15*	*17*	*15*	*17*	*0*	*yes*

Note

- *EST= Earliest Starting Time of Activity i (= earliest finishing time of preceding activity + duration of the activity i*
- *EFT= Earliest Finishing Time of activity i (=Earliest Starting Time of Activity I + Duration of activity i)*
- *LFT= Latest finishing time for activity i (=Latest stating time of preceding activity)*
- *LST= Latest Starting time for activity i(Latest finishing time of forthcoming activity- duration of activity i)*
- Slack = LST-EST = LFT-EFT

iii. Determine the minimum project completion time and identify the critical path

Minimum completion time of the project is 17 weeks and route A, E,H,I,J is the critical path

iv. Compute the probability of completing the project in 20 weeks

$$Z = \frac{\text{Specified time} - \text{Path mean}}{\text{Path standard deviation}}$$

$$= \frac{20 - 17}{\sqrt{1.78 + 0.11 + 0.69 + 0.03 + 0.11}}$$

$$= 1.82$$

From the table the probability corresponding to 1.82 is P=0.9656(96.56%)

- v. The **completion time corresponding to 95%** probability
- *P = 0.95 corresponds to Z=1.65*

- vi. If the project must be completed within half a year do you anticipate any problem?

- The answer is NO one and half years = 18 months while the project completion time is 17 months

- vi. What effect, if any, will each of the following changes have on the completion time of the project?
  - Activity D is delayed by 4 months
- *The **project completion time will be 20 months***
  - Activity E is delayed by 3 months;
- *The **project completion time will be 20 months***
  - Activity C is finished 1 month early.
- *The **project completion time will be 17 months***
- *there will be no effect to project completion time*
  - Activity E is finished 1 month early
- *The **project completion time will be 16 months***
  - *there will be two critical paths, A, E,H,I,J and A,D,G,J*

Similarities and differences between CPM & PERT

- ✓ Both techniques **CPM** and **PERT** use network methods to assist in project management and to overcome the interrelationship limitation in Gantt charts.
- ✓ Both these techniques **CPM & PERT** identify a *project critical path* whose activities could not be delayed, and also indicate *slack activities* that could be somewhat delayed without lengthening the project completion time.

CPM & PERT: Difference

✓ CPM and PERT have the underlying difference. From its origin viewpoint, the **CPM** technique was developed for *construction* projects, while **PERT** was elaborated for *research and development* projects.

CPM

- ✓In the *construction industry*, prior experience with similar projects can be used to predict time estimates for projects within a relatively tight range.
- ✓In the CPM method the expected activity time is a *single point estimate* that assumes certainty: each activity is considered of exact fixed length. That is, CPM assumes that time is **predictable or deterministic**.

PERT

- ✓ However, with *research* and *development projects*, a great deal of uncertainty is associated with time estimates because no previous similar experience exists and precise time estimates are not available.
- ✓ PERT assumes the time estimate for an activity lies within the range of earliest time and latest time.

PERT [Gray, 1981]

- ✓PERT uses *three time estimates* (optimistic, most likely, and pessimistic) to compute the average or expected time.
- ✓PERT offers a way of dealing with **random variation** and considers each activity **stochastic** in that variability is allowed in each activity.

PERT [Plekhanova, 1998; Plekhanova 2000]

- ✓It should be pointed out, that PERT was developed for *research* and *development projects*, which consist of *cognitive tasks*.
- ✓However, PERT is not concerned with the specific character of cognitive tasks.

CPM & PERT

- ✓ **PERT&CPM** have been found to be useful in project management to provide efficient resource scheduling. In particular, PERT&CPM identify the critical jobs, which control the project completion date.
- ✓ Moreover, the application of these tools reduces the degree of scheduling errors and, hence, increases the cost savings.

CPM & PERT

- ✓ However, as mentioned in project management literature, the actual savings derived from using PERT&CPM methods are difficult to identify and measure precisely.

Thank You

Questions!!!!!

9.0 Project Cost Management

IE 3654: Engineering Project Management

adopted from PMI's PMBOK 2000 and
Textbook : Information Technology Project Management

Outline of the Talk

- 9.1. Introduction to Project Cost Management
- 9.2. Why Project Cost Management?
- 9.3. Definitions of key terms
- 9.4. Project Cost Management Processes
- 9.5.Introduction to Earned Value Analysis (EVA)
- 9.6.Question and discussion

9.1. Introduction to Project Cost Management

- **Cost** is a resource sacrificed or foregone to achieve a specific objective, or something given up in exchange.

- Costs are usually measured in monetary units, such as, shillings, Kwacha, Yen, dollars.

- **Project cost management** includes the processes required to ensure that the project is completed within an approved budget.

9.2. Why Project Cost Management?

- Recall: The tripple constraints concept

- Projects have a poor track record for meeting cost goals

- Cost overrun and cannot meet cost goals

- For example; in construction average cost overrun is over of 100% of the original estimates

9.3. Definition of Key Terms

- **Tangible costs** or **benefits** are those costs or benefits that an organization can easily measure in dollars.
- **Intangible costs** or **benefits** are costs or benefits that are difficult to measure in monetary terms.
- **Direct costs** are costs that can be directly related to producing the products and services of the project.
- **Indirect costs** are costs that are not directly related to the products or services of the project, but are indirectly related to performing the project.

Definition of Key term cont…

Sunk cost is money that has been spent in the past; when deciding what projects to invest in or continue, you should *not* include sunk costs.

Profits are revenues minus expenses.

Cash flow analysis determines the estimated annual costs and benefits for a project and the resulting annual cash flow.

Life cycle costing considers the total cost of ownership, or development plus support costs, for a project. =The budget should include not only the cost to implement the project ... but it should also identify and estimate all costs to operate the facility ...”

9.4. Project Cost Management Processes

- Resource planning: determining what resources and quantities of them should be used
- Cost estimating: developing an estimate of the costs and resources needed to complete a project
- Cost budgeting: allocating the overall cost estimate to individual work items to establish a baseline for measuring performance
- Cost control: controlling changes to the project budget

9.4.1. Resource Planning

- **The nature of the project and the organization will affect resource planning**
- **There a number of questions; some to consider:**
  - **How difficult will it be to do specific tasks on the project?**
  - **What is the organization's history in doing similar tasks?**
  - **Does the organization have or can they acquire the human resources, equipment, and materials that are capable and available for performing the work?**

Inputs to Resource Planning

- WBS
  - identifies the project elements that require resources.
- Historical information
  - identifies required resources used in similar work on previous project.
- Scope statement
  - contains the project justification and the project objectives.
- Resource pool description
  - identifies available project resources.
- Organizational policies
  - may impact some of the project management decision. These are constraints, such as staffing, rentals, and purchasing supplies and equipment.
- Activities duration estimates
  - the best estimates of the time that it will take to perform the work
  - It is the output of Time Management Process: Activity Duration Estimating.

Tools & techniques

- Expert judgment
  - access the inputs to the process by subject-matter expect, group, or individual, including consultants, professional or technical associations, industrial advisory groups

- Project management software
  - help to organize resource pools, define resource availabilities and their rates, and define resource calendars.

Outputs from Resource Planning

- Resources requirement
  - describes the types (e.g. skills levels) and number of resources required by each element of the WBS.

9.4.2. Cost Estimating

- collecting and predicting the costs over the life cycle of a project or phase of a project
  - developing cost estimates for all the resources needed to complete project activities.
  - An important output of project cost management is a cost estimate
  - There are several types of cost estimates and tools and techniques to help create them
- It is also important to develop a cost management plan that describes how cost variances will be managed on the project

Inputs to Cost Estimating

- WBS
- Resource requirement
  - Outputs from Resource Planning
- Resource rates – unit rates for each resource that are used to calculate project costs.
- Activities duration estimates
  - output of Time Management Process: Activity Duration Estimating.
- Estimating publication
  - provide commercial cost data.

Inputs to Cost Estimating cont...

- Historical information
  - the cost of many categories of resources is available from the following sources: a) project file; b) commercial cost-estimating databases; c) project team knowledge.
- Chart of accounts (COA)
  - describes the coding structure or the budget categories that the performing organization uses to report financial information in its general ledger.
- Risk
  - to show the importance of considering the impacts of both opportunities and threats for costs estimates for each activity

Tools & techniques

- Analogous estimating
  – known as top-down
  – A form of expert judgment because it uses actual costs from previous, similar projects to estimate current costs
  – Although it is less costly than other estimates, it is the least accurate
  – It is frequently used to estimate total project costs when a limited amount of detailed information is available.
- Parametric modeling
  – uses project characteristics as the parameters is a mathematical model to predict project costs
  – Models may be simple or complex (e.g. simulations using statistics or function point analysis to estimate software development durations)
  – The costs and accuracy of parameters model vary.

Tools & techniques cont.

- Bottom up estimating
  - estimating the cost of individual activities or work packages and then adding the individual estimates to arrive at a project total
  - Defining smaller activities or work packages increases both the cost and accuracy of the estimate.
- Computerized tools
  - Project management software, spreadsheets, simulation tools, and statistical packages can help estimate costs.
- Other cost estimating methods
  - includes vendor bid analyses.

Types of Cost Estimates

Type of Estimate	When Done	Why Done	How Accurate
Rough Order of Magnitude (ROM)	Very early in the project life cycle, often 3–5 years before project completion	Provides rough ballpark of cost for selection decisions	–25%, +75%
Budgetary	Early, 1–2 years out	Puts actual figure in the budget plans	–10%, +25%
Definitive	Later in the project, < 1 year out	Provides details for purchases, estimate actual costs	–5%, +10%

Outputs from Cost Estimating

- Cost estimates
  - Quantitative assessments of the likely costs of the resources required to complete project activities. Cost estimates types include
    - preliminary estimate
    - budget estimate
    - analogy estimates
    - definitive and control estimates
- Supporting details
  - include description of the scope of work estimated, reference to WBS, the basis of the estimate, assumptions, and the range of possible results.
- Cost management plan
  - describe how cost variances will be managed. It is part of the project plan.

Sample Cost Estimate

Surveyor Pro Project Cost Estimate Created October 5, 2006

	# Units/Hrs.	Cost/Unit/Hr.	Subtotals	WBS Level 1 Totals	% of Total
WBS Items					
1. Project Management				**$306,300**	**20%**
Project manager	960	$100	$96,000		
Project team members	1920	$75	$144,000		
Contractors (10% of software development and testing)			$66,300		
2. Hardware				**$76,000**	**5%**
2.1 Handheld devices	100	$600	$60,000		
2.2 Servers	4	$4,000	$16,000		
3. Software				**$614,000**	**40%**
3.1 Licensed software	100	$200	$20,000		
3.2 Software development*			$594,000		
4. Testing (10% of total hardware and software costs)			$69,000	**$69,000**	**5%**
5. Training and Support				**$202,400**	**13%**
Trainee cost	100	$500	$50,000		
Travel cost	12	$700	$8,400		
Project team members	1920	$75	$144,000		
6. Reserves (20% of total estimate)			$253,540	**$253,540**	**17%**
Total project cost estimate				**$1,521,240**	

* See software development estimate

9.4.3. Cost Budgeting

- It is the process of allocating cost estimates to individual work activates
  - Cost budget involves allocating the project cost estimate to individual work items and providing a cost baseline

- The project budget is the planned cost of each activity at the lowest level, which is then rolled into a project total.

Inputs to Cost Budgeting

- Cost estimates
  - output from cost estimates process
- WBS
  - output from scope definition process
- Project schedule
  - includes planned start and expected finish dates for the activities or work packages in order to allocate costs.
- Risk management plan
  - A part of the project plan that contains procedures to manage risk throughout the project.

Outputs from Cost Budgeting

- Cost baseline
  - A time-phased budget that will be used to measure and monitor cost performance on the project
  - It is developed by summing estimated costs by period and is usually displayed in the form of an S-curve
  - Larger projects may have multiple cost baselines to measure different aspects of cost performance.

Sample (Monthly) budget

		Monthly Bugdet (Tshs)							
Task	**Estimate**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
A	**7000**	**5600**	**1400**						
B	**9000**		**3857**	**5143**					
C	**10000**		**3750**	**5000**	**1250**				
D	**6000**		**3600**	**2400**					
E	**12000**				**4800**	**4800**	**2400**		
F	**3000**				**3000**				
G	**9000**			**2571**	**5143**	**1286**			
H	**5000**					**3750**	**1250**		
I	**8000**						**2667**	**5333**	
J	**6000**								**6000**
	75,000	**5600**	**12607**	**15114**	**14193**	**9836**	**6317**	**5333**	**6090**

9.4.4. Cost Control

Project cost control include

- monitoring cost performance
- ensuring that only appropriate project changes are included in a revised cost baseline
- informing project stakeholders of authorized changes to the project that will affect costs

- During this process, project manager try to determine what facts impact, cost, how these factors can be influenced, whether these changes are beneficial to the project or product.
- Earned value Analysis (EVA) is an important tool for cost control

Inputs to Cost Control

- Cost baseline
  - includes a time-phased budget used to measure and monitor cost performance on the project
  - The cost baseline is usually shown as cost-by-period and can be charted in the form of an S-curve.
- Performance reports
  - provide information on cost performance, such as which budgets have been met and which have not.
- Change requests
  - take many forms: oral or written, direct or indirect, external or internally initiated, and legally mandated or optional.
- Cost management plan
  - describes managing cost variances

Tools & techniques

- Cost change control system
  - defines the procedures by which the cost baseline may be changed
  - It includes the paperwork, tracking systems, and approval levels necessary for authorizing changes.
- Performance measurement techniques
  - help to assess the magnitude or any variation that do occur.
  - Earned value analysis is especially useful for cost control
    - Earned value Analysis (EVA) is the tools commonly used to determine variance causes and deciding if the variance requires corrective action.
- Additional planning
  - prospective changes may require new or revised cost estimates or analysis of alternative approaches.
- Other general computerized tools
  - project management software or spreadsheets that track planned versus actual costs or that forecast the effects of cost changes.

Outputs from Cost Control

- Revised cost estimates
  - update of the project cost estimates.
- Budget updates
  - changes to an approval cost baseline. The numbers are generally revised only in response to scope changes.
  - Cost variance may be so severe that re-baselining is needed in order to provide a realistic measure of performance.
- Corrective action
  - anything done to bring expected future project performance into line with the project plan.

Outputs from Cost Control cont--

- Estimate at completion (EAC)
  - A forecast of total project costs based on project performance. The most common variations are
    - actual cost to date plus the remaining project budget modified by a performance factor
    - actual costs to date plus a new estimate for all remaining works
    - actual cost to date plus the remaining budget.
- Project closeout
  - processes and procedures for closing or canceling the project.
- Lessons learned
  - document the causes of variances, reasons behind the corrective action chosen, and other lessons learned.

9.5.0. Earned Value Analysi (EVA)

- EVA is a project performance measurement technique that integrates scope, time, and cost data

- Given a baseline (original plan plus approved changes), you can determine how well the project is meeting its goals

- You must enter actual information periodically to use EVA

How to answer the question:

“Have we done what we said we’d do?”

- % complete estimating % of Budget spent % of work done % of time elapsed
  - subjective, incomplete
  - draws false conclusions

What's more Important?

- Knowing where you are on schedule?
- Knowing where you are on budget?
- Knowing where you are on work accomplished?

EVA Integrates All Three

- It compares the PLANNED amount of work with what has actually been COMPLETED, to determine if *COST* , *SCHEDULE*, *and WORK ACCOMPLISHED* are progressing as planned.

- Work is “earned ” or credited as it is completed.

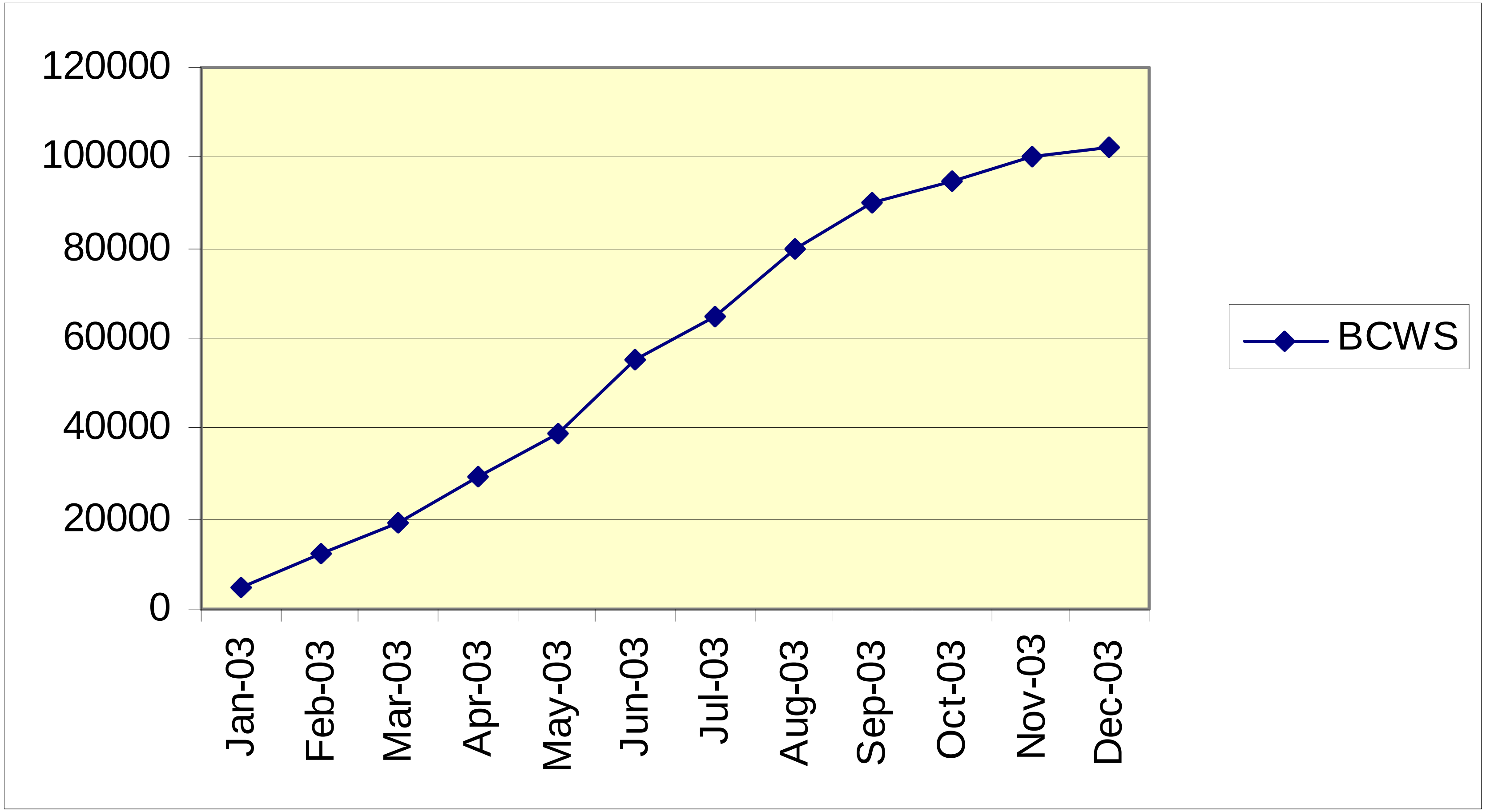
Earned Value Analysis Terms

- BCWS - Budgeted Cost of Work Scheduled=also called the budget, is that portion of the approved total cost estimate planned to be spent on an activity during a given period

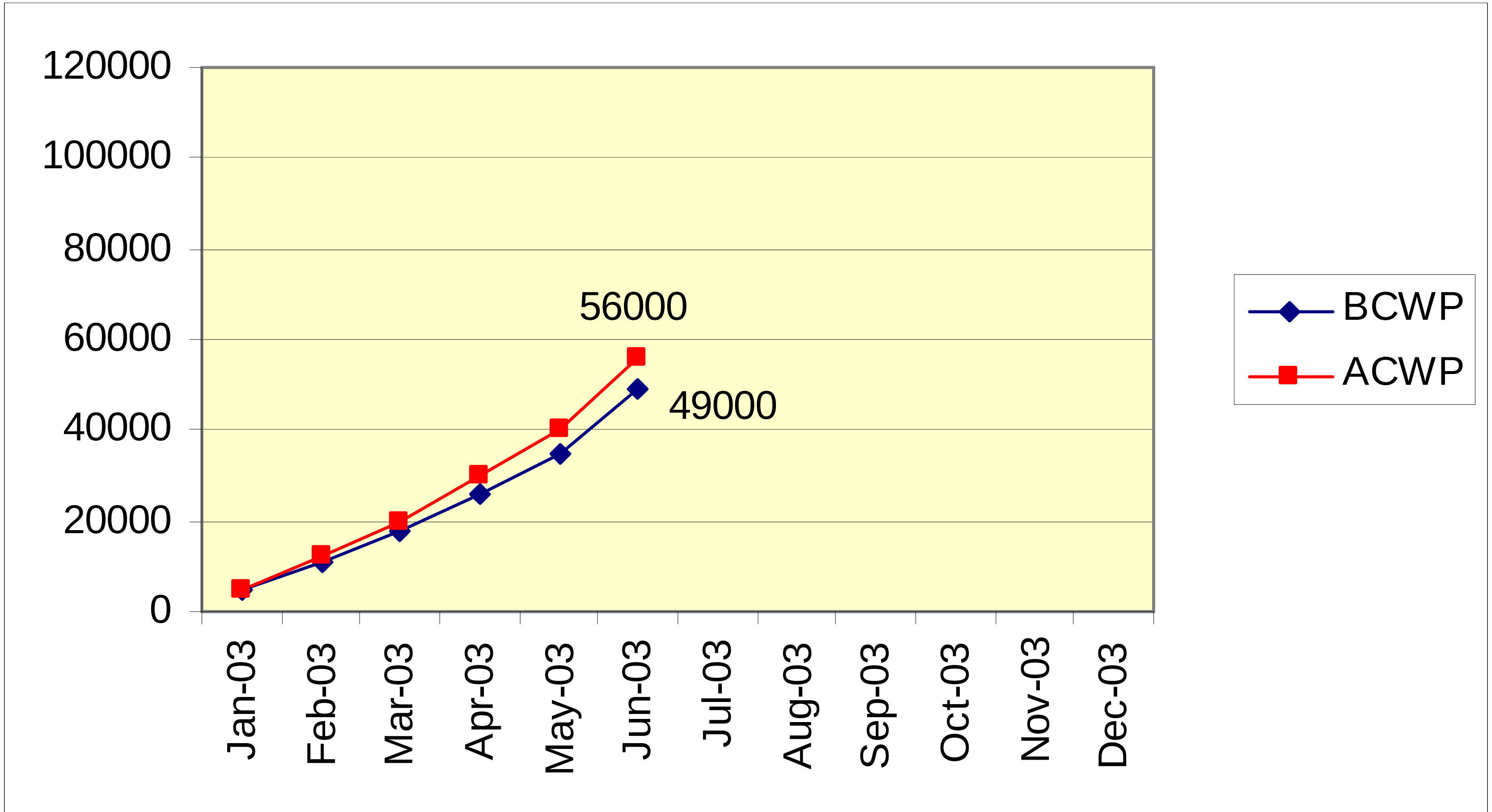
- ACWP - Actual Cost of Work Performed= is the total of direct and indirect costs incurred in accomplishing work on an activity during a given period

- BCWP - Budgeted Cost of Work Performed =The **earned value (EV),** is the percentage of work actually completed multiplied by the planned value

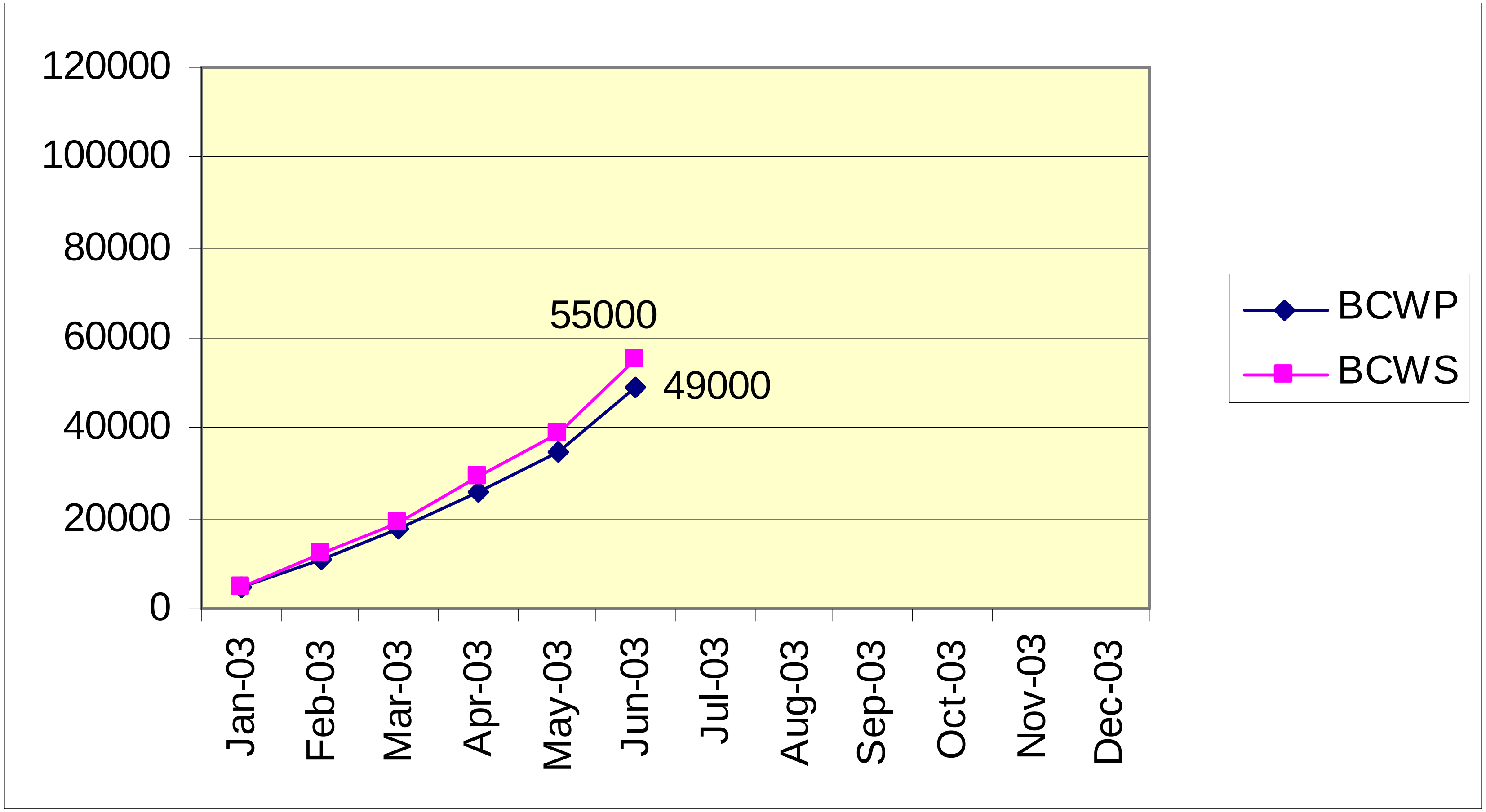
BCWS - Budgeted Cost of Work Scheduled



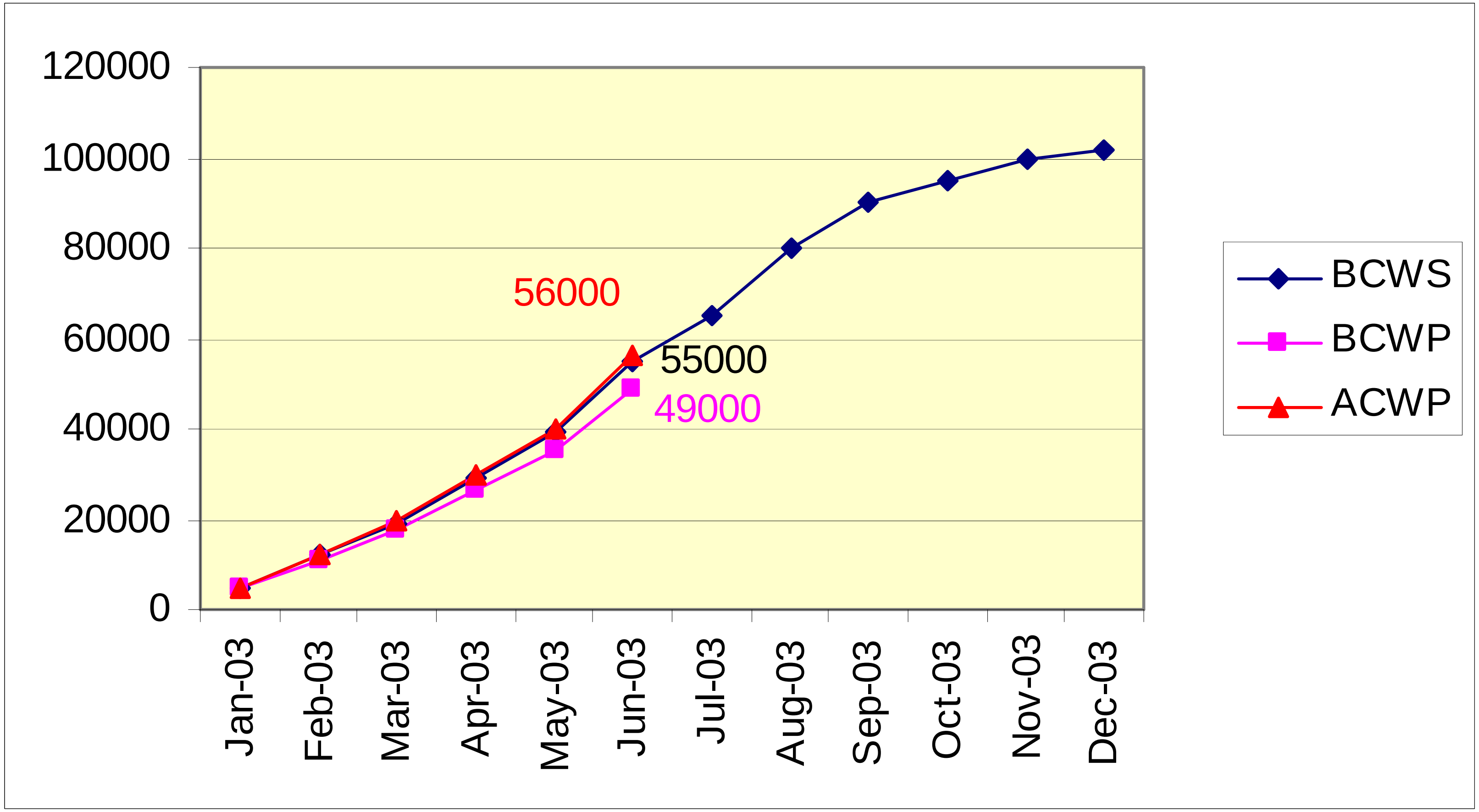
ACWP - Actual Cost of Work Performed



BCWP - Budgeted Cost of Work Performed



The Whole Story



Some Derived Metrics

- SV: Schedule Variance (BCWP-BCWS)
  - A comparison of amount of work performed during a given period of time to what was scheduled to be performed.
  - A negative variance means the project is behind schedule
- CV: Cost Variance (BCWP-ACWP)
  - A comparison of the budgeted cost of work performed with actual cost.
  - A negative variance means the project is over budget.

Schedule Variance & Cost Variance

Schedule Variance = BCWP-BCWS

$$\begin{array}{r} \$49{,}000 \\ \underline{-\ \ 55{,}000} \\ SV\ \ = -\ \$\ \ 6{,}000 \end{array}$$

Cost Variance = BCWP-ACWP

$$\begin{array}{r} \$49{,}000 \\ \underline{\ \ 56{,}000} \\ CV\ \ = -\ \$7{,}000 \end{array}$$

Some More Derived Metrics

- SPI: Schedule Performance Index

  SPI=BCWP/BCWS

  SPI<1 means project is behind schedule

- CPI: Cost Performance Index

  CPI= BCWP/ACWP

  CPI<1 means project is over budget

- CSI: Cost Schedule Index (CSI=CPI x SPI)

  The further CSI is from 1.0, the less likely project recovery becomes.

Performance Metrics

SPI: BCWP/BCWS

49,000/55,000 = 0.891

CPI: BCWP/ACWP

49,000/56000 = 0.875

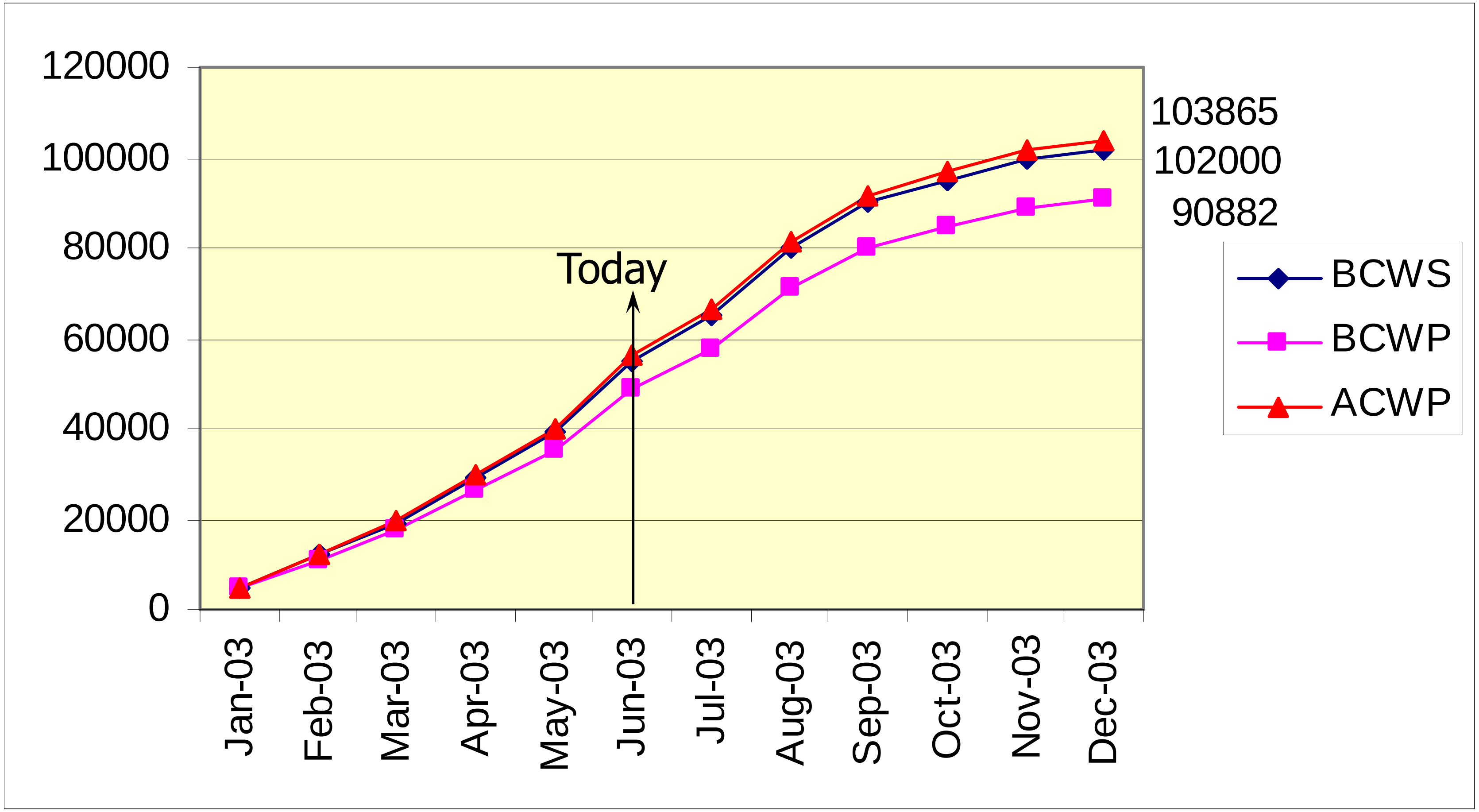
CSI: SPI x CPI

.891 x .875 = 0.780

Rules of Thumb for EVA Numbers

- Negative numbers for cost variance (CV) and schedule variance (SV) indicate problems in those areas.
  - The project is costing more than planned
  - The project is taking longer than planned
- CPI and SPI less than 100% indicate problems
  - The % of the project is over budget in cost
  - The % of the project is behind schedule in time

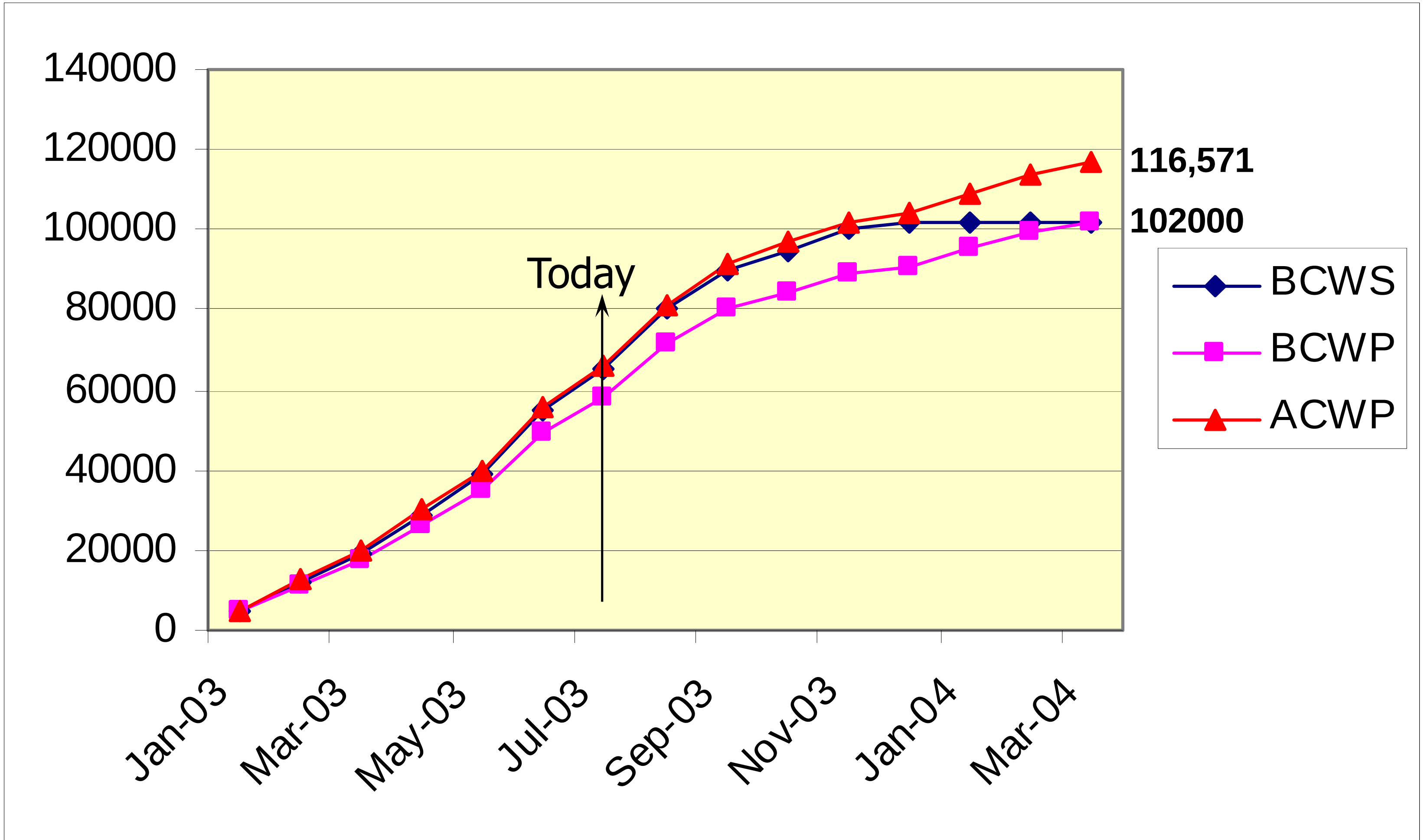
Making Projections



EVA Projection example cont..

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	**Activity**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Plan**	**% Complete**	**EV**
2	Plan and staff project	4,000	4,000											8,000	100	8,000
3	Analyze requirements		6,000	6,000										12,000	100	12,000
4	Develop ERDs			4,000	4,000									8,000	100	8,000
5	Design database tables				6,000	4,000								10,000	100	10,000
6	Design forms, reports, and queries					8,000	4,000							12,000	50	6,000
7	Construct working prototype						10,000							10,000	-	-
8	Test/evaluate prototype						2,000	6,000						8,000	-	-
9	Incorporate user feedback							4,000	6,000	4,000				14,000	-	-
10	Test system									4,000	4,000	2,000		10,000	-	-
11	Document system											3,000	1,000	4,000	-	-
12	Train users												4,000	4,000	-	-
13	Monthly Plan	4,000	10,000	10,000	10,000	12,000	16,000	10,000	6,000	8,000	4,000	5,000	5,000	100,000		**44,000**
14	BCWS or Cumulative Plan	4,000	14,000	24,000	34,000	46,000	62,000	72,000	78,000	86,000	90,000	95,000	100,000			
15	Monthly Actual	4,000	11,000	11,000	12,000	15,000										
16	ACWP or Cumulative Actual	4,000	15,000	26,000	38,000	53,000										
17	Monthly EV	4,000	10,000	10,000	10,000	10,000										
18	BCWP or Cumulative EV	4,000	14,000	24,000	34,000	44,000										
19	Project BCWP as of May 31	44,000														
20	Project BCWS as of May 31	46,000														
21	Project ACWP as of May 31	$ 53,000														
22	**CV=BCWP-ACWP**	**$ (9,000)**														
23	**SV=BCWP-BCWS**	**$ (2,000)**														
24	**CPI=BCWP/ACWP**	**83%**														
25	**SVI=BCWP/BCWS**	**96%**														
26	**Estimated cost at completion**	**$120,455**	(original plan of $100,000 divided by CPI of 83%)													
27	**Estimated time to complete**	**12.55**	(original plan of 12 months divided by SVI of 96%)													

Estimate at Completion



Requirements of Earned Value

- Proper WBS Design
- Baseline Budget Control Accounts
- Baseline Schedule
- Work measurement by Control Account
  - work-hours, dollars, units, etc.
- Good Project Management Practices

Shortcomings of Earned Value

- Quantifying or measuring work progress can be difficult.
- Time required for data measurement, input, and manipulation can be considerable.

Thank You

9.6. Questions!!!!!

Project Planning and Management

: Project Crashing and Resource Levelling

29th Jan 2017

Reasons for Imposed Project Duration Dates

- Customer requirements and contract commitments
- Time-to-market pressures
- Incentive contracts (bonuses for early completion)
- Unforeseen delays
- Overhead costs
- Pressure to move resources to other projects

Options for Accelerating Project Completion

- Adding Resources
- Outsourcing Project Work
- Scheduling Overtime
- Establishing a Core Project Team
- Do It Twice—Fast and Correctly
- Fast-Tracking (Overlapping)
- Critical-Chain
- Reducing Project Scope
- Compromise Quality

Project Crashing

- Crashing
  - reducing project time by expending additional resources
  - to reducing the total time to complete the project to meet a revised due date.
- Crash time
  - an amount of time an activity is reduced
- Crash cost
  - cost of reducing activity time
- Goal
  - reduce project duration at minimum cost

Crashing a Project

- Crashing may involve a relatively simple decision to increase groups of resources (labor-shovel)

- If do changes in technology tend to produce discontinuities in outcomes and also in cost.

Factors to Consider When Crashing A Project

- The amount by which an activity is crashed is, in fact, permissible
- Taken together, the shortened activity durations will enable you to finish the project by the due date
- The total cost of crashing is as small as possible

Principles to crash a project

1. Focus on the ***critical path*** when trying to shorten the duration [resource ready]

2. Select the ***least expensive*** way to do it

Steps in Project Crashing

1. Compute the crash cost per time period. If crash costs are linear over time:

$$\textit{Crash cost per period} = \frac{(\textit{Crash cost} - \textit{Normal cost})}{(\textit{Normal time} - \textit{Crash time})}$$

Where: slope = cost per day of crashing a project

When slope is negative : indicate the **time** required for a project is **decreased**, the **cost** is **increased**

Steps in Project Crashing

2. Using current activity times, find the critical path and identify the critical activities
3. If there is only one critical path, then select the activity on this critical path that (a) can still be crashed, and (b) has the smallest crash cost per period. If there is more than one critical path, then select one activity from each critical path such that (a) each selected activity can still be crashed, and (b) the total crash cost of all selected activities is the smallest.

Steps in Project Crashing

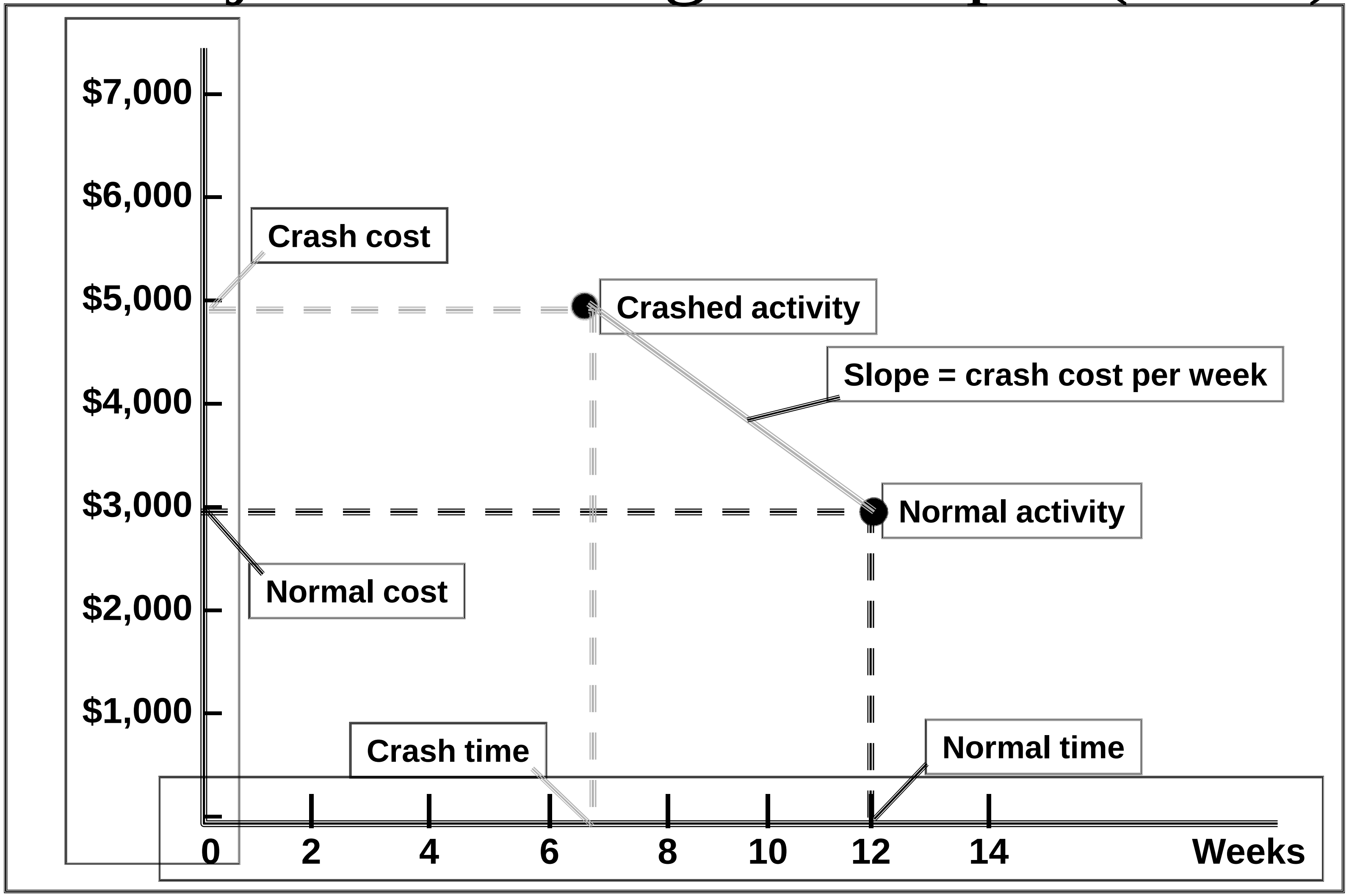
Note that the same activity may be common to more than one critical path.

4. Update all activity times. If the desired due date has been reached, stop. If not, return to Step 2

Steps as suggested by Chandra 2004

1. Obtain critical path in the normal network. Determine the project duration and direct cost
2. Examine the cost- time slope of activities on the critical path obtained and crash the activity which has least slope[1]
3. Construct the new critical path after crashing as per step 2. Determine project duration and cost
4. Repeat steps 2 and 3 till activities on the critical path (which may change every time are crashed

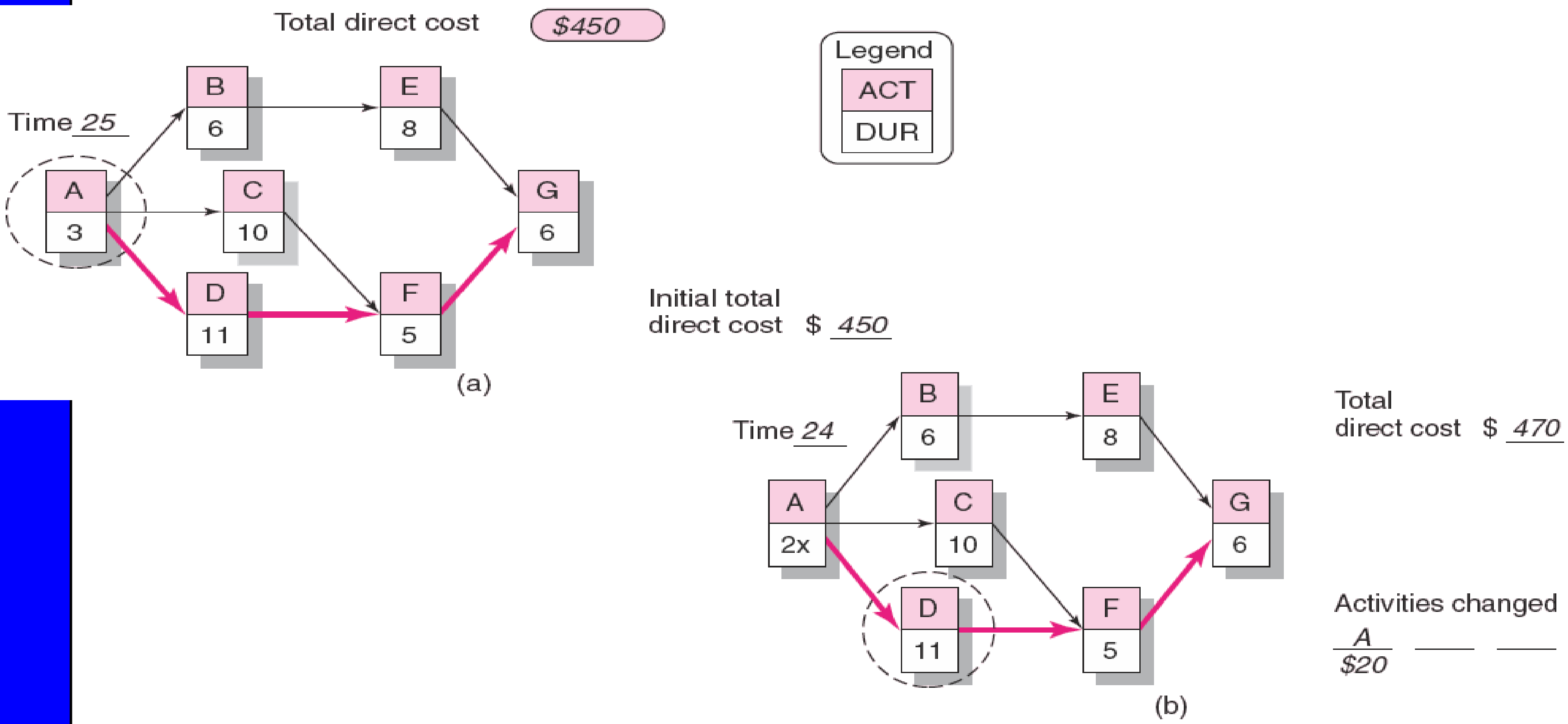
Project Crashing: Example (cont.)



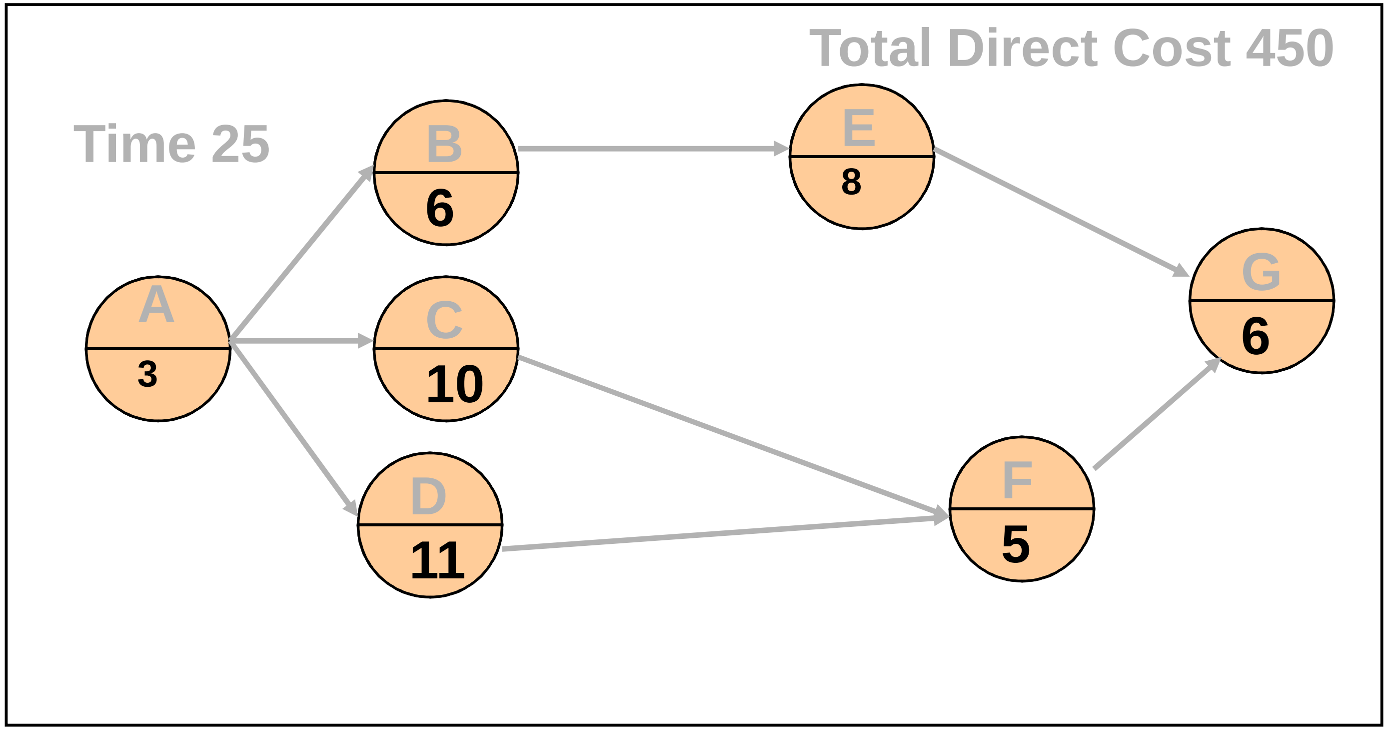
Example 1:

Activity ID	Slope	Maximum crash time	Direct costs			
			Normal		Crash	
			Time	Cost	Time	Cost
A	*$20*	*1*	3	$50	2	$70
B	*40*	*2*	6	80	4	160
C	*30*	*1*	10	60	9	90
D	*25*	*4*	11	50	7	150
E	*30*	*2*	8	100	6	160
F	*30*	*1*	5	40	4	70
G	*0*	*0*	6	70	6	70

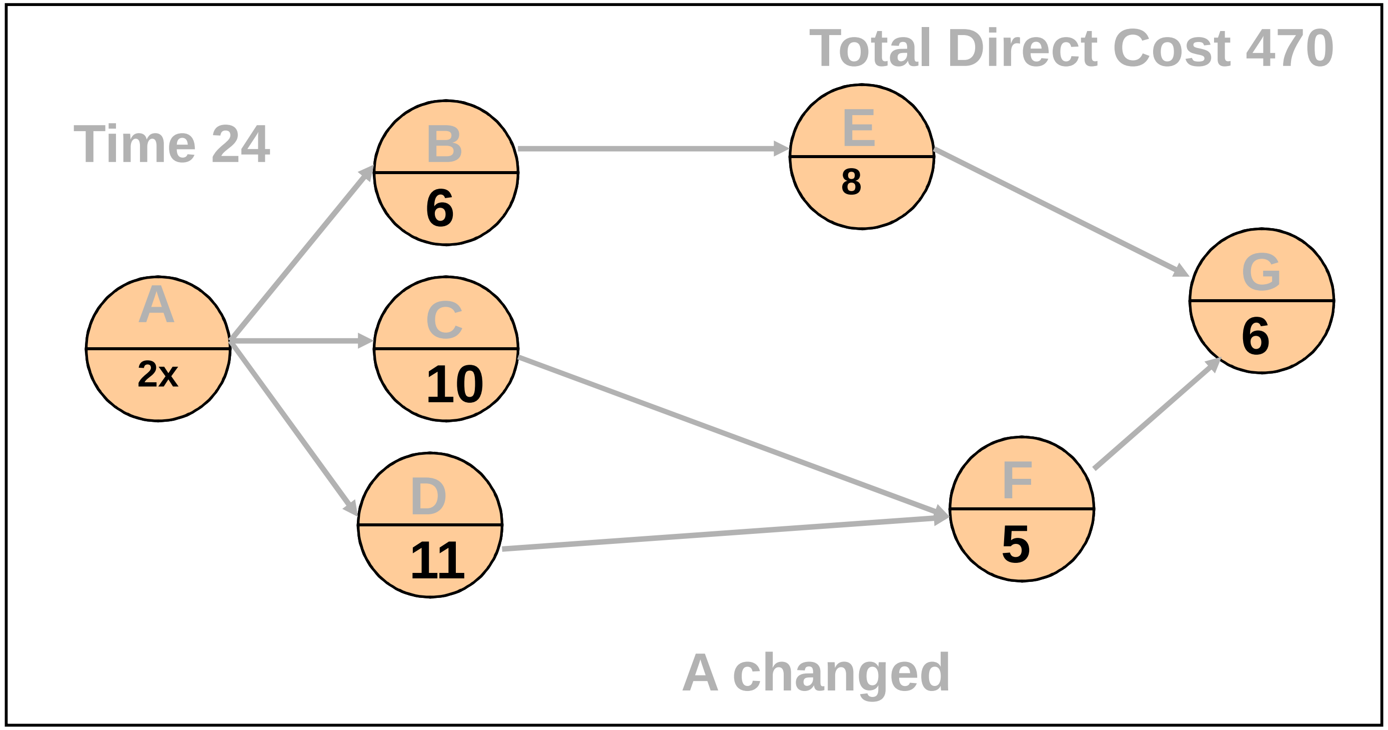
Example 1: (cont'd)



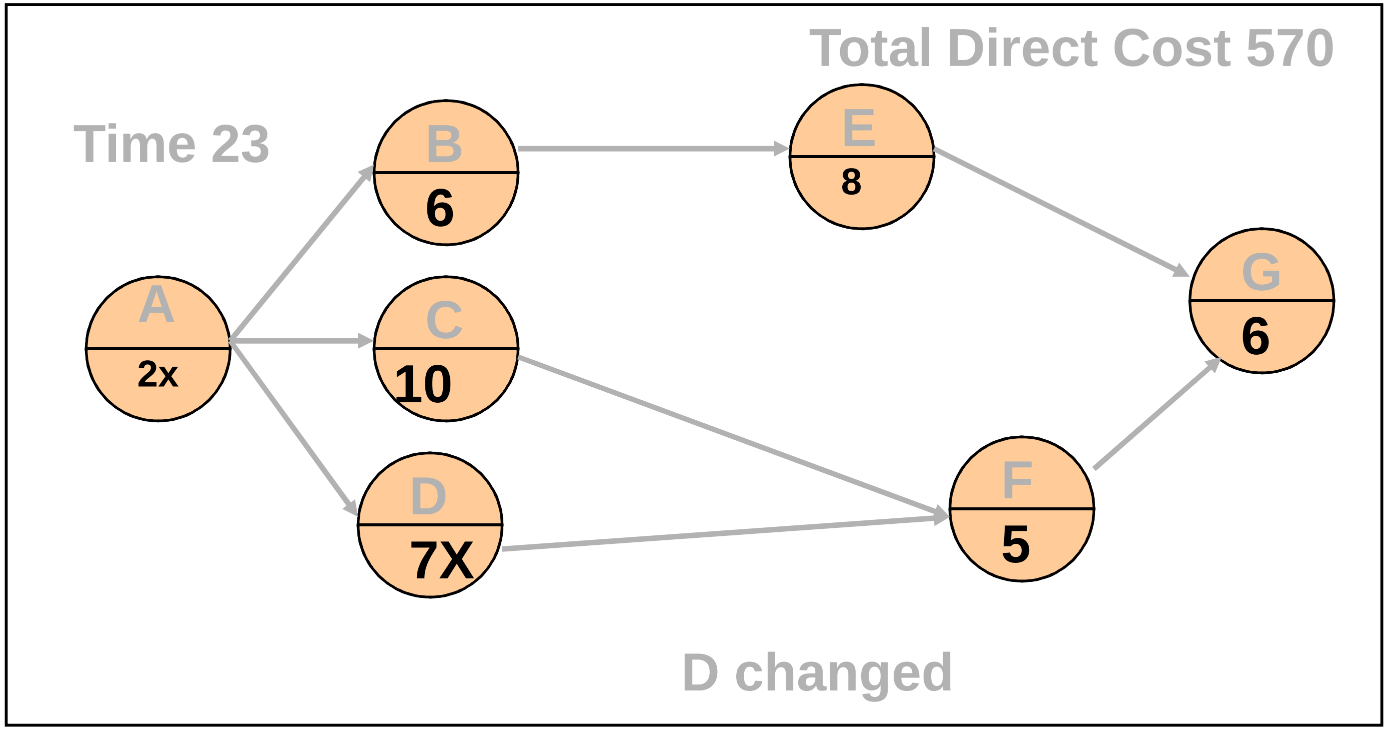
Example 1: (cont'd)



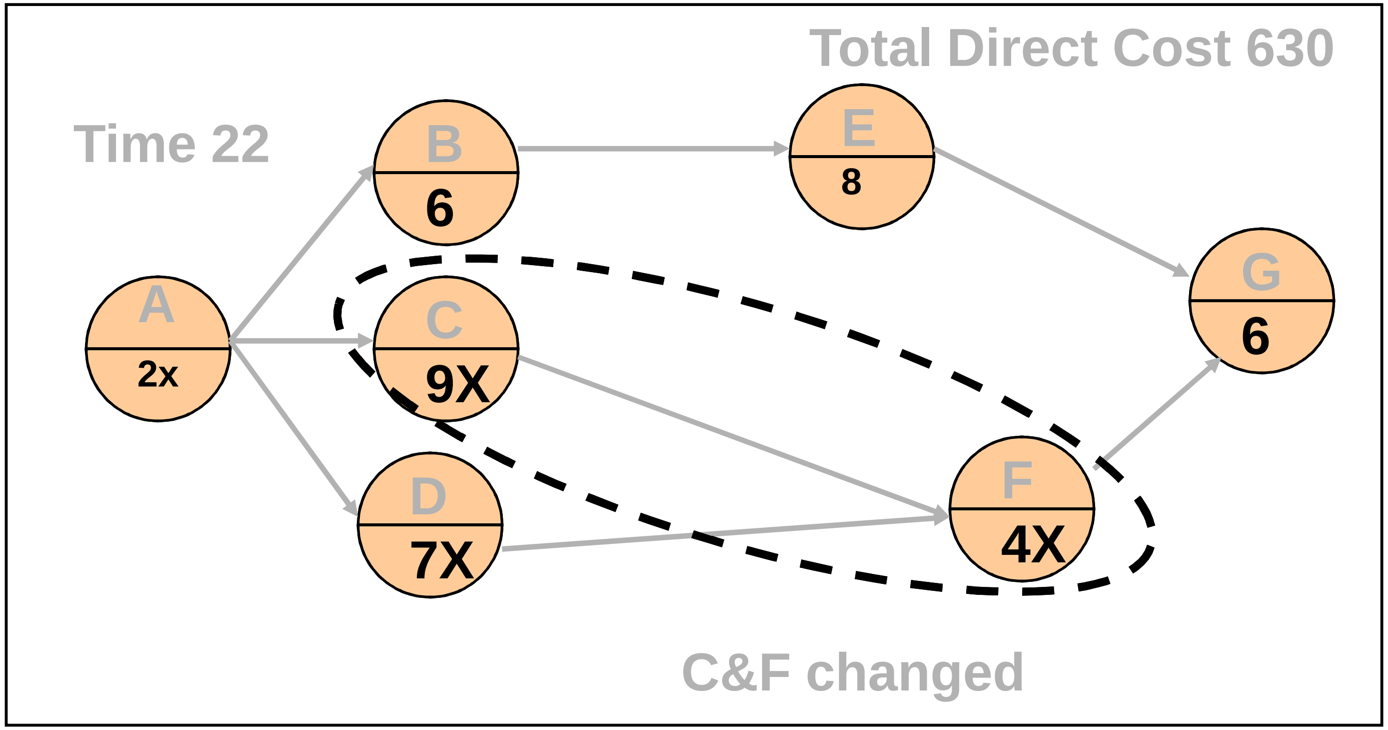
Example 1: (cont'd)



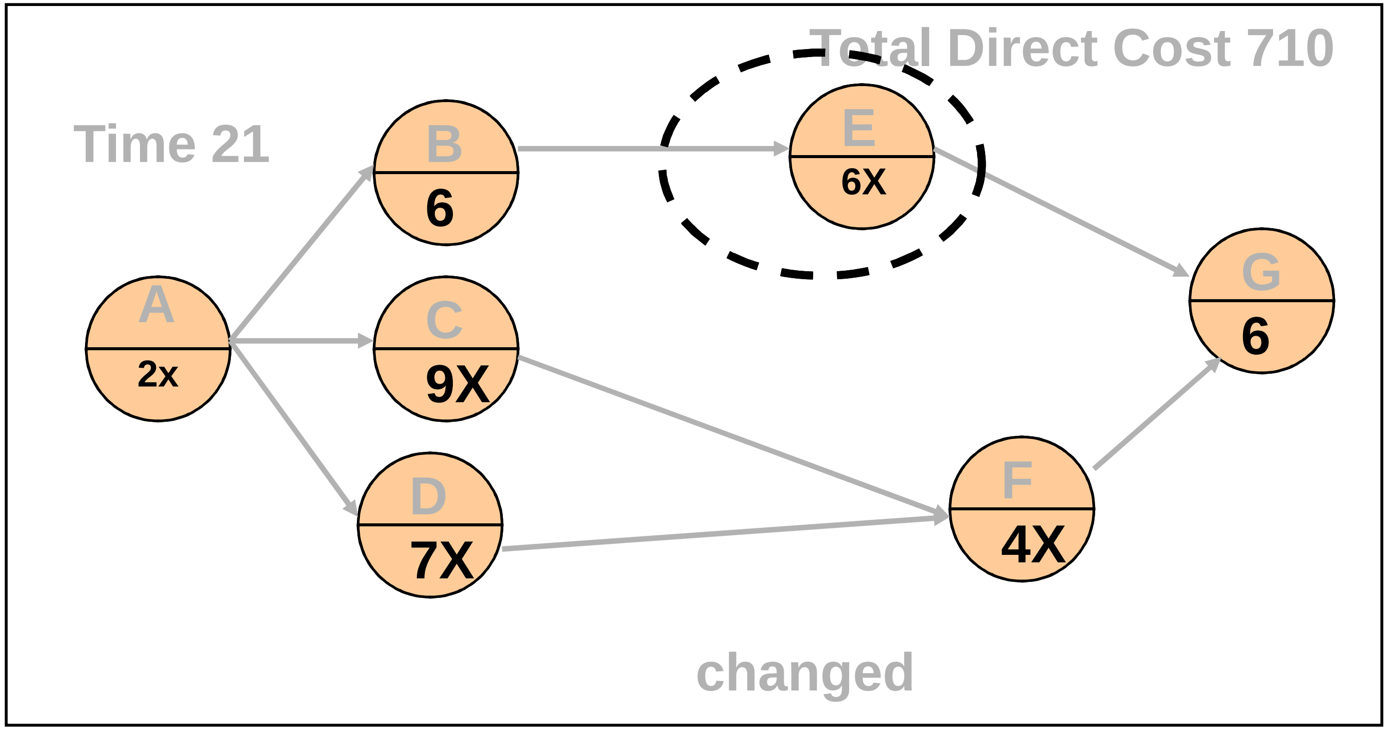
Example 1: (cont'd)



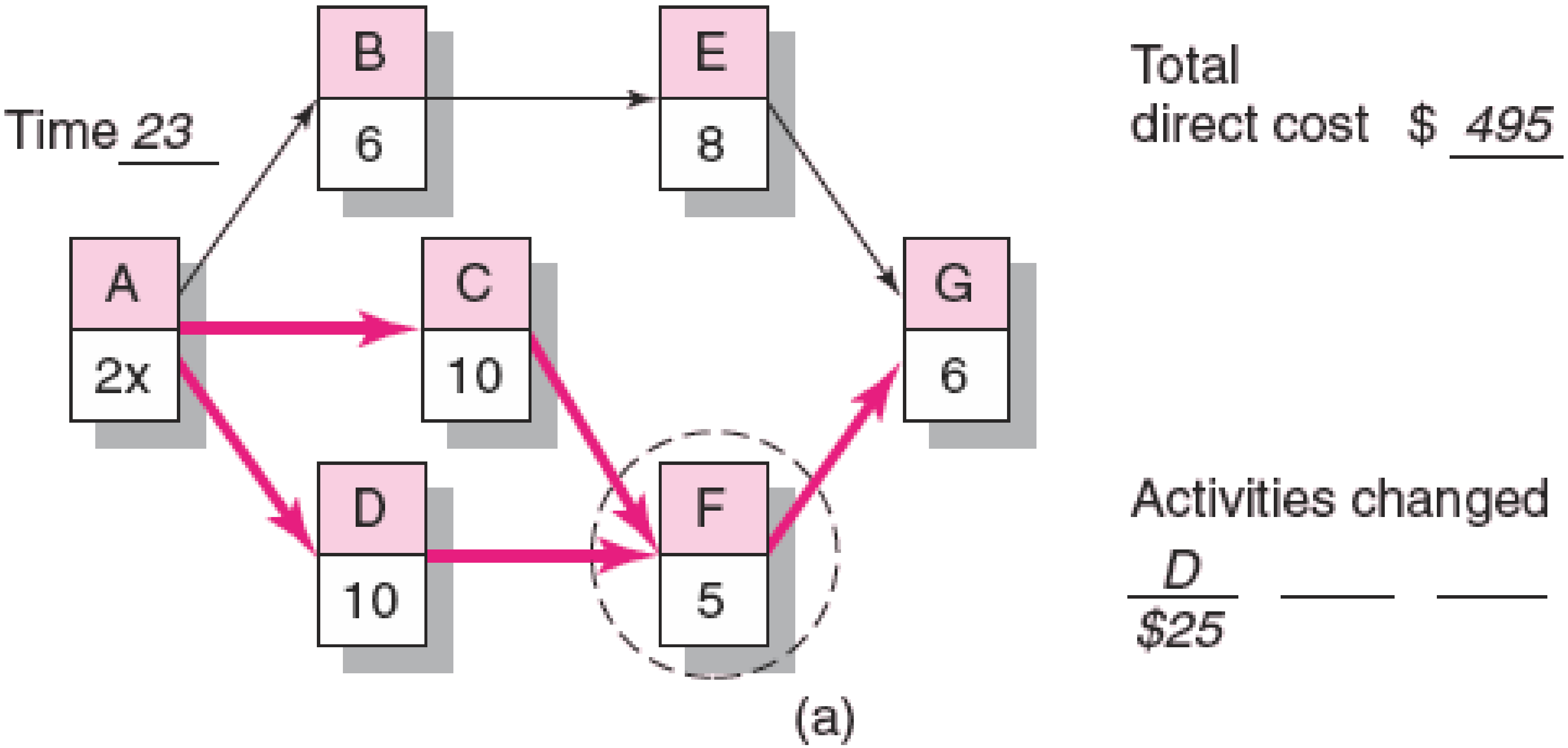
Example 1: (cont'd)



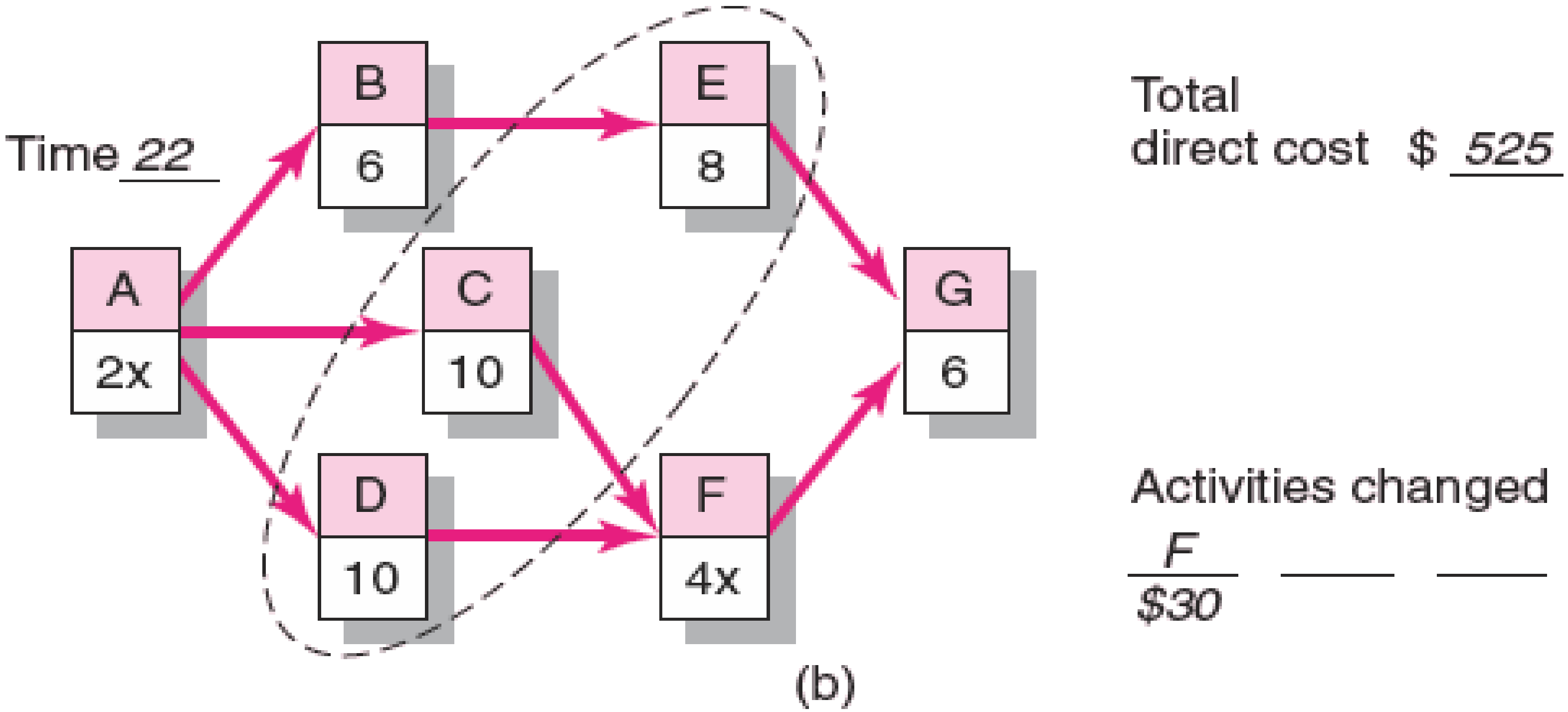
Example 1: (cont'd)



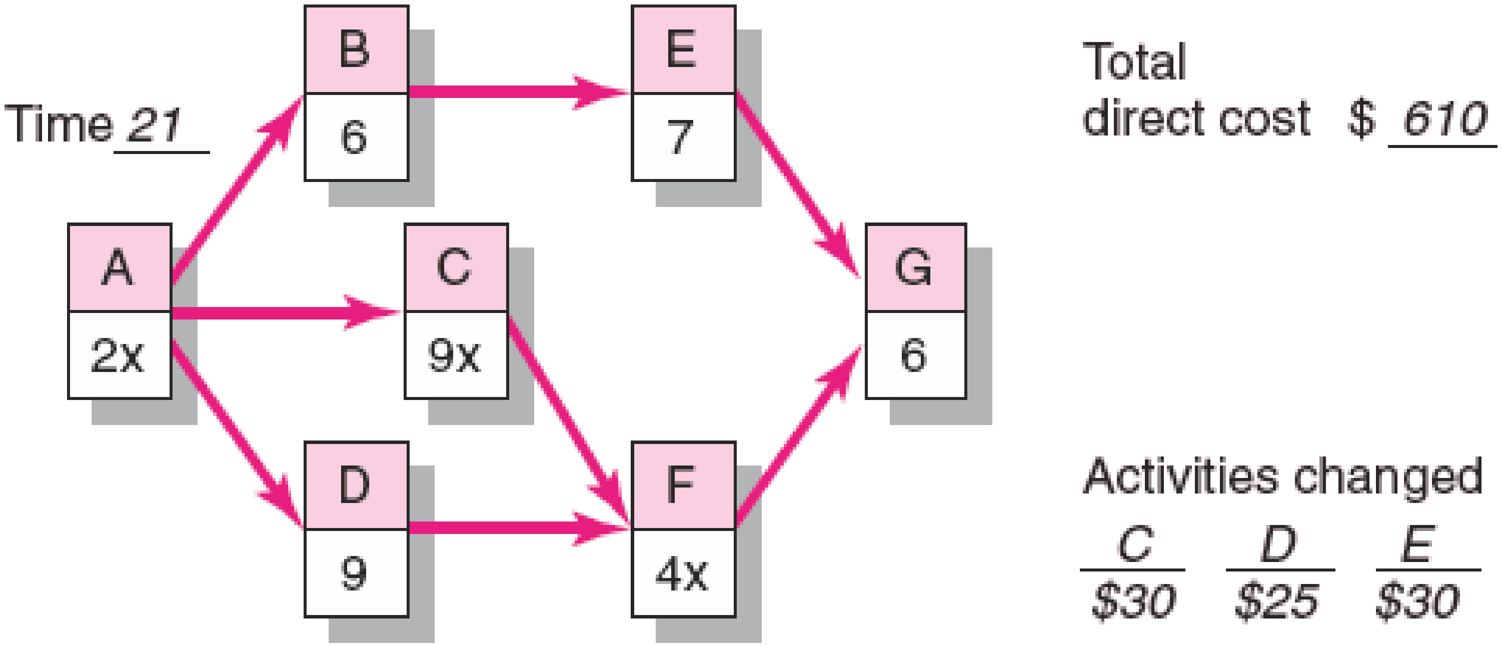
Example 1: (cont'd)



Example 1: (cont'd)



Example 1: (cont'd)

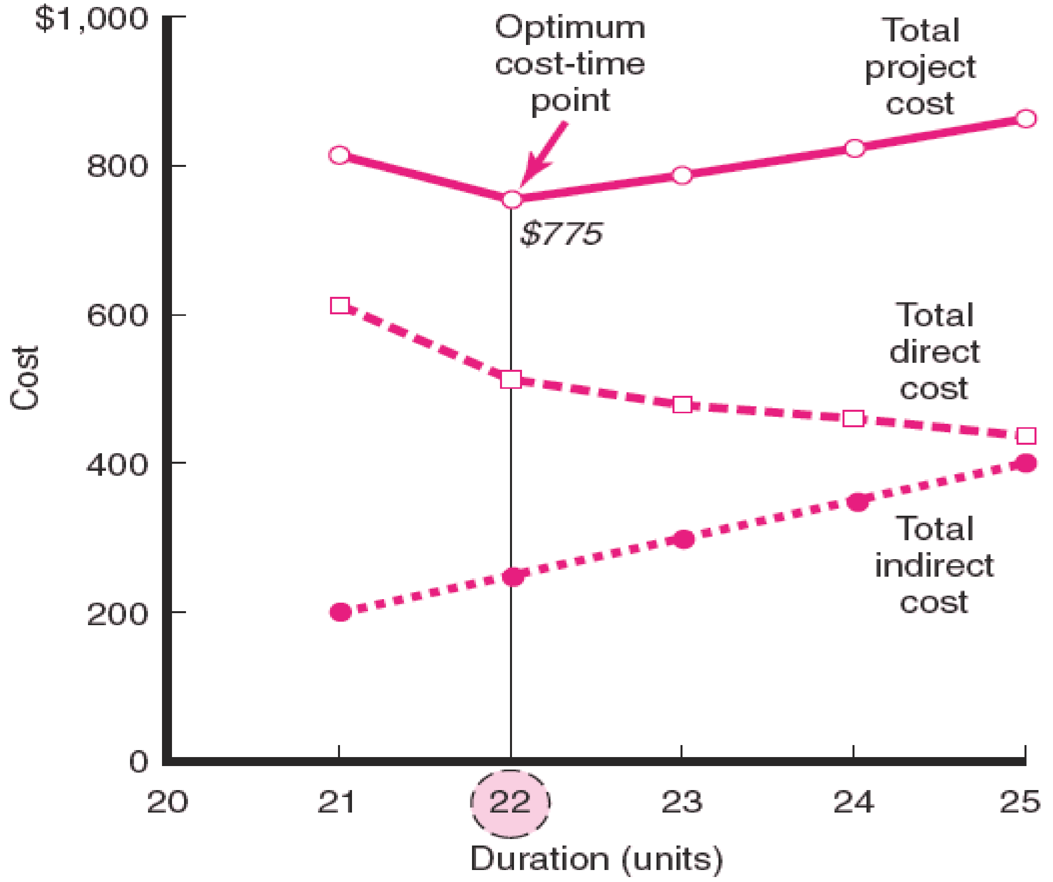


(c)

Summary Costs by Duration

Project duration	Direct costs	+	Indirect costs	=	Total costs
25	*450*		400		*$850*
24	*470*		350		*820*
23	*495*		300		*795*
22	*525*		250		*775*
21	*610*		200		*810*

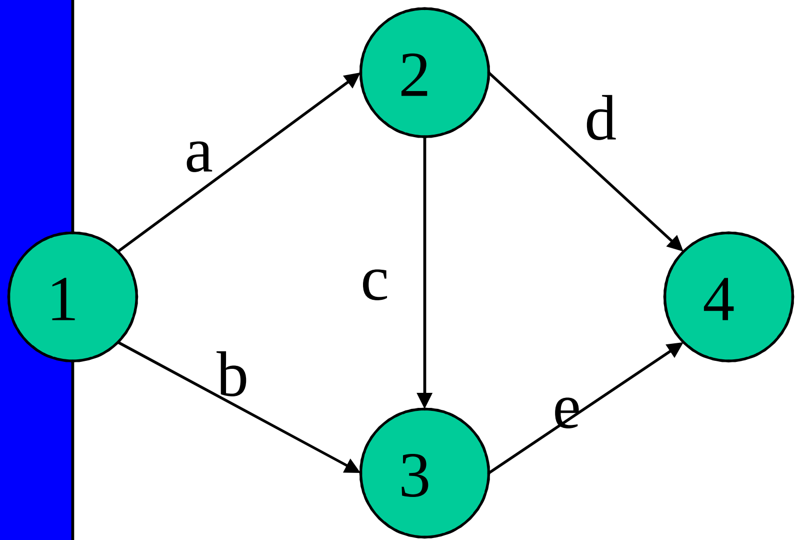
Cost—Duration Trade-off Example (cont'd)



Practical Considerations

- Using the project cost—duration graph
- Crash times
- Linearity assumption
- Choice of activities to crash revisited
- Time reduction decisions and sensitivity

Example 2

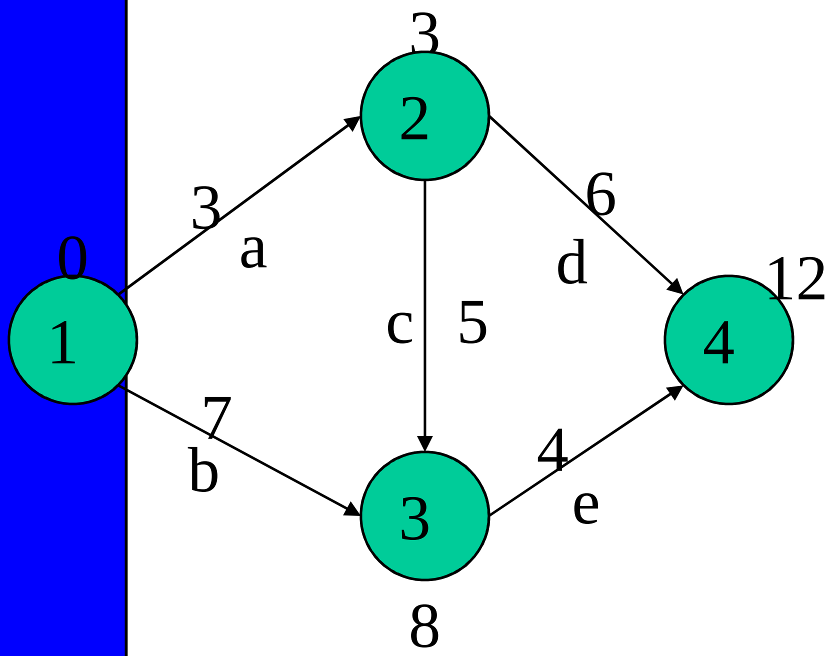


Activity	Crash Time, Cost	Normal Time, Cost	Partial crashing
a	3,$60	3,$60	No
b	6,80	7,30	Yes
c	2,90	5,50	No
d	5,50	6,30	No
e	2,100	4,40	Yes

Find the lowest cost to complete the project in 10 days

Answer

Current time and cost: 12 days and $210



Since the critical path is a-c-e, we only initially need consider these 3 activities:

a: cannot be crashed

c: can cut *3 days* at an extra cost of *$40* but only results in project completion by *day 11*, due to *b*. To reach 10 days, *cut b* by *1 day*, total extra cost *$90*

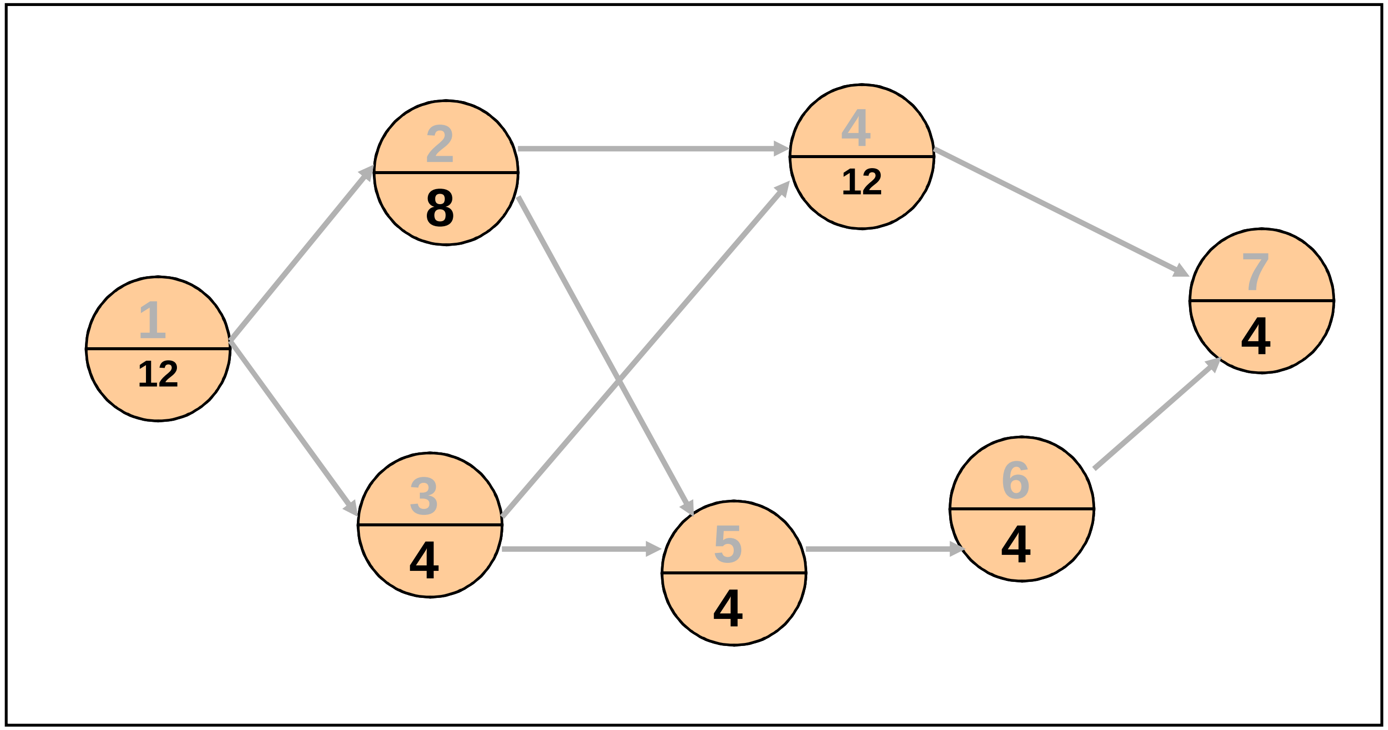
e: can *cut e by 2 days* for an extra cost of *$60* and results in project completion by day 10.

Thus, cut e 2 days at a cost of $60.

Example 3: Home work

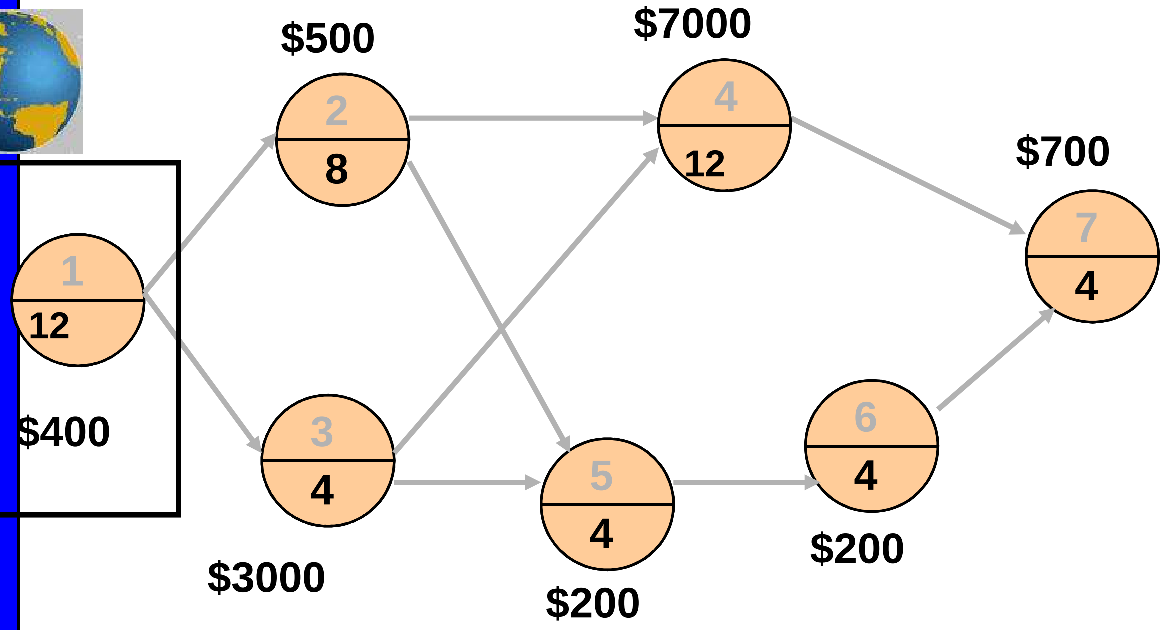
ACTIVITY	NORMAL TIME (WEEKS)	CRASH TIME (WEEKS)	NORMAL COST	CRASH COST	TOTAL ALLOWABLE CRASH TIME (WEEKS)	CRASH COST PER WEEK
1	12	7	$3,000	$5,000	5	$400
2	8	5	2,000	3,500	3	500
3	4	3	4,000	7,000	1	3,000
4	12	9	50,000	71,000	3	7,000
5	4	1	500	1,100	3	200
6	4	1	500	1,100	3	200
7	4	3	15,000	22,000	1	7,000
			$75,000	$110,700		

Project Network



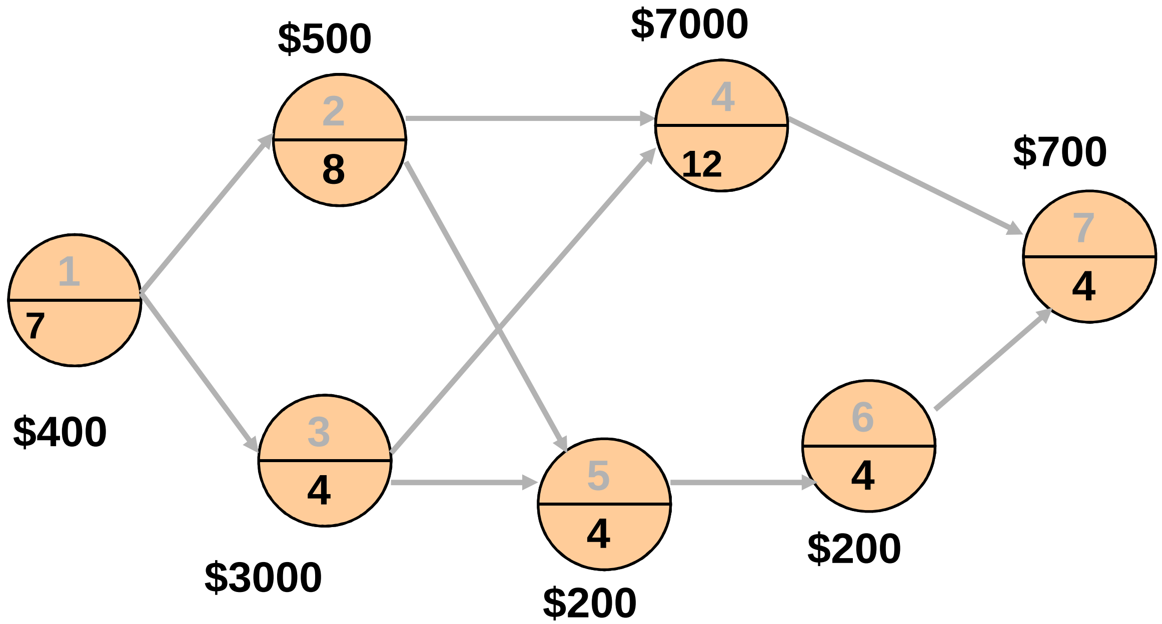
Project Duration:
36 weeks

FROM …



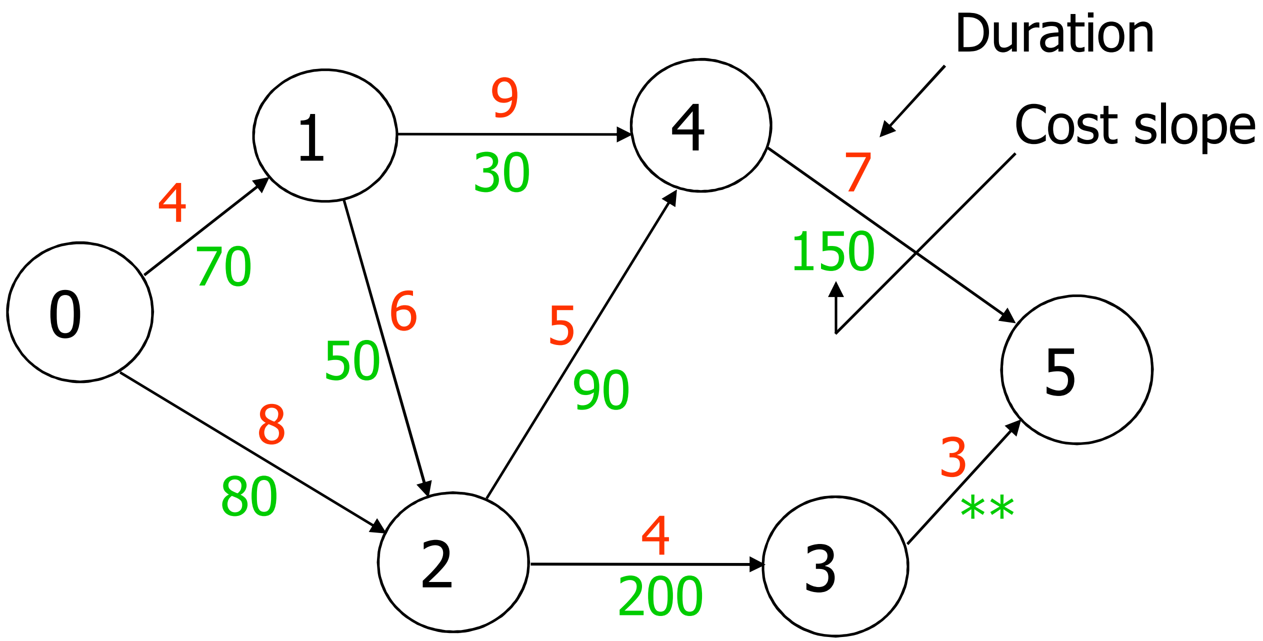
TO…

Project Duration:
31 weeks
Additional Cost:
$2000



Example 4: Home work

Consider the following AoA network:



** Activity 3-5 cannot be expedited

The duration of each task is shown above the arrows. The cost slope for each task is shown below the arrows. The initial critical path is 0-1-2-4-5 @ 22 days. The initial cost is $3,050.

Example 4: (cont.)

Cost and time data are:

	Normal		Crash		
Activity	**Time**	**Cost**	**Time**	**Cost**	**Cost Slope**
0-1	4 days	$210	3 days	$280	70
0-2	8	400	6	560	80
1-2	6	500	4	600	50
1-4	9	540	7	600	30
2-3	4	500	1	1,100	200
2-4	5	150	4	240	90
3-5	3	150	3	150	**
4-5	7	600	6	750	150
		3,050		4,280	

** Activity 3-5 cannot be expedited

Example 4: (cont.)

Develop schedules ranging from 22 to 17 days for this project. Record the critical paths and total costs below:

Schedule Duration	Critical Path(s)	Total Cost
22	0-1-2-4-5	$3,100
21		
20		
19		
18		
17		

Time-Cost Tradeoffs

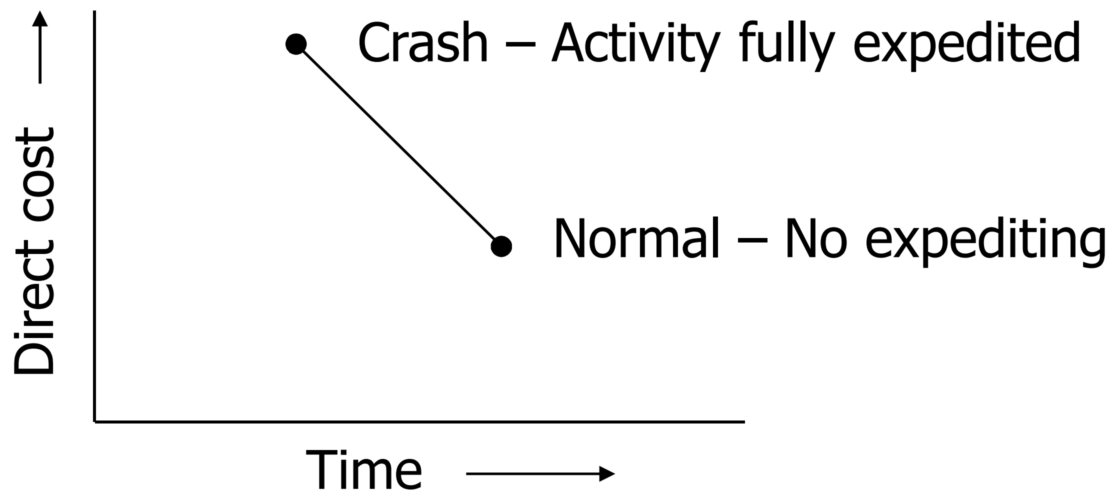
- Crashing costs increase as project duration decreases
- Indirect costs increase as project duration increases
- Reduce project length as long as crashing costs are less than indirect costs

Time-cost tradeoffs (cont.)

- Reducing the time of a critical activity usually incurs additional direct costs
  - Cost-time solutions focus on reducing (**crashing**) activities on the critical path to shorten overall duration of the project

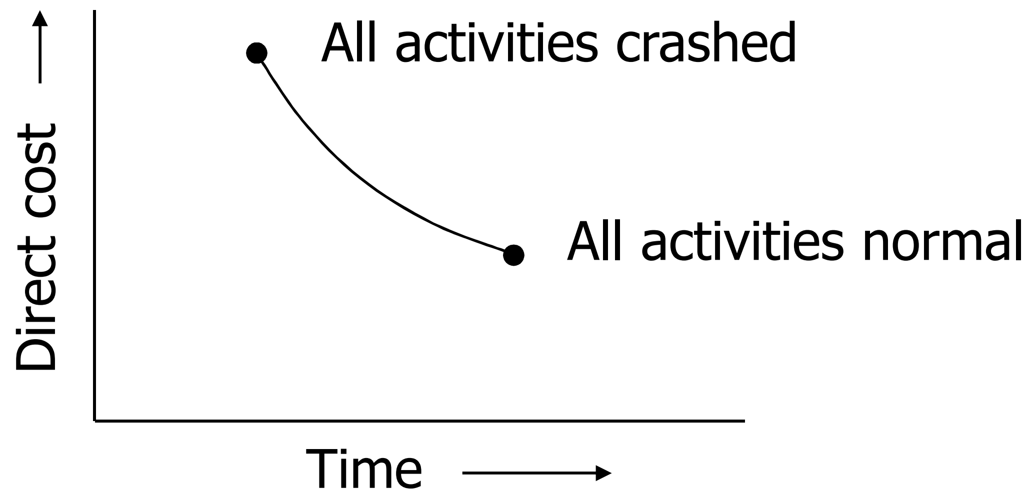
Time-cost tradeoffs (cont.)

- **Activity direct costs**

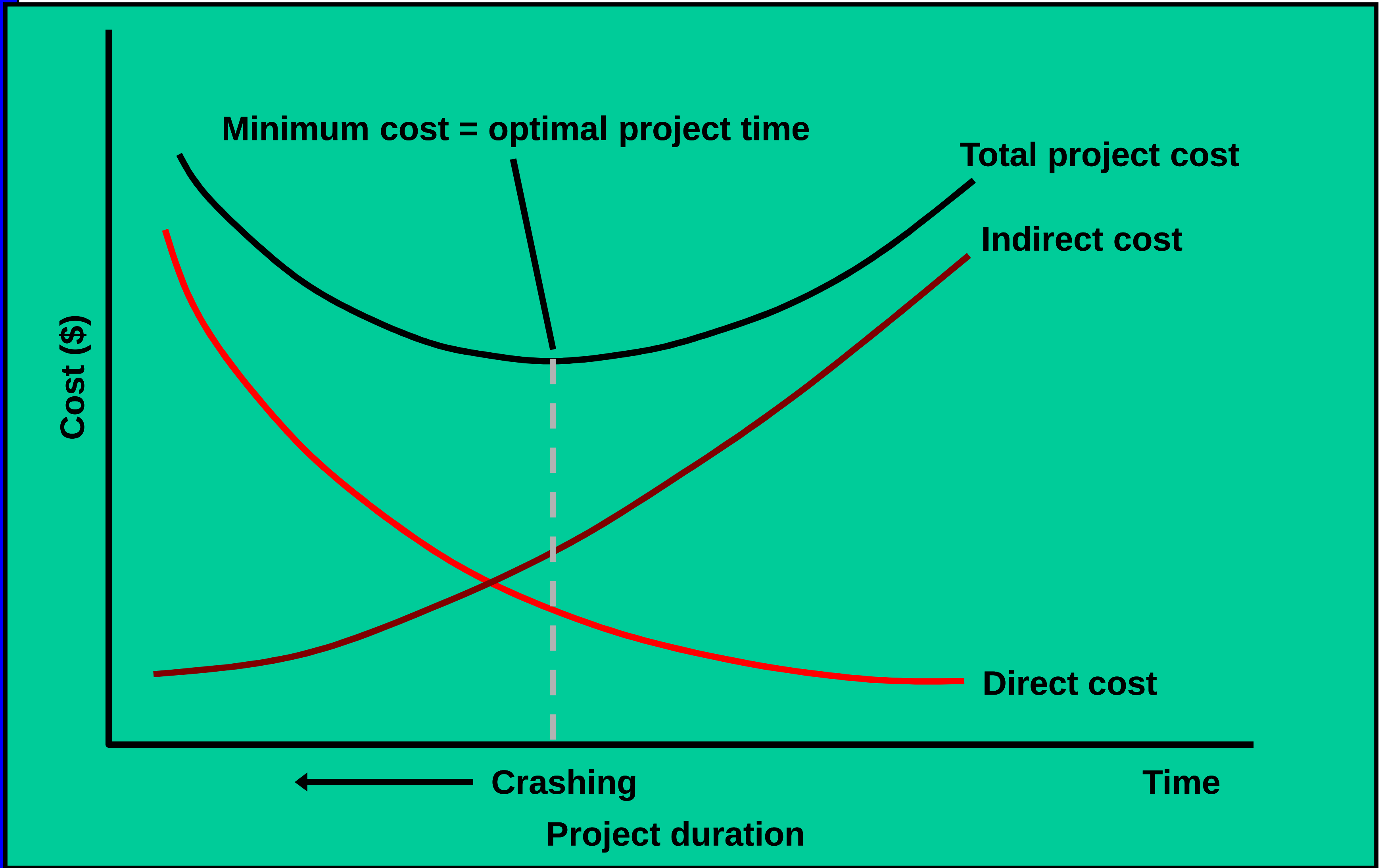


Time-cost tradeoffs (cont.)

- **Project direct costs**



Time-Cost Tradeoff



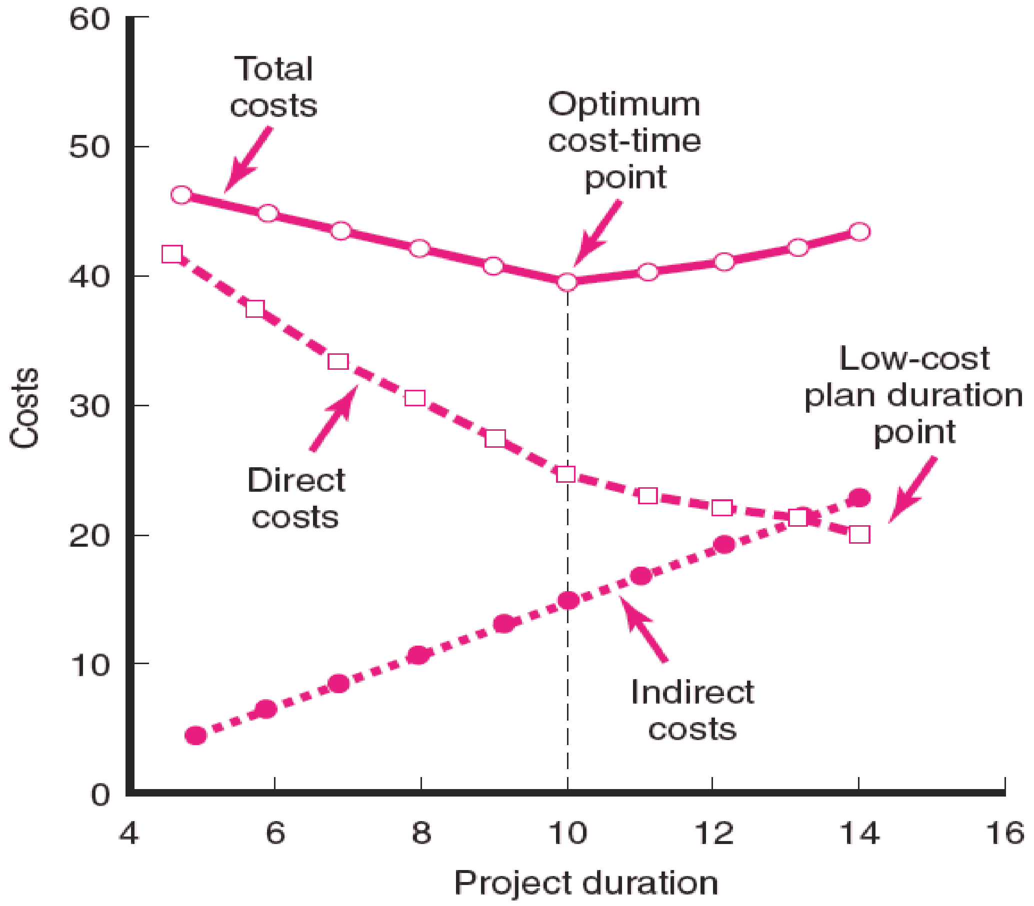
Project **Direct** Costs

- Normal costs that can be assigned directly to a specific work package or project activity
  - Labor, materials, equipment, and subcontractors
- Crashing activities increases direct costs

Project **<u>Indirect</u>** Costs

- Costs that cannot be associated with any particular work package or project activity
  - Supervision, administration, consultants, and interest
- Costs that vary (increase) with time
  - Reducing project time directly reduces indirect costs.

Project Cost—Duration Graph



Constructing a Project Cost—Duration Graph

- Find total direct costs for selected project durations.
- Find total indirect costs for selected project durations.
- Sum direct and indirect costs for these selected project durations.
- Compare additional cost alternatives for benefits.

What if Cost, Not Time Is the Issue?

- Reduce project scope
- Have owner take on more responsibility
- Outsourcing project activities or even the entire project
- Brainstorming cost savings options

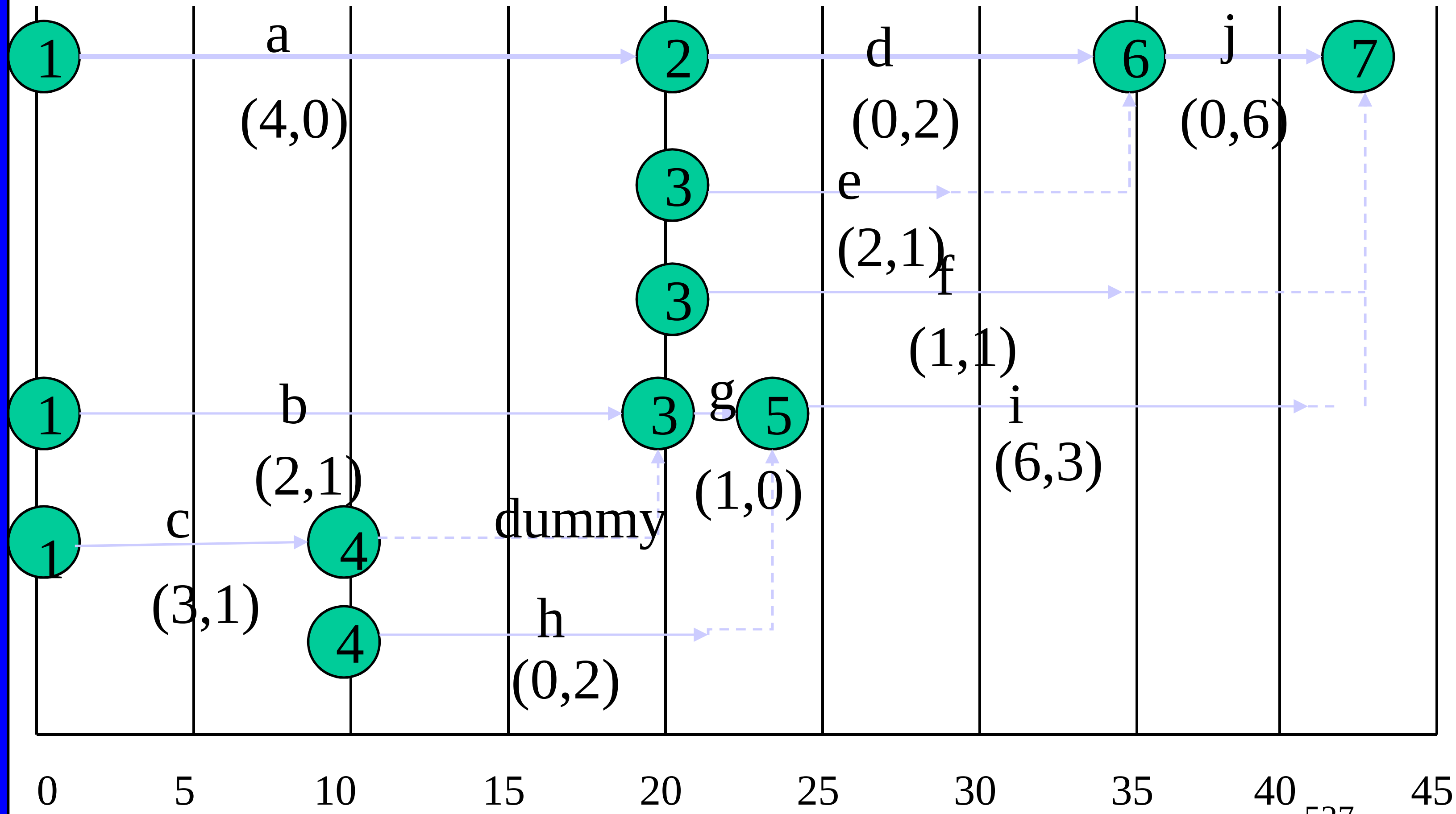
Resource Usage Calendar

Career Day Project
Resource Usage Calendar

ID	Resource Name	Work	May 25	2	9	16	23	June 30	6	13	20	July 27	4	11	18	25
1	**Secretary**	**1,020 hrs**	24h	40h	40h	40h	88h	120h	102h	40h	40h	40h	40h	40h	40h	40h
	Print forms	240 hrs														
	Gather college particulars	160 hrs	24h	40h	40h	40h	16h									
	Print programs	240 hrs					24h	40h	40h	40h	40h	40h	16h			
	Advertise in college paper	200 hrs					24h	40h	36h	0h	0h	0h	24h	40h	36h	
	Organize posters	180 hrs					24h	40h	26h	0h	0h	0h	0h	0h	4h	40h
2	**Program Manager**	**1,440 hrs**	40h	40h	40h	16h	24h	40h	40h	40h	16h					
	Contact organizations	600 hrs	16h													
	Select guest speaker	560 hrs														
	Organize food	120 hrs	24h	40h	40h	16h										
	Contact faculty	60 hrs					24h	36h								
	Arrange facility for event	100 hrs						4h	40h	40h	16h					
3	**Office Manager**	**180 hrs**	24h	40h	40h	40h	16h				20h					
	Collect display information	160 hrs	24h	40h	40h	40h	16h									
	Transport materials	20 hrs									20h					
4	**Graduate Assistant**	**1,140 hrs**	24h	40h	40h	40h	64h	80h	80h	56h	40h	40h	16h			
	Print participants' certificates	320 hrs														
	Organize refreshments	280 hrs	24h	40h	40h	40h	40h	40h	40h	16h						
	Send invitations	80 hrs														
	Organize gift certificates	220 hrs														
	Arrange banner	200 hrs					24h	40h	40h	40h	40h	16h				
	Class announcements	40 hrs										24h	16h			
5	**Director**	**400 hrs**	24h	40h	40h	40h	40h	40h	40h	40h	40h	40h	16h			
	Organize liquor	400 hrs	24h	40h	40h	40h	40h	40h	40h	40h	40h	40h	16h			

Figure 9-3 Resource usage calendar for the Career Day Project.

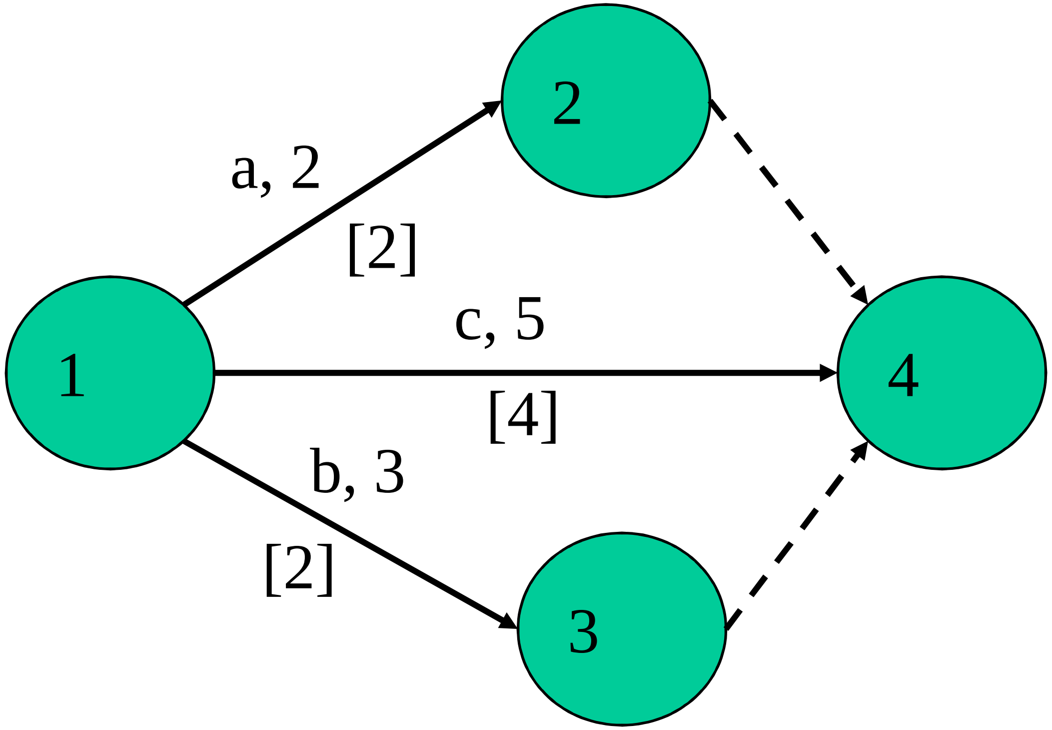
Modified PERT/CPM AOA Diagram



RESOURCE LEVELING

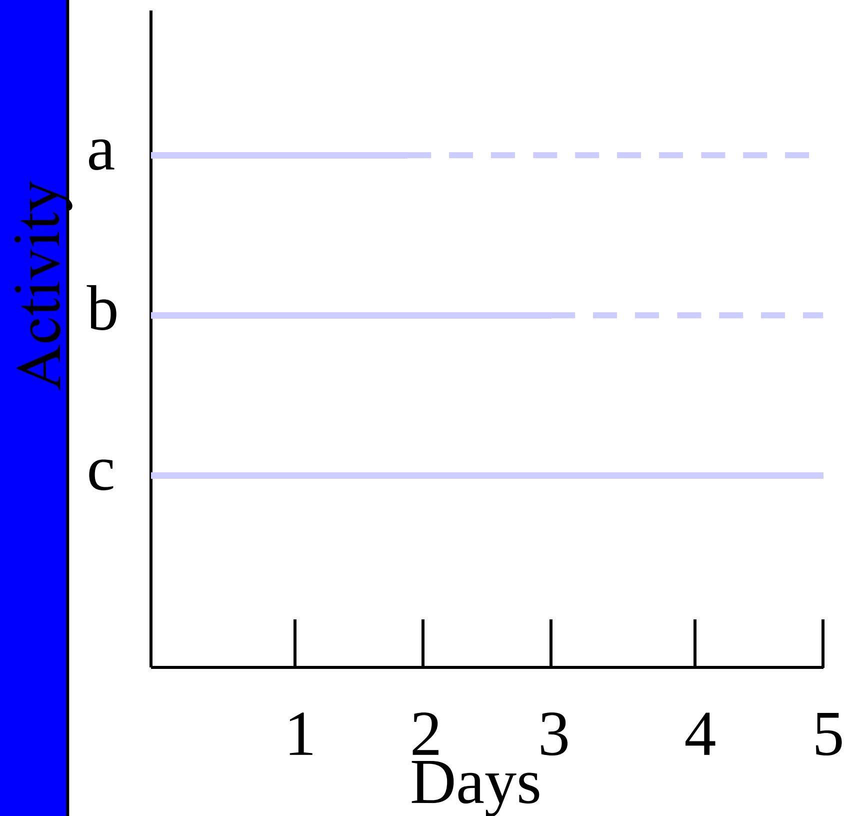
- Aims to minimize the period-by-period variations in resource loading *by shifting tasks within their slack allowances*
- Purpose to create a smoother distribution of resource usage
- Advantages;
  - Much less hands on management
  - Be able to use ‘just in time’ inventory policy with right quantity delivered
- If the resource being leveled is people, it improves morale and results in fewer problems in the personnel and payroll offices

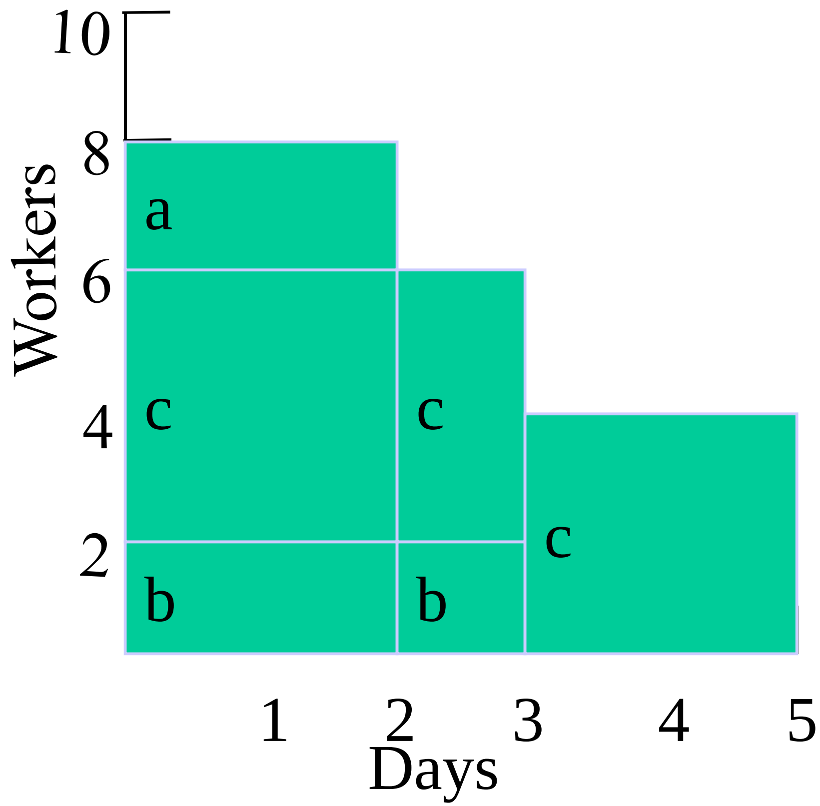
E.g: Network



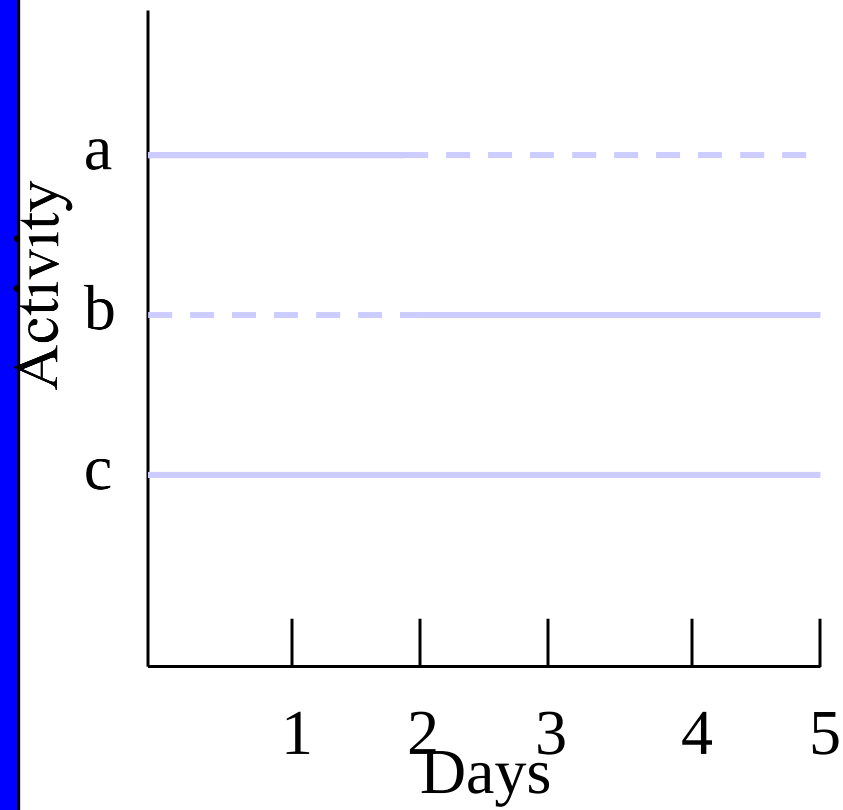
The activity time is shown above the arc, and resource usage (one resource, workers) is in brackets below the arc.

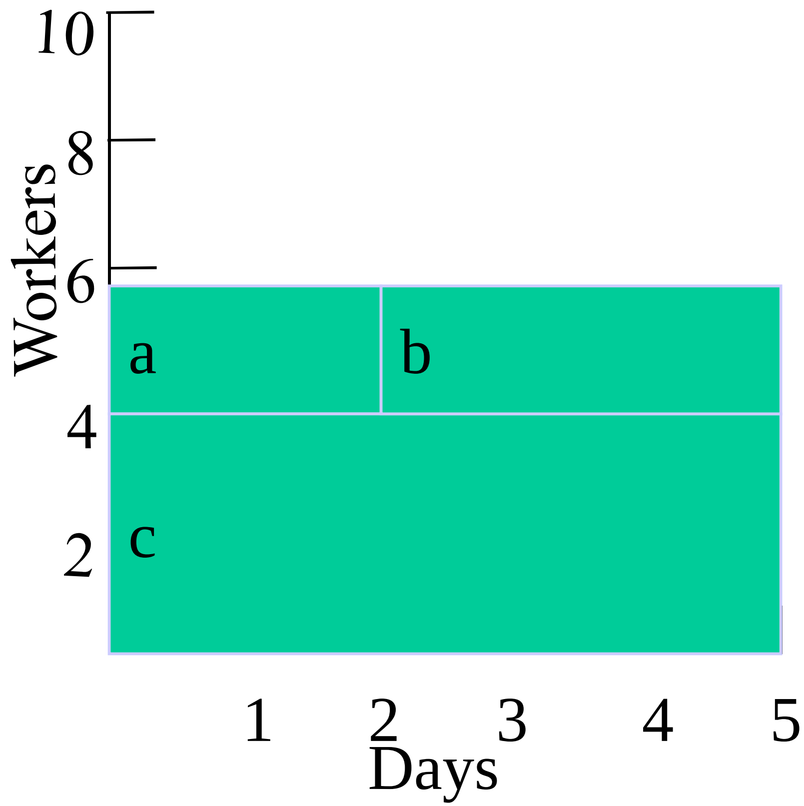
Before Resource Leveling





After Resource Leveling





RESOURCE LOADING/LEVELING AND UNCERTAINTY

- If happens excess capacity,the alternative that we can consider:
  - Try to level the demand, moving some of it forward and some backward
  - Try to alter the supply of working hours-trade off time between periods of over capacity and periods of under capacity
  - Might expend additional resources-contract worker for overload period, subcontract the workload
    - Which cheaper?Delay or subcontract?

Project Monitoring and Evaluation

Outline of the Talk

- Introduction to project Monitoring and Evaluation
- Why project Monitoring and Evaluation
- Similarities & Differences between monitoring and Evaluation
- Designing a Project Monitoring System
- Ways of Evaluation
- Selecting an External Evaluator or Evaluation Team
- Results-Based Monitoring
- Question and discussion

What is Project Monitoring?

Project Monitoring is the continuous and systematic collection and analysis of information as a project progresses

It helps to keep the work on track, and can let management know when things are going wrong

Determine whether the resources you have available are sufficient and are being well used, whether the capacity you have is sufficient and appropriate, and whether you are doing what you planned to do (see also the toolkit on action planning).

What is Evaluation?

- **Project Evaluation** is the comparison of actual project impacts against the agreed strategic plans. It looks at what you set out to do, at what you have accomplished, and how you accomplished it

- It can be **formative** (taking place during the life of a project, with the intention of improving the strategy or way of functioning of the project)

- It can also be **summative** (drawing learnings from a completed project that is no longer functioning).

Why Project Monitoring and Evaluation?

- Help you identify problems and their causes;
- Suggest possible solutions to problems;
- Raise questions about assumptions and strategy;
- Push you to reflect on where you are going and how you are getting there;
- Provide you with information and insight;
- Encourage you to act on the information and insight;
- Increase the likelihood that you will make a positive development difference.

Similarities and differences Project monitoring and Evaluation

Both Monitoring and Evaluation focus on:

- **Efficiency -** input into the work is appropriate in terms of the output
- **Effectiveness-** is a measure of the extent to which a project achieves the specific objectives it set
- **Impact-** tells you whether or not what you did made a difference to the problem situation you were trying to address. In other words, was your project useful?

Similarities and differences Project monitoring and Evaluation

Monitoring involves:

- Establishing indicators of efficiency, effectiveness and impact;
- Setting up systems to collect information relating to these indicators;
- Collecting and recording the information;
- Analysing the information;
- Using the information to inform day-to-day management.
- Monitoring is **an internal function** in any project or organization

Similarities and differences Project monitoring and Evaluation

Evaluation involves:

- Looking at what the project intended to achieve – what difference did it want to make? What impact did it want to make?
- Assessing its progress towards what it wanted to achieve, its impact targets
- Looking at the strategy of the project or organisation. Did it have a strategy? Was it effective in following its strategy? Did the strategy work? If not, why not?
- Looking at how it worked. Was there an efficient use of resources? What were the opportunity costs of the way it chose to work? How sustainable is the way in which the project works?

- There are **many different ways of doing an evaluation.**

Seven steps for Developing a monitoring system

1. Identify key issues, concerns, questions or demands which will become the focus of monitoring
2. Determine indicators
3. Determine strategies for collecting, analysing and reporting data
4. Determine the use of the information and how action will be taken
5. Determine information flow, checks and verification of information
6. Test monitoring system
7. Provide training or orientation to groups involved

Monitoring Framework

Expected results	Indicators	Baseline data	Targets	Data Sources
What do you want to achieve?	What are you measuring?	What is the current value?	What is the source of data?	What is the source of the data?

Data collection methods	Frequency	Responsibility	Reporting
How is data to be obtained?	How often will data be measured?	Who will measure the data and what resources are required?	How and to whom will information be reported?

Developing Indicators

- **Indicators** are measurable or tangible signs that something has been done or that something has been achieved

- For example, an increased number of television aerials in a community(has been used as an indicator that the standard of living in that community has improved)

- Indicators are an essential part of a monitoring and evaluation system because they are what you measure and/or monitor.

Indicators answer questions such as:

- Who?
- How many?
- How often?
- How much?

Developing Indicators

- Step 1: Identify the problem situation you are trying to address
- Step 2: Develop a vision for how you would like the problem areas to be/look. This will give you impact indicators
- Step 3: Develop a process vision for how you want things to be achieved. This will give you process indicators
- Step 4: Develop indicators for effectiveness
- Step 5: Develop indicators for your efficiency targets

Characteristics of an indicator

- Definition of a quality (what?)
- Definition of a measure (how much?)
- Definition of a target group (who?)
- Definition of a time horizon (when?)
- Definition of a place (where?)

Example: All water points will be located within a radius of 200 metres of at least 8 settlements, by December 2000, in the region of Kebri.

In addition, an indicator must be:

- **Relevant**
  (the indicator measures what is needed, and it is related to the objectives)
- **Sensitive**
  (the indicator responds to variations and changes)
- **Simple**
  (the community and other actors are able to understand it; and the data will be easy to act upon; limitation of number of indicators)
- **Feasible**
  (easy to collect information; possible to act upon; not costly)

Evaluation Steps

- Identify purpose and intended audiences
- Formulate questions and hypothesis
- Determine available resources, time requirements and appropriate level of effort
- Choose evaluation methods and analysts
- Design information gathering approaches and select or develop specific models
- Compile information
- Exercise evaluation methods using collected information
- Analyze and interpret results , write a report
- Disseminate results presented to intended audiences and provide feedback to the project

Evaluation ways

External evaluation: This is an evaluation done by a carefully chosen outsider or outsider team

Self-evaluation: This involves an organisation or project holding up a mirror to itself and assessing how it is doing, as a way of learning and improving practice

Participatory evaluation: A form of internal evaluation which involves as many people with a direct stake in the work as possible. If an outsider is called in, it is to act as a facilitator of the process, not an evaluator

.

Evaluation ways

- **Rapid Participatory Appraisal:** This is a qualitative way of doing evaluations. It is semi-structured and carried out by an interdisciplinary team over a short time

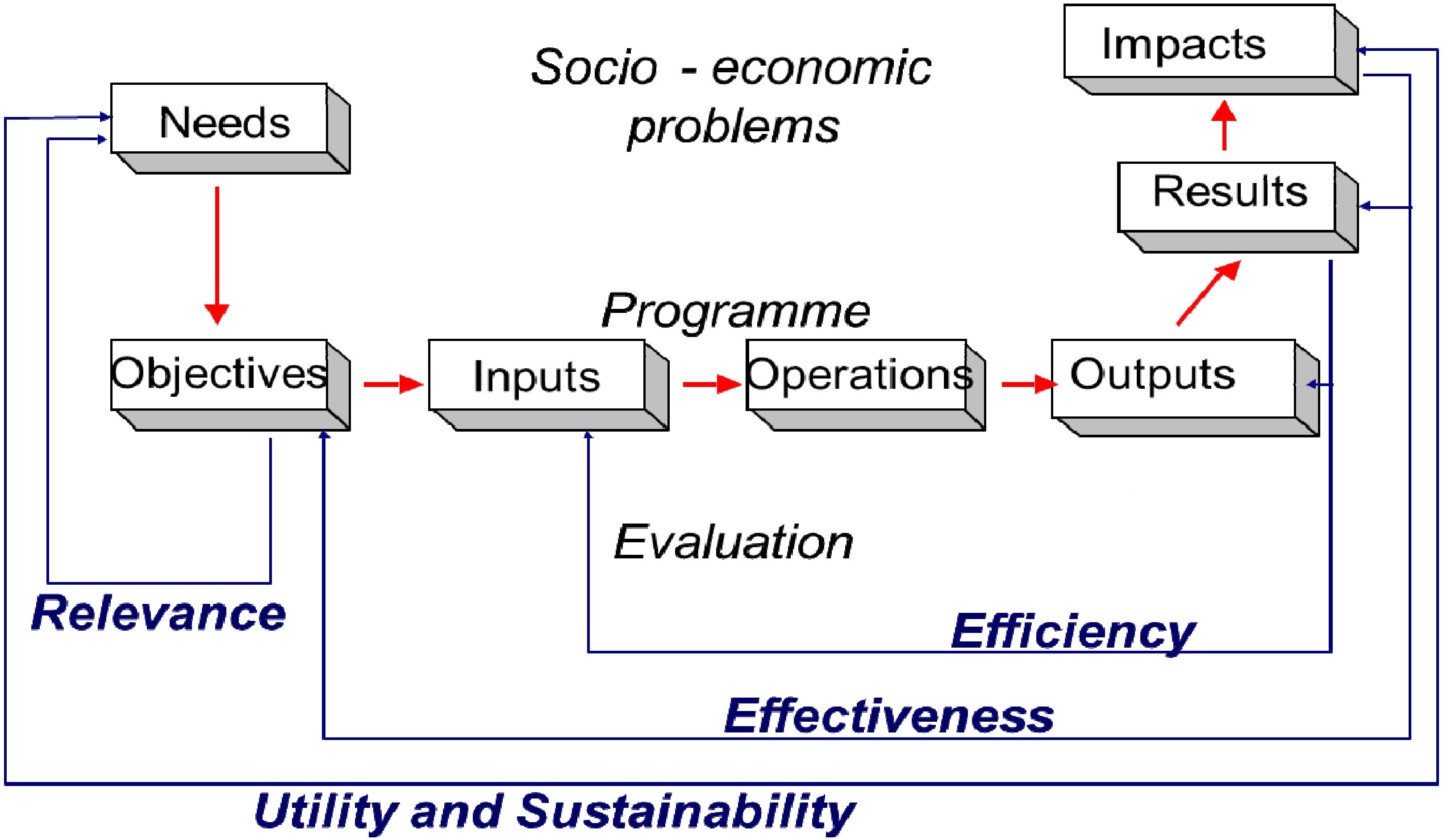
- It involves the use of secondary data review, direct observation, semi-structured interviews, key informants, group interviews, games, diagrams, maps and calendars.
- It is flexible and interactive

- **Interactive evaluation:** This involves a very active interaction between an outside evaluator or evaluation team and the organisation or project being evaluated. Sometimes an insider may be included in the evaluation team.

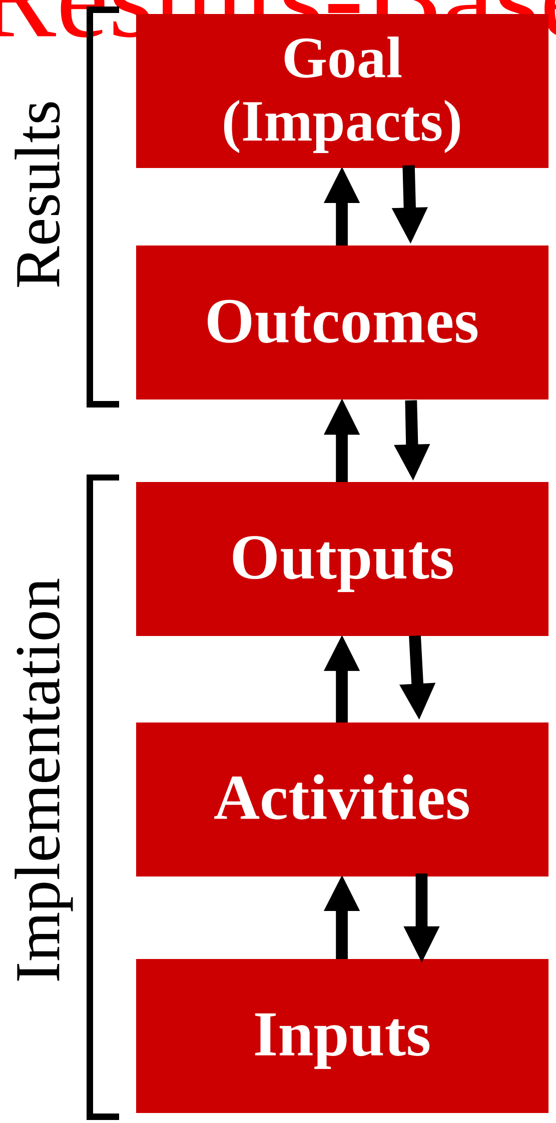
Internal Vs External Evaluation

	Advantages	Disadvantages
Internal evaluation	The evaluators are very familiar with the work, the organisational culture and the aims and objectives. Sometimes people are more willing to speak to insiders than to outsiders. An internal evaluation is very clearly a management tool, a way of self-correcting, and much less threatening than an external evaluation. This may make it easier for those involved to accept findings and criticisms. An internal evaluation will cost less than an external evaluation.	The evaluation team may have a vested interest in reaching positive conclusions about the work or organisation. For this reason, other stakeholders, such as donors, may prefer an external evaluation. The team may not be specifically skilled or trained in evaluation. The evaluation will take up a considerable amount of organisational time – while it may cost less than an external evaluation,) may be high.
External evaluation	The evaluation is likely to be more objective as the evaluators will have some distance from the work. The evaluators should have a range of evaluation skills and experience. Sometimes people are more willing to speak to outsiders than to insiders. Using an outside evaluator gives greater credibility to findings, particularly positive findings.	Someone from outside the organisation or project may not understand the culture or even what the work is trying to achieve. Those directly involved may feel threatened by outsiders and be less likely to talk openly and co-operate in the process. External evaluation can be very costly. An external evaluator may misunderstand what you want from the evaluation and not give you what you need.

Effectiveness, Efficiency and Impact



Results-Based Monitoring



- Long-term, widespread improvement in society
- Intermediate effects of outputs on clients
- Products and services produced
- Tasks personnel undertake to transform inputs to outputs
- Financial, human, and material resources

- Traditional monitoring focuses on ***implementation monitoring***
  - This involves tracking ***inputs*** ($$, resources, strategies), ***activities*** (what actually took place) and ***outputs*** (the products or services produced)
  - This approach focuses on monitoring how well a project, program or policy is being implemented
  - Often used to assess compliance with workplans and budget

A New Emphasis on Both Implementation and Results-Based Monitoring

- ***Results-based monitoring*** involves the regular collection of information on how effectively any organization is performing
- Results-based monitoring demonstrates whether a project, program, or policy is achieving its stated goals
- is a continuous process of collecting and analyzing information to compare how well a project, program or policy is performing against expected results

Results-Based Monitoring and Evaluation

- Results-based monitoring and evaluation measures how well organizations are performing
- Results-based monitoring and evaluation is a management tool!
- Results-based monitoring and evaluation emphasizes assessing how outcomes are being achieved over time

Reasons to Do Results-Based M&E

- Provides crucial information about organization performance
- Provides a view over time on the status of a project, program, or policy
- Promotes credibility and confidence by reporting on the results of programs
- Helps formulate and justify budget requests
- Identifies potentially promising programs or practices

Reasons to Do Results-Based M&E (cont.)

- Focuses attention on achieving outcomes important to the organization and its stakeholders
- Provides timely, frequent information to staff
- Helps establish key goals and objectives
- Permits managers to identify and take action to correct weaknesses

Important…

- It takes leadership commitment to achieve a better-performing organization
- Plus redeployment of resources to build monitoring and evaluation systems
- Plus individuals committed to improve organization performance

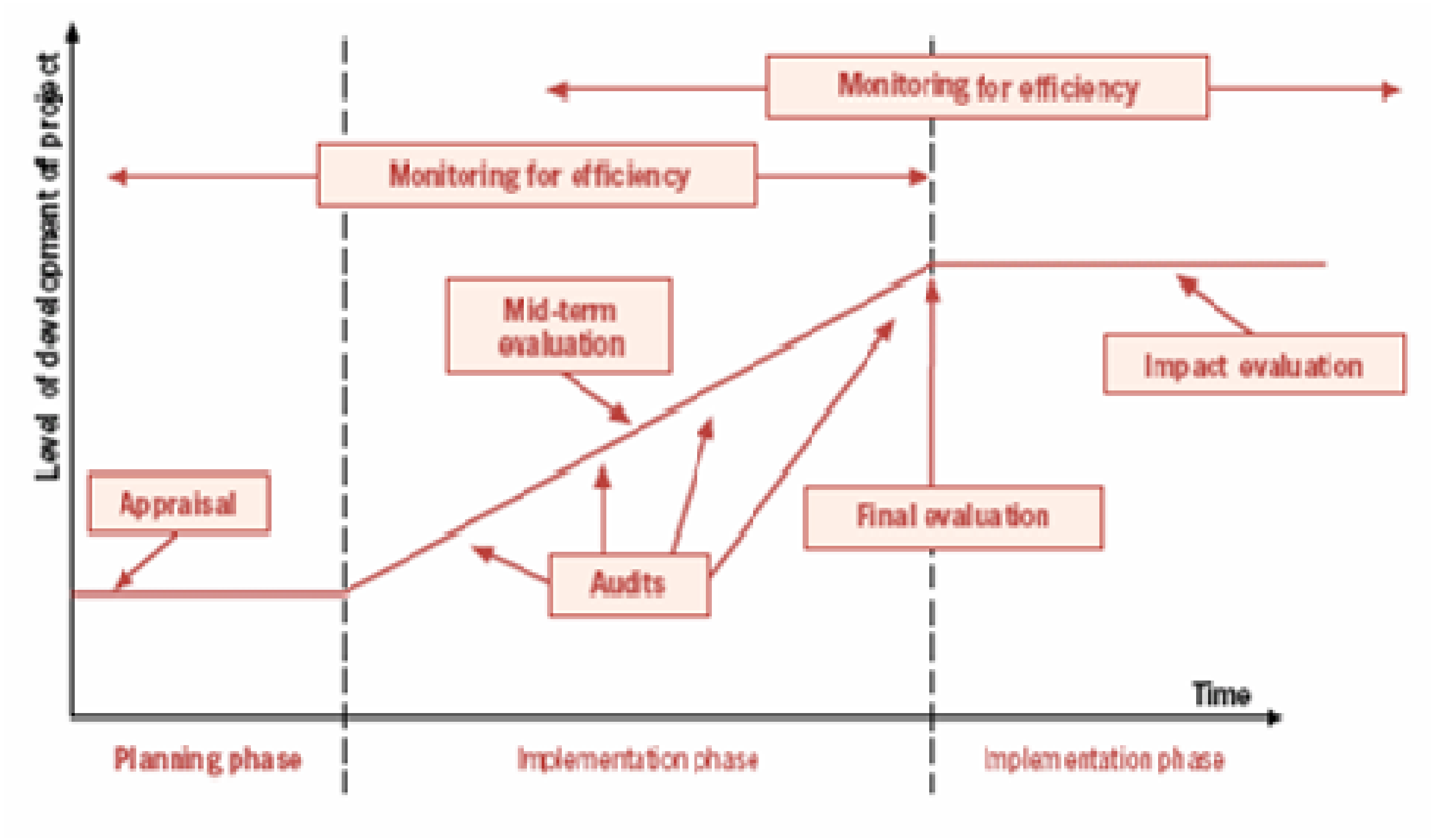
Major Activities Where Results Monitoring Is Needed

- Setting goals and objectives
- Reporting to regulators and other stakeholders
- Managing projects, programs and policies
- Reporting to Financing organization
- Allocating resources

Selecting an External Evaluator or Evaluation Team

- An understanding of development/project issues
- An understanding of organisational issues
- Experience in evaluating projects, programmes or organisations
- Good track record with previous clients
- Research skills
- A commitment to quality
- A commitment to deadlines
- Objectivity, honesty and fairness.
- Logic and the ability to operate systematically
- Ability to communicate verbally and in writing
- Reasonable rates (fees), measured against the going

Similarities and differences Project monitoring and Evaluation



Thank You

Questions!!!!!

Discussion Questions

- ***In your groups of at most five members, briefly describe how would monitor and evaluate your propoed project***

Introduction to Microsoft Project Application

IE354 :Engineering Project Management

Mohamed. J.A.M, PhD
College of Engineering and Technology-UDSM

February , 2016

About MS Project

- Already Basic project planning using Manual techniques (CPM, PERT, Bar charts
- Large projects require sophisticated tools for planning and management
- "MS-Project" is one of the most popular tools for project planning and management
- It is powerful, relatively easy to use and offers good integration with other parts of the MS Office suite of tools.

Objectives

To give you basic practice in using MS-Project, by planning simple projects that you are already familiar with;

To provide an introduction to MS-Project so that you may use it “in anger” to support project management processes

GETTING STARTED WITH MS-PROJECT

Starting the program

–Log in to a machine ……..

–Click through “Start > Programs > Microsoft Office 2000/3 > Microsoft Project”

–MS-Project should start up, with a blank “Gantt chart” view of a new project and a Help window. You can minimise the help window for now, but remember it’s there if you need it.

Saving your work

- Many people leave this to the end. DON'T! Do it immediately,
- Click through "Start > My Computer > Drive D> File > new > Folder>IE354>close window
- Save your new (blank!) project to your Folder (IE354:) with a filename that you will recognise. Do it regularly,
- Even better, use "Tools > Options > Save" to configure the program to auto save every 10 minutes (or more frequently if you're paranoid…).
- If you are prompted to save the project with a baseline, click 'Yes'. For now, don't worry about what this means.

Tasks

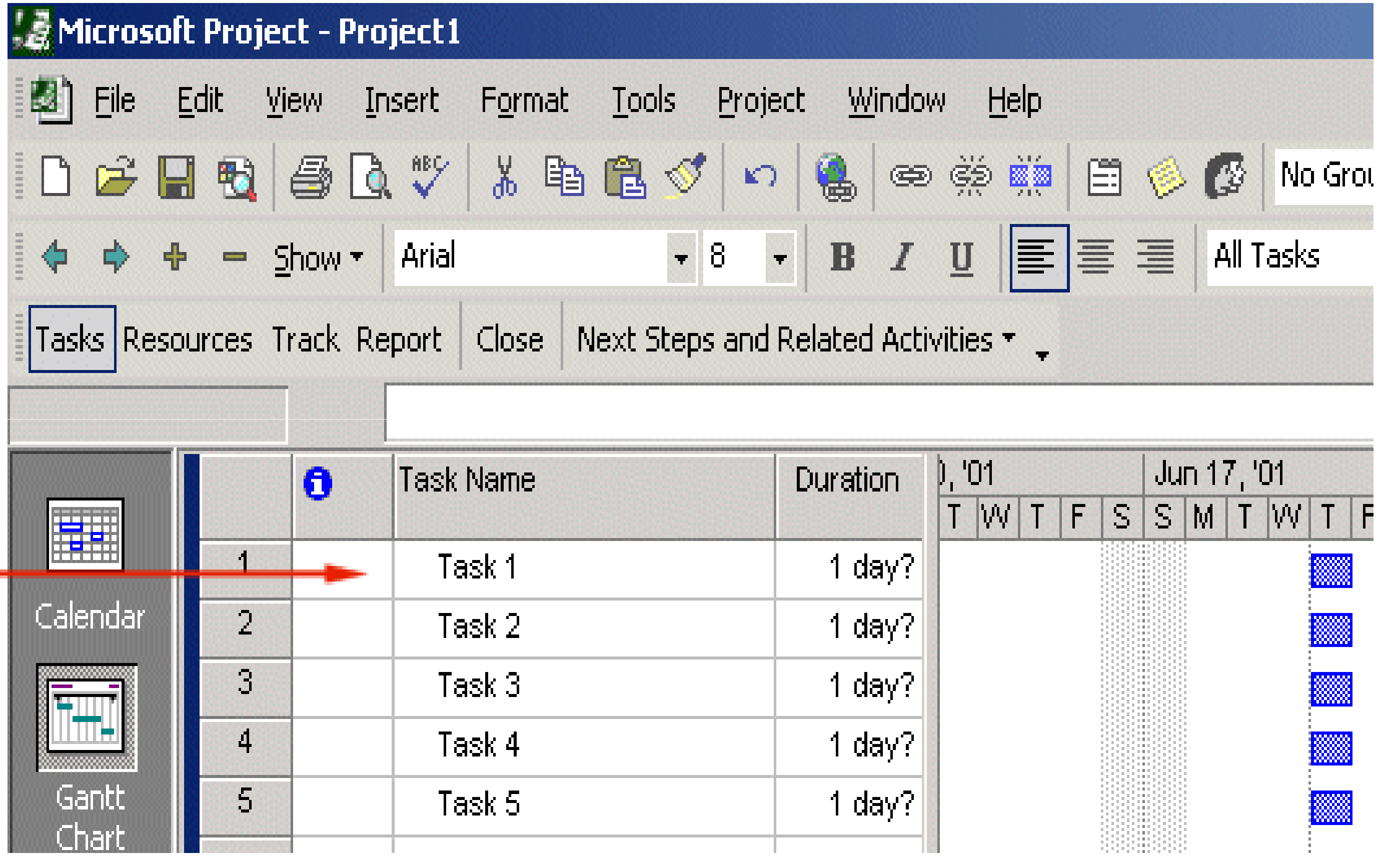
- Summary Tasks
- Sub-tasks
- Task Types
  - Fixed Units
  - Fixed Work
  - Fixed Duration (recommended)
  - Effort driven

Task Types

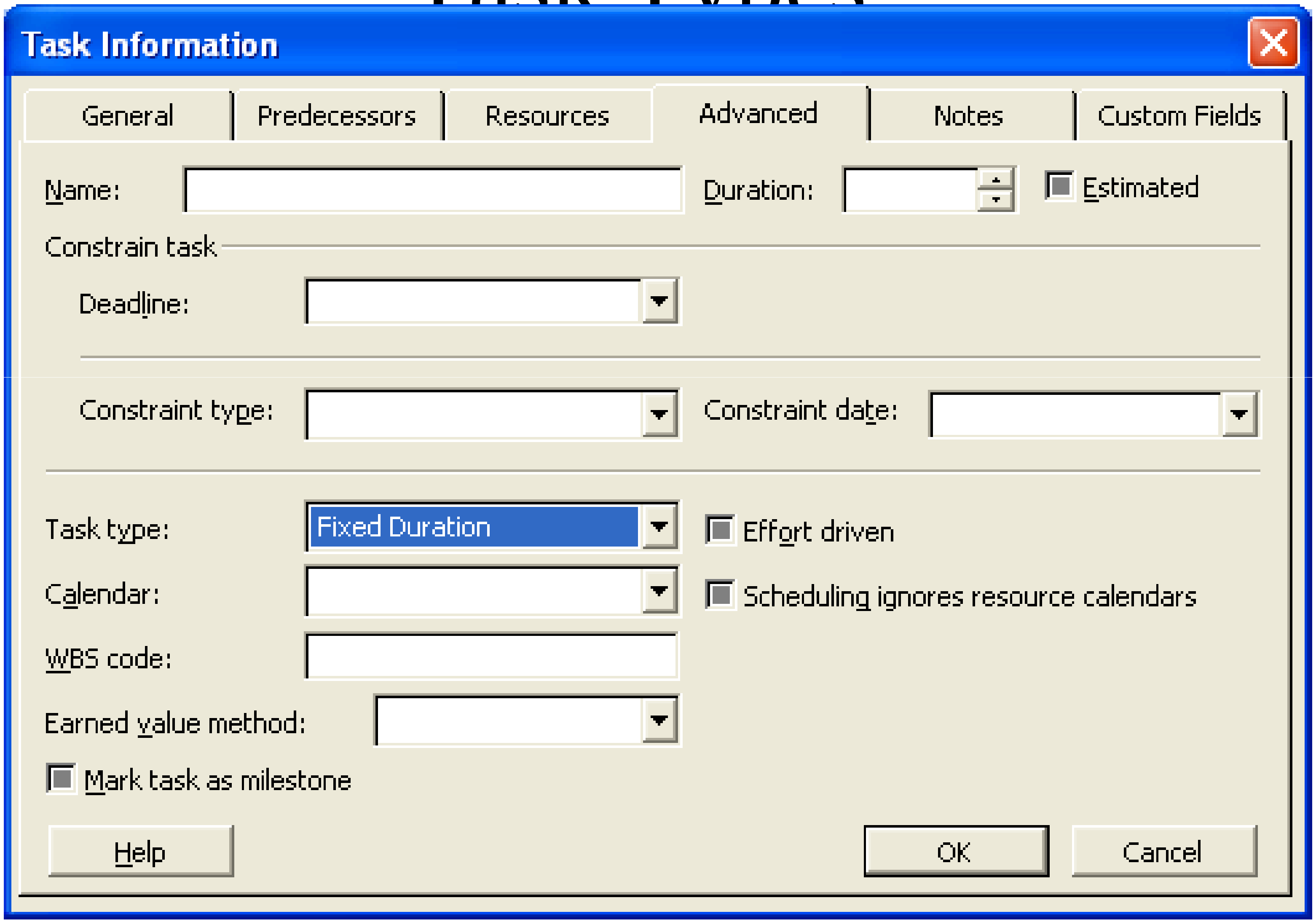
- **Fixed units –** tasks where the resources are a fixed value & changes to the amount of work or the duration do not affect the resources
- **Fixed work –** tasks where the amount of work is a fixed value & changes to the duration or the number of resources do not affect the work.
- **Fixed duration** (recommended) – tasks where the duration is a fixed value & changes to the work or the resources don't affect the duration.
- **Effort Driven –** the duration of a task shortens or lengthens as resources are added or removed from a task while the effort (work) remains the same.

Subtasks

Task Details
Entered Here

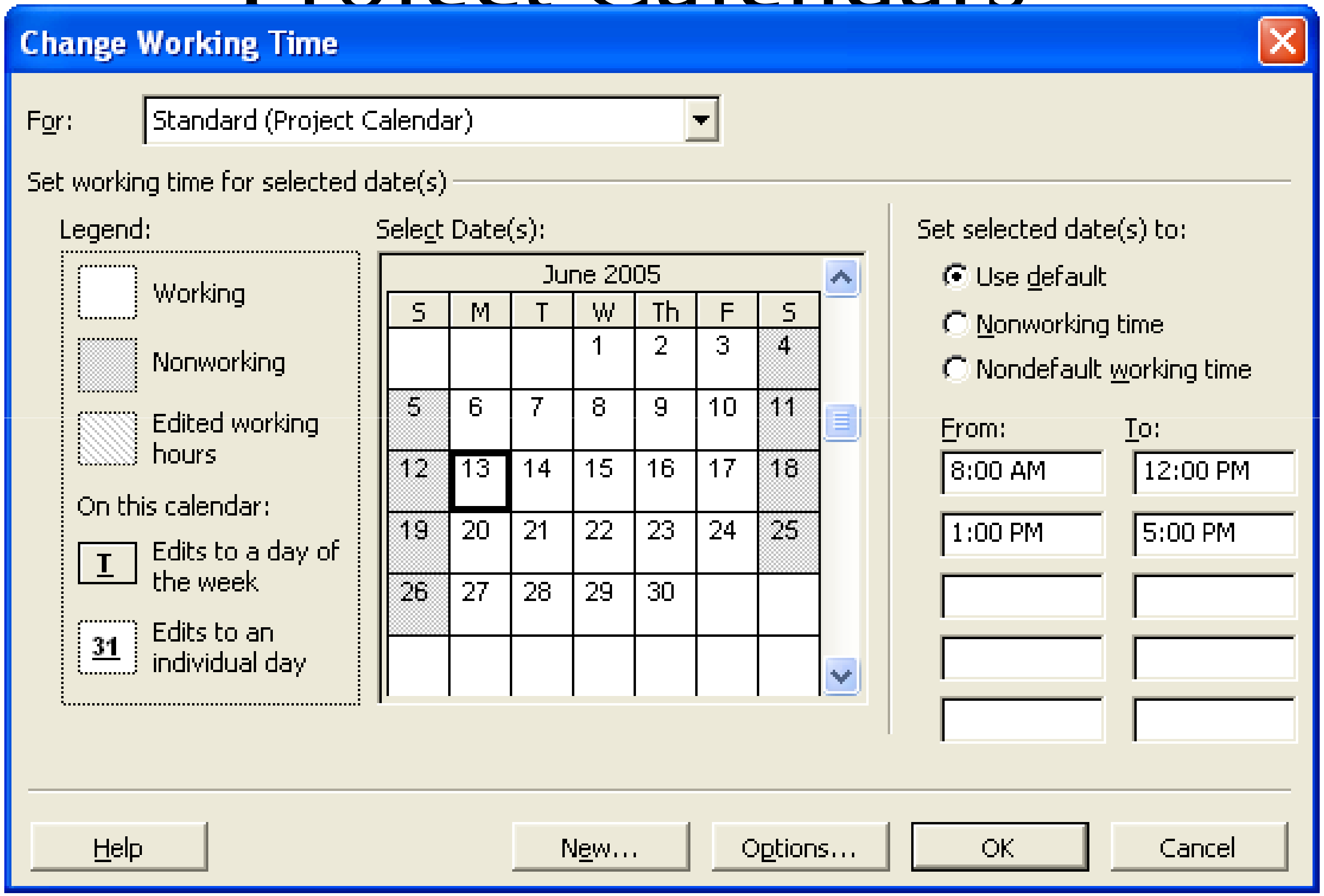


Task Types



Task Information
General
Predecessors
Resources
Advanced
Notes
Custom Fields
Name:
Duration:
Estimated
Constrain task
Deadline:
Constraint type:
Constraint date:
Task type:
Fixed Duration
Effort driven
Calendar:
Scheduling ignores resource calendars
WBS code:
Earned value method:
Mark task as milestone
Help
OK
Cancel

Project Calendars



ENTERING ACTIVITIES (TASKS)

- You must have already made a paper list of tasks and durations.

- When you start MS-Project, by default you'll see a blank Gantt chart. The first three columns (on the left) are headed "Task ID", "Description/task name" and "Duration".

- Simply work down the second column, entering Task Descriptions and pressing the Down Arrow key (↓) at the end of each entry

- MS-Project will automatically insert Task IDs as you add them, and will suggest a default of 1 time unit (1 day by default) for each task. Accept this for now.

- When you have created your list of tasks, you can add the durations that you really want. Simply click in the "Duration" box for each task and specify its duration and time unit using the keyboard and mouse.

Creating a hierarchy of subtasks

- Large projects may have hundreds of tasks = Creating these is tedious but unavoidable; displaying them **is** avoidable
- First (outside of the software), write down your tasks, grouped under headings that describe their intended effect. These headings are called "Workpackages".
- This is Simply done if you have your WBS

Eat breakfast

- *Make coffee*
- *Make toast*
- *Consume breakfast*
- *Tidy up* (OK – unlikely, but you get the idea!)

- Enter all the tasks (in any order you like, but group them together under their workpackage headings)

- use the "Indent" function (the icon) to make the subtasks part of the workpackage by moving them to the right.
- When you indent a task, it becomes a subtask of the next "unindented" task above it, i.e. part of a workpackage.
- You can select multiple tasks (shift-click) before indenting.
- This indenting to form workpackages is extremely useful to control how projects are displayed. By expanding and collapsing a Workpackage, you can show or hide subtasks to show just the level of detail you want.
- To "Outdent" (i.e. to promote) a task, simply select the task's entire row and click the Outdent icon (), or right-click and select "Outdent".

Linking tasks

- You are already familiar with the concept of “linkage” or “precedence” – that some activities need to finish before others can start (like putting on socks *before* putting on shoes *before* tying laces).

- In MS-Project these linkages are easily set up using the mouse

- Once you have entered two activities and their durations, it’s easy to create the commonest type of linkage – FS, or Finish-to-Start – between them. Simply

- With the left mouse button, select the earlier activity
- Hold down the ‘Control’ (or ‘Ctrl’) key
- Select the later activity and release the left mouse button and control key
- Click the ‘Link tasks’ icon (it looks like a chain)
- You should see the later activity’s duration bar get pushed to the right, and its left end will align with the right end of the earlier one. An arrow will appear showing the link
- The “link tasks” icon can be used at any time to edit the linkage characteristic.

11. Project Appraisal Document

IE354: Engineering Project Management

Mohamed. J.A.M,

Department of Mechanical and Industrial Engineering
College of Engineering and Technology-UDSM

Contents(Based on World Bank Guidelines)

- **A. STRATEGIC CONTEXT AND RATIONALE**
  - Country and Sector Issues
  - Rationale for Bank Involvement
  - Higher Level Objectives to which the Project Contributes

- **B. PROJECT DESCRIPTION**
  - Lending Instrument and Eligibility Criteria
  - Project Development Objective and Key Indicators
  - Project Area and beneficiaries
  - Project Components
  - Lessons Learned and Reflected in the Project Design
  - Alternatives Considered and Reasons for Rejection

Content cont..

- **C. IMPLEMENTATION**
- Partnership Arrangements (if applicable)
- Institutional and Implementation Arrangements
- Monitoring and Evaluation of Outcomes/Results
- Sustainability
- Critical Risks and Possible Controversial Aspects
- Loan/Credit Conditions and covenants

Content cont..

- **D. PROJECT APPRAISAL SUMMARY**
- Economic analysis
- Financial Analyses
- Technical analysais
- Social and Environmental assessment
- Safeguard Policies
- Readiness (checklist)
- Compliance (checklist)

F. TECHNICAL ANNEXES

- Country and sector or program background
- Major related projects financed by the Bank and/or other agencies
- Results framework and monitoring
- Detailed project description
- Project costs
- Implementation arrangements
- Financial management and disbursement arrangements

TECHNICAL ANNEXES CONT…

- Procurement
- Economic and financial analysis
- Safeguard policy issues
- Project processing
- Documents in the project file
- Statement of loans and credits
- Country at a glance

11. Project Proposal Document

IE354: Engineering Project Management

Mohamed. J.A.M,

Department of Mechanical and Industrial Engineering
College of Engineering and Technology-UDSM

The Project plan

- Content:
- **Executive summary**

  Gives a brief description of the project; background, problem, objectives, activities, outputs, budget

- **Project basic data**

Name of the project, participating institutions, Contact address, brief profile, proposed duration (start and end date), source of financing

- **Project background/profile**

The plan cont..

General description of social, economic, environmental, financial benefits of the project

Needs analysis; Why, justification, project ownership

Relevance of the project in relation to wider goals of the institition

- **Project objectives**

Issues need to be achieved, general and specific objectives, activities to be performed=**Logframe**

The plan cont..

- **Project implementation plan**

Approach, contractual agreement, schedules, resource requirement, organization plan, training requirement

- **Evaluation and Monitoring**
- **Project budget**
- **Expected problems/potential problems**

Annexes

Organization structure of the company/institution, computations, project location maps, Engineering drawings

SUPPLEMENTARY MATERIALS

PROJECT DELIVERY METHODS

Part I: ALTERNATIVE STRATEGIES FOR PROJECT DELIVERY

Alternative ways for organizing delivery of projects:

- **Doing everything in-house (using expertise within the owners organisation);**
- **Total responsibility to a contractor who will finance, design, execute, operate the project.**

- **Two essentials:**
  - A sound contractual relationship between the owner and each of his consultants and contractors.
  - Cooperation and trust between the people from different organizations and professions involved.

THE STARTING POINT

- A need for a project has been identified:

Questions:

- Where will the money be obtained to pay for the project?
- How will the project be procured (purchased, implemented)?
- If finance is available - the Owner can proceed to decide on the procurement method.
- If the finance needs to be raised or borrowed - necessary arrangement must be put in place, which may mean negotiating with a bank or international funding agency.
- When finance is borrowed - the lending agency will probably impose restrictions on the project and the method of procurement; e. g. World Bank

Key Services

Before an Infrastructure facility is realized two essential functions have to be performed:

- Design;
- Erection.

The words

- **Construction, Installation; and Erection**

shall be used interchangeable

PROCUREMENT PROCEDURES

The range of options includes:

- All work in-house;
- Design in-house and erection by a contractor
- Initial design brief in-house, design by a consultant and erection by main contractors who will use subcontractors as necessary.
- All design and management by a project manager, using several trade contractors whom work directly for the owner
- Raising the finance, design, erection and operation by a single contractor, who employs consultants and subcontractors as necessary.

THE CHOICE OF PROCUREMENT METHOD

- The choice will depend partly on:
  - the Owners policy;
  - facilities which the Owner has available in-house;
  - facilities which the Owner has available in-house; and;
  - the size and type of the project.

  There are advantages and disadvantages of each.

THE OWNERS REQUIREMENTS

- For any system of procurement, the Owner must decide what s/he wants - A Brief
- Avoid frequent changes of mind - it costs more and delays!
- The extent to which the Owner wishes to influence the detailed design and the way in which s/he sees the design developing will influence the choice of method of procurement.
- Adhere to legal and regulatory requirements.

Method 1: All work in-house

- The Owner does the feasibility study;
- This is followed by preliminary designs and estimates
- Owner then uses own expertise to prepare detailed design;
- S/he uses in-house staff to construct/erect the facility
- Use the erected facility for own purposes.
- Main Disadvantages:
  - Lack of accountability.
  - Poor quality and budgetary control;

Method 2: Design in-house and erection by a contractor

- The Owner does the feasibility study;
- This is followed by preliminary designs and estimates done by the owner;
- Owner then uses own expertise to prepare detailed design;
- S/he uses an established contractor to carry out the construction/erection;
- Owner supervises work performed by the contractor
- Contractor hands over constructed facility when construction is completed to the satisfaction of the owner.
- Main disadvantage:
  - Lack of accountability for design;
  - Lack of quality control mechanism for design.

Method 3: Initial design brief in-house, design by a consultant and erection by main contractor

- The Owner prepares the project brief (or can be assisted by a consultant);
- This is followed by preliminary designs and estimates done by a Consultant;
- Owner then uses the prepare detailed design to select a contractor to construct;
- Consultant supervises work performed by the contractor
- Contractor hands over constructed facility when construction is completed to the satisfaction of the Owner

- Main disadvantage – may be time consuming.
- This is the method that is known as the traditional method which is used very often –

Method 4: Design and Build

- The Owner prepares the project brief (or can be assisted by a consultant);
- Client prepares preliminary estimate based on prelim. designs; (or appoints a Consultant to prepared prelim. Designs);
- Contractor is appointed on for detailed design and erection;
- Client supervises the erection to ensure that performance requirements are met; (or may appoint a Consultant to do so);
- Final project accepted on the basis of performance tests by Consultant or Client;

- Main disadvantage: Costs my be high;
- Advantage: Speed; use of contractors expertise may save money;

Method 5: Design and Manage by a project manager

- The Owner prepares the project brief (or can be assisted by a consultant);
- Appoints a Project Manager to carry out the design (or obtains design services from other firms);
- Then appoints various contractors to perform different aspects of the project.
- S/he remain responsible for the project design and construction/installation/erection.

- Main Disadvantage:
  - If the PM is not good the project can fail very easily.
  - Costs may increase beyond budget.
- Advantage: Speed

Method 6: Raising the finance, design, and construction operation by a single contractor

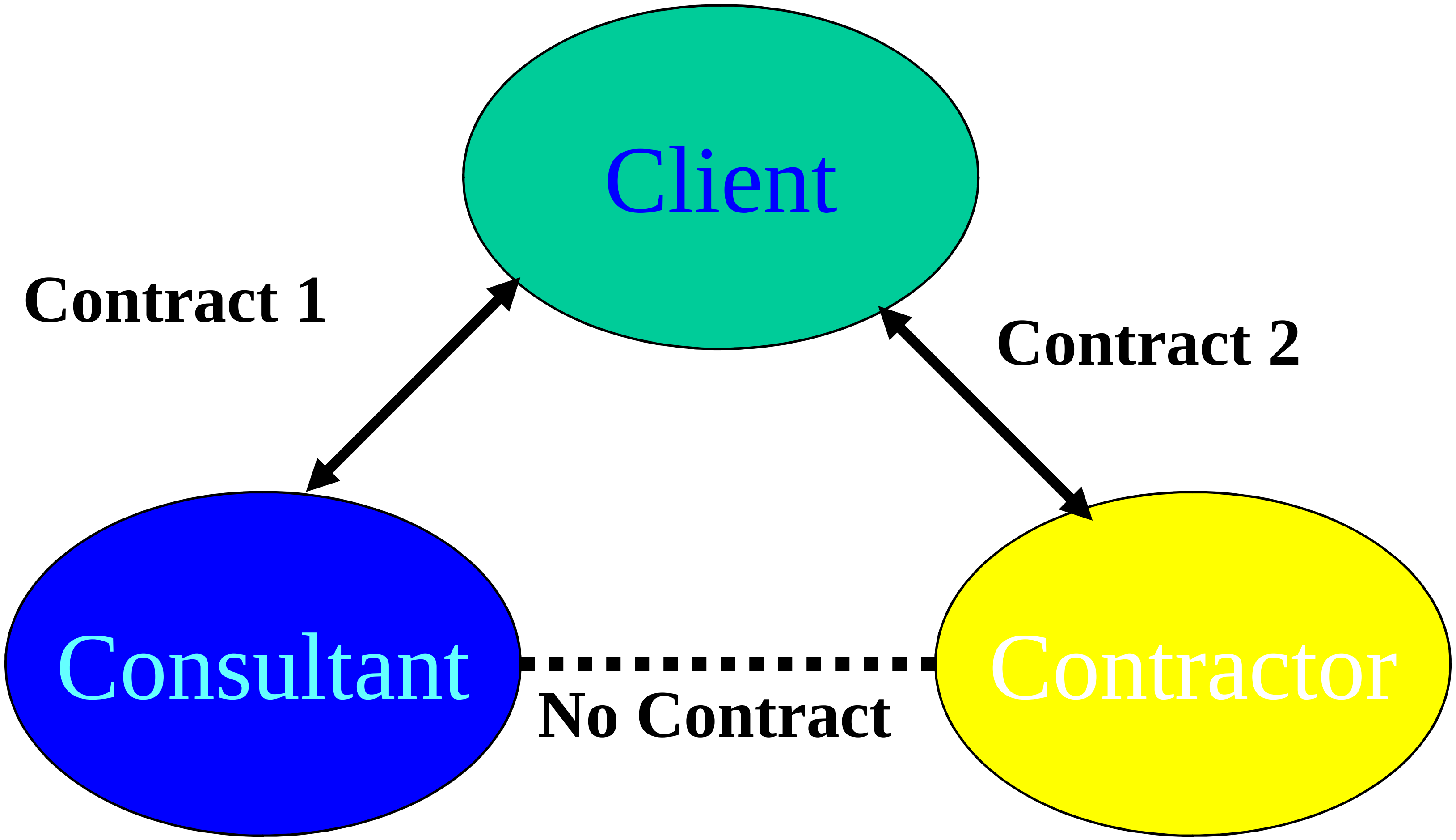
- Client may prepare a project brief and invite contractors
- Contractor performs detailed feasibility study;
- Contractor raises funds for the project;
- Appoints consultant to perform detailed design;
- Implements construction to completion;
- Starts operating the constructed facility – say a bridge which s/he then charges for crossing;
- Operates the facility until the return on investment is obtained;

- Advantage:
  - Client does not use his/her own funds for the project;
- Disadvantage:
  - Client has little control unless by means of legislation or special agreements;

Summary

- There are many other combinations of the above delivery methods.
- Government policy is now discouraging the use of methods:
  - 1 all in-house – design and erect;
  - Design in-house and erection by contractor.

- The Public Procurement Act 2001 is based mainly on the traditional method – appointment of consultant and then appointment of contractor.
- Regulations and standard documents for the same a re widely available


Client
Contract 1
Contract 2
Consultant
Contractor
No Contract

Selection and Employment of Consultants

- Definition of Consultant?
- Available Options for selecting Consultants
- There are three methods that can be used for selecting a consultant:
  - Prior knowledge;
  - Cost proposal; and
  - Quality selection.

Method 1: Selection by prior knowledge

- Selection is usually based on:
  - Using the same Consultant that has been used before and is trusted by the Client;
  - From a list of Consultants who are known to the Client and the projects are allocated in turn.
  - By advertising and choosing the one who seems to be the best.

Disadvantages:

- Not transparent;
- Limits the range of Consultants to those known only; and
- Third procedure is a not objective enough.

Selection by cost proposal

Pprocedures to ensure that the right Consultant under this approach is selected include:

- The two envelope method
- The cost weighted method
- The budget method
- Design competition
- Price negotiation.
- Problem: The details of the project are not known at the time when the Consultant is selected.

  Hence the proposal which looks cheap may turn out to be expensive

Selection by Quality

- Quality Based Selection (QBS) procedure increases the chances of selecting a Consultant able to produce a quality job. Three steps:

- Step 1: Selection

  Client identifies objectives

  Client establishes selection time frame and project brief

  Client invites proposals showing quality and capability of consultant

  Proposals are evaluated and short-list established.

  Short listed firms inspect the site

  Short-listed firms are interviewed and listed in order of preference.

- Step 2: Definition

  The first preference firm is invited to discuss the project in more detail
- The scope of services required is agreed and fees negotiated
- If agreement cannot be reached then the process is repeated with the second firm and so on.

- Step 3: Appointment

- An agreement is prepared and executed to confirm the negotiated arrangement
- All the firms who have been involved in the process are advised of the outcome
- A report is prepared giving the reasons for the final selection.

Conclusion

- Any selection procedure requires an element of subjective judgement. However, the QBS procedure that is being adopted in many countries, is seen to be fair and open. It is a procedure that is most likely to choose the “ best ” Consultant for the particular project.