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ABSTRACT

This document is an extract of EA 004 095 which reports a yearlong study of possible benefits in cost, time, and facility utilization of a systems building approach for Texas college and university construction. (Photographs on pages 7,8,9, and 13 may reproduce poorly.) (Author)

Higher Education Facilities Systems Building Analysis

Extract from
Documentary Work Report

Architecture Research Center
College of Architecture &
Environmental Design
Texas A&M University
College Station, Texas 77843

Summary Report
July 1971

Challenge

Introduction

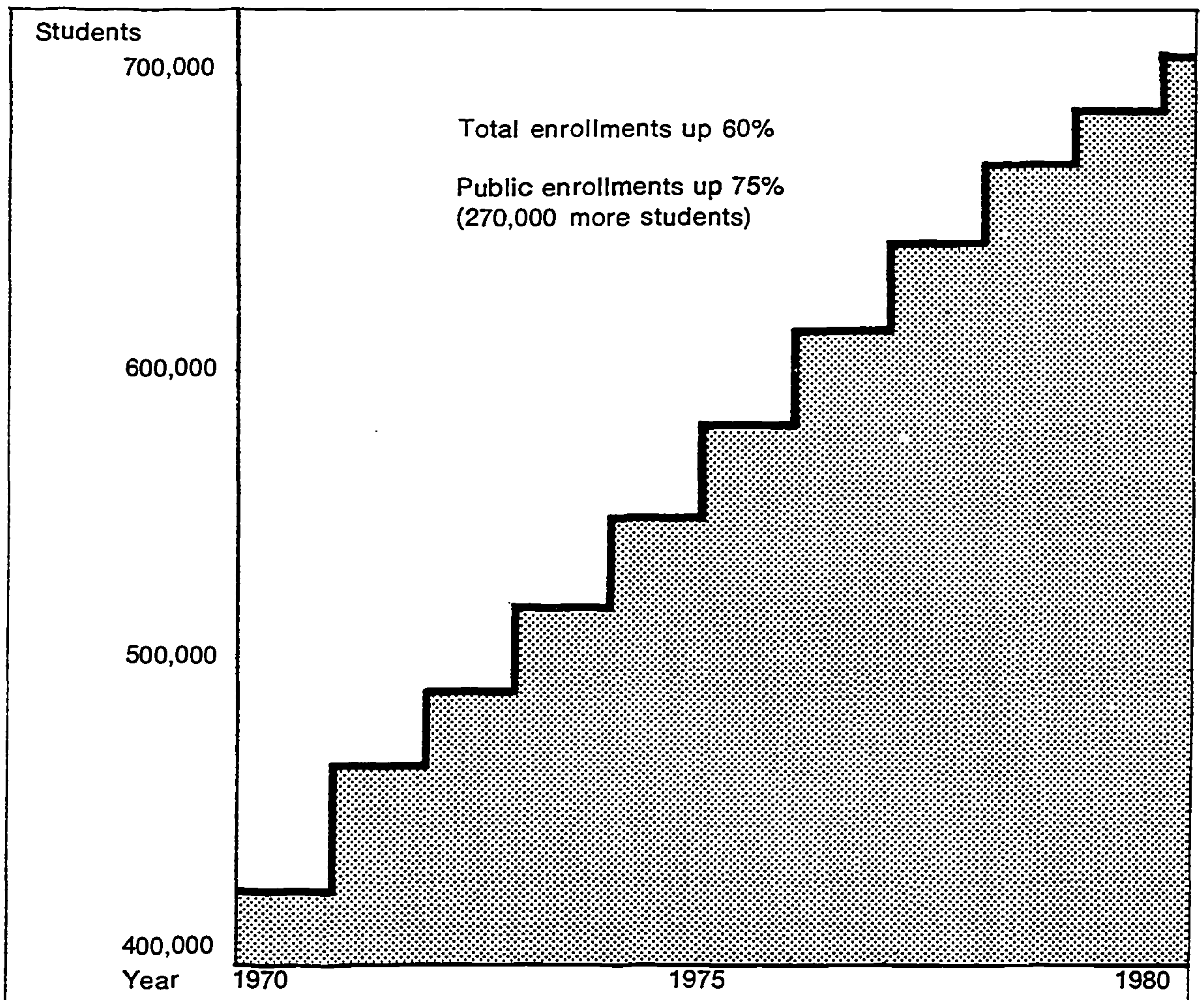
In July 1970, the Coordinating Board, Texas College and University System commissioned the Architecture Research Center of Texas A&M University's College of Architecture and Environmental Design to undertake a year-long study of possible benefits in cost, time, and facility utilization of a systems building approach for Texas' college and university construction. The study was supported by a comprehensive planning grant from the U.S. Office of Education. The purpose of this report is to present the results of the study and to make recommendations for improving the building delivery system for Texas' college and university construction.

Because one cannot reasonably talk about ways to satisfy future facility requirements without being aware of what they may be, the first part of this report deals with trends and needs in higher education and the related architectural implications. The discussion of alternative building delivery processes which follows will prepare the reader for a consideration of the utilization of present and future facilities. Finally, the results will be summarized and conclusions drawn on which recommendations for improving the process of delivering much needed college facilities will be based.

Requirements

National projections indicate a 20% increase in the college-age population (18-24) between 1970 and 1980. During that ten year period, however, college enrollments are expected to increase 60% because a greater percentage of the college-age population is seeking higher education and advanced degrees. 1980 Texas enrollments are expected to increase 280,000 or 65% from the 1970 count of 427,000. Most of this growth will be borne by public colleges, the 1970 enrollments of which are expected to increase 75% (270,000 students) by 1980.

On the average, Texas public institutions provide nearly 200 square feet of building space per student. Simply meeting the space needs of anticipated enrollment increases without considering changing educational needs or the requirements for building renovation, Texas public colleges will build 5,400,000 square feet of new facilities in the next 10 years.



Texas College and University Enrollments

Higher Education

Trends

The problem of providing needed facilities is further complicated by social and technological changes which constantly reshape the educational scene and force colleges to change as fast as they grow. Today in virtually every aspect of American life, conventional ways of thinking and doing are being re-examined and challenged. Changes result which test cultural assumptions previously held above question. The over-riding theme of current cultural concern is turmoil, and change itself has become one of the most basic facts of modern existence.

Educators tell us of developing generations which regard change as normal and necessary rather than as annoying or damaging. They are aware of this trend in today's young not only because they interact frequently with them but also because they are partly responsible for it. Education more than any other social institution besides the home mediates the environment to the young. The development of new cultural responses appear most obvious in college students because they have been exposed to the rapidly changing social environment during their formative years and have reached the age when they are more capable and likely to effect new structures.

Higher education, the cultural medium for these students, is pressured from within and without to change. The changing social scene, the growing body of knowledge and technology, rising costs, as well as the increasing population force colleges and universities to revaluate the quality and efficiency of their programs and facilities. This is to be expected. For in a time of great cultural flux, educational programs cannot long remain viable without changing to suit the society served.

The fact is that higher education is changing, although the changes occur in different combinations in different institutions. The major concepts generalized from these changes include a pervasive emphasis on the individual (individual control of study topics, pace and place of study, group participation, etc.), an increasing use of educational tools (in response to the restraints of economy and the opportunities of technology), and a growing awareness of the value of interdisciplinary studies and group participation. These concepts are closely interrelated and will effect similary interrelated architectural responses. A major task facing both higher education and architecture will be to develop facilities economically responsive to not only the new educational demands of today but to those of the future as well.

Architectural Implications

Higher education is changing at such a rate that that which we know as standard today may not be so in a few years. The great bulk of buildings on campuses in this country, however, will remain fundamentally unchanged due to the inflexibility of their designs and intended permanence of their construction. This disparity between function and facility restricts educators trying to update their programs. And thus pressures mount for facilities which can more readily support innovative programs.

No one can exactly predict future developments in higher education. And, because college buildings are typically planned as long-term investments, they must offer considerable spatial and functional variety in order to adapt to changing educational requirements. To do so within reasonable cost limitations requires flexibility in major subsystems not available in conventional college structures.

Flexibility, as a function of change, spatial variety, and economy, implies specific architectural responses. One of the more obvious is the need for clear space which means long structural spans. Another is the need for a malleable system of space division. Movable and operable interior partitioning could answer this need especially if supplemented with multi-functional furnishings. Environmental factors call for lighting systems which are changeable in intensity and location; relocatable air conditioning ducts and diffusers; relocatable mechanical and electrical distribution networks; relocatable environmental control systems; and provisions for sound control (carpeting, finishes, traffic patterns). Other parameters which contribute to spatial flexibility include an efficient, changeable signage system, functional wall finishes (chalk, display, projection), empty chases and cable trays for the addition of new services and/or equipment, and storage space for partitions, furniture, maintenance and educational equipment.

Colleges and universities are not only experiencing demands for flexible academic facilities. Growing student dissatisfaction with dormitory living and changing ideas about student housing produce demands for flexible residential facilities also. Many educators believe that student housing should narrow the gap between faculty and students, the classroom and the living room. The most important step in achieving such a goal is to provide students with two fundamental needs: privacy and participation. This means individual rooms and the opportunity to identify with groups small enough to be comprehensible. Mixing student (married and single) and faculty residential facilities could stimulate useful educational associations for both groups. The value of housing as an instrument of learning could be further enhanced by the introduction of multi-media equipment for occupants' use. Facilities so equipped would be economically feasible only if flexible enough to accommodate myriad social and technological changes without undergoing major renovation.

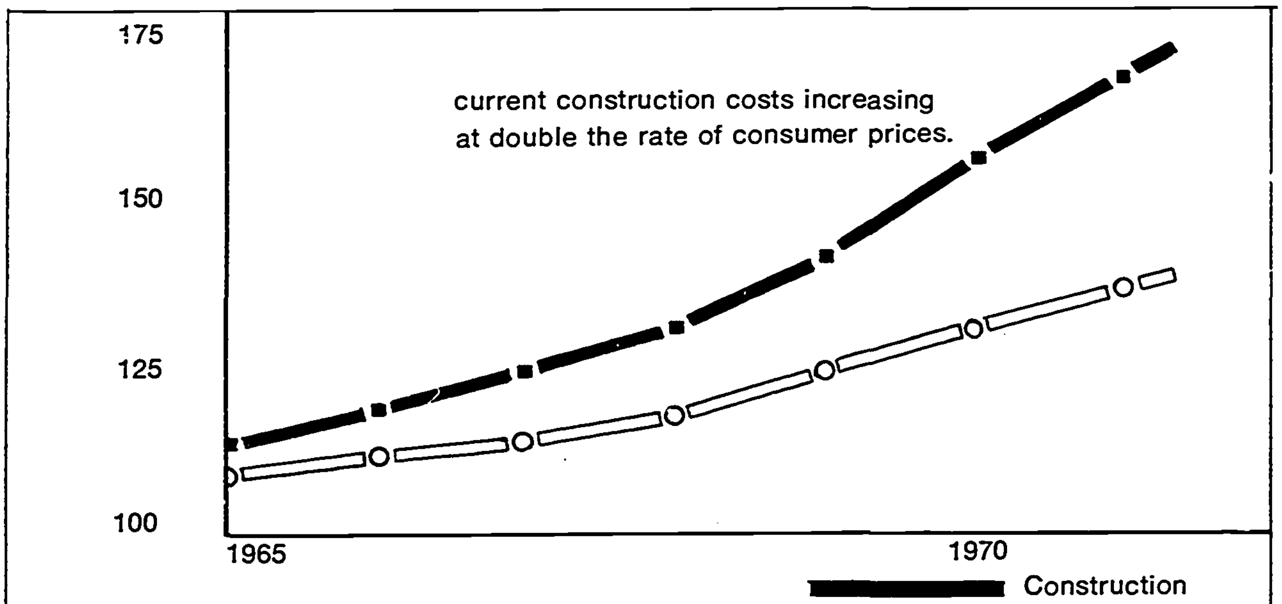
Throughout this discussion on trends in higher education and their impact on campus architecture, flexibility appears as the most significant implication. And, indeed it is, for flexible campus faclities allow colleges to respond to change within the restraints of economy. As costs of construction rise, being able to use an expensive structure flexibly will extend its useful life and forestall the difficult, expensive, and time consuming process of building a replacement.

Conventional Process

Two basic concepts shape the conventional building delivery process. First, each new building is viewed as a separate entity satisfying a unique set of requirements. Visits to recently completed college buildings revealed only cosmetic differences in building appearance, equipment, and finishes. Moreover, the facilities served similar functional requirements, although each had been produced as a significantly different structure.

Second, the sequence of activities in the conventional building delivery process are perceived as independent and separate when in fact they are neither. In the delivery process of college facilities a series of institutional approvals required at each "step" effectively separates the otherwise interdependent activities and contributes to the rising costs of such facilities.

Nationally the cost of construction increased 36% between 1965 and 1970. Recent increases have been more severe: exceeding 10% in 69-70 and currently averaging 12% per year. Texas cost trends for the same period parallel national experience and indicate the extent of the problems colleges and universities face in financing much needed buildings.



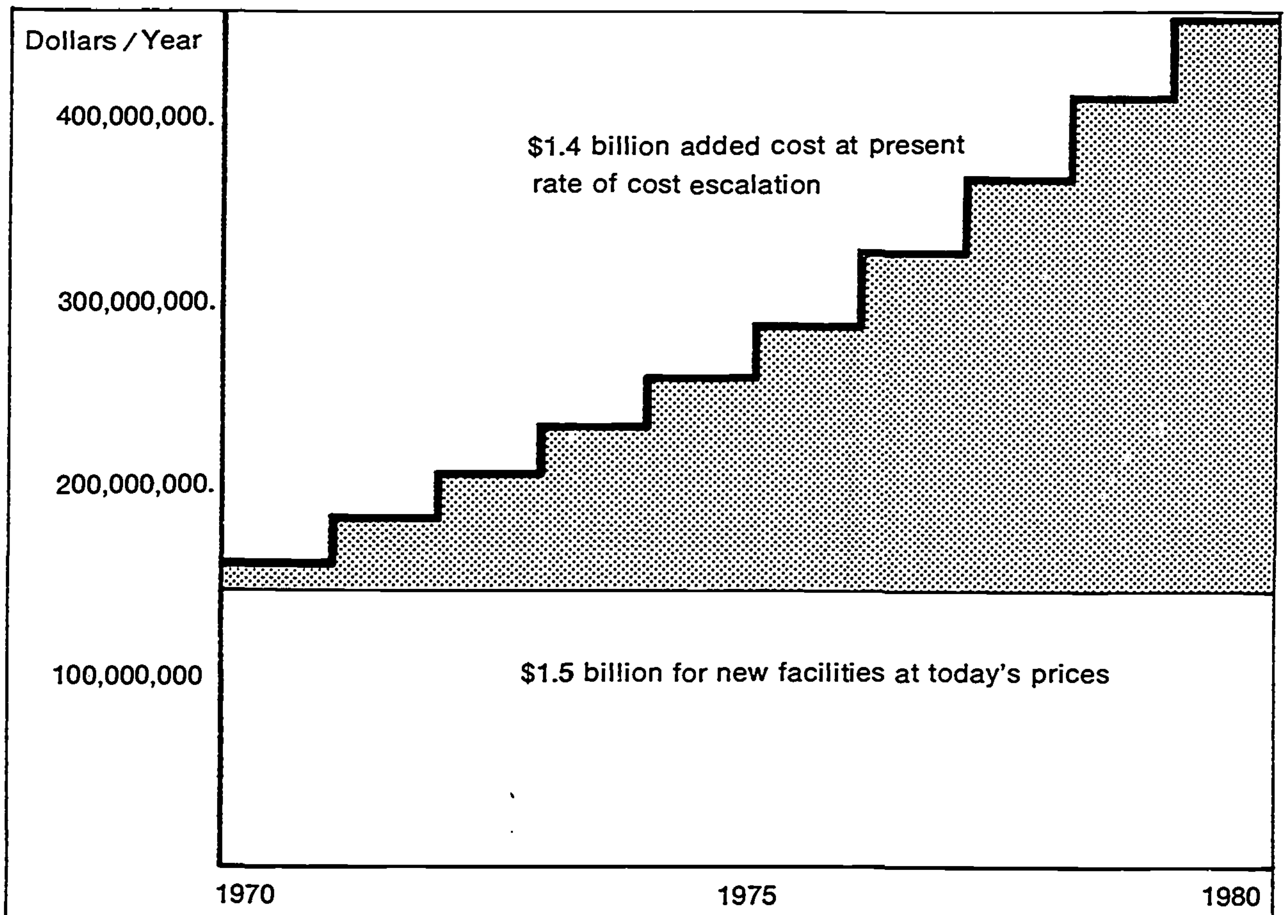
Cost of Construction/Consumer Prices 57-59=100

Texas Costs
To develop specific information concerning the costs of higher education facilities in Texas, cost data has been assembled from a number of recent college building projects. The sample includes some 60 buildings from 2 year, 4 year and advanced degree institutions on 10 different campuses across the state. Contractor cost breakdowns, the best sources of specific conventional building cost data, were used to develop cost information. Findings have been averaged and adjusted to reflect 1971 costs.

Costs per square foot for the campus building types sampled averaged:

Classroom	$27.00/sq. ft.
Laboratory	$37.00/sq. ft.
Residence	$27.40/sq. ft.

Texas public colleges will build 5,400,000 square feet of new facilities in the next 10 years. At current prices this plant expansion will require an investment of $1.5 billion. As prices escalate, the total cost could easily double during the next decade.

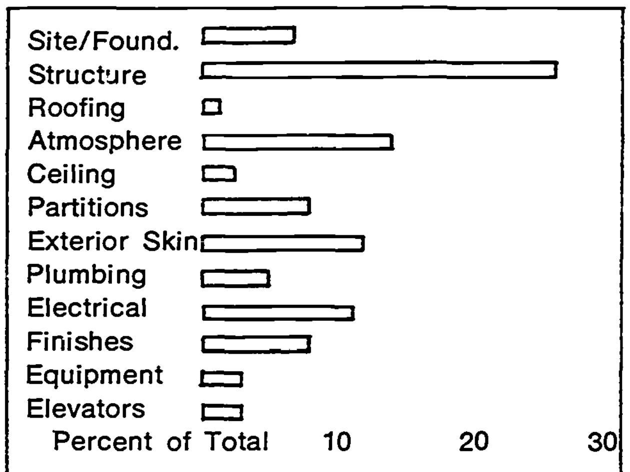


Estimated Construction Cost: New Texas College and University Facilities

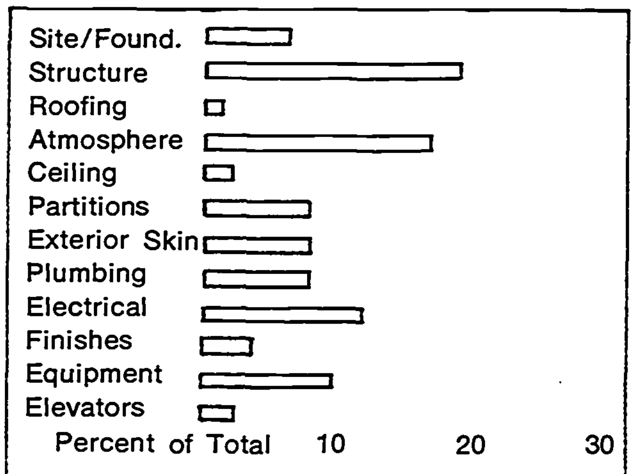
Texas public campus profiles, by building type, show that residential buildings account for nearly ⅓ of total campus facilities. Laboratories, offices and classrooms are other major categories in the profile. Junior college profiles vary substantially from the average public campus; only 11% of the junior college space inventory is used for residence with resultant increases in the proportions of laboratories, classrooms and offices.

More important for this study than square foot costs are the percentages of total building costs allocated to the various subsystems. Distribution of building costs among subsystems is a more reliable basis for comparison than square foot costs because it is less affected by project location, variations in competition or year of construction.

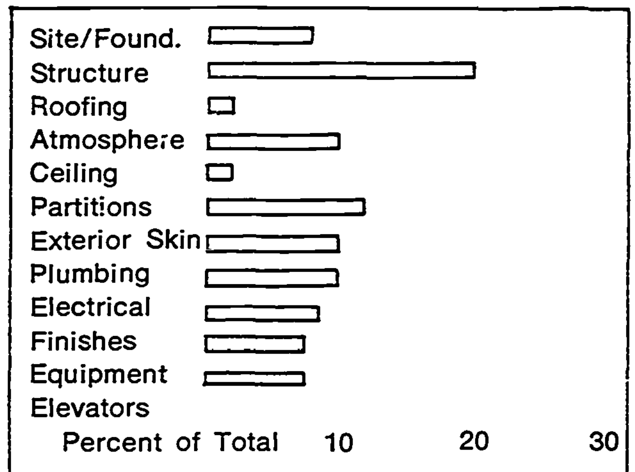
Based on an analysis of the sample building costs, the following graphs indicate average cost distributions for selected major building types. These building types were chosen because collectively they make up over half the buildings on the average Texas public college campus. Again, despite the recurring need for these facilities, they are typically produced as structures satisfying unique requirements, a characteristic of the conventional process which is both costly and time consuming.



Classroom Building (multi-story)
Comparative Cost Distribution



Laboratory Building
Comparative Cost Distribution

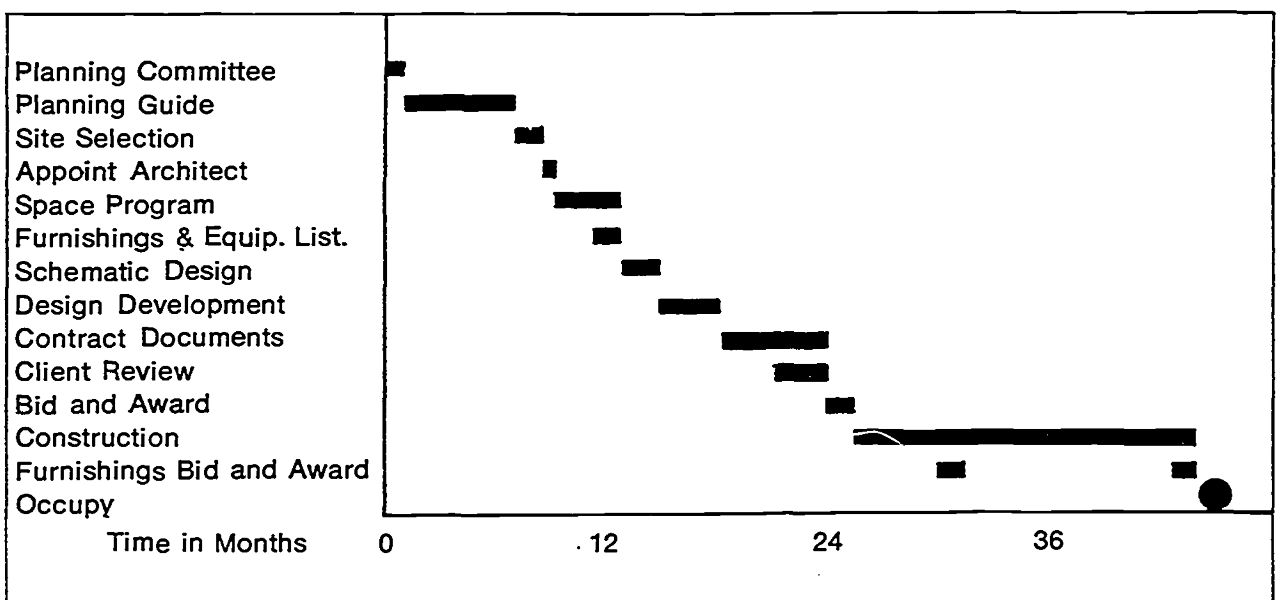


Residence Building
Comparative Cost Distribution

Time

Nationally, building delivery time for university buildings averages 42-48 months. This means that a building project conceived today will be bid at prices effective 2 to 3 years in the future. At current cost escalation rates, today's one million dollar building will cost an additional four hundred thousand dollars in three years.

It should be noted that time considerations are separated from cost considerations only for purposes of analysis; building time and cost are directly related and interdependent. Actually the many steps of the building process are also interdependent despite the fact that conventional methods separate them into a linear sequence of non-contiguous events.



Building Delivery Time Experience

Systems Building

Concept

Systems building is a comprehensive management process which attempts to optimize the cost, delivery time, and quality of building projects. A systems building approach to a building program recognizes that similar functional requirements result in similar requirements for building structure, mechanical subsystems, partitioning, and other building components. Three systems building techniques are of primary importance to this study:

- Accelerated Scheduling
- Market Aggregation
- Building Systems

Accelerated Scheduling
The nearly four year building delivery period typical of much university work wastes millions of dollars in escalated building costs and delayed educational programs. Accelerated scheduling overlaps design and construction activities conventionally performed in a linear sequence. Construction of building subsystems such as foundations and structure is begun while finish details and specific space layouts are being determined. Prebidding of basic subsystems fixes the costs of these items early in the job enhancing cost control. In addition, prebidding speeds building delivery by authorizing manufacture and delivery of certain subsystems before architectural work is complete.

Market Aggregation
Differing buildings have many similar subsystem and equipment requirements. Market aggregation techniques combine these requirements to reduce material costs by bulk purchasing. Texas universities for example will buy plumbing fixtures for the many individual building projects now under construction by individual contractor purchase orders to many dealers and suppliers. Competitive bidding of a single large guaranteed order could substantially reduce the cost of fixtures for State institutions.

Building Systems
This systems building technique is based on the use of sets of building components designed and manufactured to be assembled with a minimum of field labor. Building system components can be economically manufactured due to the repetitive aspects of their design; and reductions in field labor can also lower buildings costs. Designed to serve generalized building problems such as span, heating-cooling, or partitioning, building system components can be applied to many building requirements and can provide variety in appearance as well as function.

Other techniques such as automated design, continued production and construction, component evaluation and improvement are significant second phase activities for a systems building program.

Experience

- Internationally, systems building has been used extensively for both educational and other building programs. England began using building systems to rebuild the country after World War 2. Advanced versions of the original systems are now being used in higher education construction for laboratory, dormitory, classroom and other buildings. Approximately one half of all educational buildings in England are constructed using the systems building approach. Similar experiences are typical throughout Europe: The University of Marburg in Germany manufactures building components on campus for an extensive continuing program of construction which includes many complex laboratories.
- In North America two systems development projects have been completed for educational buildings and three others with specific university potential are underway. SCSD (School Construction Systems Development) built 13 schools in California in 1966-67 using compatible subsystems based on performance requirements. Since then the building systems components have been used in more than 1300 school projects in the U.S. The SCSD components could satisfy the functional requirements of many junior college buildings now planned or under construction.
- A systems building program in Toronto, SEF (Study of Educational Facilities), is now completing its second series of 10 multi-story urban schools. The building subsystems developed for Toronto can be directly applied to the requirements of U.S. college and university classroom buildings. As to U.S. availability, SEF system components are now being used in Boston and Detroit. A study for the New York State University Construction Fund indicated that as much as 80% of the Fund's new university construction could be accomplished with SEF components.
- Montreal's Catholic School Commission has developed a multi-story concrete building system for use in its school building program. These building components could also serve many college and university building needs in the U.S.
- The State of Florida has built 25% of its new schools since 1967 using systems building techniques and components. A systems approach for junior college building programs is now underway.
- The first building in a systems program for student housing (University Residence Building System) is now under construction at the University of California's San Diego campus.

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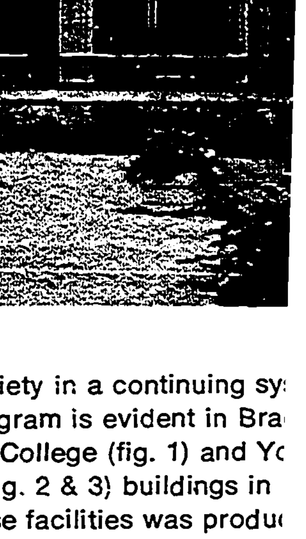

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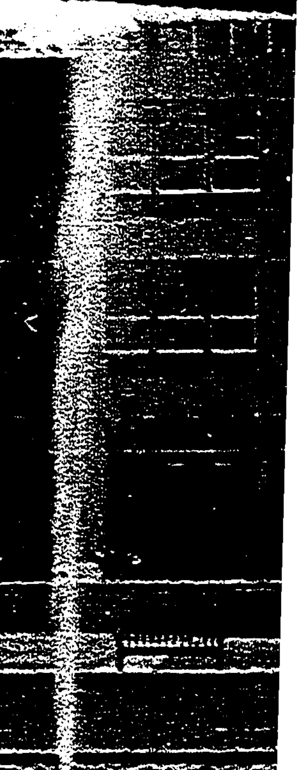

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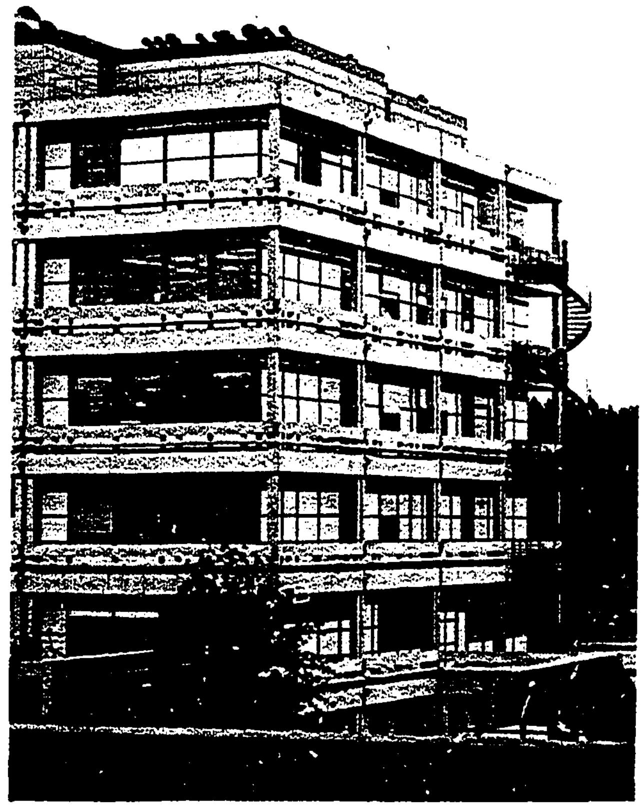

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The University of Marburg in Germany has developed a building system which has been applied to biomedical and chemical research laboratory facilities (fig. 1 & 2). SEF, a Toronto system for school construction, selected building components on the basis of performance and owning cost (fig. 3, 4, & 5).

Florida's Department of Education has applied the concepts developed in the SCSD program (fig. 6) to school construction needs across the state since 1967. Recent programs have effected and maintained cost and quality advantages over conventional construction processes (fig. 7 & 8).

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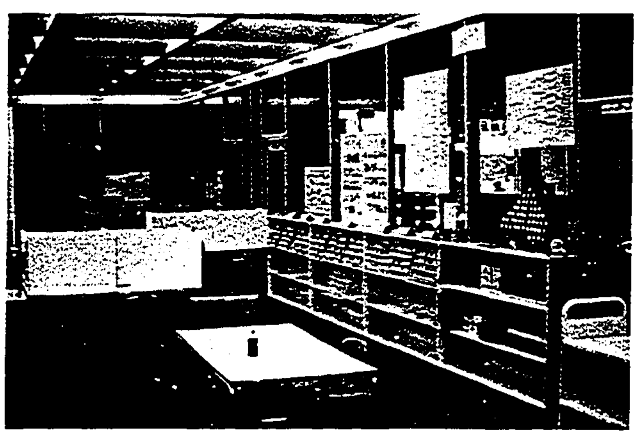

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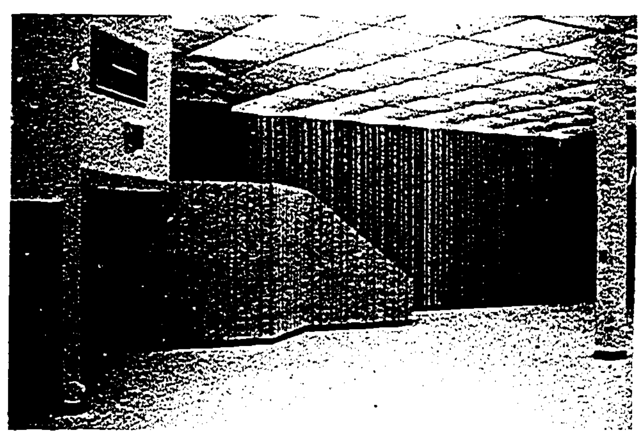

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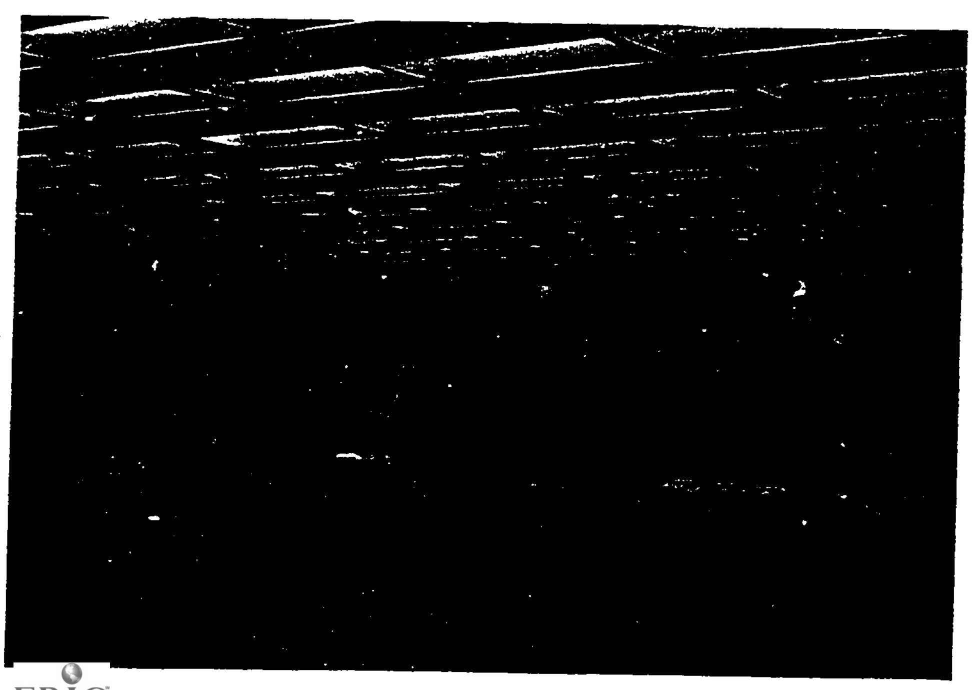

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Generally, the TAs indicated high job satisfaction but expressed some personal concerns and recommendations for change. This information was then relayed to the Curriculum Associates by the DS Coordinators. Several changes are occuring and different results appear to be emerging during the second year of the experimental phase. A copy of the actual log sheets used is found in Appendix B.

Reactions from other staff members at Parker and Spring Creek about the role and performance of the TA have been mixed. Staff members feel most positive about the assistance that TAs provide to individuals and small groups of students, the working relationship between TAs and other staff members, and the willingness with which the TAs have performed the tasks requested of them. On the other hand, staff members have been concerned with the difficulty in trying to develop a new role for the district, with identifying when a TA can and cannot work with students on his own, and in overcoming the feelings that the TA is another clerical aide.

Some district personnel (not directly teaching or working in the DS schools) have expressed concern about the future impact of the TA program as it relates to protecting educators. The most usual question from those connected to the professional teaching associations is, "If you can hire three Teaching Assistants for the same amount as one teacher, what is to prevent boards and administrators from replacing some teachers with Teaching Assistants?" The response of the DS Coordinators has been that of recognizing that a potential problem exists and that a solution will have to be found. We do not have the answer ready this instant, but we do feel that the answer is <u>not</u> to abolish the TA position. One of the recommendations in the

following section relates to this issue.

The other major issue, primarily among those involved in personnel practices in the district, is the question of how much time should the TA work directly with students, and what kinds of activities should the TA be allowed to conduct with them. The development of the TA position to date indicates to the DS Coordinators a strong need to produce a clear and concise description of the TA role, with specific guidelines for time allotments for the TAs activities with students. This is necessary to prevent the use of TAs as substitutes for absent teachers, and insure that TAs will not be expected to plan lessons, conduct the activities, and evaluate students. Planning lessons, conducting activities, and evaluating students are aspects of the role of the certificated teacher. Only the second of these, that of conducting activities, should properly be included in the TA role; indeed, it is the basic function of the TA. A second recommendation of the next section is offered as part of the response for those concerns.

In summary, the data so far indicate that Teaching Assistants are generally performing the tasks originally expected of them in the position. Further, there has been no emerging effort on the part of the Spring Creek and Parker staffs to seek more Teaching Assistants by releasing some of their certified teachers. Finally, neither staff has demonstrated a willfull intent to misuse the Teaching Assistants in any way. In fact, there has been a concerted effort in both schools to be extremely careful that the TAs are not misused and that they are asked to perform only their expected role.

RECOMMENDATIONS

The following recommendations are proposed by the DS Coordinators after studying the data gathered to date and after much deliberation and consultation with the Personnel Director, Area Directors, principals and teachers in the DS schools, and the Teaching Assistants themselves. They are presented as ideas for the beginning of further discussion and negotiation about the role of the TA and its potential for the Eugene School District.

The first recommendation addresses itself to the issue raised by many professional educators, namely, that the Teaching Assistant program is a major potential threat to teachers because approximately three Teaching Assistants can be employed for one average teaching salary. The recommendation has the following four components:

1) We propose that the district board and administration consider a major change in the budget allotments for the staffing of schools. It is suggested that an allotment be established, as is presently the case, for the provision of a necessary number of professional and clerical staff.

2) A basic change we propose is that the district in addition establish a flexible allotment for staffing each school. There would be no restrictions on the use of this allotment for either professional or non-certified staff. However, each school staff would be required to show evidence to the administration of having evaluated its needs for staff, to indicate to the administration the intended utilization of personnel acquired from the flexible allotment, and to provide a plan of

action for evaluating the results of that staff performance. The flexible allotment would allow each staff to decide whether the needs of the program would best be met by the use of TAs or of other specialists.

3) It is proposed that a school with a well-designed plan for staffing and evaluation of its program at a designated time could request the addition of Teaching Assistants from the monies allotted for certificated or non-certificated staff. It is suggested at this time, however, that a limit be set upon the amount of money that could be used from either allotment.

4) Finally, it is suggested that the EEA TEPS committee, the District Personnel Director, and the area directors work jointly with the DS Coordinators and the TAs to develop final guidelines for the previous three sections of this recommendation. These guidelines would be completed by June, 1972.

The second recommendation relates directly to the role of the Teaching Assistant, and proposes the acceptance of the position in the district's staffing pattern as an alternative way of providing education for students. The recommendation is as follows:

> We propose that the Teaching Assistant position be accepted as a regular position in the staffing pattern of the Eugene School District. Acceptance of this proposal would not necessarily provide each school in the district to have an equal number of TAs. It would mean that the position is available for schools that determine that Teaching Assistants could help them to improve the program

in that school. We mean that the district will have a set of guidelines for selecting Teaching Assistants, a description of the actual roles that the TA can perform, and a policy stating who is responsible for supervision and evaluation of the TA. It is suggested that these guidelines be developed by the same group formed in recommendation number 1.

A final recommendation is that the five elementary schools presently participating in the DS Project be provided monies to continue the Teaching Assistant Program. This provision would cover the transitional period until the studies are completed regarding the methods of budgeting in schools, the final rate of pay, and the TA role description. It is proposed that an increase in salary be granted to those TAs who have worked for one or two years in the project's experimental phase. It is further recommended that the monies needed for this recommendation be drawn from the present budget allotment for the experimental phase of the DS Project.

A FINAL REMARK

In summary, we strongly recommend that the Teaching Assistant position be established in the district as another alternative way to organize staffs for instruction. The data indicate very positive outcomes from the program to date. Recognizing the various concerns and problems also indicated by the data, the DS Coordinators will continue through the rest of this year to make the adjustments necessary to overcome the concerns.

We are convinced that the recommendations proposed in this report are realistic for the district in terms of how the district can finance such a program, how guidelines should be established for further development of the Teaching Assistant role, and what requirements must be placed upon school staffs that decide to utilize the services of the TA.

Appendix A

EUGENE PUBLIC SCHOOLS

Differentiated Staffing Project
May, 1970

PARAPROFESSIONAL
ROLE ANALYSIS

Description

The paraprofessional shall provide instructional assistance to the certified staff. The main responsibility will be to serve as teaching technician, performing a number of teaching tasks with students.

Specific Functions

1) Provide individual research help for students seeking assistance.
2) Serve as listener and helper to small reading groups.
3) Serve as a discussion leader for large or small groups.
4) Seek out information and materials for instruction by self or other unit staff members.
5) Provide assistance to teachers in analyzing individual student progress.
6) Assist teachers in the creation of learning packages or programs.
7) Operate audio-visual aids for groups of students.
8) Salary and contract hours are presently being considered.

Personal Qualities Desired

1) Demonstrates positive attitude toward children.
2) Demonstrates awareness of educational goals and objectives.
3) Possesses ability to relate positively with other adults.
4) Demonstrates ability to follow instructions and carry out necessary tasks.
5) Demonstrates desire to improve self skills and instructional skills necessary to the position.

Appendix B

EUGENE PUBLIC SCHOOLS
Differentiated Staffing Project
Instructional Assistants Log - 1970-71

NAME ______________________ DATE ______________________

SCHOOL ______________________ DAY LOGGED ______________________

A. Estimate the time in minutes spent on each task.

TASK	NO. OF MINUTES				
	Mon	Tues	Wed	Thurs	Fri
1. Working with Total Class of Students a. Discussion					
b. Reading to class					
c. Hearing pupils read					
d. Operating audio-visual aids					
e. Administrating assignments & monitoring tests					
2. Working with Small Student Groups a. Discussion					
b. Skill reinforcement - Conducting drill exercises					
c. Hearing pupils read					
d. Assisting with student research					
3. Working with Individual Students a. Reinforcement of skills					
b. Assisting with student research					
c. Desk to desk individual help					
d. Reading to a student					
e. Hearing a student read					
4. Working with Staff a. Seeking out materials					
b. Attending meetings					
c. Assisting with Evaluation of Students					

	Mon	Tues	Wed	Thurs	Fri
5. Clerical Duties a. Reproducing test, worksheets, transparencies					
b. Constructing materials (bulletin boards, games, etc.)					
c. Correcting papers and tests					
d. Housekeeping					
e. Hearing a student read					
6. Supervision Duties a. Recess supervision					
b. Noon duty					
c. Halls supervision					
d. Field trips					
7. Working Alone a. Planning					
b. Research					

B. List difficulties or problems encountered during the week. How were they resolved?

C. List any tasks performed that do not fit the categories in section A. How much time did the tasks take?

NAME ______________________________ SCHOOL ________________

DATE ______________________________

1) From whom do you receive most of your supervision?

2) With whom do you spend most of your time planning for what you do?

3) Discuss any general thoughts or feelings about the position of Teaching Assistant (paraprofessional) that you might have at this time.

4) Are there any particular kinds of training programs that you think would be beneficial at this time in assisting you in fulfilling your responsibilities better?

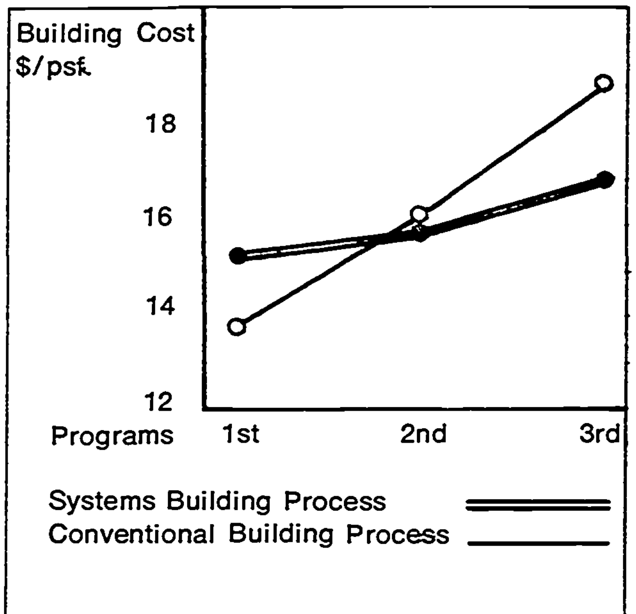
Findings

Systems Building Process

The systems building process must be understood as a complex and demanding management task. Attempts to apply the process in a framework of conventional institutional procedures are not likely to produce significant results. Further, the development or use of system building techniques in institutional construction programs demands changes in traditional processes of building delivery, as well.

- Owners will have to make many rapid decisions on costs, design and equipment; a rigid approval process at each step of the building development can eliminate the potential cost and time advantages of a systems building program. Owners in fact will be challenged to improve and expand their building administrative activities issuing more contracts at various times during the job, seeking competition and cost discounts, perhaps even coordinating subcontracted work.
- Architects will find less demand for drafting services but vastly increased demand for principal time to coordinate various project responsibilities. The architect's design freedom is limited essentially by his abilities, not by building components; examples of both well designed and poorly designed systems buildings can be found. It is desirable to retain local architects to design systems buildings.
- General contractors roles wil be reduced in systems building projects as a result of pre-bid building subsystems. Some general contractors involved with systems building programs have established themselves as construction management firms in order to capitalize on their familiarity with local market conditions.
- Manufacturers can look to systems building for larger single purchases and continuing markets for given products. Additionally, feedback evaluation will assist them in improving and updating their products.
- Labor has participated efficiently in all of the systems building programs completed to date. In fact, labor consulted early in program development has contributed to efficient job organization and definition of responsibilities.

Cost



Comparative Building Costs

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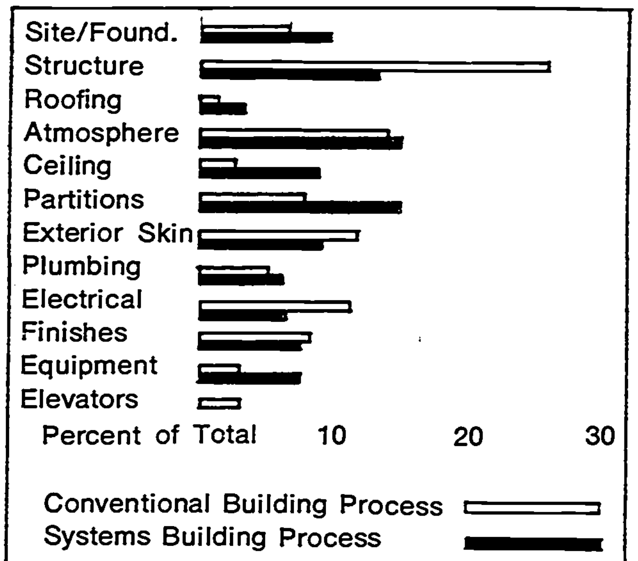


Classroom Building
Comparative Cost Distribution

2

Construction costs for the first series of buildings in new systems building programs have often been 5 to 10% higher than similar conventional projects. The comparison is somewhat unfair in that the systems buildings offer higher quality and easier plan reconfiguration than their conventionally built counterparts. But the comparison is sure to be made; the cost overruns in the first series appear to result from unfamiliarity of owners, architects, contractors, and manufacturers with the new building process, rather than from premiums paid for added quality.

Subsequent building programs using a tested systems building process have demonstrated cost advantages. SSP (Schoolhouse System Program), Florida's school building program, for example, demonstrated a 5 to 10% cost advantage over similar conventional projects after 3 years of operation (fig. 1). Two factors account for these cost advantages:
- Contractors and manufacturers become more competitive as they improve their techniques in a continuing program.
- Repetitive building system components are less subject to cost escalation than conventionally built subsystems.

As mentioned earlier, cost comparisons by the square foot are not as accurate as companison of cost distribution of the major subsystems because of variations in project location and market conditions. In order to present meaningful conventional versus systems building cost comparisons, information on multi-story classroom buildings has been developed from data on eleven completed urban school projects in Toronto's SEF program. These buildings could function as multi-story classroom space on many Texas college and university campuses. Similar information on multi-story classroom buildings in the Texas sample is compared with the SEF experience in Figure 2. The comparison presents several noteworthy items:

- Systems buildings costs were half as much as conventional buildings for structure in spite of the fact that the systems buildings studied used long span structures to accommodate changing interior space requirements.
- Systems buildings cost as much in mechanical support subsystems (heating, air conditioning, plumbing, electrical) as the conventional counterparts. The systems buildings mechanical subsystems, however, are more responsive to changing needs than conventional installations. Supply ducts and electrical panels can be easily relocated.
- Although the systems building projects appear to cost more for ceilings, the ceiling subsystem under consideration includes lighting, wiring, and diffusers for atmospheric control. Conventional ceiling costs do not reflect these items.
- Systems projects spend more for interior partitions than conventional, but these items are moveable and pre-finished.

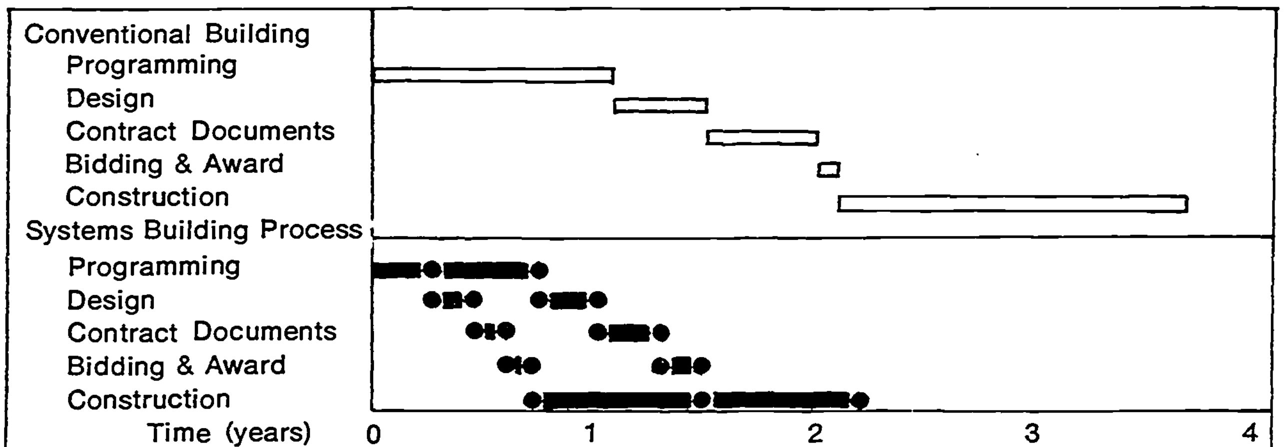
Time

Accelerated Scheduling
Overlapping design and construction activities has reduced building delivery time by as much as 50%. Initial cost advantages of this technique are directly related to the prevailing rate of construction cost escalation. At present rates, accelerated scheduling can produce a 6% savings in total building cost by bidding one half of a building's subsystems 12 months earlier than a conventional building effort. Early bidding fixes project costs for certain building subsystems, promoting more effective cost control.

Market Aggregation
Building system components used for single independent projects can offer better building quality, but initial cost savings are unlikely. Florida's experience indicates that a construction market of 8 to 10 million dollars in a single bid period is necessary to obtain significant price discounts using available coordinated building subsystems. Cost savings on the order of 20% have been obtained in markets of this size because the volume is sufficient to justify pricing at the manufacturer level, thereby significantly reducing manufacturers' selling costs.

Since building subsystems are pre-bid, it is unlikely that the full cost savings achieved through volume purchasing will be reflected in the final building price. Owners who realize a cost saving early in a construction project almost always utilize the savings to build more space or improve quality.

Building Systems
Historically, industrial labor costs have risen at half the rate of construction labor costs. This trend points to significant future cost savings through the use of component building systems. Such components offer the economies of factory production and the opportunity for continuing product improvement for repetitive building types like many campus facilities. As mentioned, some 55% of the buildings on a typical college campus in the U.S. are composed of but four major types: office, classroom, laboratory, and residential. In addition, these four share functional requirements which are often similar enough to permit the use of the same or similar building system components. The non-repetitive application of repetitively produced building components can promote flexible structures and design freedom within the limits of economy and time.



Comparative Building Delivery Time

Systems building techniques have demonstrated marked advantages over conventional methods in building delivery time. Accelerated scheduling, prebidding, and building systems used together have cut total project delivery time by up to 50% in many completed projects. It should be noted that application of these techniques brings demands for quick decisions by clients, architects, and contractors and in fact implies basic changes in the traditional architect-client-builder relationships. Positing successful administrative adjustment, these techniques help organizations meet complex building schedules, effect more precise cost control, and reduce the costs of interim financing related to long construction efforts in addition to reducing total project time.

Utilization

Academic Calendar

But perhaps institutions of higher learning could avoid having to undertake quite as many expensive and time consuming building projects if the facilities they have were used more efficiently. One of the most detrimental factors inhibiting effective utilization of college and university faciltlies is the academic calendar. Texas' public college and university fall enrollments are reduced by 7% in the spring and by 54% during summer sessions. These normal enrollment fluctuations mean that half of the State's facilities are essentially not used 4 months a year. Plans have been developed for academic scheduling which use facilities 12 months a year while allowing faculty and students the opportunity to choose between long vacations, periods of professional development, or year-round academic pursuits. These plans demand extensive scheduling changes but are effective in reducing facility needs. Judging by present enrollment patterns, Texas public institutions could support an 18% increase in annual enrollments (i.e. 50,000 more students) in existing college and university buildings by scheduling 48 weeks of annual utilization and maintaining enrollments at 90% of present capacity.

The utilization of classroom space is a second area where increased scheduling efficiency could increase institutional capacity. Disregarding the wastefulness of the academic calendar, guidelines for classroom utilization in Texas seek to schedule classroom space 30 hours weekly and fill ½ of the available student stations. If it were possible to schedule classrooms for 40 hours of weekly instruction and fill ¾ of the student spaces, present student capacity would be doubled. This projected increase is not totally realistic because residence, laboratory, and supporting facilities would have to grow in support of increased classroom enrollments. Also, educational trends are de-emphasizing the traditional lecture-oriented teaching methodology with its attendent dependence on the inflexible 30 student classroom.

Financing

No college building whether adaptable to changing needs or conventionally static comes cheap. In either case, financing new educational facilities is a critical element of the building process.

Three basic sources of funds are used to support new construction for Texas public higher education.

- Earnings of the Permanent University Fund are available to two university systems.
- Ad valorem tax receipts are available to institutions which do not participate in the Permanent University Fund.
- All institutions can utilize appropriate student fee income.

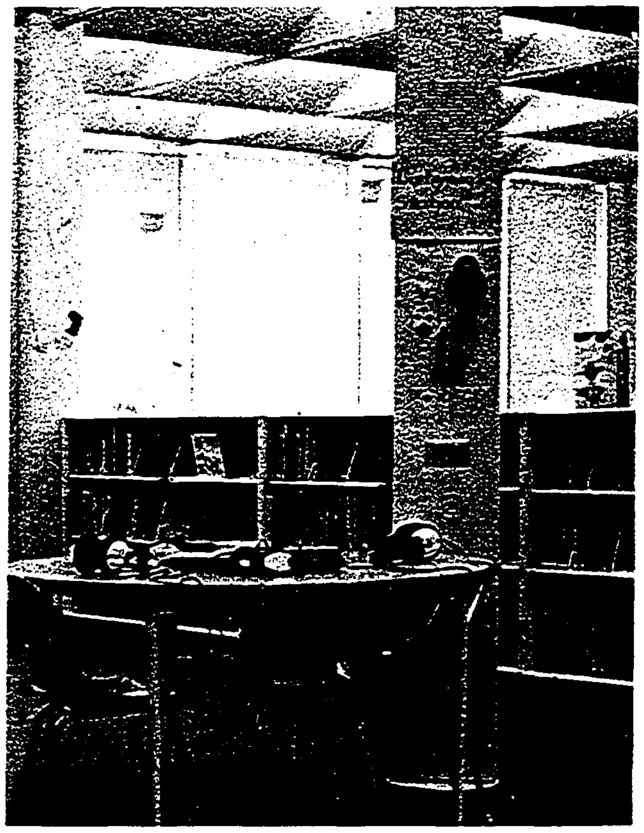
The Permanent University Fund commands a high bond rating (and low interest rate) for user universities; bond ratings for institutions relying on other income sources are not as high, resulting in increased borrowing costs for these institutions.

Adaptability

Both the problems of implementing more efficient classroom scheduling and the potential impact of educational trends underscore a major weakness of the typical classroom building — in fact, most campus buildings: the lack of flexibility. The typical classroom designed for 30 students and a 30 to 40 year life span effectively locks a college into educational patterns of the past. Interior partitions are permanent, based on structural spans which rarely exceed 30 feet. Circulation patterns, the distribution of mechanical and electrical services, and provisions for atmospheric control are difficult to modify short of major renovation which is costly, disruptive, and time consuming. Little wonder then that improved facility utilization is difficult to effect when the design of the facilities themselves compounds the task.

Educational facilities which can adapt to changing needs have been produced by using building systems. As defined building systems are sets of building components designed and manufactured to be assembled with a minimum of field labor. The definition implies more than potential for simple assembly; it suggests that the building system components are designed to solve a variety of functional building requirements. This results in components which may be arranged in many ways to adapt to changing facility needs. Specifically, it is easier, faster, and less costly to convert such buildings to other uses as colleges change. Some examples of a building systems' inherent ability to respond to changing needs are items like a utility services column which permits plug-in connection of phones, clocks, intercom, power outlets, lighting, etc., on 5 foot grid lines; ceilings which handle lighting and air conditioning along any grid line; and partition walls which offer high quality, multi-functional surfaces, excellent sound control, and movability.

1



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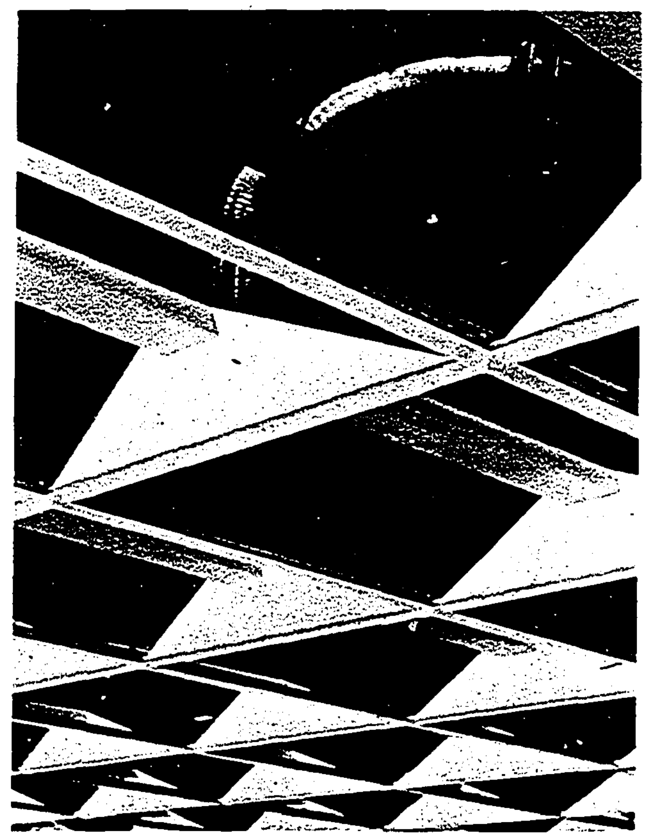
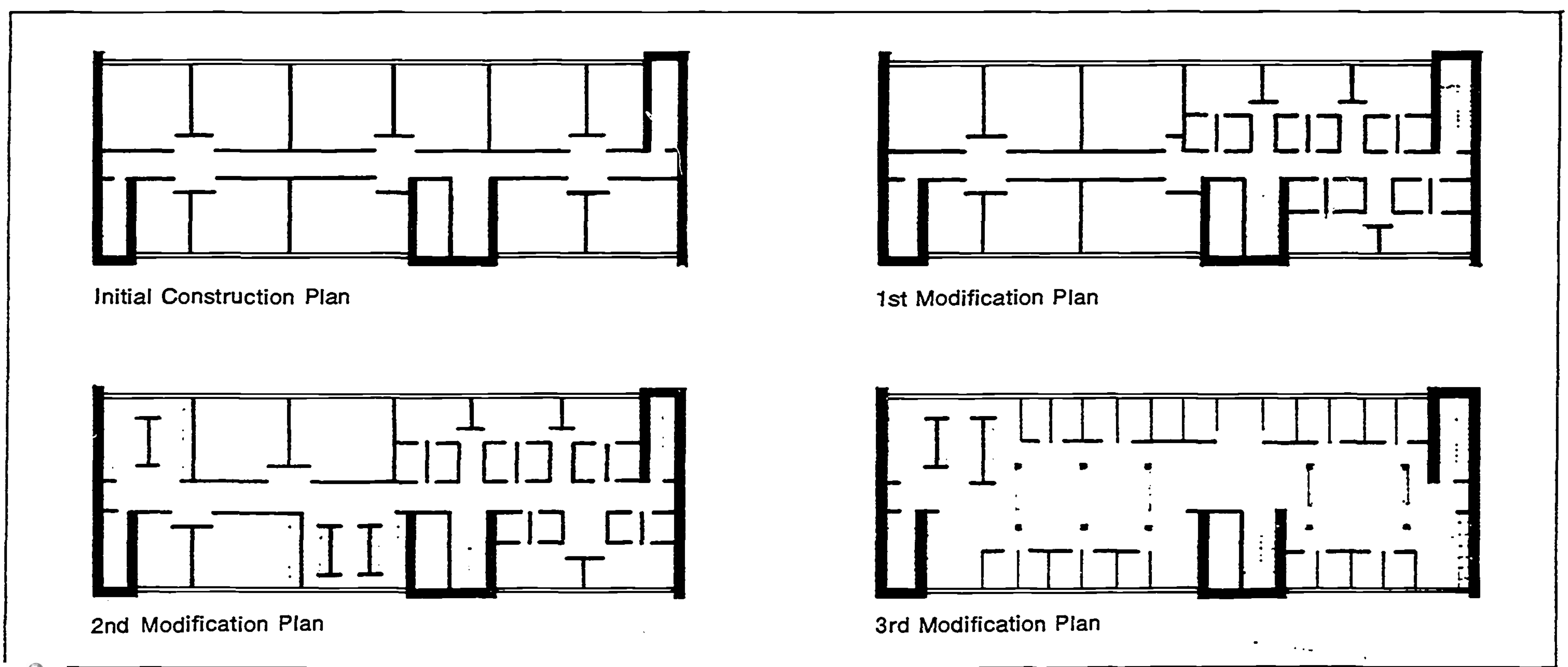


3

Long span structures (fig. 1) coupled with relocatable plug-in electronic service units, and moveable air supply points (fig. 2 & 3) permit systems building to respond and adapt to changing user requirements (fig. 4).

4



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Conclusions & Recommendations

Texas colleges and universities face significant demands for new facilities over the next ten years. Growing enrollments and longer degree programs will require a capital expenditure of 1.5 billion dollars for new construction at today's price levels. Rapidly escalating construction costs could double this investment during the next decade.

Systems building, a process of building delivery which seeks to optimize facility cost, quality, and delivery time, can play a significant role in meeting Texas' commitment to quality higher education. Techniques of the systems building process will be most effective initially in reducing delivery time; such time savings can make the difference between starting or delaying essential educational programs. As colleges and universities continue to apply systems techniques, they will effect rational cost control, long range price stabilization, and eventual first cost savings in building programs. The following conclusions and recommendations define the potential of systems building techniques and improved utiliization to contribute to higher education needs in Texas.

Accelerated Scheduling
Accelerated scheduling techniques such as overlapping design and construction and prebidding building subsystems can reduce building delivery time as much as 50% and assist a program of cost control. These techniques should be applied to urgent building projects where completion time is a critical consideration. A rapid institutional decision and approval process is essential in undertaking such a program.

Market Aggregation
Market aggregation can achieve significant reductions in building materials costs if the minimum 8 to 10 million dollar single bid volume necessary for cost savings is maintained over time. But even the State's largest universities cannot individually assemble and maintain a market of this size. A centrally coordinated program which aggregates similiar building needs and intiates purchase agreements on a continuing basis is essential for successful application of this technique. The Coordinating Board as the single entity able to determine specific statewide college and university needs for building materials should establish a voluntary market aggregation service available to all State institutions of higher education.

Building Systems
The potential now exists to provide a variety of single and multi-story university classroom facilities utilizing available building system components. Soon to be completed development projects will extend this capability to residence buildings and laboratories. But education of administrators, architects, and contractors will be necessary to exploit this capacity.

- It is recommended that individual institutions utilize available building systems where appropriate to proposed construction projects. This will speed building delivery, and provide high quality facilities which can respond to the changing needs of future educational programs. First cost savings are unlikely in single one-time building system applications, but long term cost stabilization and eventual first cost savings can be obtained through continuing high volume use of building systems components.

- It is recommended that the Coordinating Board assemble a building system development consulting group to assist colleges and universities embarking on initial building system programs.

- It is recommended that the Coordinating Board seek State or Federal support for three demonstration building systems programs at selected Texas colleges and universities. Project cost and time experience would be made available to all State institutions.

- Development of a new comprehensive building system for Texas colleges is not recommended. Available existing systems represent a quicker, more economical way to meet Texas higher education needs than a new development program. However, development of improved building subsystems by capable Texas manufacturers and builders should be encouraged in order to provide a wide variety of compatible building components in the future.

Utilization

- The academic calendar does not encourage efficient utilization of the State's higher education facilities. The Coordinating Board should assist the State's institutions in preparing and adopting an academic calendar which makes more efficient use of existing educational facilities.

- Present utilization rates for specific classroom spaces could be significantly improved. University building programs should incorporate design concepts and building components which permit new facilities to adopt to future space and functional requirement changes. A computer scheduling service for academic space utilization should be made available to all interested State institutions.

Acknowledgements

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Further Information
A more detailed report elaborating on the findings of this summary can be obtained from the Architecture Research Center Texas A&M University. The cost of reproduction (approximately $5.00) should accompany requests.

Readers interested in further information concerning systems building should contact:

Educational Facilities Laboratory
477 Madison Avenue
New York, N.Y. 10022

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Appendix A

EUGENE PUBLIC SCHOOLS

Differentiated Staffing Project
May, 1970

PARAPROFESSIONAL
ROLE ANALYSIS

Description

The paraprofessional shall provide instructional assistance to the certified staff. The main responsibility will be to serve as teaching technician, performing a number of teaching tasks with students.

Specific Functions

1) Provide individual research help for students seeking assistance.

2) Serve as listener and helper to small reading groups.

3) Serve as a discussion leader for large or small groups.

4) Seek out information and materials for instruction by self or other unit staff members.

5) Provide assistance to teachers in analyzing individual student progress.

6) Assist teachers in the creation of learning packages or programs.

7) Operate audio-visual aids for groups of students.

8) Salary and contract hours are presently being considered.

Personal Qualities Desired

1) Demonstrates positive attitude toward children.

2) Demonstrates awareness of educational goals and objectives.

3) Possesses ability to relate positively with other adults.

4) Demonstrates ability to follow instructions and carry out necessary tasks.

5) Demonstrates desire to improve self skills and instructional skills necessary to the position.

Appendix B

EUGENE PUBLIC SCHOOLS
Differentiated Staffing Project
Instructional Assistants Log - 1970-71

NAME ______________________ DATE ______________

SCHOOL ____________________ DAY LOGGED ______________

A. Estimate the time in minutes spent on each task.

TASK	NO. OF MINUTES Mon	Tues	Wed	Thurs	Fri
1. Working with Total Class of Students a. Discussion					
b. Reading to class					
c. Hearing pupils read					
d. Operating audio-visual aids					
e. Administrating assignments & monitoring tests					
2. Working with Small Student Groups a. Discussion					
b. Skill reinforcement - Conducting drill exercises					
c. Hearing pupils read					
d. Assisting with student research					
3. Working with Individual Students a. Reinforcement of skills					
b. Assisting with student research					
c. Desk to desk individual help					
d. Reading to a student					
e. Hearing a student read					
4. Working with Staff a. Seeking out materials					
b. Attending meetings					
c. Assisting with Evaluation of Students					

		Mon	Tues	Wed	Thurs	Fri
5.	Clerical Duties a. Reproducing test, worksheets, transparencies					
	b. Constructing materials (bulletin boards, games, etc.)					
	c. Correcting papers and tests					
	d. Housekeeping					
	e. Hearing a student read					
6.	Supervision Duties a. Recess supervision					
	b. Noon duty					
	c. Halls supervision					
	d. Field trips					
7.	Working Alone a. Planning					
	b. Research					

B. List difficulties or problems encountered during the week. How were they resolved?

C. List any tasks performed that do not fit the categories in section A. How much time did the tasks take?

NAME ______________________ SCHOOL ______________

DATE ______________________

1) From whom do you receive most of your supervision?

2) With whom do you spend most of your time planning for what you do?

3) Discuss any general thoughts or feelings about the position of Teaching Assistant (paraprofessional) that you might have at this time.

4) Are there any particular kinds of training programs that you think would be beneficial at this time in assisting you in fulfilling your responsibilities better?