

1.040/1.401 - Project Management

Nathaniel Osgood

Outline

- Class Objective
- Course Information
- Context
- Lecture Outlines
- Mission

Objective

Inform professionals in the art and science of directing and coordinating human, equipment, material, and financial resources to develop a project in a way that they could give maximum attention to project details in the most cost-effective way possible while maintaining a broad perspective of the project.

Enhance the following attributes of these outstanding professionals:

- Technical skills.
- Communication skills.
- Decision-making skills.
- Problem-solving skills.
- Interpersonal skills.
- Leadership skills.

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Handouts

- Syllabus Handout:
 - Course Description
 - Course Organization
 - Academic Honesty
- Survey (Problem set 1)
- Term Project Part I (TP1)c

Class Schedule

- Monday & Wednesday (Osgood)
 - Lecture
 - 1:00 PM – 2:30 PM
- Friday (Grimaldi)
 - Focused on
 - Contractor practices
 - Interactive discussion
 - Recitation
 - 3:00 PM – 4:00 PM
- Office Hours: TF, 12-1pm (Osgood)

Guest Lectures

- Dr. Oddmund Granli
 - Megaproject organization
 - Megaproject control
- Bill Fitzgerald (Behavioral components)
- Dr. Roberto Pietroforte (Façade scheduling)
- Victoria Siriani
 - MIT Capital Planning Office
- David Myers
 - MIT Facilities Management
- Prof. Fred Moavenzadeh

Analytic & Qualitative Components

- Analytic: Lectures, readings, problem sets
 - Tools for managing complexity, uncertainty
 - Presented so
 - Understand assumptions
 - Understand shortcomings
 - Anticipate future directions in construction
- Qualitative: Recitations, readings, problem sets
 - Empirical components
 - Understanding of current state of practice

Reference Textbooks

- Primary Readers:
 - System & Project Management, Peña-Mora, Anumba, Lyneis, Soibelman, Samii, Park, Kalligeros. To be published in 2003 by Prentice Hall/MIT textbooks
 - General introduction
- Construction Project Management.
Hendrickson & Au.
 - <http://www.ce.cmu.edu/pmbook/>
 - Quantitative components
- Construction Nightmares.
 - Vignettes illustrating principles from course.

Grading

- Individual Participation 15%
- Term Project / Individual Grading 50%
- Assignments / Individual Grading 35%

Grading Details

- Late Assignments: Reduced 10%/day (compounded) up to 7 Days
- Group Term Project Evaluated Individually
- For Individual Assignments: Share with others ONLY Concepts and Problems
- Academic Honesty Statement

Collaboration

- Large Group
- Group Dynamics
- Task Assignment

Academic Honesty

- Individual Work Only Allows for Group Discussion of Concepts and Problems
- Do Not Copy Previous Year Work
- Reference Any Source
- When Confused Ask Instructor

Term Project

- TP 1: Project Selection or Assignment
- TP 2: Estimating, Bidding, Mobilization Plan and Project Organization
- TP 3: Project Planning, Monitoring and Control
- TP 4: Claim, Close-Out, and Project Learning
- Deliverable: A Full Report and Presentation
- Iterative Process

Software Packages

- Primavera P3
for deterministic time and resource scheduling
- Primavera Monte Carlo
for probabilistic time and resource scheduling
- TreeAge
for decision and risk analysis
- Vensim
for system dynamics analysis

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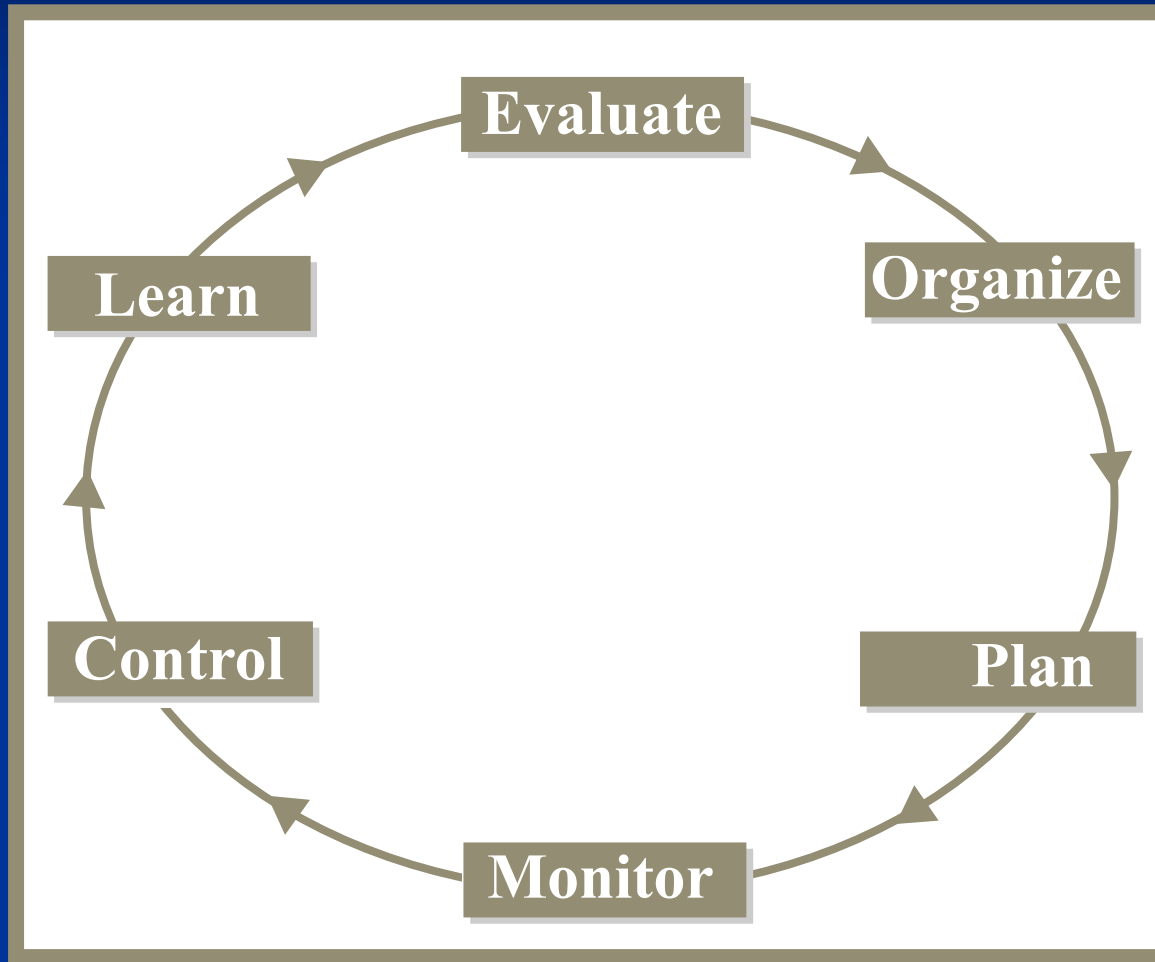
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Project Management: An Iterative Process



Project Scope

- Time /Schedule
- Cost/Budget
- Natural environment
- Political/social environment
- Quality

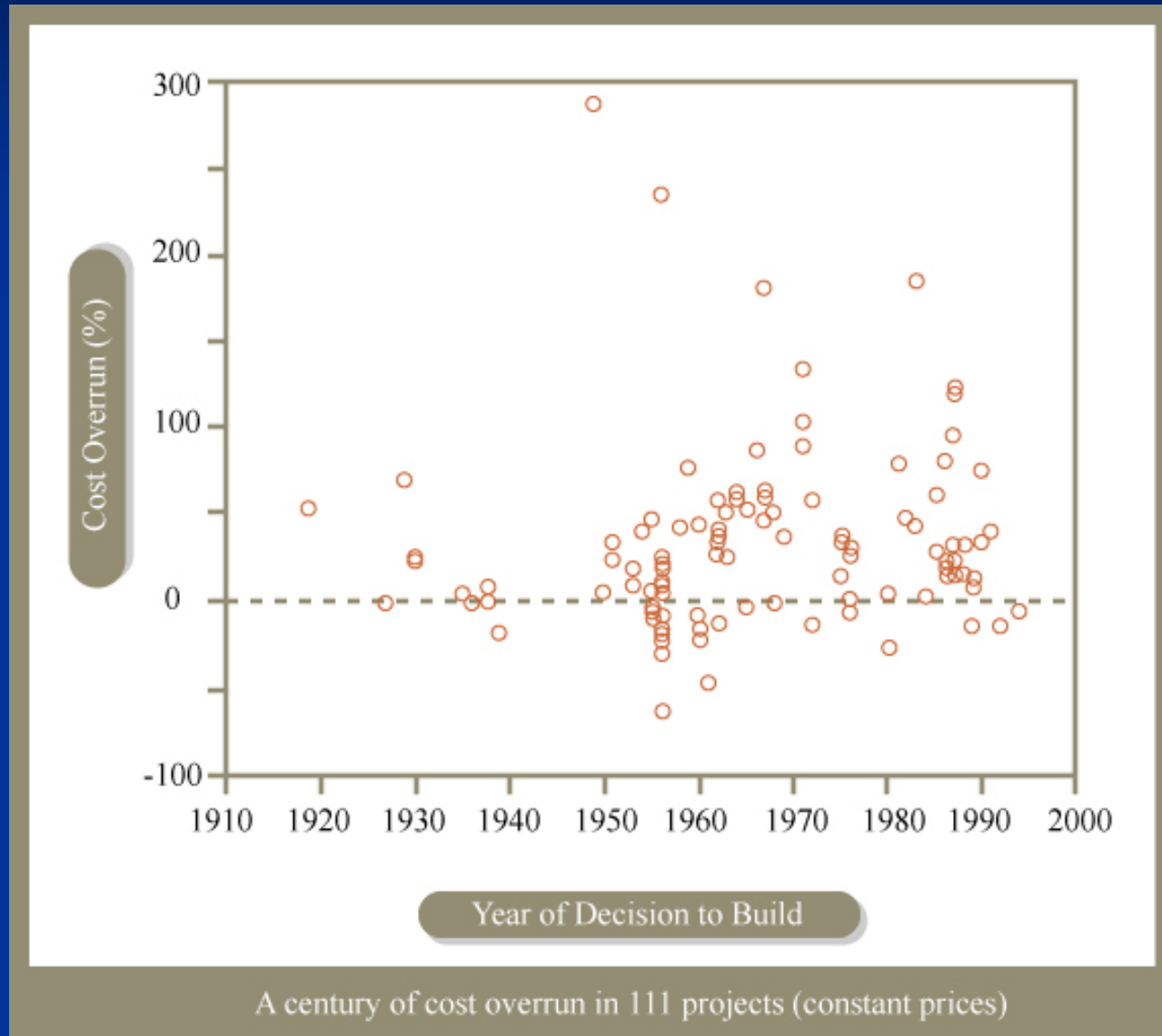
Industry Context 1

- Multiple Disciplines
- Unique and Evolving Project Team
- Generally One-of-a-kind Projects
- High Social/Political/Env. Implications
- Increasing sophistication of designs
- High
 - Time pressure
 - Cost and cost pressure (low profit)
 - Complexity
 - Uncertainty/Risk (cost, schedule, quality)
 - Turnover
 - Conflict & Litigation (claims 1% of cost)

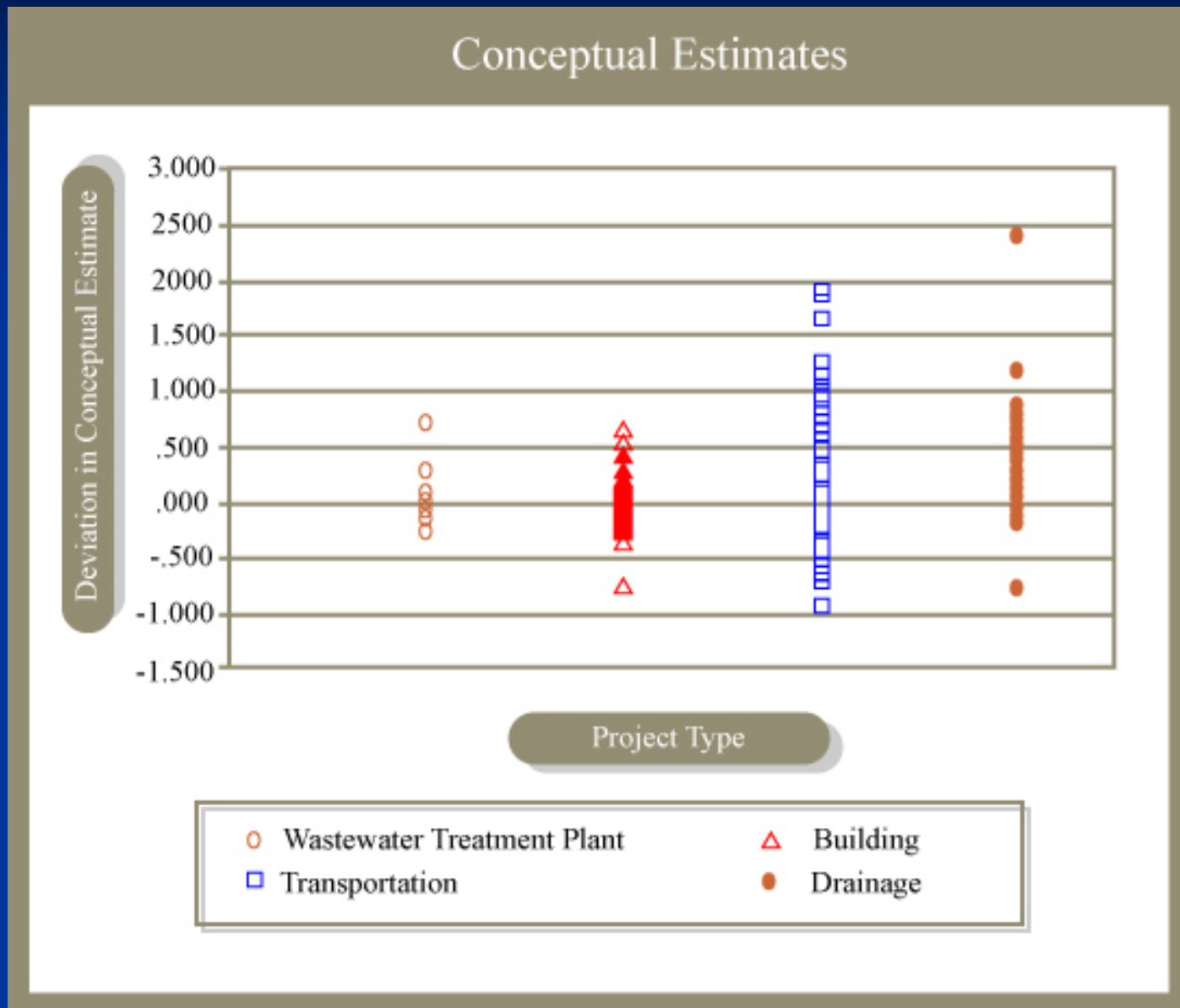
Industry Context II

- Important industry
 - Construction value >\$850B
 - Roughly 8% of US GDP
 - 700K construction firms
 - 90%<10 employees
 - 215K GC/Building, 442K trade contractors
 - Buildings are 70-80% of market
- Sectors
 - Residential const
 - Commercial
 - Industrial contractors
 - Infrastructure and heavy construction
- Affiliated institutions
 - Professional services
 - Suppliers
 - Financial Services

Uncertainty in Construction Uncertainty in Final Project Cost I



Uncertainty in Final Project Cost II



Uncertainty in Final Project Cost III

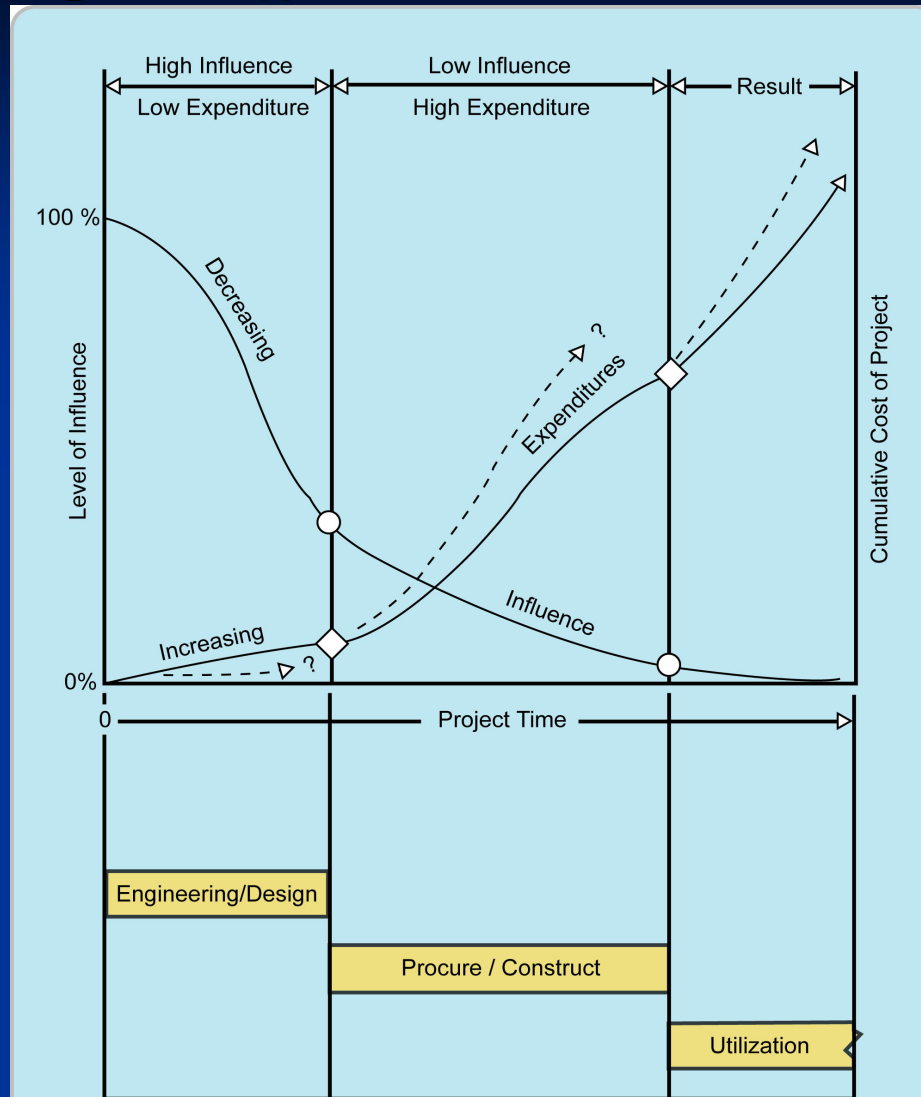
A calamitous history of cost overrun

Spectacular Projects with Spectacular Cost Overruns

PROJECT	COST OVERRUN (%)
Suez Canal	1,900
Sydney Opera House	1,400
Concorde Supersonic Aeroplane	1,100
Panama Canal	200
Brooklyn Bridge	100

Sources: Peter Hall, 'Great Planning Disasters Revisited', p. 3; Robert Summers, 'Cost Estimates as Predictors of Actual Costs: A Statistical Study of Military Developments', in Thomas Marschak *et al.*, eds., *Strategy for R&D: Studies in the Microeconomics of Development* (Berlin: Springer-Verlag, 1967), p. 148; and Mette K. Skamris, 'Economic Appraisal of Large-Scale Transport Infrastructure Investments', Ph.D dissertation (Aalborg: Aalborg University, 2000).

Growing Expenditures, Declining



Level of influence on project costs. (From Boyd C. Paulson, Jr., "Designing to Reduce Construction Costs," Journal of the Construction Division, ASCE, vol. 102, no. CO4, December 1976, p. 588.)

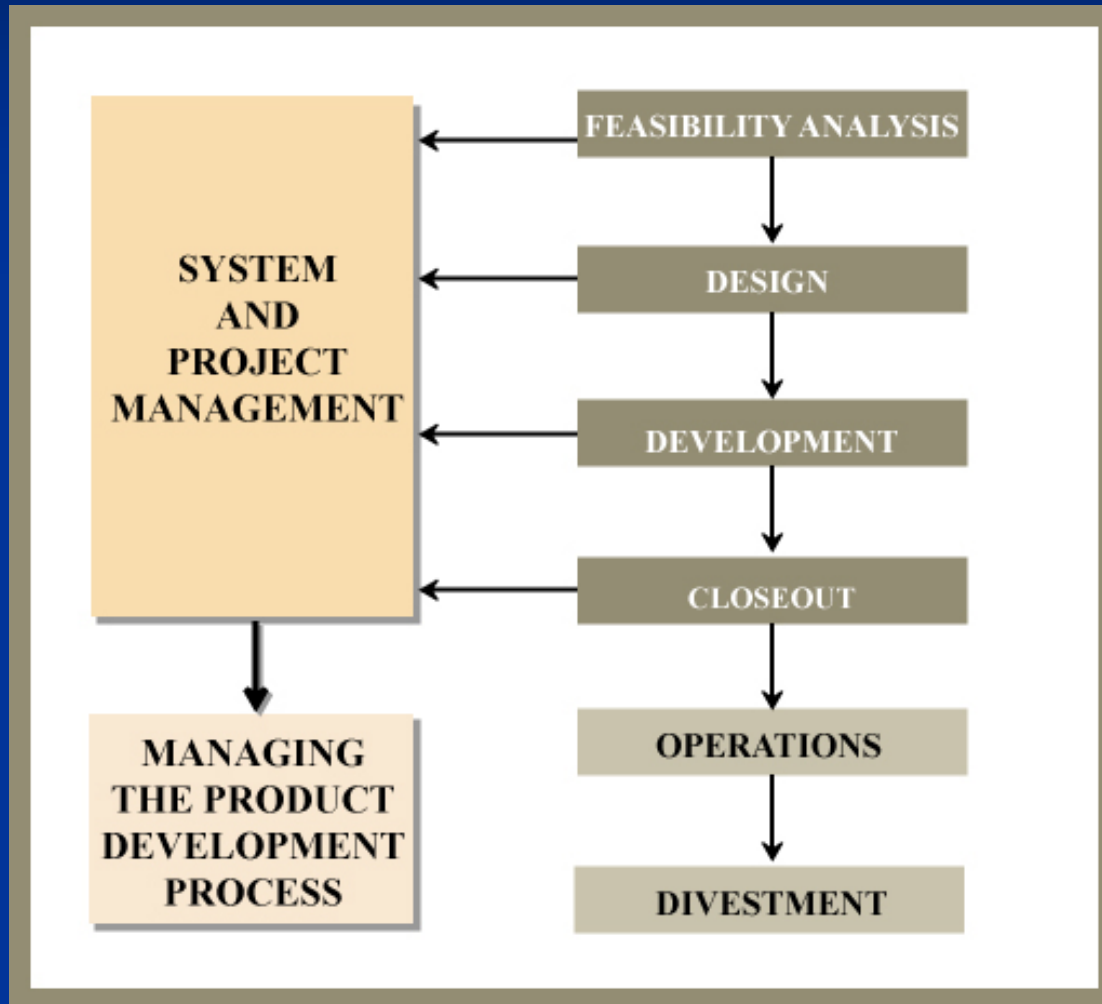
Recurrent Themes

- Complexity
- Performance (\$, time, quality)
- Uncertainty and Risk
- Flexibility
- Incentive
- Conflict
- Crucial role of qualitative and quantitative factors

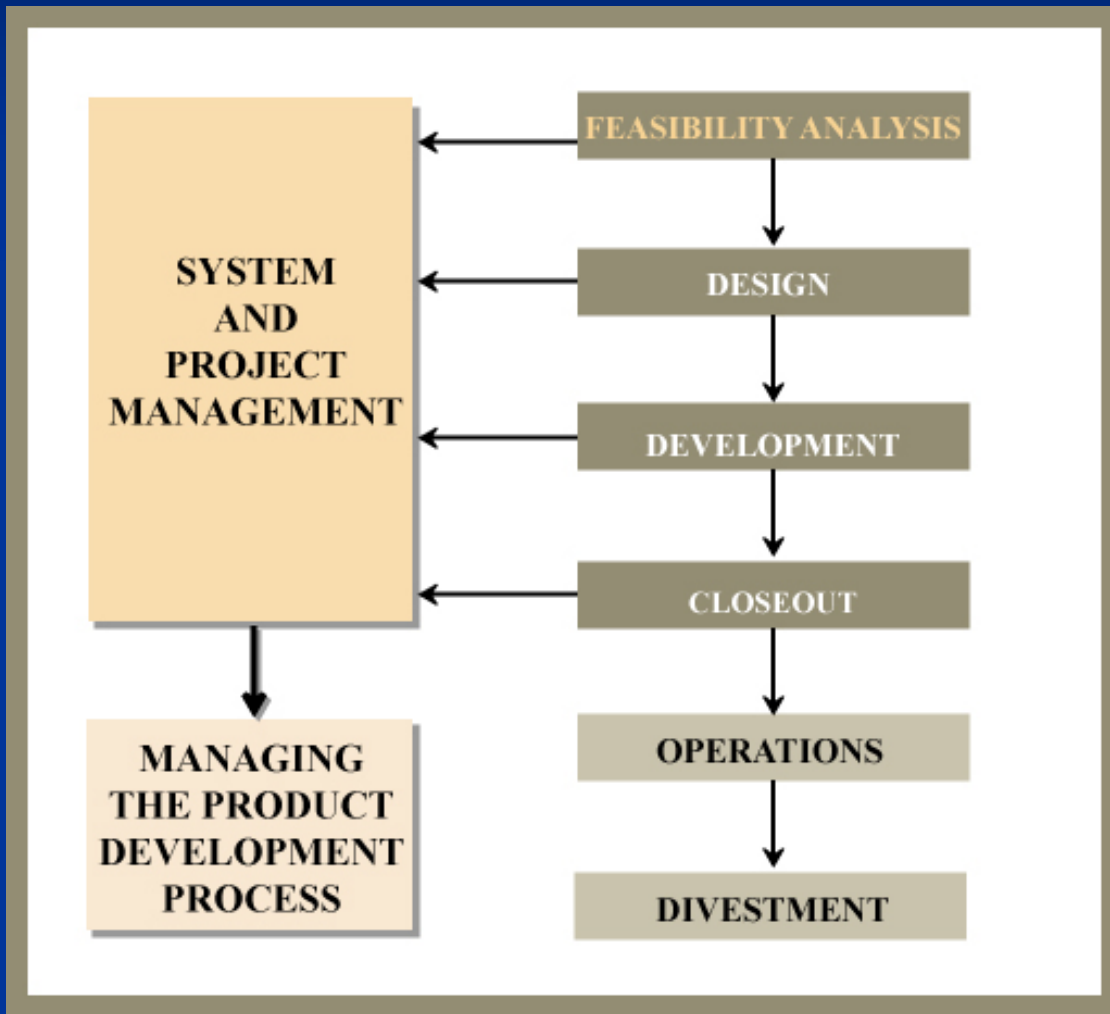
Parties –Diverse Motivations

- Owner
 - Role: Commissions project, arranges financing
 - Common Motives: Good design, save \$, finish quickly
- Designer (Architects & Engineers)
 - Role: Designs facility (typically w/owner)
 - Frequently oversees construction
 - Common Motives: Recognition, happy client
- Contractor(s)
 - Role: Builds facility (often w/design assistance)
 - Common Motives: Make \$, finish quickly, happy client

Survey of Construction Phases & Class Topics



Survey of Construction Phases & Class Topics



Feasibility Studies and Preliminaries

- Understanding project finance and evaluation
 - Helps understand economic challenges faced by owner and contractor
- Understanding and managing risk
 - Insight into risk premiums, incentives, making choices under uncertainty, management
- Deciding on fundamentals of contract
 - Delivery type (organizational method)
 - Award method (how decide who hired?)
 - Contract type (how pay?)
 - Conditions

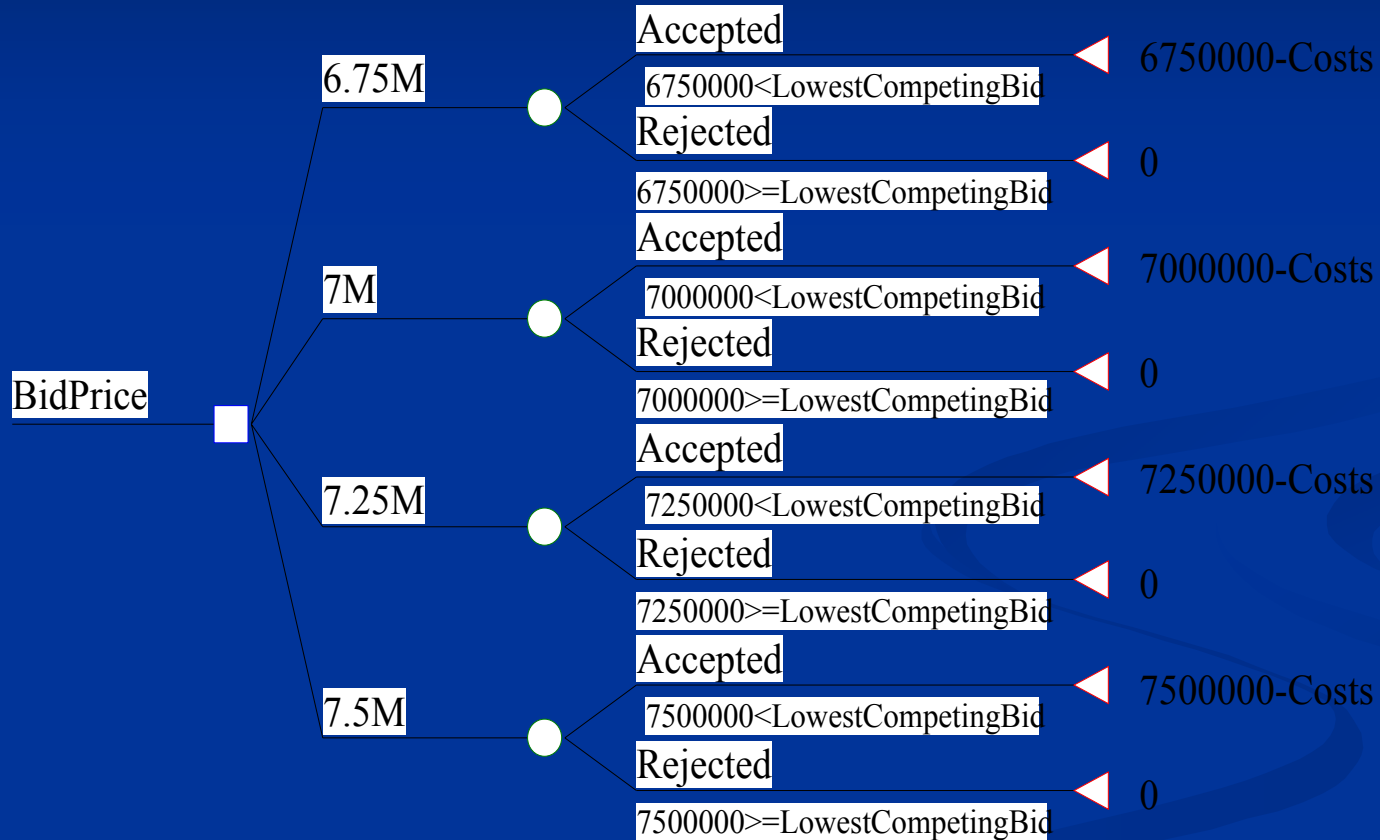
Project Evaluation and Financing

- Financing mechanisms
 - Public, private and hybrid funding
- Time value of money, present value, discounted cash flow analysis
- Evaluation measures (NPV, IRR, Cost-benefit and cost-effectiveness analysis)
- MARR and WACC

Risk Analysis

- Risk Management
 - Identification, Classification, Mitigation
- Basics of Decision Analysis
 - Decision Trees
- Risk attitude
- Essential concepts of preferences
- Sources of risk in construction
 - Particular emphasis: Changes and Claims

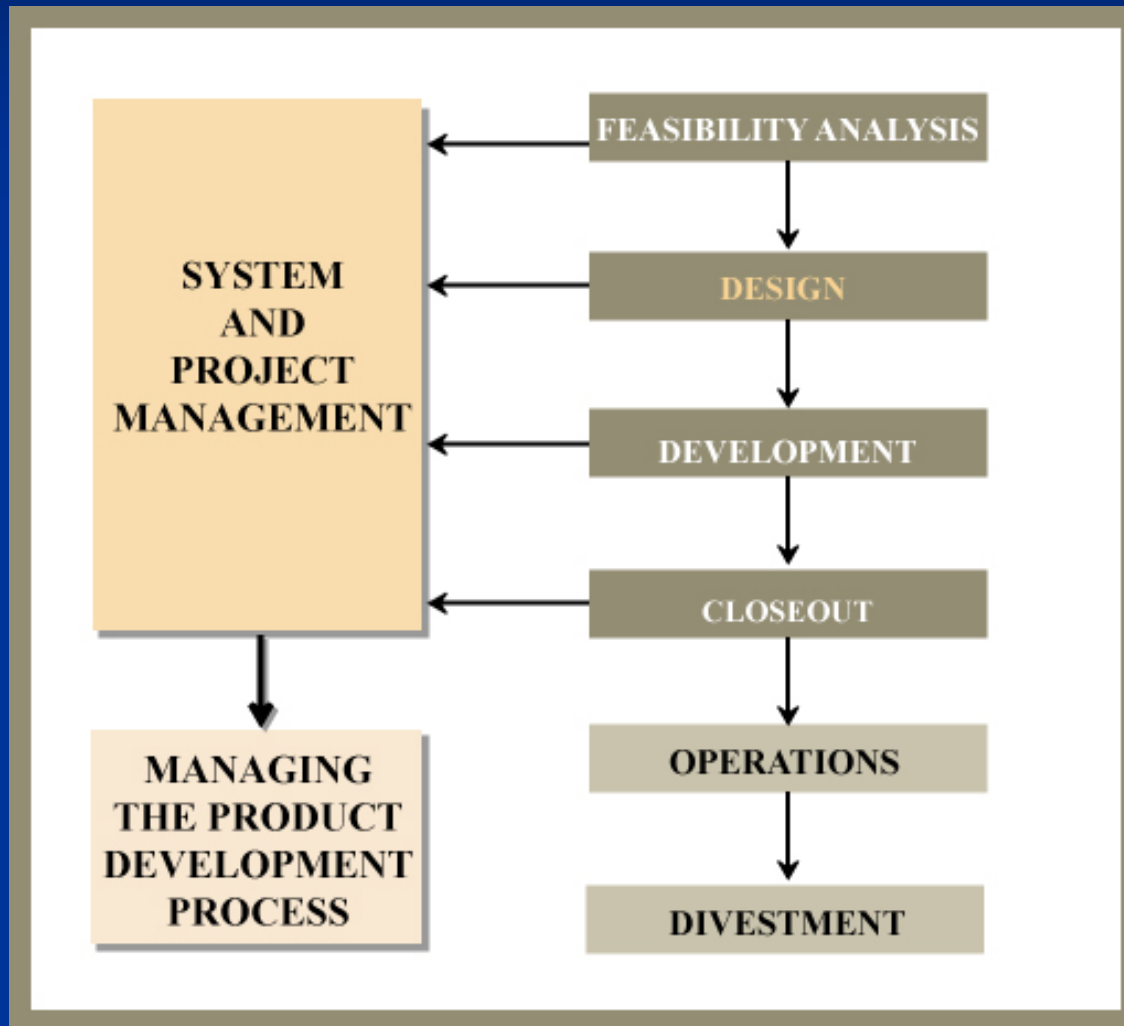
Example Decision Tree



Delivery, Award, Contract Method

- Delivery Methods – How to organize?
 - DBB, DB, Turnkey, BOT, Mult. Primes,...
- Award Mechanism – How to pick?
 - Lowest cost, Multiparameter, Negotiated
- Contract Type – How to Pay?
 - Lump sum, Cost plus %, GMP, etc.
- Contract Design
 - Scope definition
 - Risk sharing
 - Dispute resolution
 - Pointers to avoid claims, defend contract

Survey of Construction Phases & Class Topics



Design Phase

- A/E and owner Define scope, budget, time of project
- Estimation
 - Successive estimates produced
- Initial Planning
 - Deterministic
 - Probabilistic
 - Resource
- Possible roles for contractor
 - Value Engineering (Flexibility considerations)
 - Constructibility Analysis

Project Estimating

- Project Budgeting
- Life-Cycle Costing
- Successive estimates
 - Preliminary (financing) model
 - Schematic, development, contract
- Methodologies
 - Parametric
 - Quantity Takeoff
- Deterministic and Probabilistic Estimation

Deterministic Planning I

- Critical for
 - Careful examination of approach
 - Juggling diverse activities, resources
 - Reasoning on cost, time at completion
 - Monitoring & Control
 - Use in litigation
- Phased and fast-tracked construction
- Gantt (Bar) Chart
- Network Techniques
 - CPM
 - Criticality Index
 - PDM
 - Criticality
 - Splitting
 - Warnings
 - Tips to watch out for

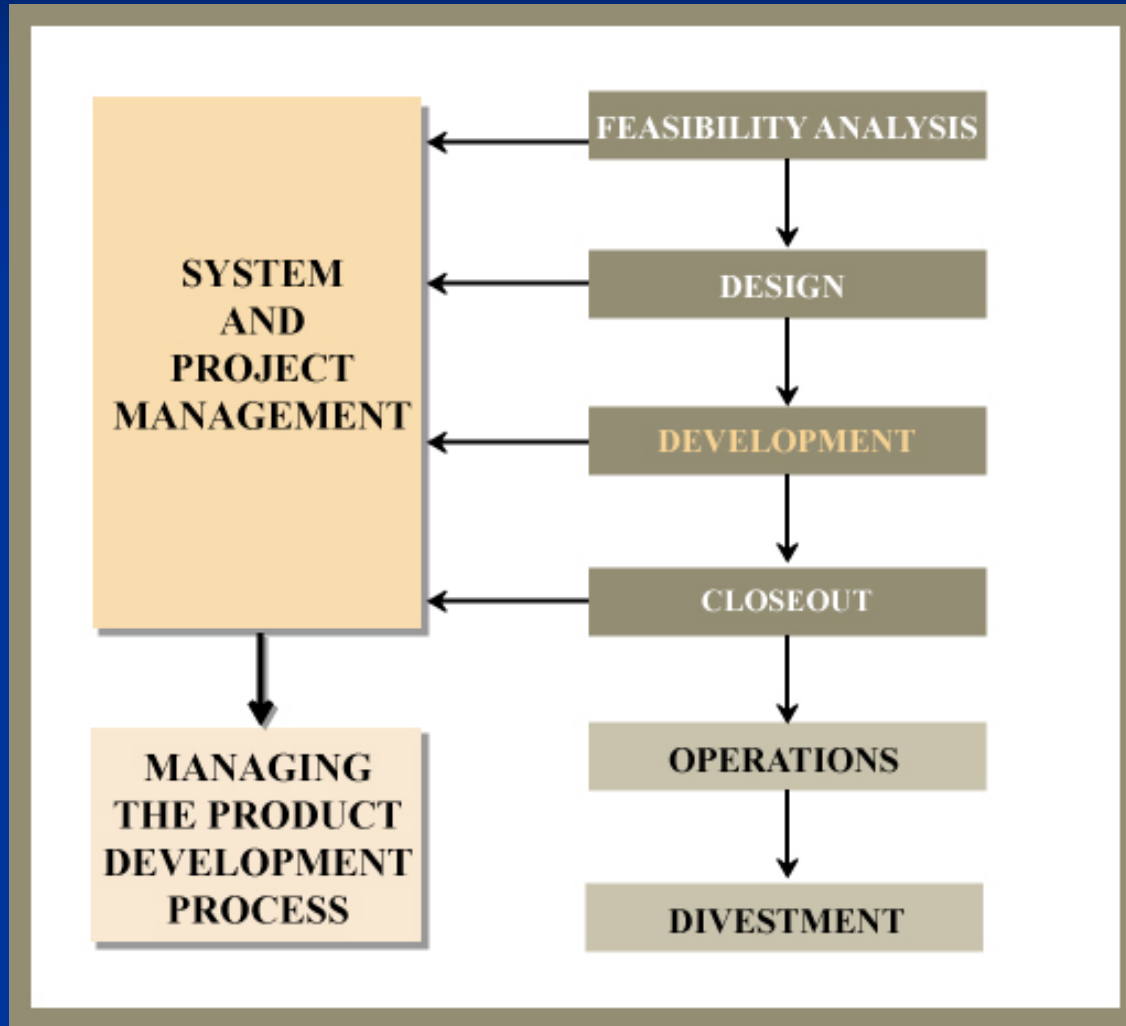
Probabilistic Planning

- PERT
- Monte Carlo Simulation
- GERT
- Q-GERT
- Dynamic Planning Methodology

Resource Planning

- Budget Management
- Resource Scheduling
 - People, Space, Equipment, Materials,...
- Resource-Cost Tradeoffs I
- Line-of-Balance Method
- Quality assurance

Survey of Construction Phases & Class Topics

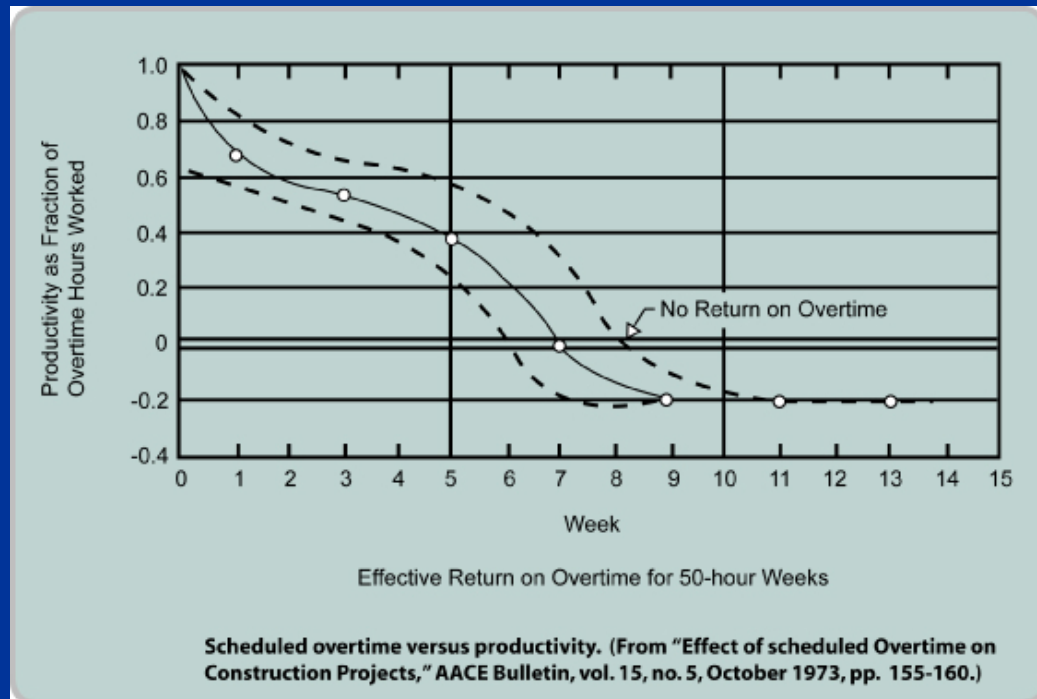


Project Monitoring

- Performance Categories
- Earned Value Approach
- Progress Reporting
- Learning effects
- Cost and Schedule Monitoring
- Reviews and audits

Project Control

- Cost/time tradeoffs
- Acceleration
 - Resource shifting
 - Project crashing
- Feedbacks complicating control
- Managing changes and risks



Claims and Changes Control

- Principles to limit damage
- Conflict escalation
- Dispute resolution
- On-call contractors
- Delay claims
- Dynamics of claims and claim resolution

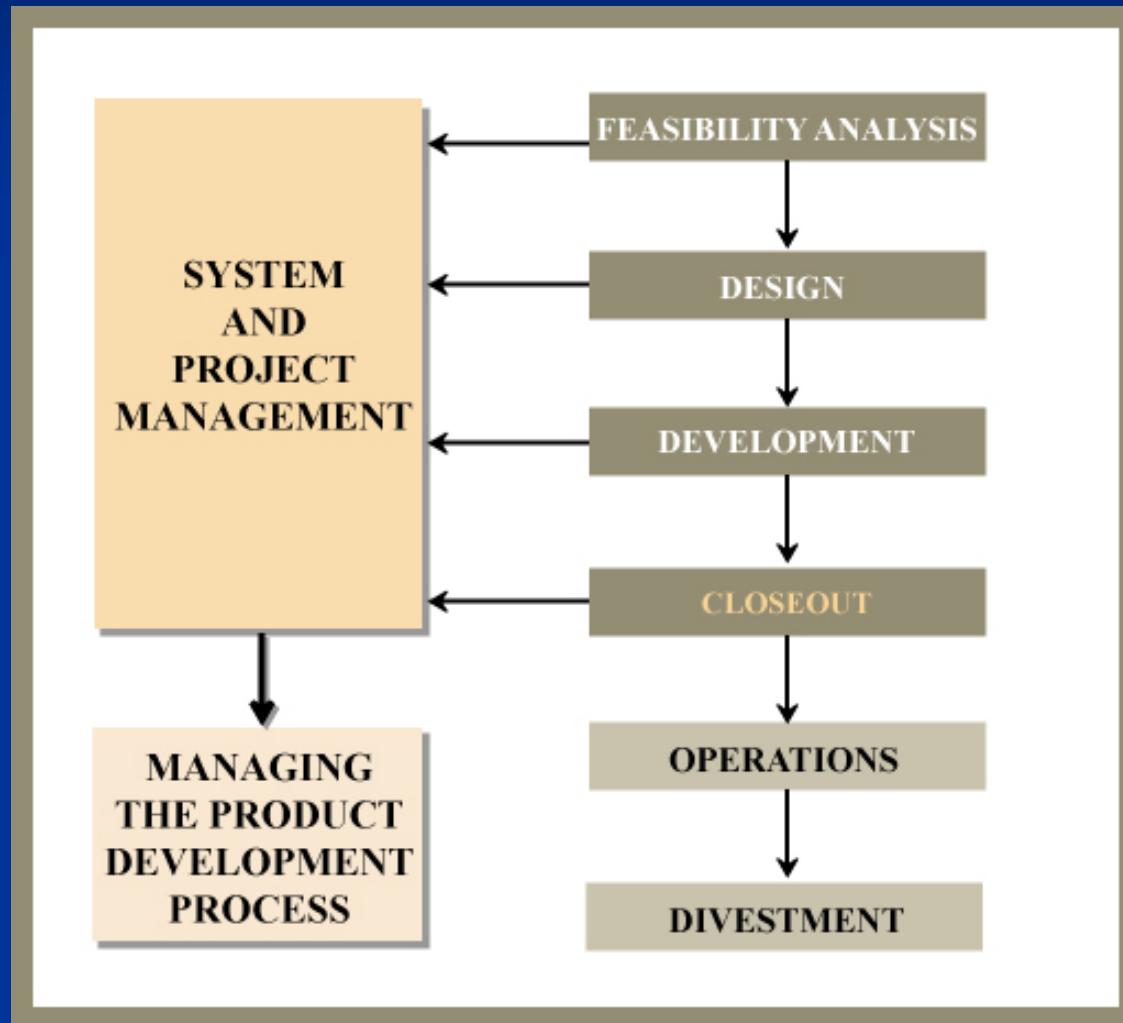
Project Control Feedbacks

- Dynamics of Changes, Rework
 - Quality
 - Cost
 - Time
- Counter-intuitive effects of acceleration
 - Overtime lowers quality, productivity
 - Fast track increases sensitivity & vulnerability

Example Feedbacks



Survey of Construction Phases & Class Topics



Project Close Out

- Substantial and final completion
- Termination
- Close Out
- Warrantees

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Mission Statement

“The mission is to help organizations achieve their project objectives and objectives of scope, quality, budget, and schedule within the context of the natural, social and political environment in which the project is being developed.”