

Section5: Construction



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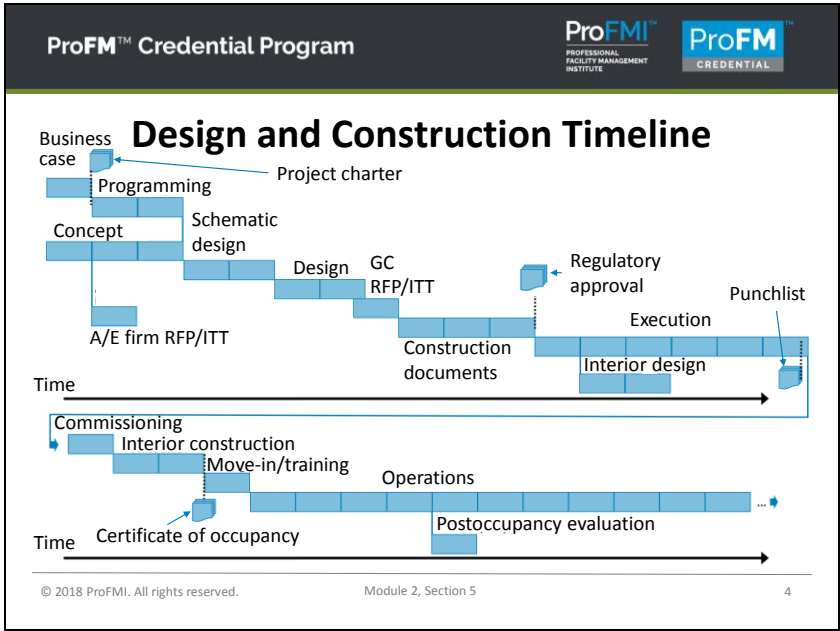
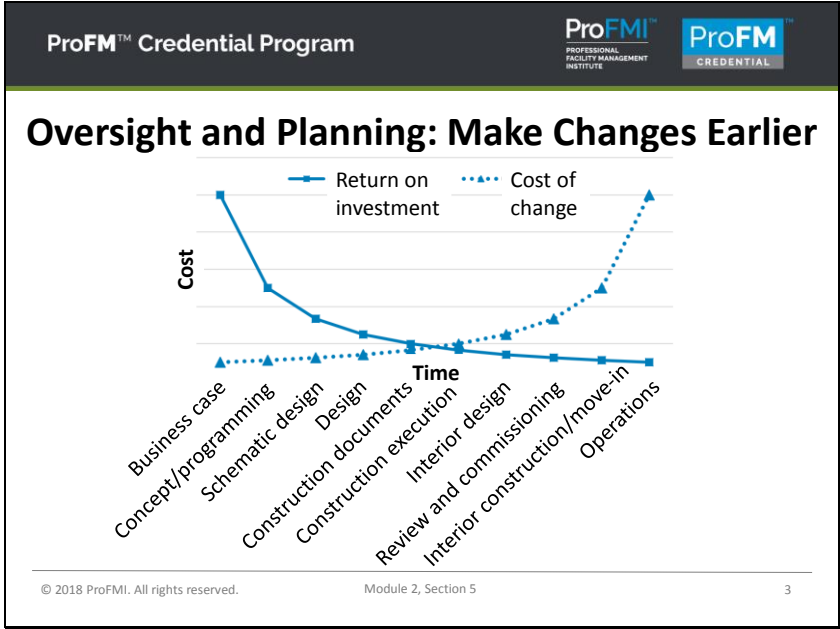
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Section 5 Topic Preview

- **Topic 1:** Initiation for Construction
- **Topic 2:** Design and Construction Planning
- **Topic 3:** Programming
- **Topic 4:** Facility Concept and Schematic Design
- **Topic 5:** Design and Construction Documentation
- **Topic 6:** Construction Execution and Monitoring and Control
- **Topic 7:** Construction Project Closeout

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 **Discussion Question**

What can facility managers do to get general contractors (GCs) to make quality facilities?

- a) Require the GC to make all construction documents rather than having subcontractors do portions.
- b) Specify minimum GC experience in similar facilities of similar numbers of square feet/meters.
- c) Review the punchlist with the GC at the kickoff.

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Construction Project Oversight

<p>Governance committee</p> <ul style="list-style-type: none">▪ Sets goals and measurable objectives▪ Specifies requirements and quality▪ Change control board final decider▪ Sets expert agenda and reviews their submittals▪ Reports to CEO/board	<p>Experts committee</p> <ul style="list-style-type: none">▪ Decides on daily design and construction issues▪ Adjusts course to stay on schedule/budget▪ First assessor of change order requests▪ Reviews alternatives, progress, and risks
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Project Management Office or Other Support

- Portfolio management/program management
- FM leadership and influence over multiple projects
- Aligns with organizational strategy and policies
- Keeps sustainability and life-cycle cost focus
- Avoids FM pain points like unnecessary confined spaces
- Corrects record keeping, IS, and as-built drawings
- Follows commissioning/decommissioning standards
- Benefits more from postoccupancy evaluations

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Project Charter: End Results and Scope

- Concise, easy-to-read statement of end results.
- Phases and milestones clear, e.g., demolition phase.
 - “The new facility shall be open for business and fully operational no later than June 1, 20XX.”
- Total square feet or meters, plus expansion options.
- Document should never need to change.
 - More than one path to success (e.g., LEED GOLD or LEED SILVER certification for health care, version xx.xx)?
 - High-level site requirements and concept.
 - Processes, methodologies, metrics, and controls to use.

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Selecting Project Manager (PM)

Contractor or employee with:


- Design-build expertise.
- Knowledge of local codes, regulations, and licensing for type of facility.
- Soft skills.

Construction management:

- Coordinate multiple construction projects.
- Oversee progress and payments.

General contractor as PM:

- May require different PM during design or GC design-build firm.



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Role of Facility Manager on Construction Projects

Facility manager as PM?

- Right skill set needed.
- No general contractor fee.
- No volume discounts from subcontractors.
- Opportunity cost:
 - Backlog
 - Additional FM staff cost

Facility manager oversight

- Get the right PM.
- Administer contracts.
- Inspect and accept completed work at site.
- Design review expertise (have or get).
- Represent end users.

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Project Team

Contractors

Architect: Design for function, looks, sustainability, and organization's vision.

Engineer: Calculate specialized area's requirements (M, E, S, C, A).

General contractor: Marshal forces, timing. Knows local and industry-specific codes?


Interior designer

Commissioning agent

External

Plan examiner

Building inspector



Proven team or
custom but new?

Internal or contractor

Project manager

Scheduler

Inspectors

Cost estimator

Modeling analyst

Project accountant

Contracting officer

Safety and compliance officer

Construction procurement officer



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Range of Architectural-Engineering Services

- Feasibility analysis and cost estimation
- Conceptual design
- Programming
- Schematic design
- Construction documentation
- Commissioning support (criteria, system integration)
- Construction review (fabricated materials, changes)



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Charter: Budget, Schedule, Constraints, Approvals

- Macro-level budget and schedule from business case
 - Adjust indexes like *Engineering News Record's* ENR index or *RSMean's Construction Cost Data* for local market costs.
- Parametric estimates: volume (square feet/meters) × rate (cost per square foot/meter for space type)
- General contractor estimate
- Constraints: Site entry, orientation, parking, trees, noise
- Signatures for accountability
- Partnering charters for collaboration

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Commissioning

- Systematic process that goes beyond punchlist.
- Verify and document facility and systems function per:
 - Specifications at average and peak loads and in failure modes.
 - Owner's operational requirements.
- Starts in design: system and subsystem requirements.
- Who is liable for rework and if change orders allowed:
 - Owner risk if prescriptive or descriptive specification.
 - Contractor risk if performance specification (end results).
- Document testing plan and schedule.

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Commissioning

- Factory witness testing.
- Inspect on arrival.
- Installed with utilities:
 - Start-up: Manufacturer recommendations and codes.
 - Document results.
- Independent commissioning authority.
- Benefits > costs?

The diagram illustrates four levels of commissioning: **Individual** (a single yellow unit), **Subsystem** (a group of units connected), **System** (multiple subsystems connected), and **Integrated** (the entire facility with a red stop sign and a plus sign). A box labeled **CMMS facility analysis** is shown next to the integrated system.

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Project Delivery Systems

<p>Design-bid-build</p> <ul style="list-style-type: none"> ▪ RFP/ITT to AE firms ▪ AE subcontractor alignment ▪ Dimensional accuracy disclaimer ▪ Substantially complete design: RFP/ITT to GCs ▪ Low/high bid comparison ▪ Change orders a risk if low bid missing things ▪ Long lead-time items delay 	<p>Design-build</p> <ul style="list-style-type: none"> ▪ AEC firm liable for errors and omissions ▪ Owner changes add cost ▪ Earlier, cheaper changes, but design frozen earlier ▪ Earlier cost estimates ▪ Shorter duration ▪ Programming reflects multi-project goals? ▪ Best value, sustainability, and life-cycle cost kept in?
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Project Delivery Systems

- Construction management at risk
 - AE firm and construction manager at initiation
 - Guaranteed maximum price (GMP) limits cost overrun liability
- Fast tracking
 - Start parts of construction early, making cost estimates hard
- Turnkey
 - Hands-off reduces owner tasks, risks less-than-ideal solution
- Integrated project delivery (IPD)
 - Collaborative from start with risk/reward contracts
 - Building information modeling (BIM)
 - Integrate to meet multiple requirements at low cost, less rework

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Building Information Modeling (BIM)

- Collaboration methodology
- Whole life cycle: concept, design, construct, operate, maintain, alter, dispose
- Open, standards-based, machine-readable format
- Any compatible software can interface (verify)
- Meet holistic goals such as for sustainability
- Less rework between design and construction documents
- More profitable for AE and GC due to faster and more accurate changes and better procurement timing
- No data reentry at handover and revision history available

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BIM Rules: Parametric Objects

Feature	Description	Example
Objects with parameters	Rules or data governs objects (e.g., an I-beam, a chiller).	I-beam engineering properties and maximum variable length.
Non-redundant objects	Same object used for two- and three-dimensional plans for consistency.	I-beam is same length in two- and three-dimensional renderings.
Automatic alignment	Placing object in model automatically adjusts variable components to fit space.	I-beam snaps to attaching I-beams, setting the length so no gaps exist.
Rule violation warnings	Validate manufacturability, size, weight, power load, capacity, pressure, etc., given any changes.	I-beam insufficient for load after different subcontractor's BIM upgrades an HVAC system.
Data aggregation	Total aggregated weight, etc.	Total weight of I-beam structure.

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Discussion Question

An executive lists software, training, change management, and consulting fees as big cost increases of BIM. What can offset these costs?

- a) All contractors using BIM
- b) Fewer errors and omissions
- c) Truly seamless transition from design to construction documents

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Methods of Design and Construction Contracting

Lump sum	Cost-plus-fixed-fee	Guaranteed maximum price	Custom
<ul style="list-style-type: none"> Design-bid-build or turnkey. Fixed price is risk for AE or GC, so build in higher profit. Change order risk. 	<ul style="list-style-type: none"> Design-build, construction management, or fast tracking. Total cost not known until plans complete. Independent estimates needed. Design change costs passed on. 	<ul style="list-style-type: none"> Construction management at risk. Only owner changes increase price. Construction manager losses from errors and omissions. Adversarial. High profit. 	<ul style="list-style-type: none"> Integrated project delivery. Incentives for collaboration. Share risks and rewards. All motivated to find ways to cut costs.

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Design and Construction Firm Bidding/Selection

<ul style="list-style-type: none"> Reasonable time for preparation and response. Customize questions to draw out answers that are differentiators. Project management and key staff expertise. Local code knowledge. Innovation in bids. Able to collaborate. 	<ul style="list-style-type: none"> Bid price, best value, and/or life-cycle cost. View plans at site (field conditions). Experts committee sets criteria weighting: <ul style="list-style-type: none"> Members should read all bids and may vote. Government organizations should document why choice differs from highest weighted score or vote.
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Scope and Schedule Planning

Scope

- Statement of need or work from approved business case
- Detailed line-item work breakdown structure

Schedule

- Milestones
 - Success risk
 - Share with all parties
- Architect decides % completion?

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Budget Planning

Order-of-magnitude budget	Occupant unit budget	Parametric estimate budget	Systems or assembly estimate budget	Unit price estimate
<ul style="list-style-type: none"> ▪ Similar facilities ▪ For feasibility studies 	<ul style="list-style-type: none"> ▪ Occupants and historical cost per occupant ▪ For project charter 	<ul style="list-style-type: none"> ▪ Square feet/meters times cost per square foot/meter ▪ From programming 	<ul style="list-style-type: none"> ▪ Market price for selected systems ▪ From schematic design 	<ul style="list-style-type: none"> ▪ Detailed line-item budget at 65% complete design, with final at 100% ▪ From GC

Iteration	Accuracy Range
1	+50% to -30%
2	+40% to -25%
3	+30% to -20%
4	+20% to -10%
5	+10% to -5%

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Parametric Estimate Budget Example

Total project cost per square foot (or meter) useful for comparisons

Project: Headquarters data center			
Project number: 120384			
Date: 11/1/2017		Budget version: 1.4	
Current milestone: Design RFPs issued			
Direct construction costs	Volume (ft²)	Rate (\$/ft²)	Cost
Demolish existing facility	3,200	\$200	\$640,000
Grade and prepare site	6,000	\$30	\$180,000
Set up site safety and security	6,000	\$5	\$30,000
Data center construction			
Common areas	1,200	\$90	\$108,000
Facility systems area	1,000	\$110	\$110,000
Data center area	1,500	\$120	\$180,000
	3,700		\$1,248,000
Other construction costs		% of direct costs	
Off-site utility connections (flat fee)	N/A		\$50,000
Fixed equipment (security and facility systems)		30%	\$374,400
Movable equipment (includes IT hardware)		13%	\$162,240
			\$1,122,320
Management reserve		9%	\$112,320
Total construction cost			\$1,946,960
Services costs		% of total costs	
Architectural-engineering designs and consulting		9%	\$175,226
Project management and cost estimating		2%	\$38,939
Programming (internal)			\$0
Property survey (flat fee)	N/A		\$20,000
Environmental assessment (flat fee)	N/A		\$50,000
Plan reviews and permitting (flat fee)	N/A		\$15,000
Land acquisition	(already paid)	N/A	\$1,200,000
Total project cost			\$3,446,126
Total project cost per square foot			\$931

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



Initial Occupancy Planning

- Relocations are separate projects needing planning.
- Long-term or project-specific contractors: Equipment and furniture installers, signage vendors, art installers, movers.
- Keys for vendors and security.
- Bottlenecks such as freight elevators.
- Storage and special dumpsters.
- Change management and communication (e.g., newsletter).
 - Milestones and how to get to work, how to pack, how to track, etc.
- Move day
 - Cater lunch?
 - Vendors on site for finding items or touch-ups.

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Operations and Maintenance Planning

-  Staff training
-  System documentation and facility handbook
-  Actual cost database and benchmarking
-  Design issues that may affect O&M

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Programming

- Project's/program's requirements for period of time
- Performance expectations of organization and end users
- Mandatory (e.g., code) requirements

Steps:

1. Identify business functions/programs by type and volume.
2. Forecast number of workers for planning horizon.
3. Perform technical analysis per worker plus support space.
4. Gather end-user input to validate technical analysis.
5. Develop quantity, quality, and custom feature specifications.
6. Compile relevant design, AE, regulatory, policy standards.
7. Set space standards and reevaluate feasibility.
8. Calculate minimum space requirements per function, program, building core, site.

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Identify Business Functions to Accommodate

- Activities to be performed over planning horizon
- Strategic plans, business cases
- Adjacency diagram

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Forecast Occupants/Perform Technical Analysis

<p>Forecast workers and guests</p> <ul style="list-style-type: none"> ▪ Needed workers: Revenue forecasts and forecasts of productivity per worker ▪ Guests ▪ Long-term horizon for facility ▪ Lead or lag expected growth? 	<p>Perform technical analysis</p> <ul style="list-style-type: none"> ▪ Workspace per worker ▪ Shared support services ▪ Common spaces ▪ Building core ▪ Security or special design ▪ Site access
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Gather End-User Input

- Technical analysis gives end users something to react to.
- Validate results, and help end users feel heard.
- Questionnaires to representative set.
- Requirements for security, accessibility, specialized areas.
- Review new requirements for applicability and feasibility.
 - For example, ranking optional additions or benefit-cost analysis
- From business requirements to facility requirements:
 - Total, average, peak?
 - Remote workers or second shift?
 - IT, copiers, printing, security, cleaning, catering, equipment...

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Specifications and Design Standards

<p>Develop specifications</p> <ul style="list-style-type: none"> ▪ Translate validated requirements into specifications for: <ul style="list-style-type: none"> ▪ Quantity of each type of space. ▪ Quality needed. ▪ Special features. 	<p>Compile design standards</p> <ul style="list-style-type: none"> ▪ AE manuals and standards ▪ Optional standards like LEED ▪ National, regional, local regulations ▪ Organizational policies ▪ Modify specifications
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Set Space Standards and Reevaluate Feasibility

- Square foot/meter requirements per worker and per support space.
 - Cubic dimensions for some spaces like warehouses.
 - Square meters/feet for other areas like shop floor.
- Review feasibility initially conducted for business case.
 - Engineering requirements understated?
 - O&M feasibility?
 - Communications dynamics between functions optimal?
 - Fine-tuned cuts to meet not-to-exceed budget.
 - Redo financial metrics for ROI, etc.

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Calculate Minimum Space Requirements

$$\left(\begin{array}{l} \text{Worker} \\ \text{Forecast} \\ \text{(Volume)} \end{array} \right) \times \begin{array}{l} \text{Area's Space} \\ \text{Standards in} \\ \text{Square Feet/} \\ \text{Meters per} \\ \text{Worker (Rate)} \end{array} \left. \right) + \begin{array}{l} \text{Area's} \\ \text{Common} \\ \text{Space in} \\ \text{Square Feet/} \\ \text{Meters} \end{array} = \text{Minimum Space} \\ \text{Requirements}$$

- Similar calculations for building core, etc.
- Convert net floor area (usable) to gross floor area (+ walls, envelope, core).
- Feasibility: Ratio of facility footprint to total site area.
- Allows new budget estimate.
- Architects—Detailed site plan validating:
 - Footprint
 - Daylighting
 - Views from and of facility
 - Circulation
 - Parking and delivery access

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Design Review Process

- Virtual meetings may visualize, edit design.
- Design charrette:
 - Shared goals, priorities.
 - Explore design ideas.
 - Collective wisdom.
- Internal design team reviews (review, assign):
 - Short iterative cycles.
 - Intense bursts of effort.
- Formal owner reviews:
 - True to goals, life-cycle cost, maintainability, sustainability?
- Criteria to move beyond each milestone:
 - Redo energy, water, peak demand simulations.
 - Meets sustainability, user needs, and other goals?
 - Added costs in one area offset by other savings?

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Discussion Question

According to Roper and Payant, when is the best time to do a constructability review?

- a) Design concept complete
- b) Design 25% to 35% complete
- c) After checking for errors and omissions
- d) Design 80% to 85% complete

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Design Concept

- Written requirements and constraints
- Visualizations and models
- Multifaceted design goals
 - Operations effectiveness
 - Sustainability and energy efficiency
- High-level cost estimate based on design features
- Concept review
 - Meets strategic goals and specific requirements? Feasible?
 - Initial price as well as O&M cost estimates




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Design Concept Areas

 <p>Site</p> <ul style="list-style-type: none">• Drainage and storm water• Parking, traffic, and public transport• Customize to climate and terrain	 <p>Facility</p> <ul style="list-style-type: none">• Mission and vision• Functional area square feet/meters• Special (e.g., delivery doors)• Structural (e.g., earthquake)• Circulation	 <p>Systems, utilities, equipment</p> <ul style="list-style-type: none">• Mechanical• Electrical• Orientation• Energy model by month• General capacities and space needs, not specific systems
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Schematic Design

- Validate regulations compiled in programming.
 - Plumbing code, HVAC code, gas code, life safety code...
 - Testing to determine capacities of potential systems
- Systems, materials, and equipment type selection.
 - From foundations to finishes
 - Landlords
 - $$\frac{\text{Rentable square feet/meters}}{\text{Gross Internal Area}} = \text{Net Internal Area} = \begin{matrix} 80\% \text{ minimum,} \\ 84\% \text{--}87\% \text{ ideal} \end{matrix}$$
 - $$\frac{\text{Inside dimensions of exterior walls}}{\text{Gross Internal Area}} = \text{Net Usable Area} = \begin{matrix} 75\% \text{ minimum,} \\ 80\% \text{--}84\% \text{ good} \end{matrix}$$
 - Occupiers
 - $$\frac{\text{Includes building core}}{\text{Net Usable Area}} = \text{Net Usable Area} = \begin{matrix} 75\% \text{ minimum,} \\ 80\% \text{--}84\% \text{ good} \end{matrix}$$

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Schematic Design

- System capacity and type enable better cost estimates.
 - May use actual quantities and prices for standardized items
 - Parametric estimates for custom areas
 - Remaining design costs accurately known
 - Estimates of lost productivity, relocations, real estate, fees
- Constructability and cost feasibility reviews.
- Schedule versus deadlines.
- Go/no go point.
- Passing final schematic design review releases designers.

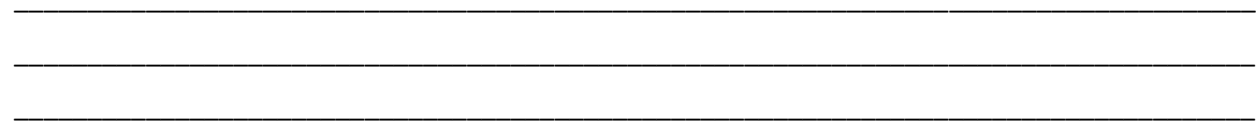
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Design and Engineering

- Full schematics and detailed engineering specifications.
- Mandatory and non-mandatory design criteria.
- Facility managers should be able to interpret two-dimensional design drawings and provide feedback.
- Other stakeholders strongly benefit from three-dimensional virtual or physical models, snapshots, and walkthroughs.
- Documents on circulation and access, systems, structure, walls, roofs...
- Modeling software for acoustics, energy, structural properties, thermodynamics, earthquakes...

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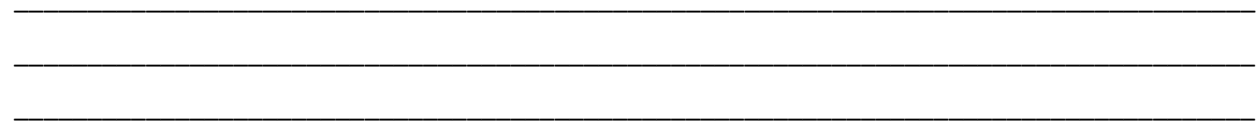


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Building Information Modeling (BIM) Designs

- BIM model can produce both two- and three-dimensional documents.
- Color-coded spaces by function.
 - Meeting rooms, etc., appropriately sized?
- Three-dimensional visualizations and walkthroughs.
 - Faster but labor-intensive
 - May require added software, expertise
- More accurate and able to show alternatives.
- Simultaneous reviews reduce duration.
- Negotiate in advance degree of precision.

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Value Engineering

Goals: All items to meet success criteria; no unnecessary or wasteful items **Risks:** Too much focus on initial cost; worse life-cycle cost/maintainability; failure to get sustainability certification

“This alternative can save money with little impact on quality, maintainability, or aesthetics.”



Design/construction consultant

“Eliminating these sustainability features and materials will get us to our cost target.”

“This is a good balance between needs and nice-to-have items.”

“Those high-efficiency systems take us over our budget.”

“These finishes cost a lot less.”

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


Construction Documents and Models

- Even with completed design, construction can't begin.
- Sequential versus parallel tasks.
- Independently produced (designs show just intent)?
 - Limits liability
 - Rework
- Collaborative (BIM, integrated project delivery)?
 - Less rework (unlikely to be none)
- Demolition plan by sequence.
- Base plan at common scale with detail layers.

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Documents for Interior Construction and Finishes

-  Installation and components plans
-  IT and telecommunications plans
-  Reflected ceiling plan
-  Floor plans and floor covering plans
-  Wall finishes plan
-  Details and joinery plans

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Construction Permitting

- Utility, building, use permits
- Zoning restrictions
- Water, sewer, and other major utility development projects done
- Early review sessions of local building code and zoning
 - May reduce project duration
 - Early correction of code violations
- Public review period and community meetings
 - Allow time
 - Communications plan and spokesperson

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Preconstruction Meeting Agenda

- Attendees: Owner representative, facility manager, AE, consultants, GC, new subcontractors since last kickoff
- Schedule in detail
 - Key milestones, including certificate of occupancy
 - Critical path tasks
 - Long-lead time and fabricated materials
- Communications
 - Project risks/assumptions
 - Change order process and authorized approvers
 - Prompt notification policy
- Payment requests and timing
- Commissioning and punchlist processes
- Job site safety, policies, and administration

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Construction and Interior Design Meetings

Construction meetings

- On-site weekly meeting.
- Review progress.
- Cost and schedule variances.
- Status of:
 - Change order requests.
 - Progress payments.
 - Risks and responses.
- Resolved issues.
- Task assignments.

Interior design meetings

- Separate project if:
 - Shell finish.
 - Shell and core finish.
- Facility manager helps owner or tenant find interior designer or GC.

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Construction Inspections

- After permits issued, construction begins.
- Government inspectors:
 - Inspections before features covered up or buried.
 - Finished work.
 - Materials and work processes.
- Owner representative inspectors (area specialists):
 - Accept or reject work as owner's representative.
 - GC meeting all terms and conditions.
 - Data for performance reviews.
 - Decide on necessary modifications.
 - Validate progress payment vouchers sent to GC or subcontractors.



Too lenient?




Too stringent?

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Discussion Question

A subcontractor is refusing to remove an invoice for removal and replacement of water heaters, claiming that the owner verbally requested a change to an on-demand system. The kickoff meeting clearly specified that the governance committee was the only approval authority. What should the facility manager do?


- a) Document the issue and forward it to legal.
- b) Indicate that the subcontractor is in breach of contract.

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Procurement and Fabrication

- Procurement schedule at design end
- Paperwork on items with long lead times
 - Especially if form critical path
- Tradeoffs: Cost, insulation, durability, sustainability, weight, maintainability...
- Factory-made fabrication
 - Cheaper labor
 - Sustainability
 - Less toxicity
- On-site fabrication
 - Logistics
 - Schedule compression



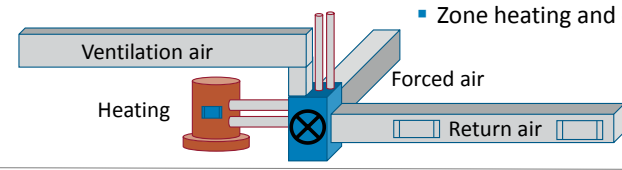
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Commissioning and Quality Control

- Precommissioning at factory or on arrival
- Barcode scanners
- Installation supervision
- With utilities
- Later at peak load

- HVAC commissioning
 - Start-up tests
 - Test and balancing
 - Ventilation/return air mix
 - Heated or chilled water rate to air volume
 - Humidity
 - Zone heating and cooling

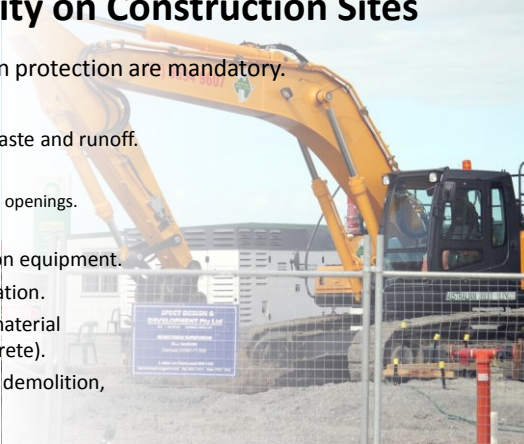


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Sustainability on Construction Sites

- Storm water and erosion protection are mandatory.
- During construction:
 - Reduce construction waste and runoff.
 - Indoor air quality:
 - Seal off ductwork and openings.
 - Keep materials dry.
 - “Roads” for construction equipment.
 - Tree or nature preservation.
 - On-site recycling and material reclamation (e.g., concrete).
 - Salvage materials from demolition, if cost-effective.



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Cost and Schedule Monitoring and Control

<h3>Cost and schedule</h3> <ul style="list-style-type: none">▪ Keep focus on schedule to reduce budget risk.▪ Timely decisions.▪ Inspector relations.▪ Communicate bottlenecks.▪ Life-cycle cost champion.▪ Remaining funds sufficient for balance of payments?▪ Change orders add to budget?	<h3>Allowances</h3> <ul style="list-style-type: none">▪ Allowance per square foot/meter for interior design/construction.▪ Owner vs. tenant:<ul style="list-style-type: none">▪ Who pays?▪ Who does project management, permitting...?▪ Facility manager ensures maximum allowance benefit.▪ Unused allowances in cash or as rent abatement.
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Performance Monitoring and Control


- Change order review and acceptance or rejection.
- Inspection to validate that plan specifications are met.
- Experts committee checks if above or below scope.
- Legal review.
- Facility manager provides facts, acts as voice of reason.
- Facility staff performance monitoring:
 - Correct mix of time on project and on O&M
 - Deferred maintenance tracking
 - Catch-up plan

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Turnover: Substantial Completion and Punchlists

- Punchlist only after “substantial completion.”
 - Brief walkthrough to verify, so as not to waste time
- If doing commissioning, focus on things it doesn’t cover:
 - Paint coverage
 - Door functionality
 - Outlets, light switches, and thermostats
 - Ceiling tiles
 - Locks and keys
 - Ductwork (no covers or blockoffs)
 - Filters and lighting units
 - Balanced and tested airflow diffusers
 - As-built drawings, owner manuals, paint samples
- Cleanup period and final walkthrough.





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Turnover: Documents, Payments

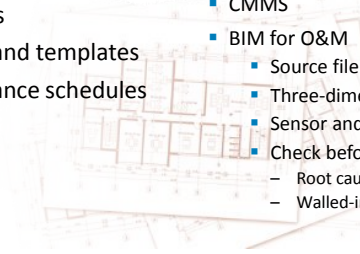
- Commissioning report
 - Changes from plan
 - Actual energy efficiency
 - HVAC zone capabilities
 - Indoor air quality levels
- Final payments
 - No outstanding lien waivers from GC or subcontractors
 - Lien insurance
- Certificate of occupancy
 - Enables occupation and use
 - Relocation only after
 - Warranty initiation date
- As-built drawings
 - What was actually built
 - Site conditions
 - Faster or fewer materials
 - Variances approved before work done
 - Still to code
 - No conflicts
 - Red-line drawings
 - CADD or BIM files
 - Cabling and wiring

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Training, FM Database

- O&M training**
 - Procedures (test some)
 - System baseline standards
 - Job aids and templates
 - Maintenance schedules
- FM database**
 - Print or digital manuals and as-built documents
 - CMMS
 - BIM for O&M
 - Source file merging
 - Three-dimensional color-coded views
 - Sensor and control feed
 - Check before field work
 - Root cause
 - Walled-in components





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Interior Construction and Relocation

<p>Interior construction</p> <ul style="list-style-type: none">▪ Overlap with general construction as feasible▪ Facility manager as GC and project manager? <p>Relocation projects</p> <ul style="list-style-type: none">▪ Facility manager project▪ Complete by deadline	<p>Owner-furnished items</p> <ul style="list-style-type: none">▪ Security and locks▪ IT/telecommunications▪ Manufacturing equipment▪ Window blinds▪ Copiers▪ Cubicles and furniture▪ Kitchen equipment▪ Signage and art▪ Carpeting▪ Walls
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Postoccupancy Evaluation (POE)

- Evaluation three months to one year after occupation
 - Annual or seasonal repetition
- Effectiveness
 - Right facility for end users' needs
- Efficiency
 - Energy use, waste generation, sustainability, program delivery, meeting program goals
- Likert surveys (subjective 1 to 5) with some open-ended questions
 - Pilot survey to ensure that right questions are asked
- Drive actual corrections and continuous improvement
 - Inform end users

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