

CHAPTER 1 – THE DESIGN PROCESS

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I. THE MISSION

At the core of any construction project are the issues and needs that the new facility is intended to address. This is often simplified to a statement such as “an OR suite capable of supporting a given number of cases,” but the most thoughtful and effective facilities come from much more complex considerations. It is appropriate to think of a building as another tool of the health care professionals whom it serves. At its best, their facility can do much more than provide a roof under which to work. A great medical facility enables its staff, makes them more capable and makes their work more effective. So the most meaningful goals are essentially formalized thoughts of what is missing, broken or inadequate in the status quo. The facility itself is to be a built response to what is limiting our medical professionals in their daily work, what new capabilities we can provide, and certainly how we can better address the health of our communities.

Sometimes the issues to be addressed have a clear answer that simply needs to be built, but it is also perfectly valid to raise issues that have no foregone conclusion and ask that they be considered as part of the design process. In either case, the first step in responding to those needs is naming them, defining them, making them less amorphous and more tangible.

Furthermore, the team selected to fulfill the project - the architects, engineers, interior designers, consultants and construction contractors - have devoted their career to understanding the myriad aspects of design and construction. They are instrumental pieces of the puzzle as translators, using their respective capabilities to turn the words of the owner into a built, real solution. And while they can propose possibilities, it is ultimately the owner who must determine the priorities. While many of the design and construction professionals have specialized expertise in medical facilities and larger trends, the health care providers themselves will have a far more intimate understanding of their own working patterns and methods. So it's critical that each area of medical specialization be represented and involved throughout all phases of a project. Furthermore, the owner can be empowered in the process by understanding what information is most important as the project proceeds.

The following are some of the more common issues related to OR design. They can serve as a useful way for an owner to prioritize their own needs and gauge the success of built projects (both their own and case studies used in preliminary research). As a general statement, there is a famous axiom in the construction world: Cost, quality, time. Of these, an owner may prioritize any two, but never all three - the third will inevitably suffer for the sake of the others. That is not to say that the owner will have to accept one of these items being beyond any control; it is a 3-way balancing act. While it is completely feasible to keep all three qualities in check, the owner should be aware that the degree to which one or two become extraordinarily important will have evident repercussions elsewhere. Beyond this acknowledgment, some of the more specific issues are:

1. Aesthetics, the qualities of a project in which the value is intended to be psychological or emotional rather than directly functional (at least in any directly measurable way). Aesthetics are an admittedly tricky issue in health care work, heavily subjective, and the ephemeral qualities of a place are often difficult to discuss in a way that can be shared and considered with the same clarity as physical fact. It is simple enough to describe the material reality of a place - its dimensions, colors, noisiness, temperature - but language fails when trying to describe how it *feels*. We are forced to speak in metaphors which are not quantifiable or reliable, often sounding more like a snake oil sales pitch (is there any way to definitively confirm that a given lobby is, in fact, gracious, peaceful or inspiring?). What's more, when considered strictly in the context of the core procedures being performed in an O.R., aesthetic considerations can

understandably be relegated to an unnecessary luxury (and a correspondingly difficult cost to itemize on a patient's bill).

Because of this, aesthetic design is often limited to one of two functions: decoration (e.g. a pattern in floor tile or an accent color for vinyl corner guards) or marketing (the public face of a business, a built icon). But if it is approached with seriousness, rather than frivolity, the results of aesthetics can be very real, meaningful and even pragmatic (albeit difficult to measure). Increasingly, facilities are putting value in design qualities associated with emotional welfare, pursuing enriching environments for their patients and staff as part of an holistic approach to health care (with due care not to interfere with the professionals' practice, of course). Consideration may be given to careful daylighting and connections to life outside the walls of the operating room, often in lieu of luxury-priced interior materials. The degree to which an owner values these qualities has become an important factor in the selection of the design consultants and choosing where to spend the project's finances.

2. There must be a proper assignment of spaces to support the mission of the facility. Effective space assignments must be predicated on a careful evaluation of the procedures to be performed, the projected volume of cases, and the equipment and staffing levels required. For preliminary planning, rules of thumb such as "1,000 cases per operating room per year" or "2-to-1 recovery beds per operating room" may be used, but these should be tested against actual turnover rates and patient recovery times. Statistical databases should be used for projections if possible, but more importantly, staff experienced in the specific operation proposed should be consulted.

3. The square footage, proportions and ambient atmosphere of each space must be commensurate with the task to be accomplished in that space. This involves an analysis of the microactivity of each space and encompasses equipment; work space requirements; zoning; ergonomics; anthropometry staffing levels; patient and visitor volume; communications; life safety systems; occupational safety systems; heating, ventilating and air conditioning systems; lighting; infection control; supplies; and maintenance.

4. There must be good flow. This is the vascular system of the facility. The importance of good flow cannot be overemphasized, and planning involves the acceptance, segregation, controlled interface, distribution and discharge of patients, medical staff, paramedical staff, pharmaceuticals, equipment, sterile supplies, nonsterile supplies, normal refuse, biohazard ("red bag") refuse, instruments, facilities engineering and biomedical engineering.

5. The spaces and systems must be flexible and capable of responding to change with minimal disruption. Provisions must be made for modifications of the initial design resulting from fine-tuning, miscalculations or medical practice evolution. Suggestions include:

- structural design to facilitate vertical or horizontal expansion;
- life safety design to facilitate occupancy and licensure upgrades;
- shell space within the facility for future internal expansions;
- soft space within the facility (i.e., spaces that can be used readily by adjacent spaces as the need arises);
- and
- modular furnishings and partitions as opposed to hard walls and millwork.

6. The design must maximize support at minimum staffing levels.

With emphasis on minimizing full-time employees and maximizing productivity, more patient and facility coverage per staff member will be needed. Centralizing functions and command points to the greatest extent possible will be mutually beneficial to patients and staff. Design suggestions include nurse station/bed station pods, shared preoperative/stage II recovery cubicles, adjacent centralized nurse work and administration, and computerized information transfer for charts, medical records and supply tracking.

II. THE PLAYERS

Once good design has been defined as it applies to the prospective project, consideration should be given to the entities required to plan the project. In broad terms, these are:

Owner

Owner refers to the individual or collection of individuals for whom the project is being planned and constructed. The owner is the visionary who provides land, time, money, the design mission statement and the method of project delivery. The owner may or may not be the user of the facility. Typically, the following are also included in this category although they may be contracted to, rather than work in the direct employ of, the owner: attorneys, accountants, lenders, insurance carriers, security forces and facilities maintenance. The owner's influence and control over the planning and construction process is greatest at the project's inception and diminishes progressively over time as more and more people become involved in the process. Conversely, the owner's vulnerability to cost is least at the project's inception and greatest as construction nears completion.

Users

Users are those individuals and groups who will occupy the facility that is to fulfill the mission statement formulated by the owner. They include executive management, administration, medical personnel, pharmacy, infection control, medical records, admitting and discharge, clinical engineering, biomedical engineering and materials management. To fulfill the owner's mission statement, the users must be committed to the project design. A communications system and incremental signoffs are crucial to progress and to the users' ultimate satisfaction. It is important that realistic expectations consistent with the owner's original mission statement, schedule and available resources be maintained within this group.

Consultants

Consultants are individuals or groups who are retained directly by the owner or are subcontracted to another consultant or contractor depending upon the project delivery method selected by the owner. Areas of expertise in which they furnish services include marketing (demographics, statistics, preferences); facility analysis (utilization, efficiencies, resource assessment, time/motion studies); predesign service (code compliance, code analysis, space programming); cost control (budget formulation and tracking); regulatory assistance (Certificate of Need [CON] assistance, health department, zoning department, building department); planning (facilities master plan, traffic, environmental); surveying; architecture (building and landscape); interior design; graphic design; engineering (geotechnical, civil, structural, fire protection, mechanical, electrical and plumbing); equipment planning (medical and food service); conveyances and material handling (elevators, dumbwaiters, track cart systems); telecommunications; data systems; and audiovisual systems.

Consultants are responsible for analyzing information furnished by the owner and users and transforming that information into useful documentation that is consistent with the owner's mission, appropriate design practices and all applicable laws. It is important to recognize that consultants are "mechanics" who are highly skilled in assembling the parts given to them by the owner and users. In the absence of specific information, they tend to rely upon their best judgment from previous projects, but those best judgments may not coincide with the owner's and users' perception of good design. Hence, it is important to define "good design" as previously discussed and track and comment on the consultants' work at each increment of planning development.

Consultants have a large amount of information to coordinate and consequently an enormous impact upon the functional and financial success of the project. Therefore, it is essential that they have substantive experience in the project types being proposed and demonstrate solid reliability through good performance references from previous project owners. Retaining local consultants will facilitate

accessibility and reduce costs, but when local talent is not available and it becomes necessary to obtain out-of-town consultants, then it is advisable that they have experience in the local code jurisdiction.

It is a good idea to tour as many projects as possible and solicit recommendations from the widest possible spectrum: contractors, chief executive officers, administrators, users and the facility's personnel. Recommendations should speak not only to the design competency of the consultant but also to costs incurred as a result of errors and/or omissions. It is advisable to tour the consultant's office to ascertain personnel and equipment resources, understand methods of project delivery and construction follow-through, and see examples of communication capabilities. Many owners and users do not understand blueprints but are reluctant to admit it. It is important that the communication skills of the consultant be compatible with the owner's level of design and construction expertise so that there is mutual confidence in the appropriateness of the end product.

Authorities Having Jurisdiction

There are many authorities having jurisdiction over any single project. The list that follows will vary from state to state. For example purposes, the state of Florida is referenced here and excludes agencies involved in raw land development, which in itself is a very time-consuming process. Authorities having jurisdiction may include:

- state certificate of need (CON) program office (not required in all states);
- state health department (operational licensure, plans and construction review and approval);
- state insurance commissioner and/or state fire marshal;
- state department of environmental regulation (water, air quality, extension of sewer systems, incinerators, gas-fired boilers, asbestos, ethylene oxide sterilizers);
- regional water management district office (protected waterways and wildlife);
- local planning and development department (zoning);
- public utilities (water, sewer, solid waste, electrical);
- public works (traffic, storm water, solid waste); and
- local building department (local building code enforcement, local fire marshal, building permits, structural, heating, ventilation and air conditioning, plumbing, electrical, handicap accessibility, energy consumption and elevators).

The above entities have direct legal authority with regard to all project reviews and approvals. Project circumstances will dictate compliance and potentially specific review and approval as well by agencies such as:

- public lenders (federal, state and local grant; bond and tax authorities);
- private lenders (endowments, trusts, banks);
- insurance carriers (factory mutual);
- U.S. Department of Justice (Americans With Disabilities Act);
- U.S. Department of Labor (Occupational Safety and Health Administration);
- U.S. Environmental Protection Agency (asbestos, polychlorinated biphenyls, carcinogens);
- federal and/or state energy efficiency agencies; and
- federal building standards (Veterans Administration, U.S. Department of Defense, U.S. General Services Administration, U.S. Department of Health and Human Services).

Organizations that have no legal mandate but whose standards must be met for voluntary accreditation include Medicare/Medicaid, the Joint Commission on Accreditation of Healthcare Organizations and the Accreditation Association for Ambulatory Health Care, Inc. The planning process will be greatly facilitated by meeting with all the various authorities having jurisdiction at an early stage of development and keeping them in the communication loop throughout the planning and construction process.

Contractor

The contractor, although referenced in the singular, is a conglomeration of many subcontractors, tradespeople and vendors. Frequently, in order to simplify contractual ties and provide centralized management, a general contractor is retained; the owner singularly contracts with the general contractor, who in turn executes and manages all other subcontracts. This arrangement simplifies the owner's task since the general contractor is the single source of delivery and liability in connection with the construction of the project. The general contractor is compensated for the assumption of overall management and liability by adding overhead and profit fees onto each subcontract and the work performed by the general contractor. Costs can be reduced in proportion to the degree the owner separately contacts, manages and assumes liability for individual tradespeople and vendors. Selection of the delivery method is an important consideration in the planning stages because some methods introduce the contractor into the planning process as it is developed, and each method requires different methods of approach and documentation. The various project delivery methods are detailed later in this article. The contractor, as transformer of drawings and words into physical construction, has tremendous influence over the quality and cost of the project. Like the consultants, it is essential that the contractor have substantive expertise in the proposed project type, demonstrate solid reliability and have experience in the local code jurisdiction. A careful investigation into the "track record" is crucial, including financial history, bonding capability and past litigation.

III. THE PROCESS

The planning process is analogous to molding and then putting together a jigsaw puzzle, but with a systematic approach. Starting with a mission statement, individual pieces with amorphous edges are developed, each contributing a fractional element to the overall design. Once the elements are defined, their proximity and continuity to each other is tested and the edges are shaped, then a continuously interlocking picture is developed. With this as a mental picture, the process is systemized as follows.

Strategic Planning

Strategic planning in its purest form is a written and committed goal statement in which the owner identifies target markets, assesses the products and services needed to serve the markets, compares the required resources to the resources available and develops a step-by-step strategy to invest the additional resources over set increments of time. The strategic plan should clearly itemize the objectives and remain consistent with the philosophy of the institution it serves. This level of planning is generally executed by the founding or executive management of the health care organization with the help of outside marketing, financial and facility analysis consultants as required to supplement the owner's expertise.

Master Planning

Master planning assesses the land and facilities available to meet the strategic plan and, by written and graphic means, projects the required land use and facility expansion over set increments of time. The expansions should be ordered and located in a manner that will not impede successive expansion yet will take advantage of and maximize the utilization of existing infrastructure and resources. The steps taken in master planning generally are:

1. Evaluate the physical condition of the existing facility and its suitability for current and future uses.
2. Analyze past utilization and volume from historic data.
3. Formulate future utilization and volume projections validated against the strategic plan.
4. Update the strategic plan, if necessary.
5. Identify major planning groups (surgery, radiology, laboratory, examination, procedures, admitting, administration, etc.).
6. Develop a program for space, identifying the square footage requirements of each planning group.
7. Determine phasing and land usage.

8. Develop graphic blocking plans that depict planning groups and phasing.
9. Evaluate infrastructure renovations and expansions.

Certificate of Need (CON)

Not every state has a CON law, and not every health care facility is subject to CON review. The CON process is mandated by individual state legislatures. The intended goal is to maintain reasonable parity between health care services provided in a region and the needs of that region's population. The process is highly bureaucratic, at times unavoidably subjective and often subject to political pressures and challenges from both opponents and proponents. Processing of CON applications varies, but a reasonable allowance would be five months. Generally the process consists of:

1. Letter of intent
2. Application
 - a. Site plan
 - b. Small-scale schematic plan
 - c. Code compliance data
 - d. Space-to-workload ratios
 - e. Building program
 - f. Cost analysis (renovation costs, new construction costs, financial feasibility and source of funds)
 - g. Project schedule, including design, construction and operations
3. Submission fee

A reasonable allowance for preparation could be a year to a year and a half. Typically, consultants specializing in CON regulations are retained and receive support from various other consultants such as professional estimators, planners, programmers and architects.

Building Programming

Building programming involves a written analysis of how each operation in a major planning group functions and a description of the space associated with that function. Each functional space is identified and described in detail as to the number of people, number of workstations, equipment, environment, material stored and processed, functional goals and adjacency priorities. The floor area allotted to each space at this stage will be based heavily on assumptions of sufficiency. Since it is very difficult to enlarge the areas needed for spaces as the project proceeds, it is important to consider whether there is any reason to doubt whether these initial assumptions will suffice. Spaces in a department are added together to establish the net department square footage. This is multiplied by a circulation and wall factor varying from 1.20 to 1.65 to yield the gross department square footage. Ultimately, the sum of all department areas is multiplied by a factor of 1.15 to 1.35 to include exterior walls and support areas such as mechanical services spaces, elevators and building structure. The circulation and wall factors are derived from historic design patterns. Under the most basic contract terms, the owner will be responsible for the majority of the effort with assistance provided by the design consultant (usually the architect), but it is often shifted more to the design consultant as an additional service.

Project Budgeting and Scheduling

At the conclusion of building programming, a construction estimate is prepared. Generally, this estimate is based on comparative costs for other facilities of a similar scope. By contract, the designer is usually required to provide this as a basic service, but only with a relatively low degree of accuracy. Therefore, professional estimators (who may be independent specialists, employees of construction management firms or general contractors) are commonly hired as a worthwhile additional service.

The resulting total project budget should include land acquisition; building construction; equipment (medical and nonmedical, fixed and movable); data, voice and video systems; conveyance systems;

testing; jurisdictional fees; furnishings; graphics; art; the owner's services (project management salaries, office expenses and reimbursables); professional services (estimating, surveying, geotechnical engineering, design consultants, etc.); and reasonable contingency allowances for bidding, construction and scope creep. In addition, a project schedule is prepared, incorporating all stages of planning, design, jurisdictional reviews and construction.

Project Delivery Strategy and Consultant Design Team Selection

The formulation of the delivery strategy and the selection of the design consultant must be in concert with the budget and schedule. In fact, the budget and schedule should be considered as tentative until consultant selection and the delivery strategy have been determined and reviewed by the owner's project management and the consultant leaders. The method of project delivery will be influenced by the following:

- the scale and complexity of the project;
- the capabilities and availability of the owner's in-house design and project management resources;
- the owner's business plan;
- the degree of control the owner wishes to exercise over the management of the project and the corresponding degree of risk the owner is willing to accept;
- the magnitude and breadth of input and options the owner wishes to consider;
- the jurisdictional review process; and
- government and/or finance-driven restraints.

Methods of project delivery include:

1. Conventional Design/Bid/Build. In this method, the owner contracts with the design consultants, the project is completed through contract documents, and bids are solicited. Generally, the architect serves as the lead consultant with many, if not all, of the consultants hired as subcontractors. The responsibility for design coordination is delegated solely, or single-sourced, to the architect. Construction bids are submitted on a competitive basis with the award going to the lowest-price or highest-value bid allowed for in the bidding documents. The owner contracts with the chosen general contractor, who in turn subcontracts with the tradespeople required to complete the construction. This single-sources the construction, coordination and liability to the general contractor. Professional cost estimators perform cost checks to meet the budget at the conclusion of programming, schematic design, design development and document completion.

This method of delivery is advantageous because it maximizes the potential for the owner's input and control in the design process and allows adjustment of the project scope before committing to a construction contract. Success of this method is highly dependent upon a complete and well-coordinated set of contract documents. If the owner's in-house level of design and construction expertise is limited, consideration should be given to the program management approach. In this permutation, the program manager provides all development, management and design services for the entire project. Program management is offered by some architects but mostly construction firms. This method relies upon the program manager becoming intimate with and being committed to the owner's philosophy and strategic goals. The owner's confidence in the program manager's understanding of the owner's objectives is crucial.

If the owner wishes to become more directly involved in the individual trade contracts and has in-house contract management resources, then consideration should be given to the construction management approach. In this plan, the owner contracts with a construction manager at the outset of the design process to act as an agent of the owner and make recommendations in the owner's best interest. The construction manager provides continuous value and cost analysis of the design as it is developed. The construction

manager then solicits bids from individual trade subcontractors and assists the owner in the analysis of bids, schedules and contracts. This method is advantageous for large projects requiring multiple-bid packages for continuously phased construction such as may be encountered in existing facilities requiring renovations and/or additions with minimal disruption to ongoing operations.

2. Fast-Track Design/Bid/Build. In this method, it is of prime importance to expedite the construction completion. The owner contracts with a general contractor on a fixed-fee basis for the general contractor's services. The design and construction documents are prepared in packages consistent with the construction sequence of the project, and the general contractor bids the packages, which are then awarded through "change order" additions to the general contractor's contract with the owner.

A variation on this method of delivery is for the owner and general contractor to agree upon accomplishing the project for the sum of the cost of the individual scope packages plus the general contractor's fee, with a guaranteed maximum price. This method relies upon the owner, designer and contractor acting in close concert to negotiate and keep the quality and quantities included in the overall scope contained within the budget maximum.

3. Design/Build. In this method of delivery, the owner and general contractor agree on a guaranteed price based on the description of the project scope set forth in an owner's request for proposal. All design consultants and construction trades are subcontracted to the general contractor. The advantages of this method of delivery are that the contractor has direct control over the design product and can maximize economics and scheduling to meet the dictates of the owner's request for proposal. The success of this method is highly contingent upon the development of the owner's request for proposal and the owner's corresponding ability to live with the quality and quantity of design elements included by the design builder when those elements are not specifically addressed in the owner's request for proposal.

Schematic Design

Schematic design is the graphic transformation of the written building program into spatial form. It should communicate how the designer intends to meet the owner's needs at a diagrammatic level, with realistic provisions for the building systems, equipment, structure and furniture that will be designed and selected at a later stage. Before proceeding into this phase, it is essential that the building program and budget be revalidated through formal signoff by the owner and users. If the program and budget are not acceptable, they should be reworked before further design drawing proceeds. The detailed arrangement of equipment, furniture and cabinetry within each space is usually not developed at this stage, meaning that the areas allotted to each function by the building program will be assumed to be sufficient. If the owner sees any doubt in this regard, either by past experience or knowledge of changing space needs, it may be preferable to confirm area requirements by additional detailed design for select spaces. While such reworking will cause a delay, it may result in time, coordination and cost economies in the long run.

Schematic design is begun by studying the relative sizes and adjacencies of the functional spaces to each other. Bubble diagrams allow arrangement of the spaces that are interconnected by lines of varying line weight to depict the hierarchy of interconnectedness and scale. As these inter-relationships are validated, the forms of the bubbles are molded to approximate the lines and aspect ratios of wall construction, structural column grids and functional space proportioning. The design multipliers for circulation and infrastructure support previously applied in the building program are translated into space geometries and distributed within the interconnected bubbles. The total is then transformed into block diagrams, from which hard line overlays showing the spaces, corridors, walls and openings of the building floor plan can be generated.

From this floor plan, interior and exterior elevation studies are generated for concept review and acceptance. At the same time, the relationship of the project is evaluated against its existing context

through the development of a small-scale site plan. Finally, the quality of the material and systems proposed for use are organized by narrative sections in an outline specification book.

This schematic design package is validated against the building program and reviewed by the project team for the owner's edification and satisfaction. The schematic design, at this point, is cost-estimated for comparison to the budget still reserving all design, construction and scope contingencies. Again, the owner's approval should be formalized by signoffs. Jurisdictional review and signoffs are recommended and may be mandatory.

Design Development

The design development fleshes out the schematic design through the creation of more numerous and larger-scale floor plans, elevations, wall sections, system details and expanded specifications. By the end of this stage, the design team should be able to answer all questions related to *how* the building will be built and function, with only specific details and product selections remaining to be fulfilled. Layers of added information and coordination include:

- construction systems (foundations, superstructure, code classifications, load classifications, vibration isolation, wind, seismic resistance, special construction);
- civil systems (utility grid, infrastructure expansion, drainage, grading, excavation, roadways, sidewalks, exterior lighting and other site features);
- life safety systems (occupancy loads, exiting and egress, stairs, compartmentalization, fire extinguishing, alarms and initiating devices, flame spread and smoke ratings, wall construction types, fire ratings);
- architectural systems (doors and hardware; windows; millwork; casework; plumbing fixtures; fixed equipment; movable equipment; owner-provided equipment; finishes; furnishings; ceiling materials and layout; special construction features, particularly those requiring coordination by other consultants; acoustical treatment; elevators; and conveyance systems);
- mechanical systems (heating, ventilating and air conditioning systems; pressure zones; fire and smoke dampers and detectors; ductwork; equipment; smoke control systems; operation sequences);
- electrical systems (fire and smoke detection; activation and alarm systems; electrical riser and diagrams; service voltages and conductor systems; equipment; audiovisual equipment; data and telecommunications equipment; normal and emergency power systems; lighting);
- plumbing systems (life safety fire protection equipment, plumbing equipment, risers and distribution, medical gas systems, waste systems); and
- special systems (food service, radiation protection, owner-provided equipment).

In many instances a book is prepared with a section devoted to each room of the building. In each section a floor plan, ceiling plan and all wall elevations are shown with all equipment, cabinetry, furnishings, lighting, critical dimensions, etc. In addition, a check list of features is itemized along with special notes. Just as in schematic design, this package must be reviewed, priced, approved and given a formal signoff. Again, jurisdictional reviews are advisable and may be mandatory.

Contract Documents

The contract documents are the legal attachments to the contract for construction between the owner and the constructor. They must fully define the scope of the work to be provided in accordance with all applicable laws and commonly accepted engineering practices and are composed of the drawings and specifications prepared by the design consultants. The drawings are organized by design discipline; the specifications, by a 16-division industry standard developed by the Construction Specifications Institute. These divisions are for reference convenience only, since the integrated sum of the drawings and specifications represent the scope of the work. This is particularly important when the project delivery method utilizes packages, by which cost and contract aggravation can become significant owing to the

increased potential for gaps in coordination responsibilities between packages. By the commencement of the contract documents phase, all of the basic design and component selection decisions should have been made. This phase represents an exponential increase in the complexity of coordination, documentation and production work hours from all previous phases. A single sheet of drawings on average represents a minimum of 40 work hours. A single change affects an average of 20 sheets of drawings and their corresponding specifications. Changes in design during this stage can be expected to have a significant impact on corresponding costs and schedules. This being said, however, it is significantly less costly to make changes at this stage than to wait until construction.

It is important that the owner remain involved in the review of the contract documents, although the emphasis will move away from the medical design team to the owner's project manager and facilities and technical staff. At the conclusion of the contract documents, the owner's technical department heads and each department to occupy the facility should receive the documents, be given ample opportunity to review them and then review all comments or questions with the project management and consultant teams. Only with final approval of the owner should the documents then be released for final bidding and construction.

IV. HINTS FOR SUCCESS

1. To maximize your influence, become involved in the design process as early as possible, even as early as the strategic-planning phase.
2. Put a project manager in place as early as possible, but absolutely no later than the programming phase. It is imperative that a single source who has a detailed understanding of the owner's goals and who is the full-time advocate is in place.
3. Interject the right types of thinkers at the right moments of development. Basically, use your global thinkers when the process is global and your detail thinkers when the process is in its detail phase.
4. Put your managers and staff who will run the proposed facility in place as early as possible. People who will actually work in the facility will have the commitment that comes from being given a charge and knowing that they will have to live with it and in it. People who do not actually have to work in the facility tend to interject their expertise from a more political and detached perspective.
5. Share concepts with and get to know jurisdictional authorities as early as possible. They are far more cooperative with teams that include them than those that regard them as an impediment or necessary evil.
6. Investigate case studies. Chances are very likely that your project's needs have already been considered by other facilities with varying degrees of success. Learn from their experience, and pass that knowledge on to the design team either by your own input or by including them in the research itself.
7. As the design work proceeds from schematic to detail, organize the unresolved issues accordingly so that they can all be addressed and incorporated when their time comes. Doing this, the owner and users can gain confidence in the final success to come from the process.

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