1. INTRODUCTION

Process
- Ongoing day-to-day activities to produce goods or services
- Use existing systems, properties, capabilities
- repetitive
- people are homogeneous
- part of line organization
- status quo and established practice

Project
- continuously evolving
- unique to meet goals within cost, schedule, quality
- complex one time processes
- developed to resolve a clear goal
- customer focused
- system must be created to integrate efforts
- outside of line organization

Project Characteristics
1. Ad hoc with a clear life cycle
2. Building blocks for organizational strategies
3. Responsible for newest products, services, processes
4. Provide a strategy for management of change
5. Crossing functional and organizational boundaries (multiple departments or international partners)
6. Involves planning, organizing, motivation, directing and control
7. Outcomes of a project involve customer satisfaction with constraints of technical, cost and schedule objectives
8. Terminated upon successful completion of objectives

Cool Facts!!
- 65% of projects go over budget, fall behind schedule and did not perform as expected
- IT projects become runaways: overshooting their budgets and timetables while failing to deliver fully on their goals
- 30% of technology based projects and programs are a success
- 2.5% of global businesses achieved 100% project success.
- average success of business critical application development = 32%

WHY ARE PROJECTS IMPORTANT
1. Shortened product life cycles
2. Narrow product launch windows
3. Increasingly complex and technical products
4. Emergence of global markets (many more consumers)
5. Economic period marked by low inflation (streamline internal processes to save money)

PROJECT LIFECYCLE (stages of development of a project)
- Conceptualization: development of initial goal and technical specifications for a project.
- Planning: specifications, schematics, schedules
- Execution: actual work of the project performed
- Termination: project completed transferred to customer

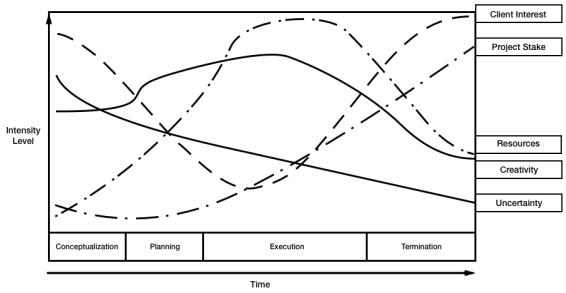


Figure: Project Lifecycles and their effects

Client interest: level of enthusiasm of customer
Project stake: amount of corporate investment
Resources: commitment of financial, human and technical resources
Creativity: degree of innovation
Uncertainty: degree of risk associated with a a project

Determinants of Project Success
Quadruple Constraint:
- time: constrained by time frame to complete project
- budget: limited budget
- performance (quality check): adhere to initially determined technical specification
- client acceptance: projects developed with clients in mind

Internal conditions: internal organizational control over expenditures of money and time
External conditions: how well the product does in the marketplace
Promise that the delivered product can generate future opportunities
- project efficiency: meeting budget and schedule expectations
- impact on customer: meet technical specs and customer needs
- business success: commercial success
- preparing for the future: opens new markets or product lines

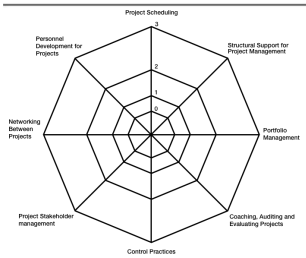
IT Project success
- system quality: satisfy criteria
- information quality
- use: system must be used
- user satisfaction
- individual impact: usefulness of the system
- organizational impact: how does it improve organization

* all stakeholders of a project should have a hand in assessing its success

DEVELOPING PROJECT MANAGEMENT MATURITY
Project management maturity models: organizations benchmark the best practices of successful project management firms
Benchmarking: manage the process improvements of the project delivery by a single organization
1. Evaluate current practices
2. Compare practices to chief competitors
3. Define a systematic route for improving these pratices

Understanding Success Criteria

Iron Triangle	Information System	Benefits (Organization)	Benefits (Stakeholders)
Cost	Maintainability	Improved efficiency	Satisfied users
Quality	Reliability	Improved effectiveness	Social and environmental impact
Time	Validity	Increased profits	Personal development
	Information quality	Strategic goals	Professional learning, contractors' profits
	Use	Organization learning	Capital suppliers, content
		Reduced waste	Project team, economic impact to surrounding community



Spider Web Diagram
0 - Not defined or poor
1 - Defined but substandard
2 - Standardized
3 - Industry leader

Once establish shortcomings, chart incremental path to desired goal

PROJECT ELEMENTS AND TEXT ORGANIZATION
1. The firm selects the projects it chooses to undertake
2. Up-font issues of project planning
    1. Selecting a team
    2. Developing project objectives and a plan for execution
    3. Cost estimating and budgeting
    5. Scheduling
    6. Managing resources
3. Implementation: actual work of the project, determine tasks
4. Project termination: kill or planned termination

2. The Organizational Context

PROJECTS AND ORGANIZATIONAL STRATEGY
Strategic management: science of formulating, implementing and evaluating cross functional decisions that enable an organization to achieve its objectives
1. Developing vision statements and mission statements: what top managers hope it will become at some point in the future
2. Formulating, implementing and evaluating
3. Making cross-functional decisions: commitment and shared resources of all functional areas to meet overall objectives
4. Achieve objectives: projects are the most effective tools to allow objectives to be met
* Projects are stepping stones of corporate strategy. The firm's strategic development is a driving force behind project development

Three phase approach:
1. Concentrate on achieving objectives through existing markets
2. Focus on new market opportunities in foreign or restricted markets
3. Pursue new products in existing markets

Strategic management is the first important contextual element in project management approaches

STAKEHOLDER MANAGEMENT
Stakeholder analysis: analyze irresolvable conflicts that occur through the planned creation and introduction of a project
Stakeholders: all individuals who have an active stake in the project and can impact the development either positively or negatively

Identifying Project Stakeholders
Internal:
- top management: control over project managers, project is timely, cost-efficient and minimally disruptive
- accounting: maintaining cost efficiency
- functional managers: occupy line positions, control esouces
- project team members: divided loyalty between project and functional group

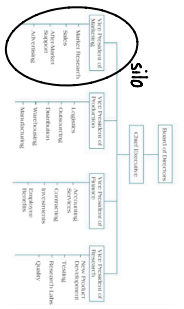
External:
- clients: not interested in expenses, as long as costs not passed on
- competitors: can force alterations, delays or abandonment
- suppliers: provides raw materials, project managers makes sure receive info necessary to implement its part and monitor deliveries
- intervenor groups: environmental, political, social groups

Managing Stakeholders
1, Assess the environment: low-key or significant, market research
2. Identify goals of principal actors: paint an accurate portrait of stakeholder concerns, hidden agendas in goal assessment of teams
3. Assess capabilities: consider strengths and weaknesses
4. Define the problem: problems in terms of our own perspective and valid concerns of the other party
5. Develop solutions: creating an action plan to address the needs of the various stakeholder groups, do political homework
6. Test & Refine solutions: manager and team are operating under imperfect information
* Alternative: planning, organizing, directing, motivating and controlling the resources necessary to deal with the various internal and external stakeholder

ORGANIZATIONAL STRUCTURE
1. Designates formal reporting, relationships, including the number of level in the hierarchy and the span of control of managers (how many people you supervise)
2. Grouping together of individuals into departments -> organization
3. Design of systems to ensure communication and integration

FORMS OF ORGANIZATIONAL STRUCTURE
Operating environment: external environment consists of all forces or groups outside the organization that can affect the organization

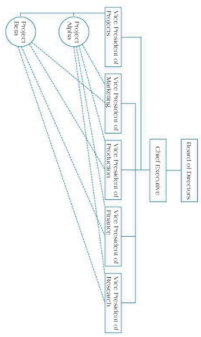
Functional Organization
Most common, structured by grouping people performing similar activities in departments



Strengths
1. Firms design maintained
2. Development of in depth knowledge
3. Standard career paths. Team members perform only their functional duties

Weaknesses
1. Functional silos
2. Lack of customer focus
3. Projects take longer
4. Projects may be sub optimized

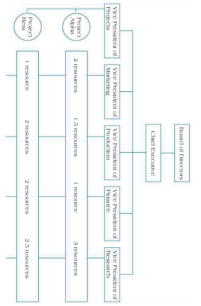
Project Organization
Grouping people into project teams on temporary assignments



Strengths
1. Project manager sole authority
2. Improved communication
3. Effective decision making
4. Creation of project management experts
5. Rapid response

Weaknesses
1. Expensive to set up and maintain teams
2. Change of loyalty to the project rather than the firm
3. No pool of specific knowledge
4. Workers unassigned at project end

Matrix Organization
Combination of functional and project



Strengths
1. Suited to dynamic environments
2. Equal emphasis on project management and functional efficiency
3. Promotes coordination across functional units
4. Maximizes scarce resources

Weaknesses
1. Dual hierarchies mean two bosses
2. Negotiation required in order to share resources
3. workers caught between competing project & functional demands

Heavyweight Project Organization
Organizations can sometimes gain benefits from creating fully dedicated project organization (Skunkworks)
- give project managers high status
- move away from functional maintenance to market opportunism

PROJECT MANAGEMENT OFFICES
A centralized unit within an organization or department that oversees or improves the management of projects
- assists project manager in achieving project goals
- wide gap in knowledge & expectations placed on project managers and teams
- central repository of all lessons learned, project documentation and pertinent record keeping for ongoing projects
- dedicated center for project management excellence in company
- can be place at several locations in a firm

1. Weather station: tracking and monitoring device
- What's our progress
- How much have we paid for the project so far
- What is the status of major project risks

2. Control tower: treats project management as a business skill to be protected and supported. Identifies what is working, shortcomings and how to resolve problems
- establishes standards for managing projects
- consults on how to follow these standards
- enforces the standards
- improves the standards

3. Resource pool: maintain and provide cadre of trained and skilled project professionals as they are needed. Supply project managers with other skilled professional to the company's projects
* critics: place all eggs in one basket, another layer of oversight and bureaucracy, bottleneck for communication

ORGANIZATIONAL CULTURE
Organization develops its own outlook, operating policies... A collective or shared learning of a group. The solution to external and internal problems that have worked for a group
- Unwritten, rules of behaviour, held by some subset of the organization, taught to all new members

How Do Cultures Form
- technology: transforms input into outputs
- environment: competition
- geographical location: affect culture and attitude
- reward systems
- rules and procedures: procedures for employee behaviour
- key organizational members: founder (Steve jobs)
- critical incidents: public expression of what rules operate (stories)

Organizational Culture and Project Management
- department interaction: between functional dep. and project team
- employee commitment to goals: promote employee commitment
- project planning: employees want to support project planning
- performance evaluation: encourage team to take initiative

3. CANADIAN FORMS OF BUSINESS ORGANIZATIONS

Sole Proprietorship: individual carrying on a business under his/her name

Advantages
1. Easy & inexpensive to form
2. Low cost to start up
3. Lowest regulatory burden
4. Owner has direct control over decisions
5. Tax advantage if business is not doing well
6. Sole proprietorships have no shareholders, all profits go to owner

Disadvantages
1. Unlimited liability
2. Income is taxed as personal income tax
3. Lack of continuity if owner needs to be absent
4. Difficulty raising capital because of insufficient personal assets to act as collateral

Partnership: two or more individuals form a business together

Advantages
1. Easy to start up
2. Start-up costs can be shared
3. Partners have an equal share in management, profits & assets
4. Tax advantage if income is low or loses money, tax as personal income tax

Disadvantages
1. No legal difference between partners & business
2. Difficult to find suitable partner
3. Conflict with managing
4. Partner is held financially responsible for business decisions made by other partners

Limited Liability Partnership: liable to amount invested to the business

Corporation: separate legal entity at federal and provincial levels

Advantages
1. Separate legal entity liability limited to corporation and assets
2. Ownership is easily transferable from one person to another
3. Has a continuous existence
4. Easier to raise capital as a corporation through sale of public & private stocks/shares
5. Tax advantage because corporate tax is a flat rate

Disadvantages
1. closely regulated
2. Expensive to incorporate
3. By law need to keep corporate records of shareholders and meetings
4. Conflict between shareholders and directors
5. by law director must be resident of the province where corporation is registered

Cooperative: owned by association of members

Advantages
1. Owned and controlled by its members
2. Limited liability
3. Profits distributed proportional to business done by each member

Disadvantages
1. Conflict between members
2. Decision making process takes longer
3. To be successful participation is needed
4. Less incentive to invest capital since surpluses are paid to members based on amount of business done by each member

4. CONTRACTS AND CONTRACT TYPES

A contract is an agreement between the owner of a project & an organization to execute a defined scope of work. A legally binding agreement that obligates the seller to provide the specified product and obligates the buyer to pay for it

Proof of a contract
1. An offer was made
2. An offer was accepted
3. There was a mutual agreement
4. There was consideration usually as a form of payment
5. The subject matter of the contract is legal
6. Both owner and seller have the capacity to enter into agreement

Specifications of a Contract
1. Names of the parties involved in contract with their addresses
2. The scope of work that is covered by the contract
3. The period of the contract
4. Contract price & the method/terms of payment
5. The language and source of law governing the contract
6. Listing of other documents that are considered part of the contract

Contract Types

1. Lump Sum Contract:
- possible to compute accurate quantities of work prior to construction
- contractor quotes one price which covers all work and services
- lump sum price includes contractors direct costs, indirect costs, contingency, profits
- difference between the quoted lump sum price & contractor's total cost is the profit
- if contractor exceeds quoted price, must absorb loss
- owner has no right to direct contractor's means and methods
- owner has no right to inquire about the actual cost of the work
- scope of project must be well defined
- drawing & specifications describes the project's end result = accurate
- contractor sets higher mark-up to account for risk
- payment made to contractor according to % of work complete

Advantages
- price quoted is guaranteed price for work
- owner has a fairly good idea of how much to budget for project
- majority of risk is on contractor
- contractor will maximize his production, performance & finish faster
- bidding analysis and selection process is easy

Disadvantages
- owner needs detailed plans & specs complete before bidding & impl.
- no flexibility to make design changes or modify contract
- deviation from original plans & specs must be handled as a change

2. Unit Price Contract
- used when it is not possible to calculate exact quantity of work required to complete the project
- project broken down into work items characterized by units m^2, m^3
- engineer estimate quantities for various work items and contractor quotes the price by unit for each work item using estimated quantities
- total contract price is determined by summing total $ of work item
- owner uses consultant to supervise construction & keep track of actual quantities
- progress payments are made for quantities of work completed
- when actual quantity differs by more than 10% -> renegotiation

Advantages
- more flexible than lump sum contracts in design & other changes
- ensures lowest price bid
- enable fast track contracts
- no risk of unseen conditions for the contractor

Disadvantages
- true contract price is not known until the project is completed
- susceptible to being manipulated via unbalanced bidding for profit and unbalanced bidding for front end loading
- owner has more risk than fixed price contracts

3. Cost + Fixed Percentage Contract
- used where the project's product cannot be explicitly defined (r&d)
- contractor reimbursed for all direct expenses as well as indirect
- contractor is paid a percentage of reimbursable cost as the fee
- % is agreed between the parties before project

Disadvantages
- difficult for the owner to accurately predict cost of project
- provides contractor with opportunity to increase cost
- no incentive for contractor to keep direct expenses to minimum
- risk is shifted towards the owner

4. Cost + Fixed Fee Contract
- contractor reimbursed for all direct as well as indirect expenses
- contractor receives a fixed fee for his expertise
- fixed fee is paid even if during fluctuation of the reimbursable cost
- risk is shifted to contractor
- contractor has incentive to get project done as quickly as possible
- contractors may tend to use expensive reimbursable materials and methods to expedite the completion of the project

5. Cost + Fixed Free + Profit Sharing
- provides reward to contractor who controls and minimizes costs
- target price is specified for total cost of project
- if contractor completes the project below the target price, the savings are shared between owner and contractor
- if contractor finishes with cost overrun, no penalty

6. Cost + Fixed Fee + Sliding Fee
- provides bonus for under-run and a penalty for overrunning price
- amount of the sliding fee increases as the contractor falls below the target and decreases as the price is overrun
- Fee = R(T-A). T = target price R = base percent A = actual cost

Provisions for Risk Allocation
the total contract price is the primary mechanism that reflects the allocation of risks among the parties to a contract
1. Force majeure: absolves owner from payment for costs due to uncontrollable events
2. Indemnification: absolves party from payment for losses incurred by third parties
3. Occupational safety and health of workers
4. Suspension of work
5. Liquidated damages

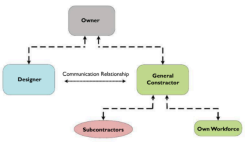
5. PROJECT DELIVERY SYSTEMS

Contracting method, contract strategy or procurement strategy. Framework for the relationships between the owner and other project participants.

Risk & Uncertainty
- risks should be delegated to the party who has the most ability to control risks
- project's cost should be lowest when risks are transferred and allocated correctly
- owner should not delegate risks that the owner has the most ability to control

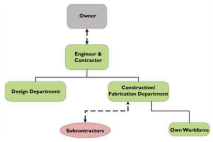
Traditional

Design Bid Build
Lump sum, unit price or cost + fixed fee, negotiated pro. fee
- owner enters into two separate contracts
- single general contractor uses his own workforce

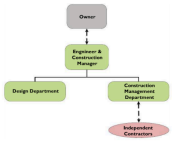


Turnkey
Lump sum & cost+
Suitable for large industrial projects
- implies the project is delivered to the owner ready for use
- the owner transfers risk to a single entity

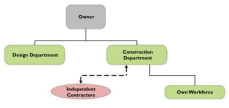
Design-Build



Design-Manage

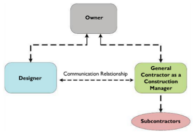


Owner-Builder
Lump sum, unit price contracts
Used by large organizations that have both design and construction/ fabrication department
- owner responsible for design and construction/fabrication
- owner retains risks associated with design and construction

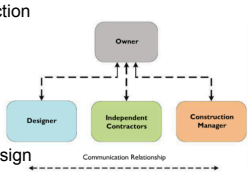


Professional Construction Management
- suitable when constructibility issues, large projects

General Contractor (Professional Construction Management at Risk)
- owner enters into two seperate contracts with design and general contractor
- general contractor enters project during the design phase
- general contractor enter into contracts with subcontractors



Construction Manager
- owner enters into three contracts
- construction manager acts as owner's agent during bot design and construction
- construction manger is an advisor and has no liability
- provides input with respect to constructibility and assists with the preparation of schedules & cost estimates
- design liability = designer, construction liability = independent contractors
- cost savings >= additional cost associated with hiring construction manager
- negotiated professional fees for construction management services
- negotiated professional fees for design services
- lump sum and unit price contracts for independent contractors



6. PROJECT SCHEDULING

ES	Identity Number	EF
Float	Activity Descriptor	
LS	Activity Duration	LF

TE = (a + 4m + b)/6
a = most optimistic
m = most likely
b = most pessimistic

7. COST ESTIMATION AND BUDGETING

Cost management: data collection, cost accounting and cost control
Cost accounting & control: identify and maintain control over project costs
Cost estimation: create a reasonable budget baseline for the project
Common Sources of Project Cost: labor, materials, subcontractors, equipment & facilities, travel

COST MANAGEMENT
Direct costs: clearly assigned to the aspect of the project (labor & materials)
Indirect costs: overhead, selling & general administration
Nonrecurring: charges applied once at the beginning or end of a project
Recurring costs: operate over the project's life cycle
Fixed costs: do not vary with respect to their usage
Variable costs: accelerate or increase through usage
Normal costs: incurred in the routine process of working to complete the project according to the original planned schedule
Expedited costs: unplanned costs incurred when steps are taken to speed up the project's completion

COST ESTIMATION
Ballpark 30% Feasibility: 10%
Comparative: 15% Definitive: 5%

Function Points
Standard unit of measure that represents the functional size of a software
Function Point Analysis: system for estimating size of software projects based on what the software does

Problems with Cost Estimation
1. Low initial estimates
2. Unexpected technical difficulties
3. Lack of definition
4. Specification changes
5. External factors: inflation, financial crisis

CREATING A PROJECT BUDGET
Budget: identifies the resources, goals and schedule that allows a firm to achieve those goals
Top-down budgeting: direct input from the organization's top management. Top management has past experience with past estimates, so costs are estimated downwards
Bottom-up budgeting: from WBS to apply direct and indirect costs to project activities, costs are accumulated upwards
Activity based costing:
1. Identify activities that consume resources
2. Identify cost drivers associated with each activity
3. Compute a cost rate per cost driver unit
4. Multiply the cost driver rate times the volume of cost driver units

Developing Budget Contingencies
1. Project scope is subject to changes
2. Murphy's law: if something can go wrong, it will
3. Cost estimation must anticipate interaction costs
4. Normal conditions are rarely encountered

8. PROJECT CONTROL

EVM: project control technique that integrates project scope, cost and schedule to assess performance and progress
Cost Schedule plan: plot of a projects planned cummulative costs that serves as a basis for comparison with the actual cost of work performed and budgeted cost of work performed

S curve :

11. COMPARISON METHODS I

Present Worth (PW): look at present worth of all cash flows associated with projects
Annual Worth (AW): convert cash flows to annuity
Payback period: how long it takes to pay back investments
Relations Among Projects
1. Independent: expected costs and expected benefits of each project do not depend on whether the other one is chosen
2. Mutually exclusive: in the process of choosing one, all other alternatives are excluded
3. Related but Not Mutually Exclusive: the expected costs and benefits of one project depend on whether the other one is chosen (2^n including do nothing option)
4. Contingent: project A could be done alone or A and B could be done together but B could not be done by itself. B is contingent on A
Minimum Acceptable Rate of Return (MARR): interest rate that must be earned for any project to be accepted
Mutually Exclusive & Independent Comparison With Equal Lives
- PW or AW must be positive. Choose project with largest PW or AW.
Mutually Exclusive Comparison with Unequal Lives
1. repeated lives: each alternative is repeated with the same costs and benefits (least common multiple)
2. study period: choose a period and make assumption about salvage. Set PW(1) = PW(2) and solve for salvage value
Payback Period

$$\text{Payback} = \frac{\text{First cost}}{\text{Annual Savings}}$$

Advantages:
1. Easy to understand
2. Easy to calculate
3. Accounts for need to recover capital quickly
The future is unknown

Disadvantages:
1. Discriminates against long term projects
2. Ignore the effect of the timing of cash flows within the payback period
3. Ignores expected service life

APPENDIX 11
Investments in a company
1. Debts: lending money to a company
2. Equity: owners of the company
Reliance on debt is limited:
1. If a company increases the share of capital from debt, it increases the chance it will not be able to pay it back -> bankruptcy
2. Lenders are aware of the dangers of high reliance on debt and will therefore limit the amount they lend to the company
Company Size & Sources of Capital
- large well known companies can secure capital both by borrowing and by selling ownership shares with relative ease because there will be ready markets for their shares
Weighted Average Cost of Capital (WACC): weighted average of the costs of borrowing and of selling shares. The cost of capital is the company's MARR
- For smaller companies, large companies are not willing to invest. The cost of capital is the opportunity cost of investors

Value of Shares: $327 723 Debt: $100 000

$$WACC = 0.1\left(\frac{100\,000}{427\,273}\right) + 0.615\left(\frac{321\,273}{427\,273}\right) = 0.15$$

12. COMPARISON METHOD II

Internal Rate of Return (IRR): rate of return calculated for a project such that all cash inflows equal cash outflows
PW(disbursements) = PW(receipts) solve for i*
AW(disbursements) = AW(receipts) solve for i*
FW(disbursements) = FW(receipts) solve for i*
IRR For Independent Project
- Invest in any project equal to or greater than the MARR
Mutually Exclusive Projects
- Perform incremental investment
External Rate of Return
- funds are invested elsewhere and earn an explicit rate of return equal to the MARR
External Rate of Return (ERR) ie: the rate of return on a project where any cash flows that are not invested in the project are assumed to earn interest at a predetermined explicit rate (MARR)
- computing a precise ERR can be complex because of the difficulty in determining when the explicit interest rate should be applied
Approximate ERR
1. Take all net receipts forward at the MARR to the last cash flow
2. Take all net disbursements forward at interest rate i*ea to the last cash flow
3. Equate the future value of receipts to disbursements and solve for i*ea
When to Use ERR
- when multiple IRRs are possible
- can evaluate simple or non simple investments
- less accurate than the IRR
Simple investments: one or more periods of outflows at the start followed by one or more periods of inflows

TABLE 12.2 Advantages and Disadvantages of Comparison Methods

Method	Advantages	Disadvantages
IRR	Facilitates comparisons of projects of different sizes Commonly used	Relatively difficult to calculate Multiple IRRs may exist
Present worth	Gives explicit measure of profit contribution	Difficult to compare projects of different sizes
Annual worth	Annual cash flows may have familiar meanings to decision makers	Difficult to compare projects of different sizes
Payback period	Very easy to calculate Commonly used Takes into account the need to have capital recovered quickly	Discriminates against long-term projects Ignores time value of money Ignores the expected service life

13. Depreciation (and Financial Accounting)

Market value: actual value of an asset is sold for in an open market
Book value: depreciated value of an asset for accounting purposes
Elements of Financial Accounting
Financial accounting: recording and organizing the financial data of business, including revenues and expenses and an enterprise's resources and the claims on those resources
Management accounting: costs and benefits of the various activities of an enterprise.
Cost accounting: determine costs of products, processes and services and an important foundation for estimating the cost of a proposed engineering project
Measuring the Performance of a Firm
Through variable: measured with respect to time
Across variable: measured at a point in time
The Balance Sheet
- snapshot of the financial position of a firm at a point in time (across variable)
Assets: economic resources owned by the enterprise.
|_ current assets: cash and other assets that could be converted to cash within a short period of time
|_ long-term assets (fixed or non-current assets): assets that are not expected to be converted to cash in the short term
Liabilities: everything a business owes (debts)
|_ current liabilities: liabilities that are due within some short period of time
|_ long-term liabilities: liabilities not expected to draw on the business' current assets. (loans and bonds)

Owners' equity = Assets - Liabilities
Assets = Liabilities + Owners' equity

Owners' equity: interest of the owner of a firm in its assets
The Income Statement
summarizes revenues and expenses over a period of time (through variable)
Revenues: increase owners' equity (sales of goods/services)
Expenses: decrease owners' equity (cost of goods sold, rent, insurance, wages)
Profits: before taxes os Revenue - Expenses
Net Profit: profit after deducting taxes
Estimated Values in Financial Statements
- estimates, may not reject market values based on cost principle of accounting
Assets: valued on the basis of their cost (book value)
Land: listed at the price paid, not its market value
Plant and equipment: listed at the price paid - depreciation
Stock or Shares: listed at par value ((issue price)
Finished Goods: inventory - manufacturing cost
Financial Ratio Analysis
- key performance indicators (KPIs)

Ratio	Definition	Comments
Current ratio (Working capital ratio)	Current assets / Current liabilities	A liquidity ratio 2 is good
Acid-test ratio (Quick ratio)	Quick assets / Current liabilities	A liquidity ratio (Quick assets = Current assets − Inventories − Prepaid items) 1 is good
Equity ratio	Total equity / Total assets	A leverage or debt-management ratio smaller = dependent on debt
Inventory-turnover ratio	Sales / Inventories	An asset management or efficiency ratio
Return-on-assets ratio (Net-profit ratio)	Net income / Total assets	A profitability ratio (excludes extra-ordinary items)
Return-on-equity ratio	Net income / Total equity	A profitability ratio (measure of investment performance; exclude extraordinary items)

Liquidity ratio: assess firms ability to meet short term financial obligations & weather fluctuations in cash flows
Working capital: reserve of cash and liquid assets
Debt management ratio: extent to which firm relies on debt
Efficiency ratio: assess the efficiency of the use of its assets
Profitability ratio: how productively assets have been employed in producing a profit

14. Taxes

Personal Income Taxes
- income less tax credits or deductions
- progressive
- no capital expenses
Corporate Income Taxes
- Net income is based on gross income less expenses
- Tax rates flat
- presence of capital expenses

15. Inflation

Inflation: Increase in average price paid for goods and services over time
Deflation: decrease in average price paid for goods and services over time
CPI: measures price changes in food shelter, medical care ..
|_ current cost of bundle of goods/services compared to bundle in base year. Base year index = 100
Causes of Inflation
1. Demand pull-inflation
2. Cost-push inflation: rising wages, import prices, raw materials prices
3. Rising House prices
4. Printing more money

CHAPTER 8 FORMULAS

Budgeted Cost of Work Scheduled (BCWS) or Planned Value (PV)
↳ budget assigned to work to be done for an activity

Budgeted Cost of Work Performed (BCWP) or Earned value: $EV = \%\ \text{completion} \cdot \text{total budget}$

Actual Cost of Work Performed (ACWP) or Actual cost (AC)
↳ total costs for accomplished work

Budget at Completion (BAC)
↳ total planned value of a project or total cost of a project

Cost Variance: $CV = BCWP - ACWP = EV - AC$ ⊕ less $ spent ⊖ More $ spent

Schedule Variance: $SV = BCWP - BCWS = EV - PV$

Cost Performance Index: $CPI = \frac{BCWP}{ACWP} = \frac{EV}{AC}$ >1 cost underrun

Schedule Performance Index: $SPI = \frac{BCWP}{BCWS} = \frac{EV}{PV}$ >1 ahead of schedule

Estimated (remaining cost) to Completion: TYPICAL $ETC = \frac{BAC - EV}{CPI}$ ATYPICAL $ETC = BAC - EV$

Project (total cost) Estimated At Completion: $EAC = ETC + AC$

CHAPTER 7 FORMULAS

Direct Labor Costs = Hourly rate x Hours needed x Overhead x Personal

Learning Rate

$T_N = T_1 N^b$

$b = \log(\text{learning rate})/\log(2)$ ← not always 2

T_N = time required for N^{th} iteration
T_1 = time required for initial iteration
N = number of units to be produced

CHAPTER 7+ FORMULAS

Cost Indexes: $\frac{\text{Cost at time A}}{\text{Cost at time B}} = \frac{\text{Index value at time A}}{\text{Index value at time B}}$

Power sizing model: $\frac{\text{Cost of equipment A}}{\text{Cost of equipment B}} = \left(\frac{\text{Size(capacity) of equipment A}}{\text{Size(capacity) of equipment B}}\right)^x$

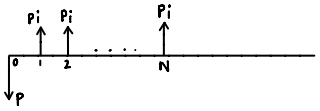
$x = 1 \rightarrow$ linear
$x > 1$ diseconomies of scale
$x < 1$ economies of scale

Applications of Cost Indexes to Estimating

1. Exclude special local conditions in historical data $\$100\text{ mil} - \$5\text{ mil} = \$95\text{ mil}$
2. Determine new facility cost on basis of specified size $\left(\frac{300\,000}{200\,000}\right)^{0.6}$
3. Adjust for inflation index $(1.08)^4$
4. Adjust for local index of construction costs $\left(\frac{1.14}{1.09}\right)$
5. Adjust for different regulatory constraints $+\$7\text{mil}$
6. Adjust for local factors for the new facility $\times (0.99)$

CHAPTER 9 FORMULAS

Simple Interest $F = P + PiN$



Effective and Nominal Interest

$i_e = (1+i_s)^m - 1$

$i_e = \left(1+\frac{r}{m}\right)^m$

Continuous Compounding

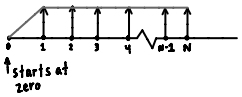
$i_e = e^r - 1$

CHAPTER 10

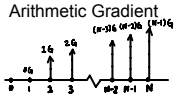
Interpolation

$\frac{x^* - x_1}{x_2 - x_1} = \frac{y^* - y_1}{y_2 - y_1}$

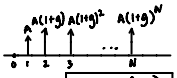
Annuity (Uniform Series)



Arithmetic Gradient



Arithmetic Gradient



if $g = i$ $P = N\left(\frac{A}{1+g}\right)$

CHAPTER 13 FORMULAS

P = purchase price
S = salvage value
N = useful life

Straight-Line Depreciation

Depreciation at n: $D_{SL}(n) = \frac{P-S}{N}$

Book value at n: $BV_{SL} = P - n\left(\frac{P-S}{N}\right)$

Accumulated Depreciation: $P - BV_{SL}(n) = n\left(\frac{P-S}{N}\right)$

Declining Balance Depreciation

Book value: $BV_{DB}(n) = P(1-d)^n$

Depreciation: $D_{DB}(n) = BV_{DB}(n-1)d$

$d = 1 - \left(\frac{S}{P}\right)^{1/N}$

Double Declining Balance

$D_{DDB}(n) = (2/N)\,BV_{DDB}(n-1)$

150% Declining Balance

$D_{1.5DB}(n) = (1.5/N)\,BV_{1.5DB}(n-1)$

Sum of Years Digits

$D_{SOYD}(n) = (P-S)(N-n+1)/SOYD$

$BV_{SOYD}(n) = BV_{SOYD}(n-1) - D_{SOYD}(n)$

$BV_{SOYD}(n) = P - \frac{P-S}{SOYD}\sum_{j=1}^{n}(N-j+1)$

CCA

Capital Cost Allowance (CCA) = depreciation
Undepreciated Capital Cost (UCC) = book value

$CCA_1 = P(d/2)$	$n = 1$
$CCA_n = d\,UCC_{n-1}$	$n \geq 2$
$CCA_n = P(1-d/2)d(1-d)^{n-2}$	$n \geq 2$
$UCC_n = UCC_{n-1} - CCA_n$	$n \geq 1$
$UCC_n = P(1-d/2)(1-d)^{n-1}$	$n \geq 1$

CHAPTER 14 FORMULAS

$MARR_{after\text{-}tax} = MARR_{before\text{-}tax}(1-t)$

$CSF = 1 - \frac{td}{(i+d)}$ $\quad CTF = \frac{td(1+i/2)}{(i+d)(1+i)}$

First Cost

$40 \cdot 0.42/5 = \$3360$

$PW = -45000 + 3360(P/A, 12\%, 5)$

Salvage

$PW = 5000(1-0.42)(P/F, 12\%, 5)$

Savings

$PW = (23000-7300)(1-0.42)(P/A, 12\%, 5)$

CHAPTER 15 FORMULAS

C_N = current dollars in year N
$R_{0,N}$ = real dollars equivalent to C_N relative to year 0
$I_{0,N}$ = value of a global price index at year N, relative to year 0

$R_{0,N} = \frac{C_N}{I_{0,N}/100}$ $\quad R_{0,N} = \frac{C_N}{(1+f)^N}$ $\quad R_N = \frac{C_N}{(1+f)^N}$ $\quad R_N = C_N(P/F, f, N)$

Real Interest Rate i'

$i' = \frac{(1+i)}{(1+f)} - 1$

$i = i' + f + i'f$

For small values of i & f

$i = i' + f$