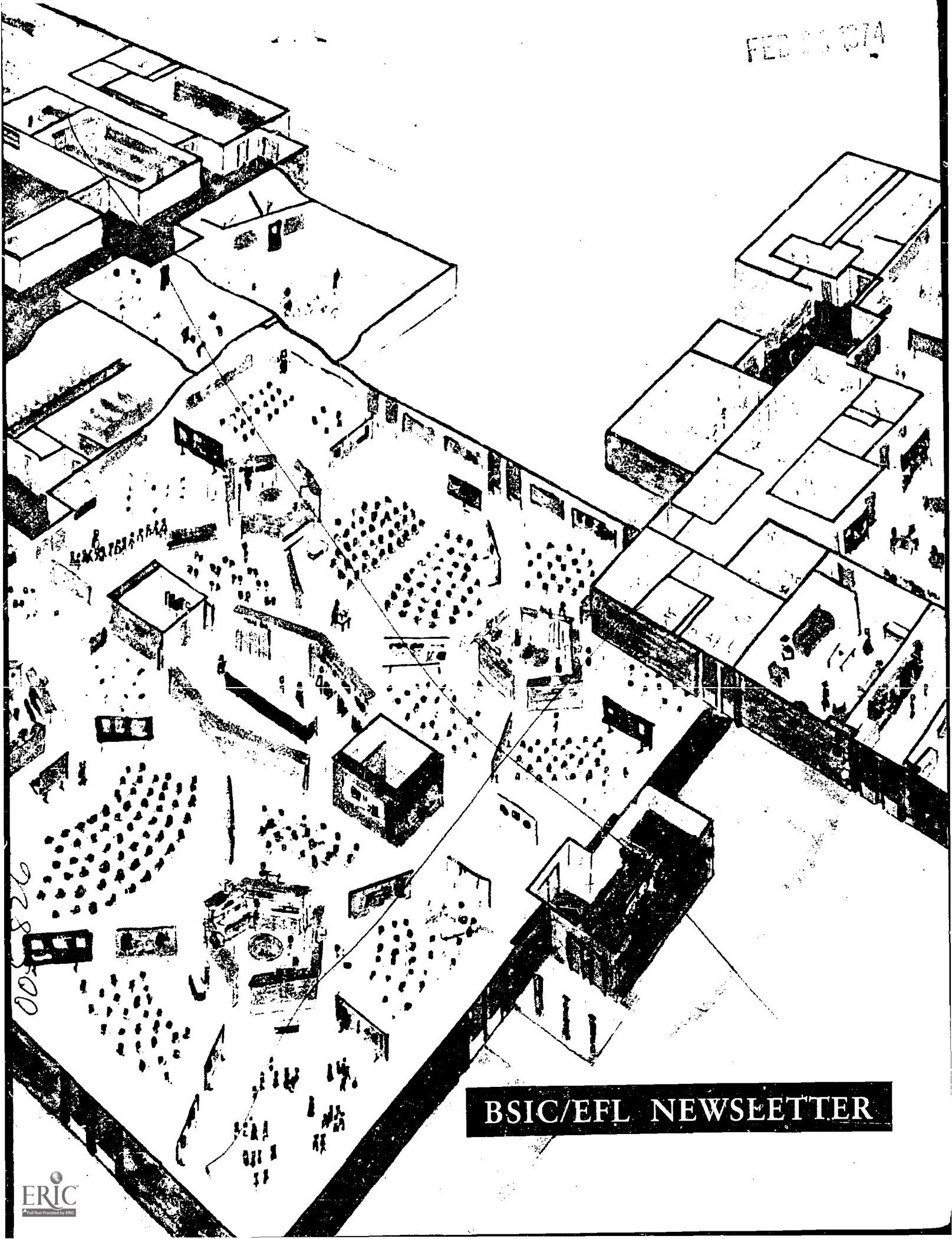
DOCUMENT RESUME

ED 087 085 EA 005 826

TITLE	A Systems Approach to the Practice of Architecture. BSIC/EFL Newsletter.
INSTITUTION	Building Systems Information Clearinghouse, Menlo Park, Calif.
REPORT NO	BSIC-Vol-5-No-3
PUB DATE	Dec 73
NOTE	15p.
AVAILABLE FROM	BSIC/EFL, 3000 Sand Hill Road, Menlo Park, California 94025
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	Architects; *Architecture; Bids; Building Plans; Check Lists; *Component Building Systems; Construction Costs; *Construction Management; Critical Path Method; Elementary Schools; High Schools; Middle Schools; Modular Building Design; Performance Specifications; *School Construction; *Systems Approach; Universities
IDENTIFIERS	*Building Systems; Energy Conservation

ABSTRACT

The main article in this newsletter concerns the adoption by an architectural firm of elements of a systems approach as a means of providing school buildings responsive spatially and environmentally to educational change, and how these activities were later instrumental in facilitating entry by the architectural firm into the construction management field. The pros and cons of construction management and building systems for client, contractors, and architect are cited. Included are photographs, building plans, and specifications of four schools completed or in progress. (Author/MLF)



BSIC/EFL NEWSLETTER

BSIC/EFL NEWSLETTER

Vol. 5, No. 3 December 1973

CONTENTS

PHOTO AND DRAWING CREDITS
George Stille, photos pp. 11, 12 (top)
Luckett and Farley, all other photos and drawings

BSIC/EFL NEWSLETTER

Published quarterly by Building Systems Information Clearinghouse/Educational Facilities Laboratories, Inc. John R. Boice, Editor; Joshua A. Burns, Assistant Editor.

News items, letters to the editor, editorial communications and requests for publications dealing with building systems should be addressed to BSIC/EFL, 3000 Sand Hill Road, Menlo Park, California 94025.

US ISSN 0084-8158

A SYSTEMS APPROACH TO THE PRACTICE OF ARCHITECTURE

THE PROCESS . . .

In order to better serve its clients, one of Kentucky's oldest architectural firms, Luckett and Farley, Inc., of Louisville, has adopted a systems approach including the use of building systems and construction management provided by the architect. Some of the work of this firm, founded in 1853 as the D. X. Murphy Co., is known to television sports fans as Churchill Downs, home of the Kentucky Derby.

Prior to undertaking its first systems project in 1968, the office had designed and built numerous Kentucky schools under the traditional design-bid-construct formula. Although these schools were sound educational facilities by the standards of their times, the firm felt a certain dissatisfaction with aspects of their performance, notably their lack of adaptability to future educational program needs.

How Luckett and Farley responded initially to these feelings by adopting a building systems approach and how later these activities were instrumental to their entering the construction management field, is the subject of this article.

BUILDING SYSTEMS

In 1968, Luckett and Farley decided to adopt elements of a systems approach as a means of providing school buildings which were responsive spatially and environmentally to educational change. In their first systems project, the firm used some of the design elements of building systems projects on a large elementary school project for the Owen County, Kentucky, Board of Education. Although this design included use of a five-foot module, long structural spans and flexible air distribution as well as other elements of building systems projects, it was fully detailed by the firm and bid traditionally using descriptive specifications.

The Owen County experience led the firm to conclude that there were additional benefits to be gained by the use of a more complete systems approach. Consequently, it was decided to use the full building systems process—including performance specifications, two-staged phased bidding and required subsystem compatibility—on their next major school project, a middle school for the Henry County Board of Education.

A preliminary scheme had already been developed for this project using nonsystem design. When this scheme was analyzed for building systems application, the firm found that the simplification of the design required to make use of building systems led to a more effective building with greater floor area at no greater cost. Building subsystems were bid on this job in October 1969 and the school placed in service in early 1971.

The Building Systems Approach. Although modified to fit the firm's office practices, the process of applying building systems which Luckett and Farley used initially follows the basic model for systems application to single school projects. This methodology consists essentially of a two-stage bidding of construction contracts. In the first stage, elements of the building system are bid, based on performance specifications and approved preliminary designs. Once the subsystems are determined, working drawings and specifications are completed and the remaining nonsystem contracts are let. The subsystem contracts awarded in the first stage are usually assigned to the general contractor for administration and coordination.

From the start of their system activity, the firm typically bid four or five key subsystems in the first phase—structure; heating, ventilating and air conditioning (HVC); lighting ceiling; partitions; carpet and roofing. Typically these key subsystems account for between 30 and 40 per cent of a project's construction cost. Later the firm replaced the standard demountable portable partition specification with a specification it developed for an office designed space divider, bid as part of the general contract.

An early development of Luckett and Farley's bidding process was the taking of separate bids in some subsystem categories for materials and installation. In this procedure, the bidder with the lowest combined price of materials and installation is then selected for both contracts.

This procedure has two advantages. First, it eliminates a trade jurisdiction problem with the lighting ceiling subsystem by allowing purchase of the luminaires from the lighting ceiling subsystem supplier as materials to be supplied to and installed by the project's electrical contractor. Secondly, by selling the materials directly to the owner instead of to a general contractor, the transaction is exempted from the state's 5 per cent sales tax.

Increasing Staff Expertise—Engineering. On the first half-dozen or so building systems projects, Luckett and Farley employed the same consulting engineers for mechanical and electrical work that they had used for years. This relationship was not entirely satisfactory to the firm as it did not provide sufficient control over the engineering aspects of the design. In addition, there was a divergence of opinion as to whether a building systems methodology which relied upon the design skills of manufacturers effectively served the client's best interests.

As a result, the firm began to hire its own "in-house" engineers in these areas. Already having structural and civil engineers on its staff, the firm now added mechanical and electrical engineers sympathetic to the systems approach it was developing. It should be noted, however, that the firm feels its clients are best served by carrying HVC subsystem design farther than many firms involved in the use of building systems, including the establishment of room and block loads and, in some cases, individual HVC unit criteria.

The First In-House Grouped Bidding. Following the successful bidding of building subsystems on the Henry County Middle School, the firm undertook a number of school projects using the building systems methodology. Because four of these projects had similar design schedules, they were grouped into a single package for subsystems bidding. The firm hoped—a hope later borne out—that a package containing over 78,000 square feet of construction would have greater attraction to national and local suppliers than four small projects.

Aside from this grouping for subsystems bidding, each of the four projects followed its own design and construction schedule. Because the firm chose to package the schools in its office, the only additional problem was obtaining approvals from three owners (one of whom had two schools in the package). As a result of the in-house packaging, the benefits of volume purchasing were obtained for these three clients without the necessity and cost of creating any intermediate organizational structure.

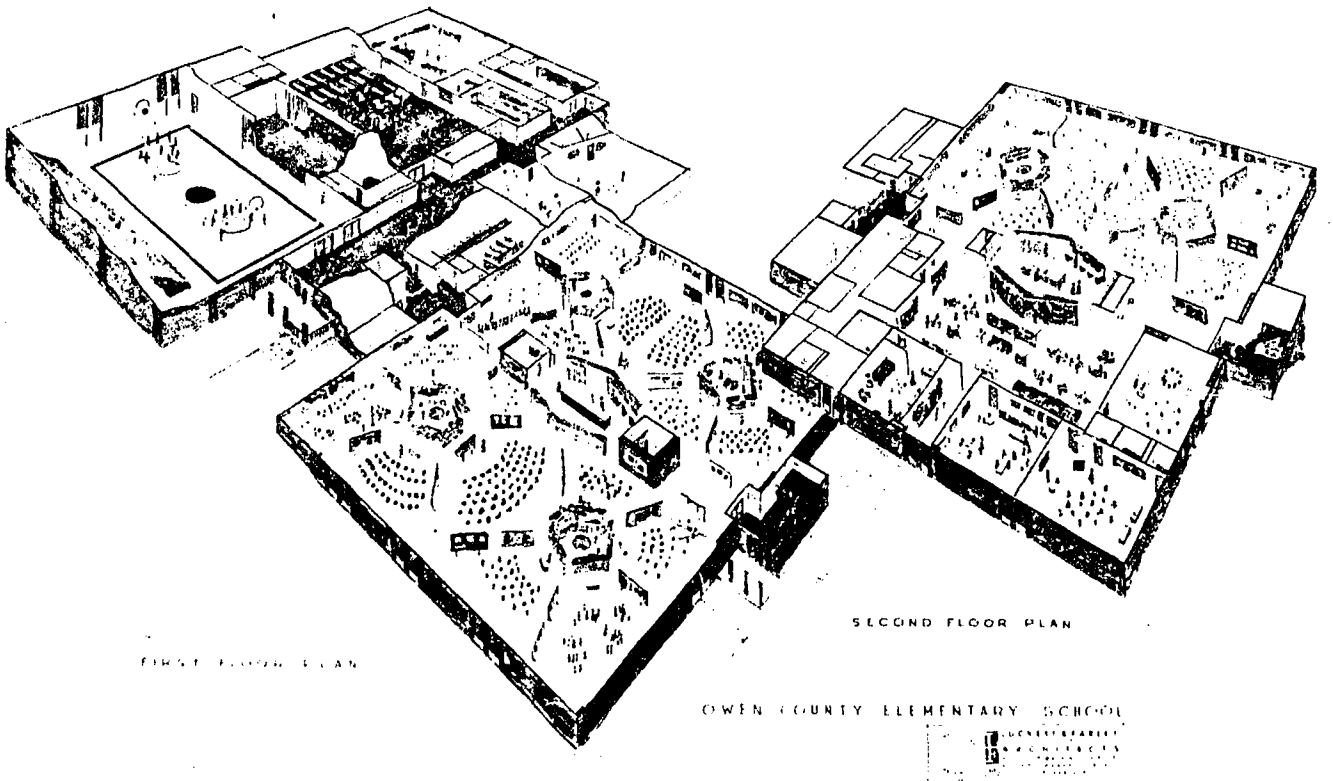
Results of Building Systems Use. To date, Luckett and Farley has used building systems on twenty school construction projects with a total contract value of over $27,000,000. Of these projects, ten used the building systems methodology plus general contracting described in the preceding section. On eight of them, Luckett and Farley has combined building systems with an in-house construction management approach.

Although the firm's initial purpose in using building systems was to exploit their flexibility, use was quickly made of their further potential as an aid in controlling cost expenditures and delivery schedules. As will be seen in the next section, these gains can be more fully exploited by an office which is able to control the total design and construction process.

CONSTRUCTION MANAGEMENT

The approach used by Luckett and Farley on their first systems jobs required that the architect perform some of the construction coordinating and managing activities done by the general contractor on conventional school construction projects. Key among these activities were selection of the building subsystem suppliers and scheduling of their on-site activities.

Prior to their systems work, the firm had occasionally bid mechanical and electrical contracts separately to insure that the owner got the best possible contractors.



The Owen County Elementary School, Luckett and Farley's first systems job, is a three-level, open-plan facility designed to accommodate 990 K–6 students.

In their private industry work, the firm had also become involved in scheduling and coordination, notably on construction work at Churchill Downs, where all work had to be completed between racing meets.

To go from these partial assumptions of construction *management responsibility* to *full control* over the construction process seemed to be a logical next step. To take over this control function, the firm developed a construction management approach.

The Construction Management (CM) Process

In the CM process developed by Luckett and Farley, construction work is performed by a number of prime contractors, each under contract to the owner. Coordination, administration and management of these prime contractors is provided by a construction manager, in this case Luckett and Farley, under a separate contract to the owner.

For Luckett and Farley the ideal situation occurs when both the architectural and CM contracts are signed by the owner and the firm at the same time. When this happens, the firm has professional control over both design and construction aspects of a project from its inception. This control allows great flexibility in project organization to meet the owner's requirements in the areas of time, money and quality.

While the architectural design work is proceeding, the firm divides the construction process into a varying number of prime contracts tailored to the specific conditions of the project, typically numbering about twenty. The work included in these contracts is based upon either functional elements of the building, such as the various building subsystem contracts; trade jurisdictions, such as electrical or plumbing; or materials only contracts for installation by another contractor. One such breakdown of the construction work is shown in Table I.

About one-third of the construction cost of the project is contained in what the firm calls the "multiscope" contract. This contract, usually let to a general contracting firm, contains the work that was formerly performed by the general contractor's own forces and includes pouring of floor slabs, masonry labor, installation of miscellaneous equipment and providing interior finishes, among other activities. The multiscope contract may also include responsibility for site work, footings and foundations.

As the design development relevant to one or more

of these contracts is completed, a bid package is prepared and bids are taken. The firm feels that the combination of CM and building systems provides a built-in capability for fast-tracking—that is, the overlapping of design, bidding and construction activities—which can be exploited when project conditions make accelerated project delivery necessary.

Increasing Staff Expertise—CM. To handle CM work, Luckett and Farley created a separate division within the firm under a registered architect with considerable construction and engineering experience. His staff includes a coordinator who is responsible for the interfacing of contracts and bid packages, and a specialist who maintains the various project schedules and does the necessary accounting. As with the earlier additions of engineering staff who could work with building systems, one of the key elements in the success of the firm's CM has been the selection of personnel who are both experienced and sympathetic to this approach.

On each CM job, an "in-house" construction management team is formed, consisting of the professionals in the CM division, the architectural project director and the project's mechanical and electrical engineers. In addition, a field team, consisting of a Project Job Manager, a full-time Clerk of the Works, and clerical back-up, is created. On state projects, a full-time Resident Inspector paid by the state serves as the Clerk of the Works.

The computerized Critical Path Method of scheduling (CPM) is used to assist in managing and coordinating the construction process. This tool is used to develop all project schedules and lists of critical dates and to provide continuous monitoring on major projects. Various experiments are presently being performed with the office CPM, including monitoring of project cash and resource flows.

Experience with CM

The present form of Luckett and Farley's CM process, described in the preceding section, is the result of a development process that is on-going. Each project teaches the firm something about their work and may point to future directions. In this section, a brief study of this evolution together with a description of what the firm feels to be its most advanced design-CM project will be made.

Greenup County High School. In 1971, the firm took its first contract for construction management services. The initial bids on this job, a $2.8 million high school project located in Greenup County, Kentucky, were taken in August 1971 for completion in the spring of 1973. The CM process used on this job closely resembled the design and construction procedures used on other building systems projects with the exception of the assumption by Luckett and Farley of the management elements of the construction process.

The success of the Greenup County job led to a decision by the firm to further develop their capabilities in CM and to seek other contracts for both architectural and CM services on future jobs.

The Second Grouped Bidding Project. In the summer of 1972, a situation similar to that which led to the 1970 grouped bidding project arose. As in the earlier program, four projects with similar design schedules—this time, two elementary and two vocational schools—were in the office. Three of these projects were under both architectural and CM contracts. Again it was decided to group the projects into a single package for bidding of building subsystems.

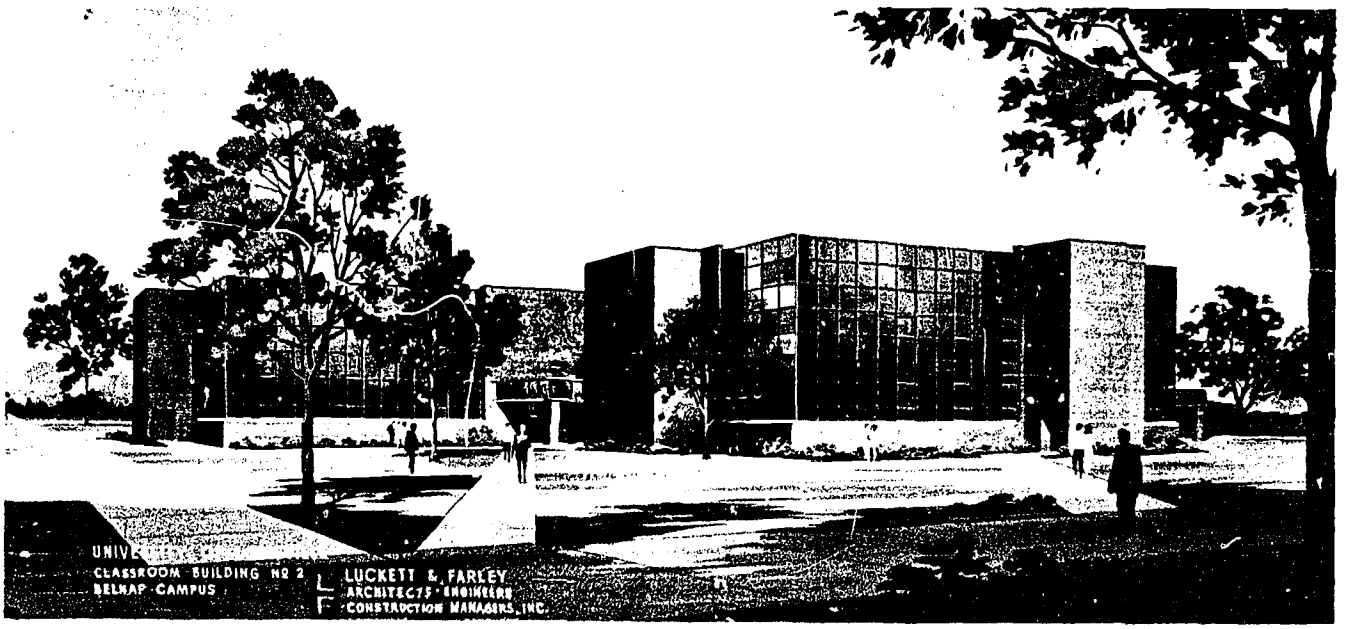
This time, the bidding was organized so that a comparison of cost between CM and assignment to a general contractor could be made. By taking alternate bids for the two management processes, the firm found that for the four selected subsystem contractors the total contract value with CM, $361,000, was about $16,500 less than the bids for assignment to the general.

The Carrithers Middle School Project. An example of the ability of the CM approach to meet tight construction schedules was provided by the 93,500 square foot Carrithers Middle School project for the Jefferson County Board of Education. The firm was asked in late 1972 to complete this school in time to open for the 1973–1974 school year. In spite of difficulties with the site—$400,000 was spent on site work out of a total construction cost of over $2.4 million—Luckett and Farley was able to design and construct the facility in ten-and-one-half months.

The University of Louisville Project. The CM approach has now been applied to seven educational facilities construction projects, during which time both procedures and capabilities have undergone considerable evolution. The firm feels that its project at the University of Louisville represents the most mature form of its CM work.

This project, an 87,000 square foot multistory classroom building and television center, is part of a new educational complex being constructed on the campus. The other half of the complex, a similar general classroom building, is being designed by another architect and constructed using another CM firm. The use of CM in this complex is the result of an early effort by Luckett and Farley to convince the state of its effectiveness.

On-site construction of the Luckett and Farley project is divided into 23 separate contracts, five of which are for materials or equipment only (see Table I). These contracts were bid in seven separate bidding packages, including a contract for metal decking let very early in the process because of the long delivery



One of the firm's most complete applications of building systems and construction management is this classroom building for the University of Louisville which houses four stories of general classroom and faculty office space and a large television center.

delay caused by shortages of this element. The completion target for the building is August 1, 1974, allowing a combined design and construction schedule of thirteen-and-one-half months.

The total contract value of the 23 prime contracts is $2,922,965, or $34.40 per square foot. The estimate of the construction cost, not including contractor's overhead, using conventional general contracting procedures, was $3,238,525. Based on these figures, CM has saved the owner nearly 10 per cent of the construction costs. Interestingly enough, actual bids were nearly 3 per cent below the CM estimate.

The fee received by Luckett and Farley for CM services on this job is $87,000, less than 3 per cent of the construction cost. This 3 per cent figure is less than what would be anticipated as contractor overhead, saving the owner further initial costs.

The fee paid to the firm for achitectural services was determined on the basis of the state AIA scale of project size and complexity. As a result, the total fees for both architecture and CM paid to Luckett and Farley will amount to slightly less than 8 per cent of the construction cost.

TABLE I

PRIME CONTRACTS: UNIVERSITY OF LOUISVILLE PROJECT

A. Metal Deck (materials only)
B. Structural Steel
C. Foundations and Footings
D. Integrated Lighting Ceiling
E. HVAC Air Handling and Ductwork
F. Metal Doors and Frames (materials only)
G. Face Brick (materials only)
H. Switchgear (materials only)
J. Finish Hardware (materials only)
K. Exterior Skin
L. Roofing and Sheet Metal
M. Demountable Partitions
N. Auditorium and Lecture Room Seats
O. Resilient Tile Flooring
P. Terrazzo, Ceramic and Quarry Tile Floor
Q. Carpet
S. Vertical Transportation
T. Sprinkler System
U. Plumbing, Heating and Ventilation
V. Electrical Work
W. Mupltiscope Contract
X. Sound System
Y. Welded Wire Mesh (materials only)

Pros and Cons of CM and Building Systems

For the Client. According to Jean Farley, CM controls the three elements of a project which are of the utmost concern to the client: time, money and quality. Farley feels that unless there is value engineering, management of construction and teamwork, a construction project has much less chance of succeeding today than it did just a few years ago.

The inherent fast-tracking in the CM process permits delivery schedule savings of up to a full year on many projects. With inflation at its present rates, it has been estimated that each month saved is the equivalent of 0.75 per cent of the first cost. An additional benefit is that the construction manager can arrange bid packages and dates to take advantage of markets or to anticipate delivery problems.

Further cost savings for the owner result from the reduction in overall project overhead and profit resulting from use of CM instead of a general contractor, and from the apparently better bids received from contractors under the CM process. Why better bids may be received will be discussed in the next section.

The need for greater client sophistication must be balanced against these gains. One of the possible disadvantages of the Luckett and Farley form of team work and CM is that it places both design and construction responsibilities in the same firm. Farley recognized this possibility and feels that clients will have to become capable of knowing when they are in fact being served professionally. Where the client is not large enough to have in-house expertise, he must rely heavily on the firm's desire to do a good job for him.

For the Contractors. Luckett and Farley's experience has been that contractors like the CM method of doing construction work. There are a variety of reasons for this, key among them being that it reduces their risk and allows early financial completion of the job. By providing them with schedule information and giving them a direct contract to the owner, the CM method reduces their exposure and allows them to concentrate on their own work. As a result, bids are better and many problems of scheduling are avoided.

On CM jobs, the prime contracts used by the firm call for full payment upon completion of a prime contractor's work. As a result no contractor capital is tied up in holdback pending project completion. This leads to better bids, lower prices and better contractor morale.

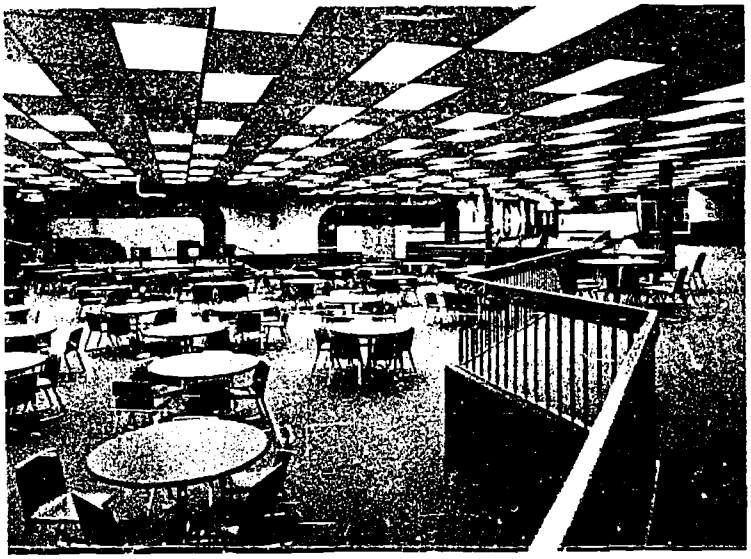
The firm also feels that the division of the project into a number of separate contracts under CM may actually allow more potential general contractors to compete for the job. Where a firm did not have the resources and bonding power to take on a large project as general contractors, it may be able to undertake the multiscope (general construction) contract which includes only about one-third of the construction cost. The general no longer has to bond all his subs; as the multiscope contractor he only bonds himself.

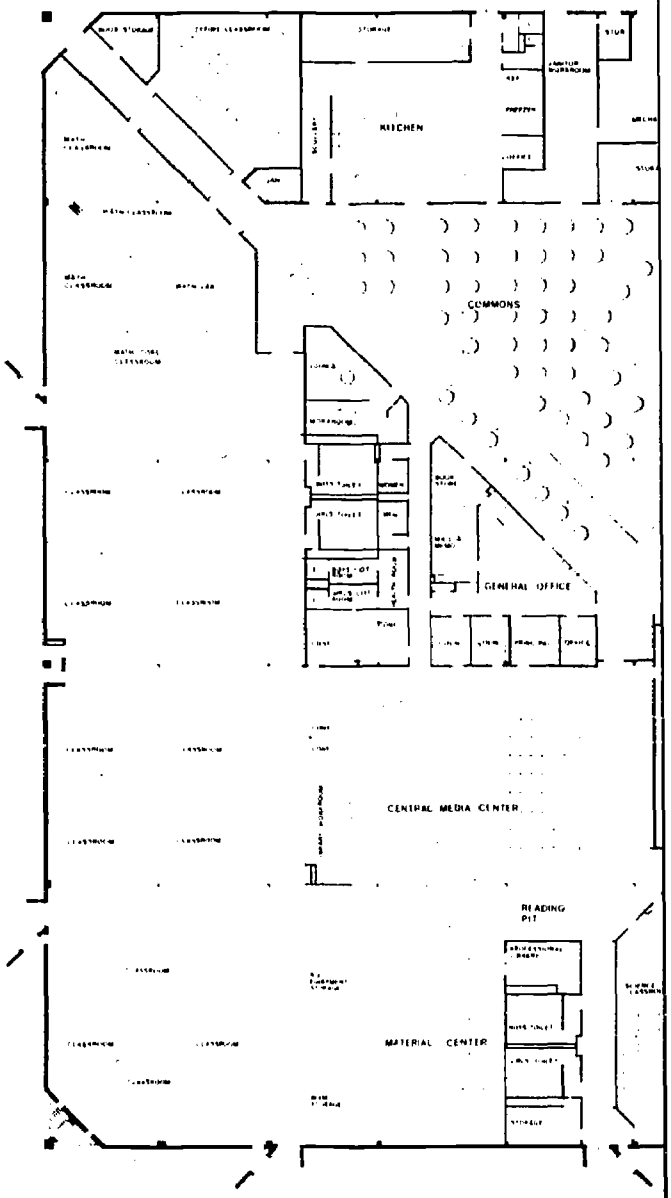
For the Architect. Aside from the general advantages of better service to the client which their CM work has brought, Luckett and Farley feels that some specific advantages accrue to the architect providing CM services. From their point of view, one of the key advantages is the integration of purpose which the increased control gives to projects.

The firm finds that the provision of both CM and architectural services is profitable for the firm. One of the drawbacks to application of building systems the firm had encountered was a sort of "hurry up and wait" process resulting from awaiting subsystem documentation from contractors selected by phased bidding. Personnel had to be temporarily shifted to other work, losing project momentum. Because of this, the firm found that on building systems projects, it was saving money for its clients but spending more to do so. With the design-bid-construct flexibility of the CM approach, continuity is regained and the office is making a reasonable return at the same time that it is benefiting its clients.

A final benefit, and one which to Jean Farley is all important, is that CM offers an opportunity for design firms to insure their own futures. To quote Farley: "Unless the design firms learn to control construction, the design function is going to be lost to other parts of the construction industry." CM offers the opportunity, in his view, to give the client what he wants and deserves, effective control over cost, time and quality.

THE PRODUCT . . .





CARRITHERS MIDDLE SCHOOL

Jefferson County Board of Education
Jeffersontown, Kentucky

Project Size:

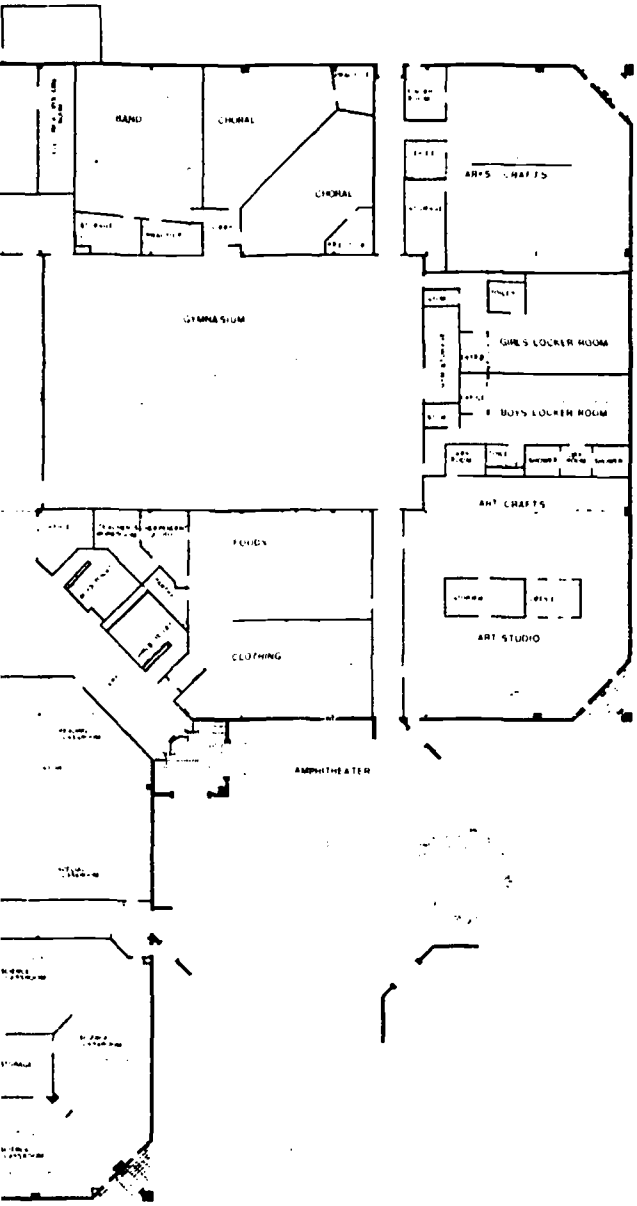
93,500 square feet to accommodate 900 students

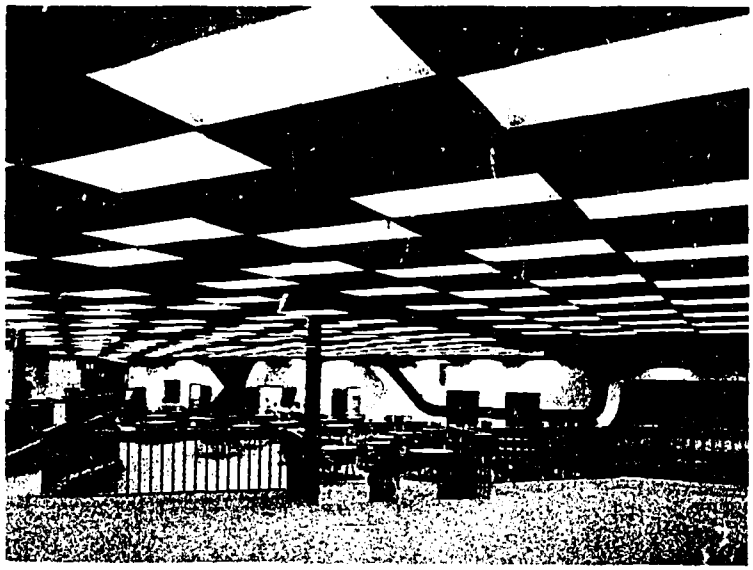
Project Costs:

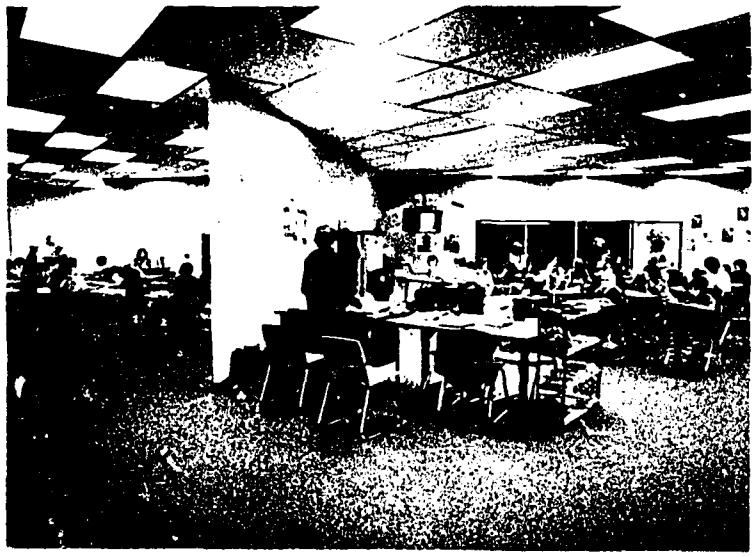
BUILDING COST: $2,044,817, or $21.87 per sq. ft.
CONSTRUCTION COST: $2,444,451, or $26.14 per sq. ft.

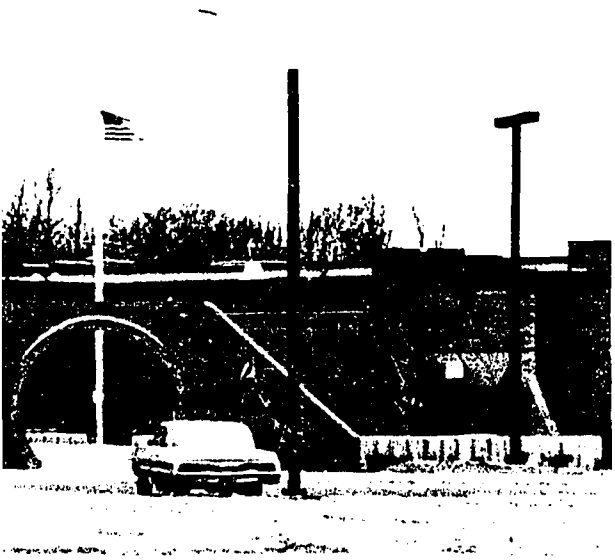
Project Schedule:

CONSTRUCTION BEGUN: January 1973
CONSTRUCTION COMPLETED: August 1973


BAND
CHORAL
CHORAL
ARTS CRAFTS
GYMNASIUM
GIRL'S LOCKER ROOM
BOYS LOCKER ROOM
ART CRAFTS
FOODS
CLOTHING
ART STUDIO
AMPHITHEATER



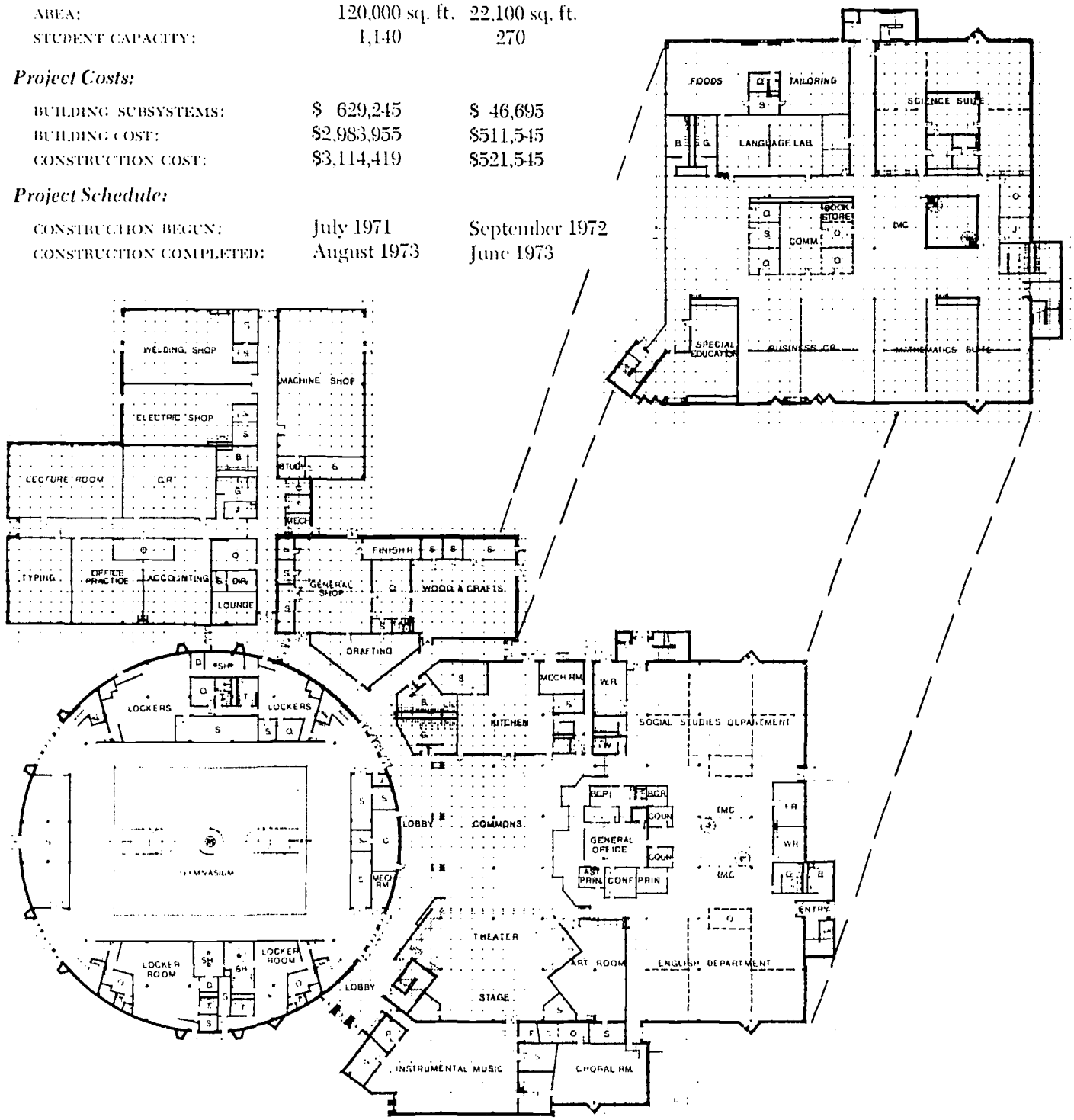


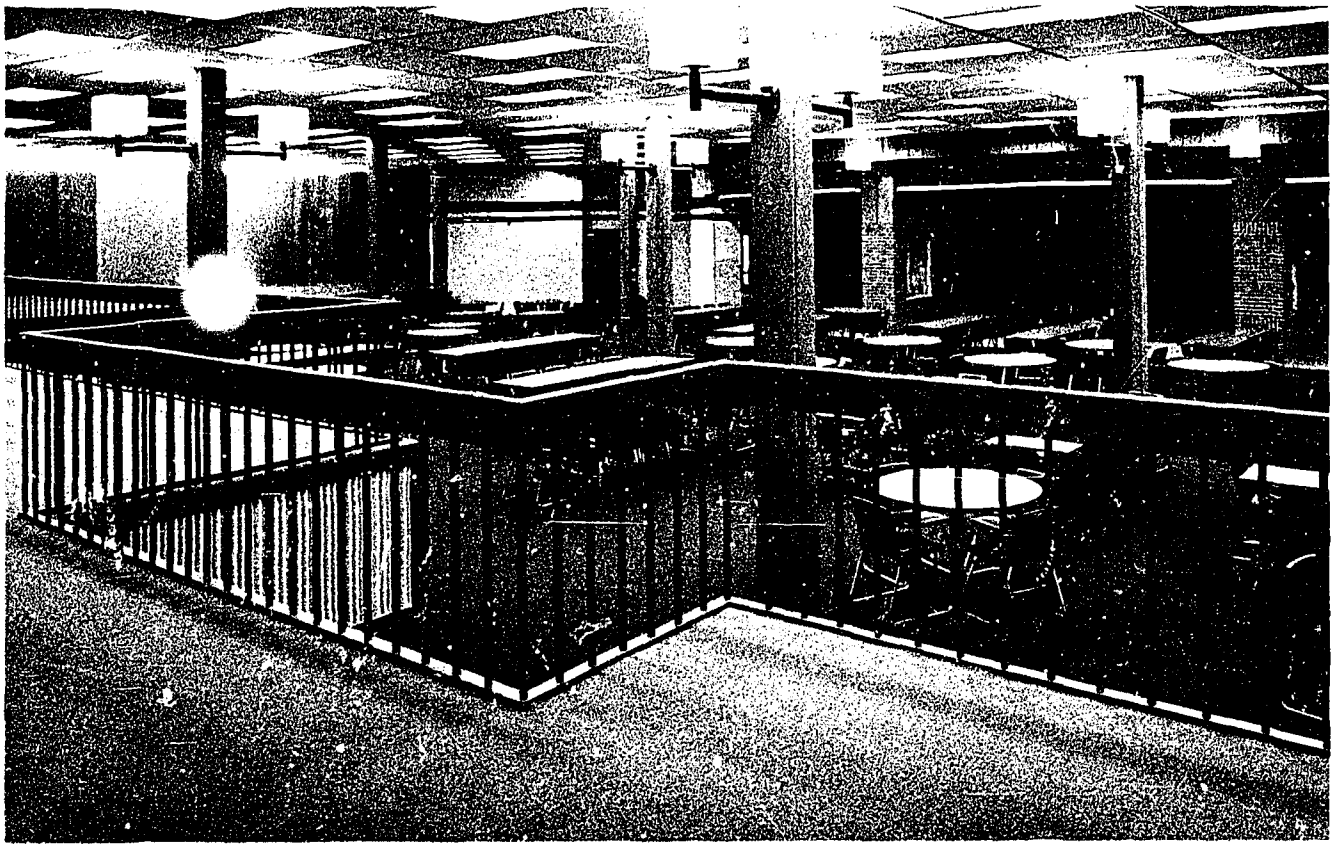


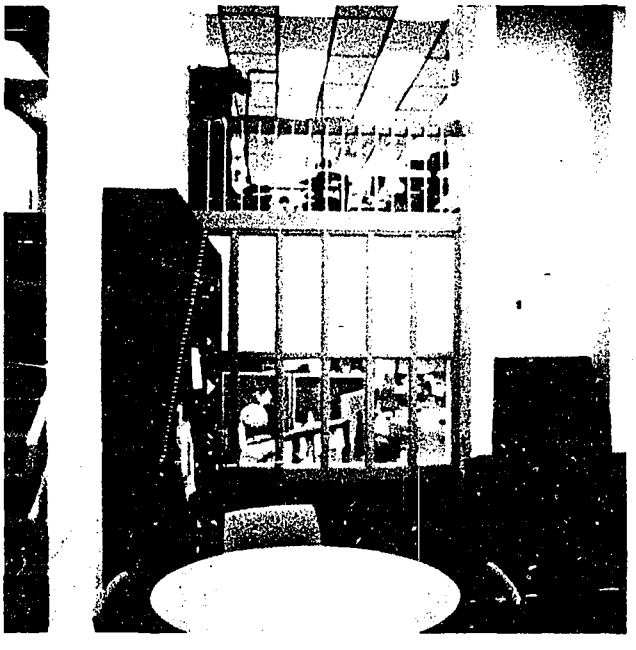
MAYFIELD HIGH SCHOOL AND VOCATIONAL SCHOOL

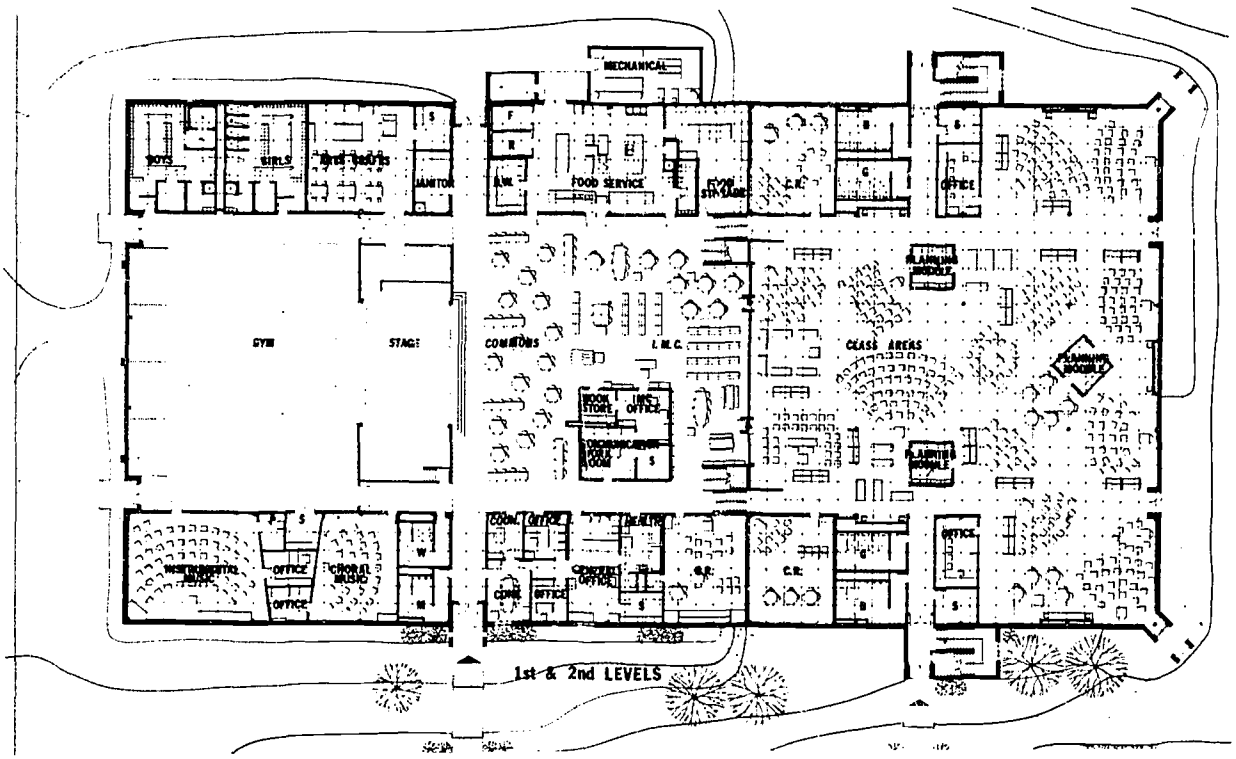
Mayfield Board of Education
Mayfield, Kentucky

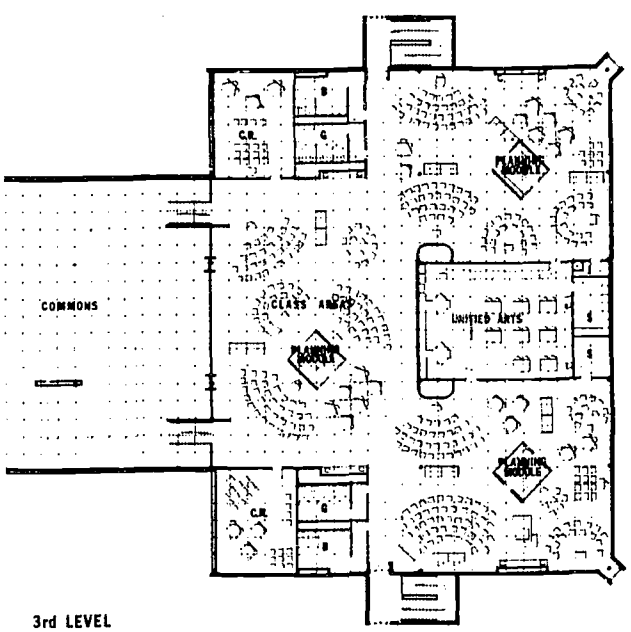
	High School	*Vocational School*
Project Size:		
AREA:	120,000 sq. ft.	22,100 sq. ft.
STUDENT CAPACITY:	1,140	270
Project Costs:		
BUILDING SUBSYSTEMS:	$ 629,245	$ 46,695
BUILDING COST:	$2,983,955	$511,545
CONSTRUCTION COST:	$3,114,419	$521,545
Project Schedule:		
CONSTRUCTION BEGUN:	July 1971	September 1972
CONSTRUCTION COMPLETED:	August 1973	June 1973











NICHOLAS COUNTY ELEMENTARY AND MIDDLE SCHOOL

Nicholas County Board of Education
Nicholas County, Kentucky

Project Size:

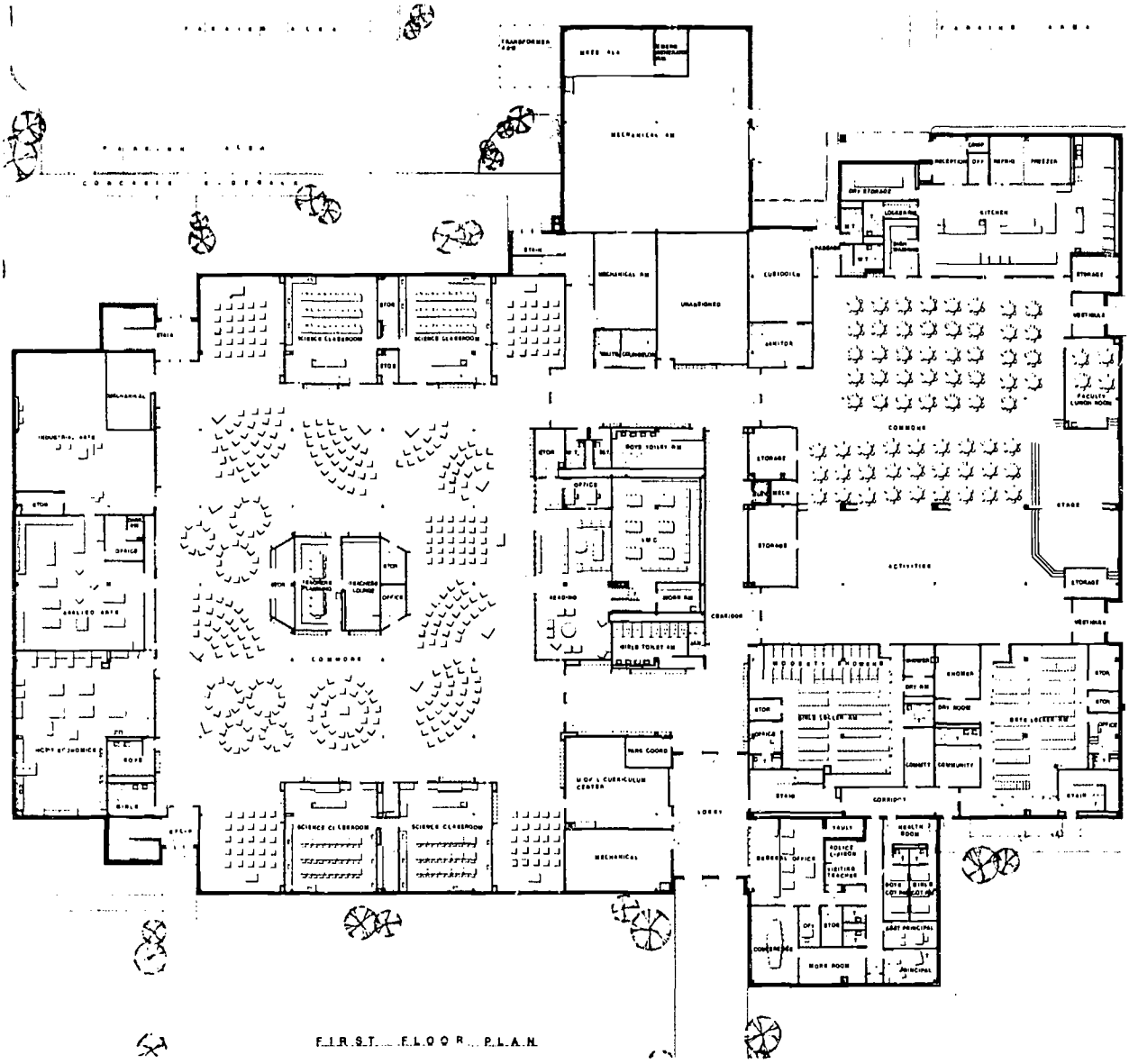
58,725 square feet to accommodate 1,350 students

Project Costs:

FIVE BUILDING SUBSYSTEMS: $418,633, or $7.12 per sq. ft.
BUILDING COST: $1,134,300, or $19.31 per sq. ft.
CONSTRUCTION COST: $1,209,300, or $20.59 per sq. ft.

Project Schedule:

CONSTRUCTION BEGUN: November 1970
CONSTRUCTION COMPLETED: June 1971



SAMUEL V. NOE MIDDLE SCHOOL

Louisville Board of Education
Louisville, Kentucky

Project Size:

140,000 square feet to accommodate 1,400 students

Construction Costs:

$3,925,351, or $28.04 per sq. ft.

Project Schedule:

CONSTRUCTION BEGUN: July 1973
CONSTRUCTION COMPLETED: estimate August 1974