Project Organization

System and Project Management
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Nathaniel Osgood

Center for Construction and Research Education
Department of Civil and Environmental Engineering
Massachusetts Institute of Technology
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

Direct Financing

Integrated Organization

Segmented Organization

Indirect Financing
Most Common Delivery Methods

TRADITIONAL DESIGN-BID-BUILD

Owner

General Contractor

Sub-contractor

Sub-contractor

Sub-contractor

A/E

PURE OR AGENCY CONSTRUCTION MANAGEMENT

Owner

C/M

A/E

Trade Contractor

Trade Contractor

Trade Contractor

Trade Contractor

CONSTRUCTION MANAGEMENT AT RISK

Owner

C/M

A/E

Trade Contractor

Trade Contractor

Trade Contractor

D/B Entity

Design Function

Sub-contractor

Sub-contractor

Sub-contractor
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

- Owner
- General Contractor
- A/E
- Subcontractor

Contractual Relationship
Communicational Relationship
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 (15-200)
  - 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 problems
- 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
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 own
  - 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

- **Contractual Relationship**
- **Communicational Relationship**

**Owner**

- **C/M**
- **A/E**

**Trade Contractor**

**Trade Contractor**

**Trade Contractor**
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

http://www.bigdig.com
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

http://www.bigdig.com
Project Organization

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- Summary
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, ½ between the DBB and the PCM System (VER...**
  - (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**
Project Organization

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➤ Design / Build

■ Summary
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

- Contractual Relationship
- Communicational Relationship
- Internal Relationship

Owner

Construction Function

D/B Entity

Design Function

Sub-contractor

Sub-contractor

Sub-contractor
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 Serves as Design/Builder and Subcontractors Design
CM Oversight Design/Build

CM Provides Agency Oversight on Owner's Behalf
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)**
Project Organization

✓ Project Delivery Systems (most common)
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➤ Summary
## Type of Relationships Among Participants

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<tr>
<td>D/B</td>
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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

<table>
<thead>
<tr>
<th>Type of contracts</th>
<th>Traditional Approach</th>
<th>Design Build</th>
<th>Construction Management</th>
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<tbody>
<tr>
<td><strong>Advantages</strong></td>
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<tr>
<td>Legal and contractual precedent</td>
<td>X</td>
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<tr>
<td>Cost determined before contract commitment</td>
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<tr>
<td>Fast-tracked construction allowed</td>
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<td>X</td>
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<tr>
<td>Minimum owner involvement</td>
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<td>X</td>
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<tr>
<td>Cost benefit from competition</td>
<td>X</td>
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<tr>
<td>Negotiation with quality contractor for unique expertise</td>
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<td>X X</td>
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<tr>
<td>Allow adjustment to new conditions without changing agreement</td>
<td>X X</td>
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<tr>
<td>Single firm control of design/construct process</td>
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## Disadvantages of the 3 Most Common Delivery Methods

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<tr>
<td><strong>Disadvantages</strong></td>
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<tr>
<td>Design does not benefit from construction expertise</td>
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<td>Design construction time is the longest</td>
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<td>Adversarial relationship owner/designer vs contractor</td>
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<tr>
<td>Contract agreement affected by changes</td>
<td>X</td>
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<tr>
<td>Few checks and balances</td>
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<tr>
<td>Cost control occurs late in project</td>
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<tr>
<td>Contract amount may be complicated by continual contractor negotiations</td>
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<tr>
<td>Contract agreement affected by unforeseen conditions</td>
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*Modified from Gould and Joyce, 2002*
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 canh create
  - Cutting corners
  - Low-quality personnel
  - Bad feelings