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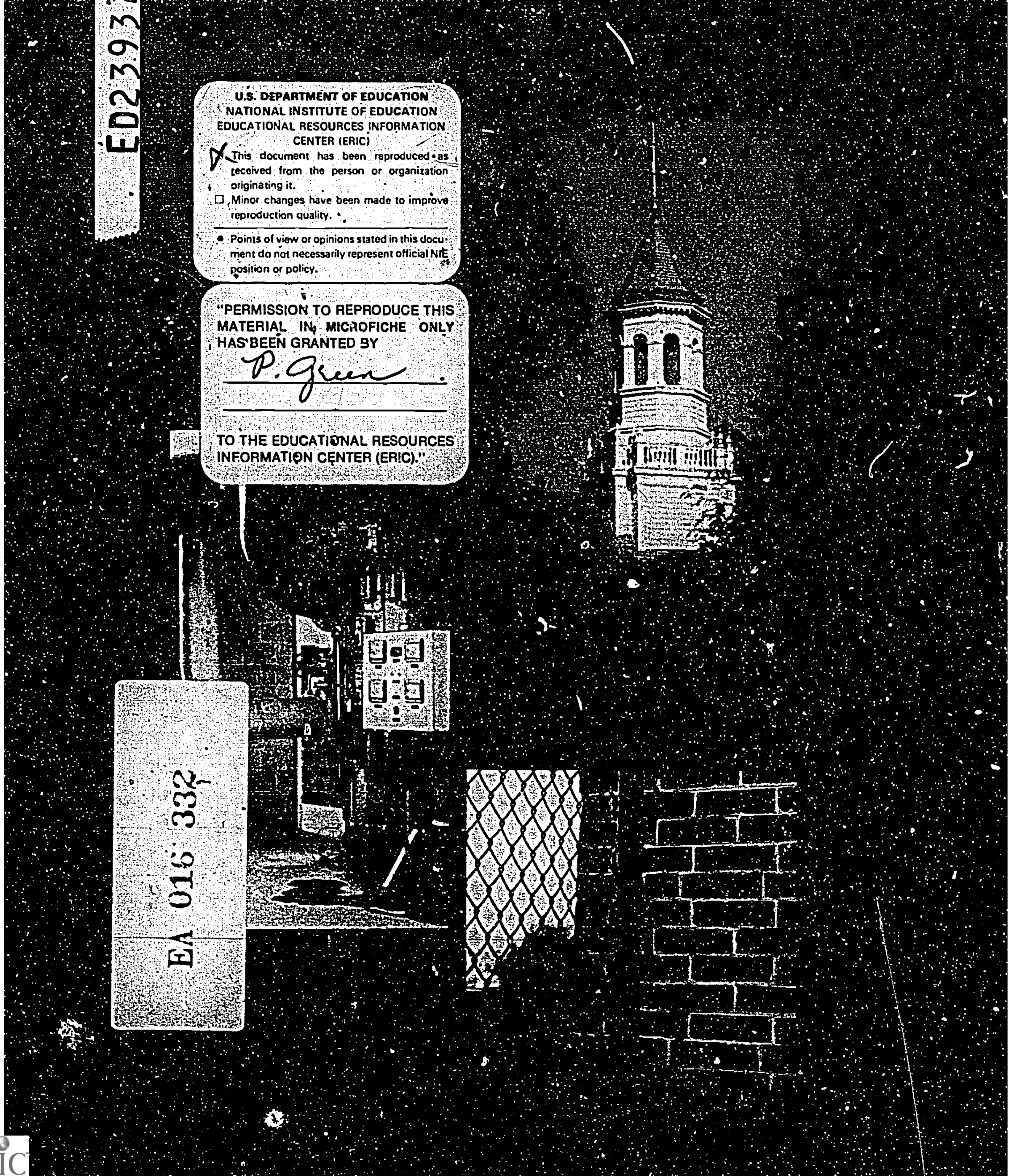
ABSTRACT

Contending that the physical plants of colleges and universities are deteriorating and inadequately fit existing institutional programs, this report diagnoses causes underlying this neglect and recommends strategies for upgrading campus care and management. Pointed out as fundamental problems are: lack of integration of physical plant concerns with the institution's broader mission; the low priority given physical plant needs; the isolation of the physical plant director from institutional decisionmaking; lack of awareness of requisite funding; ineffective management of physical plant staff; and inefficient use of institutional facilities. When these issues have been addressed, facility requirements can be integrated into academic planning. It is recommended that a facilities planning group be established to break down the isolation of the plant department and that the support of top administrators and trustees be enlisted. A thorough physical plant audit on which budgeting can be based is prescribed. Proposed methods of improving plant department management include setting work objectives, establishing training programs and advancement incentives, and considering contracting out services. Analyzing the fit between programs and facilities and allocating space accordingly are advised. A comprehensive energy management program comprising an energy audit and conservation measures is recommended, and some computer-based models for financial planning are described. (MJL)

CARING FOR THE CAMPUS PHYSICAL PLANT



CARING FOR THE CAMPUS PHYSICAL PLANT

A REPORT FROM EDUCATIONAL FACILITIES LABORATORIES
A DIVISION OF THE ACADEMY FOR EDUCATIONAL DEVELOPMENT

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Contents

Photographs in this report are illustrative of facility problems throughout higher education's campuses. Such examples do not imply that the institution did not recognize the problem or that repairs have not subsequently been made.

Foreword

The idea of this report was generated on a tour of a major eastern university. The tour covered all campus buildings, from roof to basement. In the attic of the building which might be termed Old Main were rags tied around wooden beams that support the roof. The rags in turn led to buckets. When it rained, water leaking through the roof dripped down the beams to the rags, which directed the flow of water into the buckets. During a rainstorm custodians would go to the roof periodically and empty the buckets out of a window. This was how the academic enterprise remained dry.

When the tour described took place, the term "deferred maintenance" had barely been coined. But with or without a name, what was occurring was the deterioration of one of the campus' major assets. The institution was not on the borderline of survival. Rather, it was completing a major expansion of faculty, students, and facilities. In fact, construction fences were still to be seen on campus. On the same tour, a stroll through the academic facilities revealed few classrooms in use. The resources of the institution did not seem in balance, for while new buildings were going up, Old Main was being kept dry by rags and buckets, and facilities across the campus were underutilized.

Preliminary research showed that this campus was not atypical of other campuses throughout the nation. Once space is built, it is forgotten about—left to the plant director to manage and to the faculty to fight over. In short, facilities rank low on the institutional agenda.

To research the depth of the problem, its causes, and possible solutions, visits were made to a variety of campuses—public and private, large and small—across the United States.

Campuses visited included Drexel University; Michigan State University; Ohio State University; Point Loma College; Purdue University; Rice University; Stanford University; Texas A & M University; the University of Chicago; the University of Illinois at Chicago Circle and Champaign-Urbana; the University of Nebraska; and the University of Redlands.

Conversations were held with various officers at these institutions, including vice presidents for business, administration, and academic affairs; physical plant directors; and assistant physical plant directors for maintenance and custodial care. The project is especially indebted to the following individuals who generously shared with us their information and wisdom: Theodore Simon, assistant vice president for physical plant, Michigan State University; Logan Council, former director of physical plant, Texas A & M University; and Robert Burch, director of physical plant, George Washington University.

This report is also indebted to EFL's Amy Friedman and Ellen Bussard for developing early drafts of the manuscript; Rhoda Kraus and Beryl Fields, who word-processed the document; and Nancy Ambler, who edited and produced the final publication. The research, photography, and basic writing was undertaken by EFL project director Sy Zachar.

Most important, we thank the Carnegie Corporation for its generous financial support, which made possible *Caring for the Campus Physical Plant*.

Introduction

A college or university campus is more than the sum of its buildings. It is the physical expression of the institution, its activities, and purpose. A campus provides a sense of place, a feeling created by the physical quality of its buildings, open spaces, landscaping, and setting—whether ivy-covered or urban gray.

A campus is a specialized place and its buildings are designed to house specific functions. While no one facility is unique to higher education, it is the only enterprise in our culture that brings together in one place offices, libraries, classrooms, research laboratories, residence halls, theaters, gymnasiums, heating plants, and maintenance shops. (1)

The campus physical plant is inextricably connected with an institution's mission. Campus buildings house the activities of students, faculty, and administrators. Equally important, the campus creates an environment that nurtures reflection, the development of ideas, and intellectual and personal growth—the essence of college and university missions.

The campus is as much an institutional legacy as the traditions and educational programs that are passed from generation to generation of students, faculty, and administrations. Historically, it has undergone change to meet new conditions and needs such as those arising from new areas of study. Changes in building technology—from the introduction of central heating and ventilation to gas and electric light to elevators to sophisticated climate control—have made possible new types of buildings and campus configurations. For example, until the advent of gas lighting, libraries could not stay open at night, and large enclosed lecture halls were not feasible until major improvements were made in fireproof construction as well as heating and ventilating systems. Changing teaching methods—shifts from small recitations to large lectures to individualized language and computer courses—have prompted construction or renovation of instructional space. Campuses will continue to undergo such change and renewal to meet new technological educational conditions.

In the early days of higher education in the United States, stewardship or responsibility for the campus rested firmly with the highest officer of an institution. The 1727 statutes of the College of William and Mary give this description of the president's role:

Concerning the President—Besides learning, and an unblemished good life, care must be taken that he be a man of prudence, and skillful in business, and industrious and diligent in the management of all affairs. . . . He must provide in due time that the edifices be duly kept up and repaired. (2)

8

The State of The Physical Plant

CAMPUS CARE

The physical plant of colleges and universities is suffering from years of neglect, and the resulting deterioration is nearing crisis proportions. If campus neglect is allowed to continue, the financial and educational integrity of many higher education institutions may also deteriorate.

The buildings, equipment, grounds, and hidden utility infrastructure that make up the campus physical plant require four types, or levels, of care to keep the campus in good condition, capable of meeting changing needs.

Custodial care is basically a housekeeping function, performed typically on a daily schedule. It includes sweeping and cleaning bathrooms; washing, waxing, or vacuuming floors; collecting trash from buildings, walkways, and grounds, and disposing of it; and washing windows and blackboards.

Maintenance can be divided into two basic categories: routine and preventive. Routine—or corrective—maintenance includes fixing a broken window, unclogging a drain, repairing a roof when a leak has been discovered, and replacing a burned-out motor. Preventive maintenance attempts to forestall the breakdown of equipment or systems and the deterioration of materials. For instance, such maintenance can ensure that bearings are greased, preventing the breakdown of a motor, or that a roof is inspected, checking deterioration before water seeps into a building. In the area of grounds, preventive maintenance includes pruning and spraying trees and shrubs, reseeding bare patches of lawn, painting benches and replacing missing slats, and similar tasks. Preventive maintenance is typically scheduled on a recurring basis.

Renewal and replacement covers the major overhaul and replacement of building and mechanical components related to the expected useful lifetime of each, or to the upgrading of outmoded systems to current technologies. Such care includes replacing plumbing and electrical components of utility systems, and replacement of floors, roofs, elevators, and heating and ventilating systems. In the area of grounds, such care includes replacing dead trees and shrubs, and repaving roads and walks.

These levels of care are related. Neglect of one accelerates the need for another, and just as preventive maintenance can extend the useful life of a motor, its absence will hasten corrective and more expensive maintenance. All three levels of care have been generally neglected on college and university campuses for many years, resulting in a large—often unacknowledged—backlog of repair work. In addition, the normal (and accelerated) useful lifetimes of many older buildings and their components have reached their peak. Generally, the useful lifetime of building components ranges from 15 to 50 years, depending on the item. These buildings and components continue to operate, but on borrowed time. Renewal now must be accomplished at a time when institutions are increasingly hard-pressed for financial resources.

Space realignment, the fourth type of campus care, focuses more on the function and allocation of campus space than on maintaining its structural integrity. Realignment is the mechanism through which an institution responds to changing needs for facility resources by renovating and reassigning them. It might include conversion of classroom space to offices or seminar rooms; conversion of a chemistry laboratory to a biology laboratory; or elimination of space that is unneeded, obsolete, or too costly to maintain.

Space realignment results from program changes and required modernization, and therefore is not regularly scheduled. If realignment calls for conversion of an entire building for another purpose, major building components are overhauled and replaced as part of the program change. If realignment is minor, such as a simple reassignment of office space to a different academic department, new paint and carpeting may be the only requirement.

UNRECOGNIZED NEEDS

Although those who use and those who are responsible for college and university facilities may be aware of some facet of campus neglect, they do not share a recognition of the magnitude and pervasiveness of the problem. Evidence of campus deterioration is not necessarily visible to the untrained observer. While peeling paint is seen there is little understanding of the real causes of their implications. Roofs and underground utility tunnels—frequent locations of serious trouble—are not commonly accessible. Other symptoms of neglect, such as the ungreased bearing that eventually failed and shut off all heat and air to a sealed building on one modern campus, are inherently invisible to most campus constituents. There are individual perceptions that the campus is not in top shape, and certainly "deferred maintenance" is a term widely used on campus. Because it is so widely used—and, depending on the user, can mean anything from a leaky roof to a complete facility renovation—we offer for clarification the definition formulated by the Nebraska Legislature.

Deferred maintenance shall mean any measure taken to correct structural or mechanical defects that would endanger the integrity of a building or its components or allow unwanted penetration of the building by the outdoor elements, or measures taken to correct a waste of energy, including minor repairs, alterations, and maintenance painting, cost of materials, hiring of building maintenance personnel, and other necessary expenses for the maintenance of roofs, exterior walls, retaining walls, foundations, flooring, ceilings, partitions, doors, building hardware, windows, plaster, structural ironwork, screens, plumbing, heating and air conditioning equipment, or electric systems, but excluding decorative finish or furnishing, building additions, or addition of additional summer-winter air conditions. (3)

Through time, a "desensitization" to campus neglect develops, and few institutional officers are willing to face up to the allegation that, as one plant director asserts, "deferred maintenance is no more than planned neglect." Fewer still are seriously attempting to correct existing deteriorating conditions or provide for adequate campus care in the near future. Without recognition of the need for campus care, such action on their part will be unlikely.

The occasional dramatic incident stemming from campus neglect—such as the sewer pipe that collapsed, causing a cave-in of the central quadrangle, or the broken valve that shut off all air to a hermetically sealed building, or the leaky roof that caused thousands of dollars in new equipment to be ruined during a weekend rainstorm—is all too often treated as an isolated occurrence and fails to prompt investigation into the causes. The scope of campus deterioration—both in physical and financial terms—is neither well documented nor understood at most institutions.

THE ECONOMICS OF CAMPUS DETERIORATION

There are two key ways of presenting the economics of campus deterioration to institutional administrators, trustees and funders: in terms of depreciation of assets, or erosion of endowment; and in terms of an invisible and growing deficit.

Institutions report at least annually on the state of endowment funds, and their leaders pay a great deal of attention to the status of the endowment. Indeed, size of endowment is considered a key indicator of institutional health. The recognized endowment portfolio, however, covers only cash, stocks, bonds, and other assets such as real estate.

The physical assets of the institution itself—the campus and its facilities—are not similarly measured and reported. Because institutions for the most part do not intend to sell campus facilities, the current value of the facilities is not computed.

Often the only time such a determination of value is made is when a building is used to secure a bank or government loan or when the campus insurance policy is renewed. Nonetheless, the campus physical plant usually represents the largest tangible asset of an institution, and deterioration of a campus reflects a real loss of endowment.

Another way to consider the financial impact of continued deferred maintenance and campus deterioration is to compute the real and increasing deficit it is creating. However, like its impact on physical plant endowment, campus deterioration is rarely calculated and is not reported in annual financial statements. Howard Bowen, R. Stanton Avery Professor of Economics and Education at Claremont University, observes, "Governing boards and administrators . . . are not made aware of these unacknowledged costs when they are appraising the condition of their institutions. A so-called balanced budget that may be a source of considerable satisfaction may not be balanced at all when capital costs are considered."

Bowen terms this practice "offsetting deferred maintenance assets," and links the two concepts of accounting procedures and declining assets:

The costs of colleges and universities are mainly in the form of cash expenditures, which are visible and easily recognized. They can readily be compared with cash revenues to reveal the condition of the budget. These cash expenditures, however, sometimes fail to cover completely one important type of cost, namely, the deterioration of assets when insufficient provision is made for their maintenance. Thus, when cash budgets are in balance, it does not follow automatically that total costs, including the cost of maintaining assets, have been fully recognized. What may be a balanced cash budget may prove seriously out of kilter. The cash budget of an institution reflects total costs only when enough money is being spent on maintenance or is set aside as reserves to offset the deterioration of assets. (4)

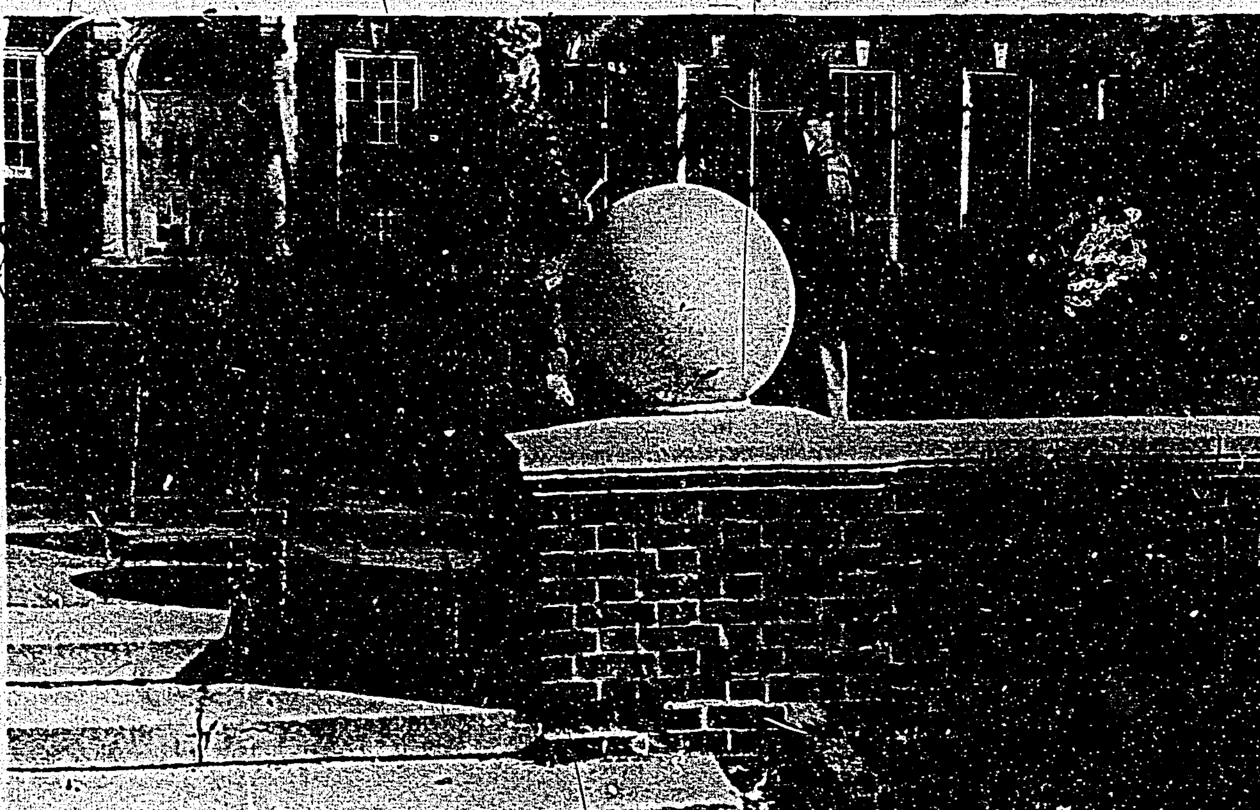
Institutions have developed the practice of deferring assets, assuming that the state government or a private donor will provide the funds necessary to offset deterioration. This strategy has worked in the past, but physical plant needs were not so grave as those now requiring attention. Bowen cautions, "There is no guarantee that financial backing to offset asset deterioration is poised ready to launch a rescue operation."

POOR UTILIZATION: AN INVISIBLE COST

Poor utilization of campus facilities represents another invisible cost to colleges and universities. Every square foot of indoor space on a campus costs roughly $3 per year to heat, light, and maintain.

Instructional space costs the same, whether it is used six hours per week or 30. Many institutions have unnecessarily spent $50 to $70 per square foot to construct space for a growing academic department, while paying operating costs for space assigned to another department that has reduced its program but not its space. Too many campuses operate more space than needed for their programs, spending money that could be used for other purposes. Not only does the cost of poorly utilized space fail to show up on institutional budget sheets, but without any method of accounting, departmental users see the space as being free. For institutions balanced on the borderline between the red and the black, inefficient use of space can exacerbate financial difficulties.

On campuses across the United States, a "desensitization" to campus neglect has developed. Note the paint peeling on art studio ceiling (above), and missing bricks on ornamental wall (below).



THE COMPETITION: INTERNAL AND EXTERNAL

To college presidents, trustees, and other institutional leaders, the condition of the physical plant is not as immediate as other problems that compete for their attention. When compared to changing enrollment patterns, financial aid requirements, faculty reduction, shrinking salaries, and library acquisitions, the condition of the campus and poor utilization of facilities can seem less urgent. In view of these issues, it is understandable that administration could easily postpone detailing the kind of information that would dramatize yet another institutional problem.

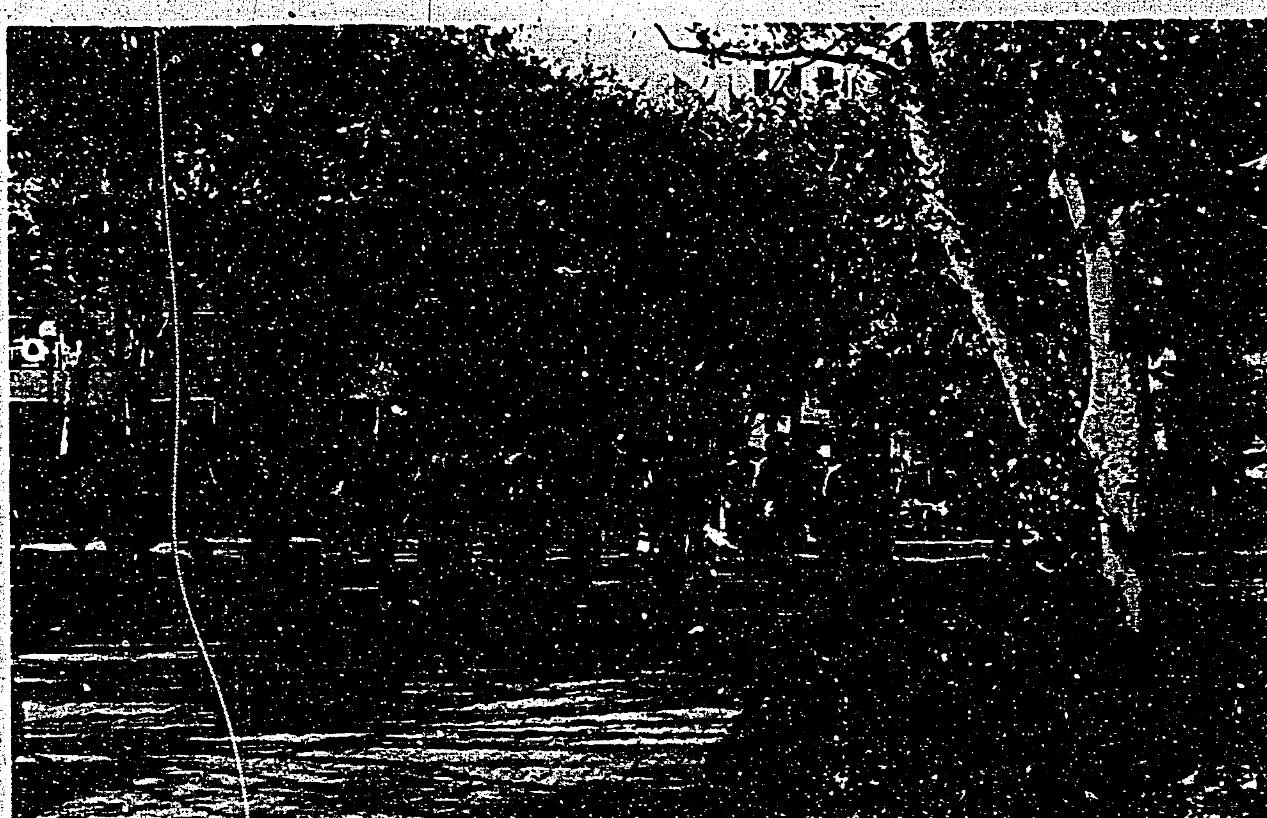
From the perspective of physical plant directors, institutional officers do not pay serious attention to the information that is volunteered them. The physical plant director at one university reports that each year he presents to his vice president a list of necessary maintenance tasks that must be forgone because of inadequate funding. This director sees no evidence that the vice president or other decision-makers positioned above him on the organizational chart are concerned about deferred maintenance. Physical plant directors across the country candidly acknowledge the problems of deterioration of their campuses, while vice presidents and provosts at the same institutions claim there are no such problems.

Not knowing the state of the campus may be a superficially safe position, since it precludes having to face yet another fundraising challenge. The position, however, is shortsighted. Governing boards and administrators must be encouraged and educated to recognize the problems of deferred maintenance and campus deterioration, and assume responsibility for maintaining and developing their institutions.

Figures available from institutions that have tackled the problems of the physical plant indicate their magnitude. At the University of Nebraska, neglected or deferred maintenance is put at $21 million. At a large eastern university, the figure is $17 million. For one urban campus less than 20 years old, $12 million in repair work is needed. Swarthmore College has completed an $8-million fundraising campaign for campus renewal. Yale University recently allocated $50 million to reduce the backlog of maintenance.

Such sums strain any institution's ability to generate funds. For example, the university with the $17-million backlog, cited above, can allocate only $1.75 million for immediate emergencies. If needed repairs are not made, and if custodial and main-

With changing demographic patterns, competition for students is keen, and a well maintained campus can prove an important factor in admissions recruitment strategies.



tenance care continue at reduced levels, the real deficit that institutions are incurring will continue to increase as problems multiply and grow into crises.

The challenges that higher education will face as a result of changing demographic and enrollment patterns only compound the problems of the physical plant. Although student enrollment is currently high at most colleges and universities, enrollment of traditional-age college freshmen is projected to decrease by the mid-1990s by 25 percent from a high point in 1979. Even with increased college attendance by older students, the Ford Foundation predicts ". . . it is almost certain that there will be at least 1.7 million fewer students to fill existing places in colleges and universities." (5)

Competition for capable students of promise will undoubtedly be brisk at nearly all institutions, and the quality of a campus is a strong selling point. A 1980 study by Cornell University's admissions office found that a visit to its picturesque campus was clearly the single most important factor influencing interested applicants to attend the university. As a result of the study, the admissions office has redirected resources to allow potential students to visit the campus.

A vice president of a major midwestern university states flatly, "You can't be a class institution if you don't look like a class institution." Maintenance and custodial care requisite to maintain quality appearance are important in attracting full-time as well as part-time students. For example, the academic vice president at a large urban university notes that a general level of dirt and trash at five o'clock has adversely affected enrollment in his institution's evening divisions. Without resources to maintain the campus, institutions will not have the flexibility or capability to remain competitive in an increasingly competitive enrollment.

Why the Campus Physical Structure Has Deteriorated

The current condition of the physical plant and its deterioration have been many years in the making, and problems have accelerated since 1975 owing to inflation and soaring energy costs. However, the ultimate reason these problems have been allowed to approach what on some campuses is an invisible crisis is that, as one university physical plant director puts it, "We haven't committed ourselves to the integrity of our buildings."

LOW PRIORITY

The board of trustees, president, and other top-level administrators determine—in the final analysis—the priorities of an institution. They establish levels and expectations of accountability, determine budget allocations and fundraising needs, and set up the decision-making mechanisms and organizational structures. Care of the physical plant is very much their responsibility, but abundant evidence suggests that a major cause of the current deterioration of campus facilities and infrastructure is the low priority assigned to facility well-being.

During the not-so-distant period of rapid expansion of campus facilities, administrative planning departments were established, development offices launched fundraising drives for new construction, and trustee building and grounds committees oversaw campus expansion. Now that institutions have entered an era requiring prudent management of existing facilities rather than new major construction programs, planning offices have been decimated and long-range facility planning no longer exists. In addition, most trustee building and grounds committees have not assumed the less glamorous, but equally important, responsibility for facility management. During the expansion period, trustees with a background in real estate development and construction were actively recruited. In the current environment, people with such backgrounds are not being sought so readily, and development offices cannot so readily mount capital fund drives for maintenance, renewal and realignment of space in existing facilities.

Boards of trustees and key administrators often have not demanded from the physical plant department the same high level of management and accountability they have from other campus administrative divisions. Setting lower expectations for the physical plant department can only signal that its performance is not as important as that of other departments.

Inadequate funds have been allocated for all four requisite levels of campus care—custodial services, maintenance, renewal and replacement, and utilization. Few institutions have sought to calculate adequate levels of funding or assess the effects of inadequate funding in these areas. Failure to assess realistic dollar needs and provide sufficient funds in operating budgets and capital improvement funds demonstrates a low priority in facilities management.

Trustees and administrators have also been reluctant to examine the utilization levels of campus facilities and require efficient use of space. Until recently, most space needs of growing departments were met by new construction, and departments losing students and funds were not required to relinquish space. This practice reinforced the faulty perception that space is free and permitted low levels of use to develop on many campuses.

Numerous institutional processes, which could be structured to reflect concerns for efficient management of campus facilities, occur with little or no information from the physical plant department. Methods for scheduling and locating classes, for example, rarely include considerations of efficiency in building operations and maintenance. The physical plant department, then, has financial responsibility for space use practices, without the influence or authority to affect them.

POWER AND POLITICS

Organizational dynamics, the politics of space, and resistance to change have also played a role in creating the current deteriorating state of the campus. Historically, the physical plant department has gone unrecognized as an important part of academia, despite the fact that few departments in the academic enterprise have a larger staff or responsibility for a larger share of the budget. It is ironic that the plant department does not have more political clout and support, since the two are usually defined by a department's size and budget. The question, then, becomes *why* is the physical plant not a viable political vehicle?

The management of colleges and universities, like that of most institutions, involves internal politics. Power within the academic community lies with the faculty. The university exists for teaching, research, and public service—activities carried out by the faculty. As the services director of the University of Chicago states, "At Chicago, the faculty *is* the university." Top administrators are usually drawn from the faculty and therefore are not as sensitive to the importance of the physical plant. Their sympathies lie with the faculty and academic departments whose needs they understand and support.

Academic officers sometimes suffer from prejudice of task. They perceive themselves as dealing with budgets, students, grants, and contracts, and the plant directors as dealing with dirt, roofs, sidewalks, coal, and oil. Physical plant directors also do not work in the administration building. Their bailiwick is usually located on the outskirts of the campus, and few realize its size, complexity, or contribution to institutional operations.

The plant director rarely mixes with those in top administration—either inside or outside the work environment. Until recently, most plant directors worked their way up through the ranks of the plant department of either a college, industry, or the military, and have technical rather than liberal arts training. They often hail from a different socioeconomic background than do the vice presidents, deans, and analysts in administration, are not currently members of the same social circle, and have little real opportunity to lobby informally for their requirements. As one director of physical plant says, "We have plenty to offer about using space, saving energy, and reducing vandalism, but nobody asks us."

Such isolation almost guarantees that the state of the campus physical plant is not one of the most important institutional concerns. The physical plant director has not traditionally played a role in either formal or informal institutional decision-making. In short, formal and informal barriers have developed —albeit inadvertently—to obstruct serious understanding of physical plant needs.

RESOURCE ALLOCATION: A POLITICAL PROCESS

Academic officers define the plant in terms of the quality of the space and how well it works in support of teaching and research, not in terms of building elements. Therefore, suggestions of major funding allocations to bring building elements up to par lose in the competition with academic funding for programs and faculty salaries.

John Millett, president emeritus of Miami University and chancellor emeritus of the Ohio Board of Regents, observes that colleges and universities see themselves as preservers, transmitters, and advancers of knowledge, and as such act rationally in the distribution of resources. However, most colleges and universities have never actually defined the rationale for resource allocation. The budgeting and resource allocation process is an exercise in power.

How do provosts and business officers decide on allocations for the physical plant department? Their answer is, "We look at what they request, and we look at what we have, and we work it out." If asked what rationale or funding formula approach is used, they repeat, "We work it out." Plant directors, explaining how their budgets are provided, state simply, "They give me a lump sum." This dialogue offers some insight into the resource allocation process.

The plant director is told, "You know your needs best," but beneath this "reassuring" response is a subtle attitude of passing the buck. Top administration also knows the plant director will take what he can get. What choice does he have?

All responsibility does not lie with the administration, however, for power and budgetary politics are a two-way street. Results are dependent on the quality of the interaction between plant and central administration.

PLANT AND MISSION: A POINT OF VIEW

A chief stumbling block in communication (and therefore funding) between the physical plant department and central administration is that the two view quite differently the relationship between institutional plant and mission.

The plant department sees itself as directly supporting the mission by housing it. Plant department funds are expended in servicing and maintaining an environment that nurtures teaching, research, and public service. The institutional view (which parallels the academic view) sees the faculty as carrying out the mission, using appropriate resources, including facilities.

Both perspectives are correct, but in communication of need and focus of priorities, they are very different. Facilities rank lower on the list of administration priorities because administrators are looking at a number of issues. By definition, however, the plant director's principal concerns are the operation and maintenance of buildings. When the plant director says, "You can't cut my budget any deeper," administration hears "wolf."

(Figure 1)

Relationship between plant and mission

PLANT VIEW	INSTITUTIONAL VIEW
MISSION	MISSION
↑	↑
FACILITIES	FACULTY
↑	↑
RESOURCES	RESOURCES

TERRITORIAL TENURE

Space allocation on campus is one of the most zealously guarded department assets, and its reallocation is a political minefield. "Territorial tenure" is how one administrator describes the unstated

A paradox in academe: the neoclassical form often associated with the academy sits surrounded by crumbling bleachers, one manifestation of the low priority afforded the physical plant.

space policy at his institution. At major universities especially, considerable segments of instructional space are "owned" by departments and never enter the registrar's pool of space. Departments retain their space, even if enrollment in courses drops and the size of the department decreases. The cumulative effect of this unwritten policy in effect at most institutions is underutilization of facilities.

The power of spacial politics is well illustrated in the reflections of one academic vice president on the situation at his university:

> Let's assume we could let go of twelve buildings, and relocate those people at a one-time cost of a million dollars. By condensing our operations, we could save $600,000 a year in operating costs—an effective payback period of 1.4 years. Never mind the potential income from sale or lease of those twelve buildings, we'd never do it. Even though the deans know [the excess buildings are] costing them money, they won't deal with the faculty. It's too hot an issue.

Many administrators maintain such a laissez-faire policy. The path of least resistance is due, in part, to the lack of political clout granted the physical plant department and the "free cost" of occupying space granted to academic departments.

PAST BUILDING PRACTICES: TODAY'S PROBLEMS

Of the four levels of requisite campus physical care—custodial services, maintenance, renewal and replacement, and utilization—the need for custodial services remains constant throughout the lifetime of a building. Maintenance and renewal needs, however, increase as a building ages, and herein lies a key problem for America's campuses today.

Of the approximately 2.2 billion square feet of building space on campuses in the United States, over half has been built since 1960. Over 60 percent of the total space has been built since 1950. Although buildings constructed before World War II have a life expectancy of close to 50 years, postwar structures were designed for a normal life of only 30 years. Even when constructed with quality materials, newer buildings have a shorter life expectancy than prewar structures. For example, older gear-driven elevators give approximately 40 years of service, while today's hydraulic lifts give 25. Older slate roofs last about 50 years, but today's flat felt roofs last only 15 years. Thus, a building constructed in 1940 with gear-driven elevators and one constructed in 1955 with hydraulic mechanisms both need elevators renewed. A 1931 building with a slate roof and a 1965 building with a felt roof both need new roofs.

The issue of shorter life expectancy for post-1950 building components is compounded by the fact that much of the existing campus infrastructure—steam tunnels and other utility lines—was built in the 1920s and '30s, and is also due for renewal. For example, the life expectancy of cast-iron pipes commonly used in the 1930s is 50 years, and their life is now over.

The period of rapid campus expansion nationwide from the 1950s through the early 1970s had additional effects that have further hastened the

need for replacement and renewal. First, the cost of projects escalated between the time capital budgets were established and the time of actual construction. Because of high inflation in the construction industry (higher than general inflation), institutions found themselves getting less and less building value for their dollars. Between 1967 and 1974, for example, while spending for new construction was fairly level at $3 billion annually, spending in terms of constant dollar value had decreased by 38 percent. Inflation put enormous pressure on planners, architects, and contractors to meet program and facility specifications by making compromises both in materials and in construction specifications. Administrators, understandably, were more concerned with retaining a new building's program components (x number of laboratories, for example) within original budgets than with the lifetime cost of maintaining the building.

Furthermore, academic buildings generally were constructed using cash grants, gitts, or capital appropriations. Other buildings, such as athletic and residence facilities, generally were constructed using local bond funding. While the latter funding required financial reserves to cover maintenance, no such reserves were established to maintain the academic buildings. Therefore, campus classroom facilities tend to deteriorate, while preventive maintenance is afforded auxiliary structures.

Renewal and replacement is now crucial for old and new campus building systems. Note damage on older slate roof (below), and newer flat roof (left).

(Figure 2)

Plant fund expenditures for buildings in actual and constant dollars FY 1967–1974

Fiscal Year	Amount (in millions)	
	Actual dollars	Constant dollars[1]
1967	2,959	2,959
1968	3,157	2,942
1969[2]	3,185	2,758
1970	3,174	2,560
1971	3,143	2,333
1972	3,179	2,182
1973	2,840	1,835
1974[3]	3,020	1,827

[1]Constant dollars in 1967 prices.
[2]Amounts estimated.
[3]Preliminary data.

Note.—Included with plant fund expenditures for buildings are additions by gift-in-kind from donor and by reappraisal of building value and other additions (these expenditures are generally less than 10 percent of the total). Included in building expenditures are expenditures for fixed equipment and for other improvements such as utility lines, landscaping, etc.

Source: U.S. Department of Health, Education and Welfare. Office of Education, Financial Statistics of Institutions of Higher Education: Property, relevant issues.

Another consequence of the enormous growth in the general construction industry nationwide during the 1950s and '60s was the massive demand for the construction labor force—demand which could not be met by then-existing labor training programs. As a result, many buildings, including campus facilities, suffered from poor construction workmanship and know-how. Colleges and universities at the time were under severe pressure to expand, and often could not or did not enforce quality control standards. Given an unpleasant choice of rejecting poor quality work and being unable to house and provide classroom space for students arriving in the fall, or accepting poor quality work and being able to accommodate the students, institutions chose the latter option. Acceptance of poor quality work voided the warranties on construction.

Horror stories about the failure rates of relatively new buildings abound. A study of 163 college and university buildings in California, two to fifteen years old, revealed that one-half had a history of leaky roofs. In another study, fully one-third of 1,000 built-up bonded roofs were reported to be in trouble within one year of completion. (6)

In addition, physical plant directors unanimously reported that newer campus buildings are more expensive to maintain. This condition is in part a result of lesser quality materials and poor quality workmanship in construction, but it is also due in part to the new buildings' vastly more complex mechanical systems—especially heating, ventilating, and air conditioning. These systems need frequent care provided by workers with specialized skills.

The upshot of these forces is that campus building components and systems—both new and old—are in need of renewal and replacement. Decisions and circumstances surrounding building construction in the 1950s and '60s have resulted in a greatly increased need for budget allocations to maintain and preserve the campus physical plant.

REDUCTION IN PHYSICAL PLANT BUDGET ALLOCATIONS

Over the past decade, the physical plant department budget—as a percentage of the total institutional budget—has remained reasonably constant. However, this apparent stability is only superficial and masks a marked decrease in real budget allocations for physical plant care.

A common perception among institutional administrators is that skyrocketing utility costs have affected budget allocations to most parts of the institution. As one university provost reports, "Utility increases are coming out of future academic increases." However, analysis of proportional budget allocations shows that utility increases in general have come almost totally from allocations to all other items within the physical plant budget category.

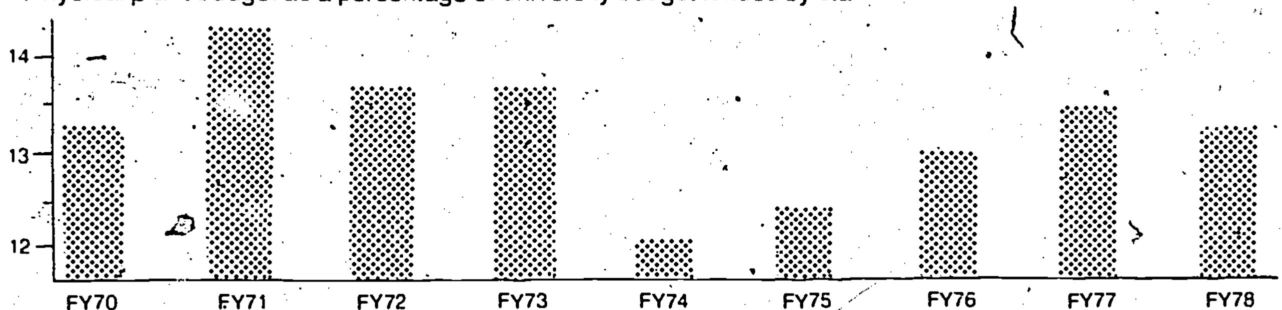
The University of Illinois conducted a study of its plant spending patterns as part of a larger analysis of physical plant needs. The patterns reveal clearly how the coupling of rising energy and labor costs resulted in large-scale reductions in personnel—reductions that translated directly into diminished maintenance and services at all levels on campus.

Between 1971 and 1978, as figure 3 shows, the physical plant budget of the University of Illinois remained reasonably stable as a proportion of the total institutional budget—14.3 percent in 1971, 12 percent in 1974 and 1975 and 13.4 percent in 1978. With a seemingly stable budget allocation, one would assume that the physical plant department should have been able to maintain the campus at a steady level of service over the years. It was not. To understand why, it is necessary to look more closely at the overall facts.

Figure 4 shows the increase in square footage for the University of Illinois, as well as the cost of operating the plant in both total dollars and dollars

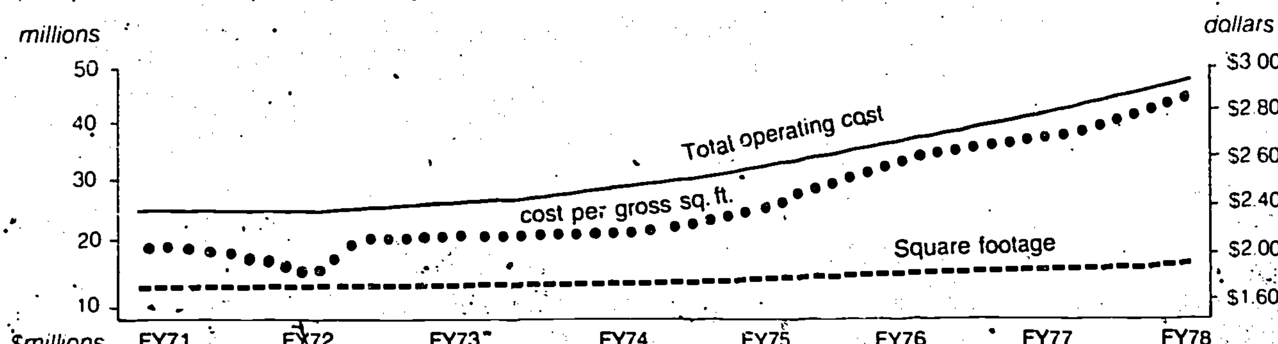
(Figure 3)

Physical plant budget as a percentage of university budget funded by state



(Figure 4)

Comparison of total plant operating costs, cost per gross sq. ft. and square footage



per square foot. Total plant budget expenditures grew by 74 percent, from $24.8 million to $43.2 million, over the eight-year period, while overall square footage increased by just over 10 percent, from 12.8 million square feet to 14.1 million square feet. Although the allocation of funds seemed to rise steadily, on a square-foot basis, the amount spent on maintaining the campus actually dropped between 1971 and 1974.

Figure 5 shows how the University of Illinois plant dollars shifted during the eight-year period. At the Champaign-Urbana campus, the categories of Superintendence, Janitorial, Building and Grounds Maintenance, and Renewal and Replacement were cut from a combined 59 percent total of the plant budget to 46 percent by 1978. This occurred while the allocation for energy rose steadily from 25 percent to 43 percent.

At Chicago Circle, percentage expenditures were cut almost uniformly across the board. The energy category represented 38.8 percent of the budget in 1971 and 47.9 percent in 1978. The maintenance categories were cut from 46.7 percent to 38.8 percent of the total plant budget.

CUTBACKS IN PERSONNEL

The statement that higher education is labor intensive has traditionally referred only to the faculty and support staff needed to carry out teaching and research. The physical plant department has not usually been included in the assumption, primarily because of its low visibility on campus. However, as Figure 6 illustrates, plant operation is indeed very labor intensive.

With the exception of purchased utilities (elec-

(Figure 5)

Percent breakdown of expenditures by operation and maintenance function at the University of Illinois Champaign-Urbana Campus: FY 1971-1978.

Budget Category	FY71	FY72	FY73	FY74	FY75	FY76	FY77	FY78
O & M[1]	59.4	56.6	57.1	56.6	50.9	50.5	47.8	46.5
Utilities[2]	24.9	28.5	29.3	30.8	37.3	37.5	41.8	43.5
Miscellaneous[3]	15.7	14.9	13.6	12.6	11.8	12.0	10.4	10.0
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

1 O & M includes: superintendence, janitorial, building maintenance, renewal and replacement, and grounds maintenance.
2 Utilities includes: utilities purchased and utilities power plant.
3 Miscellaneous includes: security, fire protection, transportation, and other items

(Figure 6)

Percent object of expenditure for operation and maintenance functions

	Personal Services	Equipment	Contractual Services	Commodities	Telephone	Utilities
Superintendence	.83			.10	.07	
Janitorial	.94	.05		.01		
Building Maintenance	.85	.01	.07	.07		
Renewal and Replacement	.49		.26	.25		
Grounds Maintenance	.79	.03		.18		
Utilities Purchased	.05					.95
Utilities Power Plant	.43		.28	.29		
Security	.89	.01		.10		
Fire Protection	.87	.04		.09		
Transportation	.65	.05	.15	.15		
Miscellaneous	.81		.09	.10		

tricity and gas), labor consumes the majority of the plant dollar (83 percent of the superintendence budget and 94 percent of janitorial funds at the University of Illinois are spent on labor). The majority of the cost of renewal and replacement, listed as contract services, also represents expenditures for labor.

Yet it was in labor that the University of Illinois physical plant department had to make cuts in order to accommodate the increase in hourly labor costs and absorb the increased energy expense item. Between 1971 and 1978 the university decreased its labor force by 24 percent—545 plant employees—while the combined hourly cost of labor rose by 33 percent as Figure 7 illustrates, the decrease or supposed savings in labor was still outstripped by increased labor costs. The case of the University of Illinois is not unique. Rather, it presents a clear picture of what has happened to plant budgets at institutions across the country.

As Bruce Wiggins, services director at Stanford University, observes, "We used to have a full crew of painters, carpenters, upholsterers, and even a window shade man. All of them disappeared through budget adjustments and forced savings."

As the number of skilled craft employees has been reduced, so has maintenance. Planned maintenance of roofs, motors, and steam and electrical lines is not carried out. Maintenance has assumed an emergency status, and for lack of personnel, potential problems are discovered only after they become real problems for the users of the building. By that time, it is necessary to spend thousands of dollars replacing whole systems. Routine inspection could have identified and solved potential problems at far less expense.

Based on a 1971 level of operations and maintenance, the University of Illinois had, by 1978, underspent by $8.6 million. As figure 8 illustrates, just to maintain the campus at the 1971 level and keep up with rising costs, the university should have spent $49.4 million, rather than $40.8 million.

Claremont's Howard Bowen notes the "cyclical pattern of undermaintenance in lean years and of partial catching up in good years." However, it is far more tempting during more prosperous times to strengthen instruction, student activities, research, and services, while postponing maintenance for yet another year. Deferred maintenance exists even in the best of times. According to Bowen, "In periods of inflation, the problem is intensified. Each postponement increases the eventual cost."

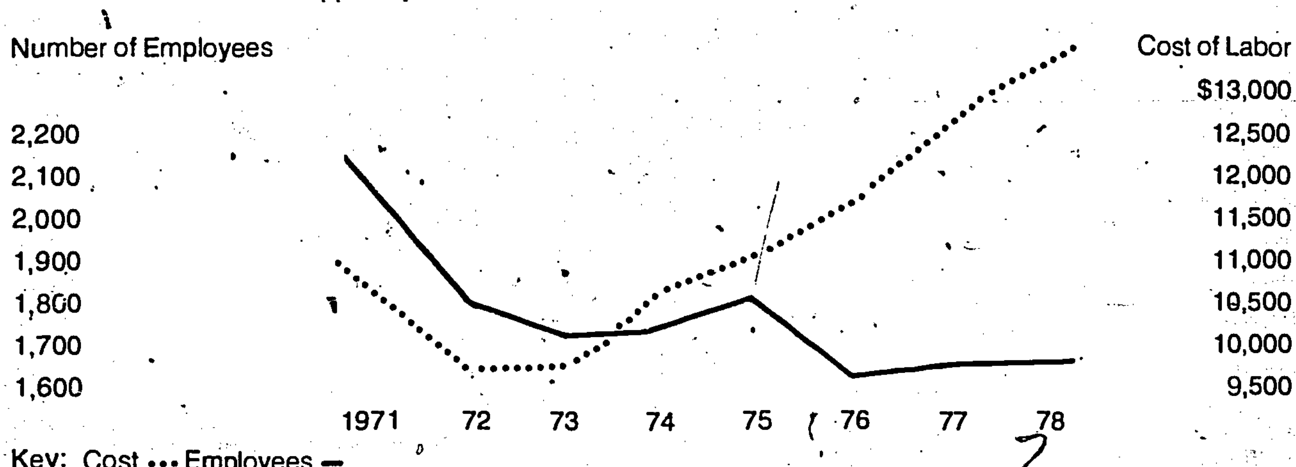
What Needs to Be Done?

As we have seen, the campus physical plant is plagued by deteriorating facilities and inadequate fit between those facilities and institutional programs. To solve these problems, the issues underlying them must first be addressed. To reiterate, these issues include:

- ☐ lack of integration of physical plant concerns with the broader mission of the institution
- ☐ low priority given physical plant needs by institutional leaders
- ☐ isolation of the physical plant director from institutional decision-making
- ☐ lack of top administrative awareness of requisite plant financial allocations, resulting in insufficient funding allocated for physical plant care

(Figure 7)

"Decrease" in labor outstripped by increased labor costs.



- ☐ inadequate management of the physical plant department
- ☐ inefficient utilization of existing facilities.

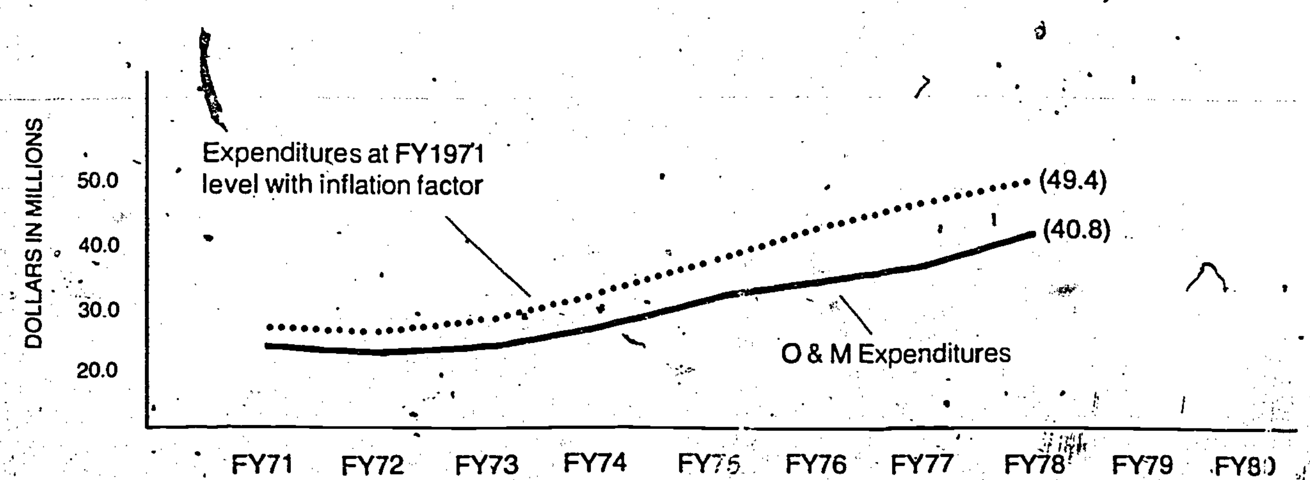
Once these issues are addressed, facility planning can occur in the context of academic planning. Facility requirements—translations of academic requirements—are ultimately derived from the mission of the institution. Therefore, logical facility planning cannot occur unless the institution itself knows where it is going academically. Facility planning requires an aligning of space and program, a determination of those buildings in which the institution should reinvest. It does not make economic sense to invest large sums in what is currently the Modern Language Building if enrollment in that discipline is steadily declining and the job market for graduates in that field is bleak. But the facility may be worth investing in to house an expanding discipline such as computer science.

Academic planning requires that a college or university examine the consequence of societal needs and institutional mission and resources. The following questions may be useful as a first step in integrating academic and facility requirements.

- ☐ How will the mission of the institution change to meet societal needs over the next five, ten, fifteen, and twenty years?
- ☐ What changes will be made in existing programs and academic disciplines?
- ☐ What is the projected impact of inflation on the institution's budget—tuition and fees, outside income, faculty salaries, cost per student, physical plant care?
- ☐ What are the enrollment projections or targets, and how are they divided among disciplines?
- ☐ What facilities will be needed to support projected programs at their projected enrollment levels? What proportion of these facilities should be general purpose space and what proportion should be specialized space?
- ☐ What amount of physical plant square footage should the institution be operating today?
- ☐ How much will it cost to upgrade campus facilities to adequate standards? What amount of funding can the institution now afford for physical plant improvements, and what level of additional fundraising effort is required to upgrade the plant to accepted standards?
- ☐ How is the physical plant department operated now? What are its areas of responsibility, and does it have the financial and personnel resources to carry out its responsibilities? Are there organizational impediments to effective plant operations?
- ☐ What services does the physical plant department provide? Are they sufficient and feasible? What would be the impact on the campus if they were discontinued? If services were added? If some services were contracted out?
- ☐ What would be the effect on buildings, campus, and ultimately programs if the physical plant continued to operate as it has in the recent past?
- ☐ How are decisions about the physical plant made now? Are they integrated with other institutional decisions? How are the registrar, faculty, continuing education department, and

(Figure 8)

Funds required to provide O & M services at FY 1971 level



Academic planning—an understanding of the college or university mission and projected enrollment, services, and facility requirements—is necessary before physical plant issues can be properly addressed.

other administrative departments involved—formally and informally—in decision-making regarding the physical plant?

- ☐ Should all areas of the campus be maintained at the same level of service? If different areas were maintained at different standards, how would the institution be affected? Who would make these decisions and on what basis?

Underlying physical plant issues now addressed—and academic planning integrated with facility planning—what positive steps can be taken to upgrade the legacy represented in a sound campus facility? We offer here strategies and working tools developed by college and university administrators and physical plant directors across the country.

- ☐ Establish a Facilities Planning Group—a small, ongoing working committee comprised of administration, faculty, and physical plant representatives. The group can be an effective mechanism in working toward overcoming the political isolation of the plant department within the larger institution.
- ☐ Secure the commitment of top institutional administrators and trustees. A special "Memorandum to Trustees" is included in this report to help ensure their leadership in caring for the campus physical plant. It is also essential to

secure the commitment of the entire university community—faculty, students, and alumni. A campus tour can help in this endeavor to secure the commitment of these varies campus constituents. Ensure that the mission of the institution and the physical plant are clearly linked—a measure that will help gain the support of the physical plant department.

- ☐ Undertake a physical plant audit to assess the condition of each campus building, the grounds, and the support systems (e.g., heating and ventilating) that allow the institution to function.
- ☐ Based on data collected in the audit, determine adequate funding levels for building renewal and replacement, and custodial and maintenance care. Budgets should reflect short- and long-term institutional goals.
- ☐ Improve management of the physical plant department. Setting objectives for work, establishing training programs and advancement incentives, exploring contracting services, and improving communications between plant department and its constituents are among the avenues that can lead to better management.
- ☐ Improve utilization of campus facilities. Examine the fit between programs and facilities, then allocate and schedule space accordingly.
- ☐ Institute a comprehensive energy management program on campus. Conduct an energy audit similar to the facilities audit, and implement conservation and management strategies accordingly. Remember that campus maintenance is reflected in corresponding campus energy management.

These working tools and strategies, explored in more detail, constitute the remainder of this report.

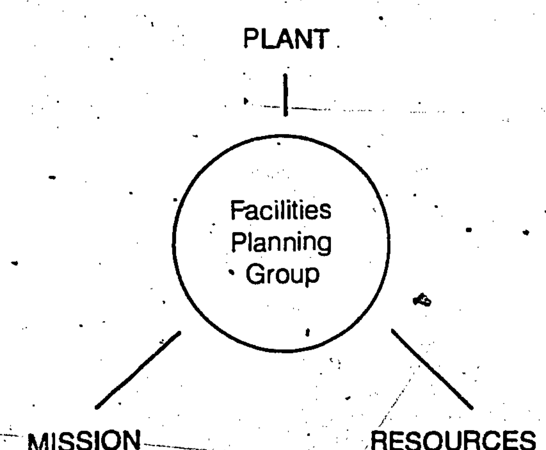
Working Tools and Strategies for Improving Campus Care and Management

The blend of institutional mission, administrative structure, physical plant, faculty, and campus character does not lend itself to a single approach to facilities management and planning. Some colleges and universities across the country have developed programs for improving care and management of the campus physical plant. We present here a collection of those tools and strategies that address common problems and can be easily adapted to meet the needs of diverse institutions.

THE FACILITIES PLANNING GROUP

A small, ongoing, working committee of top administrative, academic, and physical plant representatives can be an effective mechanism for overcoming the political isolation of the physical plant department. This committee, as Figure 9 illustrates, might be called the Facilities Planning Group, can be a planning group charged with integrating institutional needs over the next 10 to 25 years in terms of academic program, plant, and resources necessary to carry out the institutional mission.

(FIGURE 9)



The Planning Group—reporting to the president—will be responsible for defining the mission of the physical plant so that it supports the mission of the institution. Members of the Planning Group should include the chief business officer and/or administrative vice president, the physical plant director, and a highly respected faculty member. If the group is chaired by the faculty member, it will have greater credibility and support among other members of the academic community. In turn, it will be the forum at which the needs of the physical plant are presented and strategies are developed for dealing with those needs. After campus care and use goals and strategies are developed, the group will also be the body to oversee their implementation.

The Facilities Planning Group will not only provide the physical plant director with the opportunity to "make his case," but it will also help increase understanding of physical plant needs and build support for the plant among administrators and academics. Finally, as the group advocates raising the priority accorded to the physical campus, it will demand a higher level of management performance and accountability from the physical plant director.

A CAMPUS TOUR

Probably the greatest stumbling blocks to improving care of the campus are poor understanding and communication of the magnitude of deterioration, and the cost of poor utilization of facilities. A tour of the campus presents an opportunity to demonstrate the impact of neglect at all levels of care, provide information on the costs of needed repairs, and point out potential savings possible through improved utilization of facilities.

The campus tour should include what might be called the invisible campus—areas not usually seen by anyone except plant personnel—roofs, utility tunnels, central heating plant, and trade shops. A comprehensive tour should cover both the most basic and complex issues.

Members of the trustee executive committee, as well as members of trustee committees charged with responsibility for buildings and grounds, should re-

The "hidden campus," including steam tunnels, should be part of a campus tour.

ceive a comprehensive personal campus tour that presents the dual issues of neglect and poor utilization of space. Trustee tours should be conducted for groups of five to 10. The institution president or a vice president should conduct the tour to emphasize the high priority accorded to the issue of campus care. He or she must understand plant problems and be personally convinced of their importance in order to conduct the tour effectively. However, the recognized expert of the tour should be the director of the physical plant department.

Members of the Facilities Planning Group obviously need a more detailed tour of the campus in all areas than do trustees. This group should visit the physical plant department offices and shops, and meet the people who are responsible for campus care. Such a meeting will help provide an understanding of how the plant department operates—a prerequisite to the development of a comprehensive institutional plan for improving the condition of the campus.

An audiovisual tour of the campus—whether slide show or videotape—should also be produced. Such a production is invaluable because it can be shown to large audiences, including key groups that cannot visit the campus. Audiences might include state legislative committees, trustee board members-at-large, alumni chapters, and other potential funding sources.

Campus public affairs staff might be recruited to develop and produce the show. A special benefit of using in-house personnel is that in producing the program, they will develop an understanding of facility issues and may also become advocates of improving campus care.

All tours should review:

- ☐ the condition of buildings, grounds, and service lines
- ☐ energy use—how much of a building is lighted, heated, and cooled, and how much of it is in use
- ☐ utilization patterns of space and buildings.

A good place to begin a tour of the campus physical plant is at the top—on the roofs of the campus. Roofs typify the deferred maintenance problems faced by facilities, and their deterioration is of the greatest concern because such damage allows moisture to seep into the building, harming other building elements. The plant director should lead the group down through a building to point out ceiling, wall, and even carpeting problems that stem from roof deterioration. Stains and peeling caused by water damage are only an external manifestation of more serious internal problems. Other building problems—restroom fixtures, flooring, windows, and heating components (e.g., radiators, on which valves no longer function)—should also be pointed out.

The plant director should delineate the problems, causes, and costs of requisite repairs and maintenance. He should be prepared to explain the costs of maintaining a facility in good condition with planned maintenance versus emergency and deferred maintenance. (Good condition might be defined as the "as built" or the 1971 condition. "As built" can be used as a standard, given that obvious requisite modernizations—such as installing up-to-date laboratories in a 1940 chemistry building—have been implemented. The year 1971 serves as a useful standard because it precedes the 1972-73 recession—the beginning of serious inflation problems for higher education—and the 1973-74 oil embargo.)

Outside each building, the group should look at the window casings to see if the paint is blistered or peeling and if the wood sashes and frames are rotting. The plant director should explain that if the wood is allowed to disintegrate, replacement of entire window units will be necessary at considerable cost. He should discuss previous and current outdoor painting cycles, as well as brick and mortar problems and their remedies. (A pair of binoculars is useful during the outside tour.) As the tour continues, the quality of sidewalks and roads, and the maintenance level of campus landscaping should be examined.

Tour members should look at buildings through the eyes of prospective students, and their parents, donors, alumni, and members of the community. Visual appeal of classroom and other facility space sends an important nonverbal message about an institution.

The central heating plant, more than any other part of the plant, gives one a sense of the scale, sophistication, and costs of plant operations. The sheer size of the heating and cooling facility, thousands of gallons of oil or tons of coal burned, or millions of cubic feet of gas consumed, is impressive.

After touring aboveground, the group can be led literally underground. The tour leader may wish to point out miles of pipes and conduits carrying steam, chilled water for air conditioning, electricity, gas, water, sewage, and telephone lines under the typical campus. Most facility users are totally unaware of the extent and condition of this underground network.

QUESTIONS TOUR MEMBERS MIGHT WANT TO ASK

About campus facilities:

- ☐ What are the specific problems (e.g., deteriorating roof, stained walls, missing motor, broken fixtures)?
- ☐ Why does the problem exist (e.g., insufficient manpower, labor shortage, insufficient funds)?
- ☐ What is required to rectify the problem (e.g., additional funds, authorization to hire new personnel, greater freedom to contract work out)?
- ☐ What are the priorities of the problems vis-a-vis each other?
- ☐ Is there a comprehensive list of all necessary facility repairs?
- ☐ What is the current cost of accomplishing necessary maintenance?
- ☐ What would be the result—in terms of both further facility repairs and deferred cost—if necessary maintenance is not accomplished?
- ☐ How much greater will be the cost of deferred maintenance—taking into account additional deterioration and inflation—than current costs?
- ☐ What is the current inspection, repair, and replacement cycle for roofs, pipes, motors, windows, and all other major building elements?
- ☐ How are priorities for repairs set, and who establishes them?
- ☐ Are academic considerations taken into account in developing the repair schedule for the campus?

About physical plant department facilities:

- ☐ How much gas, oil, or coal does the central plant burn?
- ☐ How much electricity is generated and/or purchased and distributed around campus?
- ☐ How many gallons of chilled water are produced?
- ☐ How many personnel are required to maintain the heating/cooling and electrical systems and distribute them around campus?
- ☐ What do the trade shops do?
- ☐ How is their work assigned?
- ☐ What are the skills of shop workers?

PHYSICAL PLANT AUDIT

An audit of the physical plant is the major tool for evaluating its existing condition, determining what repairs are needed and how much they will cost, and establishing priorities for undertaking repairs. A complete audit, using consistent evaluation criteria and analysis, will summarize and detail the physical condition of each new building on campus and evaluate its present and long-term effect on programs. In so doing, the audit will:

- ☐ expose the entire range of plant problems
- ☐ produce a plant data base that can be updated periodically
- ☐ evaluate facility utilization and space realignment needs
- ☐ provide a basis for objectively setting plant priorities, justifying emergency capital repair requests, and developing annual and long-term plant budgets.

Who Should Conduct the Audit?

The physical plant audit will have at least three components: a facility audit of campus buildings; an infrastructure audit of the campus utilities distribution network, and a grounds audit of paved and landscaped areas of the campus. Each of these component audits should be conducted by a team with expertise in related fields—structures, mechanical and electrical systems, safety and sanitation, local and state building codes, horticulture and landscaping, regulations of the Occupational Safety and Health Administration, handicapped accessibility requirements, architectural history, and facility use analysis and space programming.

In addition to the plant director, the academic and/or business officer of the Facilities Planning Group should be involved in the audit process in order to gain a more intimate knowledge of the complexity of plant problems, and provide insight into academic and fiscal considerations. As the audit team tours the facilities of a given department, a representative from that department should be present to discuss problems involving use of the facilities, as well as the degree to which the facilities support the work of the department.

If a qualified team with engineering skills can be assembled from the physical plant department and planning office, and team members can be relieved of some of their normal duties, the audit may be conducted entirely by institutional personnel. They have the advantage of intimate knowledge of the physical plant. However, if carrying out an audit prevents them from performing their regular duties or they will find it necessary to work at their regular jobs at an overtime rate, it may be more expedient to contract the audits to outside consultants.

Such consultants can bring a valuable external and sometimes more objective vision to the problems of the physical plant, but they must work closely with the physical plant department. In addition, reports produced by outside consultants sometimes are granted greater credibility than reports produced by an institution's own employees.

Components of the Audit

We present here the basic components of the facility audit. The same basic strategy is also applicable to the infrastructure audit as well as the grounds audit.

The physical analysis of facility condition is one of the major components of a facility audit. Facilities are surveyed and evaluated in terms of the soundness of major structural elements such as roof, walls, windows and flooring, and service systems such as ventilating and air conditioning. Bases on which they are reviewed include adaptability and suitability for present uses, compatibility with future institutional plans, and aesthetic, social, or historic value.

Physical analysis should include a detailed description and evaluation of each building element. Some institutions use a weighted rating system to achieve a composite evaluation of individual buildings. The evaluation is then compared with those of other buildings to develop priorities for action. The audit bases its rating system on a combination of remodeling needs and financial cost. Therefore, the weights attached to each component of the physical analysis reflect the difficulty and cost of repairing each component.

A comprehensive audit includes an examination of the current utilization of space, suitability to present uses, and flexibility for conversion to other uses. Information is needed about space assignment, intended use of each room, actual use patterns, and perceptions of current users as to suitability. Analysis, based on acceptable utilization goals, will begin to reveal where realignment can occur. Once space realignment plans are solidified, the cost of carrying out remodeling or renovation to accomplish realignment can be calculated.

Facility audit systems can be simple or complex, depending on the needs of an institution. The rating system below, developed by the Tennessee Higher Education Commission to evaluate each university system building and recommend action, illustrates the central elements of a facility audit.

- ☐ *Satisfactory:* No capital outlay of funds needed during the next five years. Condition value multiplier: 1.0

PHYSICAL FACILITIES EVALUATION SUMMARY

Building Number & Name ____________________

Location ____________________

Survey Date ____________________

Survey Team ____________________

____

____

		Ratings Possible	Ratings Actual
I.	Primary Structure	(40)	( )
	1. Foundation System	13	____
	2. Column & Exterior Wall System	13	____
	3. Floor System	7	____
	4. Roof System	7	____
II.	Secondary Structure	(9)	( )
	1. Ceiling System	3	____
	2. Interior Walls & Partitions	3	____
	3. Window System	2	____
	4. Door System	1	____
III.	Service Systems	(34)	( )
	1. Cooling	10	____
	2. Heating	10	____
	3. Plumbing	5	____
	4. Electrical	8	____
	5. Conveying	1	____
IV.	Functional Standards	(12)	( )
	1. Assignable Space	4	____
	2. Adaptability	4	____
	3. Suitability	4	____
V.	Safety Standards	(5)	( )
	TOTAL	100	

Building Rating

S. Satisfactory	95-100	____
2. Remodeling — A	75- 94	____
3. Remodeling — B	55- 74	____
4. Remodeling — C	35- 54	____
~~U. Demolition~~	0- 34	____

PHYSICAL ANALYSIS: Service System/Heating System

.... Building
.... Current Primary Function

A. System types
1. Transfer medium steam ..... hot water ..... air ..... elect ....
2. Space equipment

Radiators	2-pipe fan coil	Multizone ....
Convectors	4-pipe fan coil	Double Duct ....
Finned Tube	Unit Ventilators	Terminal Reheat ....
Baseboard	Radiant	Con. Vol. Sing. Zone ....

3. Energy source: central plant .... coal .... gas ....
oil .... electricity ....
4. System capacity: Total .... BTUH
Control type: pneu .... elect ....

B. System evaluation

	S	2	3	3	U
1. Heating capacity					
2. Temperature control					
3. Heating all seasons					
4. Noise level					
5. Energy consumption					
6. Air circ/ventilation					
7. Filtration					
8. Humidity control					

C. Comments: ....
....
....

D. Numerical evaluation (circle one)

	Condition Value Multiplier
S. Satisfactory	1.0
2. Remodel A: requires restoration, cost not more than 25% of total replacement	0.8 + / − .1
3. Remodel B: requires major modernization cost 25% and 50% of total replacement	0.5 + / − .1
4. Remodel C: requires major remodeling cost greater than 50% of replacement	0.2 + / − .1
U. Demolition: system totally unsatisfactory and cannot be remodeled—replace	0.0

E. Numerical rating: 10 X .... (condition value multiplier) =

- ☐ *Remodel A:* Building is currently adequate; requires restoration to present acceptable standards without major room use changes, alterations, or modernizations. The approximate cost of Remodel A is not greater than 25 percent of the estimated replacement cost of the building. Condition value multiplier: 0.8+/-.1
- ☐ *Remodel B:* Building requires major updating and/or modernization. The approximate cost of Remodel B is greater than 25 percent, but less than 50 percent, of the estimated replacement cost of the building. Condition value multiplier: 0.5+/-.1
- ☐ *Remodel C:* Building requires major remodeling. The approximate cost of Remodel C is greater than 50 percent of the replacement cost of the building. Condition value multiplier: 0.2+1/-.1.0
- ☐ *Demolish:* Should be demolished or abandoned because the building is unsafe or structurally unsound, irrespective of the need for the space or the availability of funds. Condition value multiplier: 0.0

Using this rating system, an exterior wall system, for example, is categorized by the audit team as Remodel A. It is then assigned a condition value multiplier of 0.8 (this value can be modified on a 0.9 to 0.7 scale, depending on the condition). The point value of the exterior wall system (13) is multiplied by the condition value multiplier to obtain the component rating: $13 \times 0.8 = 10.4$. After evaluating each component according to this system, the entire building is rated. The ratings are then totaled.

The composite rating system used by the Tennessee Commission is relatively simple to understand. The score each building receives, such as a 60 or an 80 on a 100-point scale, communicates quickly and directly a building's overall condition. Below is the summary evaluation sheet. Each of the categories in turn has a detailed evaluation form, such as the heating system one, which follows.

A second way to analyze the results of a facility audit to establish priorities for action is to rate the severity of individual conditions or problems uncovered in the audit. The following classification system, from the University of Nebraska, illustrates this analytical approach.

Class I. items for immediate action to provide safety and protection against costly damage.

- ☐ *Priority 1.* Elimination of potential cause of injury or death.
- ☐ *Priority 2.* Elimination of any other condition which, if not immediately corrected, might lead to costly physical damage or deterioration of state property.
- ☐ *Priority 3.* Elimination of conditions which lead to energy waste.

DETERMINING ADEQUATE FUNDING FOR BUILDING RENEWAL AND REPLACEMENT

Allocations for renewal and replacement of major building components are often inadequate because the category is an anomaly in the budgeting process. Renewal and replacement dollars come from the annual operating budget at some institutions and the capital budget at others. Because the renewal and replacement of building components represents lower financial investment than its equivalent in new construction, the smaller projects may or may not be eligible for bond financing at public institutions. Private institutions rarely develop adequate capital reserve funds for this purpose.

Far too often, a project that ought to be undertaken as an item of planned renewal is ignored until it presents an immediate need. Because neither operating nor capital funds were budgeted beforehand, money to complete the emergency project is drawn from the physical plant operating budget, depleting funds earmarked for planned maintenance.

In order to overcome this cycle of deferral and crisis, institutions need to budget for a planned series of renewal projects. The two methods presented here will aid in determining aggregate funding levels while avoiding separate cost estimations for each project. In so doing, the guidelines permit flexibility in determining precisely which renewal and replacement projects will be undertaken in any given year.

The SR3 Formula

The formula developed by Harlan D. Bareither, retired senior associate vice president for planning at the University of Illinois, is the less complex of the two. The simplicity of this formula, known by the shorthand SR3 (space realignment, renewal, and replacement), stems from averaging the replacement needs equally over the life of a building, thus allowing the entire campus to be treated as a single unit and generating an equal proportion of current replacement costs each year. (See Figure 10.)

Bareither's research and analysis of facilities led him to conclude that three major components of a building—the foundation, superstructure, and exterior walls—do not normally deteriorate. These three components constitute one-third of a building's construction cost. The remaining two-thirds of a building require realignment, renewal, and replacement, either because of changes in the program or use of the building, or because these elements have deteriorated and must be renewed.

(Figure 10)

Building Components	Changes Required	Division of Costs
Foundation Superstructure Exterior Skin	No Deterioration if Properly Maintained	⅓ of New Building Costs
Roofing Interior Finishes Elevators Electrical Plumbing Heating Ventilating Changes General Fixed Equipment	Will Need Replacement Due to Obsolescence of Program	⅔ of New Building Costs Air Conditioning

Bareither states that the life span of the other building components depends on their maintenance and the initial construction materials. He concludes that the normal useful life of a building is about 50 years, with one-third of the building having an infinite life and two-thirds of the building requiring two complete replacements over a 100-year period.

One of these replacements will occur because of academic changes and replacement of obsolete equipment, while the other will occur as part of a complete gutting and rehabilitation of the building. Changes necessitated by academic requirements will also provide for normal roof and elevator replacement, exterior-interior painting, upgrading of plumbing, safety features, and space realignment and remodeling.

Bareither also developed a formula for determining the funding level required for space realignment, renewal, and replacement, based upon the replacement cost of facilities. What would it cost to replace a campus in a given year? The University of Illinois, for example, has 20, 605,224 gross square feet of space. The replacement cost of the campus is estimated at $1,515,077,300, or $73.53 per gross square foot. The formula for determining the financial amount of SR³ is:

ANNUAL SPACE REALIGNMENT, RENEWAL, AND REPLACEMENT REQUIREMENT = 1,515,077 × .667 (⅔ to be remodeled × .01 (one time per hundred years) = $10,105,565 divided by 20,605,224 sq. ft. = $0.49.

Note: Replacement cost is calculated in current dollars by applying appropriate inflation factors to the original cost of each building and major addition.

Renewal Needs and Building Age

The "two-thirds" approach to renewal and replacement is also reflected in recent work done by Douglas R. Sherman and William A. Dergis of the University of Michigan. (7) Again, while all buildings require ongoing and scheduled maintenance, a major renewal of a building occurs approximately every 50 years. Based on 1971 studies by McKee-Berger-Mansueto, Inc., and the University of Illinois, and a study sponsored by the former U.S. Department of Health, Education and Welfare, building renewal costs should not exceed two-thirds of the cost of new construction. If they do, the institution would gain more by demolishing and then rebuilding.

Sherman and Dergis point out that the building renewal needs of a campus or grouping of buildings (such as a dormitory complex) grow with the average age of the campus. At the same time, because different facilities were built at different times, their renewal needs will vary.

Consequently, if the two-thirds approach is to generate renewal dollars on a schedule consistent with renewal needs, it must be weighted to skew fund generation toward older structures. To accomplish this, a 50-year building life cycle was adopted and incorporated into an "age factor," equal to building age/1,275, where the number 1,275 is the sum of 1 + 2 + 3 . . . + 49 + 50, representing the 50 years of a building's life. Thus, for a building one year old, the factor becomes 1/1,275. For a building five years old, the factor becomes 5/1,275, and for a building 50 years old, it is 50/1,275. (Note that 1/1,275 + 2/1,275 + 3/1,275 + ... + 49/1,275 + 50/1,275 = 1.0.)

By multiplying the current renewal value of each building (two-thirds of its current building value) by its age factor, it is possible to calculate the amount of money generated by each building. Thus, instead of generating a constant two percent of its current renewal value each year for 50 years (as in a straight line schedule), a building will generate 1/1,275 of its value the first year, (less than one-tenth of one percent), 2/1,275 the second year, and so on, until the fiftieth year, when it generates 50/1,275 (almost four percent) of its current renewal value. In this way, a collection of older buildings generates relatively more renewal funds than does a similar group of newer buildings.

Example: An unrenovated building, South Hall, was constructed in 1967 at a cost of $1,000,000.

Market Index for 1967 = 2.66
Building Value (BV 1980) = $1,000,000 × 2.66 = $2,660,000
Building Age (BA 1980) = 13 years
Therefore,
1980 Appropriation = ⅔ BV × BA/1,275

= ⅔ ($2,660,000) × 13/1,275
= $18,081

The $18,000 is not allocated for South Hall alone. Rather, the funds are combined with other facility renewal dollars to establish a pool. As buildings come due for renovation, the pooled dollars are used, either to revitalize each facility in turn or to renew partially a number of facilities.

To paraphrase a Nebraska state legislative committee report, an institution can pay now or pay later—but it is prudent to begin allocating annually the requisite amount determined by using the formula. These allocated funds are, in effect, drawing rights, established by the institution or state to renew campus facilities on an ongoing, planned basis. Knowing that renewal and replacement dollars are available, the institution can undertake comprehensive and long-range renewal planning based upon the "actuarial table of buildings" which will be developed.

DETERMINING ADEQUATE FUNDING FOR CUSTODIAL AND MAINTENANCE CARE

Traditionally, the lack of an accepted definition of "adequate funding" has hindered the allocation of custodial and maintenance funds. Several formulas, however, provide sound methods of estimating "adequate" funding levels. The principle behind formula-based budgeting is to identify those institutional characteristics, or variables, which are most directly related to the cost of providing custodial services and campus maintenance. (Formulas assume no built-in deferred maintenance expenses.) The relationship between those variables can be expressed in a formula, and the value of each variable changed to meet new conditions.

The best known method of formula budgeting, commonly referred to as the Texas/Oklahoma formula, was developed by Walter Kraft at the University of Oklahoma in 1949 and subsequently modified by W. H. Badgett, director of physical plant at Texas A & M. This formula and variations of it have been widely used by state universities in justifying budget requests to legislative appropriations committees.

The Kraft formula is:

MAINTENANCE BUDGET = MAINTENANCE COST FACTOR × CURRENT REPLACEMENT COST OF BUILDINGS

Kraft determined that building construction rather than square footage or building volume was the key cost variable. He divided campus facilities into three categories based on construction type and developed a Maintenance Cost Factor based on the approximate average of Oklahoma's experience over a period of 15 years. These categories and factors are:

Construction Classification	Factor
Wood frame construction	1.75%
Masonry-wood construction	1.30%
Masonry-concrete or masonry-steel construction with concrete floors	1.10%

Badgett added to Kraft's formula a 0.15 percent factor for air-conditioned structures to reflect their higher maintenance costs.

Kraft's work has been synthesized into the formula for building maintenance recommended by the Texas College and University Coordinating Board. The formulas for the 1981-83 biennium are:

BV × K = ANNUAL MAINTENANCE ALLOWANCE

Definition of terms:

1. BV is current replacement cost of building, applying appropriate factors for specific classes of construction as taken from the Markel Appraisal Chart (Cincinnati, Ohio) to original construction cost and to each capital improvement.
2. K Maintenance Cost Factors are:
   Air-conditioned wood frame construction = .0190
   Non-air-conditioned wood frame construction = .0175
   Air-conditioned masonry—wood frame construction = .0145
   Non-air-conditioned masonry—wood frame construction = .0130
   Air-conditioned masonry—concrete construction = .0125
   Non-air-conditioned masonry—concrete construction = .0110

The Coordinating Board of the Texas College and University System also recommended the following formula for the other basic plant services of grounds care, custodial service, and physical plant administration and plant services:

GROUNDS CARE =
SW (.70P + 122L + .50HC)I

Definition of terms:

1. SW is the average hourly earnings for services (adjusted) as shown in the *Survey of Current Business*, published by the Bureau of Economic Analysis of the U.S. Department of Commerce.
2. P is the total linear feet of perimeter of all campus buildings including academic, office, service, administration, dormitories, etc.

3. L is the total acreage of lawns and regularly maintained areas, including malls, flower beds, parking lots, sidewalks, streets, etc. Exclude all buildings, street areas, and areas covered under Organized Activities (e.g., college farms).
4. HC is the fall semester head count enrollment.
5. I represents a one-year inflation factor for labor and materials. For fiscal year 1983 this factor is 1.126.

CUSTODIAL SERVICES =
SW X GSF/22,400 X 2,080 X 1.2

Definition of Terms:
1. SW is the average hourly earnings for services for January as shown in the *Survey of Current Business*, as cited above.
2. GSF is the gross square feet of building space eligible for state funding.
3. 2,080 is the product of 40 hours per week times 52 weeks.
4. 1.2 is the nonsalary cost factor.

Physical Plant Administration and General Services

ADMINISTRATION and GENERAL SERVICES BUDGET =
SW ([FTSE + 2 × FTEE] × 3.90) + (RCB × 0.0028)

Definition of terms:
1. SW is the average hourly earnings for services for January, as above.
2. FTSE is the full-time equivalent student enrollment.
3. FTEE is the total full-time equivalent employees.
4. RCB is the replacement cost of buildings calculated for the building maintenance formula above.

A different approach was proposed by George Weber and William H. Horsey of the University of Maryland. They developed a formula intended to eliminate the variances of institution size, composition, and location for four principal functions: administration, building maintenance, custodial services, and grounds maintenance. In developing this formula they made certain assumptions:

- ☐ work is performed by in-house personnel
- ☐ the institution is open for business 45 hours per week, as a norm (the formula can be modified if the standard week is longer or shorter)
- ☐ the institution provides 190 gross square feet of space per FTE (which can again be adjusted)
- ☐ the institution has a building-to-land coverage of 0.25 (i.e., 25 percent of the total developed campus area is landscaped).

This formula is based on the gross square footage maintained by the plant department. The *minimum* basic budget is:
FTE = GSF/10,000

The *optimum* basic budget is:
FTE = GSF/10,000

The annual budget for the four basic functions is FTE × S × MSF.

Definition of terms:
1. FTE is the number of FTE physical plant employees required to perform the four basic functions.
2. GSF is the number of gross square feet operated and maintained by the plant department.
3. S is the average annual salary and benefits.
4. MSF is the factor for computing materials and supplies measured as a percentage of total salaries and wages.

The procedure from this point is rather simple. Staff requirements in FTE are computed, and adjustments are made for hours of operation and intensity of use. The total FTE staff is then divided into four basic functions on the following basis:

☐ Administration	5 percent
☐ Building Maintenance	25 percent
☐ Grounds Maintenance	10 percent
☐ Custodial Services	60 percent

Salary dollars for each category are computed by multiplying the FTE by the appropriate average annual salaries and benefits for each group. The budget for materials and supplies for each group is then determined by using the following factors as multipliers:

☐ Administration	0.087
☐ Building Maintenance	0.427
☐ Grounds Maintenance	0.429
☐ Custodial Services	0.111 (8)

LINKING THE PLANT TO THE UNIVERSITY MISSION

The plant department is clearly linked to the overall university structure through the reporting and funding processes. However, the way in which the plant is connected to the institutional *mission* is often unclear to members of the department and other university employees and constituents. The faculty and administration may carry out the mission, but plant staff provide and maintain the setting in which that mission can be accomplished.

The establishment of plant goals and objectives can help department workers identify links between themselves and the larger organizational mission, as well as define priorities and delegate responsibility within the department. According to Logan Council, former director of physical plant at Texas A & M, defining the plant mission and setting priorities are the most important steps to physical plant improvement. At Texas A & M, the physical plant department and university vice president worked together to develop a mission statement for the department which places primary importance on maintenance, renewal, and replacement, and lesser importance on requests for special services.

The statement is this:

- ☐ In accomplishing routine as well as non-routine maintenance, the Physical Plant Department shall achieve effectiveness through planning and scheduling of manpower and materials.
- ☐ Whenever possible, all periodic work shall be identified, scheduled, and managed as a routine task.
- ☐ Likewise, the organization shall be responsive to the needs of other departments and will provide problem-solving, consulting and modification services in a competent, economical and expeditious manner.
- ☐ Management and organization will maintain personnel performance, University appearance, and facility operations consistent with the wishes of the President and Board of Regents of Texas A & M University.

Once plant department priorities are set, specific objectives for accomplishing tasks can be established. The Facilities Planning Group can provide an appropriate forum for helping to define plant mission and set department priorities. Regular review and reporting to the group by the plant director are crucial to ensuring that objectives are met. At Texas A & M, such reportage is supplemented every six weeks by a campus walking tour taken by the director of physical plant and university vice president. If the physical plant department receives diverse demands for low priority tasks from highly vocal people, the review procedure with top administrators can provide reinforcement and encouragement to maintain priorities. Within the department, weekly staff meetings can be held, at which time progress is charted and problems resolved.

In order to establish objectives for facilities management, an analysis of current plant operations, followed by an examination of where improvement can occur, are required.

Plant analysis involves two components: identifying and measuring the current services and products of the plant department. What does the plant department do, on a day-to-day basis, to provide services the campus requires? A categorical listing of all services (from cleaning faculty offices to removing hazardous wastes, distributing electricity and distilled water, and repairing window shades and roofs) can be a powerful tool in educating the Facilities Planning Group and the campus community in general as to what the department does. The listing can also act as a "consciousness-raising" instrument, for often not until all plant department activities are detailed is the scope of department responsibilities evident to employees themselves.

Once a roster of plant services and products is complete, they can be measured. Measurements provide an opportunity for the plant department to examine its work and report on its activities—in meaningful figures—to the academic community. For instance, the plant might gauge square feet of cleaning; acres of roof inspected and repaired; acres of campus grounds mowed; square yards of surfaces painted; and the number of windows cleaned or replaced, fan belts checked and adjusted, or keys produced annually. In calculating such measurements, the department must also determine the man-hours required to accomplish these tasks, as well as the cost to provide the labor and materials.

Based on the services inventory and measurements, the plant might formulate realistic annual objectives for custodial care and maintenance. For example:

1. Custodial care will be provided to all facilities during the fiscal year at a cost not to exceed $X.
2. All major campus roads and parking lots will be cleared within X hours of a 6-inch snowfall, using Y man-hours.
3. All roofs will be inspected annually at a cost not to exceed $X in labor.

Plant improvement examines the current plant operation—the normal work output—and then looks for areas in which improvement is necessary or desirable. For example, if the campus plumber completes an "average" job in a half hour, and he works an 8-hour day, in theory he should be able to complete 16 jobs per day. If he completes only 8 jobs per day, one must ask, "Why is the plumber working at 50 percent capacity?"

A work analysis might show that the plumber's 8-hour workday breaks down this way:

8:00 – 8:30 AM	- pick up job tickets, organize tools, procure materials necessary to complete jobs
8:30 – 8:45 AM	- travel to job #1
8:45 – 9:30 AM	- complete job #1
9:30 – 9:35 AM	- travel to job #2
9:35 – 10:20 AM	- complete job #2
10:20 – 10:35 AM	- coffee break
10:35 – 10:45 AM	- travel to job #3
10:45 – 11:00 AM	- undertake job #3
11:00 – 11:15 AM	- travel to shop for special tool and return to job #3
11:15 – 11:45 AM	- complete job #3
11:45 – 12 noon	- return to shop and clean up for lunch

The analysis of the afternoon is similar. Travel time, break entitlements, return to the shop complex, plus cleanup (which many union agreements stipulate be done during production time), limit the number of jobs that can be accomplished. Analysis, then, might reveal that eight is an ideal number.

A "brainstorming" session with plant tradesmen might produce the idea that someone other than the plumber procure the equipment and supply needs in advance of the day the jobs are to be carried out, and prepare a tool and supply box based on the job orders to be completed. The truck might be better supplied or the plant might establish supply zones for certain types of equipment in strategic locations on campus.

By examining how jobs are performed, the constraints of each, and those activities which can be made more efficient, realistic targets for improvement can be established. In this way, major increases in productivity can be achieved in all of the major trade shops.

Objectives in the example of the plumber might be: to increase the number of plumbing repair jobs by X percent (or an average of X per day), at a cost of $Y, and Z work hours. (This covers the additional supplies required and the need for a helper to assemble job tickets and tools.)

Such a sample analysis suggests that the people who can do the analysis best are often those directly involved with the job. The analysis and objective-setting process is really one of brainstorming and team building in which a group of workers focuses attention on the job each does, trying to identify how they can work not necessarily harder, but better.

At Texas A & M, Logan Council placed emphasis on organizing work and staff in order to *schedule as routine* as much work as possible in three priority areas—routine and planning maintenance, "fire fighting," and work for others. He created area shops throughout the campus, in addition to the central shop, and divided his staff into work crews. The area shops and their assigned staff are responsible for maintenance and work in each sector of the campus. The central shop is responsible for major renovation projects, equipment overhaul, and work orders.

This organization of work load and staff has proved successful in all three priority work areas. The area shops have lessened staff travel time and increased visibility of the department throughout the campus. By breaking the campus into smaller units, work crews and supervisors can gain intimate knowledge of their areas and better schedule routine and fire fighting work. Areas of responsibility are clearly defined, and employee morale is good.

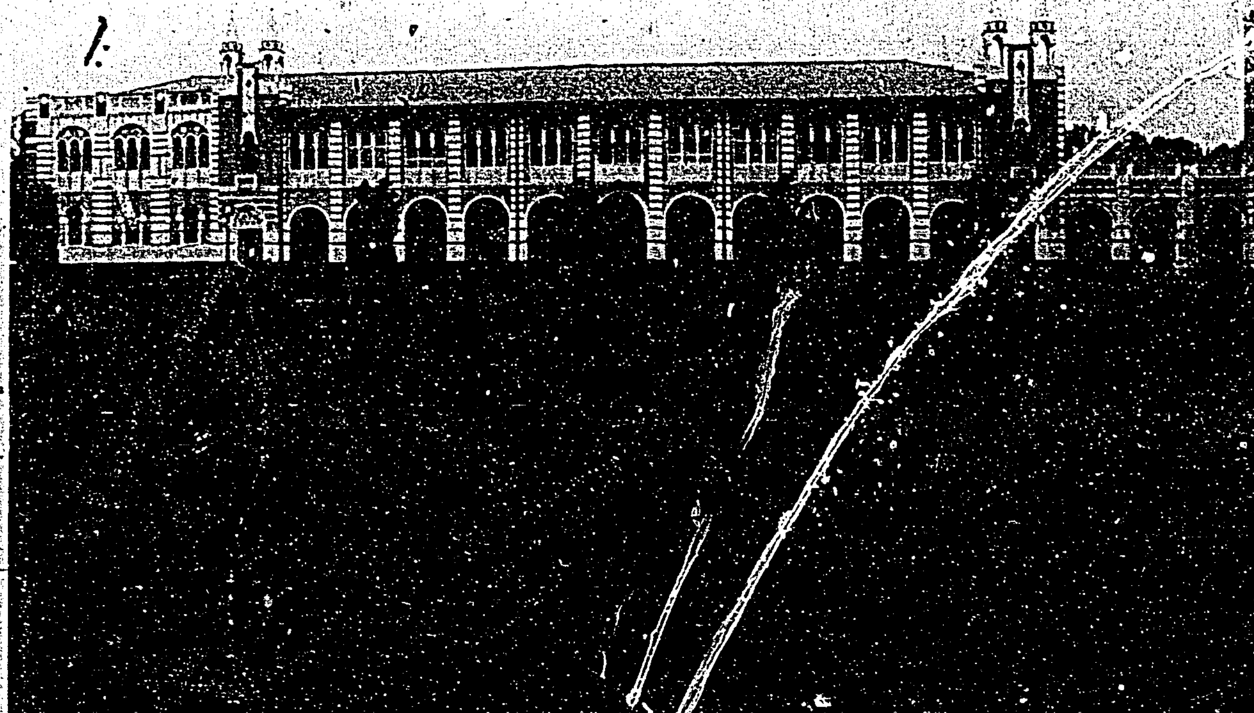
Personnel

The traditional method of employee promotion through the plant ranks (generally without any additional training), from craftsman to supervisor to assistant director to director, is inadequate in relation to the complexity of the job. As one plant director observed, "With 15 to 20 percent of the institutional budget, you need wisdom behind the plant."

The plant department labor force is usually the second largest on campus—smaller only than the faculty. Personnel represent 80 to 90 percent of the physical plant budget and rank among the top problems cited by physical plant directors. In short, directorship of the plant represents managing people as well as boilers and budgets.

Training and opportunity for advancement are key factors in maximizing staff productivity. Training in specific job skills, whether classroom cleaning or general maintenance, can increase worker produc-

Realistic objectives for custodial care and maintenance might include performance guidelines for clearing snow from campus walks and roads, trimming hedges, and mowing lawns.



Employee training and opportunity for advancement are key factors in worker productivity (below). Another plant efficiency factor to consider: is the plant shop (above) properly equipped and its personnel adequately skilled to complete the job, or should the task be contracted out?

tivity. At many universities, for instance, a new worker is handed cleaning equipment, assigned to a co-worker for a few days of on-the-job learning, and then placed on his or her own. At Purdue University, however, cleaning is a subject of formal laboratory training. All new custodians are taught how to clean each type of surface and material with which they will come in contact, which equipment and cleaning agents to use, and how to use them.

Perhaps more important than training in specific tasks is training in people skills. The old-line supervisor, with nearly dictatorial powers to hire, fire, discipline, and control wages, is largely a person of myth now, in the university as well as in industry. Negotiated wage agreements and grievance and appeal procedures have eliminated the omnipotent supervisor. Yet many physical plant supervisors and managers grew up in the old school and, lacking personnel motivation skills, feel frustrated with their inability to manage. They tend to lay the blame on the worker. For example, one director of a physical plant department complained that "the fear of firing is not as great as it used to be." He blamed public welfare programs and increased job security for lessening the incentive to work, thereby making his management job more difficult.

Under the direction of assistant vice president for physical plant Theodore Simon, Michigan State

University has developed training programs for all physical plant department employees to ensure career development and in-house promotion, as well as promotion of worker self-esteem. Employees receive training in such people skills as listening, writing, motivation, team building, and leadership. Training improves the ability of the plant department worker—who traditionally lacks advanced formal education—to communicate with a professor who wants a laboratory renovated and to advance to supervisory responsibility.

Edwin B. Feldman, president of Service Engineering Associates, a firm that has consulted with many colleges and universities on employee training, lists the following as important training topics for plant supervisors and managers: leadership, motivation and morale building, team building, time management, creative thinking and problem solving, working with other departments and organizations, worker training, worker counseling, practical psychology, report writing, and personal development.

Training in these areas is provided by a range of institutions and organizations. In fact, the campus personnel department should be able to provide much of this training. If that department's resources are limited, it should be able to provide contacts in the community—the training department of a local corporation, for example. Personnel training courses are also offered at community colleges and life skills centers. Professional affiliation groups, such as the Association of Physical Plant Administrators, offer seminars, as do local chapters of the Building Operators and Managers Association.

It is the responsibility of the plant director to direct appropriate personnel to training programs which will strengthen the individual and in turn the department. A training program investment is one of the most sound investments the plant director can make.

Contracting Out Tasks

Outside contractors are routinely used for specialized jobs such as elevator service and maintenance, which require skills not available on campus. Contracting is also used for large projects, such as building renovations, which may be beyond the scope of in-house work forces.

There has been a trend for campuses, through attrition and retirement, to phase out many of its highly specialized shops, such as shade, venetian blind, and upholstery repair. This work is now more commonly bid to outside companies. But observations indicate that when the craft leaves the campus, the work does not get done. Shades get repaired or replaced only on what might be called an emergency basis. Upholstery is repaired if the department that uses it pays for it.

Contracting provides financial benefit to the institution by relieving it of employing personnel who are not fully utilized. The campus must ask, "Are the skills not fully needed, or as rising energy and labor costs absorb more and more plant dollars, were these skills deemed the least necessary?"

Campuses must evaluate whether it is more economical to use in-house forces or contractors. Among the conditions that should be weighed in such an analysis are: campus labor and overhead costs versus outside contractor costs; and caring, pride of workmanship, and morale of campus labor versus work quality and supervision of contractors. In some instances a mix of in-house and outside workers may prove the best solution.

It may also be appropriate for in-house shops to bid against outside contractors. Examination of bids can reveal numerous issues of plant operations such as wages, supervision and overhead costs (both of the plant department and central administration), and quality of workmanship of each.

Custodial Care

Custodial jobs are generally undertaken by the least skilled and lowest paid members of the physical plant department. They are recognized as dead-end jobs, and it is difficult to motivate custodial employees. Turnover rates of 25 percent annually are not uncommon, and for many workers, a custodial position is a second full-time job. Because the work is generally done at night and at widely scattered locations, employees work independently of close supervision.

For these reasons, some institutions have contracted for custodial services with outside firms. Large contracting firms may provide greater opportunities for advancement to employees than do institutions. Robert Burch, director of physical plant at George Washington University, reports that top University administrators have been very pleased with contracted custodial services, and he credits this largely to career possibilities for the contractor's employees. George Washington University also treats the contractor's line managers as though they were GWU staff, including them in weekly department staff meetings.

Nonetheless, motivational and quality control problems are inherent in custodial work and cannot be delegated entirely to contract supervisors. Over time, the quality of work may deteriorate, and some institutions find that contract monitoring takes more effort than it is worth. Stanford University, for instance, employs students to inspect a contractor's custodial work on a regular basis.

Campus Communications

It is up to the director of physical plant to initiate improved relationships with the rest of the campus community both to overcome their traditional isolation and to increase recognition and understanding of their function. Stories in both campus and local media provide an opportunity to personalize the invisible campus—to give the plant department a face. Stories might focus on the subterranean world of tunnels, the issue of deferred maintenance, or the significance of the campus landscape in the context of architectural history.

Communications can also be fostered by the use of area shops. Those at Texas A & M cultivate a personal relationship between the staff and their "clients" in each campus sector. At George Washington University, all work is assigned out of one main shop, but the physical plant department has three representatives: one for administration, one for academic departments, and one for auxiliary enterprises. Each of these representatives is the liaison with the entire physical plant department—assisting with work orders and rectifying problems.

Well-designed brochures have proved helpful to the plant image at both Purdue University and Texas A & M. These brochures improve access to the physical plant department by listing telephone numbers for responses to various services and requests, and providing instructions for filling out work order requests. They also educate people about the workings of the department. Project flowcharts show how a work order is processed, and statistics illustrate the scope of physical plant operations (e.g., 2,000 annual lock and key changes; 7,000 annual inspections of fans, motors, and pumps; and responses made to 400,000 annual telephone requests). The plant director can enlist the assistance of the campus public affairs office in producing such a brochure, and in providing guidance for campus news stories based on physical plant department operations.

IMPROVING UTILIZATION OF CAMPUS FACILITIES

Poor utilization of campus facilities occurs for several reasons:

- ☐ Academic departments may control more space than they really need because of the prestige accorded departments with large volumes of classroom and office space.
- ☐ Instructional space, such as classrooms, seminar rooms, laboratories, or studios, sits idle much of the time. Such a use pattern may be the result of too little demand for that space because it is poorly located on campus, poorly equipped, or specially equipped for a narrow range of purposes.
- ☐ An academic department may "own" instructional space which it does not fully utilize for its own courses, but which it withholds from general use by not allowing the institution's registrar to schedule classes in it.

Here are several strategies which can result in improved utilization of facilities—reapportioning space as needed, thus avoiding the necessity to build new space for growing departments and programs, and possibly identifying excess space. As a provost at the Massachusetts Institute of Technology asserts, "It's time we learned how to turn around within our own skin." Instructional space can be used more intensively, though such intensive use may require upgrading poorly equipped rooms and centrally scheduling use of all teaching space. Space can be made more efficient to operate, so that its costs are lower and the impact of less than maximum utilization is reduced.

Scheduling Instructional Space

According to the Coordinating Board of the Texas College and University System:

> Because of . . . diminishing enrollment growths, increasing cost of new construction and need for improved utilization of existing space, the emphasis in facility planning must change from new construction to other, more pressing facilities needs. The new construction of additional space should become virtually an option of last resort, after the most careful study of other alternatives. (9)

Classrooms, lecture halls, and teaching laboratories are some of the least intensively used spaces on campus. Better use of existing space is the least expensive source of additional teaching space, and may permit realignment or conversion of some instructional space to other purposes.

Improving space utilization requires review of both the space itself—its location, size, and condition—and the way classes are scheduled to use it. Entering data on all instructional space in a single inventory and scheduling its use centrally are key to improving utilization.

Under the guidance of James F. Blakesley, coordinator of space and schedules, Purdue University has for 30 years emphasized maximum facility utilization. The results have been dramatic. At the time of World War II, Purdue had 270 classrooms and 6,000 students. When the postwar G.I. bulge of 13,000 students passed through the university, there were still 270 classrooms. In the late 1970s, when Purdue's enrollment hit 30,000, the university operated 270 classrooms. As it enters the 1980s, Purdue has 270 classrooms. Not all classrooms are necessarily the same spaces that existed in 1942. The lecture halls are larger and the teaching laboratories newer, but the university is effectively scheduling five times as many students in the same number of classroom spaces.

The philosophy of improved scheduling that has guided Purdue's efforts is:

- ☐ use teaching space to the fullest
- ☐ offer the widest choice of courses to students (with minimum schedule conflicts)
- ☐ remove constraints on development of new courses or programs mistakenly attributed to facility and schedule.

The principles and techniques developed at Purdue to analyze space needs and organization of time/schedules, as well as to improve facility utilization, are broadly applicable to colleges and universities.

Analysis of Space Use and Needs. Blakesley's method for analyzing existing space utilization and planning for future needs is more sensitive to realistic classroom configurations than the simple ratio of gross square footage per student that is commonly used. He developed a set of four equations which relate the following key attributes of space, use, and enrollment.

The key data elements are:

1. *SF per student station (square feet per student station)*: The amount of space needed for each student in a class. This space will vary for different types of classes and their physical requirements, such as laboratories, studios, conference rooms, and lecture halls.
2. *SCH (student contact hours per week)*: A curriculum element reflecting the number of hours students and teachers are together for a particular course.
3. *Percent of station use*: Average attainable use relative to room capacity, when a room is in use.
4. *HRS*: Average number of hours per week that a classroom is in use.
5. *Total SF*: Total amount of assignable space, given in square feet.
6. *Total Enrollment*.

Using the following four equations, one can relate enrollment to amount of space needed or assess current space utilization. The important concept is the computed space factor SF/SCH—square feet per student contact hour.

- ☐ HRS × % station use = SCH per station
- ☐ $\frac{\text{SF per station}}{\text{SCH per station}} = \frac{\text{SF}}{\text{SCH}}$
- ☐ $\frac{\text{SF}}{\text{SCH}} \times$ per student = SF per student
- ☐ SF per student × total enrollment = total square feet.

Blakesley's analytic method can be used in several ways. One can average and aggregate data to:

- ☐ analyze total institutional needs and assess current use
- ☐ test effects of different degrees of utilization in specific types of space (such as labs or lecture halls)
- ☐ assess departmental teaching space needs, or the effects of structuring courses with greater or fewer numbers of student contact hours.

Principles of Space Allocation and Location. Blakesley also provided the following guidance on location and use of general classroom space, to maximize the impact of new construction or renovation:

- ☐ Locate classroom space centrally on the campus, near areas of heavy pedestrian traffic, and also centrally within buildings. A minimum of classroom space should be located at the periphery of the campus, and such space should be used for specialized and advanced classes. Central class location reduces the amount of "nonproductive" time needed between class periods and promotes shared use of classrooms by all departments. Blakesley further recommended that central lecture halls be scheduled for a minimum of 38 hours of use per week.
- ☐ Treat teaching spaces as interchangeable. All teaching space should be centrally managed and scheduled. To be effectively interchangeable, all space should be well maintained and equipped so that it is of equivalent high quality.
- ☐ Encourage departmental office expansion through renovation of existing classroom space, *provided* that the department uses no additional total space. This is a strong incentive to schedule courses in time periods of traditionally low demand.

- ☐ Place classroom space, created through new construction or renovation, in central campus locations. Overbuild somewhat the *size*—but not the *number*—of rooms. In a tight economy, departments are more likely to increase the size of classes than the number of sections.

Analysis of time used and organization. The key elements in analyzing the use and organization of time are units of time, length of academic week, and time patterns. Units of time (commonly 45 or 60 minutes) are the basic modules of a schedule, often called a period. Classes are usually scheduled in multiples of these units.

The length of the academic week is a function of both the number of hours per day and days per week that are available for classes. Many institutions operate using 35 or 40 hours per week. Purdue University, however, used a 55-hour week.

A time pattern is the specific combination of meeting hours during a week for a particular course. For example, M–W–F 9:00–10:00 is one common pattern; T 9:00–10:00, W 2:00–5:00, Th 6:00–7:00 might be another pattern.

The number of time patterns available in a week is the single most important factor in eliminating scheduling conflicts and maximizing course choice. As the number of time patterns increases from 10 to 20, the probability of scheduling conflicts decreases exponentially.

The availability of numerous, nonconflicting time patterns is thus equally important to both small and large institutions. The number of time patterns available has a much greater impact on scheduling conflicts than does the number of courses. Roughly the same probability of conflict would be found at an institution offering 100 courses during 13 time patterns as at an institution offering 3,200 courses in 14 time patterns. In both institutions, if a student needed to select 6, 7, or 8 courses (time pattens), the probability of conflict would double with each additional course.

The number of different time patterns that can be accommodated in one academic week depends on the complexity of patterns required by the curriculum. Courses which have lectures, sections, and long laboratories or studios have more complex patterns than simple lecture courses. Thus, an institution or single department with complex time pattern requirements must have a longer academic week to provide the same degree of flexibility in course selection as an institution or department with simple time patterns. In order to achieve flexibility in course selection, courses should be scheduled evenly, us-

ing all available time patterns. The advantage of having numerous, nonconflicting time patterns is lost if most courses are offered in a few popular hours.

Principles of scheduling. Blakesley provided guidelines for preserving flexibility of course selection, based on analysis of time use.

- ☐ Classes with large enrollments, especially those required to be completed by many students, should be offered in several sections, filling different time patterns. A single-section large lecture class is only superficially cost effective if it results in underutilization of all other space during the time it meets.
- ☐ Courses which are least likely to be selected by the same student should be scheduled during the same time patterns. These include, for example, advanced courses in diverse fields of study and required sequence courses in the same field.
- ☐ Courses which are likely to be selected by an individual student should be scheduled in nonconflicting time patterns.
- ☐ All time patterns should be utilized, regardless of tradition. Noontime classes should be encouraged, but combinations of classes should not be scheduled back-to-back at midday. Multiple lecture/laboratory courses should be scheduled so that enrollment is equally distributed during morning and afternoon hours. In other words, the scheduling of all lectures in the morning and all labs in the afternoon should be avoided.

Academic Departments and Central Scheduling

Departments which have traditionally scheduled their own classes in their "own" space can still enjoy a certain degree of flexibility working within such a centralized scheduling system. At Purdue University, Curriculum Schedule Deputies estimate student demand for courses in all university departments and work with academic departments to establish nonconflicting time patterns for sets of courses that a student might select. Each department is then allocated a certain amount of time and space, and the department is responsible for detailed scheduling.

Campus space, whether used for classrooms, laboratories, studios, offices, or lounges, is not free, and it is important that users be aware of its operational cost.

Departments adding new courses or sections in addition to those offered the previous year must schedule them in low-use time blocks.

The impact of this coordinated approach to scheduling and space utilization at Purdue is impressive. If the university were today operating at the same degree of space utilization as in 1949, it would need an estimated $25 million in new classroom construction and an additional $825,000 in annual operating allocations.

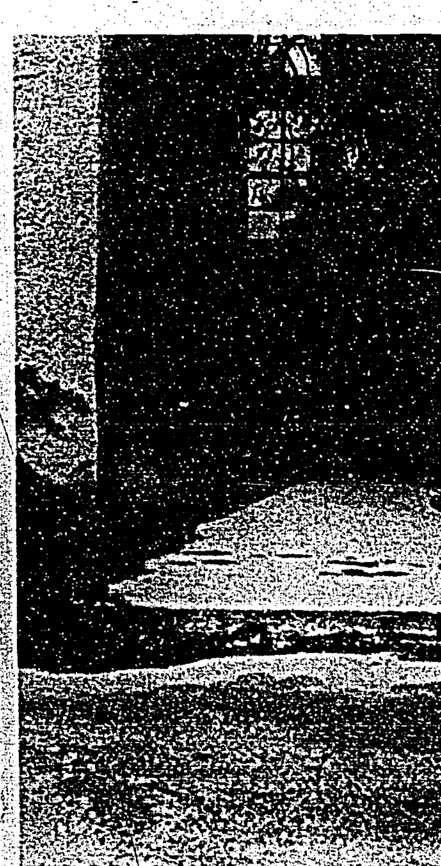
Space Costing

Traditionally, space has been free to users in colleges and universities, and funds for care and operation of buildings have been allocated directly to the physical plant department. Space costing is a strategy for assigning to departmental users of institutional space accountability for the costs of operating and maintaining that space. The strategy can be effective in increasing awareness among faculty and administrators of the real cost of occupying space, and in introducing incentives for more efficient use of space. Space costing can encourage realignment of space to meet institutional needs and avoid unnecessary construction.

The "free space use" system has resulted in two predictable situations. First, departments try to acquire and keep as much space as possible, regardless of any objective measure of need. Second, when money available for facility operation and care is insufficient, the physical plant department is caught in a bind. If the plant sets its own priorities, departmental space users are dissatisfied with the level of service they receive. If space user demands are met, maintenance and renewal efforts which are necessary but less visible are forfeited.

Using space costing, each academic (and perhaps administrative) department has available a given amount of money to pay for the cost of space occupied and used. Each department has flexibility to negotiate with the physical plant department (or outside contractors) levels of custodial service and can achieve economies by reducing energy consumption or the amount of space used. In effect, a "free market" for space is established and departments which can swap among themselves are usually forced into making their own trade-offs.

Variations possible with this strategy are enormous. The costs which can be "billed" include utilities, insurance, custodial services, routine maintenance, renewal and replacement, amortized construction costs, grounds maintenance, and administrative overhead. Costs can be billed on a per square foot basis, although they also may be weighted by desirability of space. Cost of shared spaces, such as lecture halls, may be prorated by



hours of use and weighted so that a lecture hall "costs" more to use at hours of high demand than at low demand.

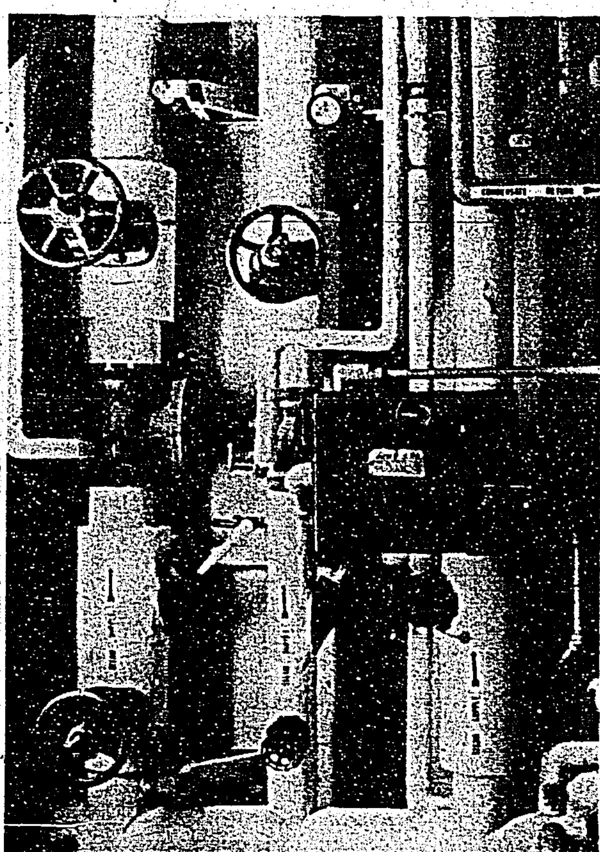
Safeguards should be created to ensure an institutional minimum standard for custodial care. In addition, enough money must be set aside for renewal and replacement. The crucial elements in this strategy are, of course, the amount of money available to each department and the process by which it is allocated.

At Brown University and the University of Alabama-Birmingham, space costing is used to recover more accurately space costs and indirect costs allocated on a per square foot basis from research grants and contracts. Departments determine how much of their space is used for each research contract, and the costs of that space are charged to the contract. At both universities, all academic departments are given an accounting of their total space costs, although not directly charged, in order to increase awareness of the true cost of using space.

At the University of Pennsylvania, facility use funds have traditionally been collected and distributed centrally, in the common manner. Yet concern over efficient space utilization has led to a gradual introduction of the space costing strategy. In 1976 the cost of space already occupied was computed and assessed to each college within the university. At the same time, each college was allocated 95 percent of its "rent." For the next several years, each college received one percent less of its rent from the central allocation process, and thus was forced to develop outside sources of income to pay the difference from the central allocation. Rather than tackle, head on, central determination of how large an allocation each college "should" have (and therefore how much space it "should" have), the university is applying pressure to each college either to reduce the amount of space it occupies or cultivate independent income sources.

Space costing requires a detailed data base, broken into square foot units, for accurate assessment of costs to individual buildings. The data base developed for an energy management program also provides much of the information needed for space costing. Several computer software packages are on the market for tracking space inventory, utility costs and consumption patterns, and other information needed for space costing.

Varied aspects of campus energy management—coal awaiting use at the campus generating plant (left), a leaking steam line in need of repairs (middle), and properly functioning steam supply lines (right).



Comprehensive Energy Management

Because the cost of energy is the most rapidly increasing institutional budget item, decreasing energy consumption is an important component in reducing operating costs and permitting funds to be allocated instead to physical plant care. A comprehensive energy management program includes more efficient use of facilities and scheduling improvements, as well as improvements in operation and maintenance of buildings and higher-cost retrofitting of building components. An energy program therefore needs to be developed collectively, with information contributed by all campus constituents and responsibility for action delegated among those constituents.

At most colleges and universities, energy conservation efforts have focused either on reduction measures or capital intensive solutions, such as double glazing windows or installing a sophisticated control system.

Work by California's Pacific Gas and Electric Company suggests, however, that of the first possible 25 percent reduction in campus energy consumption, 20 percent is derived from improved operations and maintenance, and 5 percent from "energy conservation measures." Maintaining the boiler system, reducing hot water temperatures, cleaning condenser coils, maintaining proper Freon levels in coilings, adjusting belts and dampers, lubricating bearings, reducing outside air by 10 percent, setting time clocks and analyzing lighting levels with lumen reduction can save a campus 20 percent in energy consumption.

Effective plant maintenance is effective energy management. It does not make economic sense to purchase or lease a sophisticated energy control system if boilers are poorly serviced or dampers on the roof do not work. Energy management has become capital intensive for two reasons. First, our society has a penchant for giving problems a "technological fix." Second, the budgeting process often makes it easier to justify adding a piece of equipment than hiring an additional person. It is easier to quantify the payback of a piece of hardware.

As one campus chief operating engineer said, "If I could hire two more men, I would save more than twice their salaries in energy." In other words, an investment of $40,000 in labor can reduce operating costs by more than $80,000. That can be viewed as a six-month payback annually, or perhaps more appropriately, as the personnel generating $40,000 in income. A faculty member recovering twice his salary is viewed with great favor, and a plant worker accomplishing the same should also be regarded favorably. In each case, income is being generated for the institution. The cost avoidance of energy management can be used as the lever to undertake a comprehensive energy management program, including the hiring of necessary personnel.

The Facilities Planning Group, using base data provided in a facility energy audit, can be an effective nucleus for establishing such a program. With energy audit data in hand, and working together with the plant director, the group can explore alternative or complementary actions to reduce campus energy consumption. A comparison of consumption economies with the cost of implementing the various conservation measures (whether personnel or technical) will determine the payback period. In addition to financial considerations, of course, decisions on conservation procedures should take into consideration effects on academic program, comfort levels of buildings, inconvenience, and architectural significance of certain buildings. After the Planning Group has debated and agreed on an energy conservation plan, it can establish a reduction goal of, say, 20 percent below current consumption. At regular intervals the group can review progress in meeting that goal.

MODELS FOR INSTITUTIONAL PLANNING

The ability to plan for the future is paramount if institutions are to proceed along an orderly course. We offer here two of several excellent planning models available today.

The first, the EDUCOM Financial Planning Model (EFPM), was originated at Stanford University and is in use at a number of colleges and universities across the country. The EFPM is not technically a model, but a computer-based building system. Based on the "TRADES" budget-planning model developed at Stanford, its capabilities were expanded and generalized with support from the Lilly Endowment. The EFPM allows the user to test various policy and financial options. For instance, if faculty are given an 8 percent salary increase, by how much must tuition increase? To give salary increases of 8 percent and hold tuition constant, by how many FTE's (full-time equivalent students) must enrollment increase? The ability to program inflation rates, salary increases, and budget projections, and to set up the information on matrices, allows the decision-maker to see the impact of internal and external cost escalators. The EFPM can also be used to create macro and micro facility models. In other words, a model can be developed for each building as well as for the overall facility or physical plant budget.

The EFPM provides a blank matrix of 560 variables and 12 years. The user determines the categories, base-year values, and relationships. In most planning models the structure is fixed, but EFPM allows the content to be determined within limits of the 560 variables per model. Using EFPM, an institution can develop its own planning matrix by projecting the impact of both external factors (e.g., inflation rates, enrollment changes, utility cost escalation, and changes in endowment income) and internal factors (e.g., personnel and collective bargaining agreements, FTE's, and the need to replace the roof on Old Main).

An EFPM planning model can be created specifically to determine the effect of various external and internal actions on the facility's budget. Among variables that can be examined and plotted along a 12-year horizon are energy and labor agreements.

> Once the data files are created, the user runs the model from a computer terminal, specifying through a question-and-answer dialogue alternative values of the variables, functions to be performed, and reports to be generated. The functions include forecasting up to 12 years and finding the feasible ranges of primary planning variables, subject to a specified set of constraints and calculating and plotting trade-offs between such variables (e.g., between tuition growth and faculty salary growth rates). The program can be operated by someone at the institution other than the creator of the data files. (10)

Of significant value is the ability of EFPM to project specific cost variables and show their impact on the institutional budget. The Facilities Planning Group can therefore ask EFPM for the effects of various facility options. For example, if energy costs are assumed to rise at a rate 5 percent above that of inflation, and the total plant budget cannot increase faster than the inflationary rate of the economy, how much would labor and materials have to shrink in order to accommodate rising utility costs? What would be the savings if the library were closed an hour earlier, or if the fans were shut off one hour before closing time? What would be the effect on the budget of decreasing the level of custodial care?

The physical plant budget can be broken down into as many as 560 discrete costs or variables, and these again can be manipulated to show the budgetary impact of raising and lowering the cost escalation of various components of the budget. It must be kept in mind, of course, that the quality of the forecast is as good or as bad as the data or assumptions on which it is based.

For institutions that prefer a ready-made model which can be adjusted to fit local conditions, the Community College Planning Model (CCPM), recently developed by the Academy for Educational Development, is a useful tool. Again, the name of the model is misleading. Its usefulness is not limited to community colleges. However, it may be particularly appropriate to state systems of higher education because it is set up to simulate state funding mechanisms.

The CCPM is more limited than EFPM in that it can be used only to analyze relationships between enrollment and finances. However, because it *is* a model, the user does not have to create all of the questions. The model is probably most useful in analyzing alternatives in resource allocation and budgeting procedures. The CCPM can combine limited historical trend analysis as well as future enrollment and financial projections.

The EFPM and CCPM systems can be equally useful for analyzing the effects of variables. For instance, one could determine the impact on the total institutional cash flow of average salary increases over a 10-year period in determining requisite levels of tuition income. Determining the impact of salary increases for specific numbers and categories of employees in the physical plant department is another level at which the EFPM and CCPM analysis might prove useful.

Final Words

In the last 25 years, public expenditures, plus private philanthropy for new construction in higher education, totaled almost $60 billion. New brick-and-mortar investments of that magnitude on the nation's campuses are, with few exceptions, over. The next great building boom in higher education is not in sight in this century, and campus physical plants currently in place hold the classrooms, laboratories, and libraries in which future scholars will work. These physical assets of the nation's campuses cannot be allowed to deteriorate further.

There is a direct relationship between institutional mission and facilities, and responsibility for the academic enterprise includes responsibility for the care and management of the campus physical plant. As in 1727, when the institutional statutes of the College of William and Mary placed with the president operating responsibility for institutional facilities, responsibility for their campuses must lie with top administrators and boards of trustees at institutions across the country. As an important institutional resource—one which today's college and university leaders will pass on to future generations of scholars—the campus physical plant should be cared for and nourished as if the existence of the institution were dependent on it.

Notes

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