

Project Organization

System and Project Management

1.040/1.401J

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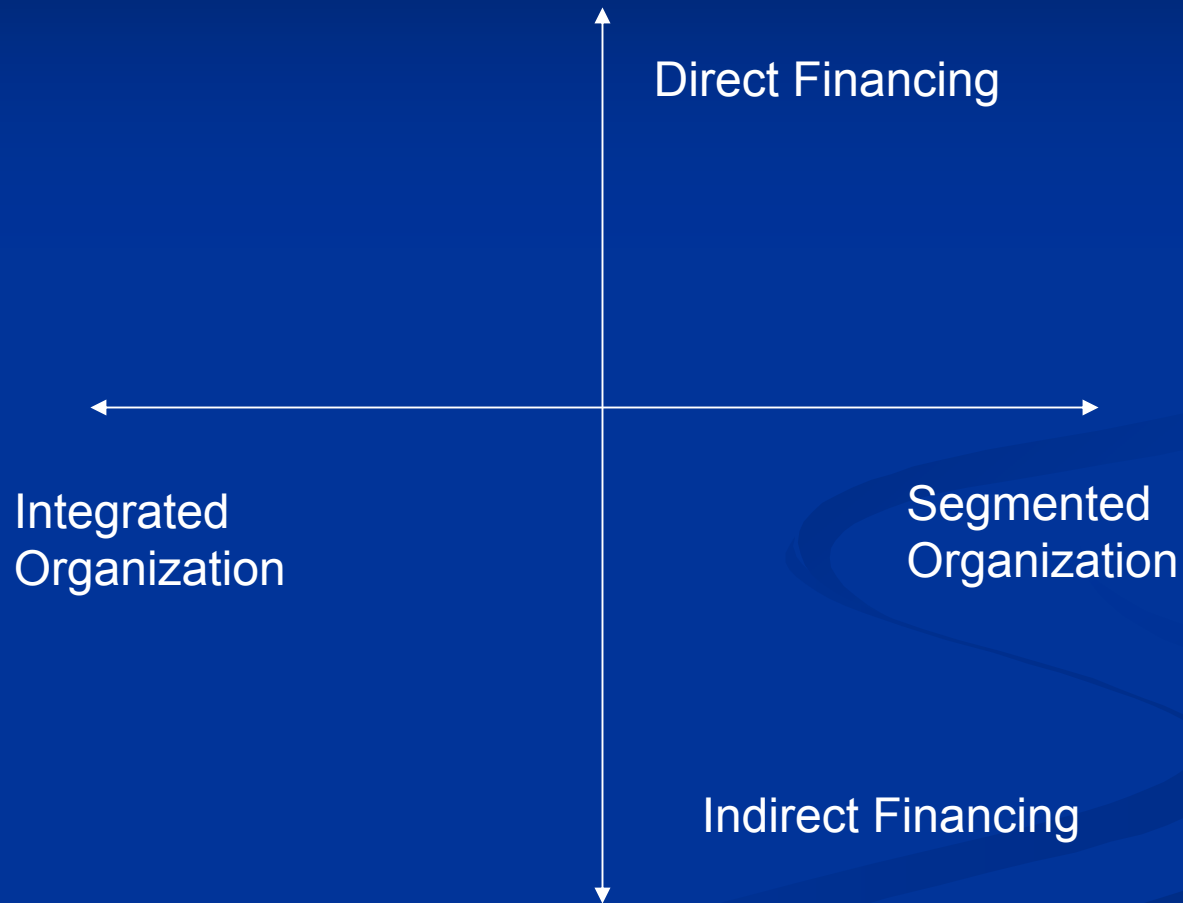
Project Organization and Contracting

- Major components of contract
 - Project Delivery Method (Organizational relationships)
 - Traditional (GC)? Design-build? Turnkey?
 - Payment Scheme
 - Lumpsum? Cost plus %/fixed fee? GMP?
 - Award Mechanism
 - Bidded? Negotiated?
- Relatively sparse space (high covariance)

Project Organization

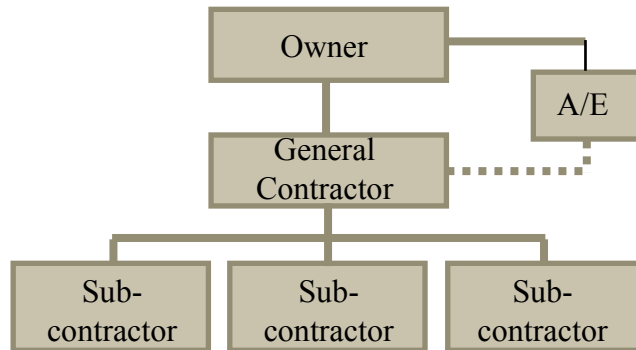
- Project Delivery Systems (most common)
 - Traditional
 - Pure Construction Management
 - Construction Management at risk
 - Design / Build
- Summary

Broad Delivery Method Space

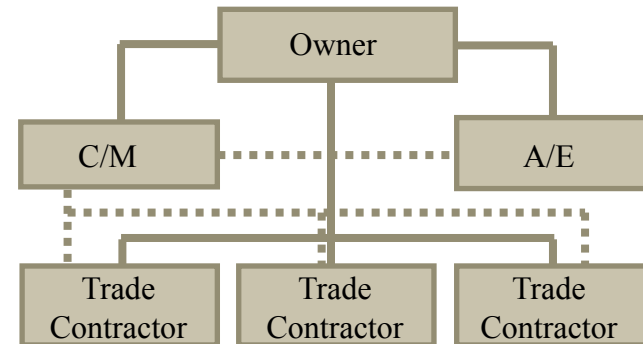


Most Common Delivery Methods

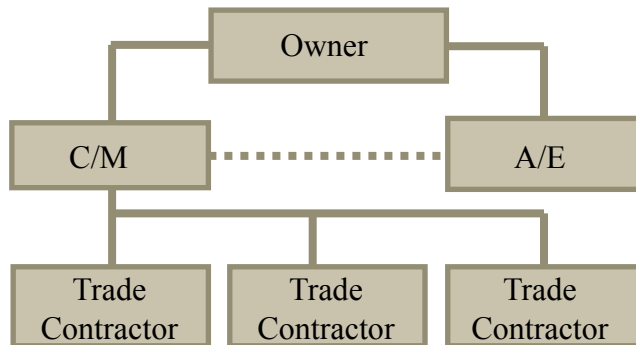
TRADITIONAL DESIGN-BID-BUILD



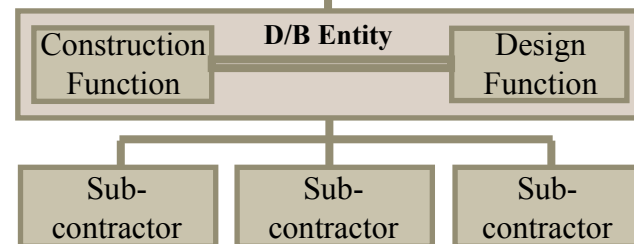
PURE OR AGENCY CONSTRUCTION MANAGEMENT



CONSTRUCTION MANAGEMENT AT RISK



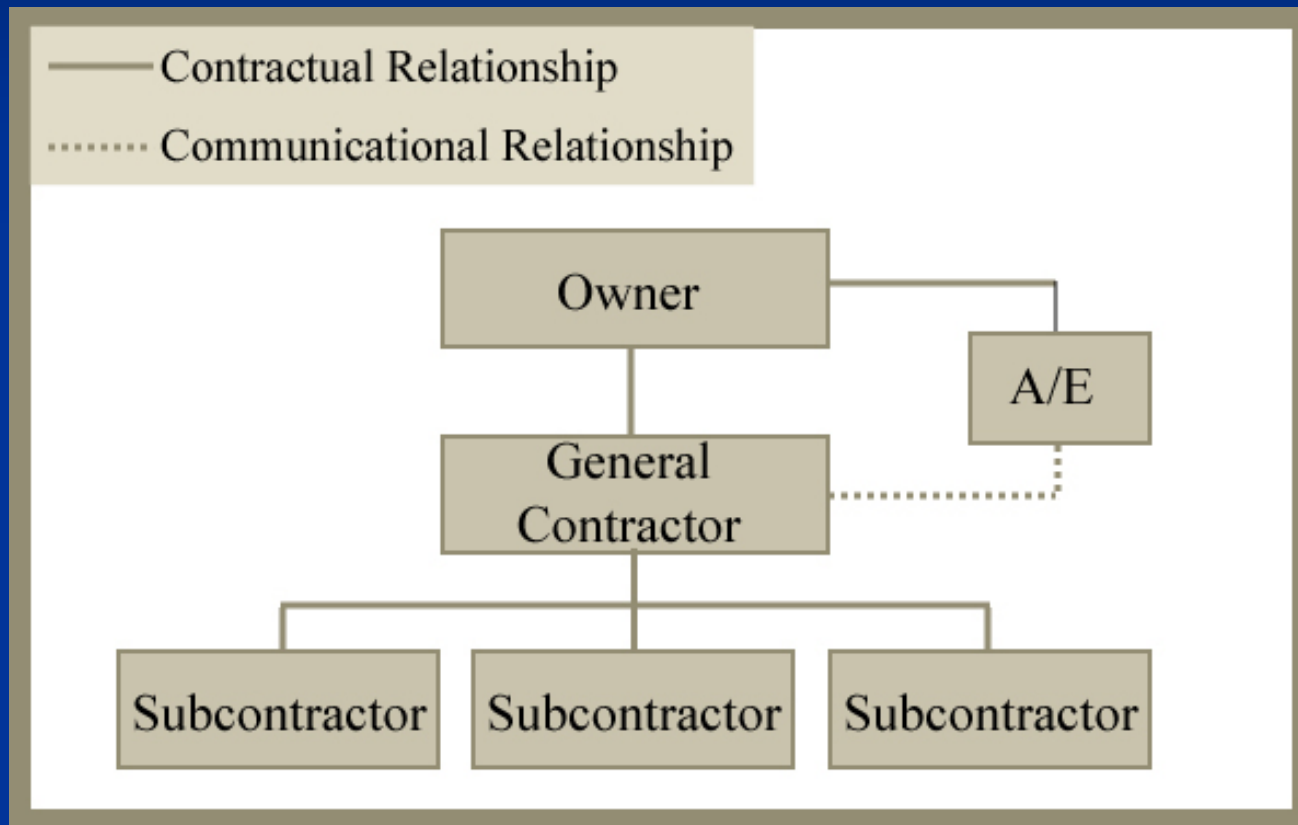
Owner



A Bit of History (Western World)

- Antiquity, Middle Ages: Design build
- 15th century
 - Greater Distinction between architect & trades
 - Greater attention to design
- 18th century: Century of engineering
 - General contractor in charge of trades, little subcontractors
- Before 1930s: mixture of methods
 - Most design-build, some with alternative financing (94%)
- Post WWII: Emergence of more specialized needs, subcontracting
- 1960s, 1970s: More complicated structures, emergence of CM, constructability needs

Traditional Delivery Method



How To: Traditional

- Hire a design professional in charge of the preparation of the design and contract documents
- Competitive bid or negotiation with contractors *after* design complete
- Contractor in charge of the delivery of the completed project (may decide to subcontract)
- The contractor is the only one responsible of the execution of the work

Traditional Delivery Method

- Sequential Construction Process
- Collaborative Relationship between A/E (Chosen on Qualification Basis) and Owner
- Different Participants' Interests:
 - Owner: Quality and Value Product, Delivery Schedule, Site Safety
 - Contractor: Profit, Construction Time, Relationships, Reputation
 - A/E: Profit, Aesthetics, Relationships, Quality, Recognition
- Lump Bids Commonly Adopted, Resulting in Adversarial Relationship between the Owner and the Contractor

General Contractor Responsibilities

- Still responsible for a large fraction of jobs
 - Particularly public jobs with bidding
- For larger job, GC doesn't do much of work (sometimes <10%)
 - Sometimes verge up against CMs
- Division of responsibility for problems (Different teams)
 - Owner must mediate fights between contractor, designer
- Contractor designs temporary structures
 - Engineer needs to stamp (often *not designer* architect)

Subcontractors

- GC manages most subcontractors
 - Exceptions: Tenant subcontractors
 - Overhead at each level
 - Handles submittals
 - Get bids from subcontractors (bid shopping a danger; no formal guarantee of award of contract)
 - Bidding here typical (commodity)
 - Can be large number of subcontractors (I15 200)
 - Responsible for failure
 - Shop drawings typically produced by subcontractors
 - E.g. engineer consultants
 - Signed off on by architect to say that meets design needs
 - Problem: Things can fall through the cracks

Subcontractors 2

- Motivations
 - No In-house ability
 - GC overstretched
 - GC lacks familiarity with local conditions
 - Need to get warrantees
 - Laws and regulations (assign subs to contractor)
 - Due to specialization, more efficient, cheaper
- Sometimes GC provides equipment to subs
- Tensions (e.g. how quickly, many subs on site)
- Subcontractor management very important for productivity
- Sometime owners or GC put umbrella insurance over
- Required to have bonding by owner (so don't go after)

Role of Architect/Engineer

- Typically negotiated contract
 - Recruited on service rather than commodity basis
 - Financial stability, other factors critical
 - Sometimes have design competition
 - Don't want to push too low:
 - Poor design
 - Poor personnel
 - No time for double-check
- Contrast
 - Price of design has small impact on overall price
 - Quality of design has big impact on overall price

Role of Architect/Engineer II

- Sometimes do own value engineering (dangerous)
- If estimates off, may be required to redo design at own expense
- Carry errors and omissions experience
- Limited participation in construction process
 - Typically “observes” constructions
 - Avoid official assumption of inspection guarantees
 - Review shop drawings – with disclaimers
- Avoids close communication with GC
- Do not want to direct construction methods
 - May put suggestion in contract documents

Advantages

- Well known method (courts, companies)
- Flexibility during design (vs. design-build)
- Cost defined early (when bidding)
- Good contractual protection for the owner
- Open bidding procedure very easy
- Owner not too involved in the construction process
- Fiduciary relationship between A/E & owner
- Good if uncertainty primarily in design

Disadvantages

- Design not reviewed before construction
 - Miss opportunities for major time/cost savings
 - May yield changes due to constructability probs
- Sequential and linear process preventing from overlapping of tasks and money saving
- Few interactions among the participants
- Too rushed to consider multiple alternatives
- Construction can't start until design is complete

Disadvantages II

- Innovative financing difficulty
- Leads to very conservative design strategies
- Difficult for complex projects

Changes Difficult

- Owner can be at contractor's mercy
 - Role of on-call contractor
- Design Fixed after construction starts
- High pressure if have
 - Bidded
 - Lumpsum
- Sometimes contractors seek changes to make \$

Project Organization

✓ Project Delivery Systems (most common)

✓ Traditional

➤ Pure Construction Management

■ Construction Management at risk

■ Design / Build

■ Summary

How To: Construction Management

- The Owner hires both a design firm and a construction management firm *before* the beginning of the construction of the project
- Typically CM selected based on quality
- Many variations are possible in the delivery method depending mostly on when the management team is hired and its skills

General Characteristics

- Started in late 1960s
 - World trade center
 - Madison Square Garden
- May recommend A/E
- Check billings
- Specific CM firms tend to be quite sophisticated
 - Warning: Many GCs claim CMs
 - “design CM”, “construction CM” “owner CM”

Tasks

- Preconstruction
 - Constructability, value eng, estimation, alternatives, schedule, financing, manage designer, early procurement
- Field supervision
 - QA, Targets met, invoice checking, coordinate work of contractors, M&E, change orders, payments, claims, inspections for design requirements, sometimes safety

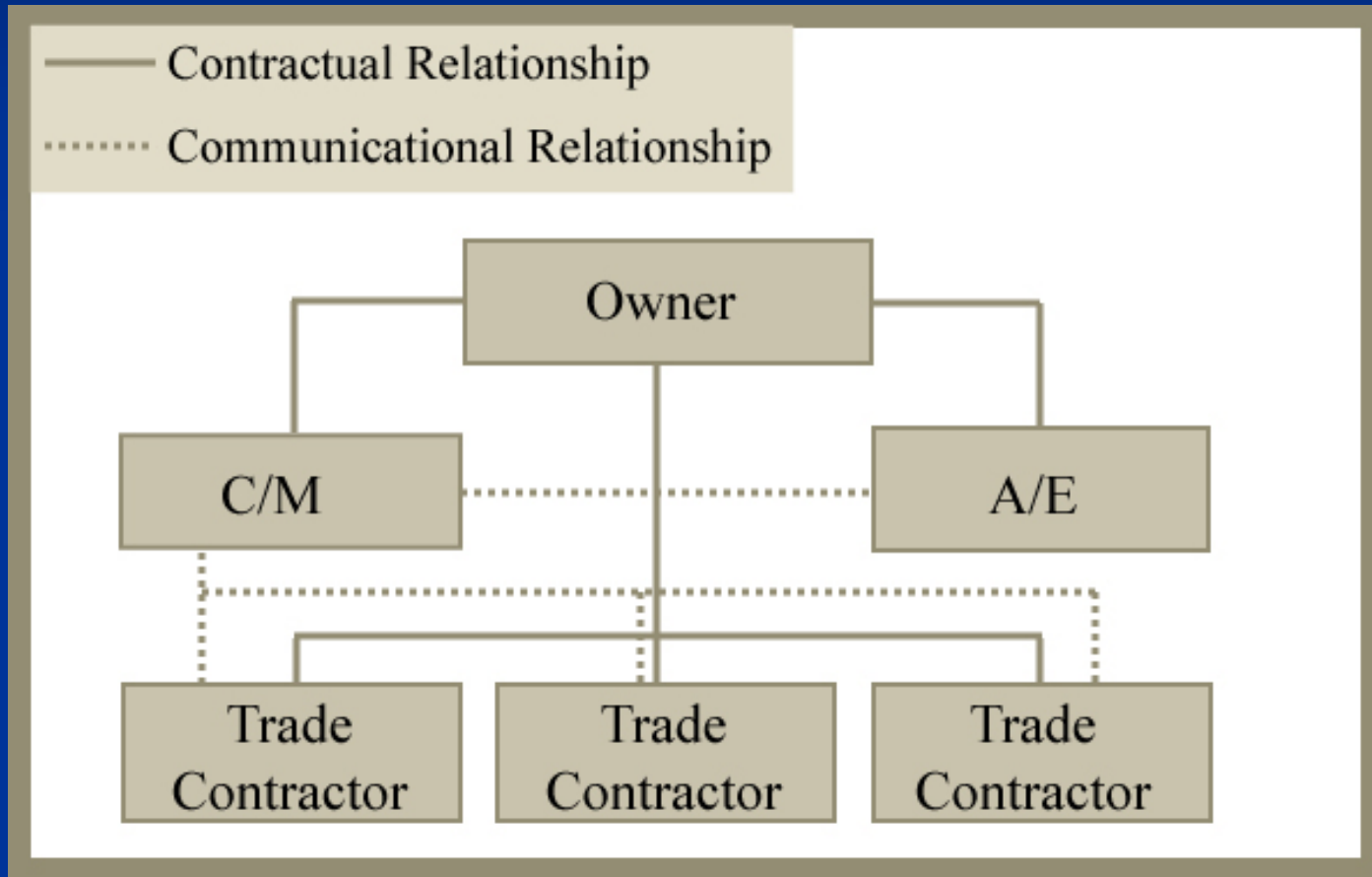
CM General Advantages

- Involvement in design allows better
 - Knowledge of price early on
 - Eliminates risks in design before bids
 - Constructability, value engineer. reasoning from start
 - Working construction constraints into design plans
- Allows flexibility in the Schedule (Fast tracking)
- Can select CM based on quality
- Really familiar with plans before price/get bids

CM General Disadvantages

- Don't know total cost when start construction
- Potential conflicts with other parties
 - Designer
 - Subcontractors
 - (Where applicable) GC

Pure (“Agency”) Construction Management



Pure Construction Management

- Great Flexibility in the Schedule and for Changes
- Market Competition for subcontracts
- Fiduciary Relationship with the Contractor
- Small Financial Risks of PCM and High Risk of Loss of Reputation
- PCM Generally Paid a Fixed Fee (professional)
- Take over work of designer, GC, owner
- PCM as Facilitator/Mediator in Conflicts

Advantages Pure CM

- Great Flexibility for Changes
- CM more objective, less partial
- Less conflict between owner and CM
- Small Financial Risks of PCM
- Have both
 - Cost competition (for subcontractors)
 - Often 5-8% savings for dealing directly with subs
 - Fiduciary relationship with CM
- One common reference point: The CM
- Owner can get rid of particular subcontractor
- Lessens owner's responsibilities

Disadvantages Pure CM

- Lower incentive for CM to reduce price, time
- Owner alone takes risk on cost of project
 - No guarantee from CM!
- Participants must all be cooperative and well communicating
- High Risk of Loss of Reputation
- All parties must be committed from the beginning

Lessens Owner's Responsibility

- E.g.
 - Project control
 - Job meetings
 - Management meetings
 - Reports (operational and annual)
 - Administrative tasks
 - Budgets
 - Drawing approval
 - Oversight
 - Quality assurance

Central Artery / Big Dig

- Most complex highway project in American history
- The project consist in building 161 lane miles of urban highway - about half underground in a 7.5-mile corridor
- Planning for the Central Artery/Tunnel Project began in 1982
- Congress approved funding and the project's basic scope in April 1987

Central Artery / Big Dig

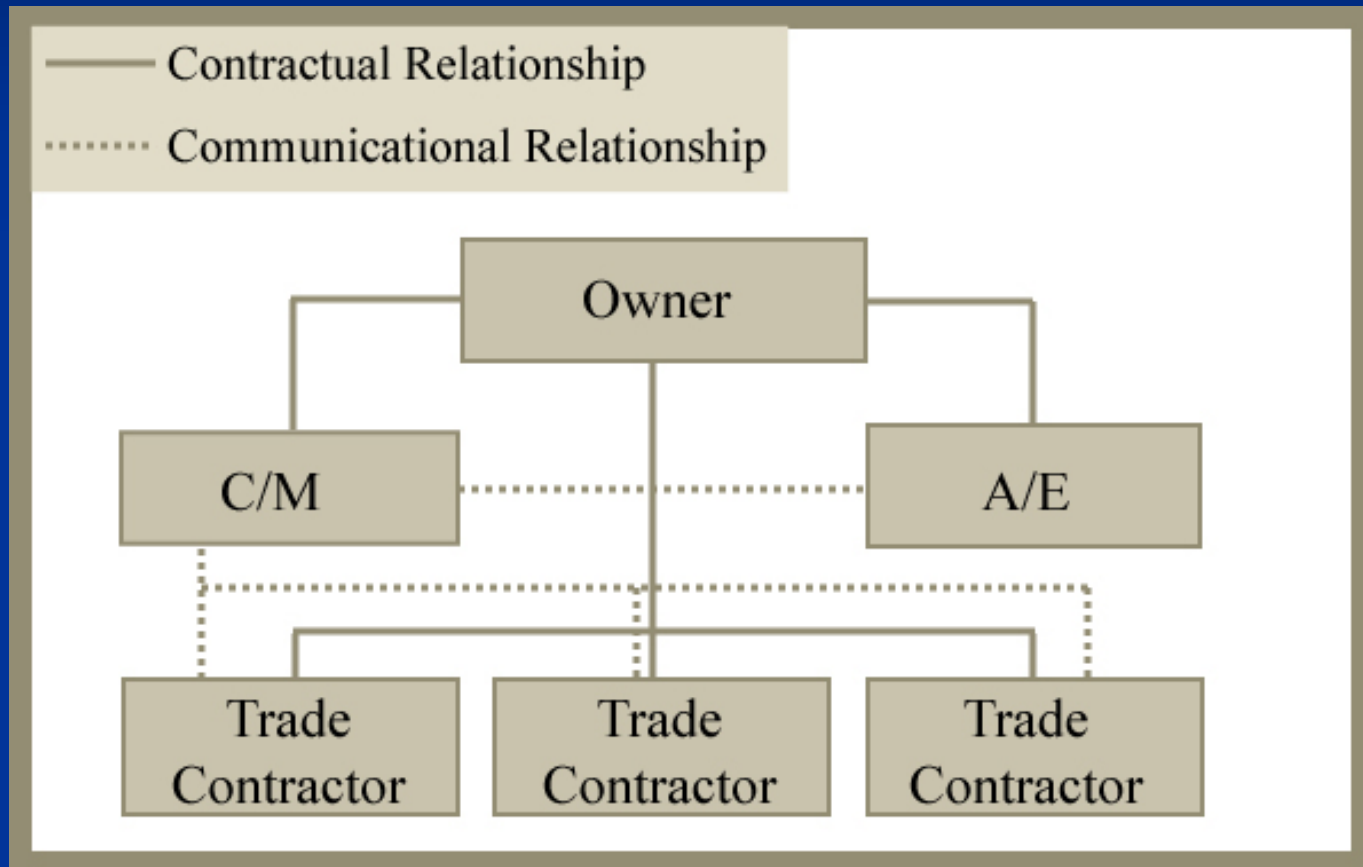
For the Fort point channel:

- Notice to proceed was granted to Modern Continental on March 7 1997
- Expected date of completion: March 13 2002
- Estimated cost: 301,377,284.10 \$
- Modified estimated cost: 403,929,276\$
- Modified date to completion: December 2004
- Engineers + consultants = 100
- Workers on the site = 800
- Priorities = schedule- cost- technical

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Construction Management at Risk



Construction Management at Risk

- CM *usually* Guaranteeing Maximum Price: GMP to give the owner security that the project will be built within budget
 - Often set at 95% of design
 - This is a big difference from pure CM
 - Fee typically 10-15%
- Reduced Owner Risk
- Risk-wise, $\frac{1}{2}$ between the DBB and the PCM System (VERY similar to GC hired early)
- Contractual Relationships betw. CM&subs
- Performance bonds typical

Advantages CM at Risk

- Reduced Owner's Risk
- CM at risk usually goes with Guaranteed Maximum Price (GMP)
- Contractual Relationships between CM and Trade Contractors

Disadvantages CM at Risk

- The GMP is a defined price for an undefined product
- Bad during design: Design pressure
- Tension
 - CM hired early: more price risk
 - CM hired late: less value during design
- CM is no longer impartial (may argue against changes b/c of own interest)
- Risk of adversarial relationship
- The contract can be hard to enforce

Albert and Barrie Zesiger Sports and Fitness Center

- Groundbreaking : October 2000
- Occupancy : 2002
- Designed by the architectural firms of Roche & Dinkeloo and Sasaki Associates
- Construction: Turner Construction Co.
- Cost : \$45 million
- Olympic-class 50-meter pool
- An 11,000-square-foot fitness center

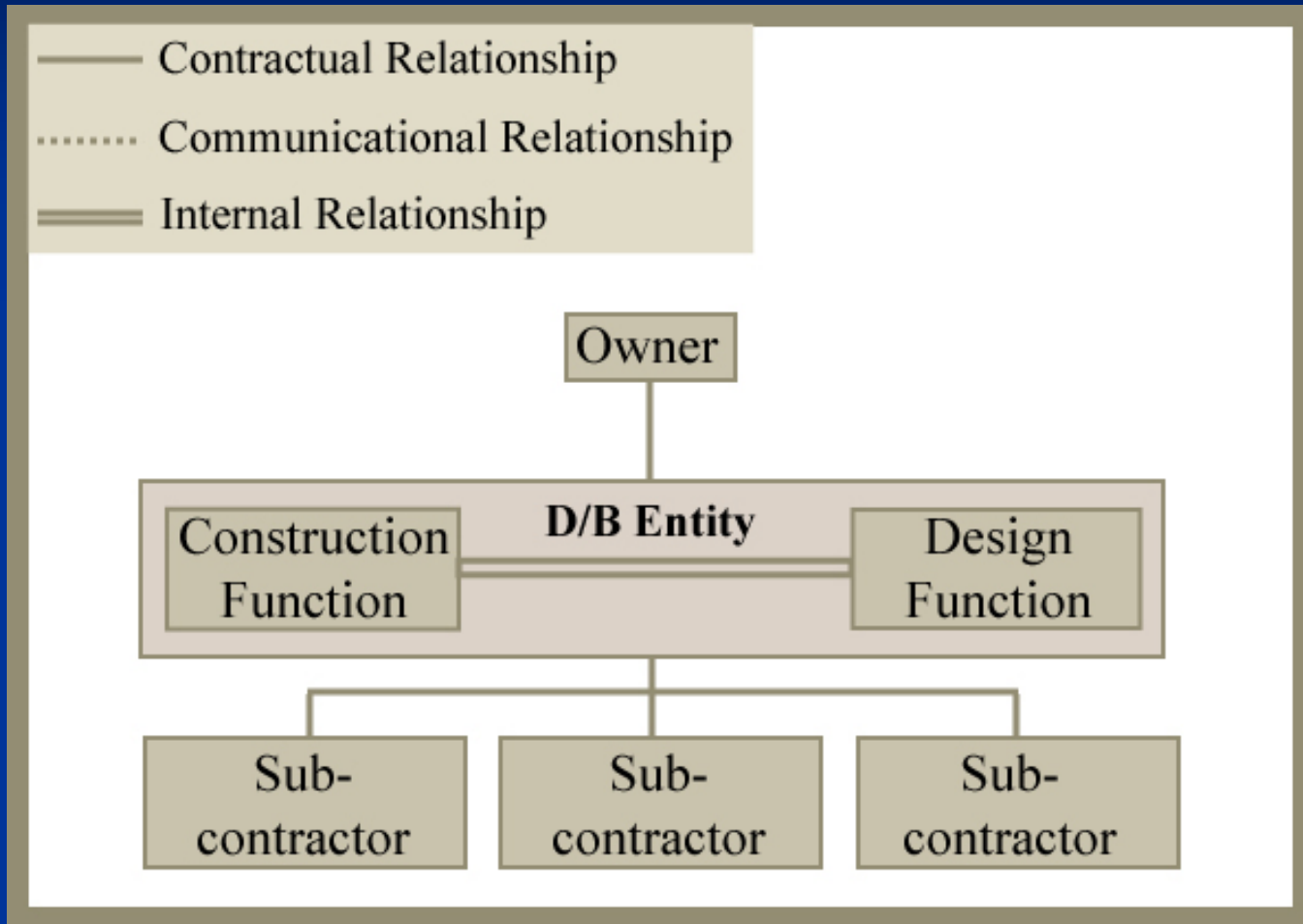
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How To: Design / Build

- The Owner
 - Develops 20-30% design
 - Hires a design/build firm that will complete both design and construction
- This firm can be a design/build firm but also a joint-venture firm for this specific project
- Possibility for the design/build company to hire subcontractors
- Solicit work with RFP (honorarium, phased)
- Can be good for complex projects – but need phased design to shield parties from risk

Design-Build



Design-Build

- One Contractual Team Responsible for Design and Construction Function
- Owners with more Emphasis on Schedule Despite Less Control and More Uncertainty of Cost
- Loss of Control Over Design and Flexibility in Changes
- Owner with Enough Knowledge about Design and Construction to Establish the Initial Parameters, Review Proposals and Monitor the Process

Back to the Future...

- Dominant method early in US history
- Recent drivers
 - Downsizing of US corporations (outsourcing design)
 - Desire for single source of responsibility
 - Time pressure
 - Shortcomings of tightly defined architect role
 - Constructability issues
 - Limited design oversight

Bridge Designer/Engineer

- Serves as bridge between
 - Owner
 - Design-build team
- Preliminary design before DB team hired
 - Maybe up to 30% design
- Monitors development of design and construction
 - Fiduciary with owner

Advantages DB

- Allows Fast Tracking
- May be good for some complex projects
 - Close coordination within team
 - Institutional knowledge build up
- Single source of accountability
- Good interactions among participants
- Designer/contractor conflicts not exposed to owner
- Easier incorporation of changes caused by field conditions

Disadvantages DB

- Lack of fiduciary relationship with designer
 - Risk of sacrificing design quality to protect profit
- Pricing isn't possible at the beginning
- Can be bad for complicated projects
 - Very important for owner to be closely involved to specify important aspects of design up-front
- Can lead to delay of construction steps for design completion
- Demands sophisticated owner (construction, quality, oversight of submittals, negotiation,...)

Design-Build Disadvantages II

- Fewer checks and balances
 - Changes in contract
 - Problems may be hidden
 - May take a direction that the owner does not really want
 - Design-build firm can give high quote for changes
- Fast tracked: Change can require
 - Rework
 - Iteration
- Owner responsible for Quality assurance
- Package: Can't get rid of individual components of team

Public Use Challenges

- Regulatory hurdles
 - Federal use allowed
 - Federal Acquisition Reform Act of 1996 allowed
 - Many states still do not allow
- Major opposition from
 - Architectural lobby
 - Unions

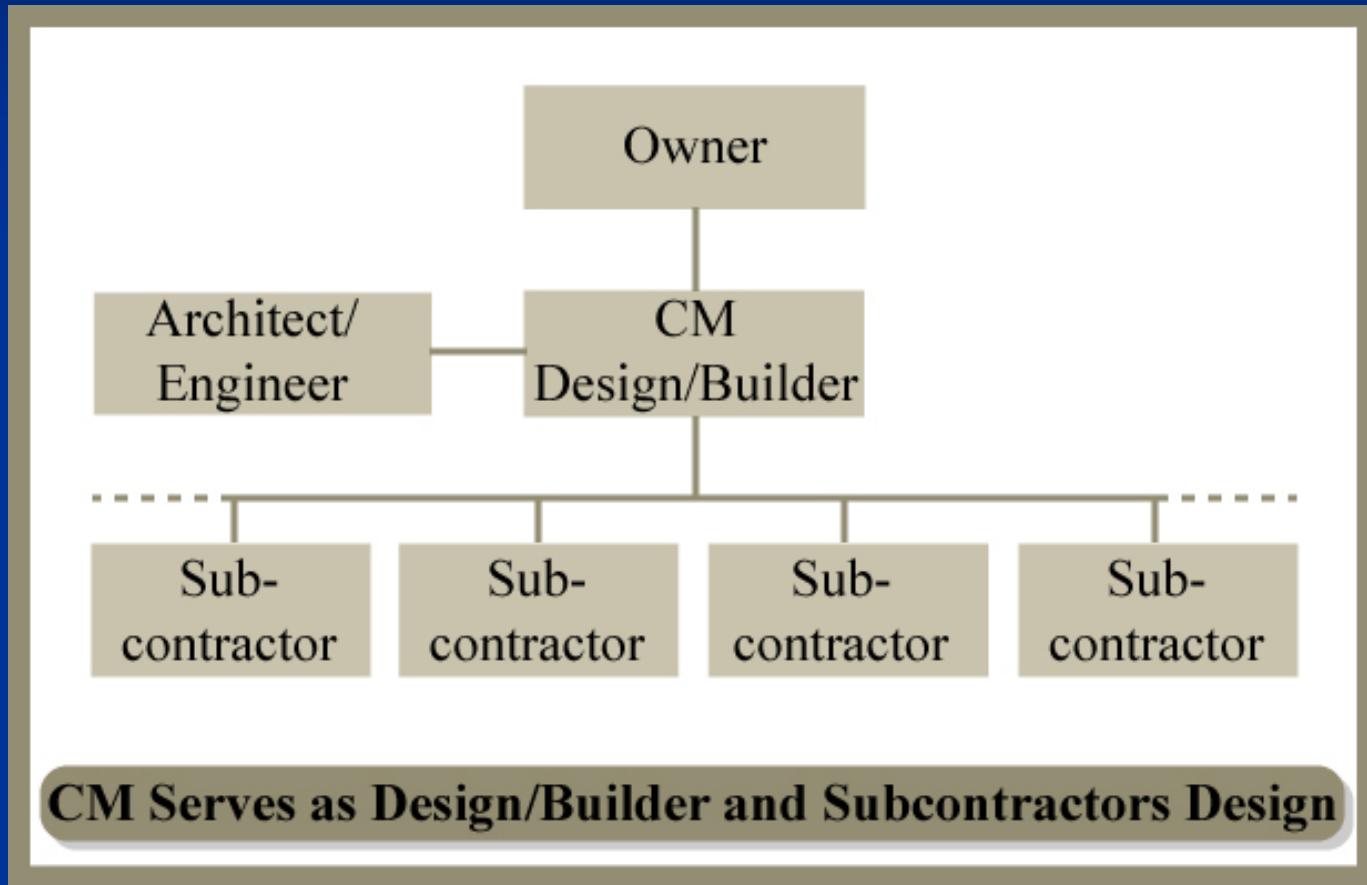
Pricing and Selection

- More comprehensive selection process typical
 - Design/Price/Schedule/Team
 - Design competitions undertaken
- Timing tension for when to recruit DB firm
 - Earlier recruitment:
 - Greater risk – and Risk premium
 - Later recruit: Less knowledge up front
 - Uncertainty early
 - Limit creativity (closer to GC)
- Often have segmented pricing (cost-plus design, fixed price or GMP build)

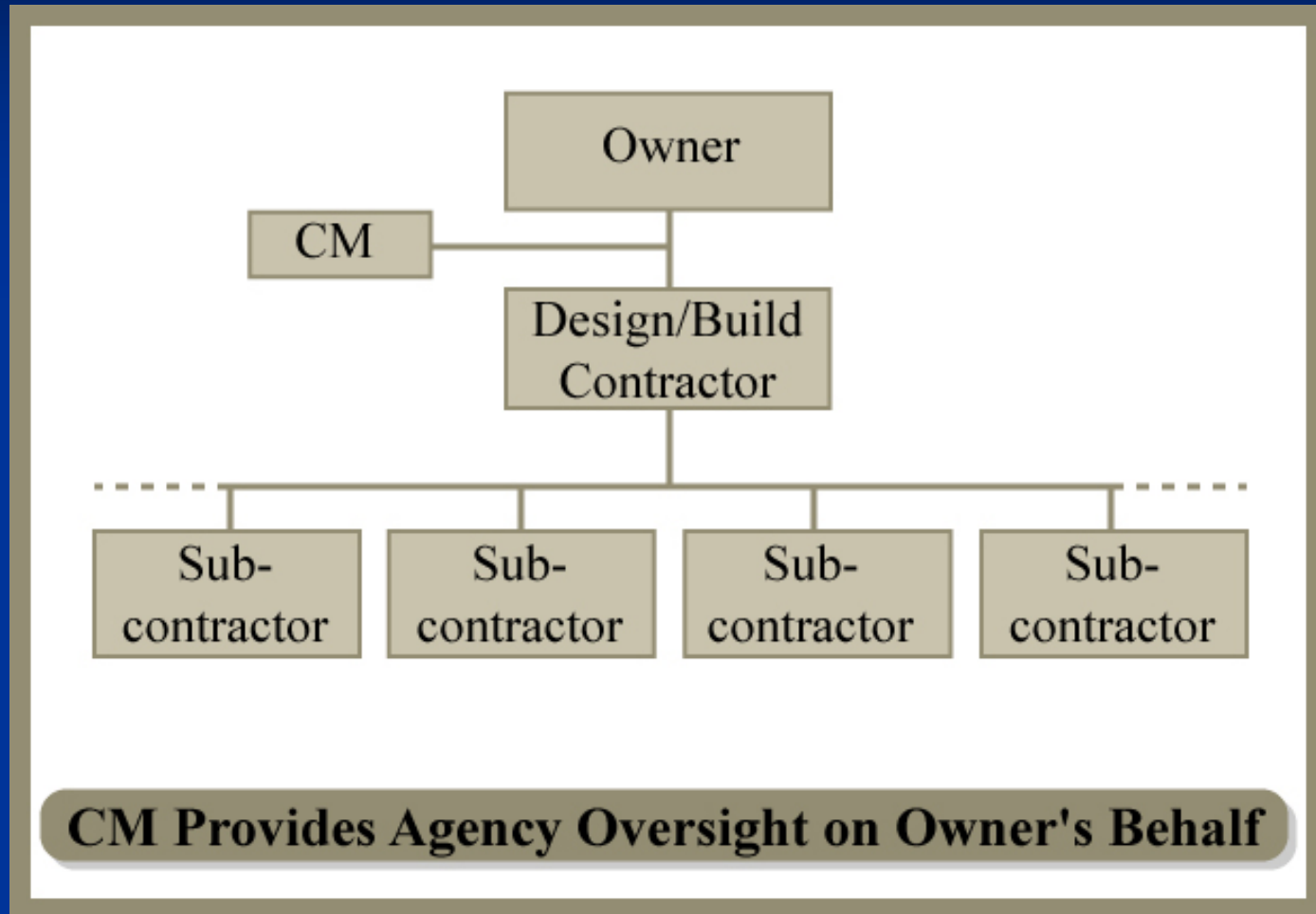
Example Design-Build: I15

- Originally slated as DBB, but made DB to fast-track
 - Hard deadline due to Salt Lake City Olympic Games
- US DOT as owner agency
- Bidded project (with rights to use unsuccessful)
 - Unsuccessful bidders became subcontractors
- Reputation foremost
 - 200 Subcontractors
 - Few reviews

Modified CM Design/Build: Design Subcontracted



CM Oversight Design/Build



Other Delivery Methods

- Multiple Primes
 - Allows owner time to raise money
- Turnkey (Like DB but Contractor Financed)
 - Very common in residential housing
- Design-Build-Operate-Transfer (BOT)
 - Long-term financing (vs. DBO)
 - Can compete on size, transfer time, etc.
 - Have different guarantees needed to entice
- Owner/Agent (Owner does part of design)

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Type of Relationships Among Participants

	Owner-A/E	Owner-Contr.	A/E-Contr.	Owner-CM	CM-A/E	CM-Contr.
DBB	K	K	C	—	—	—
PCM	K	K	—	K	C	C
CMR	K	—	—	K	C	K
D/B	K*		I	—	—	—

I - Internal Relationship

K - Contractual Relationship

C - Communicational Relationship

*** - Contractual Relationship between the Owner and the D/B Team**

Advantages of the 3 Most Common Delivery Methods

	Traditional Approach	Design Build	Construction Management
Type of contracts			
Advantages			
Legal and contractual precedent	X		
Cost determined before contract commitment	X		
Fast-tracked construction allowed		X	X
Minimum owner involvement	X	X	
Cost benefit from competition	X		X
Negotiation with quality contractor for unique expertise		X	X
Allow adjustment to new conditions without changing agreement		X	X
Single firm control of design/construct process		X	

Disadvantages of the 3 Most Common Delivery Methods

Type of contracts	Traditional Approach	Design Build	Construction Management
Disadvantages			
Design does not benefit from construction expertise	X		
Design construction time is the longest	X		
Adversarial relationship owner/designer vs contractor	X		~X
Contract agreement affected by changes	X		~X
Few checks and balances		X	
Cost control occurs late in project		X	
Contract amount may be complicated by continual contractor negotiations	X		~X
Contract agreement affected by unforeseen conditions	X		~X

Issues with Bids

- Low bidders can be unreliable
 - Prequalify aggressively!
- To allow for fast-tracking may bid early (30%)
- Don't try to force delivery from low bid
- Growing Frequency: innovative bidding method
- Pressure for lowest bid can create
 - Cutting corners
 - Low-quality personnel
 - Bad feelings