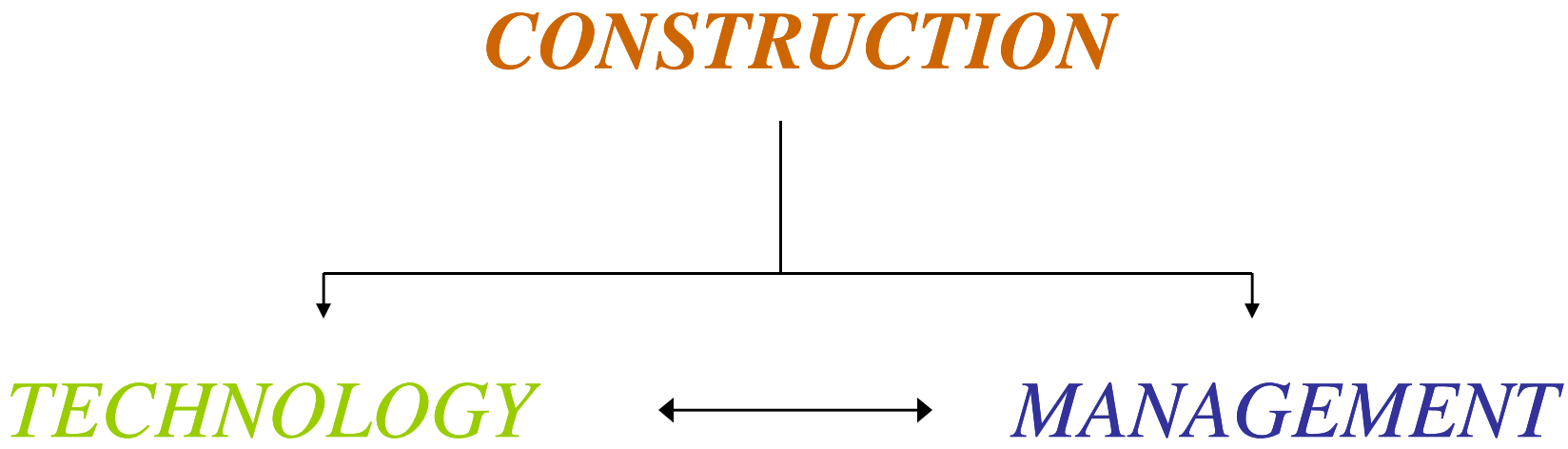
Project and Construction Management

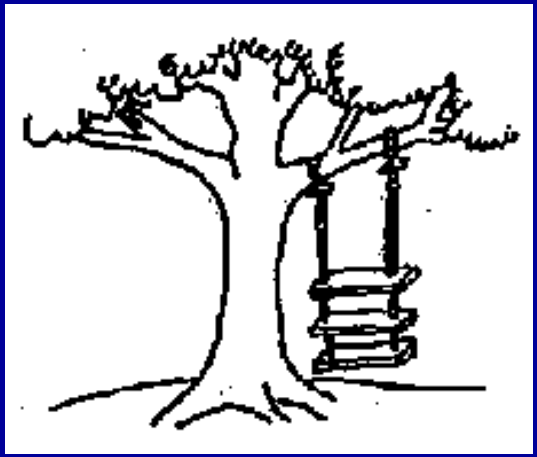
Lecture #03

An Overview of PCM

Luis A. Prieto-Portar 2009.



So, why is an <u>engineering</u> manager needed in construction?



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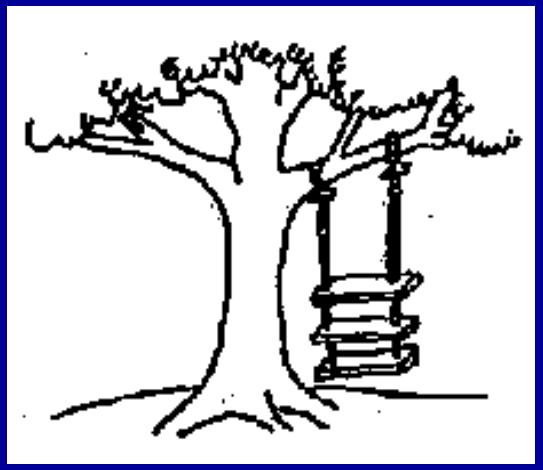

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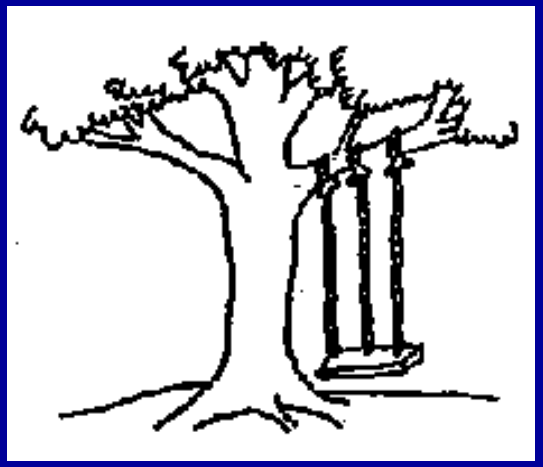

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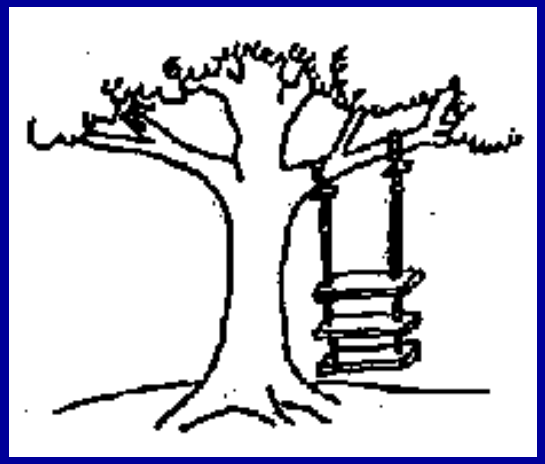

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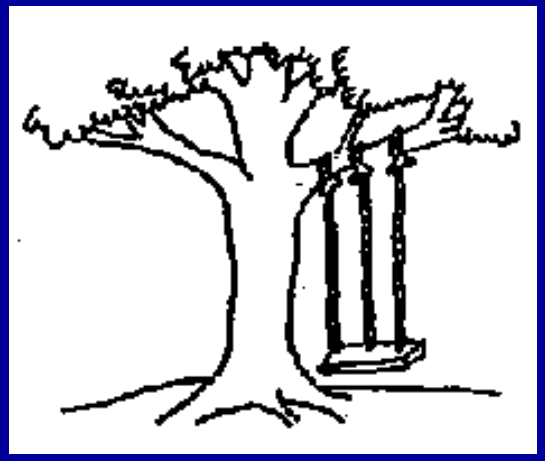

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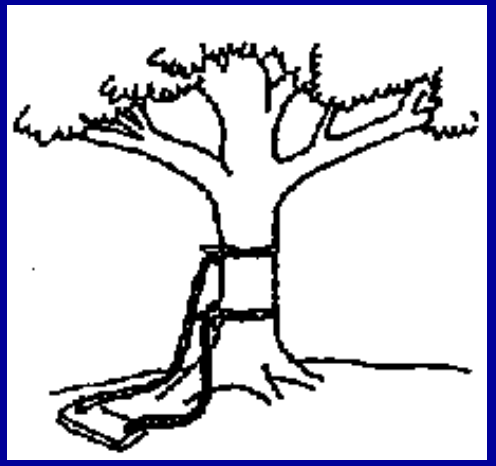

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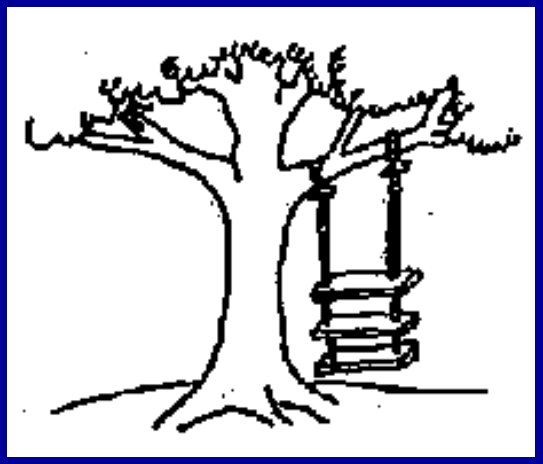

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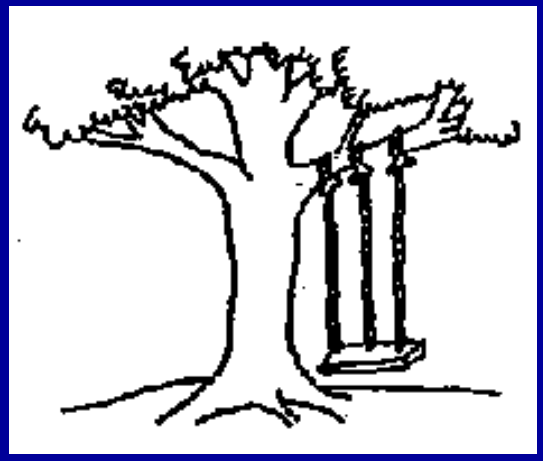

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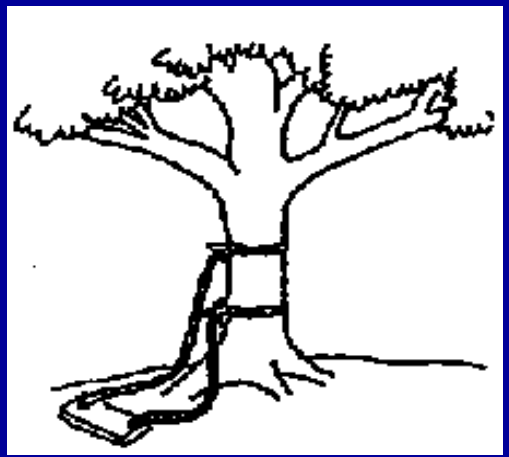

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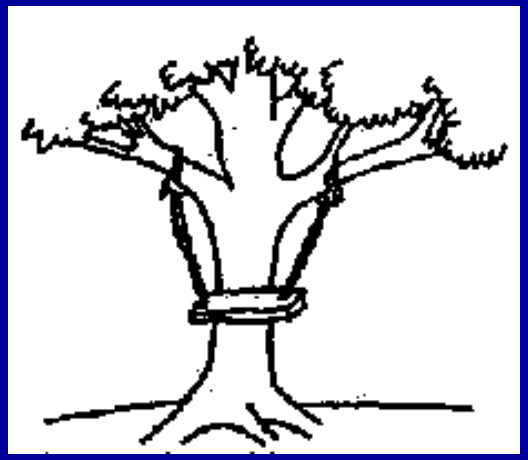

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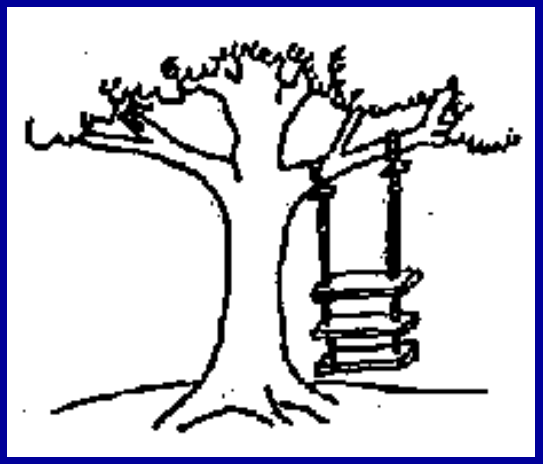

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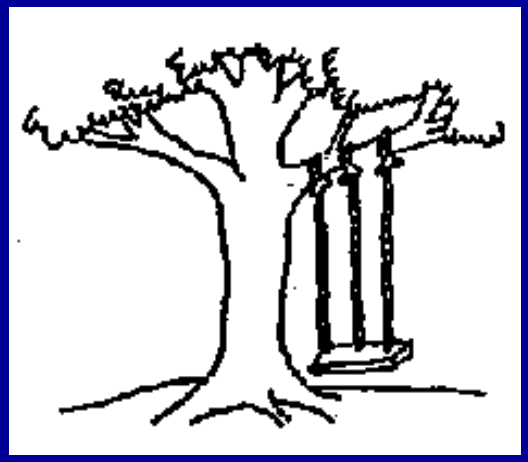

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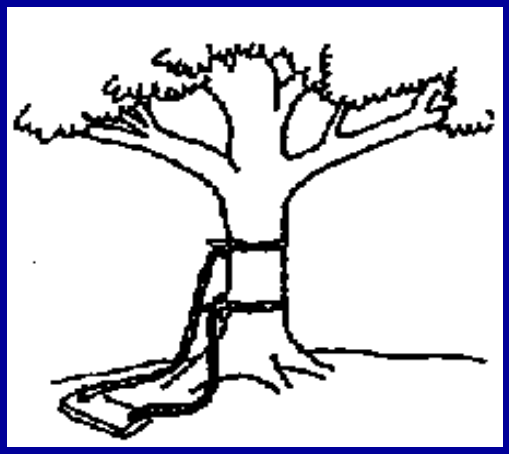

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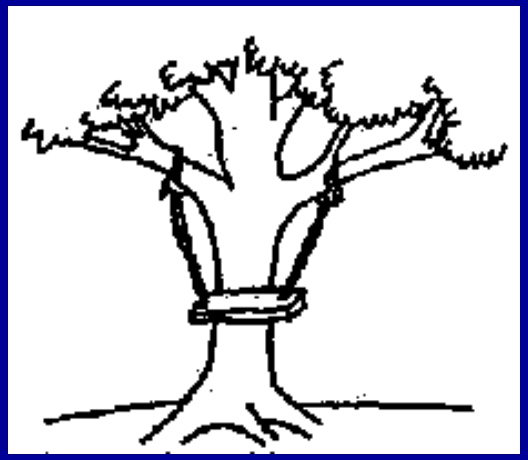

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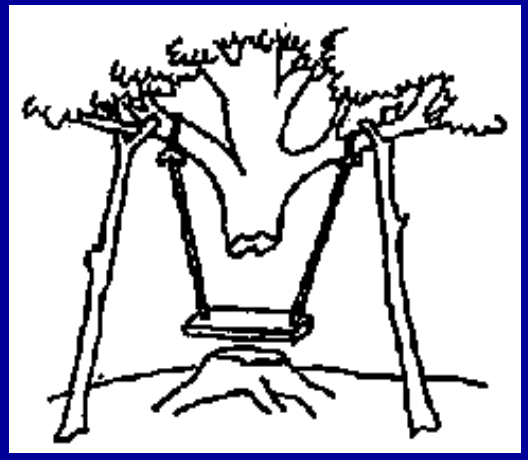

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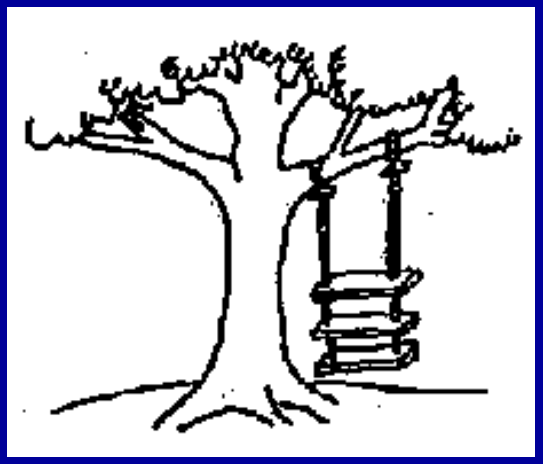

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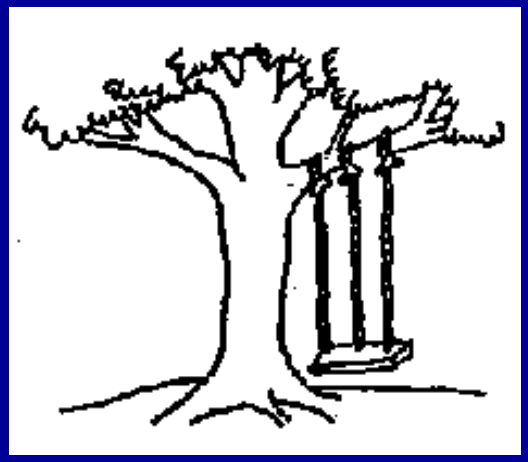

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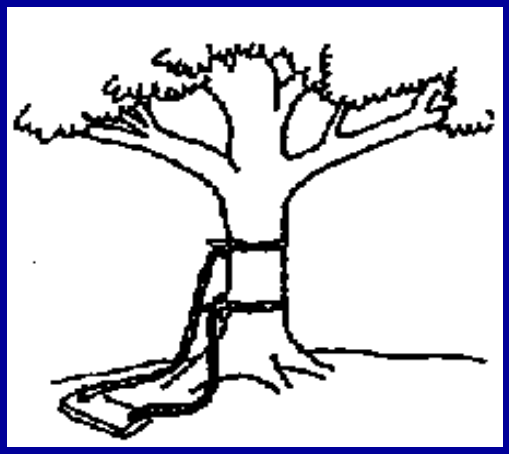

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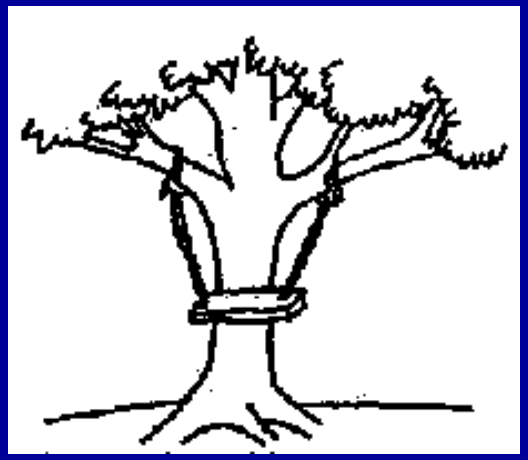

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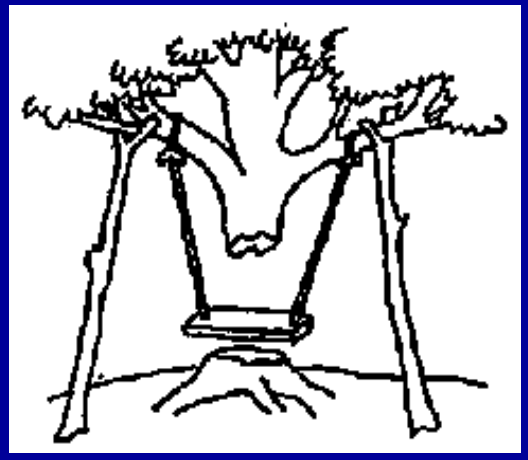

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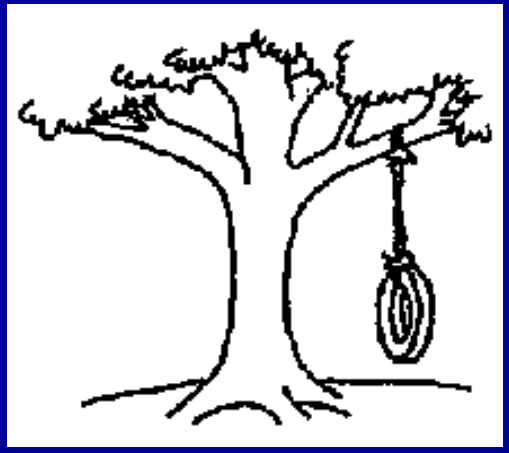
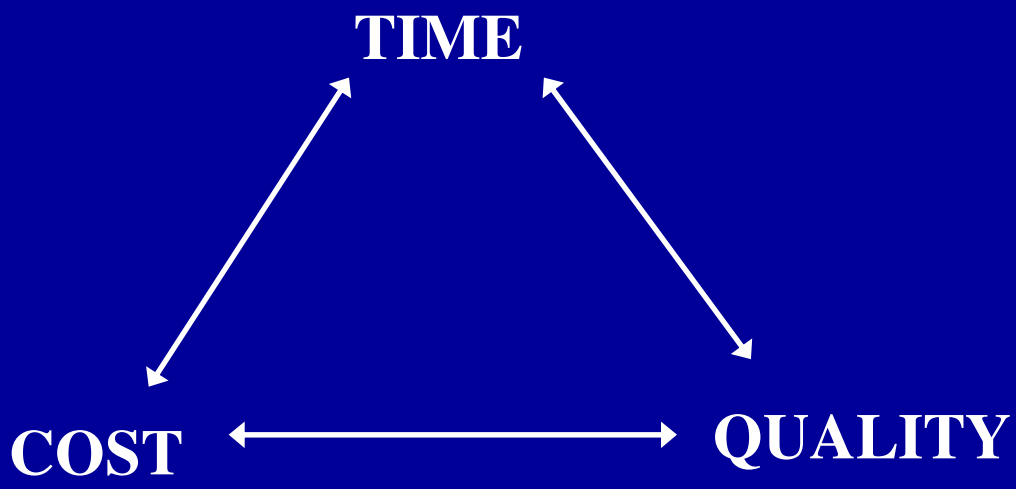


What the user wanted.

The Management TRIAD:



CONSTRUCTION versus MANUFACTURING

- Construction:

- Unique/Prototype product
- Factory for each product
- High Complexity
- Low Volume
- Little or/no Standardization

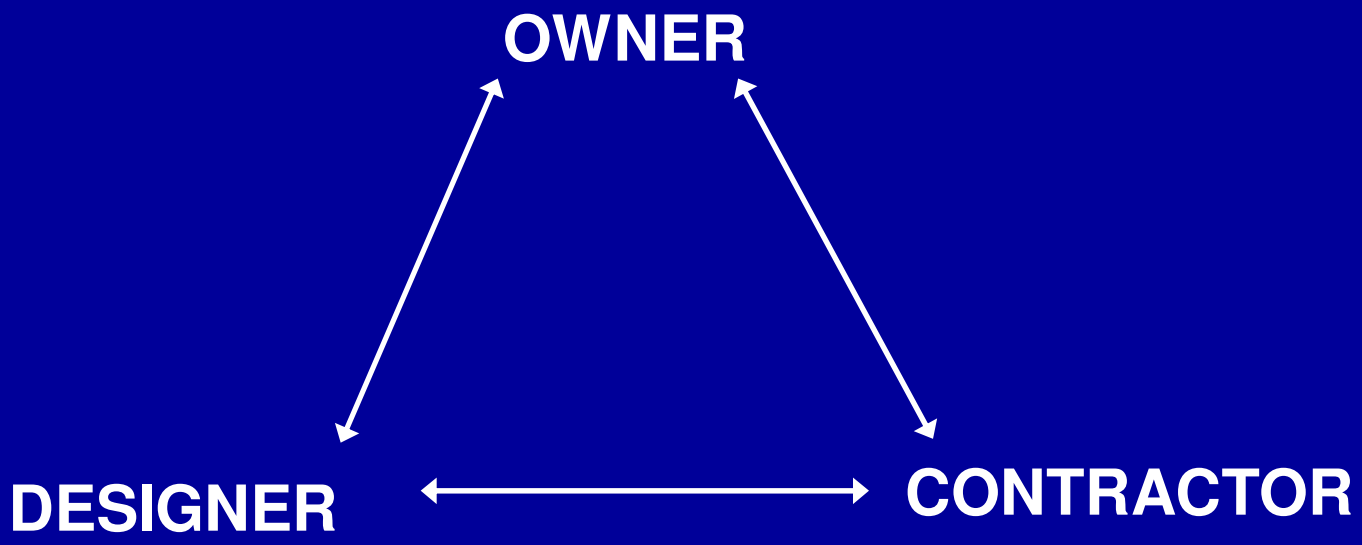
- Manufacturing:

- Standard product
- Factory for mass production
- Low Complexity
- High Volume
- High Standardization

TYPES OF CONSTRUCTION

- Building
  - Architects empowered
  - Driven by Aesthetics
- Engineering
  - Engineers empowered
  - Driven by Engineering principles
- Industrial
  - Industrial/Production engineers
  - Driven by production needs

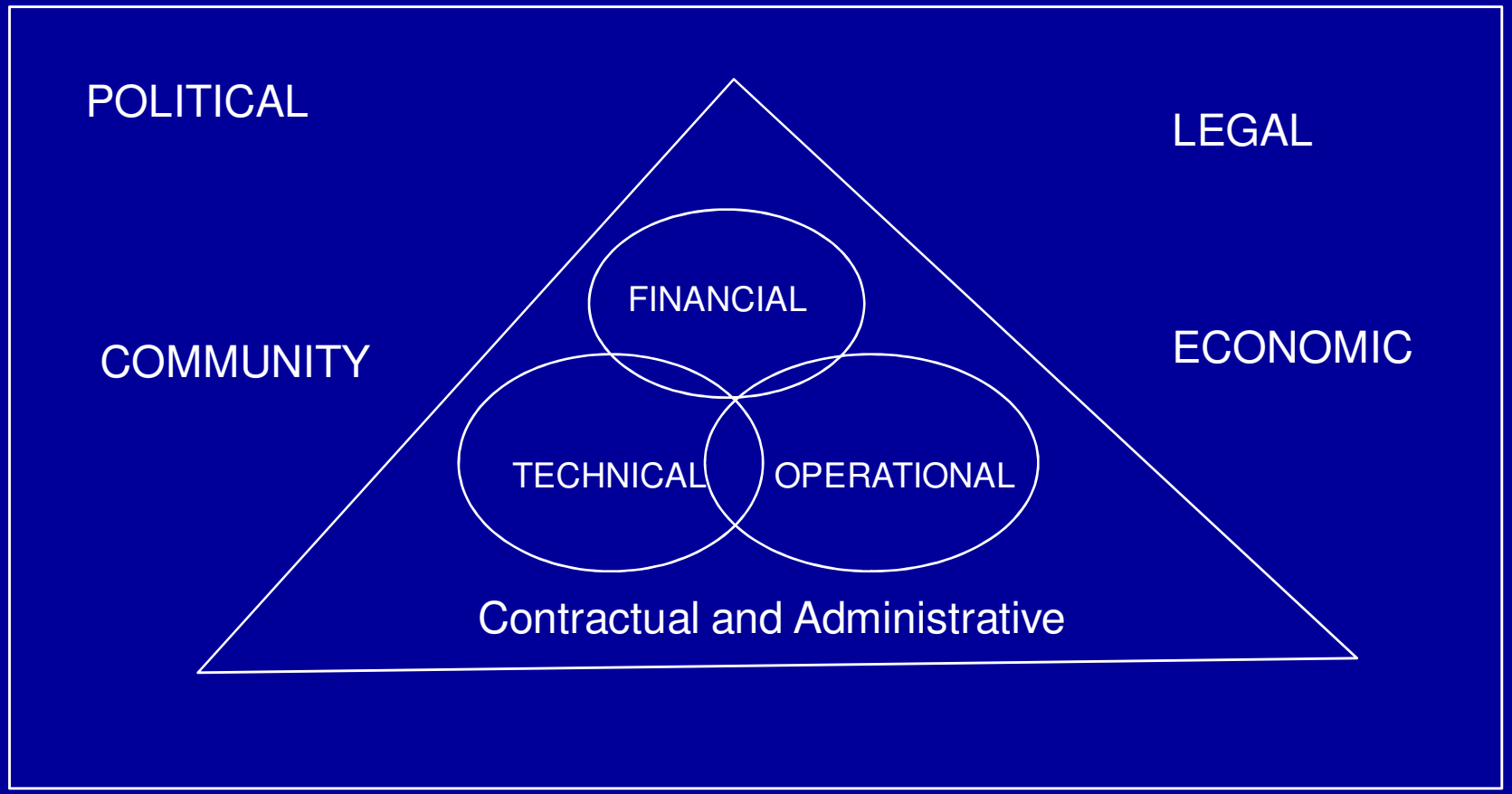
PARTICIPANTS



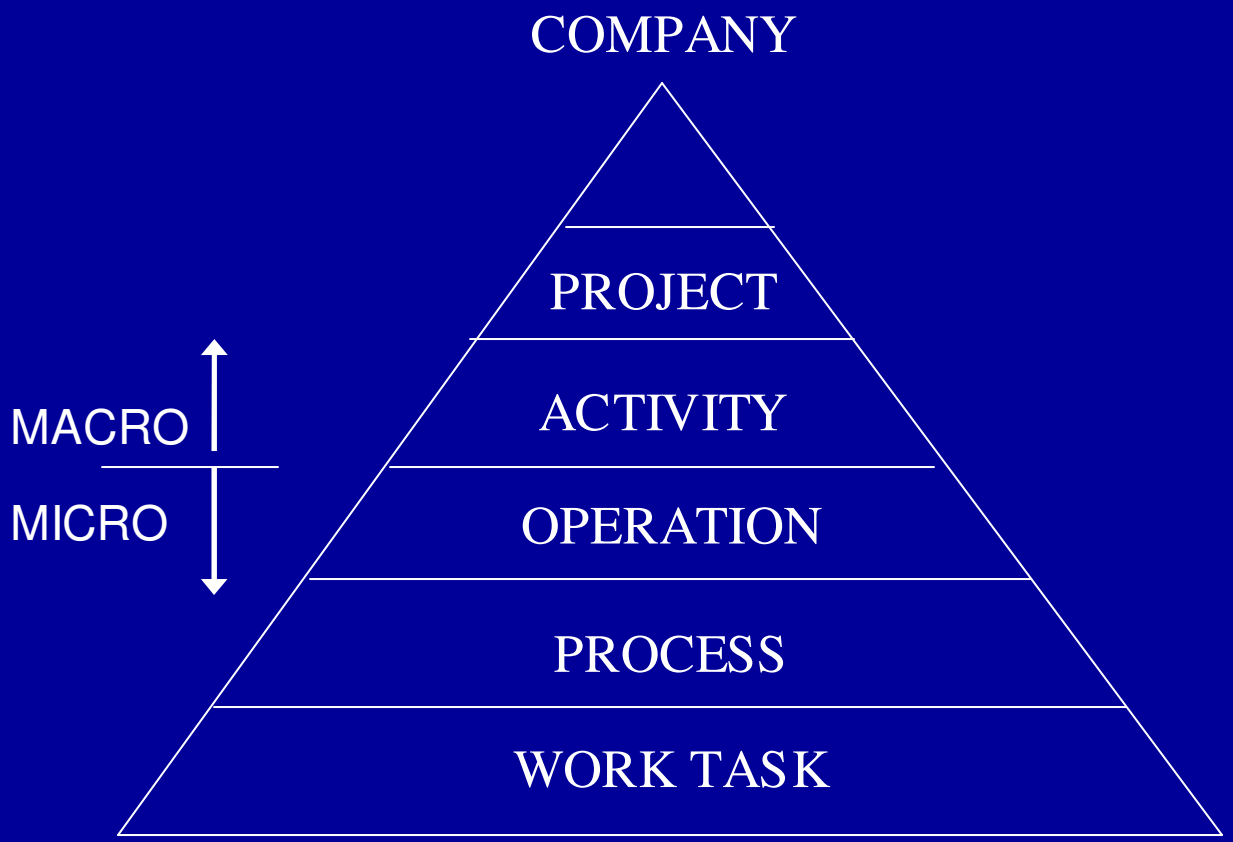
PARTICIPANTS

- Owner/ Client
  - Private
    - Investors
    - Banks
  - Public (our money)
- Designers:
  - Architects
  - Engineers
  - Consultants
- Constructor/ Contractor
  - General Contractor
  - Trades / Specialist Contractors (foundations, civil, electrical, HVAC, concrete, steel, roofer, tile, etc)
- Suppliers
- Regulators/ Inspectors
- Community

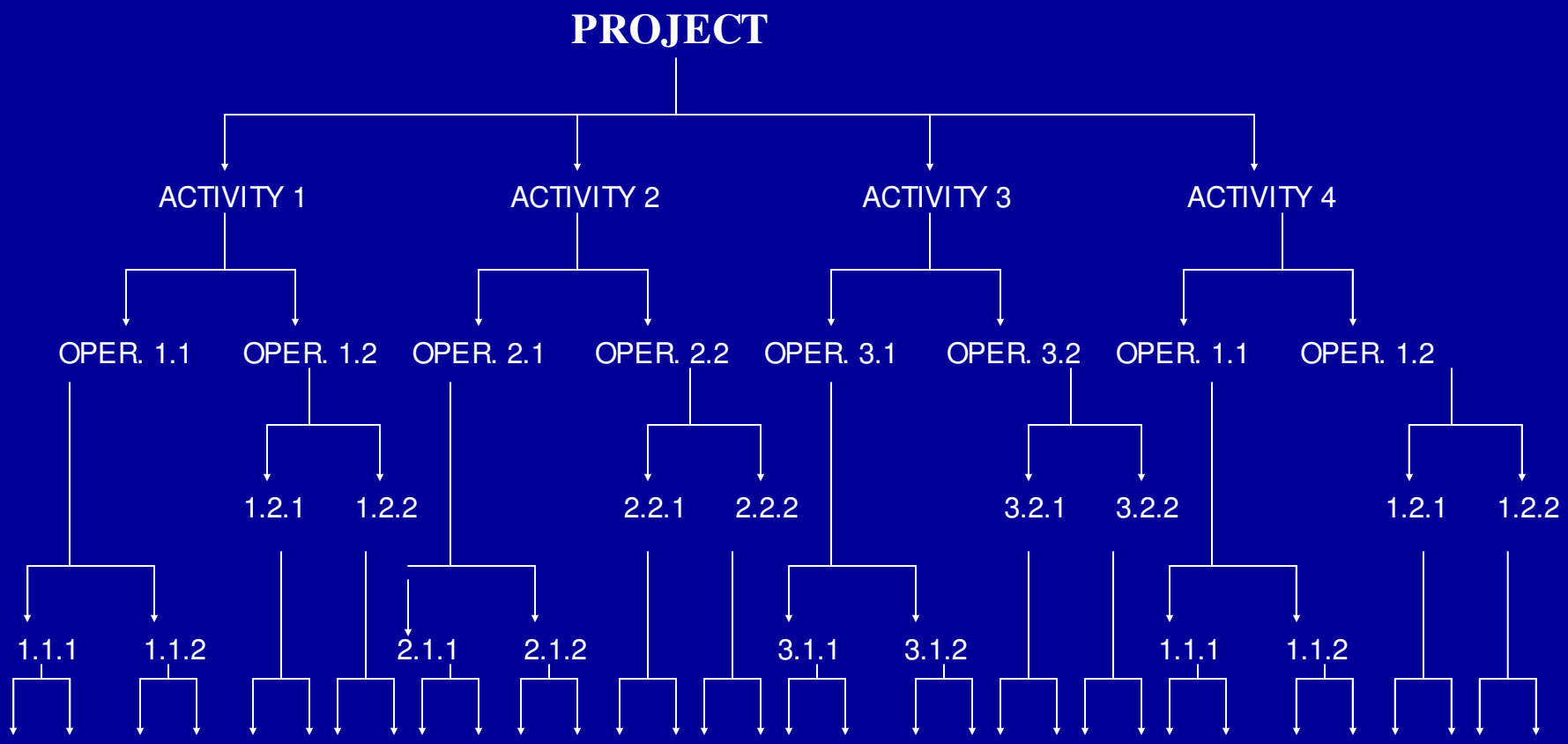
ASPECTS OF CONSTRUCTION PROJECTS



LEVELS OF MANAGEMENT

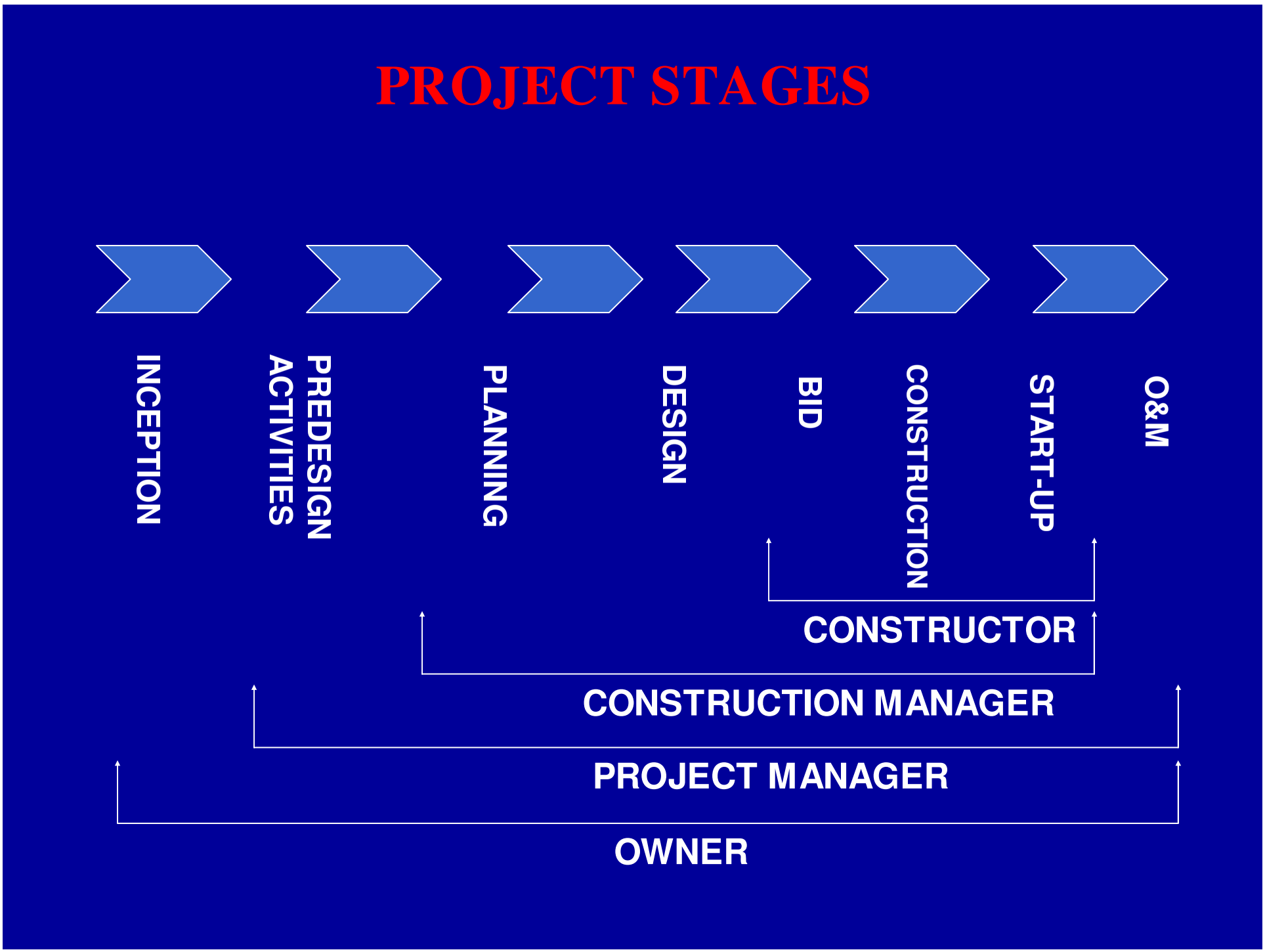


The Work Breakdown Structure (WBS)



PROJECT DEVELOPMENT STAGES

PROJECT STAGES



The boundaries between stages are nor clear.

Different books/publications use different approaches.

Constructors handle very little of the whole project.

Owner needs to be involved in everything.

The Construction Manager is involved in everything that may affect the construction.

The Project Manager is involved in everything that the owner wants (and may parallel the owner's involvement).

Owner's Pre-Project Activities

- Inception
  - Identification of the need
  - Define overall objectives
- Feasibility
  - Options Determined
  - Technology assessment
- Concept Design
  - Architect Appointed
  - Define Project Requirements
  - 1st Cost Plan/ Execution Plan
  - Define "Value for Money"
  - Life Cycle Cost Analysis

Statements of the Project:

What do we want to achieve?

Is it feasible?

Is the technology available?

What options are open?

Value Management exercises => define the Value for Money.

What and where are we willing to spend the money?

The Construction Manager will give construction input at the very early stages

➔ better design concepts

➔ curtails creativity

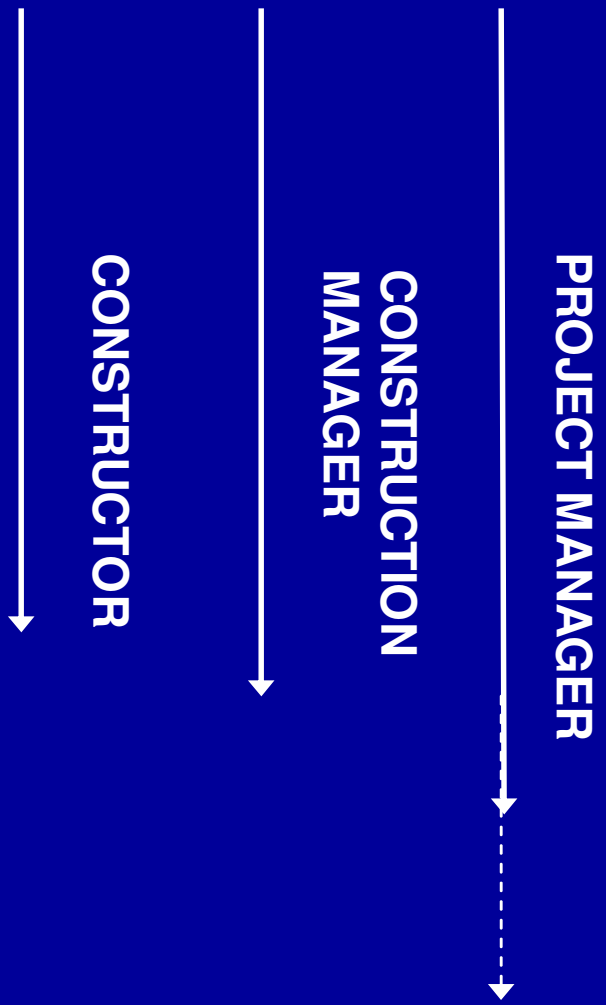
➔ a headache for designers.

Project Activities
Design Development

- Scheme Design
  - Design Management
  - 1st Estimate/Cost Plan
  - 1st Schedule
- Design Production
  - Design Management
  - Detailed Construction Estimate
  - Detailed Construction Schedule

Project Activities Implementation

- Construction
  - Bidding process
  - Contract Award
  - Project Execution
  - Management of Changes during Construction
  - Testing/Start-up
- Operate and Maintain
  - Life Cycle Costing
  - Operation Costs
  - Maintenance Costs
- Disposal of the Facility



III. ISSUES DURING DESIGN

ESTABLISHING THE NEED

- Define the Problem/Requirement/Objectives
- Define the Client/ Owner/ User
- Define “Value” for the Client/Owner/User
  - Value Management
- Sketch/Conceptual Design
  - Sketch drawings/ Estimate
- Feasibility Study
  - Economic: Cost/Benefit Analysis- Public Projects
  - Financial: Cash Flow and Profitability
  - Commercial: Market Research
  - Technical: Can it be done?
  - Legal: Legal framework for the project
  - Political: Support for the project

Activity:

Define in groups what are the requirements you would specify for a new house. Discussion.

Exercise:

Prioritize the importance of the spaces in a house.
Prioritize the functions that a house provides

Exercise:

How would you approach the feasibility study of a New Public Roadway?

FEASIBILITY STUDY

PRELIMINARY FIGURES FOR THE TRIAD:

QUALITY

- Description of the building / construction / technology
- Basic functional definitions
- Basic sketches of the idea

COST

- Cost-to-Benefit ratio - Financial Viability
- Early Cost Plan - Cost per functional unit- Single Price
- Correction with inflation indexes

TIME

- An idea of starting period
- Estimate of construction time

Possible Homework Assignments.

Check cost indexes in ENR (or RSMEANS, etc).

Compare the evolution of the Construction cost index with the Building cost index on a year-by-year basis. Include calculations and graphical analysis.

Compare with the current inflation rate.

Compare with general producer price index. What can you say?

Which construction materials have increased more in costs? What should we expect from this increase?

How does Miami Cost Indexes compare with the National Average? Discuss.

Compare Miami with the rest of the USA. Is it an average index? Is it a low index? Is it high?

Investigate costs per functional unit: for example, building, high-rise, low-rise, etc.

DESIGN

PRELIMINARY → FINAL

Consultant Management / Design Management

- Architectural (layout, finishes)
- Structural (foundation, structural frame)
- Mechanical (HVAC)
- Civil (drainage, pavements)
- Electrical and plumbing / security systems

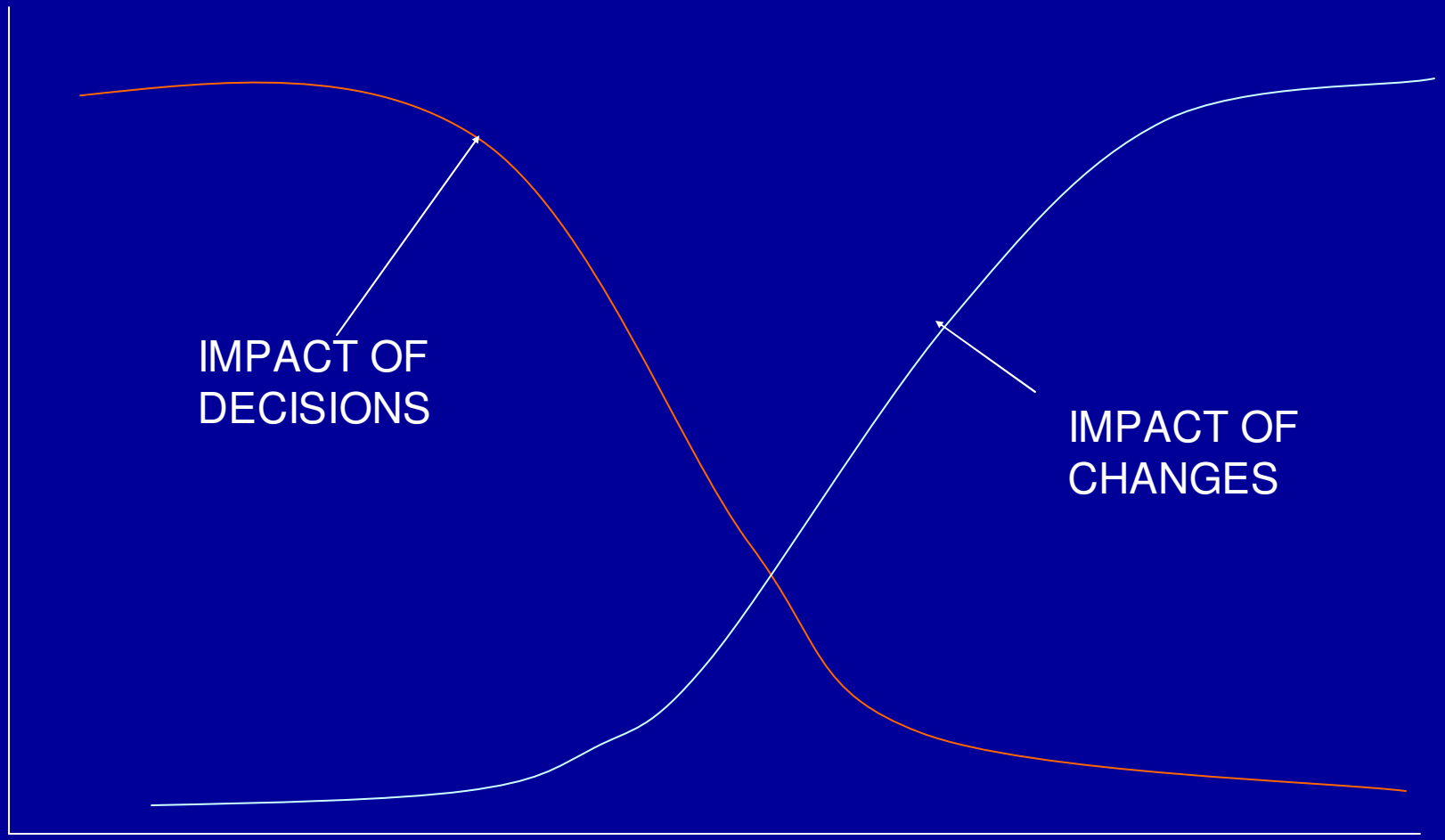
Constructability Review / Value Engineering / LCC

Cost Estimate /Schedule / Construction Specs

Management of Changes during design

- Owner generated
- Permitting related

DESIGN- Impact of Decisions and Changes



IV. The Bid Package

Possible Homework Assignments.

Prepare two Notices to Bidders that contain as a minimum:

Type of project - Description
Size of the project
Time frame for the project
Availability of Plans and Specifications
Time, Place and Date for Bid Opening
Requirements for bidders
Type of Procurement

NOTICE TO BIDDERS

- Posting
  - Newspapers
  - Specialized Magazines / Reporting Systems
  - Short Lists (Prequalification)
  - Internet
- Contents
  - Type of project - Description
  - Size of project
  - Time for the project
  - Availability of Plans and Specifications
  - Time, Place and Date for Bid Opening
  - Requirements for bidders
  - Type of Procurement

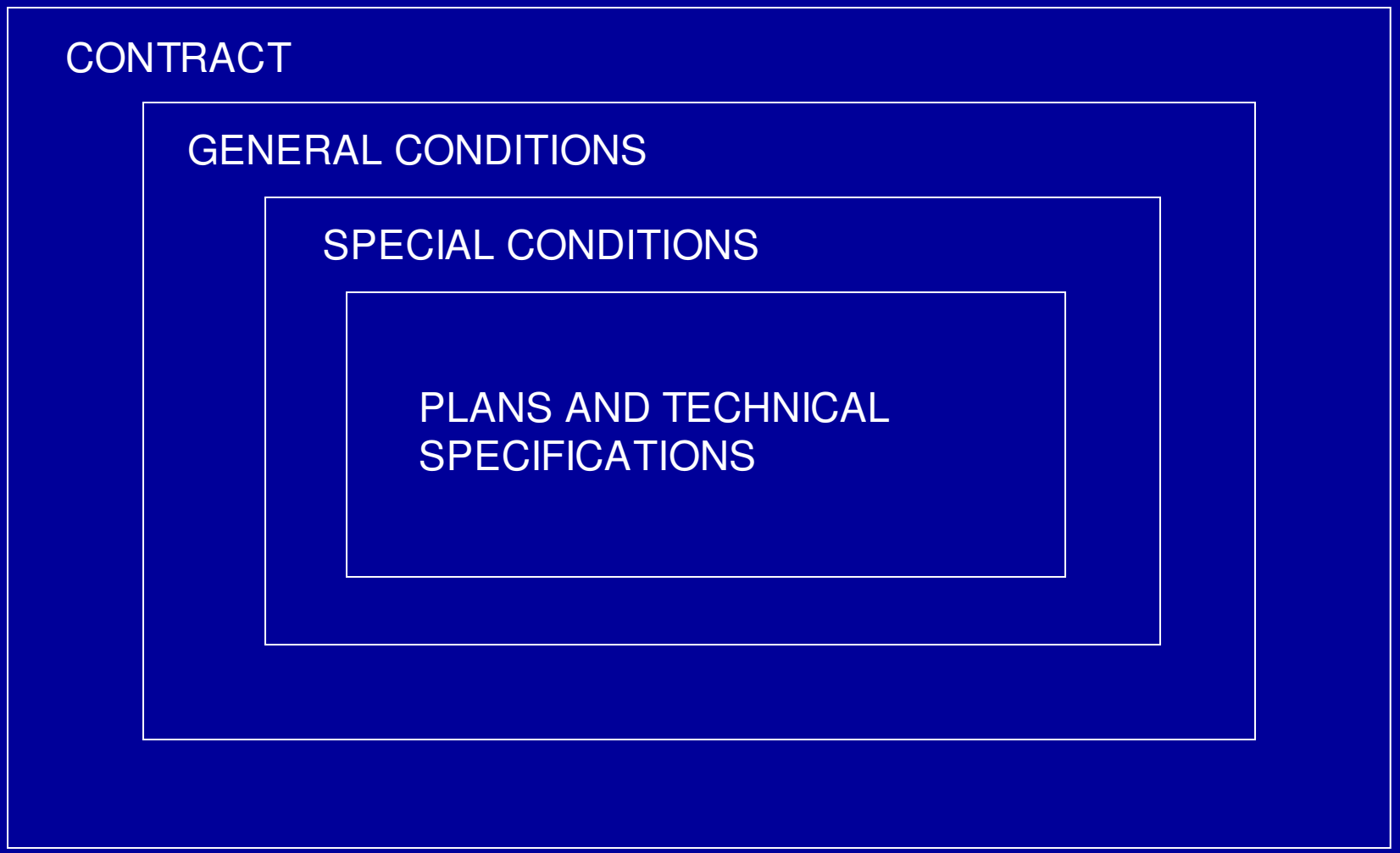
BID PACKAGE

- Plans (from Design Development)
- Specifications- Standards (ACI, ASTM, ASCE)
- General Conditions - Generally Standard
- Special Conditions - Particular to the project
- Proposal Form ➔ Offer and Objective Selection
- Draft Contract Agreement➔ Procurement Type
- Changes to the Package- Addenda

- Large Projects➔ “Show Room”

- Decision to Bid

BID PACKAGE


CONTRACT
GENERAL CONDITIONS
SPECIAL CONDITIONS
PLANS AND TECHNICAL SPECIFICATIONS

BID PREPARATION

- SIMULATION OF the PROJECT EXECUTION
  - Cost Estimating
    - Quantity Take-off
    - Quotations from vendors based on Specifications
    - Indirect Costs (Bid preparation, office overhead, etc)
  - Scheduling
    - Construction Methods and Productivity Analysis
  - Bid Bond (Actual Guarantee, Certified Check, etc)
    - Damages to client due to contractor's failure to start
    - Pre-contractual responsibilities of the contractor
  - Performance and Payment Bond
    - Surety to finish project in case of contractor's default
    - Surety to pay outstanding liens and charges

V. ISSUES DURING CONSTRUCTION

CONTRACT AWARD

- Acceptance period
  - In which Bids (quotations) are valid
  - In which the owner must evaluate and decide
- Comments on evaluation
- Contract Award
- Contract Execution
- Notice to Proceed (NTP)

CONSTRUCTION ISSUES

- Time Extensions and Change Orders
  - Design Problem
  - Modifications
  - Weather
  - Strikes
  - Late Deliveries
  - Coordination of Sub-Contractors
  - Unforeseen Conditions
  - Suspensions / Delays / Interruptions
  - Others

CONSTRUCTION ISSUES

- Value Engineering
  - Input from the contractor
  - Substitution of Components / Methods / Elements
  - Savings shared between Owner and Contractor
- Finish Late
  - Liquidated Damages (LDs)
- Finish Early
  - Bonus
- Cost Overruns / Savings

Possible Homework Assignments.

Investigate the definition of Value Engineering.

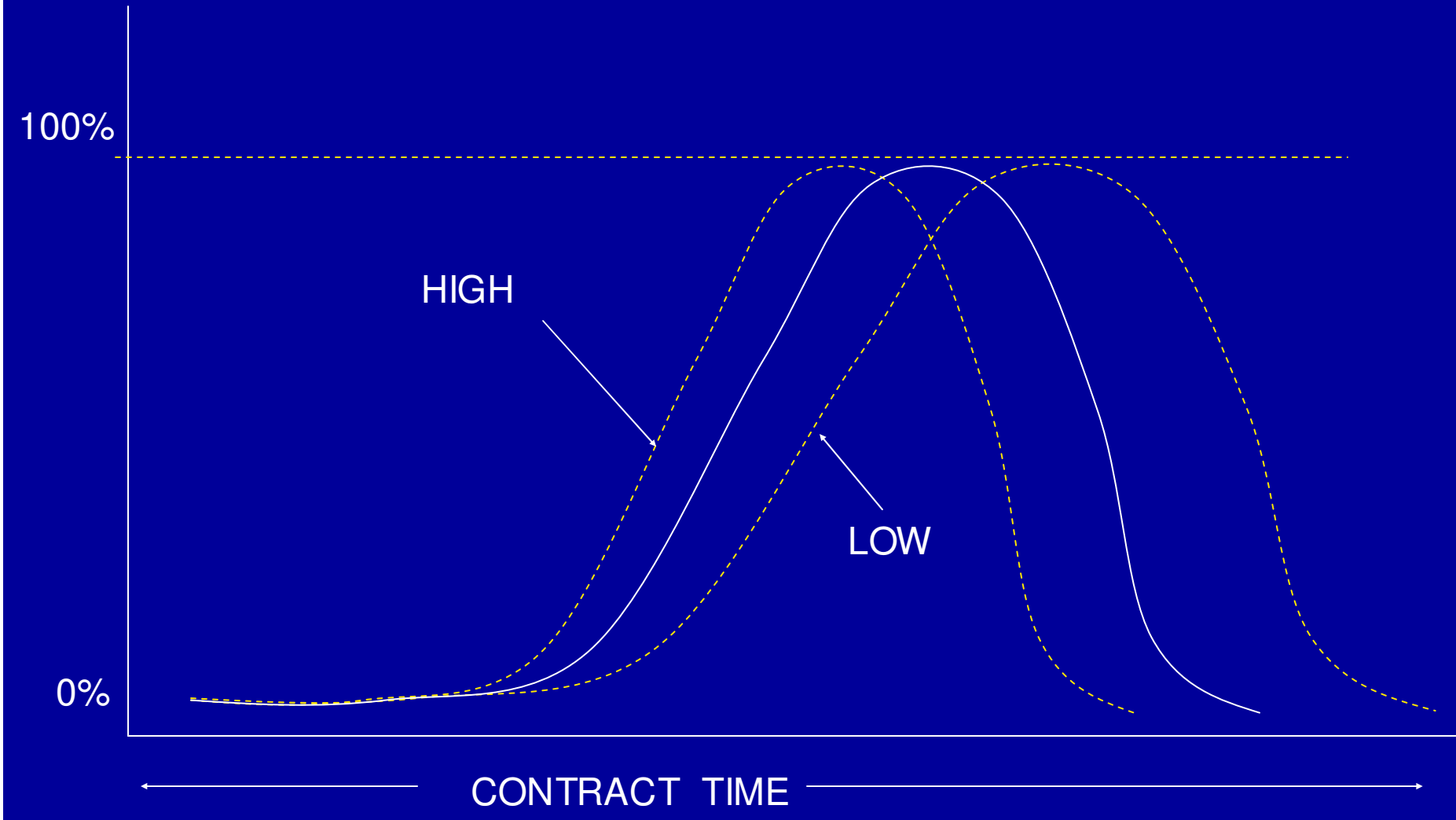
History of Value Engineering.

Definition of Liquidated Damages (for example, predetermined sum which becomes payable by a party to a Contract if certain specified breaches occurs).

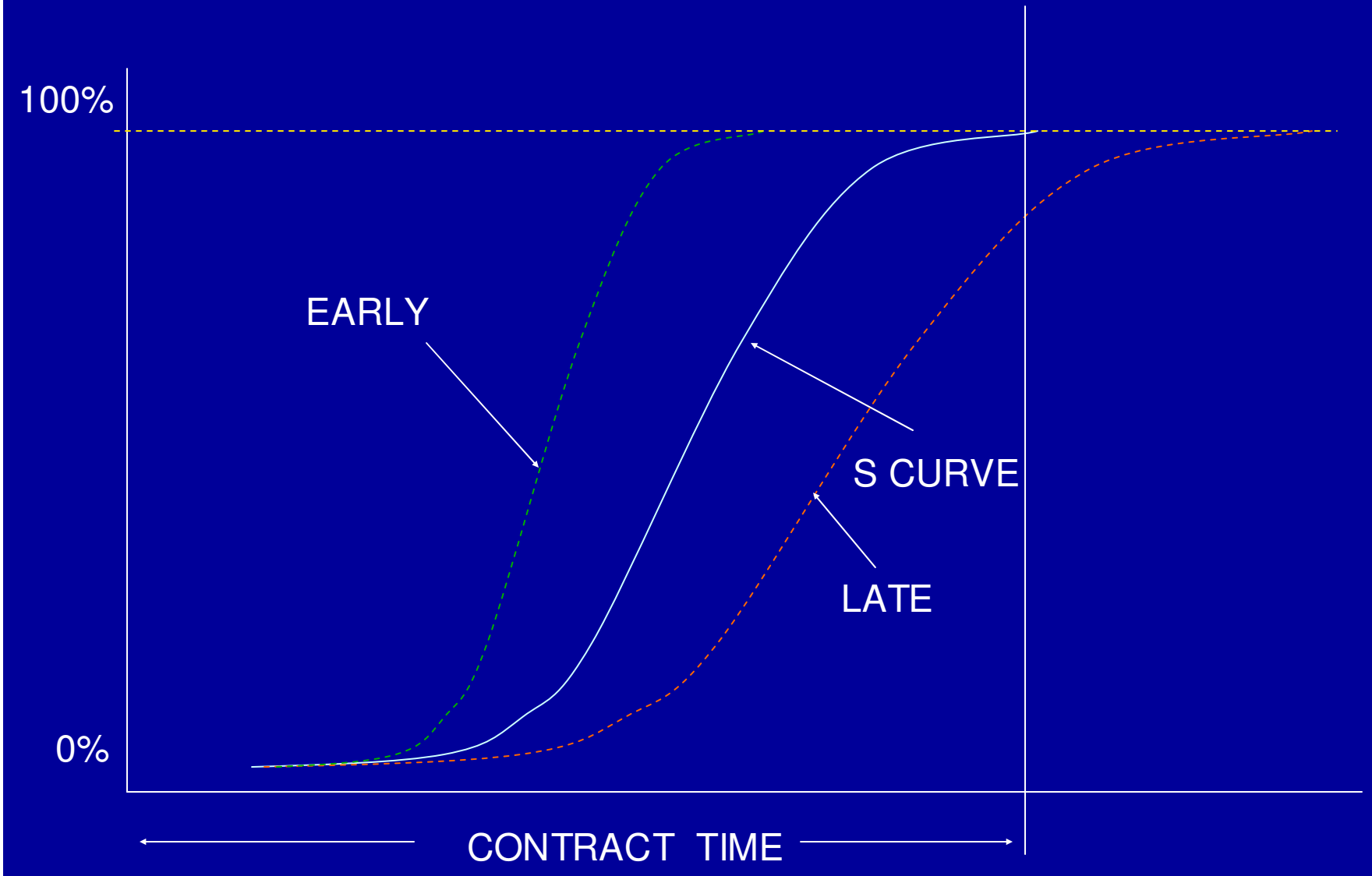
CONSTRUCTION ISSUES

- Payment
- Retainage
  - Generally 10%
- Project Control
  - Reporting Progress
    - Schedule
    - Cost
    - S - Curves

REPORTING PRODUCTIVITY



REPORTING PROGRESS S-CURVES



CONSTRUCTION ISSUES

- Substantial Completion / Beneficial Occupancy
- Punch List
- Acceptance and Final Payment

VI. CONSTRUCTION CONTRACTS

DEFINITIONS

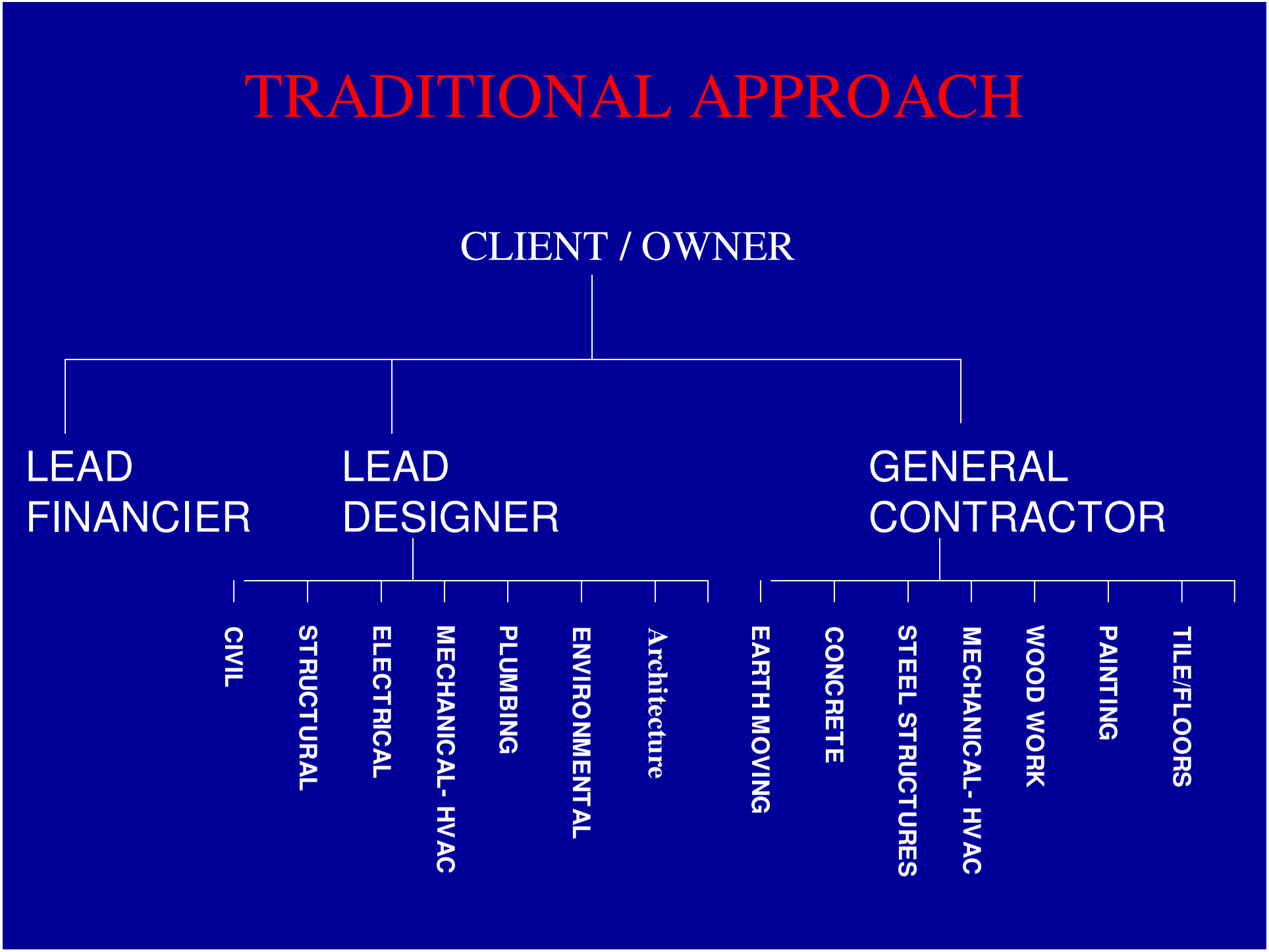
- Set of Promises
- Legally Enforceable Promises
  - Manages the Process
  - Controls the End Product
- Guarantees / Punishments / Fines

Possible Homework Assignment.

What are the implicit promises contained in a construction contract?

Time
Cost
and Quality

TRADITIONAL APPROACH



TRADITIONAL APPROACH

- Designers: Design products to work together;
- General Contractor: Construct products to work together.

Traditional Delivery Systems

- Competitively Bid Contract
  - Government Clients
    - Lump Sum
    - Unit Price
  - Objective Selection of: “Responsible Bidder”
- Negotiated / Cost Plus
  - Private Projects
    - Management Fee
  - More Subjective Selection
    - Not subject to audit

LUMP SUM CONTRACT

- Guaranteed Price
- Little Flexibility
- Applied to Simple Projects
- Changes are Expensive
- Confrontation between Owner-Contractor
- Little Control by the Owner
- Incentive to perform

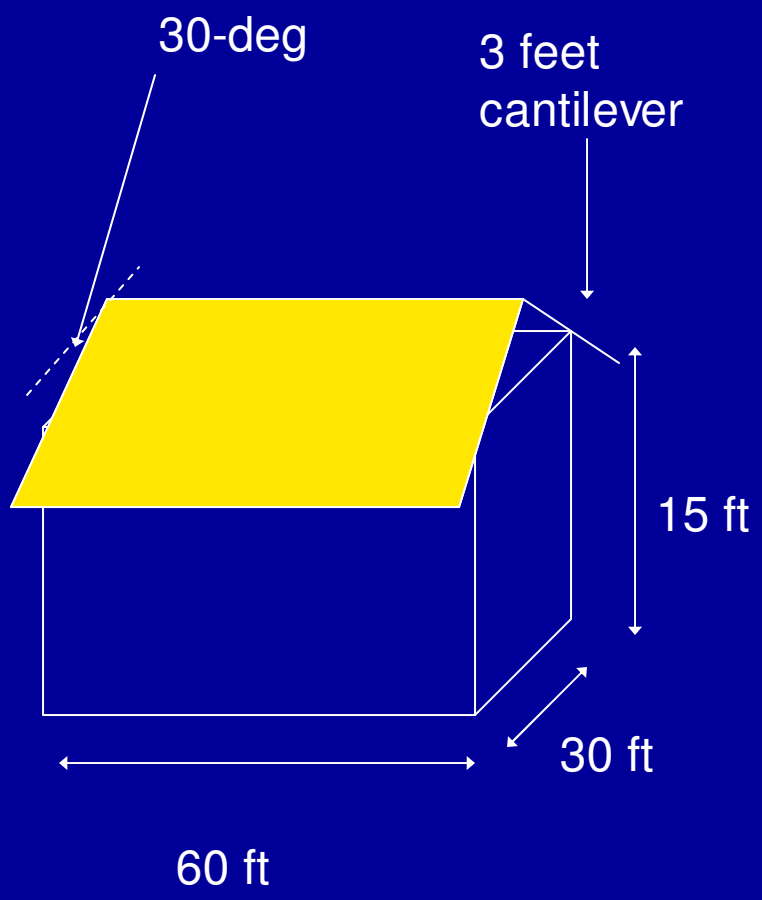
UNIT PRICE CONTRACT

- Guaranteed Unit Prices
- Some Flexibility
- More Complex Projects/ Based on Items of work
- Changes are easily implemented
- Less Confrontation Owner-Contractor
  - More quantities➔ more money
- More Control by the owner
- Less incentive to perform

MANAGEMENT FEE CONTRACT

- Award based on qualifications
- Price TBD - Just initial estimate
- Large Flexibility
- Very Complex Projects with considerable uncertainty
- Changes are easily implemented
- Contractor is Owner's agent
- Total Control by the Owner
- Little incentive to perform

For example,



UNIT PRICE CONTRACT

	Quantity	Price	Total
Exterior Walls	2,756.25	$ 5.00	$ 13,781.25
Roof	2,494.80	$ 10.00	$ 24,948.00
Floor	1,800.00	$ 4.00	$ 7,200.00
		Subtotal	$ 45,929.25
		Indirect	$ 4,592.93
			$ 50,522.18

LUMP SUM CONTRACT **$ 50,522**

x 1.1

$ 55,574

COST PLUS CONTRACT **$ 45,929**

x 1.1

$ 50,521

INNOVATIVE DELIVERY SYSTEMS

- Design and Build
  - Single Point Responsibility
  - Improved Communication (Design-Build)
  - Non- Fragmented approach
  - Constructability considerations during design
  - “Construction efficiency” driven design
  - “Fast-Track” approach

INNOVATIVE DELIVERY SYSTEMS

- Construction Management
  - Construction Manager plays role of client
  - Single Point Responsibility / Coordinator
  - Improved Communication (Design-Build)
  - Non- Fragmented approach
  - Constructability considerations during pre-design and design
  - “Construction efficiency” driven design
  - “Fast-Track” approach

INNOVATIVE DELIVERY SYSTEMS

- Design, Build, Finance and Operate
  - Preferred by certain Public Clients
  - Private developers in Public Services
  - Design / Build + Operator➔ Decreases Risk of Malfunction
  - Financial package based service revenue
  - Single Point Responsibility for the entire project
  - Improved Communication (Design-Construction- Operation)
  - Non- Fragmented approach
  - Constructability and Operational considerations during pre-design and design
  - “Construction and Operations efficiency” driven design
  - “Fast-Track” approach

IX. CASH FLOW

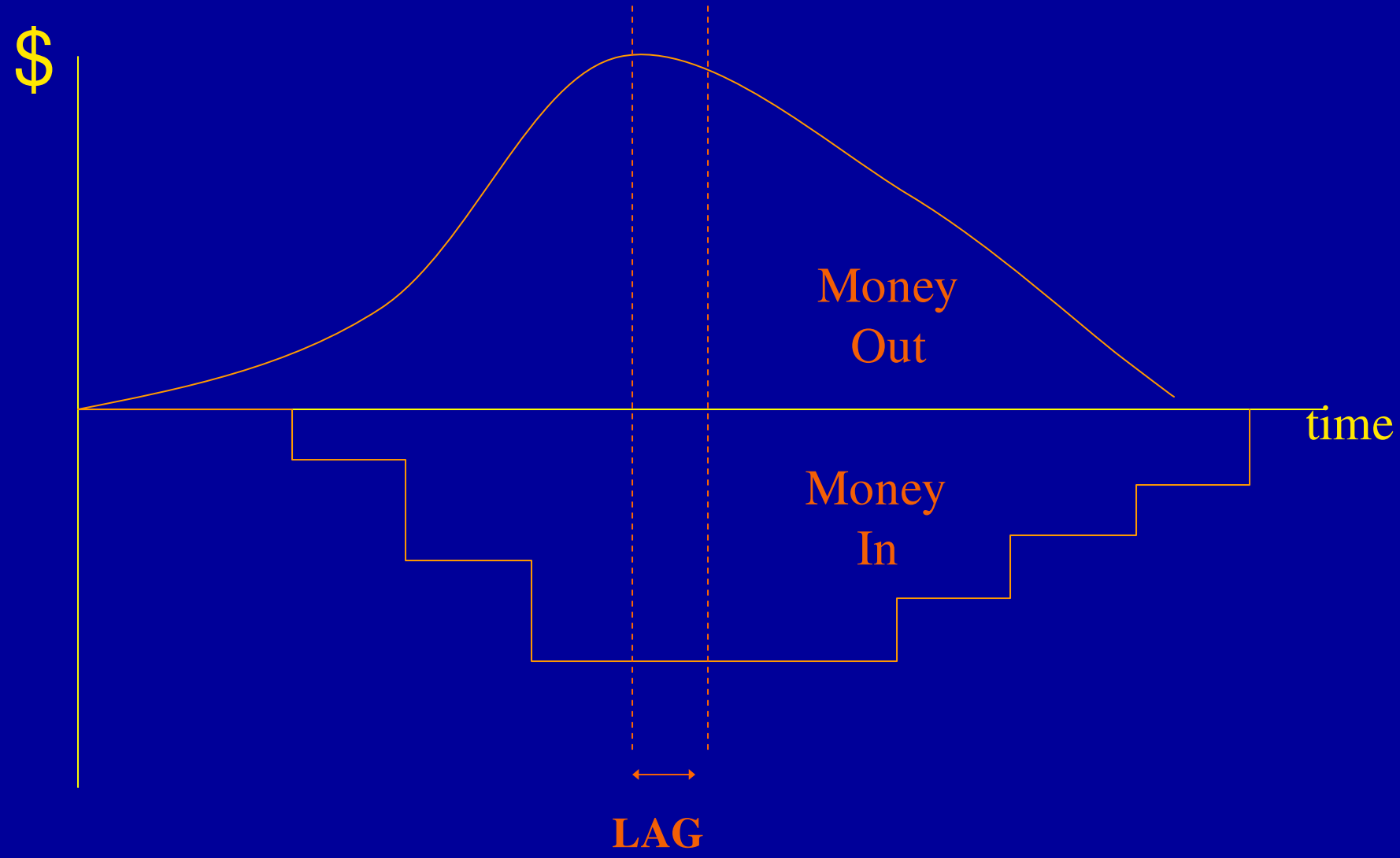
COSTS

- Cost of the land
- Cost of the permits
- Site preparation
- Professional fees
- Finishes, equipment
- Cost of Promotion and Sales (ads, commissions)
- Taxes
- Financial costs (interest payments)
- Direct Construction Costs
  - High Uncertainty
  - May be a low share of total costs

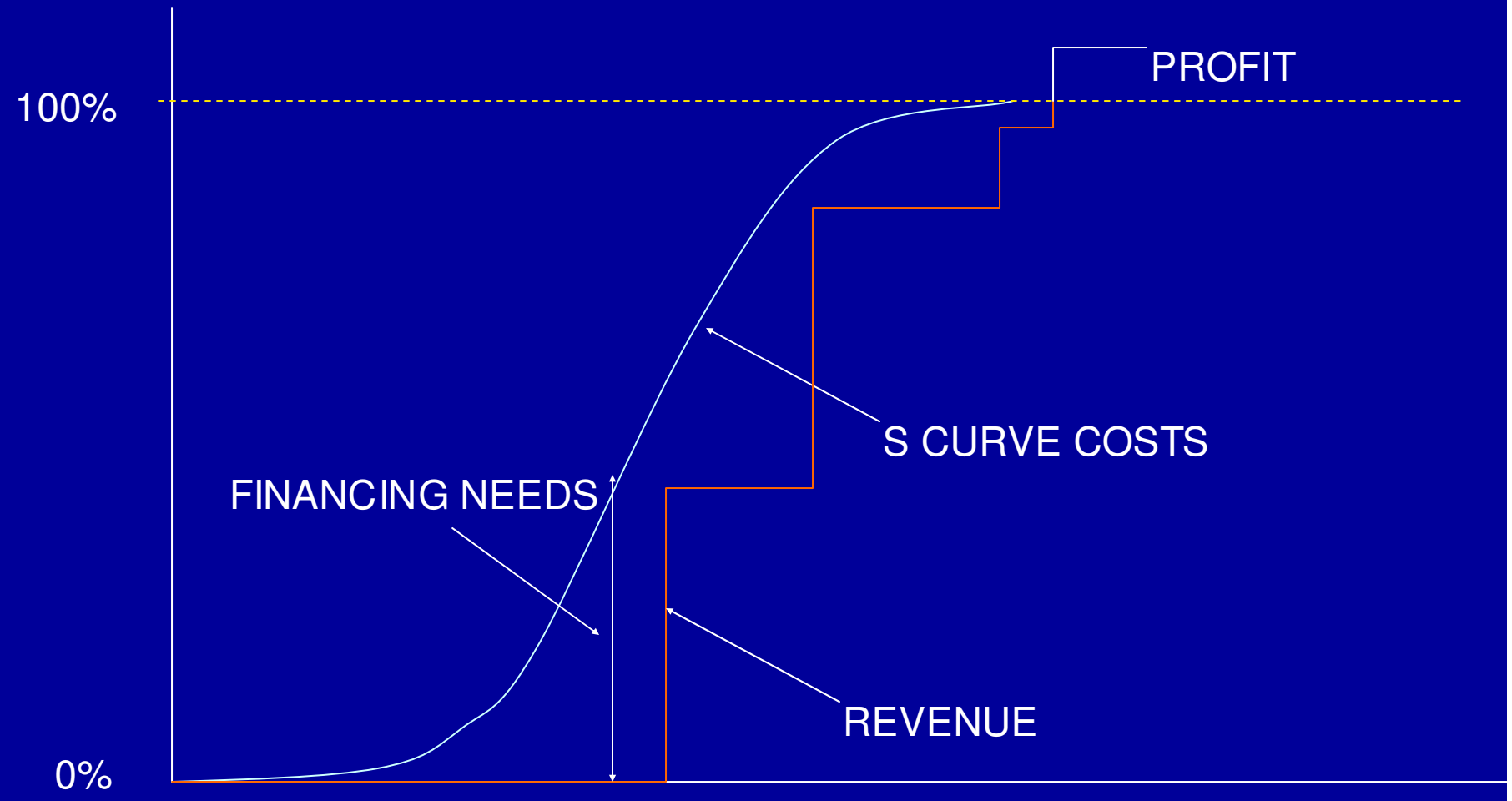
REVENUE

- Regular Pay Requests
- Sales
- Interest

MONEY OUT and MONEY IN



FINANCING NEEDS



RATE OF RETURN

- Bank Interest Rates?
  - Active?
  - Passive?
- Risk Free Rate (RFR)
- Risk Premium (RP)
- Inflation (I)
- Risk Adjusted Rate (RAR)

Possible Homework Assignment.

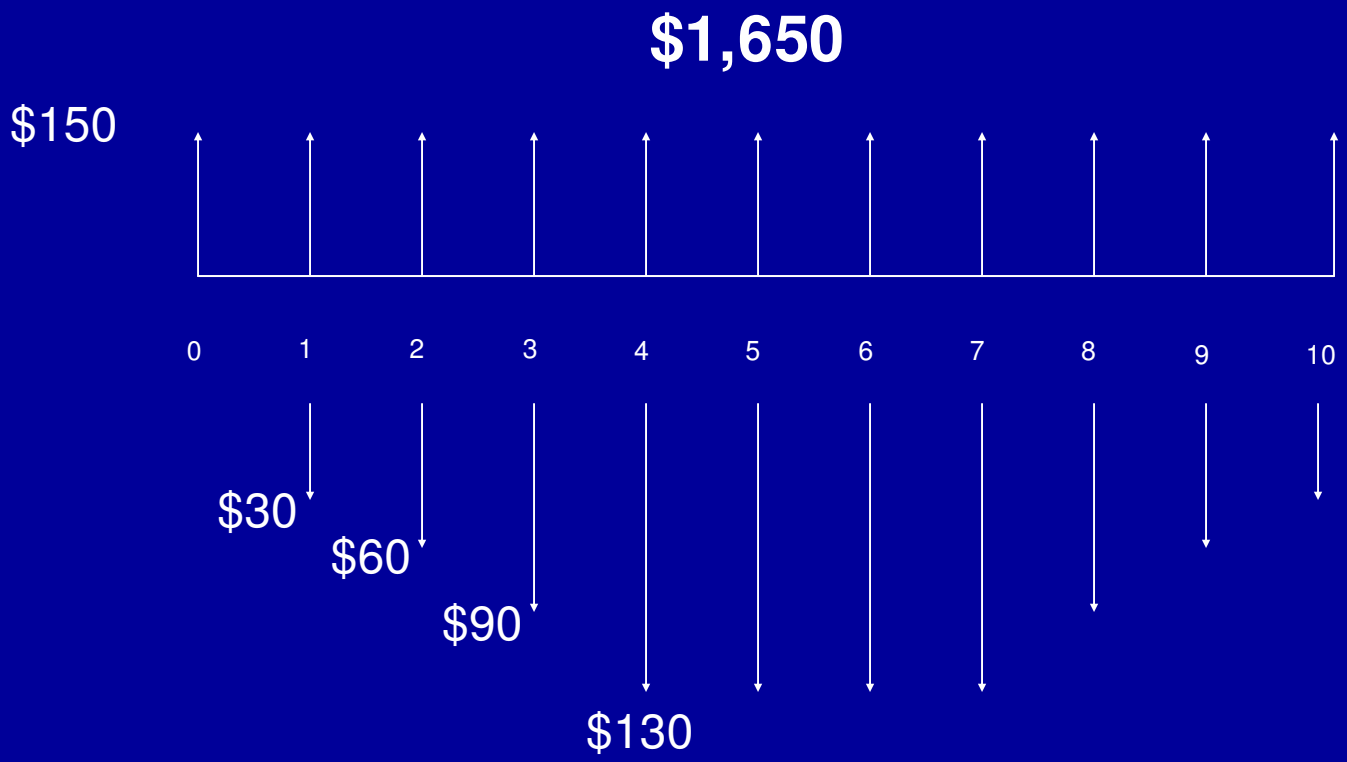
Visit a local bank and discuss rates for construction.

In developing countries rates of 18 to 35% are common for certain projects. How would you handle this type of situation?

DISCOUNT RATE

- Cost of the Money
- Future Value
- Present Value
- Internal Rate of Return (IRR)
- Net Present Value (NPV)

CASH FLOW ANALYSIS



X. FUNDING

SOURCES OF FUNDS

- Private Projects
  - Banks and Other Lenders
  - Investors (venture capital, etc)
- Public Projects
  - Public Budget
  - DBFO

BANKS- LENDERS

- Guarantees/ Incentives / Fines
- Supervision capacity of the project
- Technical viability and certainty
- Commercial viability
- Financial viability
- Regulatory certainty / Rules of the Game
- Use of Trust Funds
- Variable Interest Rates

INVESTORS

- Sometimes the Constructor is the investor
- Higher Risk Perception
- Expected Rate of Return (ROR) increases
- End Users sometimes are Investors (e.g., Building projects)
- Control capacity of the project
- Technical Viability and Certainty
- Commercial Viability
- Financial Viability
- Regulatory Certainty/ Rules of the Game
- Use of Trust Funds

PUBLIC PROJECTS

- Taxes
- Bond Issuance
- Fiscal Year
- Rigid Financing
- Slow to admit and implement changes

References:

1. **Gould F., "Managing the Construction Process", 2nd Edition, Prentice Hall, New Jersey, 2001;**

2. **Fisk E., "Construction Project Administration", 6th Edition, Prentice hall, New Jersey, 2000;**