DOCUMENT RESUME

ED 082 278 EA 005 309

TITLE New Academic Building: Newark State College. A Progress Report.

INSTITUTION New Jersey State Dept. of Higher Education, Trenton.

SPONS AGENCY Educational Facilities Labs., Inc., New York, N.Y.

PUB DATE Oct 72

NOTE 24p.

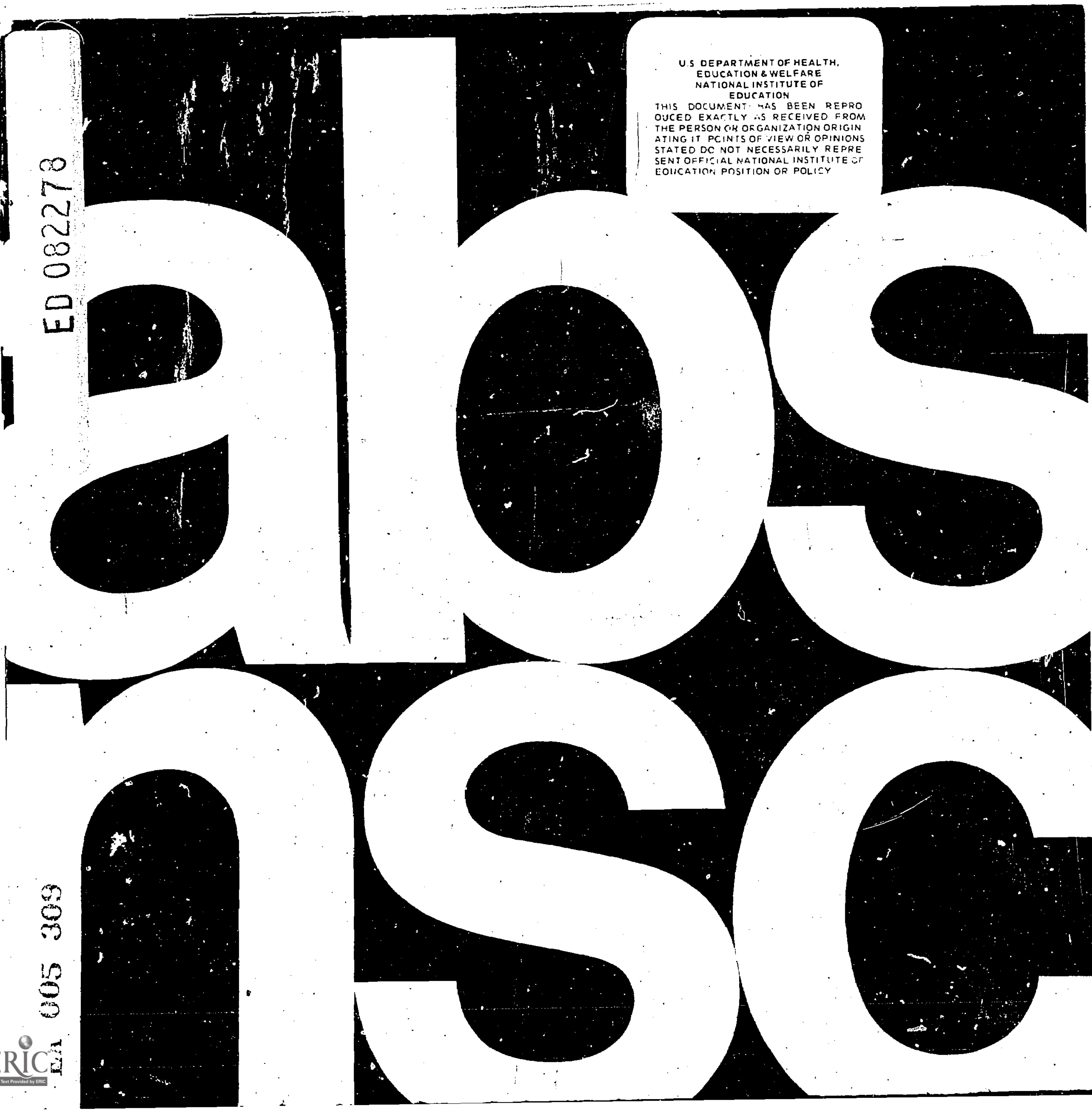
EDRS PRICE MF-$0.65 HC-$3.29

DESCRIPTORS *Architectural Programing; Building Design; College Buildings; *College Planning; Construction Management; Cost Effectiveness; Facility Utilization Research; *Flexible Facilities; *Modular Building Design; Site Selection; Structural Building Systems; *Systems Approach

IDENTIFIERS ABS; *Academic Building System; Newark State College

ABSTRACT

The major special feature of a planned college building is the application of Academic Building System (ABS) planning concepts to the building design and construction. The primary feature of this approach is total future flexibility of general academic space by use of movable and compatible subsystems. These subsystems appear in the form of partitions and integrated light/air ceilings and mechanical distribution systems in nonobstructed space modules, which are separated from towers containing fixed elements of mechanical-electrical service and vertical circulation. The concept as a whole takes into consideration the cost of academic buildings in meeting changing and unknown programs. A summary of a cost analysis of the economic implications of the ABS concepts versus conventional building techniques is included. (Photographs and diagrams may reproduce poorly.) (Author/MLF)



a progress report

new academic building

newark state college

union, new jersey

State of New Jersey
The Honorable William T. Cahill, Governor

Department of the Treasury
Joseph M. McCrane, Treasurer

Division of Building and Construction
Walter T. Peters, Jr., Director
Alfred W. Wensley, Administrator, State Architect

Department of Higher Education
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Newark State College
Nathan Weiss, President
C. Harrison Hill, Jr., Director of Institutional Planning

October 1972

J. Robert Hillier, Architects, P.A.
Princeton, New Jersey

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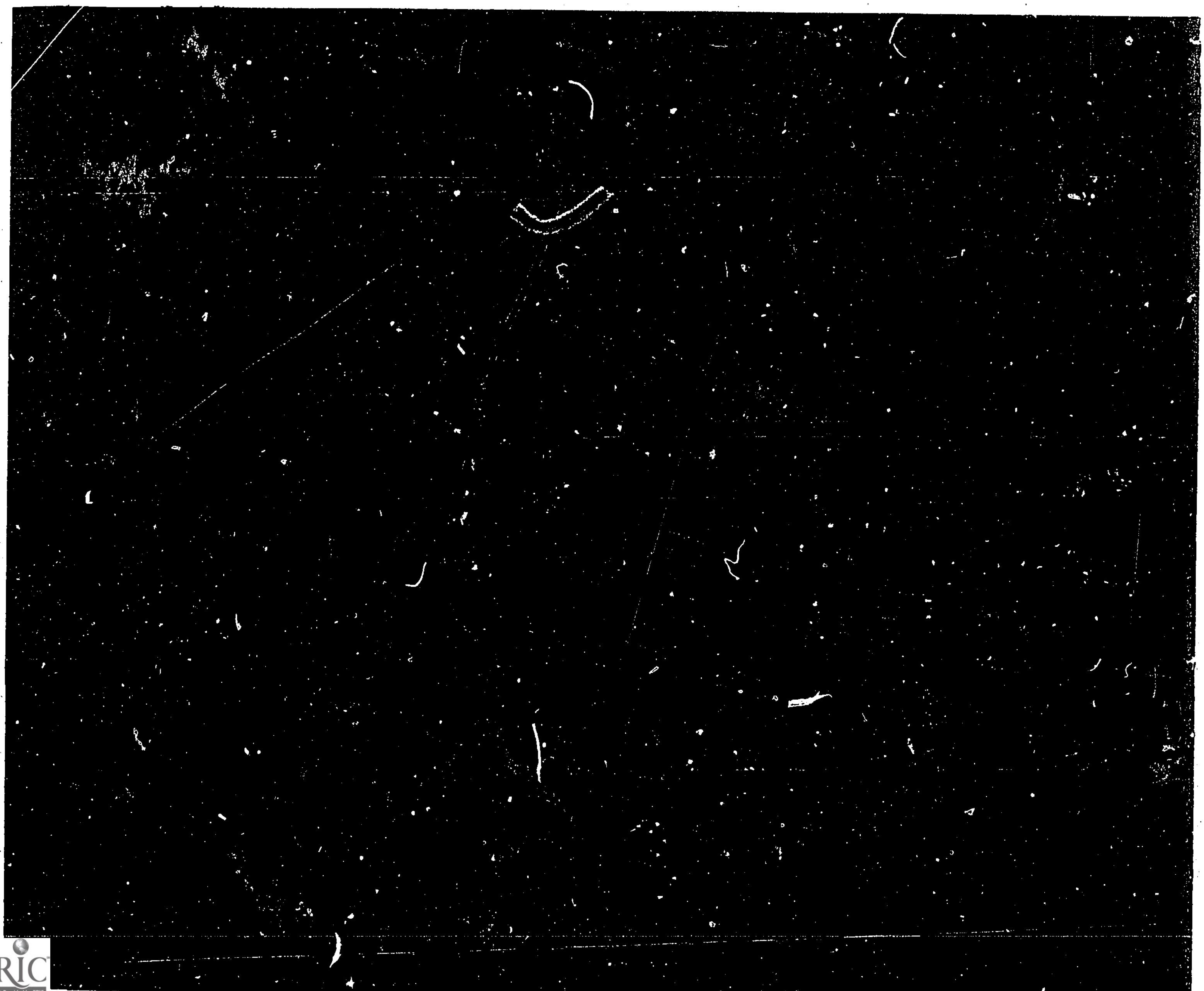

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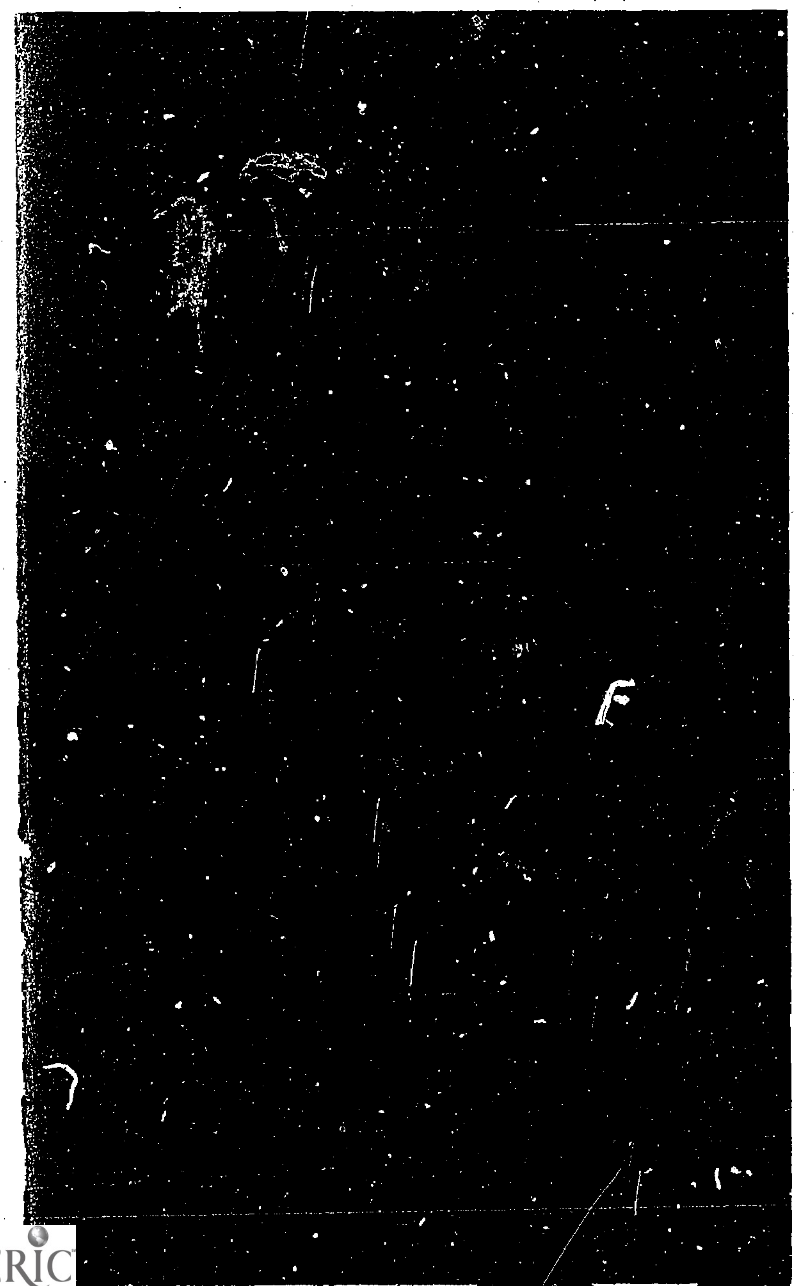

Newark State College is an institution currently in transit toward a multi-purpose role in higher education. At the same time that academic change is taking place, expansion is being projected at a growth rate of 500 students per year to a maximum full-time undergraduate enrollment goal of 7,500 students in 1977. This combination of academic transition and rapid growth requires expansion and alteration of existing physical facilities.

In June 1971, the State of New Jersey, Board of Higher Education, and the Board of Trustees of Newark State College, approved in concept the plan to construct a new general purpose academic building to meet the academic space needs of a projected enrollment of 6,000 students in the fall of 1974, and to alter certain existing academic facilities for improved utilization and upgraded environmental quality.

The firm of J. Robert Hillier, Architects/Planners, was selected in September 1971 to provide professional services for the proposed Academic Classroom Building and the alteration of existing classroom buildings.

Since October 1971, the Architects have met and worked with the Office of Institutional Planning at Newark State College to collect and analyze data to develop a program upon which this design is based.

During the course of the program phase of the project, the New Jersey Department of Higher Education obtained a grant from Educational Facilities Laboratories to study the applicability of incorporating the "ABS (Academic Building System)" planning concepts in the design and construction of the proposed academic building. The application of ABS implied the development of a highly flexible facility designed to meet immediate gross program space needs while retaining adaptation capability to meet future unknown demands in the category of general academic space.

A final program document, submitted and approved by all agencies in late January 1972, established the feasibility of a new academic building to satisfy the space deficit required to meet the general academic area needs for 6,000 full-time students. In addition to the detailed program, a cost analysis of the economic implications of the ABS concepts versus conventional building techniques was developed. A summary of that analysis has been included in the following pages of this report.

Program

Fundamental goals of Newark State College's Educational Master Plan are: the further development of a strong liberal arts core curriculum; the diversification of major offerings; the expansion of enrollment at a rate consistent with quality education; and the increased enrollment of upper division students transferring from two-year colleges. All of these goals are underlined with the need to provide adequate instructional space and support facilities, including faculty offices, faculty research space, and related audio-visual areas. Even before going into a detailed analysis, it was obvious that existing academic classroom facilities totaling 43,055 net square feet in 58 instructional areas would be inadequate for 6,000 students. Using the basic New Jersey Department of Higher Education planning module of 9.6 net square feet of academic classroom space per student, 57,600 net square feet is considered adequate for 6,000 students at a four-year college. At the present time 353 full-time faculty share office space which, when compared to "New Jersey State College Standards," is only considered adequate for 261 faculty. At an enrollment of 6,000 students, the full-time faculty is projected to 440. Faculty research space and audio-visual space are virtually non-existent as the campus presently exists.

Although at first glance the 43,055 net square feet of existing space seemed to represent a good portion of the needs for 6,000 students, a part of it was located in facilities which require related internal expansion, e.g., library, gymnasium. A large amount of the academic space was assigned as large classrooms providing up to 75 student stations where the average scheduled section size has been between 25 — 40 student stations, resulting in extremely poor student station utilization.

Through inventory and analysis of existing academic facilities, a plan was developed to reassign, subdivide, and alter existing buildings in a way which would provide the best plan of improving the utilization of the space within the constraints of construction limitations and user requirements. This plan then established an adjusted existing quantity of general academic space in various type and size components which could be used to determine deficits to be corrected by the new building when compared against the gross space needs for 6,000 students.

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In August 1971, the Office of Institutional Planning at Newark State College prepared a report titled, "Projected Space Requirements by Discipline at 6,000 Full-Time Day Students." This report studied in depth the academic space needs by discipline for both lower and upper divisions at an enrollment of 6,000 students.

Utilizing square foot/credit hour-subject hour conversion factors, the report identified an academic space need of 55,440 net square feet of general classroom space. This number, when combined with a 7% service factor (59,300 net square feet), compared favorably with the planning module total of 57,600 net square feet and was, therefore, used as a basis for the total academic classroom space need for 6,000 students. Since many of the projected curriculum courses do not exist at the present time, sizing of the actual classrooms to meet the needs of the future could only be projected based on existing distribution of course section sizes, plus some speculation on methods of instruction in the future. Although the Newark State College administration believes in the potential of large group and individual autotutorial instruction in the future, the basic classroom section size of up to forty students was still considered a desirable group instructional unit in the future.

New Academic Building Program

Category	Area (net sq. ft.
Academic Classrooms (including service)	25,550
Faculty Offices (including support)	16,340
Audio-Visual Facilities	2,520
Assignable net Area	44,410
Non-assignable Area (50% of assignable)	22,205
Total Gross New Building Area	66,615

The distribution of current course section sizes was then applied proportionally to the academic space need of 55,440 net square feet. This projected breakdown of classrooms, compared with existing facilities and adjusted existing facilities resulted in a deficit of 25,550 net square feet of general classroom area for which the new academic building should provide.

Newark State College indicated the need to develop one large 200 student station classroom as part of this facility to provide for multi-media large group instruction methods utilizing multiple projection techniques. It was envisioned that an audio-visual graphic production facility, including preview and library facilities totaling approximately 2,500 net square feet in area, should also be included in this facility.

The main function of this area would be in the preparation of autotutorial material to service future programs in individual instruction, however, during the design period this requirement expanded substantially.

One of the most critical areas of concern on campus at the present time is adequate faculty office space. Following the same inventory and adjustment procedures outlined in determining the classroom needs, it was found that there are adequate facilities for only 261 faculty members. The new facilities will include associated conference/seminar areas, work areas, and secretarial support space which are nonexistent in existing areas.

The new academic building will provide adequate space for 119 additional faculty offices based on current student/faculty ratios and related part-time overloads totaling 16,340 net square feet.

As mentioned previously, the major special feature of this project is the application of ABS concepts to the design and construction of the project. Reference is made to the "Academic Building Systems — July 1971 — Volumes 1-3, a Joint Effort of Indiana University and the University of California and Supported by the Legislatures of the States of Indiana and California; Educational Facilities, Inc.; and the Office of Education, U.S. Department of Health, Education, and Welfare."

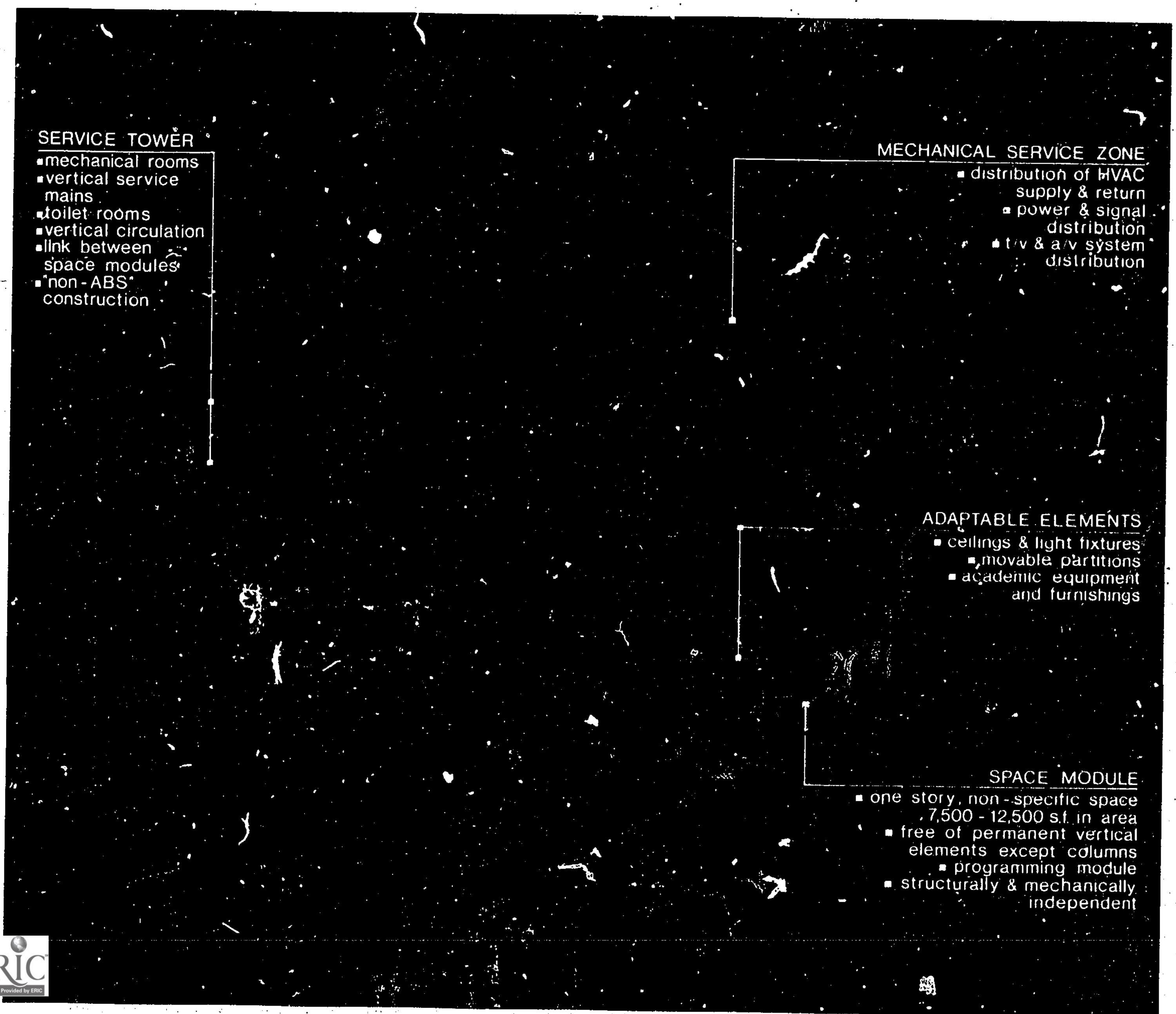
The principles established by the research of the ABS study were applied to all phases of this project. The primary feature of this approach is total future flexibility of general academic space by use of movable and compatible subsystems, such as partitions and integrated light/air ceilings and mechanical distribution systems in non-obstructed space modules, which are separated from towers containing fixed elements of mechanical-electrical service and vertical circulation. The concept as a whole takes into consideration life cost of academic buildings in meeting changing and unknown programs. Perhaps the word "non-obsolescence" best describes this feature.

It was determined at this time that the new building should be divided into six 9,000 square foot space modules which would eventually house the academic program plus two service towers. The Newark State campus is essentially a three and four-story campus. After taking compatibility with this general building scale into consideration, together with the economy offered by minimally protected steel framing systems for this height building, it was decided to organize the six space modules programmed in two three-story blocks served by independent service towers.

Certain ABS principles, including the lateral force-resisting perimeter frame utilizing ten-foot exterior column spacing and ten-foot beam spacing (which appears awkward and somewhat uneconomical when using steel frame and composite slab design), was discarded early in our investigation of the ABS planning concepts. Column spacing in the building aligns with basic five-foot planning grid. The five-foot planning grid, which defines a sub-module for partition arrangement within the basic space module, was further subdivided into a two foot six inch by five foot module in order to provide a smaller increment of planning flexibility.

The recommended techniques of "phased construction" and "pre-bidding of subsystems" are being applied to the construction phase of the project; site preparation and structural contract bids have been received and are expected to be awarded in the near future while total design of the project continues.

Academic Building Systems (ABS) Planning Concepts



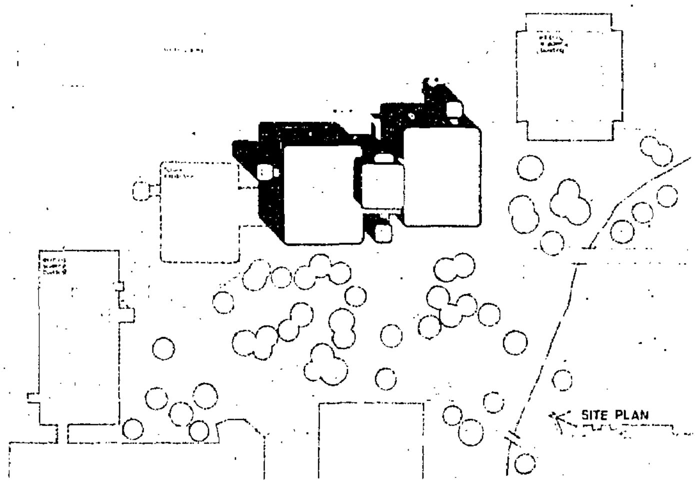
Siting Concept

The site selected for the building is a relatively flat parcel of land located between an existing four-story academic classroom and faculty office building — Willis Hall — and a three-story science laboratory and faculty office building currently under construction. Located at the eastern edge of the major parking area adjacent to Morris Avenue, the entire building site is visible above cartop level from off-campus vehicular traffic.

By building the initial three-story space modules close to Willis Hall, enough space is preserved for the future construction of a third space module between this new building and the science building providing instructional space needs for the current projected enrollment goal of the College.

The total complex will serve as an academic link while preserving and defining a natural green space to the west and separating the major parking area to the east from the green campus.

Initial coordination was made with Clarke and Rapuano Landscape Architects, currently studying pedestrian and vehicular circulation patterns on the campus and agreement was reached on the siting. Details of final walk connections, however, have not been worked out at this time. The site design shown indicates a general approach to the final connection to walkways and paved areas.



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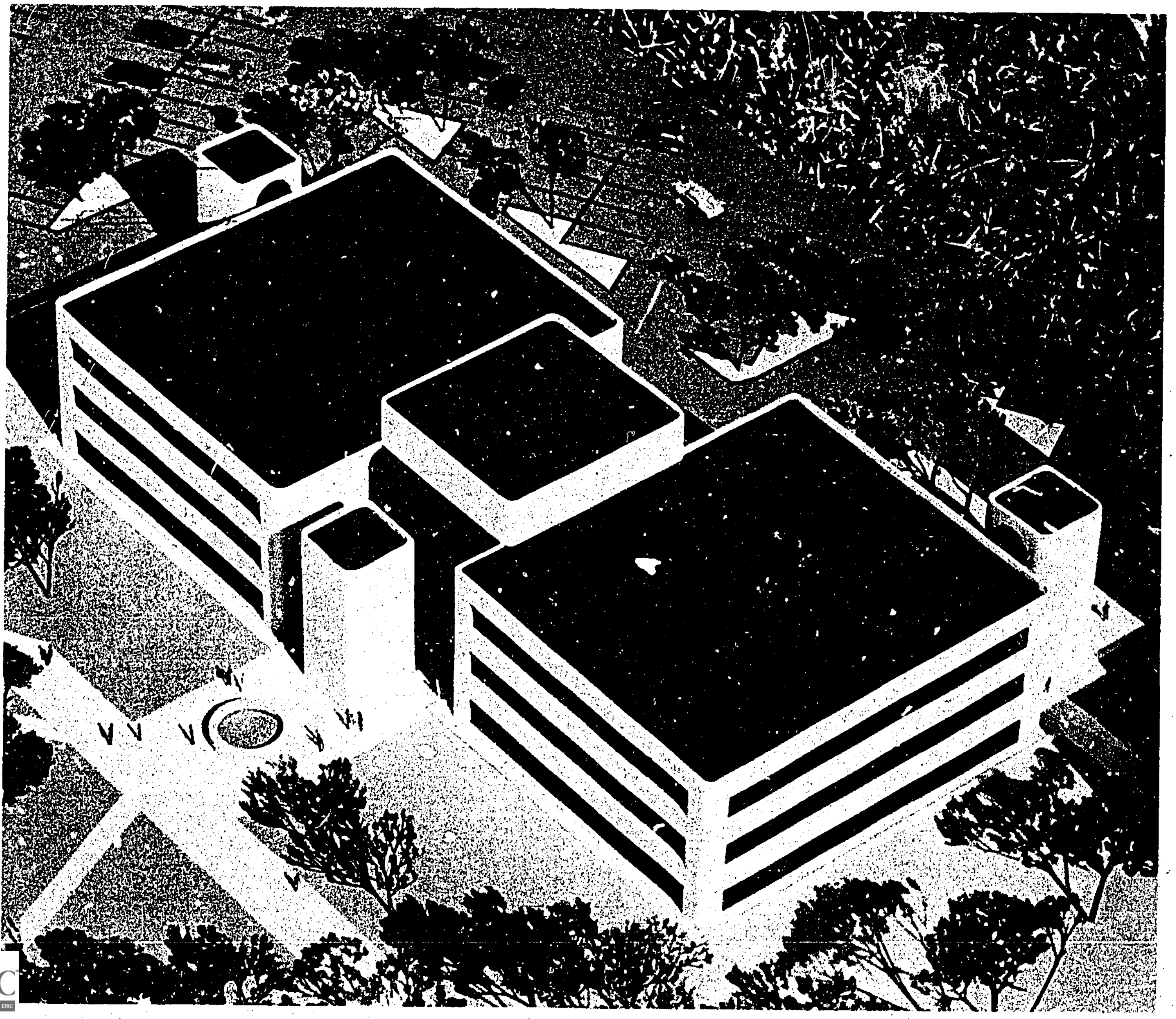


Cost Evaluation

An evaluation was made by comparative study of the premium initial construction costs and the life cost implication of the ABS building against those of the non-ABS, or conventional, building. In order to study the cost differential between the two building types, estimating models were developed using the basic siting and planning concepts established in the program document.

Similar building configurations were maintained for both building types in an effort to keep comparisons on an equal basis. As the study progressed, alternative planning concepts emerged which modified the original ABS approach of the program document. All the cost estimating data in the study was based on take-offs of extremely simplified sketch concepts which made the study valid on a comparative basis rather than a true final cost evaluation.

During the program phase of the project the decision was reached that the new academic building would provide flexible space for general "dry" academic space since new science facilities currently under construction were programmed to meet laboratory space needs for a full-time enrollment of 7,500 students. Therefore, it was decided to take the shallow service space ABS approach rather than the deep space approach providing catwalk ceiling access since wet services will be kept to a minimum.

Three alternative schemes based on ABS concepts were evaluated. However, they differed only in major air handling methods. Each ABS concept was based on two three-story non-specific space modules of 9,000 square foot floor areas with uniform ceiling heights of 9'-0" and constant mechanical service zones based on 14'-7" floor-to-floor heights.

In the ABS-1 concept, each space module would be served by its own independent mechanical unit. Considering the fact that package mechanical units are now available to handle the requirements of more than one space module, it was decided to investigate the relative cost of the ABS-2 scheme which combines the mechanical units of two adjacent space modules. Since basic space flexibility can be achieved independently from the air handling source, the ABS-3 scheme based on the use of a central pre-fab factory manufactured penthouse similar in all respects to the conventional system was introduced for comparison.

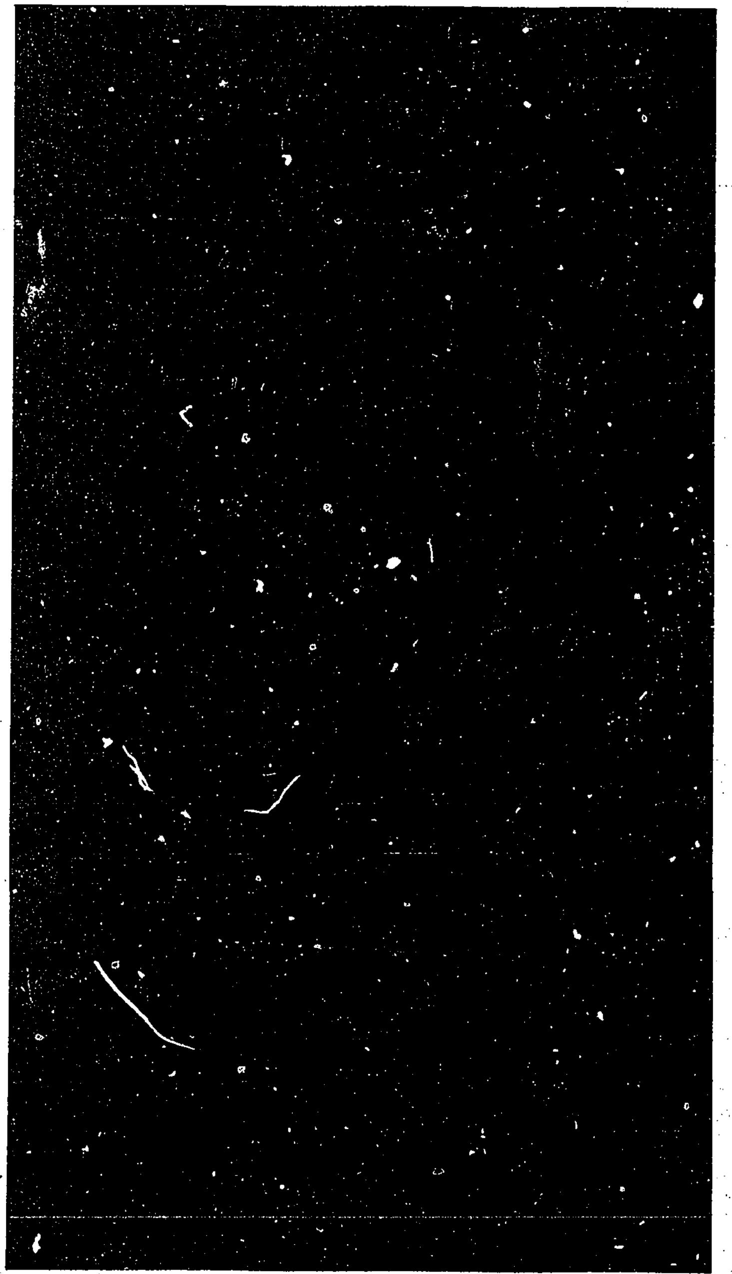
The non-ABS or conventional building concept satisfied the same program space requirements disregarding flexibility of component subsystems to allow easy change in the future. Ceiling heights were varied within 12'-7" floor-to-floor heights to provide for horizontal mechanical air handling equipment. The structure was designed independently of other subsystem modules and to meet initial live load design requirements rather than 100 pound uniform live load design in the ABS concept, in order to achieve maximum economy when considered separately.

The same exterior building systems were maintained in the ABS and non-ABS schemes. Major differences occured in the interior adaptable elements. The ABS models included 9'-0" high interior prefinished movable partitions offering STC 40 acoustic ratings which stopped at the ceiling construction comprised of a 30" x 60" modular integrated light air distributing system also offering an STC 40 rating. Conventional interior systems consisted of metal stud laminated field finished drywall partitions offering STC 40 ratings taken up to the underside of structural decks at points of ceiling height change. The ceiling was based on 2' x 4' lay-in mineral board design.

Mechanical distribution varied between the conventional diffuser system and the slotted ceiling air boot system used in the ABS models. Both concepts were based on a "heat from light" return system.

Following are summary unit cost comparisons of the major categories of work between the four schemes compared, extracted from the "Cost Estimate Comparison Study" dated March 22, 1972.

	Conv.	ABS-1	ABS-2	ABS-3
General Construction	24.30	25.80	25.40	26.80
Plumbing	1.60	1.70	1.60	1.70
HVAC	10.15	11.00	10.70	11.75
Electrical	4.20	4.70	4.65	4.85
Totals	40.25	42.90	42.35	45.10
%premium over conventional:		6.6%	5.25%	12%



The estimates did not take into account variables of cost related to time, although there is an implied time saving using the procedural concepts of phased design and construction.

"Life-Cost" implications were then studied by developing unit alteration costs for renovating one 9,000 square foot space module in the conventional scheme and the ABS schemes by estimating the work required to change identical hypothetical plan arrangements in each scheme. One plan change maintained initial corridor configurations while a second plan change required total spacial rearrangement.

It became obvious that if future flexibility requirements could be limited to areas around fixed corridors, the ABS concept was an invalid economical approach, however, if total flexibility of over 35% of the building area over a ten-year period was required, there was a potential "real" savings by paying the initial premium to insure this flexibility. It was decided that this was a justifiable approach since all of the flexible space on campus will be located in this building and a proposed administrative services building which when combined represent only 13% of the campus building area excluding dormitories.

Based on the data and conclusions reached in this study, a schematic design based on the ABS-2 approach was initiated for the new academic building.

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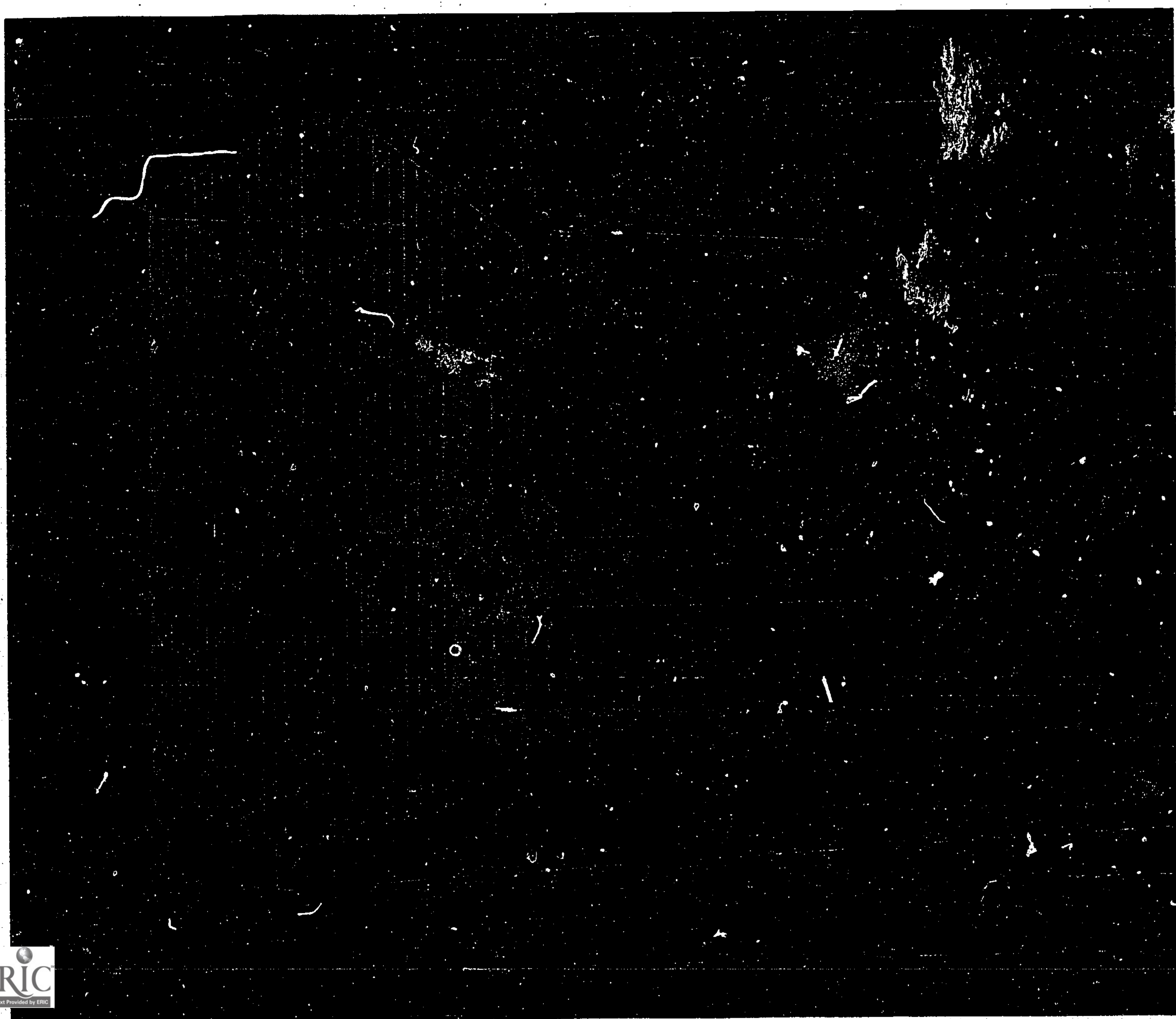

Schematic Design

Final design of the building commenced following the ABS-2 scheme defined in the cost evaluation study. The building has been sited in close proximity to the original program concept location, allowing for future expansion of one additional space module element and its associated service tower north of this phase of construction.

Major pedestrian entrance from the campus is provided for through the central service tower with secondary entrances through the stair tower vestibules. A service entry is provided on the east side of the service tower.

Early in the design of the building, the decision was reached to locate major mechanical equipment in a central penthouse on the roof above the service tower or core, instead of in a basement area, due to extremely high water levels encountered during an investigation of soil and foundation.

This penthouse provides for the steam absorbtion chiller, steam-hot water convertors, cooling tower, related pumps, and the electric substation for the building. Provisions have been made to handle future expansion loads in all of this major equipment.

Each floor of the service tower below the penthouse contains the air handling equipment and power/signal panels for the space modules north and south of the core. In addition, each floor of the core provides for lounges, toilets, vending areas, public telephones, elevator, and central lobby areas joining the adjacent space modules. Although efforts will be made to prevent dullness in the general academic areas, it was considered important in the design concept to create a more exciting environment in the non-ABS lobby areas which would provide a spacial contrast to the uniformity of the modular academic areas. Each lobby area, except at the ground level, consists of a widened bridge connecting the adjacent areas and the stair tower within a three-story glazed lobby space.

During the design process emphasis was given to developing an architectural expression of the ABS concepts in some way on the exterior of the building as well as on the interior. The result was found in a five-foot modular metal and glass skin relating to the interior subsystems module which will be handled as an exterior subsystem. The modular insulated core metal panel and glass walls are representative of the component systems technology that comprises the interior subsystems package.

Stair towers have been designed as structural concrete entities divorced from the building perimeter which reflect a dominant building material used throughout the campus.

One major non-ABS space — a 200-seat lecture room — is being provided for on the ground floor of one space module as originally programmed. The space will be provided with a sloping floor, fixed seating, and multi-image front projection facilities.

All other areas within the space modules are being considered flexible within the constraints of the 30" by 60" ceiling module. Site development will be limited to minimal areas directly related to the perimeter and entrances of the building as mentioned earlier.

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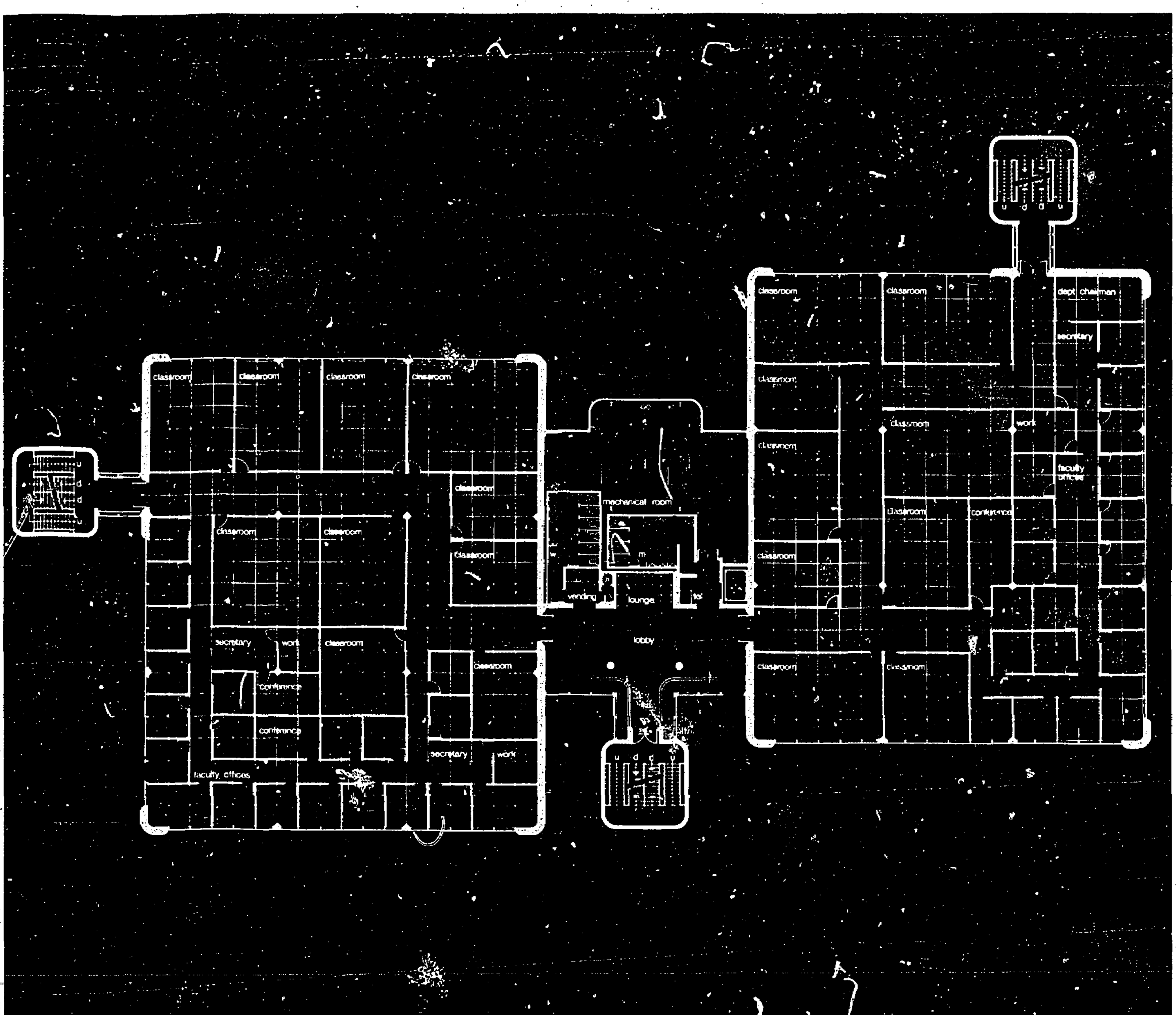
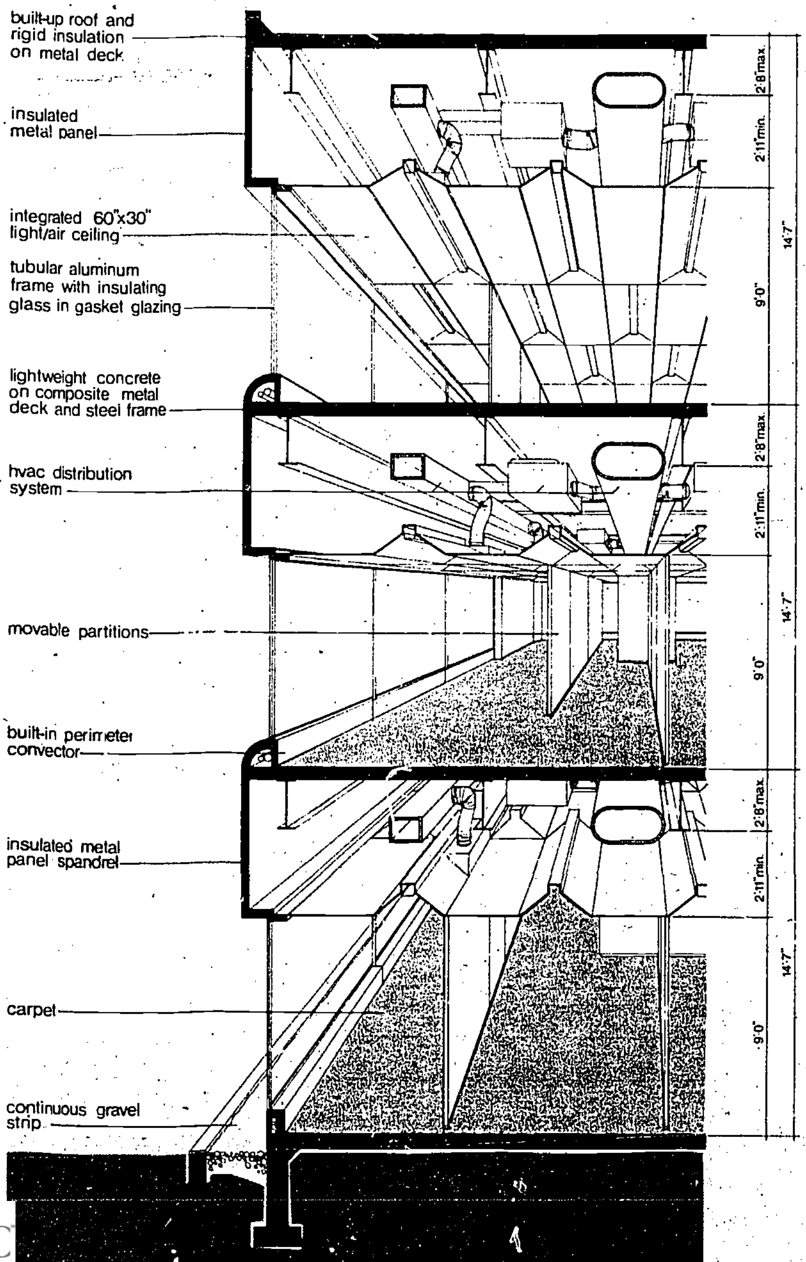
Basic Floor Plan



Building Construction Systems



Subsystems

The design concept of this building is based on the following construction systems:

Structure Steel frame using composite concrete on metal deck slabs to support an overall design live load of 100 pounds per square foot with a structural bay spacing of 30 feet by 35 feet. All foundations are reinforced poured concrete.

Exterior Skin Spandrel and solid walls are prefabricated, prefinished, aluminum-faced foam core insulated panels shop formed to the shapes indicated and joined with a neoprene gasket system at the 5-foot module of planning grid. Panels are physically supported at the slab and aluminum tubular mullions of the window system. Aluminum window walls are based on tubular design mullions glazed with one inch insulated reflective bronze glass in a neoprene gasket sealed system. Lobby and stair connection walls are aluminum tubular window walls glazed with bronze glass and Plexiglas at curved areas.

Interior Partitions Nine-foot high movable partitions in the areas of space modules, using thirty-inch wide factory-laminated vinyl covered gypsum board panels on metal studs providing for mechanical attachment and removal of the reusable panels The basic partition system is designed on an acoustical rating of STC 40, and a fire rating of one hour where required. Work surfaces such as chalkboards and tackboards, metal door frames, sidelights, wood doors, and hardware will be part of this system. All other partitions are conventional masonry and drywall with field applied finishes.

Ceilings Thirty-inch by sixty-inch integrated ceiling system throughout the space modules utilizing 50 per cent coffered light fixture elements providing air distribution through grid slots and return air through the lighting fixture while providing fire protection for the structure. The ceiling system will also offer an STC 40 acoustical rating and be compatible with the partition system. Other "non-ABS" areas will have drywall with field applied finishes.

Applied Finishes Flooring throughout the space modules will be carpet. Lobby and core areas will be finished with tile floors and ceramic tile walls in wet areas. Ceilings and walls of lobby areas will be finished with carpet.

Stair Towers Poured in place exposed architectural concrete.

Plumbing Conventional facilities, including toilets, fire standpipes, drinking fountains, and storm drainage are included as required by projected maximum population and building size.

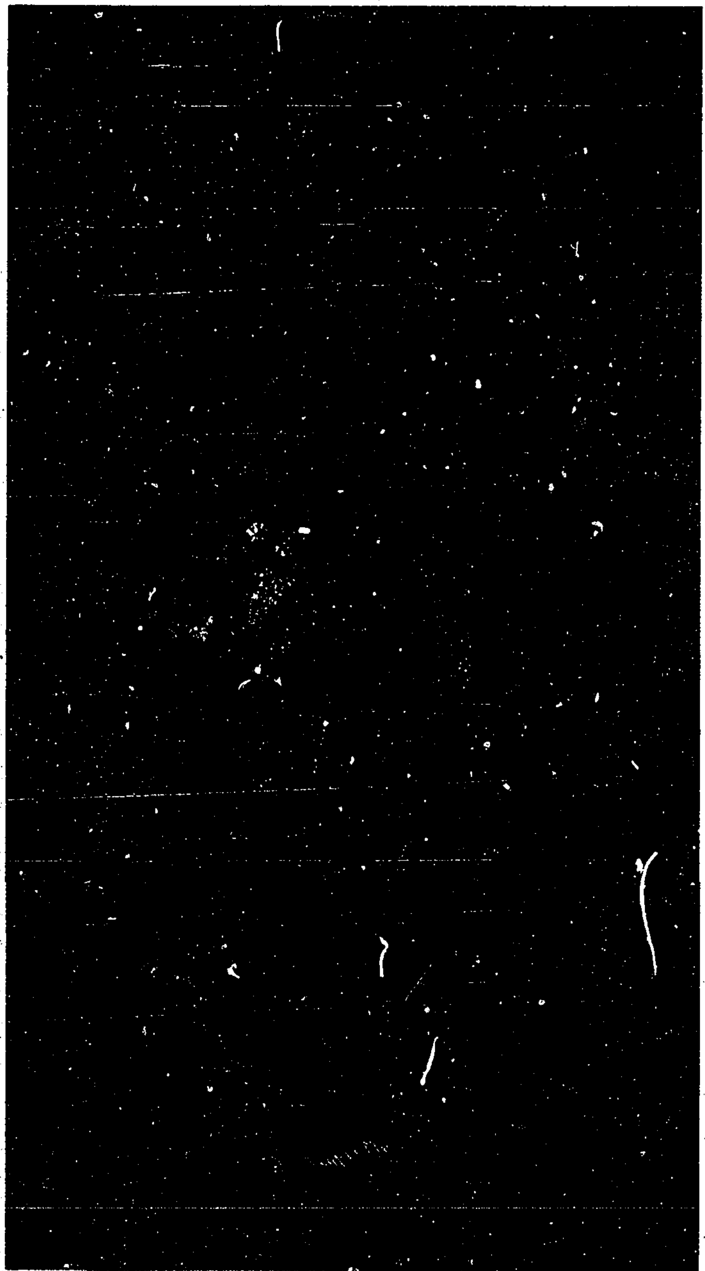
Heating, Ventilating, and Air Conditioning The system is based on the ABS concept of future flexibility utilizing ceiling mounted induction boxes receiving medium velocity conditioned air from a factory assembled air handling system located within the core area and then distributing low velocity air through ductwork to flexible supply air boots mounted on the ceiling suspension system. Return air will pass through the light fixtures into the ceiling return plenum where it will be re-introduced to the induction boxes to provide temperature control of supply air. The system is basically divided into interior and exterior zones. Each exterior zone is approximately 300 square feet based on a depth of 10 feet from the exterior wall, and interior zones are between 500 and 1,000 square feet each.

The supply air boots, mounted on the ceiling track, may be moved up to 15 feet from the low velocity duct by adding a length of flexible duct to the connection, if required. It is possible that the major amount of supply air to a particular room will be supplied by one induction box, and the remaining supply air supplied by another box which is also supplying several other rooms. The thermostat location for the boxes would be determined by the type of use the rooms are intended for and the amount of time each room will be in use.

The perimeter of the building will be heated by fin and tube radiation using variable water temperature controlled by outside temperature.

Electrical Systems Lighting throughout the space module incorporates a compatible two-lamp return air fluorescent fixture within the coffered ceiling elements. Other systems will in general be conventional in nature with provisions for flexibility built into the method of distribution. Junction boxes will be placed above the ceiling in a pattern, which in the event partitions are moved, will serve as a means for making new connections to lighting fixtures, receptacles, etc., and terminating home runs.

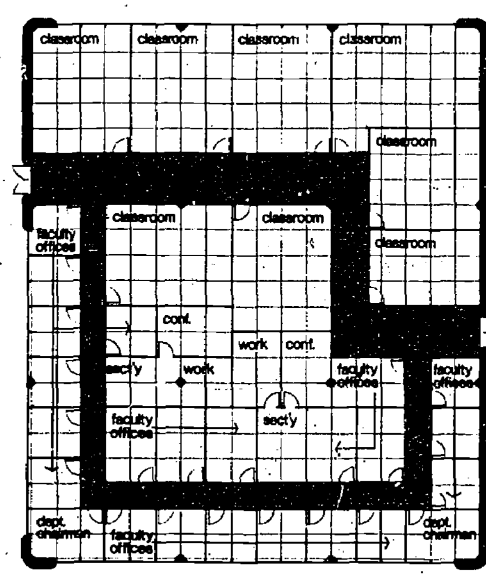
A fire alarm and detection system will be installed throughout the building. In addition, dial access television and audio will be distributed from the ceiling through drops to equipment.

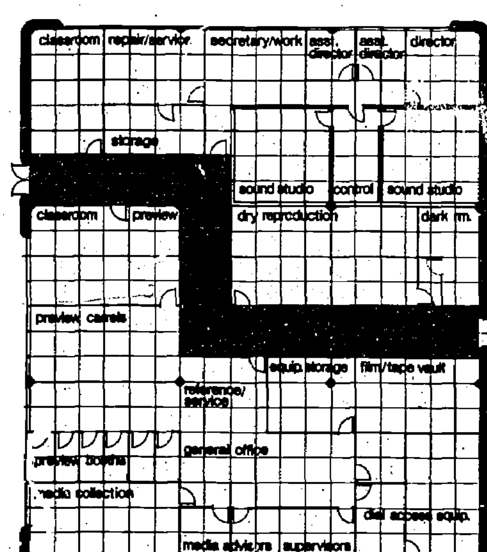


Flexibility

The purpose of this building is to provide flexible general "dry" academic space for Newark State College. While the completion of this building will provide 100% flexible instructional space, it represents only 9-1/2 per cent of the total area of available space on campus exclusive of dormitories. Although the original program for this building was based on furnishing classroom, faculty office, and audio-visual space needs for 6,000 full-time undergraduate students. It is envisioned that the real function of the building will be to provide surge space for new academic programs as they develop. This has already been evidenced in the College's request to provide area for the evolving Instruction Resource Center in lieu of a relative area of classroom and office space originally programmed. The adjacent proposed occupancy diagrams are included in this report to indicate some of the potential for layout rearrangement within the limitations of the planning grid of a space module.

Some consideration is being given to allow for flexibility in final plan arrangement until the building is ready to receive partitions. This will require bidding quantities and types of partitions and doors based on preliminary estimates of need until decisions related to final occupancy are reached.





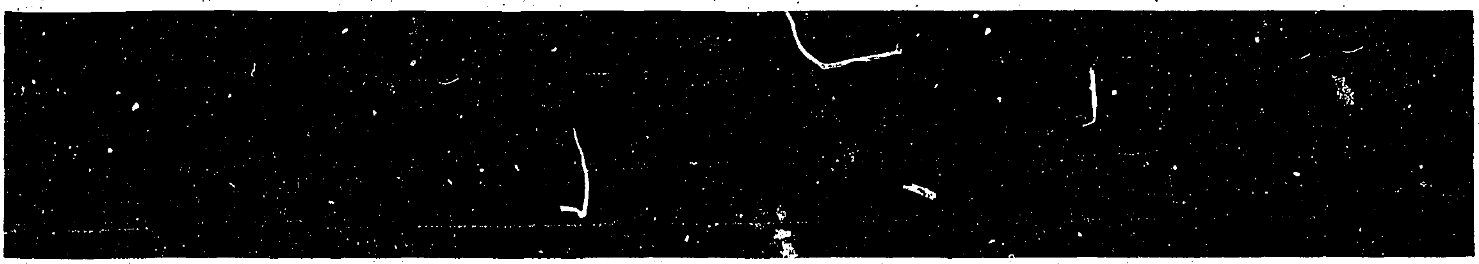
Procedures

Part of the ABS planning concept includes application of non-traditional construction procedures including Phased Design and Construction; Pre-bidding; and Construction Management.

After evaluation of the construction time schedule, it was decided to proceed with the phased construction of the project into two packages which would allow for completion of construction in the fall of 1973. Contract documents were prepared for site preparation, foundations, and structural steel immediately following schematic design approval of the entire project. This will allow for the commencement of foundation construction and structural steel erection while design is completed on the details and interior plan arrangement of the building.

Serious consideration is being given to apply a limited form of construction management to the construction phase of the project which would provide for more direct control of the various sub-contracts making up the total construction package.

Project Schedule

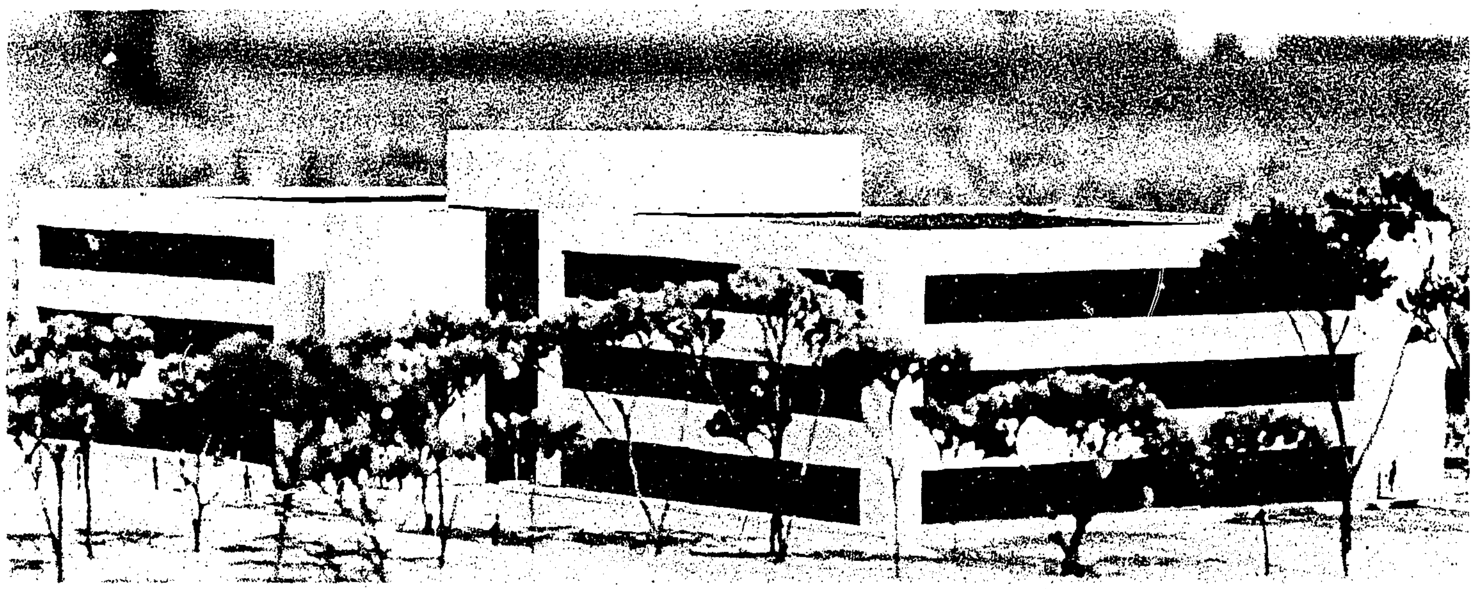


Summary

Newark State College is projecting expansion at a rapid growth rate during a period of academic transition. The application of the ABS planning concepts and procedures is enabling the College to prepare additional space which will adapt easily to satisfy space needs of general academic programs which do not exist at this time. The concept is not considered a panacea; however, the basic principle of planning for inevitable change reduces the difficulties of the renovation process normally associated with academic space changes — high costs, construction mess and disorder, and disruption of schedules due to down time of space. In addition, there is evidence that the built-in concept of flexibility can promote an attitude toward academic program experimentation by removing the fears and constraints of conventional alteration work.

Although the project is still in progress, the application of the ABS principles to the design and construction of the project has allowed an earlier construction start than would normally be anticipated if it were necessary to complete full construction documents prior to bidding. Acceptance to the constraints imposed by a logical sequence of design has permitted telescoping of the design process while allowing the incompressible construction schedule to begin earlier.

Final evaluation of the success of the approach to the project should be made only after the College has occupied and tested the flexible potential of the concept.



This project has been made possible in part
from a grant received from
Educational Facilities Laboratories, Incorporated

Design
Florence Graham/Graphic Design

Photographs
Mauro Mujica

Rendering
Albert Lorenz