Construction and Renovation

Why does it cost so much to build or renovate space? Why does a construction or renovation project take so long to finish? Who is responsible for the construction process? What *is* the construction process? We could restate the meanings hidden behind these questions as follows: "There aren't enough dollars to build it right, so something has to go." "We didn't plan for the building, but we needed it yesterday anyway." "Those responsible for the funding and program should be in charge of construction." "Whatever the construction process, make sure it's speedy and economical." Planners might respond to these concerns with the following suggestions:

- Define and develop specifications for the program before you develop the budget.
- Planning, design, and building take a long time; plan on it.
- Only one person can be responsible for construction--the chief campus officer.
- Take the time, and include the people, it takes to build it right.

Construction should be the culmination of the planning process. But what does it take to get to that point? What elements of the construction planning process assure its success or failure? The basic steps leading to construction are program definition, program delineation, and design and documentation.

Program definition

It seems a simple, logical concept: you have to know what you are going to put into a space before you can build it. Yet many projects get planners into trouble precisely because not enough effort is spent at the start defining the project's scope. Too often, pressure to meet a critical need for space or to meet funding deadlines precludes the development of an adequately defined program statement. The program definition should include no less than the following: a title and description of the program, a primary program focus, and the primary activities that are to occupy the structure.

The **program description and title** should include not only the eventual name of the structure but also a description that conveys to the lay reader the purpose for the building. This should be a concise and clear statement that will last throughout the life of the project.

The **primary program focus** should describe the utilization that will occupy 70 percent or more of the assignable space in the structure. As a guideline, planners can rely on the traditional functional classifications associated with the academic medical center--i.e., instruction, research, clinical services, library, institutional administration, and support services. This section of the program definition should also include the campus zone into which the building fits, limitations on infrastructure capacity, any environmental and community agendas, criteria associated with the campus character, and an estimated "life term." This section should not include the budget. The most important thing to convey to the lay reader is why the building is needed. In this statement, planners should summarize the results of the campus study or needs assessment that planners used to move the project into the campus's list of priorities for capital programs.

The **primary program activities** that are to occupy the structure must be defined as follows:

Organizational relationships: To the extent that different organizations will be housed in the new structure, the scope of each should be explained. The explanation should include the subsets of the organization(s) that will move to the new structure and should explain how those units work with the balance of the organization. Areas of commonality and dependence should be developed.

Program relationships: The extent to which certain programs depend upon and/or achieve benefit from others should be explained. This section should also explain the extent to which activities are influenced by elements exterior to the building, such as the public, deliveries, and security.

Program scope: How large is each program in terms of numbers of employees, visitors, and students? What is the composition of the staff and what is the direction that each of the major activities in the building expect to pursue?

Special considerations: Any other factors that will have an impact on space design--e.g., the need to accommodate large equipment, extra floor-bearing capacity, natural lighting, soundproofing, limited access, and any needs that are peculiar to that group or individual activity--must be identified on an activity-by-activity basis.

All of the above must be developed in enough detail so that the designers can understand the facility's space "packaging" requirements, the space planners can site the building and apply acceptable standards or guidelines for allocation of space, the financial staff can estimate the project costs, and the campus leadership can support and market the project.

Program delineation

The next step in the programming stage of a capital project involves the conversion of the program definition into space layout. If the program definition is too vague, or if the descriptions of activities cannot be expressed in space parameters, the project will have little chance of meeting prospective users' expectations, of staying within budget, or of being completed on time.

The conversion from program definition to actual space assignments is usually completed in one of two ways: by determining how much of a type of space can be built for a set amount of available or projected funding (the wrong way); or by applying standards or guidelines that represent experience obtained from developing like or equivalent space (the right way).

In addition to understanding the need for a responsive programming stage of the construction process, all parties involved with the process from program approval on must be sure they are using the same terms to refer to the project budget. Although the appendix to this publication contains a complete dictionary of space definitions, a few terms warrant additional attention as they relate to the budget (construction and project costs) and to space (gross square footage and assignable square footage):

Construction cost: total cost of the shell, interiors (less moveable equipment), mechanical equipment, building-site development, and

logistical and servicing systems. In practice, every cost except fees to ready the building for occupancy.

Project cost: total cost of completing the building, including fees.

Gross square footage: all space in the building measured from the outside of the building walls. Represents 100 percent of the space budgeted and to be built.

Assignable square footage: only that space, measured from the inside of the walls and ceilings, that is actually occupied by program activities.

Keeping these definitions in mind, and remembering always that accurate program definition and delineation are prerequisites to a successful new building, we can address two additional considerations that affect the *renovation* of structures. The first consideration is obtaining adequate information about the quality of a building's space to determine when to discontinue renovation, maintenance, and occupancy. The chapter on obsolescence planning provides information and measures to be used in making such a decision. The second consideration is the imperative need for surge space to accommodate the program activity housed in the space that is to be renovated. Surge space is defined as "temporary replacement space required for a short term while permanent space is readied." General experience shows that, without adequate surge space, a renovation can cost up to twice the amount of a like project with surge space and can take up to twice as long to complete.

The programming phase for renovations should be no less rigorous than for a new building. The start and finish of the capital process should also be no different. The full process is outlined later in this chapter.

Design and Documentation

The essential requirements at this stage of the program development process are accuracy and thoroughness. The architect must accurately depict what the program narrative describes in understandable design terms, and the drawings must be thorough in order to leave no margin for misinterpretation by the contractor. There is probably no greater area of exposure in which a project can go wrong than the interface between the

architect and the contractor. That interface has as its primary focus the reading and understanding of the project's architectural documents.

Who Is in Charge of Construction and Renovation?

Unlike most areas of administrative support, in which one person takes charge, responsibility in the capital planning and construction processes is not always clear-cut. Everyone seems to have a say in the project, and if they don't, they want to (sometimes with good cause). There are many ways to manage the responsibility for construction and renovation. Ultimate responsibility rests with the vice-chancellor or vice-president for administration or the equivalent.[1] From that position on down, there are several different involvement scenarios. They usually can be grouped into three organizational frameworks: longitudinal, segmented, and phased.

Longitudinal responsibility takes all of the organizational units that have responsibility for part of the capital construction or renovation process and places them under one manager. The organizational units under one manager in this configuration would include capital planning, architect and engineers/design, environmental health and safety, construction management, inspection, maintenance and operation of plant, and plant accounting and capital budgeting. All the responsibility, both reward and blame, rests with one organization.

The primary benefit of this organizational arrangement is that it facilitates a faster and less expensive process because communication is easier and timelines for interaction between units can be shortened. The primary negative aspect is that, with the time pipeline in the capital process lasting as long as 10 years, mistakes and mismanagement can stay undetected for a long time. When using a longitudinal pattern of responsibility, it is imperative that planners build into the capital process an evaluative mechanism, usually in the form of a high-level review committee that measures the organization's effectiveness against a set of performance criteria.

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[1] The frame of reference for titles used in this chapter is a freestanding health sciences institution. Readers from institutions that are part of a larger university can translate these titles according to their own situation. "Vice-chancellor or vice-president for administration," for example, might become "assistant vice-president for administration."

Segmented organizational arrangements are the most typical in universities. Specifically focused units are assigned to various managers, none of whom has responsibility for the complete process. This type of configuration relies on the match, or lack thereof, of responsibilities to personal management strengths.

The primary benefit of this arrangement is that the institution can mix and match organizational needs to individual management capabilities and requirements to experience. The primary negative aspects are that it raises questions of who is really in charge and lends itself to intra-organizational competition (which is not necessarily all bad).

Phased organizational patterns originate with one basic objective in mind: to separate the operational demands of the campus from the forward-looking (i.e., planning) and evaluative (i.e., feedback) activities. The reasoning behind such a pattern is that operational demands can absorb all of an institution's resources. This form of organization divides responsibility into time phases--i.e., events that have already happened, current events, and events that may or could happen.

In this format, plant maintenance and operation represents a completely operational function, while the capital planning office typifies a forward-looking office best isolated from the rigors of everyday crisis. Plant accounting would fall within the past, and units such as architects and engineering and environmental health and safety would fit into either a current or future organizational grouping.

The primary benefit of a phased organizational arrangement is that it clearly leaves some staff to look back at what happened and try to correct it by looking ahead, unencumbered by the workload of today and tomorrow. The primary negative aspect, again, is the difficulty of not knowing who is in charge of the continuum of a project from conception to occupancy.

The following matrix summarizes some of the above alternatives, although experience has shown that there is almost no limit to the mix and match of organizational variables.

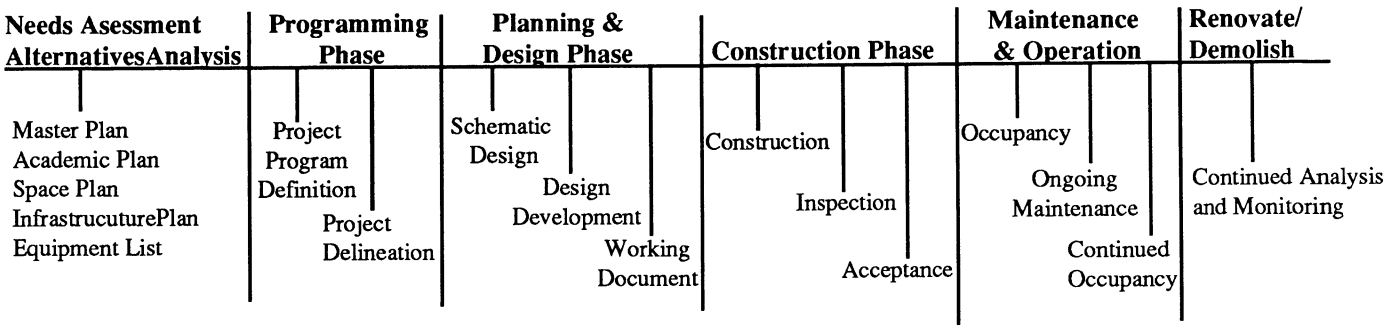
	Types of Organization		
Areas of Responsibility	**Longitudinal**	**Phased**	Segmented
Capital Planning	A	P	P
Capital Budget	A	P	F
Architects & Engineers	A	P/O	P
Envir. Health & Safety	A	P/O	P
Project Management	A	O	O
Inspection	A	O	O
M & O Plant	A	O	O
Plant Accounting	A	O	F

Management Assignment:
(A)dministration
(F)inance
(O)peration
(P)lanning

Alternatives to Managing the Construction Process

Construction and renovation follow a fairly straightforward process. The important question is not so much "How is it done?" as "Who does it?" "When?" and "How many resources will it require?" The process can be explained simply as identifying a need, developing a solution, securing the resources, and building a building. Another way to look at the total process is depicted on the diagram that follows.

Capital Project Phases



Internal Versus External Expertise

How much of the construction process should be managed externally? The answer will depend more on the location of the campus and its age, history, and tradition than on anything else.

The location of the campus can determine its ability to rely upon the design and construction services provided in the surrounding community. Large institutions located in densely populated areas can draw upon a large range of community-based resources to supply their design and construction needs. Whether campus leaders want to avail themselves of these resources and become more dependent upon their community is a product of tradition, attitudes toward change, and, in the end, dictated institutional policy. If there is a trend, it is for more and greater dependence upon the private sector, not only for construction but also for the study and design phases leading to construction. Over the last decade, many nationally-based firms have added substantially to their service portfolios, which now include everything from space planning to layout, interior and exterior design, engineering, construction, and construction management.

In the academic world, however, traditional wisdom and practice are hard to break. That wisdom holds that, "If it is to be done right, we have to do it ourselves." Although there is no set formula to conclude whether or to what extent a project should be managed internally versus externally, planners should address the following general questions if they consider changing the traditional approach to design and construction management: Will increased dependence on the outside add to the project costs? If so, are there offsetting attributes? What is the impact on time if a project is managed by one outside organization? Is competition generated by a larger number of firms doing business on the campus good for the quality of work done? Does more reliance on the outside mean a loss of control over the campus's future program? Is the institution at the mercy of the outside organization for completion schedules? Can you safeguard against this with adequate construction documentation? Are dealings with outside entities or individuals as "friendly" as dealing with campus staff? Are you prepared to deal more deeply, and at what risk, in the for-profit environment? Who is ultimately responsible for work done by an outside group? Is everyone aware of this assignment of responsibility? How can the overall architectural integrity of the campus be sustained given increased dependence on the outside?

There are other reasons for seeking outside help if you haven't already: you'll never know if it will be successful unless you try it; you can always remove an outside contractor from a project or preclude the contractor from future awards, which is not so easy on the inside; and if it doesn't work, you can always go back to what you were doing and use the experience as an evaluative example.

Responsibility for Project Management

Given the right mix of outside and inside expertise, how is the construction stage of the project best managed? The choices, for the most part, are management by the architect, the contractor, campus architecture and engineering or facilities management services, or a project manager. Someone must be responsible for the day-to-day management of the project, or chaos and cost overruns will prevail. History has taught that if the primary players in construction management--i.e., campus, architect, and contractor--are not compatible, trouble can be expected. One of these players is the eventual occupant--the faculty.

The decision as to who is in charge of a project depends in great part on a campus's construction history and its use of reliable professionals, but the use of the construction manager has been increasing. The essence of this approach is to designate one individual--either a member of the campus design-construction team or an outside person--to represent the campus in the day-to-day project operation. Although this approach is not new, what is new is the increasing involvement of the project manager early in the program definition stage. Participation in the planning phase gives the project manager a more thorough understanding of the project and thus gives that individual further wherewithal to coordinate with the architect and contractor. To assure the fit of structure to program, the project definition and delineation planner can be included through building occupancy. Regardless of what project management scenario is adopted, the active involvement of the project's sponsor or client (i.e., faculty) in every step of the project's development and management is essential to acceptance of the eventual project.

Timing of Construction

In addition to the confusion associated with who is in charge of the construction process, the other most pressing concern is the time it takes to complete a renovation or construction project. The time to carry capital projects from the "identification of need" stage to occupancy appears to be lengthening. Some of the most obvious reasons follow:

- Individual projects are being reviewed more intensely against the campus's master plan, and some situations call for a total update and revision of these plans.
- Environmental reviews and legal challenges (or the threats thereof) are requiring more initial justification of programs.
- Studies for alternative solutions to space needs, both in terms of other space or sites and costs, have increased.
- Lawsuits from contractors over inaccurate and/or incomplete construction documents are extending the degree of detail and time needed to prepare documents.
- In more complex projects, the amount of time-consuming "change orders" is growing due to rapid changes in technology during a project's development, incomplete working documents because of "fast-tracking," and changes in eventual occupancy.
- The state of the campus infrastructure has deteriorated to such a degree that time and funds have to be found and devoted to correct those deficiencies before dependent projects can commence.
- There are fewer construction and renovation funds for more projects, and many of the most desired projects are very utility-intensive and require complicated structures and support systems.
- Campuses are landlocked and require either site clearance or surge space before a project can start.

All of the above take time, incur the need for additional dedicated professional expertise, and thereby add to the project's cost. Some of the most common situations that are or can be part of a construction or renovation project and can add to its final cost in time elapsed are listed below:

Site clearance and relocation of old program	1-3 years
Master-plan update or verification of program needs	1-2 years
Program definition and delineation	1 year
Environmental and legal review	1-2 years
Design and documentation	1-2 years
Construction or renovation	3-4 years
Occupancy, move, and settle-in	1 year

This amounts to a range of from 5 to 15 years. No wonder programs change in the meantime, leaders leave, and costs increase! We can estimate from this breakdown that a 10-year time span is a reasonable planning target for a major new addition of campus space.

Costs of Construction

All of the elements described above--size and scope of the campus, organizational arrangements, methods of construction, and the time pipeline--generate costs. The outline that follows attempts to give relative weights to major cost components that comprise a final project budget of a general multi-purpose academic building.

The costing outline does not include costs arising from master-plan updates, environmental reviews, legal challenges and defense, program relocation before site availability, or inflation. It represents a template composite of building cost breakdowns associated with several major projects at a large academic medical center. Each campus will vary, of course, as will regions. The composite is simply a starting point, a checklist that can be presented as an overview of the elements of cost to a faculty member or other interested party.

BUILDING COST EVALUATION

I. Construction

Shell		
(1) Excavations and Foundations	70	
(2) Load-Bearing Walls and Columns	40	
(3) Floor and Roof Structures	80	
(4) Exterior Cladding, Windows, and Doors	70	
(5) Roofing and Waterproofing	20	
	280	
Interiors		
(6) Interior Partitions, Doors, and Glazing	65	
(7) Floor, Wall, and Ceiling Finishes	35	
	100	
Equipment, Specialties, Stairs, Elevators		
(8) Function Equipment (fume hoods, glass wash, etc.)	45	
(9) Stairs and Vertical Transportation	25	
	70	
Mechanical and Electrical		
(10) Plumbing Systems	45	
(11) Heating, Ventilation, Air Conditioning	100	
(12) Electric Lighting, Power, Communications	65	
(13) Fire Protection Systems	10	
	220	
TOTAL BUILDING		670
Sitework		
(14) Site Preparation and Demolition	30	
(15) Site Paving, Structures, and Landscaping	10	
(16) Utilities on Site	10	
TOTAL SITEWORK		50
SUBTOTAL BUILDING AND SITEWORK		720
Other Construction Costs		
(17) Security Systems and Fire Alarm Hookup	5	
(18) Utility Shutdowns and Air Balancing	10	
(19) Telephone and Computer Cabling	10	
(20) Keying and Signage	5	
(21) Asbestos Removal	10	
TOTAL OTHER CONSTRUCTION		40
SUBTOTAL CONSTRUCTION COSTS (BUILDING, SITE, OTHER)		760
(22) Construction Contingency	40	
TOTAL CONSTRUCTION COSTS		**800**

II. Fees

(23) Project Definition (legal/envir. review/mitig./bidding)	20	
(24) Design Consultant(s)	100	
(25) Special Studies (lab, landscape)	30	
(26) Inspection	10	
(27) Project Management	30	
(28) Contingency (fees)	10	
TOTAL FEES		**200**
TOTAL PROJECT COST (CONSTRUCTION + FEES)		**1000**

Contingencies are listed in both the construction and fees sections of the table. This represents sound budgeting--as the costs and responsibilities for each section belong to different organizational entities--and thus adds some degree of accountability for each.

The fee segment of the outline equals 20 percent of the total project cost. This amount appears about normal given traditional university cost-accounting for construction, but with the relatively recent additions of increased detail in programming, code-conformance requirements, and expanded demands for special studies, this fee segment is increasing on many projects. Given the complex design, testing, and study requirements associated with construction and renovation of high-intensity research and clinical buildings, it is becoming increasingly more common to see the fee segment of a research or clinical project approach and even exceed 30 percent.

As stated earlier, the costs of time--e.g., inflation and debt--are not figured into the calculations. These costs eventually will represent the items that must be forecast, budgeted, and included within the campus financial plan.

Although the above breakdown provides a general guideline of what the cost elements of a composite building might look like, it does not address the extent of costs nor the reasons for differences in total costs. Construction costs vary greatly due to three variables: the location of the medical center and the prevailing cost indexes associated with doing business in that area, the building site and the constraints associated with constructing on that site, and the nature and complexity of the building itself and the accuracy of the program delineation associated with each specific project.

While the cost categories that comprise all eventual project costs are similar, each project takes on an expenditure profile all its own. These differences are due to influences that are not only quite dissimilar from project to project, but can result in large variances even within a specific cost category. The cost variances, common to new construction as well as renovation, often emerge from circumstances involving either logistical and technical factors or factors related to human behavior and communication. With carefully, thoroughly planned projects, logistical costs can be forecast. They are variations that occur because assimilation requirements are not yet firm. They require adjusting the project's phasing and could result in

changes in space layout and some redesign. Costs due to behavior or communication, on the other hand, are usually either not expected or so situation-dependent that forecasting is almost impossible, other than on an all-inclusive contingency basis. They result from

- Disagreements between the project manager(s) and faculty regarding the precise nature of what is included in the approved project budget. These result in delays, change orders, and, sometimes, redesign.

- Alarm, reaction, and demands for mitigating measures on the part of campus neighbors and interest groups when construction projects intrude into or disrupt their real or perceived lives. This extends project completion periods, adds costs for redesign, and results in compromised access and environmental safety measures and possible litigation costs.

- Perceptions by those outside the campus design and construction profession that universities are just too difficult, bureaucratic, and restrictive to work with. Thus, collective wisdom and tradition demands that project estimates advanced to cover university-managed projects slide toward the high end of the cost of doing business.

- Contractors' perceptions that construction contracts are too restrictive and inhibiting. Therefore, incremental costs are built in throughout the project budget to cover the costs attributable to the lack of contractor flexibility.

- On-site project manager's inability, either through the lack of authority and/or fear of risk, to make timely changes in the project's scope. Resulting stoppages in construction for consultation absorb contingencies.

- Too many bosses--e.g., campus architect, project manager, budget director, president, faculty, dean--all with a vested interest and favored position. The costs of compromise and tinkering with a project to accommodate individual preferences can soon add up.

- Overreaction to suggestions and, at times, demands for mitigating measures (usually safety-related) that expand the scope of a project beyond need. This can affect not only the design, cost of material, and sequencing of the project, but may also result in a substantial residual cost of operation.

- Fear of litigation. This can result in increased cost and will add time to the project as all appropriate individuals and interest groups that could raise legal obstacles are pacified and/or rendered ineffective.

- Political gerrymandering--i.e., the change of a project in midstream due to any of a myriad of reasons, such as unexpected additional funding, a new dean with different objectives, potential recruitment or loss of a "star," or accommodation of an unexpected change in technology or emergency. This can result in total rebudgeting.

All of the above, and more, can surface before a construction project reaches conclusion. The increased costs can easily exceed a project's contingency reserve. Part of the success in project management lies in the ability to anticipate these factors and to plan for the unexpected. Of course, sometimes there just is not enough money, time, or vision to achieve that noble objective.

A final note: one of the benefits of integrating the campus's general financial ledger with the space inventory system is the ability to generate historic per-square-footage costs. With a computer interface in place and with several years of construction and renovation costing experience, a campus should be able to develop a cost-per-square-footage guideline. The guideline--expressed in current day costs--gives a range of costing experience, from a general office structure to the most complicated, utility-intensive research laboratory. Such a guide not only assists planners in estimating project budgets; it also gives faculty a better understanding of what it will take to house their expectations.

Additional Sources of Information

1. At Columbia University, planners in the office of the deputy vice-president for health sciences operations prepare detailed pie charts

to represent the actual cost of renovating space as soon as a job is completed and the account closed. Their library of such charts has been helpful in preparing estimates for different types of renovations in different types of buildings. For more information, contact Isis R. Wilson, deputy vice-president for health sciences operations, Columbia University, 630 West 168th Street, New York, New York 10032. Telephone (212) 305-5738.

2. *Facilities Planning News*, a division of Tradeline, Inc., publishes *Facilities Planning Handbook: Terminology and Practical Ideas for Planners*. The second edition (1990) contains (1) a collection of findings, recommendations, reflections, and warnings from facilities planners across the country; (2) a compilation of profiles of recently completed facilities projects, presenting the "vital statistics" and design objectives of selected biotech, corporate office, R&D, and training facilities; and (3) a glossary of more than 700 words and phrases related to facilities planning. For more information, contact Tradeline, Inc., P.O. Box 1568, Orinda, California 94563. Telephone (415) 254-1744.

3. A "project management by data system" merges data from the SARA Systems, Inc., Database--a capital projects database covering all phases of project management--and from the Association of University Architects (AUA) capital projects database. The data covers a period of 25 years and is the largest construction cost and project database ever organized. The system, usable in desktop and portable PC environments and UNIX mini/mainframe environments, provides a standard format for calculating and comparing project areas, costs, and schedules for facilities construction or renovation. Examples of uses:

   a. Using historical data from the data base, such as type of program and number of people, the system will calculate the amount of square feet required, the net to gross ratio of the building, and the cost of construction.

   b. The system will define a facility's condition based on the date of construction, subsequent renovations, and ongoing maintenance information.

For more information about the SARA/AUA system, contact Bruce H. Jensen, FAUA, 2319 Foothill Drive, Suite 265, Salt Lake City, Utah 94109. Telephone (801) 466-3613.

4. In 1988, Adamson Associates conducted a study of the factors influencing the costs of construction and renovation at The University of California-San Francisco, Parnassus site. For more information, contact Eric Vermillion, director of financial analysis, Office of Construction Management, UCSF, Box 0894, 3130 20th Street, San Francisco, California 94143.

5. See abstract of "Final Report of the Task Force to Review and Update the Planned Renovation of the Health Sciences" (1989), University of Washington (page 186).

6. See abstract of "180 Longwood Avenue Building Utilization Study" (1988), Harvard Medical School (page 174).

7. The following bibliography may also be of interest:

Braybrooke, S. 1986. *Design for research: Principles of laboratory architecture*. New York: Wiley and Sons.

Kershner, E. G. 1987. Why do university buildings cost so much? *NACUBO Business Officer*, Apr., 29-35. (National Association of College and University Business Officers)

Rush, S. C. and S. L. Johnson. 1989. *The decaying American campus: A ticking time bomb*. Association of Physical Plant Administrators of Universities and Colleges.