

Design by Phases

Part 1

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Most engineers use a six-phase project methodology. In chronological order, the six project phases are pre-design, schematic design, design development, construction documents, bidding and negotiations, and construction administration. It's important to proceed in the proper order as the project develops. Completing a task during the wrong phase can create a domino effect that will cause extensive rework, time, money, and even embarrassment.

A checklist that defines the tasks assigned to each phase can assist in the process. Entry-level engineers should use this index until they know it by heart. Seasoned engineers should use it as tool simply to ensure they are on schedule. It also can be used as an instrument to inform the owner-client of what you've produced at each phase and what you'll need for the next phase.

Here is a phase-by-phase summary of the purpose of and tasks to be completed during the first three phases of a project. The last three phases are the subject of the next column, in the November/December issue of *Plumbing Systems & Design*.

Phase 1. Pre-Design

This phase of the project requires meeting with the owner to define the exact scope of work. Then the engineer prepares a written summary of the anticipated work. Preparation of a project budget and project schedule also are part of this phase. The engineer works jointly with the owner to establish the timeline for the project and the available funds.

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✓ Pre-Design Actions

Initial Meeting

1. Discuss the client's objectives.
2. Discuss the client's wish list.
3. Discuss the project scope and program.
4. Discuss the project budget.
5. Review the existing drawings and surveys.

Architect's and Engineers' Responsibilities

1. Write the basic services agreement.
2. Perform a zoning and code analysis to determine local codes, building department requirements, and restrictions.
3. Complete a field survey (for a remodeling project).

Phase 2. Schematic Design

The American Institute of Architects' owner-architect agreement states, "The Architect [or Engineer] shall provide those services necessary to prepare drawings and other documents illustrating the general scope, scale and relationship of project components for approval by the Owner." An ancillary purpose of the schematic design phase documents is to prepare an estimate of the probable construction cost so it can be compared with the owner's budget. To develop a cost estimate with reasonable accuracy and gain the owner's approval, the engineer must develop documentation sufficient to communicate the design intent to the owner and whoever is responsible for preparing the cost estimate (the architect, an independent cost estimator, or a construction manager). Those in the industry commonly understand two important aspects of the schematic design phase:

✓ Schematic Design Actions

Plumbing

1. Assess the adequacy of existing toilet fixtures.
2. Assess the adequacy of existing drinking fountains.
3. Review the existing drawings and buildings to identify all code deficiencies and possible approaches.
4. Establish the quantity and locations of roof drains.
5. Identify new spaces requiring floor drains.
6. Suggest locations for drinking fountains or water coolers.
7. Establish space requirements for water heaters and special equipment.
8. Establish locations of primary vertical and horizontal pipe runs.
9. Indicate all of the above on schematic architectural floor plans.
10. Prepare an outline of major materials and systems.
11. Support preparation of the cost estimate.

Fire Protection

1. Review the existing drawings and buildings to identify all code deficiencies and possible approaches.
2. Determine fire pump, engine type, gallons per minute, and head requirements.
3. Establish the preliminary size and location of fire standpipes or other primary sprinkler risers.
4. Establish the size and location of special equipment.
5. Indicate all of the above on schematic architectural floor plans.
6. Prepare an outline of major materials and systems.
7. Support preparation of the cost estimate.

- The most far-reaching decisions—those have the most profound effect on the eventual design and cost of the project—are made during the schematic design phase.
- The later in a project the schematic design information is generated, the more likely it is that the team's efficiency during the later phase, will be adversely affected. Consequently, shortcuts during this phase can have a disproportionately large adverse impact on the project's success.

The schematic design phase tasks and deliverables are even more necessary when, by virtue of the project's complexity or schedule, the game plan calls for the team to proceed directly into the construction documents phase. Without a design development phase, adequate time and effort must be allocated so this phase's tasks and deliverables can be fully accomplished.

Phase 3. Design Development

According to the standard American Institute of Architects' owner-architect agreement, the objective of the design development phase is "to establish and describe the size and character of the project as to architectural, structural, mechanical, and electrical systems, materials and such other elements as may be appropriate...for the construction manager's review [when there is one] and for the owner's approval."

Much of the design development phase is spent considering design options for various portions of the project. The final design evolves from this process. The results of the design analysis and development must be adequately documented to communicate the design intent to both the owner and the construction manager, even though the documents will fill different needs for each of them:

- For the owner, documentation should demonstrate that the design was developed in accordance with the owner's objectives and expectations; and that the specific materials and systems selected for the project, along with the ways in which they will be assembled, are acceptable to the owner.

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✓ Design Development Actions

Components of a Well-Developed Set of Documents

1. Project title
2. Drawing title
3. Scale
4. North arrow, as required
5. Project number
6. Drawing number
7. Date
8. Names: Drawn, checked, and approved by _____

Plumbing Engineering Services

Required by the plumbing group at the start of design development

1. Approved schematic floor plans and site plan
2. Schematic building sections
3. Schematic building elevations or perspective
4. Building construction type occupancy and use group
5. Fire resistance requirements
6. Special areas requiring plumbing

Required from the plumbing group to the architectural group at the start of design development

1. Plumbing design concept developed and indicated on schematic architectural plans
 - a. Preliminary sizes and locations of vertical stacks, risers, leaders
 - b. Preliminary size, number, and locations of roof and floor drains
 - c. Suggested locations for drinking fountains and water coolers
 - d. Special space requirements for water heaters and special equipment
 - e. All other primary vertical and horizontal pipe runs
2. Floor plans
 - a. Vertical stacks, risers, leaders, floor drains
 - b. Horizontal piping runs
 - c. Water heaters and other equipment
3. Site utilities plan
 - a. Water and gas service, pump houses or pumping stations, as required

- b. Sanitary sewer or sewage disposal system
 - c. Storm drainage piping and catch basins
4. Catalogue cuts of all equipment exposed to view (e.g., plumbing fixtures, faucets, water coolers, hose cabinets)
 5. Outline specification
 6. Cost estimate of plumbing work (if required)

Final review and coordination with all disciplines: Incorporate final revisions

Fire Protection Engineering Services

Required by the fire protection group at the start of design development

1. Approved schematic floor plans and site plan
2. Schematic building sections
3. Schematic building elevations or perspective
4. Building construction type, occupancy, and use group
5. Fire resistance requirements
6. Special requirements

Required from the plumbing group to the architectural group at the start of design development

1. Fire protection design concept developed and indicated on schematic architectural plans
 - a. Preliminary size and location of fire standpipe or other sprinkler risers
 - b. Preliminary location of hose racks and cabinets
 - c. Size and location of space for special equipment
2. Floor Plans
 - a. Head and piping layout
 - b. Fire hose cabinets
3. Outline specifications
4. Cost estimate of fire protection work (if required)

Final review and coordination with all disciplines: Incorporate final revisions