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Divisible Auditoriums.

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Building designs which have been significant in the development of the divisible auditorium and theater and the fundamental concepts of the multi-purpose facility were reviewed. While not a comprehensive collection of divisible facilities, the installations reported on are those that appear to be landmarks in the evolution of the multi-use concept, and not necessarily those that represent the highest development of a particular approach to divisibility. The installations reviewed range from teaching auditoriums in high schools to multi-arts theaters at a university. In addition, a section is included on the acoustics of the operable or movable partition which is often utilized in divisible facilities. This document previously announced as ED 015629. (BH)

DIVISIBLE AUDITORIUMS

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FOREWORD

The school auditorium, long regarded as a luxury item in many a school construction budget, gained a new image of practicality and fiscal respectability in September, 1961, with the opening of a new auditorium at the Boulder City High School in Nevada.

At the same time, new avenues were opened for the design of theaters and auditoriums of all types—school, college, community, and commercial.

The Boulder City hall, designed with research assistance from Educational Facilities Laboratories, demonstrated that auditoriums and theaters could be divided successfully by operable, sound-retarding partitions to create spaces usable for purposes other than drama or assembly.

In Boulder City's case, this meant that the school could afford an auditorium, since the same space could be divided into three instructional areas. In the process, the need for five conventional classrooms to meet projected enrollment increases was eliminated.

Even before the Boulder City project was completed, other communities across the nation began to look to divisibility as a solution to the problem of obtaining assembly and theatrical space economically. Five years later, it is estimated that as many as 100 divisible theaters and auditoriums either are in being or are on the drawing boards.

Many are direct adaptations of the Boulder City concept. Some, reflecting new trends in instructional methods, are designed to accommodate heavy use of audio-visual devices. Still others, particularly in the colleges, are intended to house several of the performing arts in the same hall; in these, instructional use is secondary.

As educators and architects struggled with the technical problems of divisibility, significant gains were made in the mechanics and acoustics of operable partitions and in the design of the halls in which they are employed.

In short, the divisible theater/auditorium has come a long way since Boulder City (and an earlier EFL report on that project[1]), and this report is an attempt to keep school and college educators, planners, and architects abreast of developments.

This report is not intended to be comprehensive. The installations reported on are those that appear to be landmarks in the evolution of the divisible auditorium, not necessarily those that represent the highest development of a particular approach to divisibility. A number were designed with EFL assistance.

The final product, then, is a collection of ideas, all of them fresh and original in their day, that have been pivotal in the development of the divisible auditorium and the divisible theater. Hopefully, any or all of these ideas will prove helpful to communities and institutions as they plan better facilities for assembly, drama, concert, dance, and education.

EDUCATIONAL FACILITIES LABORATORIES

1 See *A Divisible Auditorium / Boulder City, Nevada;* No. 4 in EFL's Case Studies of Educational Facilities.

THE EVOLUTION OF DIVISIBILITY

As is true of virtually everything new, there really is nothing new about the divisible auditorium.

As early as 1849, a proposed school design called for the grouping of four classrooms around a central hall "in which the infant school is taught and where the school is assembled for religious and other general exercises."[2] The hall was not divisible, but the principle of multipurpose space for assembly and instructional purposes clearly had been established.

The records do not indicate just when the first architect or educator thought of dividing such a hall with operable partitions. But, by the turn of the century, New York City was including in virtually all its elementary schools an assembly room that could be divided, by means of wooden partitions that moved on metal tracks, into four classrooms of equal size.

The New York City attempt at divisibility proved hugely unsuccessful (although a number of the divisible assembly rooms still are in use). The halls were inadequate for both assembly and instruction.

The wooden partitions were acoustic sieves, permitting noises from one classroom space to intrude in the others. The assembly hall worked poorly: because of its flat floor, it was difficult for pupils in the rear to see what was occurring up front.

Educators, denied regular auditoriums by many tax-conscious communities, turned to other multipurpose solutions. There appeared across the nation such hybrids as the cafeteria-auditorium (the "cafetorium" of recent jargon), the auditorium-gymnasium, and, in extreme cases, the auditorium-cum-gymnasium-cum-cafeteria. Particularly in recent years, operable partitions were installed so that the size and shape of the rooms could be altered to suit the different functions.

The multipurpose room was more successful than were the New York assembly hall-classroom combinations, largely because sound transmission was not a problem. But, flat-floored, they still did not serve as good assembly or theatrical space. There were hazards: if missed by the mop, spilled lunchtime soup could mean a spilled pupil at gym time. And they were costly in janitorial time: chairs and equipment had to be shifted virtually from hour to hour as the room changed function. Despite these problems, the multipurpose room remained a popular solution, and many still are being built into new schools.

Beginning in the middle 1950's, however, there were a series of developments that prompted a new look at the old New York combination of assembly and instructional space. Educators began experimenting with and adopting new educational patterns, such as team teaching. In place of the traditional classroom arrangement, the new patterns called for the assignment of pupils to small, large, and, in some cases, very large groups for instructional purposes.

To accommodate these new arrangements, educators began to demand instructional space that could be expanded or contracted from period to period to fit different groups. And, unlike the New York educators of 1900, they found that industry had gained the know-how to produce operable partitions that would act as an effective sound barrier and thus permit divisibility in instructional space. In fact, where only 3 or 4 manufacturers of sound-retarding operable partitions were active in the school market in 1958, today there are 20 or more.

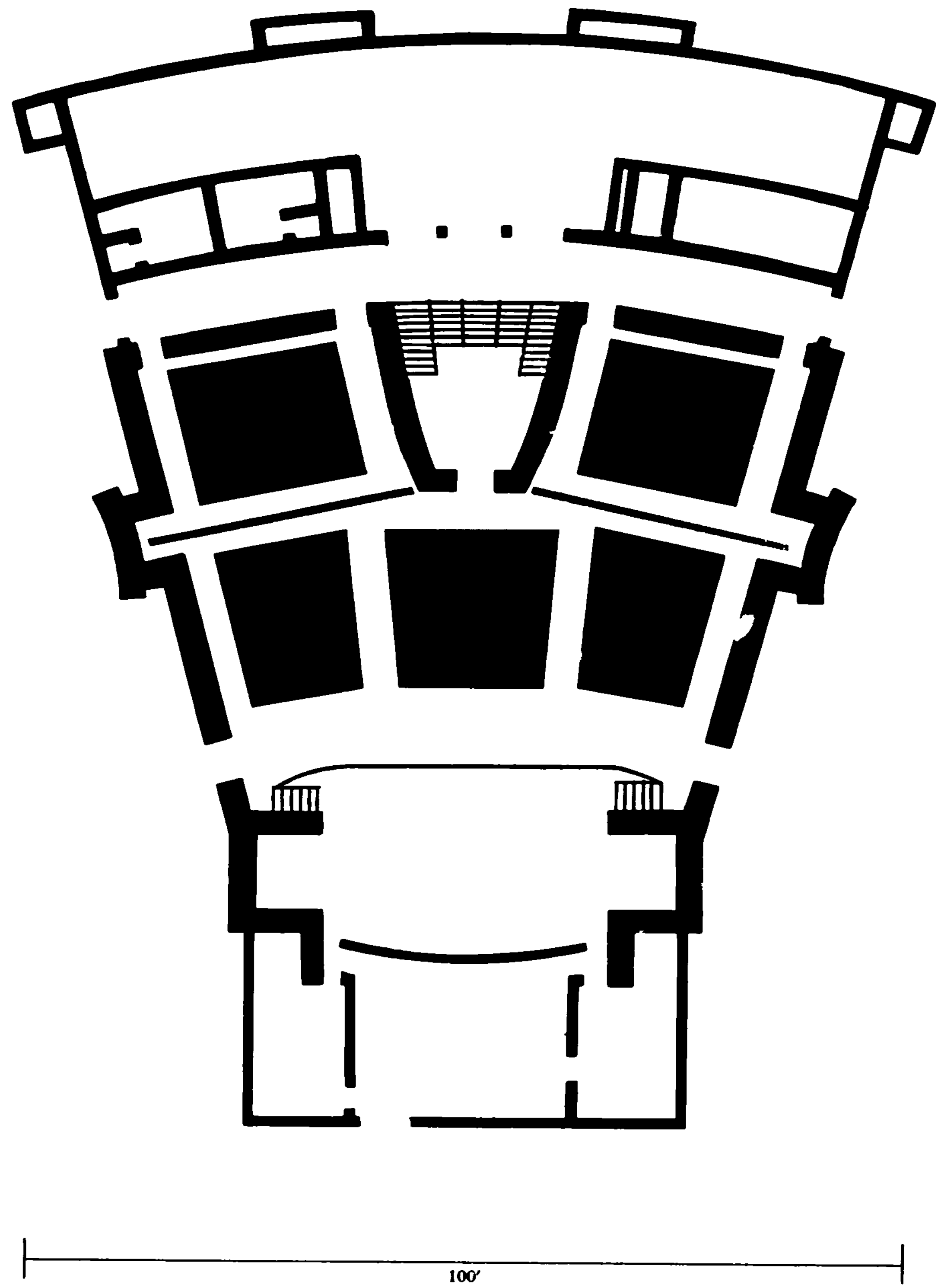
At the same time, it was realized that good spaces for large-group lectures should have sloped or stepped floors, in effect that auditorium-type space would make good space for lectures. It seemed only a logical next step to install operable partitions in the auditorium to carve it up into appropriately sized lecture spaces that would be in use 90 per cent of the time. In this way, the educators could have their assembly space and justify it on both educational and economic grounds.

Later and unrelated developments tended to make the concept of divisibility in assembly and theatrical space attractive to the colleges and universities. There were demands for greater emphasis on the fine arts in higher education to offset a preoccupation with science and mathematics as tools of the space age. The colleges and universities responded. Many of them began to build or contemplate building fine arts centers that would include theaters, concert halls, and ballet studios, as well as facilities for painters, sculptors, ceramicists, and the like.[3] No exact figures are available, but the proliferation of cultural facilities on the campus is indicated by statistics acquired from the magazine *College and University Business*. A *College and University Business* survey of campus theaters and auditoriums, which make up only part of a fine arts center, showed that 12 projects valued at $11.2 million were put out to bid in 1963.[4] The 1964 survey turned up 33 projects valued at $46.2 million.

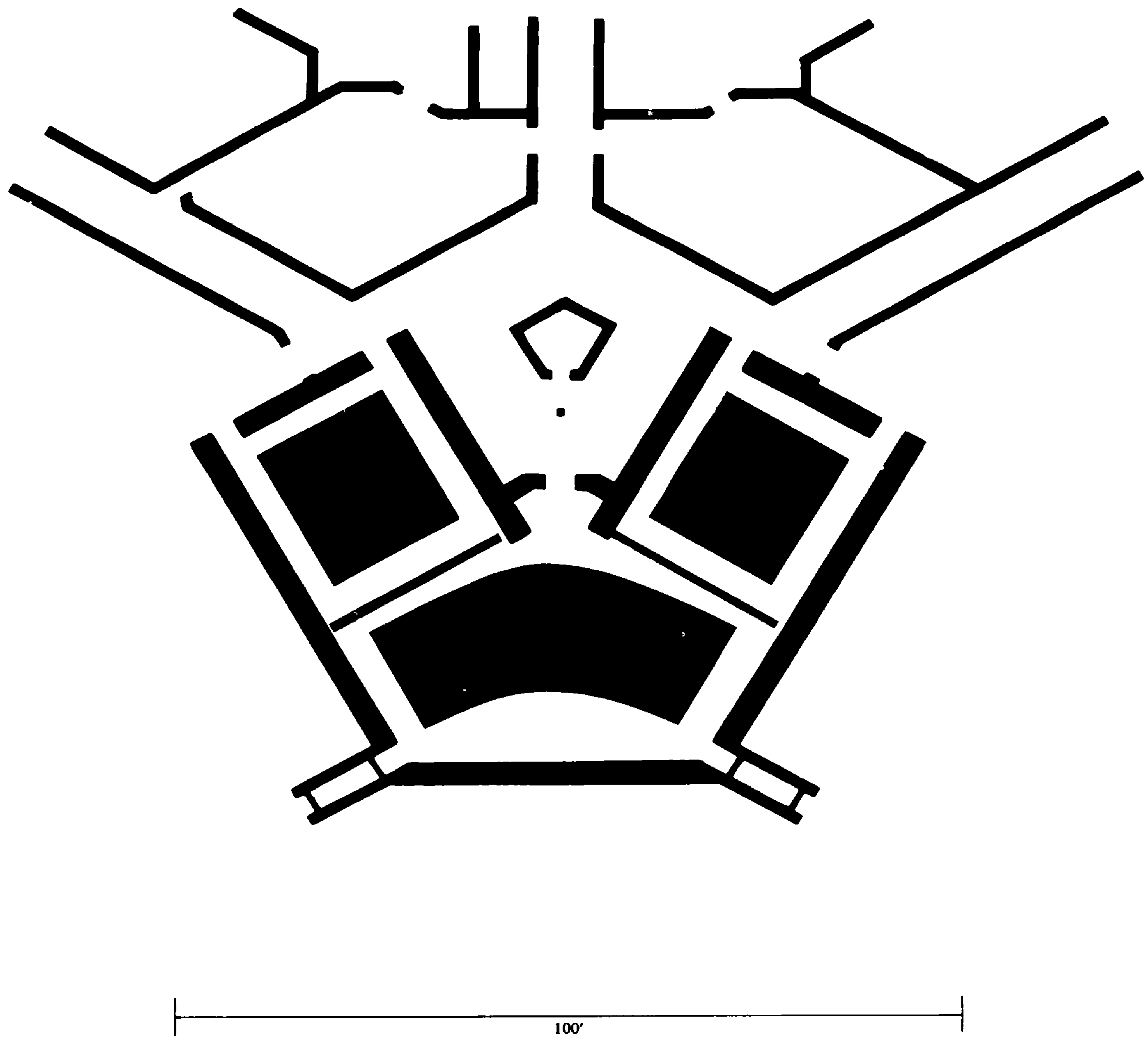
But the colleges and universities also were on the brink of an almost overwhelming demand for sheer expansion. Projections in 1960 indicated that enrollments would double by 1970, triple before 1980. Many institutions faced a financial

[2]Henry Barnard, *School Architecture* (New York, Barnes, 1849), p. 261. [3]For trends in the design of college and university fine arts centers, see EFL's *College Newsletter No. 6*. [4]*College and University Business*, May, 1964, pp. 66-70.

Boulder City High School Auditorium
Boulder City, Nevada
Clark County School District



Science Lecture Halls
Valley High School and Edward W. Clark High School
Clark County, Nevada
Clark County School District



struggle just to provide enough student seats and dormitory beds, much less build elaborate fine arts facilities. Others were short of space on campus and could find no room for a complex of separate buildings housing the various arts. Both to those short of funds and those short of land, the erection of multipurpose buildings housing such functions as theater, concert, and dance in one space held great attraction. And the development of sound-retarding operable walls made such a solution seem feasible.

Then, there are the larger institutions and those in urban or suburban areas that have become entrepreneurs of the arts in their communities.[5] These face the dichotomy between the need for small theaters (plus or minus 500 seats) for experimental productions and the demands of theatrical and operatic road companies and popular entertainers for houses accommodating audiences of 2,000 or more. Again, divisibility may offer a solution to their dilemma.

The Trial Balloon

As in many situations involving a heavy capital investment, the schools and colleges were reluctant to risk building something new—a divisible auditorium might or might not work. But, in 1960, a potential first customer was found in the Clark County School District in Nevada. Clark County's newly unified school system, based in Las Vegas, included Boulder City, a community developed by the Federal Government in the 1930's during the construction of Boulder (now Hoover) Dam and maintained since then as a bedroom community for the dam's operating employees. In 1960, the town was released from federal control. It became apparent that its growth rate would accelerate and that its schools would be required to admit a greater share of the county's booming population. Meanwhile, its 700-student, junior-senior high school was without an auditorium, and its educators were facing the need for improved instructional programs, including large-group instruction. It was decided that, to meet the triple problems of enrollment growth, the lack of assembly space, and the need for large-group teaching spaces, Boulder City High School would get a divisible auditorium.

The 500-seat facility closely resembled many earlier school auditoriums. But the wedge-shaped hall had one distinguishing characteristic: the rear half of the seating area was split into two alcoves by a two-story core containing a lobby and an audio-visual control center above it. The alcoves thus were surrounded on three sides by permanent walls. All that was needed to convert them into teaching spaces for 105 students each was to close off the fourth side with a partition. The partition had to act as an effective sound barrier, but it also had to be opened during assemblies and other occasions when the auditorium's full 500-seat capacity was required. The partition had to be moved easily, which meant that an operable wall had to be used.

The partitions chosen for the project, manufactured by the Silent Wall Division, Koppers Company, Inc., were relatively elaborate. They are made up of 3-inch thick, rigid panels, each a multilayered sandwich of steel and acoustic insulation materials and each 4 feet wide by 14 feet 4 inches tall. The panels are joined by continuous, piano-type hinges, and, driven by electric motors, can be stored in outside pockets at either side of the building in two minutes. Gasketing between the panels and an elaborate pneumatic sealing system, at the top and bottom of the partition and at the jambs, insure that sound will not leak.

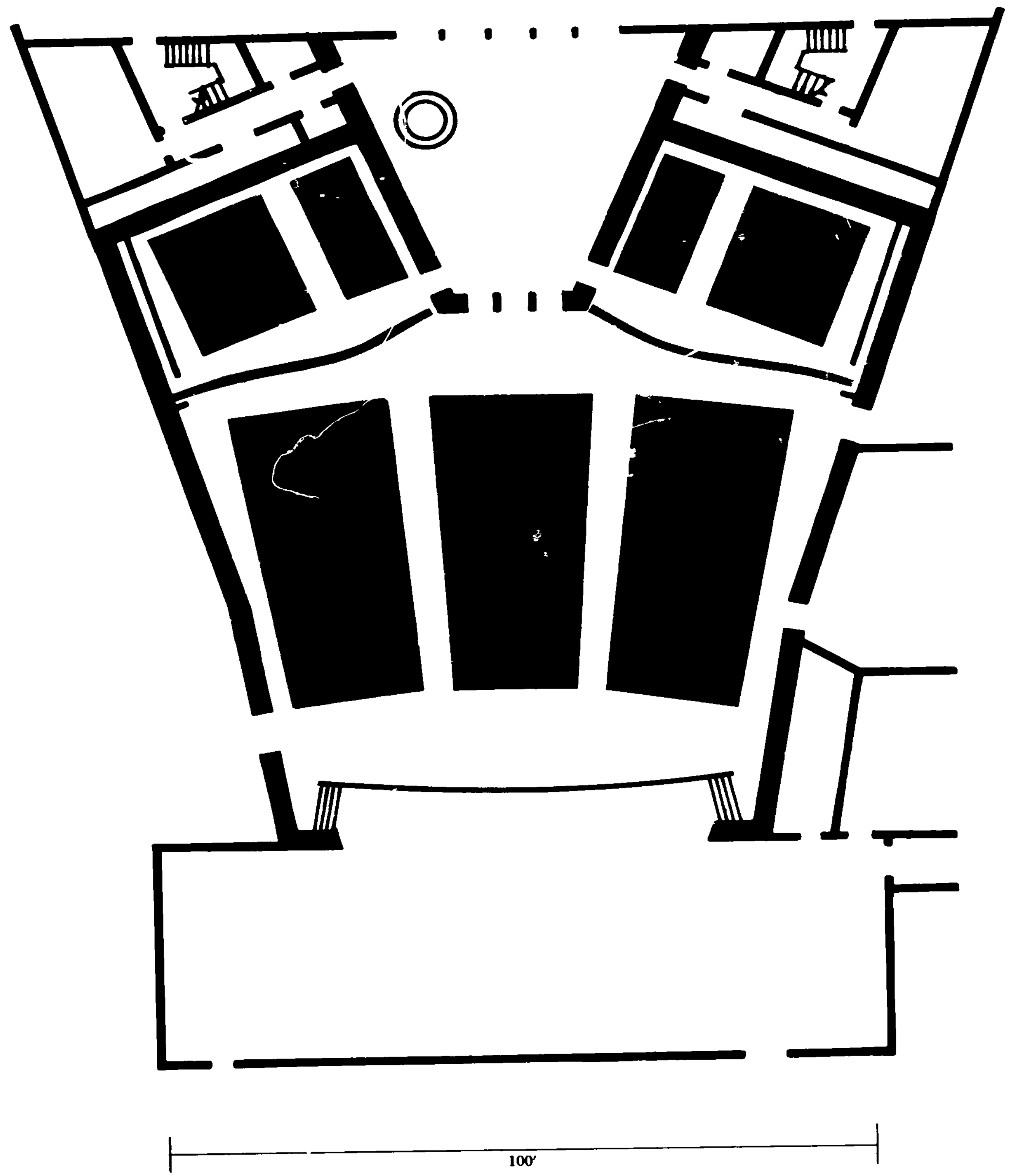
The acoustics of operable partitions will be discussed more fully later in the report. It is sufficient to note here that the architects specified a door for Boulder City that would provide roughly the same acoustic privacy as a 4-inch brick wall weighing 40 pounds per square foot. But Las Vegas schoolmen now feel that they got more sound isolation than they needed. In two new science lecture halls built into county high schools, the specified sound-reduction requirements for operable walls will be substantially lower than those for the Boulder City partitions.

The story is much the same when the economics of operable partitions and divisibility are considered. The Boulder City installation was not inexpensive: installed, the walls ultimately cost $30,477 or $31.26 per square foot. In contrast, the operable partitions to be installed in Clark County's two new auditoriums are expected to cost slightly more than $13 per square foot and, with one exception, the costs of partitions in other installations in this report range from a low of about $8.50 to a high of $20 per square foot. These lower costs can be attributed largely to improved design of operable partitions and to a greater volume of sales. There is reason to believe that neither development would have occurred had Boulder City never happened. And, despite the high cost of the partitions, Boulder City educators feel they got their money's worth.

Initially, it was projected that use of the divisible auditorium would head off future requirements for five conventional classrooms as enrollments grew. The savings, at roughly $25,000 per classroom, would far outweigh the $30,000 outlay for divisibility. Use of the auditorium to date does not entirely support that thesis, but the indications are that, eventually, the gamble will pay off. Currently, the large, 220-seat main seating area (70 portable chairs can be added to bring it up to a 290-seat capacity) is in full-time use, seven periods a day for large-group instruction in 11th grade social studies, 10th grade health, and driver education. The two alcoves are occupied an average of three hours a day, one for 7th and 8th grade science and the other for use by teachers in other subjects on a reservation basis. And school officials insist that, as enrollments grow and as the school moves more heavily into large-group teaching programs, the utilization rate will improve dras-

[5]The growing role of the college and university as impresario is documented in two recent books: Alvin Toffler, *The Culture Consumers* (New York, St. Martin's Press, 1964) and *The Performing Arts: Problems and Prospects*, Rockefeller Panel Report on the Future of Theater, Dance, Music in America (New York, McGraw-Hill Book Company, 1965).

Darien Senior High School Auditorium
Darien, Connecticut
Darien Public Schools



tically and eventually may approach 100 per cent for all three areas.

All this is true despite the fact that, beyond divisibility, efforts to design the auditorium for instructional use were limited by budget. The seating has tablet arms for student note-taking. Built-in audio-visual capacity is limited to front projection of film and slides from the audio-visual control center into the main seating area. Chalkboard on the alcove side of the operable partitions, storage and floor space for roll-in teaching stations, and remote control of lighting represent the only built-in instructional tools in the two rear areas.

Similarly, the Boulder City auditorium cannot be said to do much to advance the art of theater. The stage is little more than the standard proscenium stage found in any high school auditorium, although its equipment and that of the control center is elaborate enough to permit vocational programs in lighting and stage management; and television programs can originate from the control center.

In sum, the Boulder City auditorium was a prototype. As such, it demonstrated that it is practical, from the standpoints of both economics and technology, to divide the traditional school auditorium into smaller spaces that can be utilized more fully. It remained for the designers of later auditoriums and theaters to apply more fully the potential of divisibility to the needs of instruction on the one hand and the performing arts on the other. The success of this effort is reflected in the theater and auditorium designs described in the balance of this report.

Sold: A Teaching Auditorium

Darien, Connecticut, is an extremely well-to-do Fairfield County community, inhabited primarily by the families of executives who commute daily to New York. Despite their affluence, Darien's citizens are inclined on occasion to cast a critical eye at school expenditures and vote down items that appear extravagant. The critical mood apparently prevailed in 1957, when Darien's voters defeated a $3.9 million bond issue for the construction of a new high school. The result, after a special advisory committee had worked over the plans, was a new bond proposal, approved by the voters, that eliminated a proposed 800-seat auditorium and the school's football field and track.

Two years later, perhaps in part because of a post-Sputnik concern about educational quality, there was a change of heart. Considerable agitation arose for construction of both the auditorium and the athletic fields. Meanwhile, Darien had appointed a new school superintendent, Dr. Gregory C. Coffin, a proponent of the team-teaching approach to instruction. Dr. Coffin, who calls himself an "enthusiast of multipurpose space," urged that the auditorium be divisible and that it be equipped with up-to-date audio-visual capacity for large-group instruction. A new, $760,000 bond proposal was drawn up and the proposed facility presented to the voters as a "teaching auditorium." The referendum won handily, and, in January of 1964, Darien opened its new auditorium.

In many respects, the Darien installation is identical in concept to the Boulder City auditorium. It is larger, with a total capacity of 1,200, seating 800 in the main area at front and 200 each in two alcoves patterned after those in Boulder City. The operable partitions closing off the alcoves differ in both appearance and cost. Made of wood slats bound to a ½-inch thick glass fiber blanket and then to a thin vinyl membrane, the partitions are coiled or reeled into garages at the outside wall of the auditorium. Each alcove is closed off by twin partitions running on parallel overhead tracks. A 2-inch air space between the partitions provides additional sound insulation. The acoustic privacy is approximately half that of Boulder City's partitions but Darien's costs—at $9.10 per square foot—were substantially lower.

Like Boulder City, Darien expects that its teaching auditorium will obviate the need for new instructional space. The high school originally was designed for 1,000 students with the expectation that eight classrooms would be added later to bring total capacity to 1,200. Now, Dr. Coffin predicts that full use of the auditorium will increase the school's capacity by 200 and avoid the need for the eight rooms.

At present, the auditorium is far from that level of utilization: each of the rear alcoves is used one period a day for large-group instruction in English and social studies. But usage is expected to pick up as changes continue in the educational program. Significantly, however, Dr. Coffin feels that full utilization of the auditorium will not be possible until computers are employed to build the school schedule. Manual scheduling, he pointed out, is too slow and cumbersome to handle the complex arrangements of hours, instructional space, teachers, and students called for by the new educational programs, in which pupils move from large groups to small groups to independent study. And without large-group instruction, he added, the auditorium never will be used as much as it could be.

"The only way we can fully utilize this space," he concluded, "is to have enough flexibility in scheduling. And that flexibility can be achieved only by computer scheduling."

A start will be made toward computer scheduling in Darien this year. Utilizing an adaptation of GASP (for Generalized Academic Simulation Program) developed at the Massachusetts Institute of Technology under grants from EFL, a master schedule for the high school will be built by computer.[6]

But the significant advance in the Darien design is in the capacity of the auditorium to accommodate instruction. The rear alcoves have stepped floors, providing superior sight lines for lecture purposes to the sloped floors at Boulder City. The wooden seats are complete with fold-down tablet arms for note-taking purposes.

In addition, the alcoves are well equipped for front-screen projection of film and slides and for overhead projection. Each alcove has two electrically operated screens, one for conventional projection, the other for overhead projection. The

[6]See EFL's report, *School Scheduling by Computer: The Story of GASP.*

smaller overhead screen is mounted on a flat plate that folds against the ceiling. At the flip of a switch, the flat plate swings down to a vertical position, bringing the screen to the proper height for overhead projection, and the screen unrolls. If overhead projection is to be used, a lightweight, T-shaped stand made of aluminum is attached to the bottom of the screen and positioned to tilt the screen. The tilted position eliminates the keystoning distortion common in overhead visuals.

The auditorium is wired for even more elaborate audio-visual capability, including simultaneous rear projection of multiple images in slide, film, or filmstrip form. But the necessary projection and control systems have not yet been installed.

Automating the Instructional Auditorium

The Darien auditorium has a first cousin at Ridgewood High School, Norridge, Illinois. The Ridgewood hall is smaller, seating 430 in the main area and 200 each in two rear alcoves, for a total capacity of 830. The alcoves are closed off by coil-type partitions, as at Darien, but the Ridgewood installation involves a triple rather than a double partition. And there is full capacity in all three areas for film, filmstrip, slide, and overhead projection, and use of tape-recorded materials.

Ridgewood, however, has taken a further step still to be attempted in Darien, in that it has placed the control of audio-visual devices in the hands of the instructor. Each of the three seating areas or teaching stations is equipped with an elaborate teacher console, containing motion-picture, filmstrip, slide, and overhead projectors, and a tape recorder. Controls built into the console also permit the instructor to regulate lighting and sound levels in his part of the auditorium. All of the projectors are rigged to throw images on a single screen, which can be tilted by the use of guy wires for use with the overhead projector. All of this means that the teacher does not have to tell a technician when to turn equipment on or off or when to change images. Ridgewood's auditorium offers still further evidence of the economic viability of the divisible auditorium. In the fall of 1960, the high school and the shell of the auditorium had been completed. At that juncture, it became apparent to the school board that, by September of 1962, enrollment increases would pose the need for additional building space to accommodate 300 students. The board faced two alternatives. The first was to complete the auditorium shell as a conventional facility and construct an addition to the school, at a total cost, including the shell, of $600,000. The second was to complete the shell as a divisible auditorium, which would accommodate the 300 additional students without an addition, at an estimated cost of $400,000. (The final cost was $406,060.) The board chose the latter solution and estimated its savings at $200,000.

Ridgewood, incidentally, claims the highest utilization rate of any divisible auditorium now in business. The school reports that there is activity in one or more of the auditorium's teaching areas for 100 per cent of the school week and that utilization of each of the three areas averages 80 per cent.

Divisibility and the Balcony

Perhaps it can be attributed to the romantic heritage of the South, but it took Mississippi to extend divisibility to the balcony. A 1,500-seat auditorium in Tupelo, Mississippi, boasts four teaching alcoves, two on the orchestra floor and two on the balcony, each of which can be isolated from the main hall by an operable partition. The alcoves seat 200 each, the main hall, 700.

The $620,000 auditorium is an addition to Tupelo High School, which currently enrolls 825 students and has a projected capacity of 1,100. But the auditorium, planned in cooperation with city officials, also will serve as Tupelo's first community facility for large civic and cultural events. Therefore it has a capacity of 1,500, or 36 per cent larger than the total student body.

The large capacity serves to explain another departure in the Tupelo plan: unlike Boulder City, Darien, and Ridgewood, the operable walls will be manually operated. The architects reasoned that occasions when the full 1,500-seat capacity of the hall is needed would be infrequent and, therefore, that the walls seldom would have to be opened. They concluded that manually operated walls, even though more difficult to move, could be used in place of the more expensive mechanically operated types.

Built-in audio-visual capacity in the auditorium is limited to conventional, ceiling-mounted screens for front projection in each of the four teaching alcoves and in the main hall. Seating in the four alcoves is equipped with tablet arms. There is no provision for remote control of audio-visuals. A note of interest, however, is that live telecasts for the school system's educational television program will emanate from the auditorium's teaching spaces.

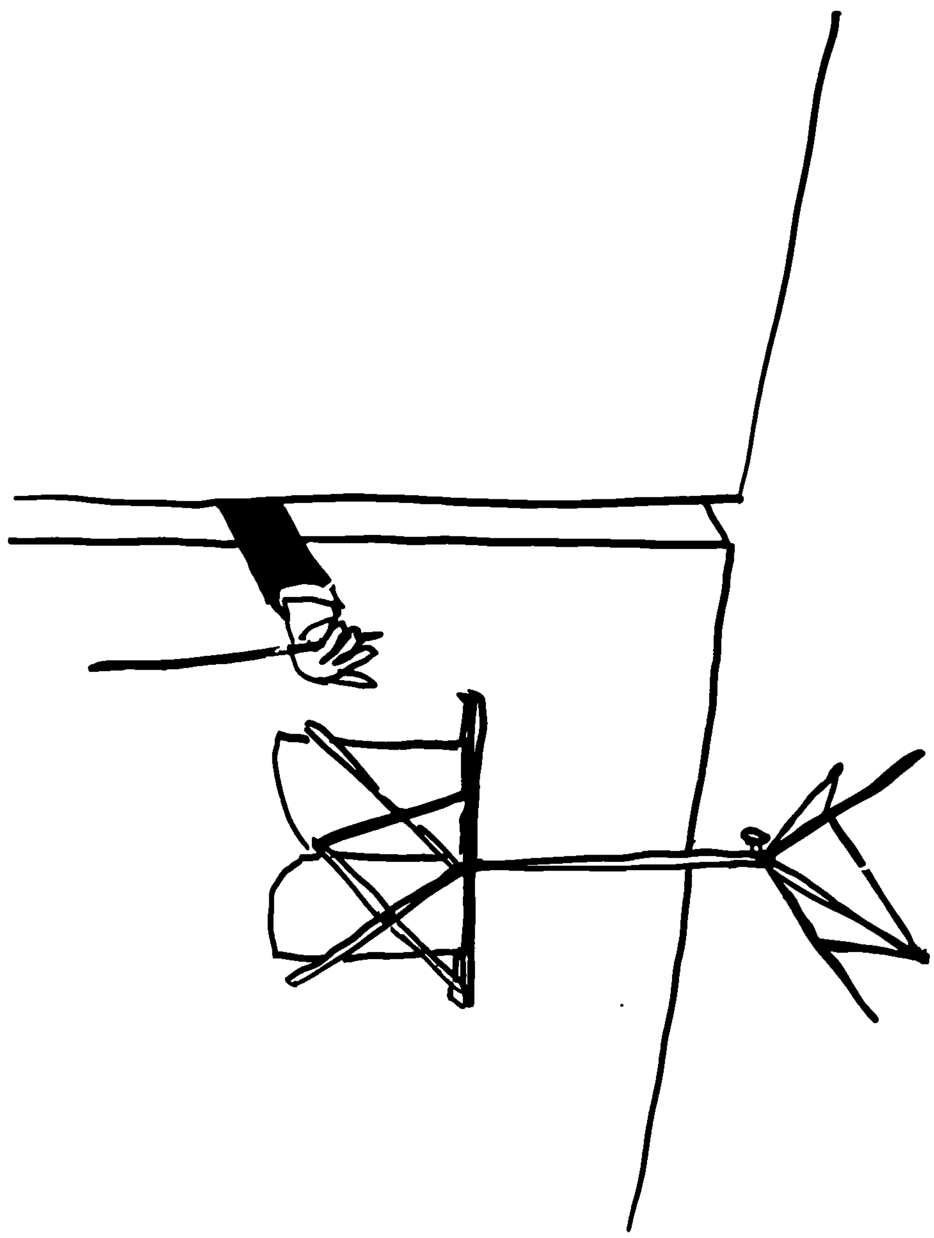
Tupelo's school administrators are unable at this stage to estimate the extent to which their new auditorium will be used in the instructional program. But administration and faculty alike are striving toward maximum utilization and look upon the auditorium as a vehicle for change.

C. E. Holladay, Tupelo's superintendent of schools, noted that few communities now have the types of spaces available in his new auditorium and added:

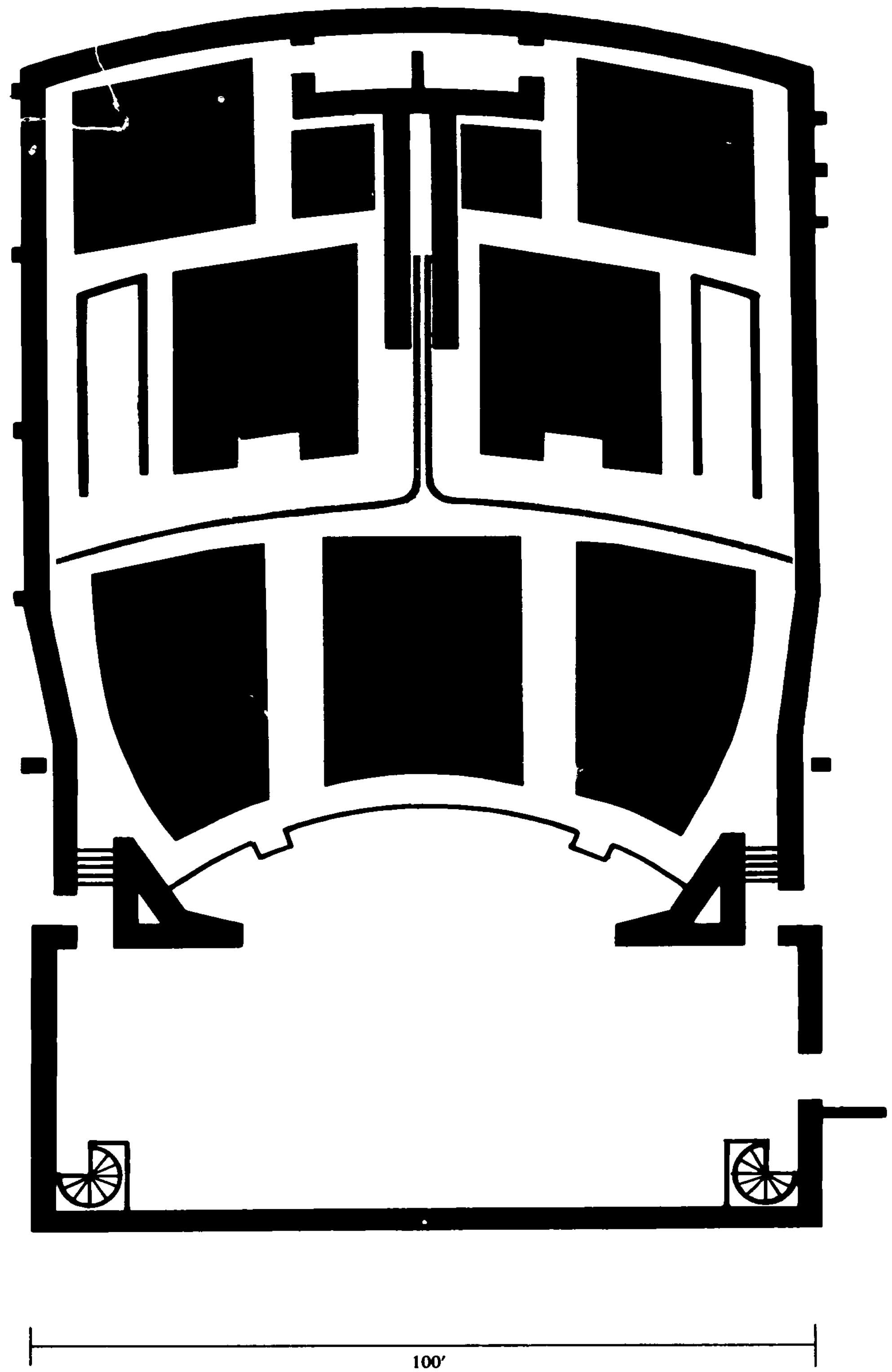
"Most school systems will not have such an opportunity to develop team-teaching programs."

To capitalize on their opportunity, Tupelo's educators last summer brought in a faculty team from Ridgewood for a workshop on large-group teaching techniques. This fall, team teaching programs were started in English and social studies, and planning is under way for extension of team teaching to other subject areas.

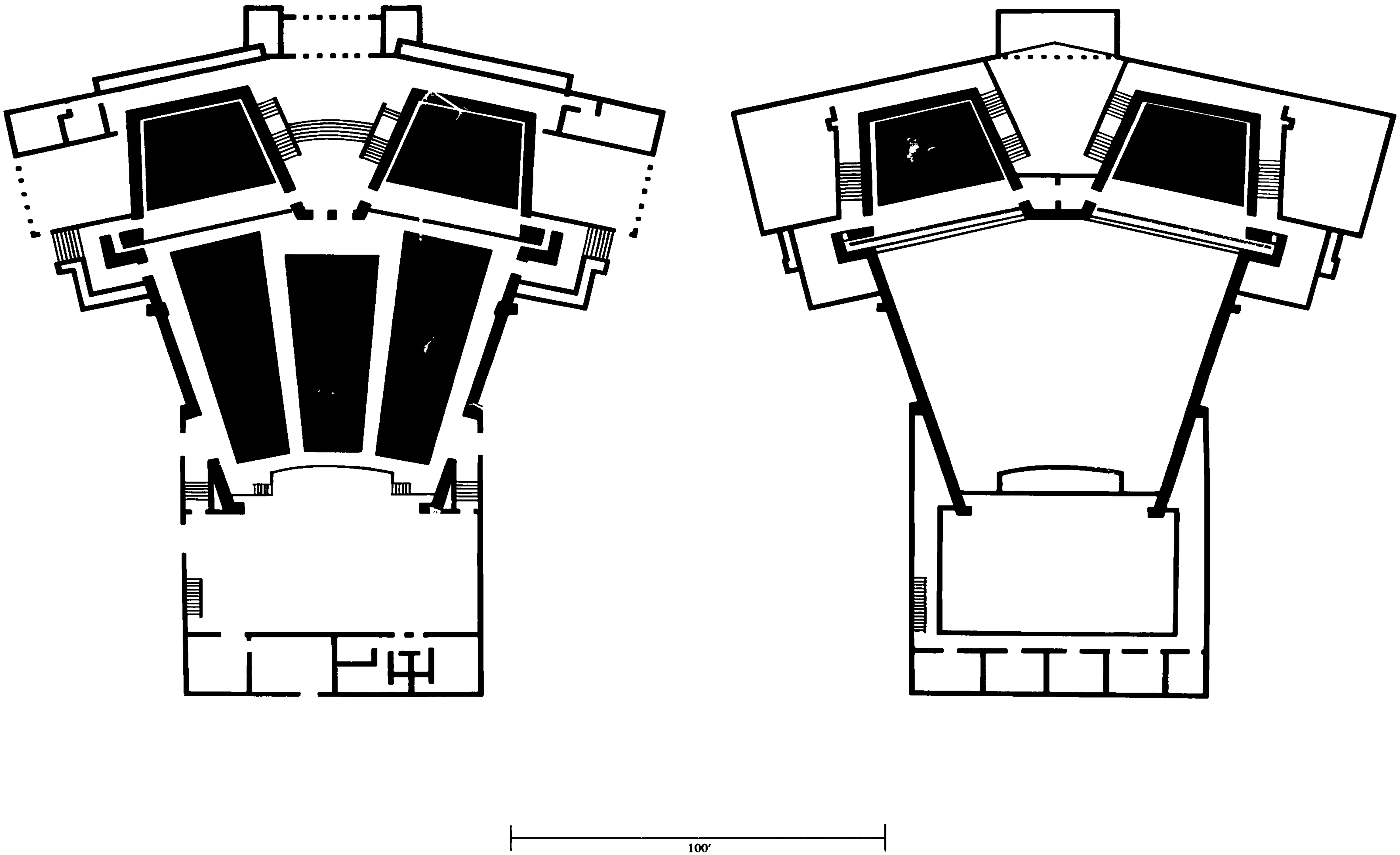
"We wish to do the very best possible job," commented Superintendent Holladay. "To our knowledge, this is a pilot program for Mississippi. We expect that



Ridgewood High School Auditorium
Norridge, Illinois
Ridgewood High School District Number 234



Tupelo High School Auditorium
Tupelo, Mississippi
Tupelo Public Schools



other school systems will be observing our progress."

A New Direction in Divisibility

Lest the reader conclude that divisibility in an auditorium necessarily is a matter of isolating front from rear, his attention is called to Plainview, Long Island. Plainview, a sprawling suburb in eastern Nassau County, has two auditoriums, one in being and one under construction, in which the partitions run fore and aft rather than port to starboard.

The first is in Howard B. Mattlin Junior High School, which opened in December, 1963, and, in 1964, was cited as one of 12 schools in the country that have most "effectively implemented educational change."[7] The second is John F. Kennedy High School, scheduled to open in September of 1966 with a capacity of 1,500 and provision for later expansion to a capacity of 2,000.

Both have 600-seat auditoriums planned as instructional facilities, with heavy emphasis on the use of audio-visual methods. There is limited provision for theatrical or musical events; the primary planning emphasis was on instructional uses. The audio-visual emphasis is reflected in the shape of the auditoriums and in the spaces created when they are divided by operable partitions. The three teaching areas—one for 300 students and two for 150 each—in each auditorium are wedge-shaped, providing ideal sight lines[8] for audio-visual presentations. Both halls are relatively shallow so that projected images can be read by students in the last row.

Rear projection, regarded as preferable for instructional purposes since lights can be left on for note-taking, is employed in both Plainview facilities. In Mattlin's case, the projectors are located in a projection-production area behind the rear stage wall and images are thrown onto lightweight portable screens set up on the stage. Kennedy's auditorium also will have a backstage projection room, but the screens will be built into the rear stage wall and will not have to be moved.

At Mattlin, the architects and partition designers attacked the difficult problem of dividing the stepped-floor auditorium fore and aft by cutting out the bottom of the partitions to fit the steps. Each of the two partitions is in two parts, one dividing the stage, the other the auditorium proper. Through a complicated overhead tracking system, both sections are moved into garages at the side of the hall to open up the auditorium. Movement of the partitions is accomplished partly by mechanical means and partly by hand.

A simpler solution, and one which may prove more effective, will be tried at Kennedy. There, the architects have built a low, "dwarf" wall that provides a level track for the partitions even though the auditorium floor is sloping. A swinging divider the same height as the wall extends from the first row of seats to the stage. As at Mattlin, the operable walls are in two parts, but Kennedy's will be garaged backstage and at the rear of the auditorium. They will be electrically operated.

Mattlin and Kennedy cap a 10-year, $35 million school construction program that started in 1954, when the Plainview-Old Bethpage School District had 100 pupils in a four-room elementary school. When Kennedy is completed next year, the district will have nine elementary schools, two junior high schools, and two high schools and an enrollment of about 12,000 students. But the system's growth has involved more than enrollments and new buildings. Educationally, it has made substantial progress in moving from a traditional instructional program to a forward-looking approach that will "focus attention in a creative, productive way upon individual student needs." The new program will involve heavy use of large-group teaching patterns with audio-visual backup. In these patterns the district's new instructional auditoriums will play a crucial role.

Divisibility in the Round

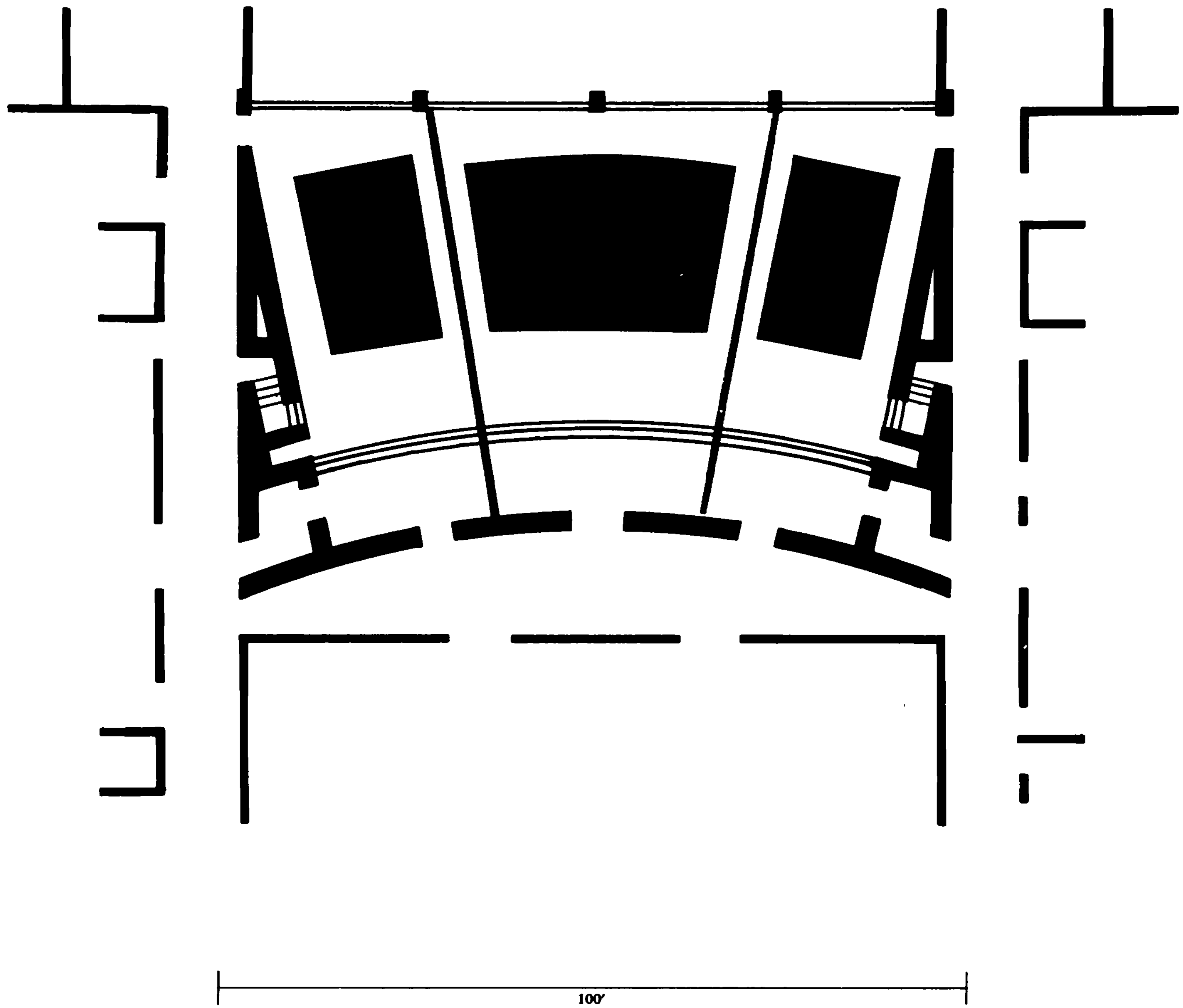
A few miles east of Plainview, across the Suffolk County border, Half Hollow Hills, Long Island, is in a stage of growth much like that in Plainview five or six years ago. Recognizing that continued population growth would force school expansion and that educational patterns were likely to change, Half Hollow Hills' school administrators were determined that their new Candlewood Junior High School would be built for expansibility and convertibility to future educational programs, among them, large-group instruction. At the same time, the district had an active program in the dramatic arts, both at the junior and senior high school levels and in its adult education program. What was needed was an auditorium that would provide good space for both instruction and theater.

Handed these requirements, the architects came up with a theater-cum-teaching-auditorium-in-the-round. The circular auditorium, 96 feet in diameter, forms the core of a two-story circular wing of the school. The wing also houses the library, classrooms, and office space. The auditorium is divided by four folding partitions, electrically operated, which meet at the center of the circular stage when closed. The partitions divide the seating area into four lecture halls, two seating 184 and two seating 169. (Movable seating can bring the capacity of each area to 191, for a total of 764 seats.) Like Plainview's Kennedy High School, the Candlewood auditorium has dwarf walls, to provide support and a level track, in the sloped seating area for the folding partitions. Again like Kennedy, the sections of the dwarf walls between the first row of seats and the stage are hinged and can be folded into a recess in the stage perimeter to permit circulation. Independent control of lighting, heating, ventilation, and audio systems is provided in each of the four lecture halls, giving the individual lecturer complete control over the instructional environment.

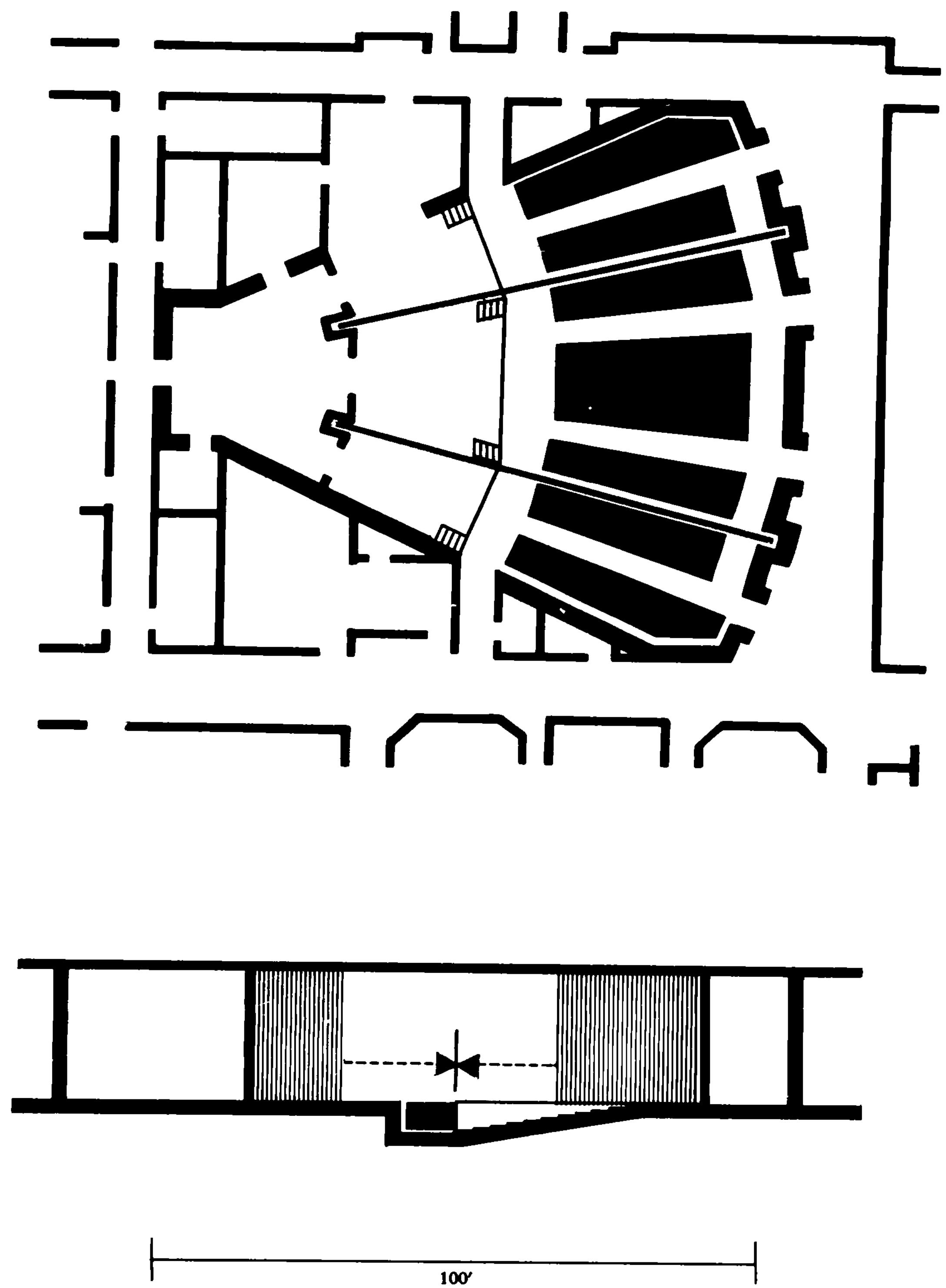
As at Mattlin, portable screens mounted on the stage provide capacity for rear-

[7] See *Middle Schools*, one of EFL's Profiles of Significant Schools. [8] For a discussion of the design of auditoriums for audio-visual instruction, see *New Building on Campus: Six Designs for a College Communications Center*, No. 7 in EFL's Case Studies of Educational Facilities.

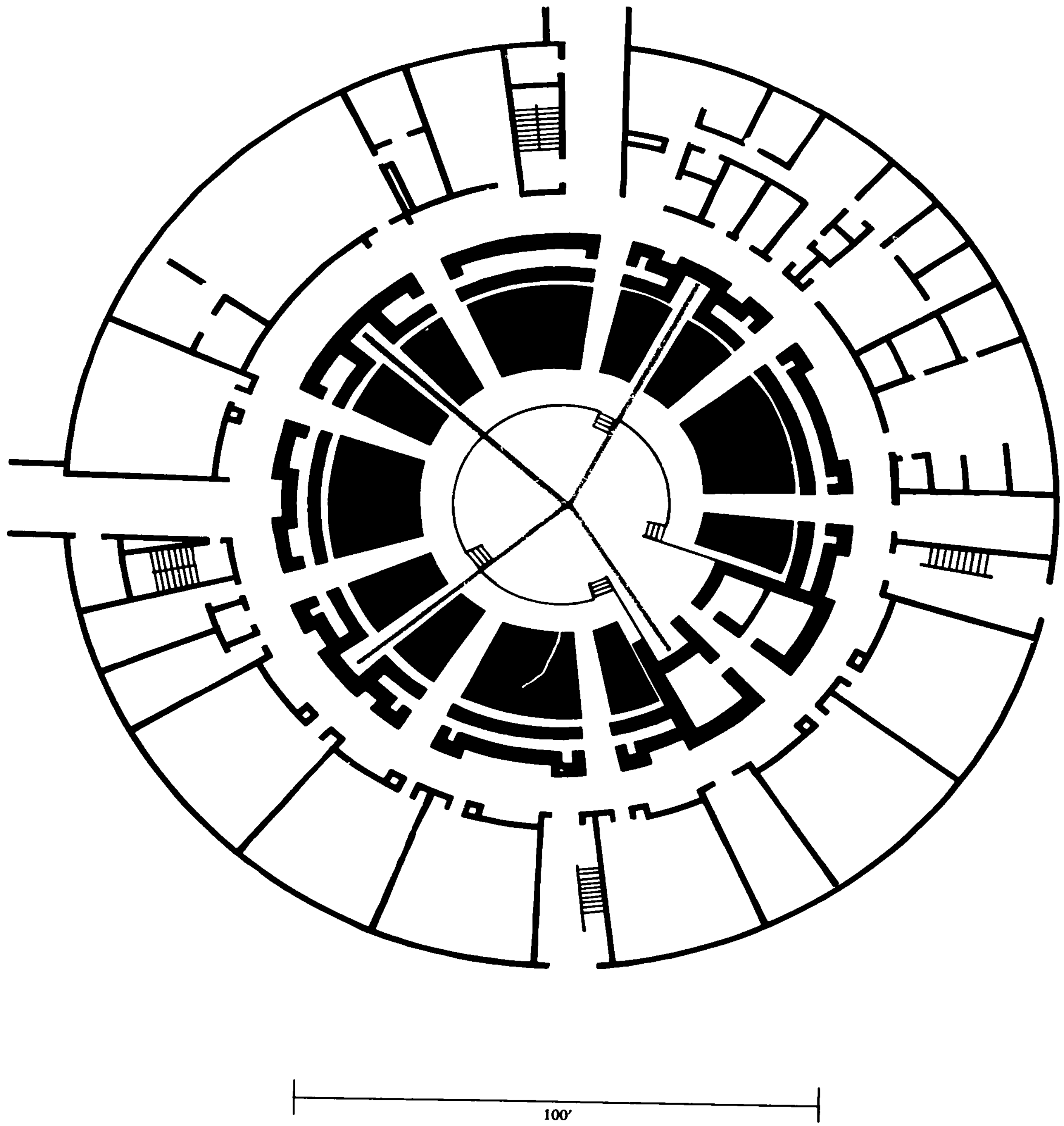
Howard B. Mattlin Junior High School Lecture Hall
Plainview, Long Island, New York
Plainview-Old Bethpage School District



John F. Kennedy High School Auditorium
Plainview, Long Island, New York
Plainview-Old Bethpage School District



Candlewood Junior High School Auditorium
Half Hollow Hills, Long Island, New York
Half Hollow Hills School District



screen projection. Visuals can be used to back up lectures without darkening the room. School officials expect the auditorium to be extensively used in the instructional program when it is in full operation. The school's educational program is designed to acquaint junior high school pupils with the kinds of instruction they will encounter in high school and college and will include large-group teaching. Eventually, large-group sessions in English, social studies, foreign languages, and science will be held in the auditorium, according to Dr. Zaven M. Mahdesian, Superintendent of Schools.

Although the auditorium is limited as a theater to productions in three-quarter-round or open-stage formats, and has limited technical facilities for theatrical lighting and staging, school officials predict it will be regularly used for the production of plays and musical comedies.

The crucial point is that the auditorium, with its divisibility-in-the-round, will be a full-time facility, operating day and night for both instructional and theatrical programs.

Arts and Instruction in One Campus Hall

A year or two ago, it was not uncommon for a 100-voice chorus to share the auditorium at Foothill College in Los Altos Hills, California, with a large-group lecture in history. In fact, for as many as six hours a day during the academic year, the front half of Foothill's auditorium was likely to be in use for dramatic or musical rehearsals and productions while instruction took place in the rear. Foothill's growing performing arts program now has forced lecture activities into a new "forum" building. But, that such joint occupancy could occur without conflict reflects the fact that divisibility has spread to college auditoriums. In Foothill's case, the attractive 980-seat auditorium is split into two seating areas. The first, with proscenium-type stage, has a capacity of 350. The second, used for lecture purposes, seats 630. The two areas are separated by twin, accordion-type partitions that move on parallel tracks across a curved, transverse aisle to cut the auditorium in two. A two-foot air space between the partitions helps reduce sound transmission from one area to another. The partitions are manually operated and require 10 to 15 minutes to open or close.

No one claims that the lecture area is totally isolated from sounds emanating from the stage. Piano chords can be heard through the partitions, as can the deep bass tones of voices carried on the theater's speaker system. But Foothill's administrators testify that the transmitted sounds are muted enough not to interfere with hearing in the lecture area.

Foothill, a public, two-year college, opened in September of 1961 and gained immediate recognition for its outstanding campus plan and for architecture that complemented the region's beautiful, hilly terrain. And while the architects might design Foothill's divisible auditorium differently today, it must be counted as a significant contribution to an excellent campus.

A Fine Arts Center Fosters Educational Innovation

The new Rockville Campus of Montgomery County College has as its focal point a handsome building called the "Fine Arts Center." But, from its design and from the testimony of the College's administrators, the Center obviously will be devoted far more to instruction in all subject areas than to performances in the arts.

Although the building contains rehearsal and gallery space for the arts, its key feature is a divisible theater-auditorium unique in the elaborateness of its provisions for instruction. The auditorium consists of a large, square main hall, seating 110 in permanent, stepped seating on three sides and 250 more in portable seating in a flat-floored central area. It is usable as a lecture hall or, with portable seating removed, as an arena theater or as an instructional laboratory in drama and dance.

On three sides of the main hall are large alcoves, each seating 132. The alcoves can be used as seating area for theatrical or musical productions in the main hall or can be closed off by folding partitions to become lecture halls.

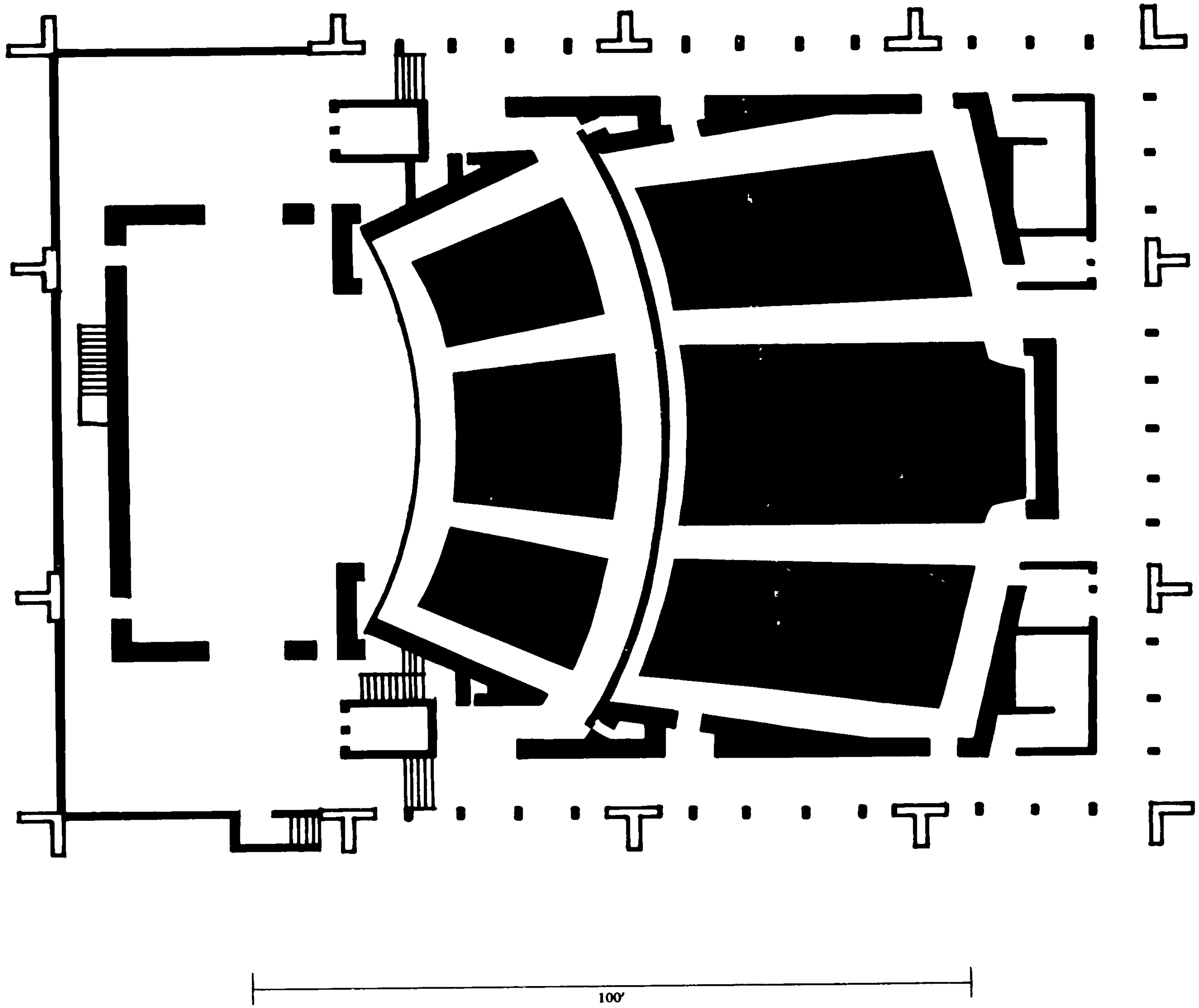
But most significant is the auditorium's audio-visual capacity, unequaled in other installations investigated in preparation for this report. Each of the lecture alcoves and the main hall are equipped with projection booths for conventional front projection of film or slides. In addition, however, rear-screen projection is possible in all three alcoves. The alcoves are equipped with canted rear screens mounted above the folding partitions. Single or multiple images can be projected onto the screens from projection rooms connected by an enclosed catwalk suspended from the ceiling on three sides of the main hall. Each of the areas has an independently controlled audio system.

Unlike some of their colleagues, the College's officials make no claim that their new auditorium will result in a reduction in other instructional space on the campus and thus in cash savings. What the Fine Arts Center does provide, they boast, is the assurance that the new college will have a wide enough variety of instructional spaces to accommodate any conceivable educational program of the future. And, perhaps most significant, the Center will be the first auditorium to be built by the public school system of Montgomery County, which serves primarily as a bedroom community for the nation's capital.

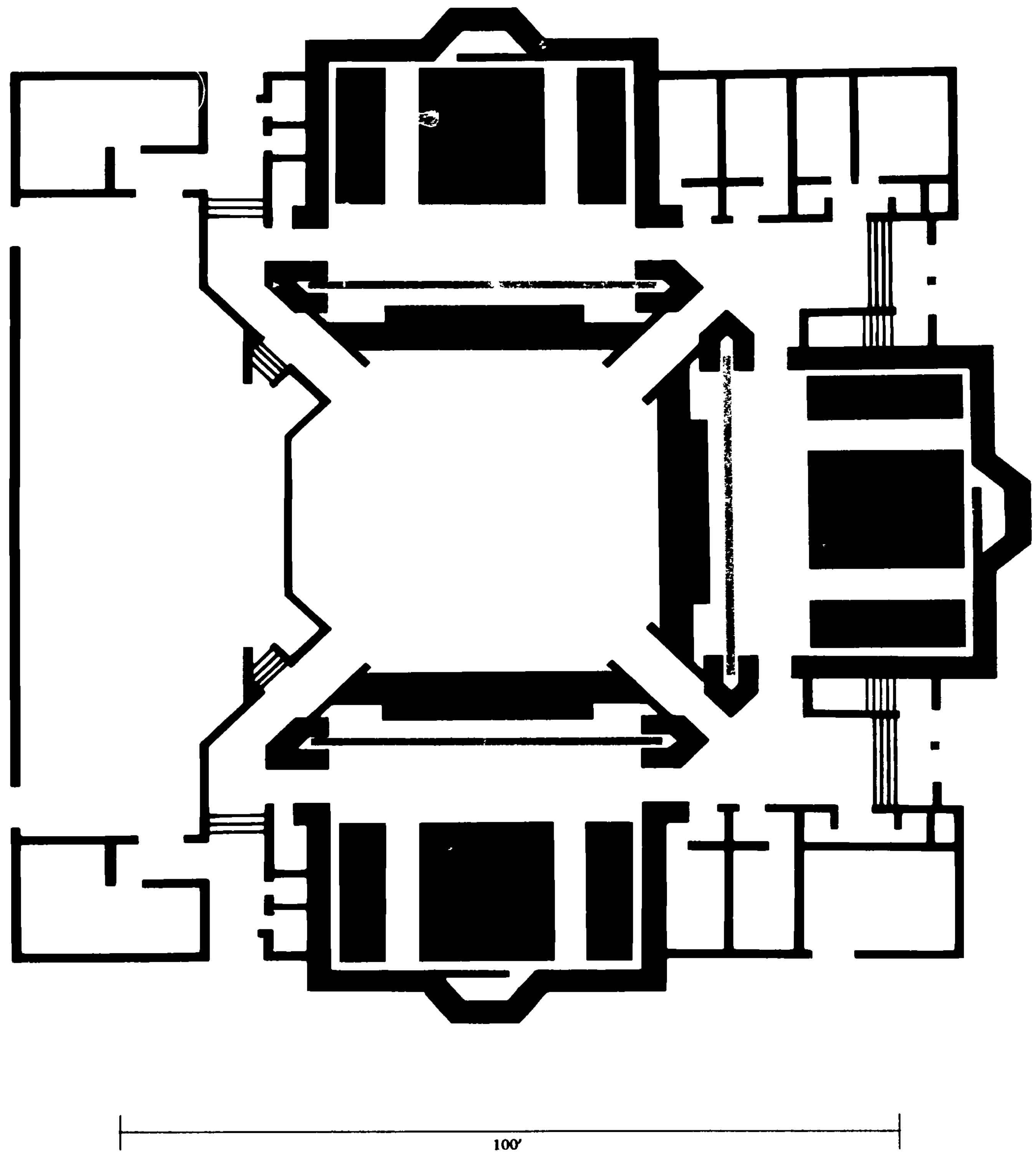
"Montgomery County does not build auditoriums in its schools and colleges," explained Dr. Donald Deyo, Dean of the College during the planning of the Rockville campus. The policy, he said, was prompted by the need to provide classroom space, rather than other facilities, in a period of explosive growth.

The departure from long-standing school board policy, Dean Deyo added, was prompted by fears that the instructional facilities in the new $12.6 million campus would be outmoded, in terms of new instructional methods and techniques, the day the campus opened. It was impossible to predict what balance would be

Foothill College Auditorium
Los Altos Hills, California
Foothill Junior College District



Fine Arts Center
Montgomery County Junior College
Rockville, Maryland



needed between large-, medium-, and small-group spaces to accommodate future programs. To meet these unknown future requirements, classroom buildings on campus were built as loft structures, with demountable, non-load-bearing, cinder-block partitions between instructional areas. Two large-group lecture halls were provided, a science hall for 150 students and a humanities hall for 220, both fully equipped for audio-visual presentations.

Most significant in terms of this report, the Fine Arts Center was designed as large-group instructional space—as well as space for drama and music—accommodating groups ranging from 110 to 750 students. Over-all, the campus can accommodate groups ranging from 10 to 750 and any size in between.

"Without the auditorium," said Dean Deyo, "we would have lost many of our variables in the size of instructional space."

College administrators predict that the Center will be fully utilized. The lecture areas are expected to be in use continuously from 8 a.m. to 5 p.m. during the regular college day and heavily used in the evening program.

Eighteen faculty members representing 10 departments are using the lecture rooms and the audio-visual systems in their lectures this year. They will be assisted in the planning and production of audio-visual presentations by an existing technical staff, which is scheduled to expand as qualified personnel can be found and as use of the audio-visual equipment increases.

As theatrical space, the Center involves a number of compromises. The only fixed theatrical facility is a conventional proscenium stage, which the planners felt at the outset would be the form most often employed for junior college dramatic productions.

The stage lacks a fly loft, so that a cyclorama or roll-in scaffolding will have to be employed to create scenery, although structural provision was made for possible addition of a loft. Because the cruciform shape of the auditorium affects sight lines in the side alcoves, these are not planned for use as audience seating during proscenium productions. Thrust and arena stage arrangements are possible, however, through the use of sectional, portable platforms which can be stored backstage when not in use.

The side alcoves can be used for audience seating in arena and thrust performance, and, in the arena form, portable seating can be placed on the stage to create a theater-in-the-round. Seating capacities are approximately 500 for proscenium, 575 for thrust, and 750 for arena.

The College's planners and administrators feel that the compromises were justified by the versatility of the building, the high utilization expected of it, and the stringencies of a limited budget. Primarily because its cruciform shape produced structural economies, the Center is expected to cost only $13.80 a square foot, slightly less than the average cost of the seven buildings involved in the $4.5 million first stage of the campus.

The School Auditorium as Educational Theater

The emphasis so far in this report has been on instruction as a joint occupant of the traditional school or college auditorium. But divisibility can be employed in a hall designed primarily around the performing arts to permit use of the same space by the different arts despite conflicting acoustical and visual requirements.

A case in point is the auditorium of Longmont Senior High School in Colorado. The auditorium is designed for divisibility, although the operable partitions have not yet been installed, and is patterned in some respects after the Boulder City prototype. But at Longmont, unlike Boulder City, the emphasis was on a design that would serve the performing arts in a school environment.

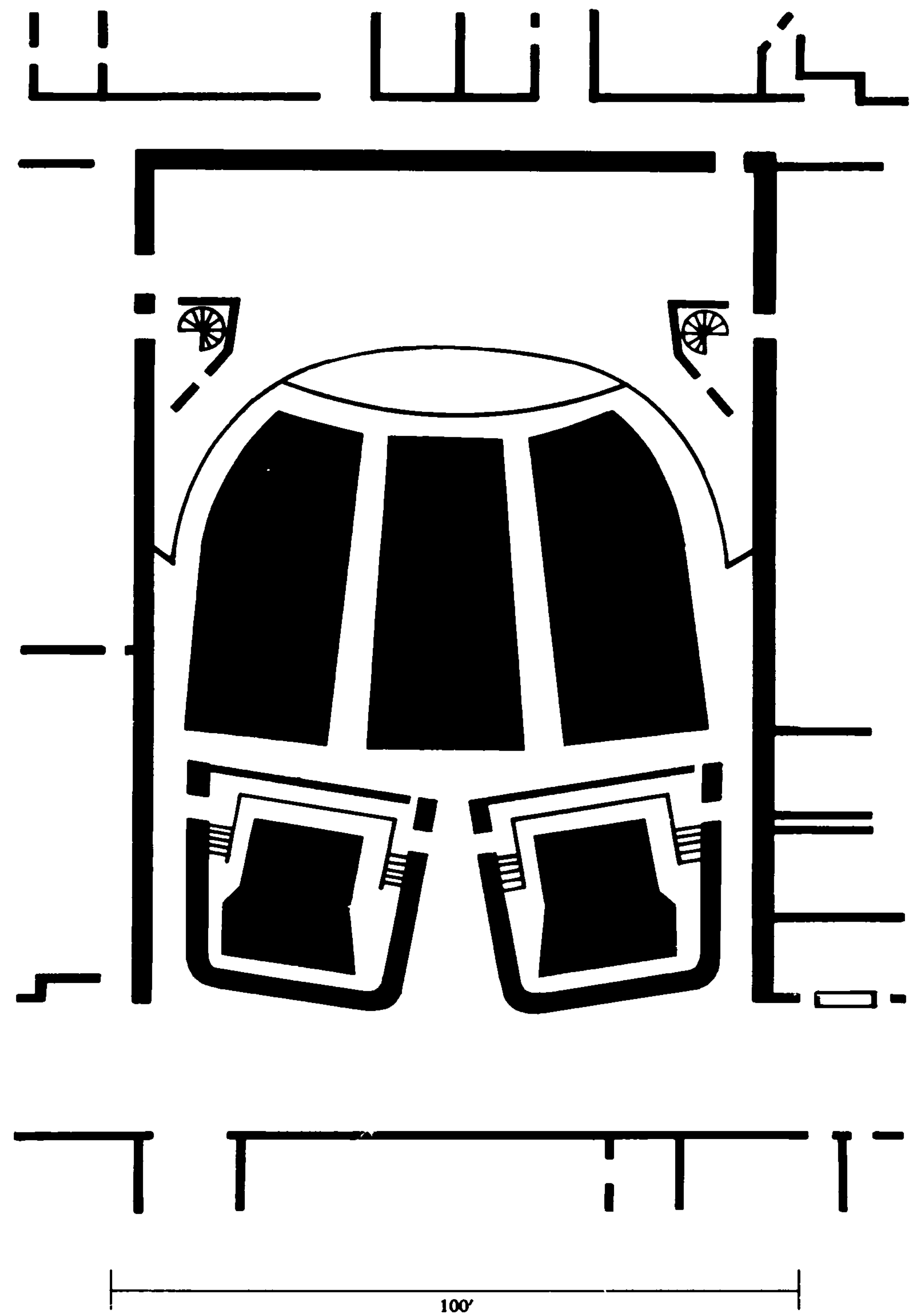
At the suggestion of theatrical consultant James Hull Miller, Longmont chose to reject the traditional proscenium-arch stage or any other formal stage form in favor of an open platform with long arms on either side of the auditorium that embrace almost half the seating area. Mr. Miller, whose views on theater design conflict with those of many of his colleagues, insisted that the open stage provided a flexibility that would serve the diverse needs of a modern secondary school. The open stage, he said, could be set up to approximate a proscenium for traditional theatrical productions, but its very openness would challenge teachers and pupils to experiment with other theatrical forms. The caliper-shaped arms embracing the seating area would, he added, establish "an excellent performer-audience relationship not offered by the traditional stage." In addition, he argued that musical programs would "really come into their own on this platform."

Again following the Miller viewpoint, the Longmont stage was built without a fly loft or many of the technical accouterments normally provided for scenery handling. Instead, backdrops are provided through a projection system in which images are thrown onto the back wall (or fixed cyclorama) of the stage and through the use of space-centered scenery—set pieces that stand free on the stage platform. If required, the set pieces are carried on and off stage, not lifted into (flown) or lowered from a loft as is regular theatrical scenery.

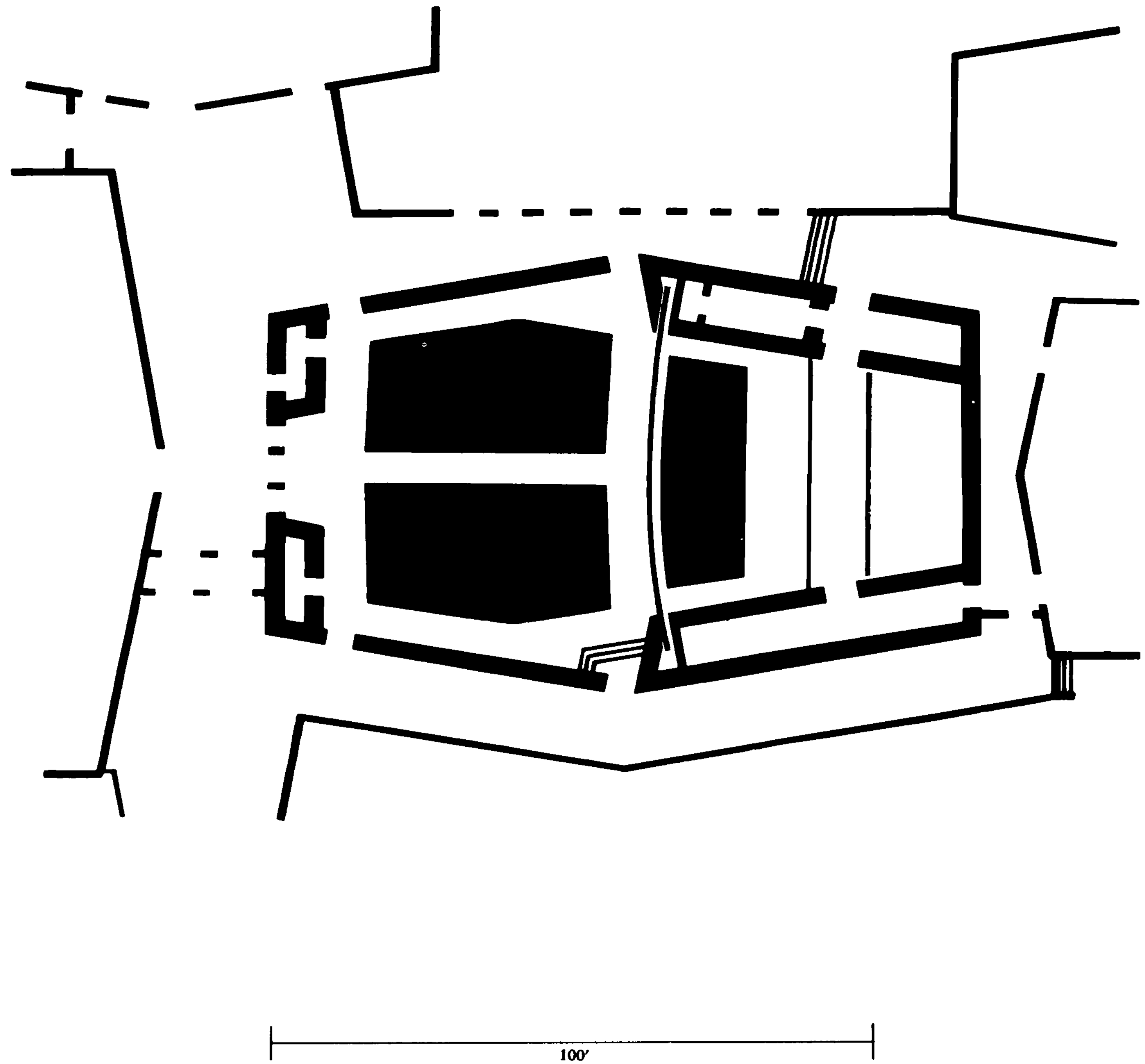
Elimination of the fly loft, with all its elaborate rigging, reduced the cost of the auditorium, although that economy was partially offset by the need for a more extensive catwalk system than that provided in traditional theaters. And it is expected that the lack of a loft will enhance musical performances, since sounds lost in the traditional stagehouse now will be projected into the audience by the auditorium's acoustically oriented ceiling system. The large size of the open stage also has been cited as an advantage to the music department, since it makes possible performances by sizable instrumental or choral groups.

Longmont educators give their 750-seat auditorium high marks in economy, acoustics, and versatility in housing the performing arts, although they would make some changes in details. Outside the performing arts and school assemblies,

Longmont Senior High School Auditorium
Longmont, Colorado
St. Vrain Valley School District Number RE-1J



Recital Hall
Fine Arts Center
University of Rhode Island
Kingston, Rhode Island



there is little evidence the auditorium is being employed in the educational process. The two rear alcoves, seating 88 each, are used for part of each day as study halls; but, lacking operable partitions closing them off from the main hall, the alcoves cannot be used effectively for instructional purposes. Operable walls will be added when the school enrollment nears capacity, and administrators are planning team teaching programs in English and social studies that will be conducted in the alcoves.

M. V. Chase, Longmont's school superintendent, feels the auditorium "is the finest facility in the country . . . [a facility] school districts everywhere have been seeking ever since the one-room school."

A Tunable Hall for a Fine Arts Complex

"Despite a high degree of sophistication in the science of acoustics, listening is still a subjective experience and if a design is satisfying, it is extremely good fortune."

Thus, architect Lester J. Millman summed up what probably is the designer's thorniest problem in creating a hall for the performing arts. The problem is compounded when the hall is divisible or when an attempt is made to achieve excellent acoustics for different types of performances. Mr. Millman, whose firm is designing a new fine arts complex for the University of Rhode Island, faced both these complexities in planning a divisible recital hall for the center. His solution was a "tunable" hall in which acoustical panels or "clouds," suspended from the ceiling, and movable draperies can be adjusted to alter the acoustics of the space. The arrangement, similar to that in the new Philharmonic Hall at New York's Lincoln Center, theoretically will make it possible to tune the hall for a piano recital, then re-tune it for a band concert. But, as the designers of Philharmonic Hall discovered, the results will remain theoretical until the building is completed (sometime in 1966) and put to the acid test under actual performance conditions.

The hall eventually will be divided front from rear by an accordion-type partition in much the same manner as the Foothill auditorium. Divided, the hall will contain two seating areas, one with 432 fixed seats at the rear and the other with 96 movable seats. (The accordion partition and fixed seating are not included in first-phase construction plans and are scheduled for later installation.) The movable seating can be removed during a concert to expand the regular, stepped orchestral area to accommodate as many as 100 musicians. A raised choral platform, equipped with permanent risers, is located behind the orchestral area. The choral platform can be closed off by an operable partition when not in use. The partition has a hard, reverberative surface to provide proper sound reflection for orchestral music or soloists.

The architects suggest that, through use of both operable partitions, as many as three activities may be conducted in the hall at one time. It seems probable, however, that multiple uses generally will be limited to lectures in the rear area while rehearsals are conducted in the orchestral and choral areas. University officials are planning tentatively to use the hall for examinations.

The recital hall is one of four buildings to be erected in the first phase of an 11-building project that eventually will house music, drama, art studios, and exhibit space. It will share lobby, ticket, dressing, storage, and other auxiliary facilities with other buildings in the complex. At this early date, Rhode Island's flexible recital hall represents a promising first step in the creation of a modern center for the fine arts, one that well may influence the design of other fine arts facilities.

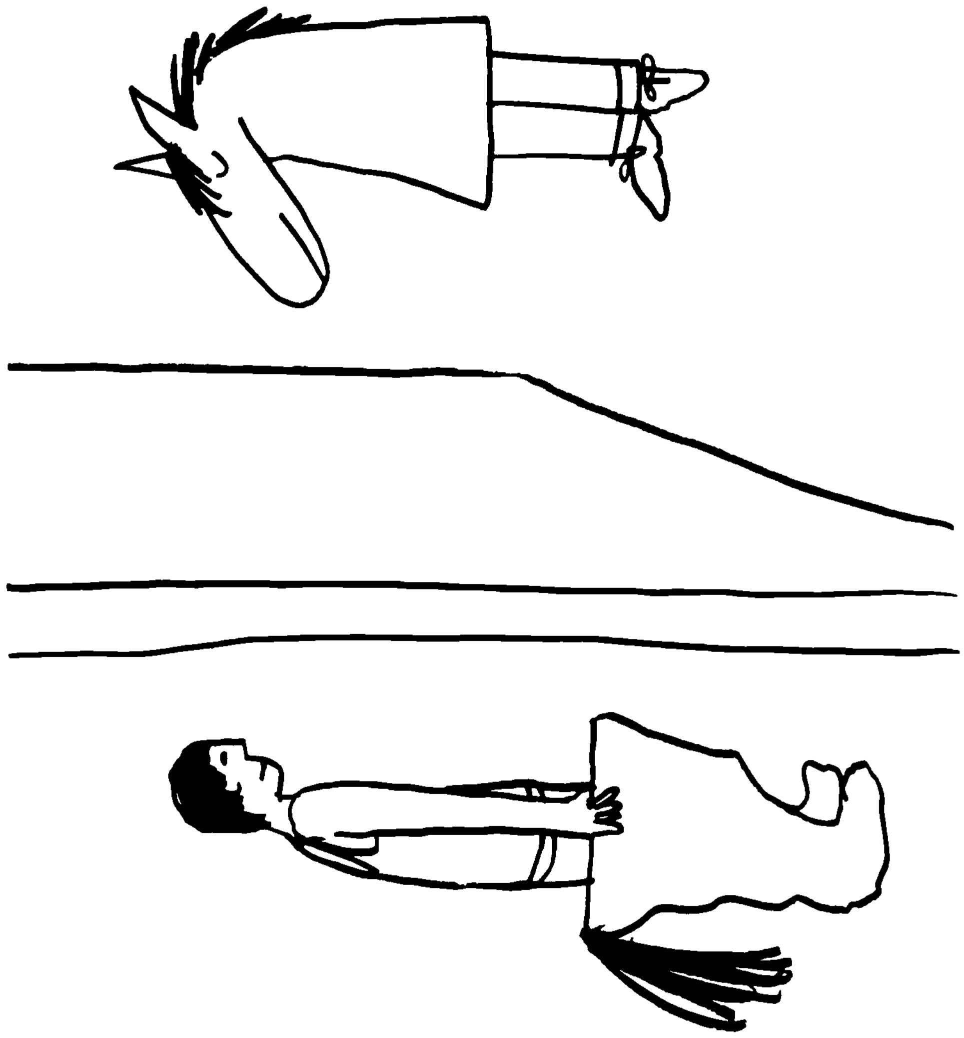
A Hall of 21 Functions

Not all institutions have the real estate to accommodate multistructure arts complexes on the Rhode Island pattern, but must seek other ways to provide facilities for the fine arts. Perhaps the most dramatic example is to be found at Webster College, a Catholic women's college operated by the order of the Sisters of Loretto in a well-to-do suburb of St. Louis.

Like many institutions of its size and type, Webster a few years ago faced the problem of rethinking its objectives and identity in an era when public institutions and major urban universities were gaining in enrollments and importance to the extent that the very existence of smaller private institutions was threatened. What, the Webster administration asked itself, could the small colleges, and particularly Webster, do to insure their continued role in higher education? Out of serious self-examination and a careful study of the roles of other institutions in the St. Louis area came the decision that Webster, rather than existing simply as another small liberal arts college for women, henceforth would specialize in teacher training and the fine arts. The arts program would be employed to tie the College closer to the community. At the same time, the College would expand its enrollment gradually, from 750 to 1,500 by 1970.

To meet these objectives, new facilities would be needed. Instructional space would have to be added. And the College's small auditorium, totally inadequate for either theater or music at an institution specializing in the arts, had to be replaced. But the new facilities would not be easy to come by. The College's potential for raising capital funds was not unlimited, and the prospects seemed dim for money to build a theater, a concert hall, and all the new instructional facilities that would be required. Furthermore, the potential for expanding the College's postage-stamp campus was limited: there would be no room for a theater and a concert hall as separate buildings. The College administration felt that it was inefficient to create single-use theaters and concert halls that would be used infrequently. The solution seemed obvious: Webster would combine theatrical, concert, recital, and instructional space in a single structure.

If the solution was obvious, it also seemed impossible to execute. Webster needed a small, intimate theater, seating no more than 500, for drama. It also needed a large theater, seating up to 1,200, for road company productions and



performances by popular artists. Concert and recital space was needed, but concert acoustics require a long, relatively narrow shape rather than the wide, shallow form desirable in a theater. And the problems were compounded by the College's desire to create theater space that could double in brass as instructional and assembly space. It seemed improbable that the conflicting requirements of these divergent uses could be met in a single facility.

But Webster had a determined administration—headed by Sister M. Francetta, President, and Sister M. Jacqueline, Vice-President—convinced that a flexible, multi-use theater-auditorium was not only feasible but would make history in theater architecture. Their enthusiasm was infectious. Hotel magnate Conrad Hilton, who was educated by the Sisters of Loretto and became their long-time benefactor, was impressed enough to guarantee $1.5 million in gifts to help finance what subsequently has been named the Loretto Hilton Center for the Performing Arts. And Educational Facilities Laboratories, convinced of the significance of the project, agreed to underwrite the unusual costs involved in developing the new design concepts.

The St. Louis architectural firm of Murphy and Mackey was retained to design the building, and the College set out to study the best examples and acquire the best advice in theater design. With the help of the EFL grant, a faculty-architect team visited the Shakespearean Festival Theater of Canada in Stratford, Ontario; the Arena Theater in Washington; the Tyrone Guthrie Theater in Minneapolis; Harvard's Loeb Theater; Philharmonic Hall at New York's Lincoln Center; and the theaters at Grinnell College in Iowa and Wellesley College in Massachusetts.

Robert Newman, of the acoustical consulting firm of Bolt, Beranek and Newman, and George C. Izenour, theater design and engineering consultant, were brought in to lend their expertise to the design effort. In addition, theater experts Tyrone Guthrie and Jo Mielziner were retained to review and discuss the design.

Early in the planning process, it was decided that the basic element of the Center would be a 500-seat little-theater with a thrust or Shakespearean stage as the basic theater form. At the same time, the stage and seating arrangements would be flexible enough to permit productions in modified proscenium form on one hand and arena or theater-in-the-round on the other. The hall would be expansible to accommodate 750 for such functions as musical comedy, 1,000 for concerts, or 1,200 for commencement. And it would be re-shapable to provide appropriate acoustics for music. This adaptability was to be provided through the creation of three alcoves surrounding the basic theater space, one seating 250 and the others, 125 each. The thrust stage was to consist of two lifts or elevators that could be lowered to form an orchestra pit for proscenium productions or to create a flat floor for as many as 200 additional seats. Seating could be placed on the stage to convert the hall into an arena for theater-in-the-round. The basic thrust stage was to be symmetrical in form, but, at the urging of Dr. Guthrie, provision was made to create a dissymmetrical or irregularly shaped stage by adding portable platforms. It was decided that there would be no fly loft and that elaborate machinery and equipment for staging would be held to a minimum. Scenery would be provided through the use of projected images on a cyclorama and the employment of wagons, rolling towers, or scaffolding to support free-standing sets.

The building was to include other facilities for instruction and the performing arts: a lobby that would double as exhibit space, and, in the basement, a 130-seat rehearsal hall usable for small, experimental dramatic productions, a dance studio for practice and small recitals, four general classrooms seating 25-30 each, and 12 offices and/or practice rooms. Auxiliary spaces to be provided were shafts for the lifts, storage space for costumes and props, dressing rooms, and a greenroom (a gathering place for the cast, and, after performances, their guests).

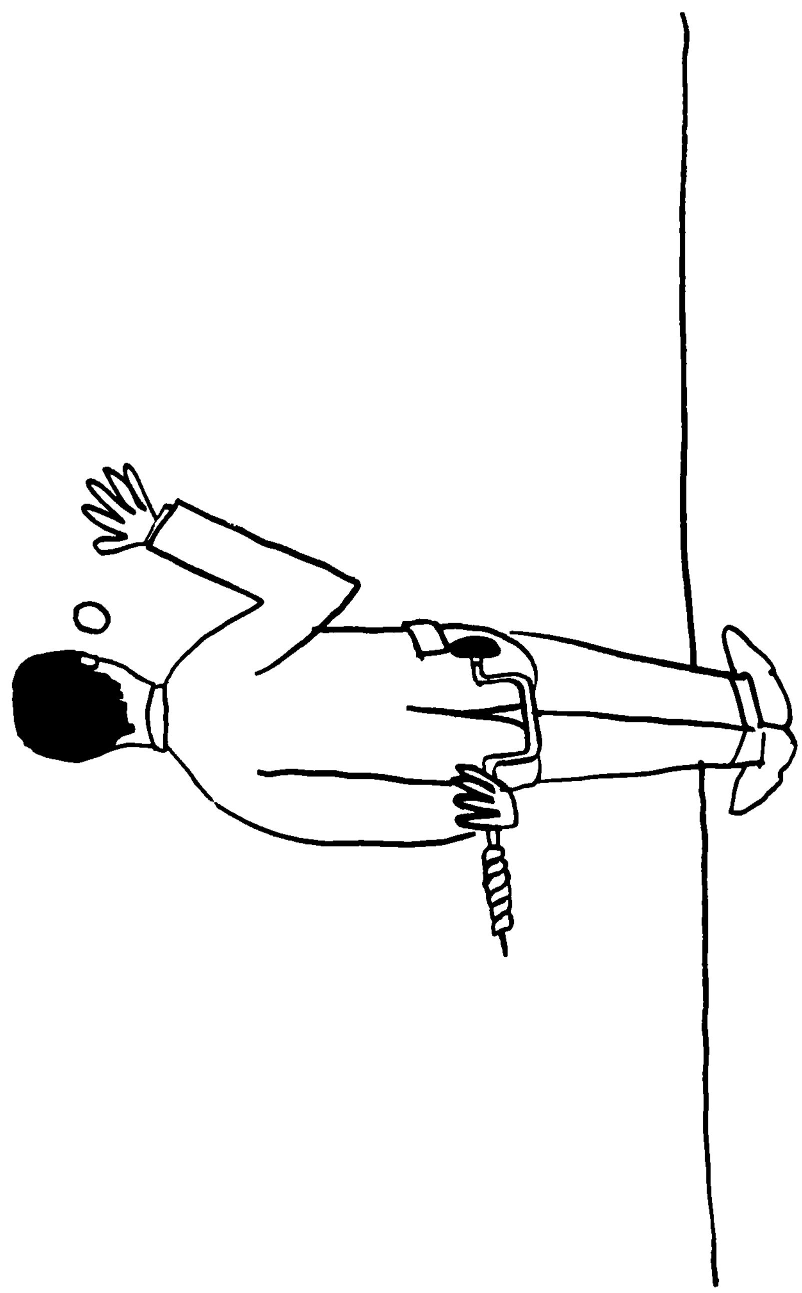
The planners, led by Theodore Wofford, architect-in-charge, initially calculated that their flexible theater-auditorium would accommodate 5, or perhaps 6, different functions. But, as the planning progressed and new alternatives were explored, it was discovered that the hall could be arranged in at least 21 distinct patterns to accommodate different functions. A partial listing: instruction; drama in thrust, round, or proscenium form; opera; musical comedy; ballet; recital; lectures; panel discussions; commencement; chamber and symphony concerts, and the Mass. Audiences could range from 125 or 250 for large-group instruction, to 500 for drama, to 750 for musical comedy, to 1,000-1,200 for lectures, commencement, and the Mass.

But a key design question remained to be answered. The expansibility and chameleon-like adaptability of the hall would be lost unless an effective means could be found to close off the alcoves from the basic theater area. Webster's planners came up with a radically new approach to the problem, one that promised to revolutionize the art of dividing theaters and auditoriums.

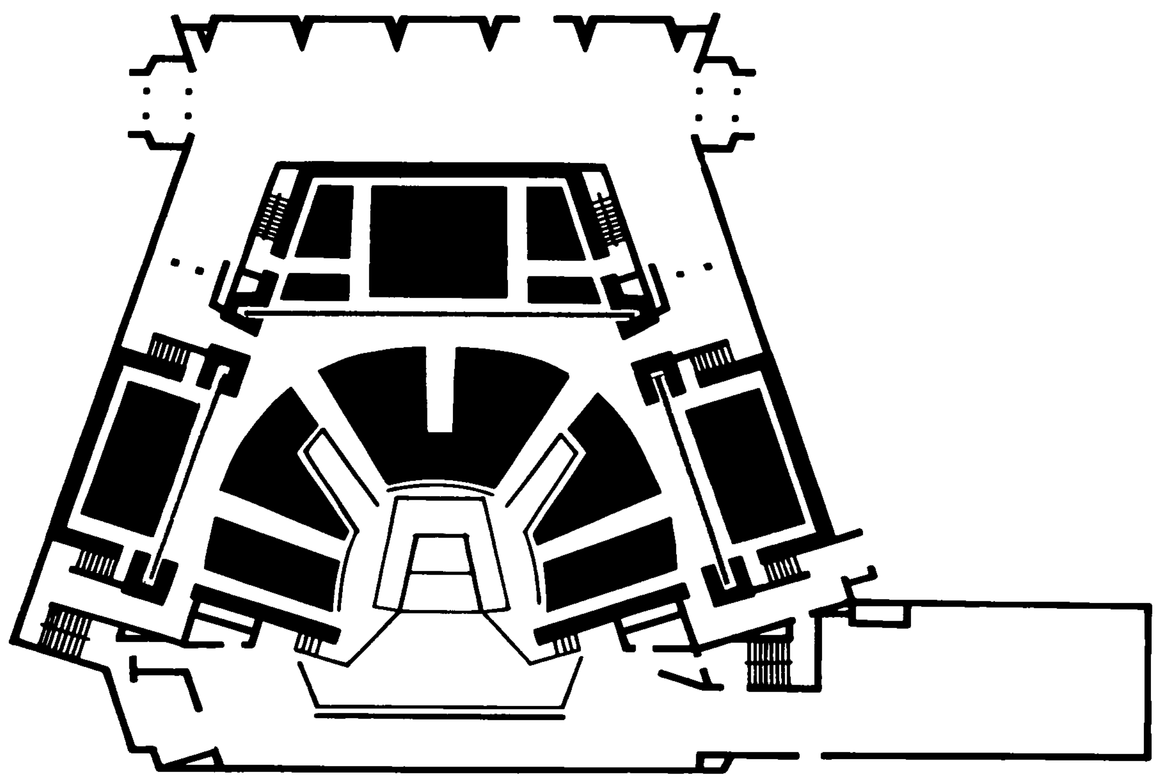
The Operable Iron Curtain

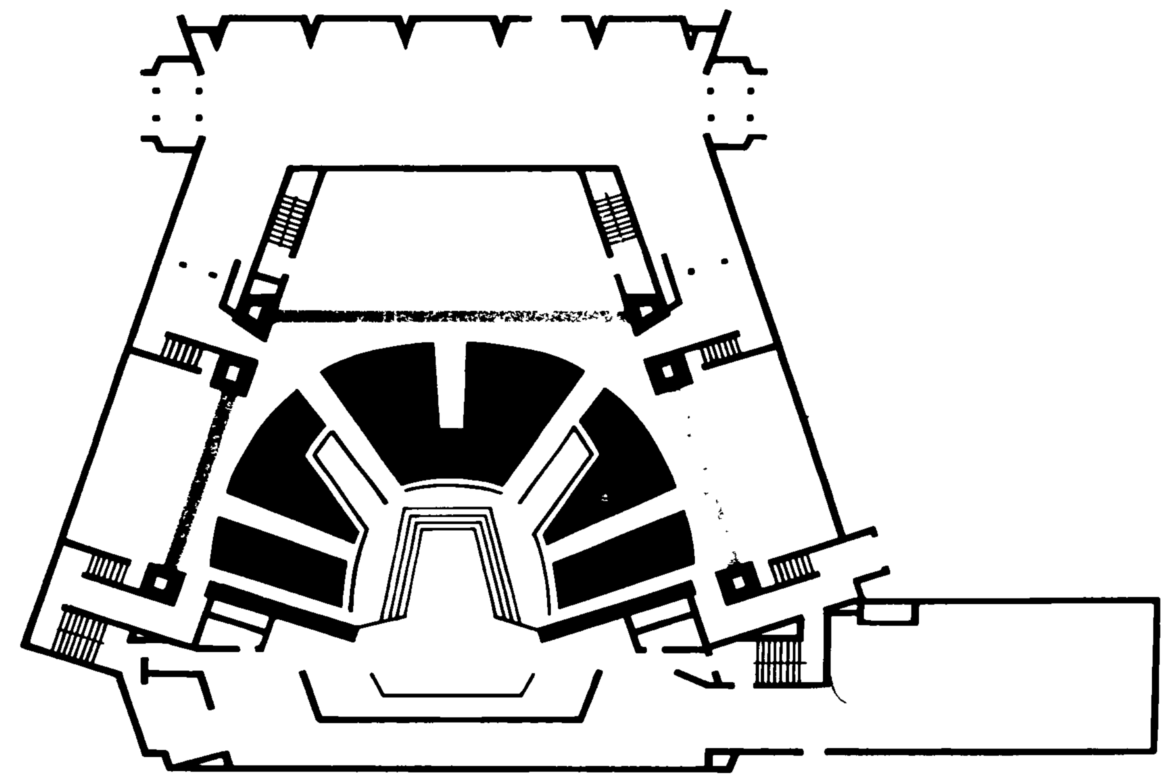
The history of divisibility, both in classroom areas and in auditoriums and theaters, has been one of efforts to design an operable partition heavy enough to block transmission of most sounds, light enough to be moved easily, tight enough in its joints and seals to prevent leakage of sound, and inexpensive enough to be economically feasible. Until Webster, most of these attempts had resulted in the development of panel-type folding or sliding partitions or accordion and coil-type walls. But Webster's planners felt that none of these provided adequate sound isolation in a hall designed for the performing arts.

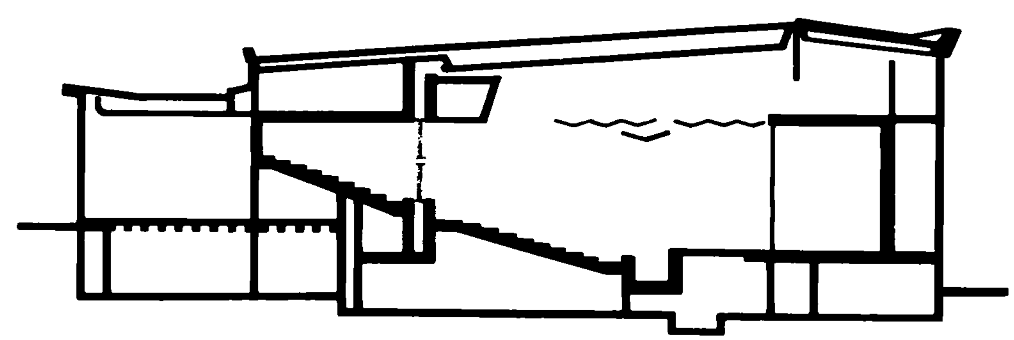
Robert Newman argued that, to separate theater spaces, operable walls had to have considerable mass—they must weigh at least 25 pounds per square foot—and have airtight seals to prevent sound leaks. The operable walls then on the market, in his view, either would lack the necessary mass or would have ineffective seals

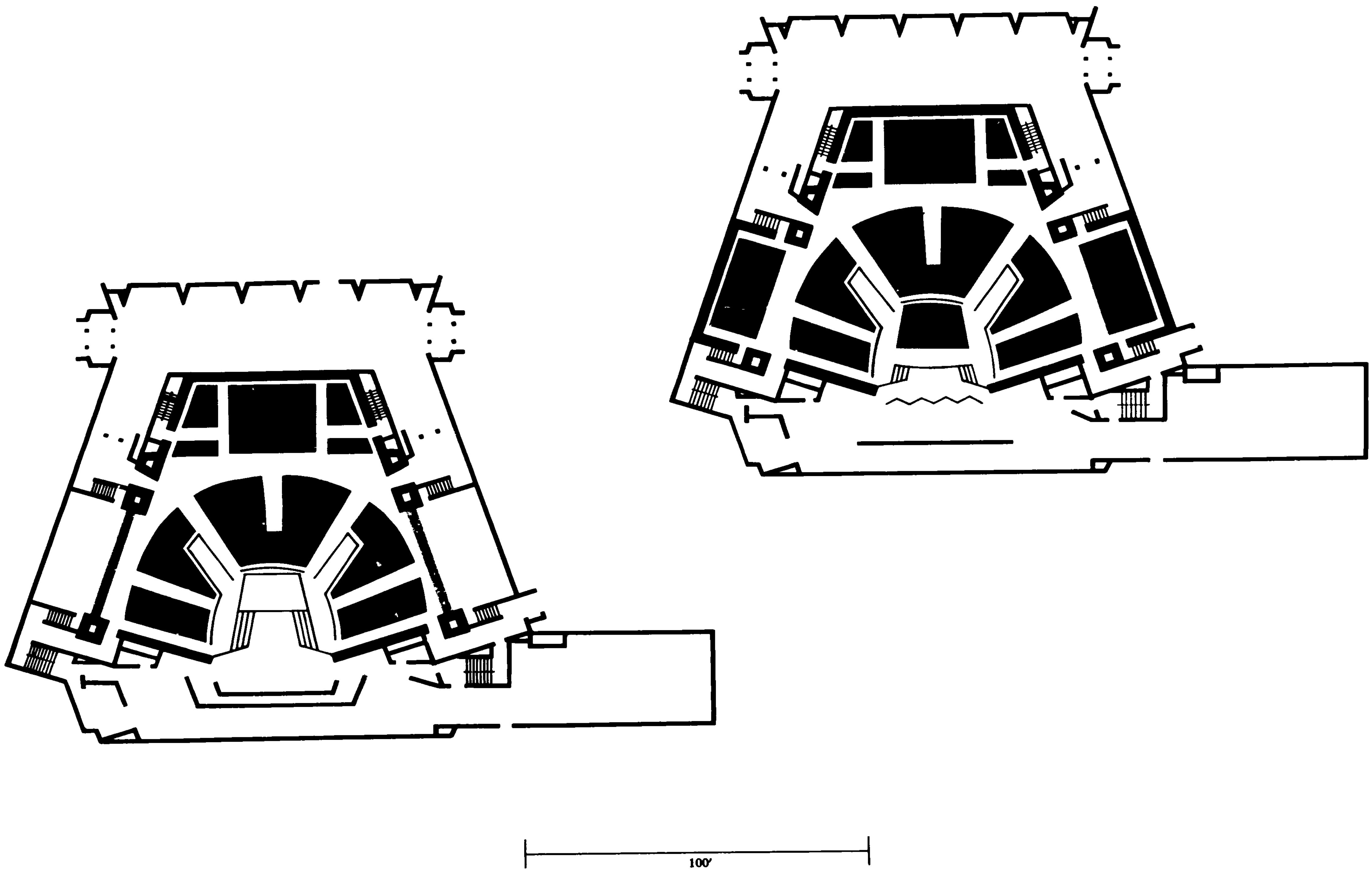


Loretto Hilton Center for the Performing Arts
Webster College
Webster Groves, Missouri





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because there were too many joints and seams to close. Mr. Newman had a kindred spirit in George Izenour, who commented in a recent interview that "you can't repeal the physical laws of sound transmission. You must have mass and a seal to provide the sound attenuation [loss] that will provide real acoustic privacy between areas in a theater."

A simple and highly effective acoustic barrier, Mr. Newman suggested, would be a solid slab of concrete or steel, which would satisfy the requirement for mass and would be easy to seal. The architects, accepting that hypothesis, struggled with design concepts in which the monolithic walls could be moved horizontally and garaged on one side or the other of each of the alcove openings. But the necessary tracks and long garages tended to block traffic patterns and to break up the symmetry of the building. Then, Mr. Izenour offered the solution: why not move the partitions up or down rather than horizontally and garage them above the ceiling or below the floor? At first, it was decided to keep the partitions in one piece and garage them below the floor, a solution employed earlier in a 107-ton, hydraulically operated partition dividing a lecture hall at the University of Hamburg in Germany. But it was found that the garages would cut up usable basement space and that a good deal of power would be required to raise the partitions into the closed position. Ultimately, it was decided to split the doors in half horizontally, so that one segment would be garaged above the ceiling and the other below the floor.

As they finally emerged from the design effort, the three partitions each consist of two built-up plate girders of $\frac{5}{8}$-inch steel. Each girder is shaped like an oversized I-beam, with a web or vertical section of 7 feet 8 inches, and 22-inch flanges at top and bottom. The girders closing off the larger alcove are 75 feet wide and those for the smaller alcoves, 44 feet wide.

Surprisingly, each of these massive doors (the 75-foot version weighs a total of 34 tons) can be moved by a $\frac{3}{4}$-horsepower electric motor. In fact, before the motors were installed, the doors could be cranked open or closed easily with a hand-operated winch. The secret to their ease of operation lies in the fact that the bottom girder is slightly heavier than the upper one and that the two are counterbalanced by the rigging system. In effect, when the lower girder descends into its garage, its weight helps lift the upper girder into its garage above the ceiling. In the event of a failure in the system, the weight of the lower girder will cause the partition to open, eliminating the danger that the doors would accidentally close on someone who got in the way.

The steel girders met Mr. Newman's requirement for mass. But there still was the problem of creating a seal between the two halves of each partition and around all four sides of the alcove openings. Initially, the seal was to be provided by air-filled neoprene gaskets. But experimentation indicated that an elaborate compressed-air system would be required to maintain adequate air pressure in the gaskets. And there were fears that, if the doors were kept in the closed position for long periods of time, the gaskets would be subject to fatigue and tend to become unusable in five years or less. A simpler and better solution was sought and found in the form of beryllium copper, an alloy that can be formed or shaped in a cold state, then tempered to provide any desired degree of spring. The metal, which never before has been used for this purpose, is applied in strips, much like weatherstripping, at all points where a seal is required. When the doors close, beryllium copper strips meet beryllium copper strips, are compressed, and form air- and sound-tight seals at all points between and around the girders.

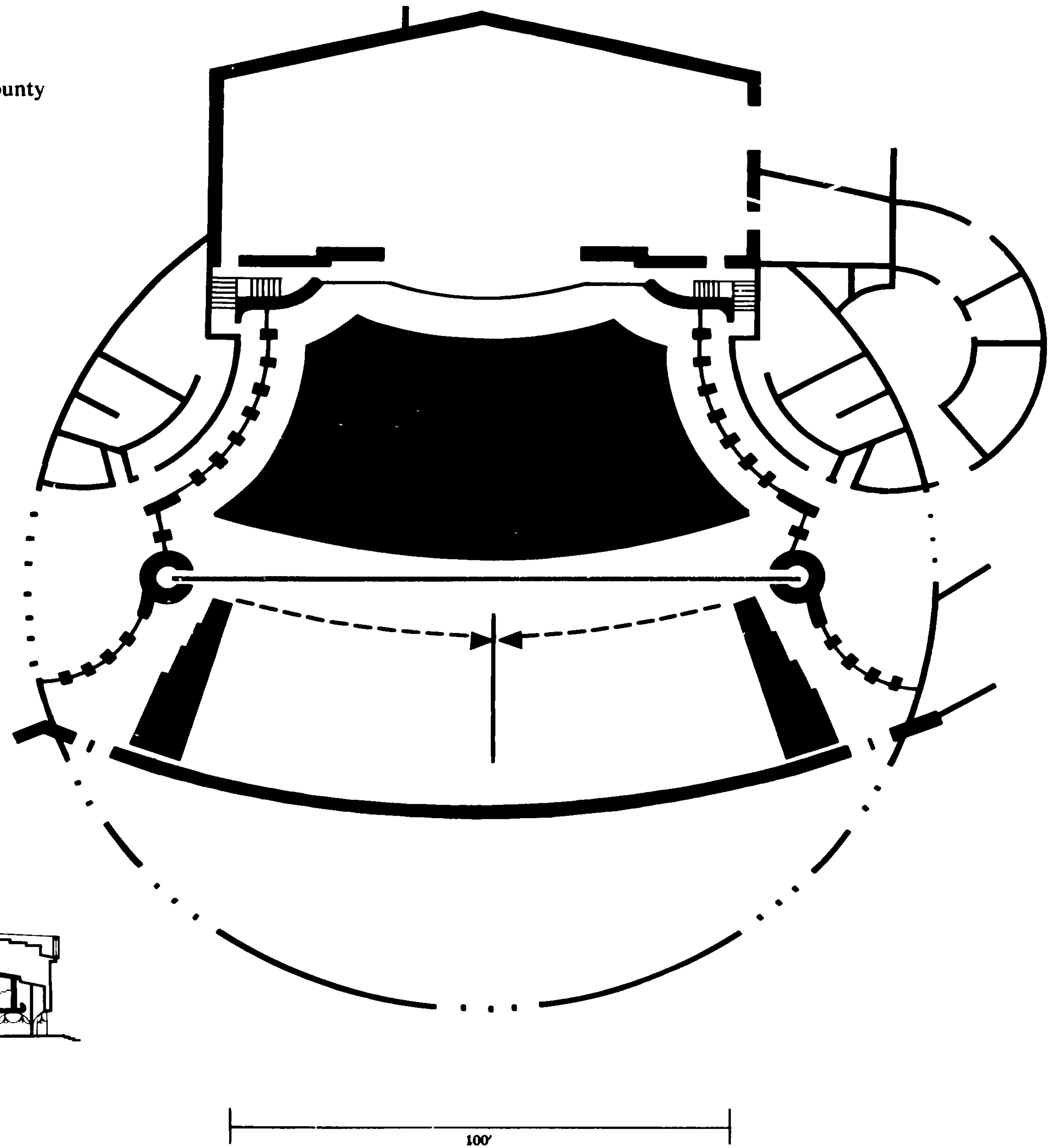
The doors posed another problem in that their flat, sound-reflecting surfaces would create disturbing reflections in the theater, particularly during dramatic performances. To solve the problem, the designers applied a series of 6-inch-deep plywood baffles to the theater side of the girders. To permit changes in the reflective qualities of the doors for different types of performances, draperies were mounted in front of the baffles. The two-ply draperies (of velvet with a flannel lining) move on tracks attached to the upper and lower flanges of each girder. When the draperies are withdrawn, the doors offer a relatively reflective surface suitable for music; when closed, the door surfaces are more absorptive, creating a better acoustical environment for speech.[9] The baffles and draperies both fit within the flanges of the girders and do not interfere with their operation. On the lecture-alcove side of the doors, the 10-inch-wide space between the web of the girders and the edges of the flanges is used to mount blackboards and projection screens and to store movable seating from the first row of each alcove and a teacher's folding desk.

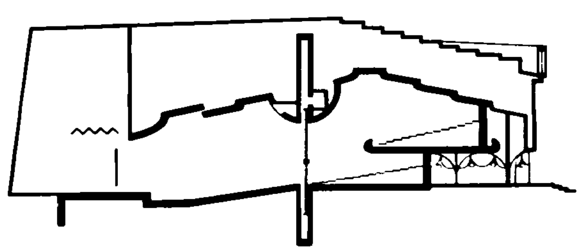
The doors have yet to be tested in actual operation, but the designers insist that both Mr. Newman's requirements have been met and that their operable iron curtains will provide more than adequate sound isolation between the theater and the alcoves. These high-performance partitions are not inexpensive. The architects estimate that the steel doors, including structural supports, rigging, machinery, controls, seals, and the wood baffles and draperies will cost a total of $78,850 or $33 per square foot. If the wood baffles and draperies, essentially acoustic finishes to provide variable acoustics for music and drama, are eliminated, Webster's cost of divisibility amounts to $22 per square foot.

All told, the Center, completely equipped and furnished, is expected to cost about $1.75 million or $32 per square foot. This cost is significantly higher than it would have been without the flexibility provided by the operable partitions and by the lifts and staging, which together cost an estimated $25,000. But, like the other institutions discussed in this report, Webster feels that its investment in flexibility is more than justified. It has avoided the need to build several structures for the performing arts, eliminated the projected need for a new classroom building, and

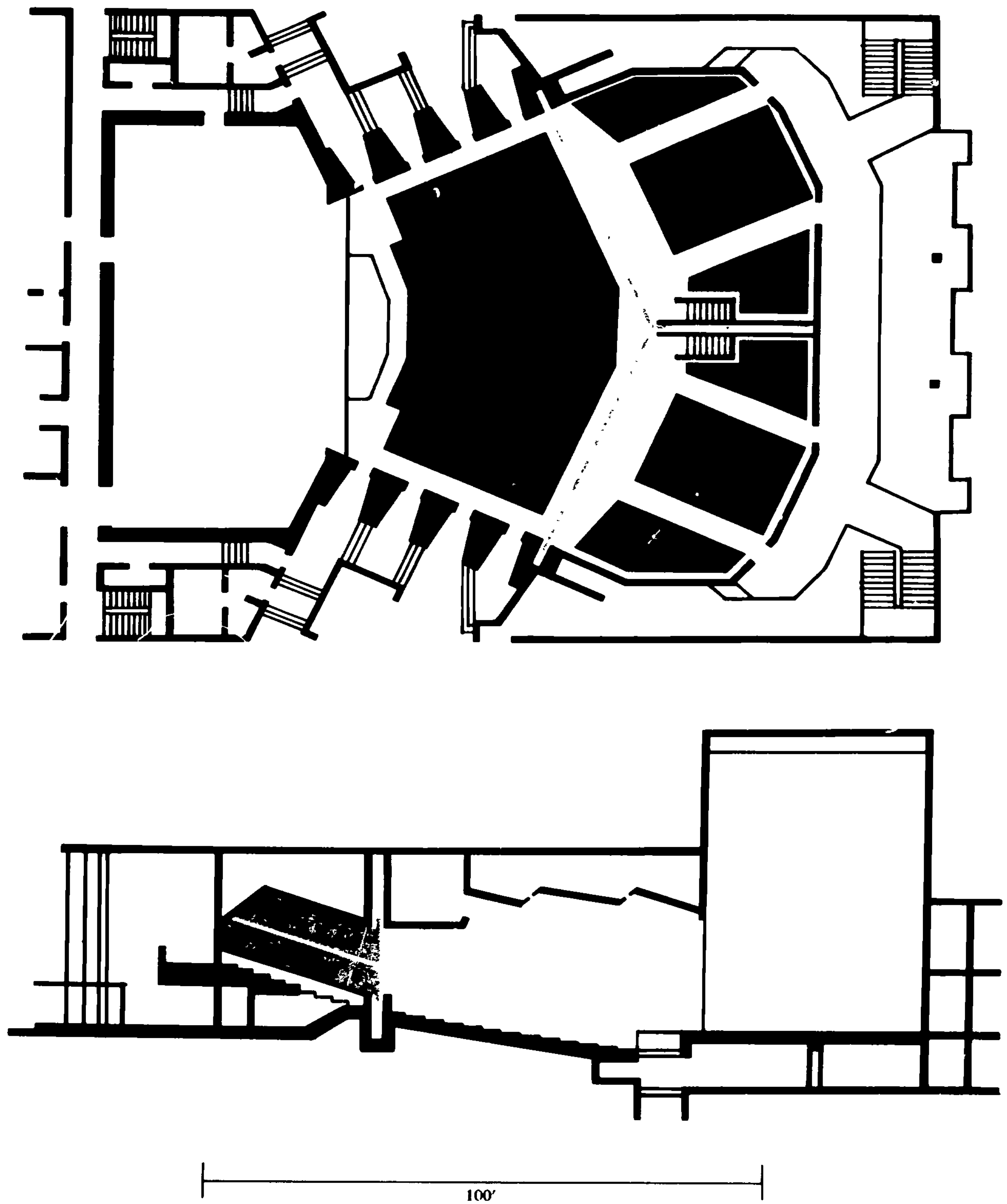
[9]The acoustic phenomenon referred to here, known as *reverberation time*, is discussed more fully in the acoustics appendix to this report.

Veterans Memorial Auditorium
Marin County Civic Center
Marin County, California
Board of Supervisors of Marin County

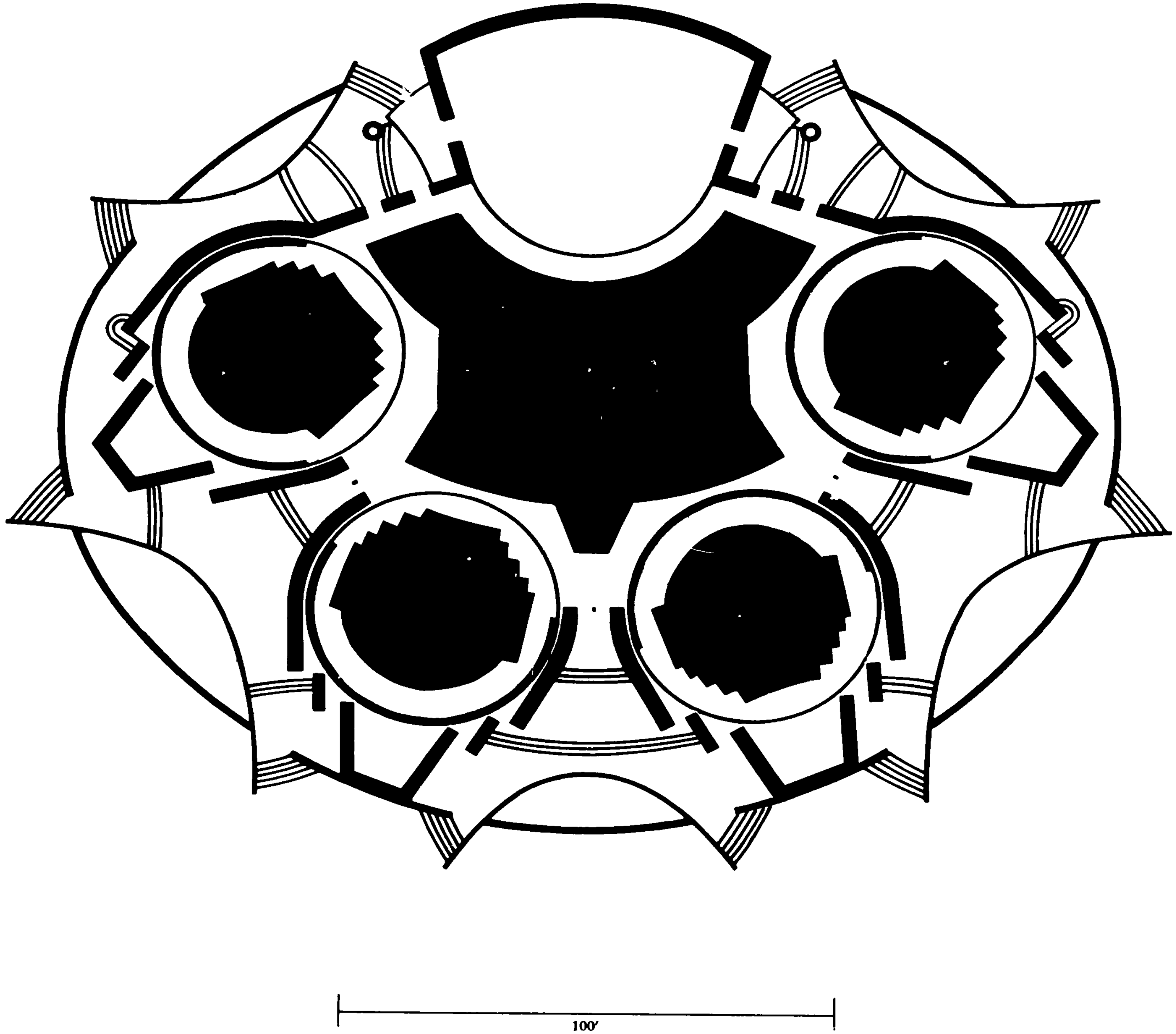




Performing Arts Center
Grosse Pointe High School North
Grosse Pointe, Michigan
Grosse Pointe Public School System



Multi-Use Learning Center
South Mountain High School
Phoenix, Arizona
Phoenix Union High School System



created a theater that, because of the multiplicity of functions possible within it, will be utilized "just about around the clock," 7 days a week, 12 months a year.

Divisibility and the Future

Sophisticated as it is, the new Webster theater is unlikely to remain the last word in the design of divisible theaters and auditoriums. The process of innovation and refinement started in Boulder City can be expected to continue. Bugs, such as mechanical difficulties encountered in moving the partitions in some of the earlier halls, are likely to crop up again and demand new solutions. And, as different institutions with differing programs and requirements attempt to create multi-use space, new approaches to divisibility undoubtedly will be tried.

As an example, Marin County, California, already is trying a new wrinkle in a 2,400-seat auditorium planned for its civic center. Taliesin Associated Architects, Ltd., of the Frank Lloyd Wright Foundation, working with Mr. Izenour, adapted Webster's iron-curtain approach to divisibility to create a single, massive partition 128 feet wide, 48 feet tall, and weighing 120 tons. The bipartient partition will separate an area of permanent, stepped seating in front of the stage from a flat-floored exhibition space at the rear and from a flat-floored balcony area. When the partition is closed, the rear areas can be used for exhibits, banquets, and other functions requiring a flat floor. But, when the partition is opened, fully upholstered theater seating fitted to telescopic risers can be moved out to provide regular, stepped seating areas, increasing audience capacity from 880 to 2,400.

A still more dramatic departure from the Webster approach is planned in a performing arts center being designed for a new high school in Grosse Pointe Michigan. There, divisibility will be provided by a single, Y-shaped iron curtain that, when closed, will divide the center's auditorium into three seating areas, one for 430 and two for 200 each. Unlike Webster, all three areas are part of the auditorium itself and not in the form of alcoves. The massive, 40-ton steel partitions, developed by Mr. Izenour and the Detroit architectural firm of Harley, Ellington, Cowin, and Stirton, are counterbalanced and electrically operated, as at Webster.

The auditorium and related facilities of the performing arts center will serve the music, speech, and drama programs of the new Grosse Pointe High School North as well as a wide variety of community cultural activities. In addition, the 200-seat rear areas will be employed as lecture halls for team teaching programs in several subject areas. Equivalent lecture space will not have to be built into other parts of the school. Front-screen projection systems for film and slides, complete with remote controls for teacher operation, will be provided in all three areas.

And, most recently, Phoenix, Arizona, is considering an entirely new approach to divisibility. Instead of operable walls, Phoenix plans to employ operable lecture halls. On turntables, the lecture halls will turn their backs on the main auditorium when in use for instruction. The proposal, not yet approved, calls for the use of the promising new technique in the design of a multi-use learning center for the existing South Mountain High School. If the prototype is a success, identical learning centers will be added to three more existing high schools and to two new high schools scheduled to be built in the next few years.

When the turntables are in the lecture position, the lecture halls face a preparation area/teaching platform that will be equipped for full audio-visual backup of instruction. When the turntables are reversed, the preparation areas are closed off and can be used by teachers and technicians preparing lecture-demonstrations without interference with activities in the auditorium. This arrangement has the advantage of avoiding the need, encountered in other divisible auditoriums, to eliminate seating to provide open space for a teaching station.

Because of the cost of the turntables, the multi-use learning centers will not be inexpensive. It is estimated that they will cost an average of $600,000 apiece, in contrast to the $450,000 cost of the most recent conventional auditorium of equal seating capacity built by the school district. But the planners insist that the difference is justified by the fact that the total cost still is lower than the cost of building both a conventional auditorium and the conventional lecture space needed to replace that provided on the four turntables. The school administration estimates that the lecture halls can be kept in use at least 70 per cent of the school week in team teaching programs and a visiting lecturer program.

There also is educational justification for the added expense, in that the learning centers will make it possible to create a wider variety of teaching spaces in the four existing high schools. The lecture halls will accommodate large-group instruction and some of the traditional, boxlike classrooms in the existing buildings will be broken up to provide space for seminars and independent study. According to Dr. Howard C. Seymour, Superintendent of Schools, the learning centers will enable the schools "to add flexibility to their educational offerings."

The lecture halls and the main auditorium will be equipped for both front- and rear-screen projection of visuals. Folding tablet arms will be provided in all lecture hall seating for note-taking purposes and in alternate seats in the main hall for testing and examination purposes. An unusual stage design has been provided to accommodate the schools' dramatic and musical programs. Essentially, the stage follows the proscenium pattern, but will not have a fly loft. An oversized forestage extends over the orchestra pit, covering all but a two-foot "sound gate," which is expected to release the same volume and quality of music into the auditorium as a normal orchestra pit. The large forestage will permit modern productions in a modified thrust pattern as well as the more traditional productions accommodated by the basic proscenium layout.

The design concept involved in the Phoenix learning centers, developed by the Phoenix architectural firm of Cartmell and Rossman with research support from EFL, involves a drastic departure from both the layouts and the approach to acoustical separation (described in detail in the acoustics appendix) employed in earlier divisible auditoriums. If successful, the Phoenix concept may prove as important a milestone in divisibility as was Boulder City. In any event, it serves to confirm a recent assessment of the future of divisibility in theater and auditorium space by Dr. Edward A. Spare, Associate Commissioner of the New Jersey State Education Department. In a report to New Jersey's Northern Valley Regional High School District on an inspection tour of 14 divisible auditoriums in seven states, Dr. Spare concluded that:

"We must realize that this approach to a relatively new educational facility is still in an embryonic stage and we can improve it with each construction program."

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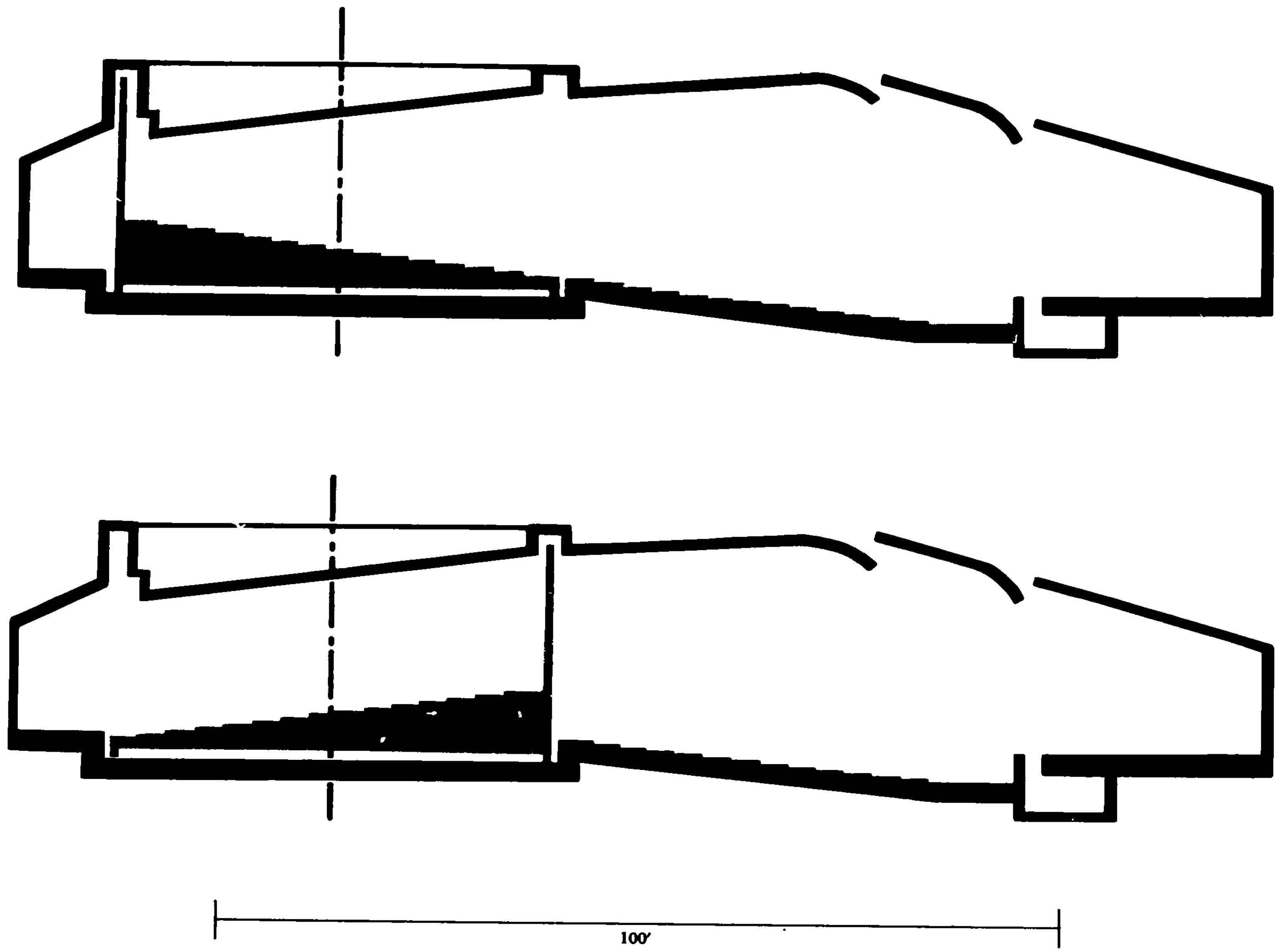
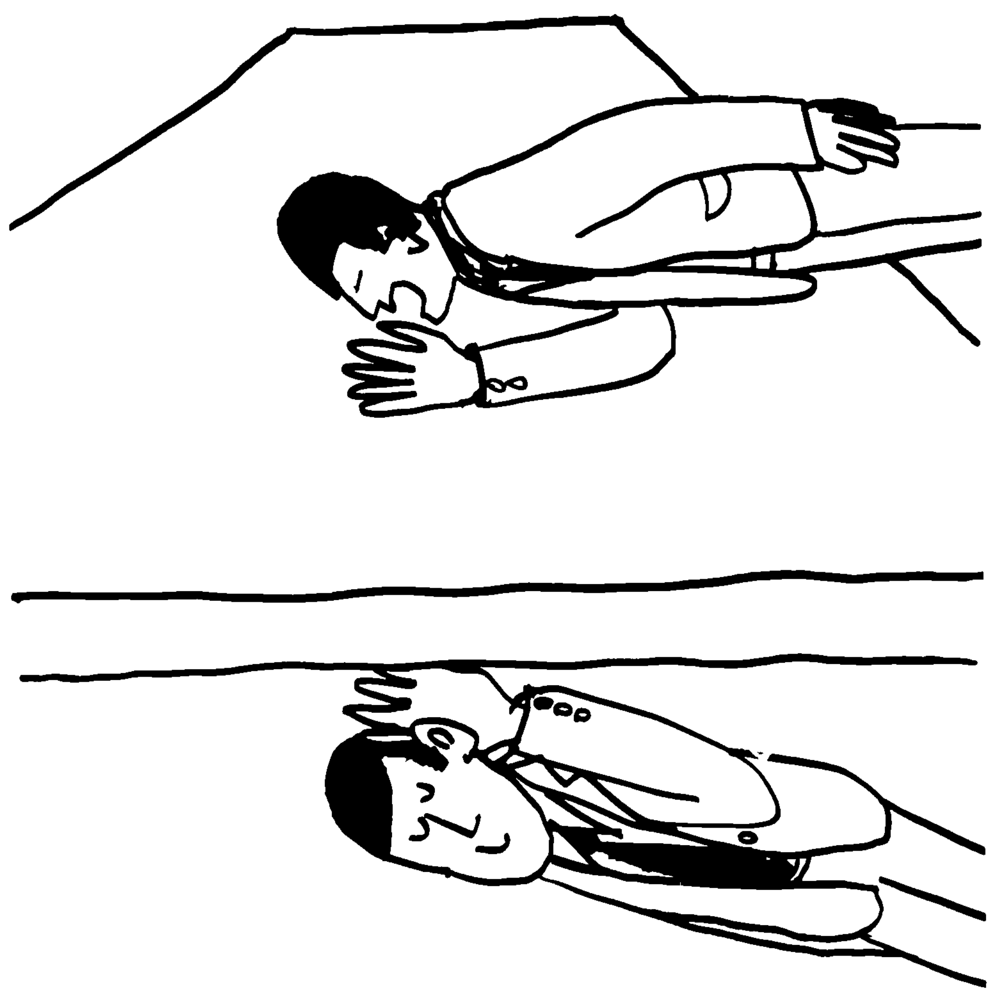




THE ACOUSTICS OF DIVISIBILITY

Unquestionably, the thorniest problem encountered by the designers of divisible auditoriums and theaters is that of acoustics. But the problem is a far more complex one than the need to answer the obvious question: "Do those partitions really stop sound?"

The effectiveness of operable partitions as sound barriers is indeed crucial if divisible halls are to work. But divisibility, because it involves changes in the size and shape of spaces and thus in their acoustical properties, poses a host of other problems for the architect and his acoustical consultants. This appendix is an attempt to outline these problems, in all their complexity but in nontechnical terms, for those not versed in the language of acoustics.

First, it must be emphasized that no operable partition actually "stops" all sound, although it has been claimed that Webster's iron curtains will come close to doing just that. (It might be added that no conventional partitions stop all sound either.) Rather, the partitions described in this report were designed to reduce the transmission of noise so that different activities can take place on both sides of the partition without interfering with each other. Obviously, then, the nature of the activities to be carried on in the hall will determine how effective a sound barrier is required.

If the hall is to be used solely for instructional purposes, relatively little noise will be generated and relatively little sound isolation will have to be provided by the partition. If loudspeakers for voice and audio-visual sound tracks are employed, a greater volume of sound, and equally significant, a different *quality* of sound will have to be blocked out by the partition. And, if the hall is to accommodate live music, still greater sound isolation will be required.

This scale of requirements is not absolute. Other factors can alter the pattern. If, for example, low-volume, ceiling-mounted speakers can be used in place of a loudspeaker at the front of the room, isolation requirements should be no greater than those for unamplified speech. Similarly, constant sound levels created by air conditioning or mechanical ventilating systems can help to mask sounds coming through a partition, again lowering sound isolation requirements. The level and frequency range of these ambient sounds should be pre-engineered through the careful selection and installation of air diffusers. In effect, architects and acoustical consultants can create a predetermined level of "acoustical perfume" to mask extraneous noise.

As was indicated in the body of the report, the manufacturers of operable partitions have taken a number of approaches to the problem of meeting sound isolation requirements. These include panel-type folding or sliding partitions, or accordion- and coil-type walls, all employing varying layers of wood, metals, plastics, or fabrics, and acoustically absorbent materials to reduce sound transmission. Another type is a lead-impregnated vinyl curtain which combines limpness and the weight of powdered lead to provide an acoustic barrier. And, most recently, solid steel girders have been employed as space dividers.

The available partitions vary widely in weight, sound isolation, ease of operation, and cost. Some are manually operated; others are opened and closed mechanically. In general, the lighter, manually operated versions offer less sound isolation and cost less than the heavier and mechanically operated types. However, there are exceptions to this rule of thumb and, within any one partition type, a wide range of prices and effectiveness is available.

The acoustic qualities of materials used in the partition will be of little value unless an effective sealing system insures that sound will not leak through joints or around the edges of the partitions. Again, the manufacturers have developed systems of varying complexity and effectiveness. The simplest and least expensive is a sweep seal, most often employed in light, accordion-type partitions. The sweep seal is simply an extra skirt or flap installed on the bottom or top of the partition, which sweeps along the floor or ceiling, providing an airtight seal. Its primary advantage is simplicity; its primary disadvantages are that it increases the difficulty of moving the partition and, because of wear, tends to lose its effectiveness. Generally speaking, sweep strips cannot be used with very large or very heavy partitions if manually operated. However, a recent adaptation of the accordion partition provides for ease of movement through a jacking system that lifts the partition, freeing the seal from the floor. To date, the jacking system has been used in smaller partitions for classroom use, but there is reason to believe the solution could be employed in larger partitions for auditoriums.

Larger, accordion-type partitions and coil-type walls generally employ friction seals of felt or similar materials at top and one side, a tightly fitted, insulated jamb at the other side, and a sweep seal at the bottom. These partition types often are used in double or even triple installations to provide adequate sound isolation in divisible auditoriums. The "dead" air spaces between double partitions greatly enhance their effectiveness as sound barriers.

Two general approaches have been taken to the sealing of panel-type folding partitions. One involves the use of spring-loaded jacking mechanisms that employ pressure to force seals against floor and ceiling tracks and against the jambs at either side of the partition. The other is a more complex pneumatic system that inflates gaskets at either side of the partition and a gasket in the floor. The floor gasket pushes the partition tight against the ceiling track to complete the seal. In both cases, strips of neoprene or other sealing materials must be placed between each panel to close off the joints.

Partitions employing individual sliding panels generally rely on gaskets at either end of each panel and a tight fit, with sweep strips or mechanically operated compression gaskets, at top and bottom tracks. The manually operated, sliding panel approach is not believed to have been tried in auditoriums and theaters, but was employed in the Clark County, Nevada, science lecture halls. The lead-vinyl curtain, again not yet adapted to auditorium use, relies on tight sleeves at either side of the partition and a weighted cuff at the bottom to provide seals. And, as described earlier in the report, the Webster iron curtains employ compressive seals made of beryllium copper.

No attempt will be made here to rate the effectiveness of the partitions mentioned in this report or of others available on the market. Laboratory tests have been conducted on most of the partitions mentioned here, and test data usually are available from the manufacturer. The tests, conducted in specially designed laboratories under tightly controlled conditions, form the basis for manufacturers' claims of partition effectiveness. These usually are expressed as a Sound Transmission Class (STC) rating and the partitions in this report have been rated at STCs ranging from the high 20's to the low 50's. An STC of 40 indicates that the partition is roughly as effective a sound barrier as a 4-inch cinder-block wall. It should be stressed that an STC rating should not be taken to mean that sound transmission through the partition necessarily will be reduced by an equivalent number of decibels. The same partition will reduce transmission of sound with different effectiveness at different sound frequencies (expressed in cycles per second) and generally will be less effective at very low frequencies (or pitch) and more effective at middle and high frequencies. The STC rating is an expression of the effectiveness of the partition in isolating common sounds, such as speech, taking into account different requirements for different frequencies under normal conditions and must be read as such.[10]

A new type of test information may become available to clients and architects before mid-1966. At least 12 partition manufacturers have agreed to a uniform test and labeling program to be conducted by the National School Supply and Equipment Association. Under the program, the cooperating firms will submit their partitions and a complete set of working drawings to NSSEA. An NSSEA architect will supervise erection of the partition in an approved test laboratory, insuring that there is no deviation from normal erection procedures in the field. The doors will be operated at least five times, then subjected to acoustical testing. After the tests, the architect will demolish the partition to determine whether it was built in accordance with published specifications and drawings.

The test results will be translated into a letter rating, ranging from "A" for an STC of 13-22 to "G" for an STC of 48-52. In addition to the rating, the label will specify the type of seals employed: the thickness, width, and length of the panel; weight of panel or weight per square foot if accordion-type; force required to operate doors and sealing mechanisms; space required for stacking, and depth of the head section.

The new procedure, however, is opposed by a number of partition manufacturers and has been criticized by several acoustical consultants. In general, the critics argue that the replacement of the STC ratings by the new letter ratings will be confusing to architects who are accustomed to working with STC ratings. More serious, they charge that the five-STC spread of the new letter ratings is too great. STC ratings of 38 and 42 are included under the new letter rating of "E". But, the critics argue, a rating of 42 STC is much more difficult to attain, and a partition with a 38 STC is not comparable to one with a 42 STC. And they question test requirements that rule out use of two of the nation's largest acoustical testing laboratories. Finally, a spokesman for one nonparticipating manufacturer pointed out, the American Society for Testing Materials is preparing a revised test procedure[11] that will eliminate the need for the new NSSEA procedure. What the industry really needs, the spokesman added, is a standardized field test, since even the best laboratory-test results bear little relation to partition performance in the field.

Indeed, when actually installed in buildings, operable partitions tend to perform somewhat below the ratings indicated by laboratory tests. And improper installation or lack of architectural attention to the control of leaks over, under, or around the partition will mean that, no matter what its rated effectiveness, the partition will be useless as a sound barrier. In other words, the architect must insure that sound cannot flank or bypass the partition through ductwork, the ceiling, the walls, or the partition's own machinery and garage spaces. Therefore, the actual effectiveness of a partition will not be known until it is installed and tested under operating conditions. Since only three of the installations described in this report have been field-tested, any attempt at comparative ratings would be meaningless and very likely unfair.

How, then, are planners of divisible theaters or auditoriums to select partitions with reasonable certainty that they will work? The following are offered as guidelines: First, determination should be made by the architect, probably with the help

10For a fuller description of Sound Transmission Class (STC), see *American Society for Testing Materials (ASTM) Standards*, E60-91T, Appendix A. (American Society for Testing Materials, 1916 Race Street, Philadelphia, Pennsylvania, 19103). 11*ASTM Standards*, E60-91T, Appendix B.

of an acoustical consultant, of the degree of sound isolation required in the spaces to be divided by the partition. The determination will be based on the type of activities to be carried on in each space and on other considerations outlined earlier in this appendix. Then, a determination should be made of the expected frequency of operation of the partition. If it is to be moved frequently, mechanical operation probably is desirable. If not, a less costly manually operated partition may be adequate.

With this information in hand, the architect then can identify the partitions available on the market that appear to meet the client's requirements for sound isolation (based on STC ratings) and ease of operation. The brand names and manufacturers of partitions described in the report will be found in an appended credit list. But the list is by no means representative of all partitions on the market, and a search should be made of the catalogues available to the architect.

Finally, architect, client, and consultant ideally should visit theaters or auditoriums in which the appropriate types of partition have been installed. If possible, they should operate the partition and determine its ease of movement. With the hall in actual use, they should satisfy themselves that there indeed is adequate sound isolation between spaces divided by the partition. However, if sound leaks exist, the visitors should bear in mind the possibility that the architects and engineers rather than the partition manufacturer may have been at fault. If field-test results are available, they should be studied by the architect and consultant. (They probably will be unintelligible to the client.) If a promising partition is new and untested in actual use, keep in mind that, in partitions at least, the new has tended to improve on the old.

Planners of auditoriums following the Phoenix pattern will face a very different set of considerations. In the first place, there are no operable partitions to evaluate. And, more intriguing, no attempt is made to achieve an airtight seal to provide acoustical privacy between areas in a divisible auditorium. Instead, acoustical baffles are employed to provide adequate sound attenuation between spaces.

Specifically, the Phoenix designers had to handle the problem of sound transmission over the top or around the ends of the curved back wall of the lecture halls and transmission under the turntables. They solved the first problem by providing a slot in the ceiling, 28 inches wide by 24 inches deep, in which the top of the wall will travel. The 10-inch-wide partition will extend 13 inches up into the slot, leaving a 9-inch opening all around between the partition and the top and sides of the slot. The opening, in turn, is to be lined on all sides with 3 inches of sound-absorbent fiberglass, leaving a 3-inch-wide air gap through the baffle.

A different approach was taken to prevent sound transmission around the front end of the lecture hall walls. A curved, fixed partition will extend from the front of the preparation areas so that, when the halls are rotated to the lecture position, the fixed partitions and the lecture hall walls overlap for a distance of 8 feet. The two walls will be 9 inches apart and, as in the baffles at the top of the walls, the gap will be lined on either side with 3 inches of fiberglass, leaving a 3-inch opening.

To handle sound transmission under the turntables, a skirt of acoustically absorbent materials will be dropped from the edge of the turntables to the bottom of the machinery wells under them, again creating a baffle.

The acoustic baffles are similar in principle to those employed in air-conditioning ductwork to prevent the ductwork from transmitting sounds from one room to another. Such ducts are designed so that air will travel through them but sound will be absorbed. A seal, which would block air movement, is impossible. Baffles, which usually employ a labyrinth, and acoustically absorbent materials to inhibit sound transmission, offer the best answer. Applied to the Phoenix learning centers, the principle will make it possible to provide adequate sound isolation between the lecture halls and the main auditorium without creating a seal. This means that the lecture halls will rotate freely and that the highly complex and costly effort to provide a tight seal can be avoided.

Models of the baffles for the top and ends of the lecture hall walls have been tested in the laboratory, and the results indicate that the baffles will provide adequate sound isolation and that the Phoenix approach will work. But the real test will come only when the first of the proposed learning centers is up and in operation.

Divisible or not, the theater or auditorium is regarded by the experts as posing the most difficult acoustical design problems of any building type. Divisibility and multi-use designs simply complicate matters. The problem of even sound distribution in the hall is a case in point. In any theater or auditorium, sound must be so distributed that speech on the stage can be heard clearly and distinctly at any point in the seating area. If the hall seats less than 1,000, distribution should be possible without amplification. Normally, this is accomplished by designing the ceiling so that sound is reflected into all audience areas. But the alcove designs and ceiling height limitations involved in many divisible theaters and auditoriums render this solution impossible. Even distribution without amplification is possib . . , the main hall (although an amplification system usually is advisable) but amplification usually must be employed to achieve satisfactory speech levels in the alcoves. And experience with a number of divisible auditoriums indicates that, as in any situation where loudspeakers are distant from the stage, an electronic delay must be built into the system so that amplified speech does not reach the alcove sooner than unamplified, airborne speech and create an echo effect.

Then, there is the question of reverberation time. Sound created in an enclosed space tends to be reflected from surface to surface and thus to linger, sometimes for two seconds or more, until it eventually is absorbed, transmitted through walls and other surfaces, or has escaped through ducts and other openings. The length of time between the creation of a sound and a drop to one-millionth of its original intensity is termed *reverberation time*. Reverberation is a crucial factor in theater and auditorium design since it lends a desirable quality, called *presence* by musicians. Reverberation time should be greater for music than for speech.

Reverberation time is governed by the size and shape of spaces and by the absorptive qualities of materials used in wall, ceiling, and floor surfaces and furniture, and of the audience. It is possible, therefore, to design a predetermined reverberation time into a hall with reasonable accuracy through the choice of size, shape, and materials. If the hall is to accommodate music, reverberation times must be calculated for a number of sound frequencies in order to insure fidelity to the original sound. But again, the solution is complicated by divisibility. Usually, architects find it necessary to design longer reverberation times into the main hall than the alcoves. And, allowances must be made for the fact that divisibility affects the shape of spaces and thus their reverberation times. If an operable wall is opened, the distance between reflective surfaces is increased and reverberation time is increased. Similarly, the materials employed in the operable wall will have different absorptive qualities and thus will affect reverberation time. For these reasons, the designers of Webster College's steel partitions employed large wood baffles to break up the smooth steel surfaces of the partitions and added movable draperies to create an absorptive surface and shorter reverberation times for speech. Reverberation times also can be adjusted to suit different activities through the use of adjustable panels or a combination of "clouds" in the ceiling and movable draperies in the attic above an open ceiling.

Another acoustical problem to confound the designers of divisible auditoriums is *flutter*. If opposite walls in a theater are straight and perfectly parallel, sound tends to bounce back and forth from wall to wall, creating distortion. The solution generally has been to create splayed side walls or other irregular shapes in the main hall. Ideally, the alcoves designed into divisible auditoriums should be similarly treated, but many existing alcoves have parallel side walls and may be susceptible to the flutter problem.

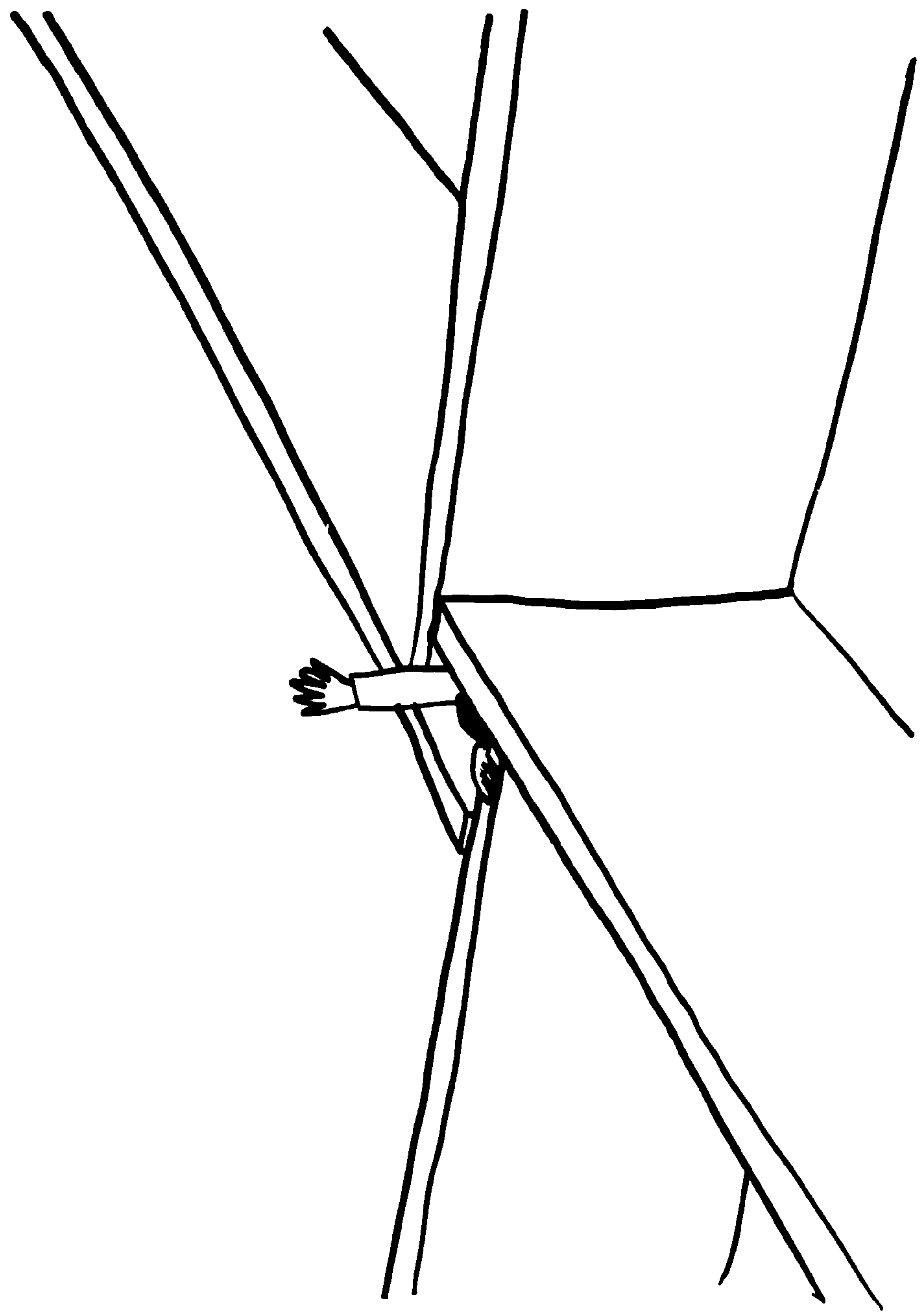
Other shapes can pose problems as well. If side or rear walls of the main hall or alcoves are concave, sound will tend to focus in one area and even distribution will be impossible. Convex surfaces, on the other hand, disperse sound and enhance even distribution.

Finally, there are acoustical problems in theater and auditorium design that are not affected by divisibility. Most important is the problem of excluding outside noise from the hall. Street noises, the sound of passing aircraft, machinery noises, and noise emanating from such areas as scenery shops, all must be kept out of the auditorium or theater space. To solve these problems, architects have tended to use lobbies and other access areas as sound traps to isolate street noises. Aircraft noises can be blocked through the use of double ceilings. Machinery, such as air-conditioning units, can be placed on flexible mountings and isolated by heavy masonry partitions. And scenery shops generally are separated from stage areas by two sets of heavy metal doors that create a sound lock.[12]

In sum, the acoustics of divisibility, like the acoustics of all theaters and auditoriums, are highly complex and a potential source of grief to designers and owners alike. They must be approached with the greatest care if the hall and its divisibility are to work.

JAMES J. MORISSEAU

12For a more detailed discussion of the acoustics of theaters auditoriums, see Harold Burris-Meyer and Lewis Goodfriend, *Acoustics for the Architect* (Ne ork, Reinhold Publishing Corporation, 1957) and the acoustics chapter of Charles M. Gay, Charles D. Fawcett, and William J. McGuiness, *Mechanical and Electrical Equipment for Buildings*, 4th ed. (New York, John Wiley & Sons, Inc., 1964).



Credits

The following pages offer comparative data and credits on the theaters and auditoriums described in this report. Partition ratings are not included since field-test results are available for only three auditoriums and experience indicates there is little relationship between published laboratory-test results and actual results in the field. Cost data are not offered for either the buildings or the partitions. Building cost data are omitted because many of the auditoriums in the report are integral parts of school buildings, making cost breakdowns impossible. Similarly, it has proved impossible to obtain accurate figures on the *total* cost of installing partitions, including structural alterations to the building, acoustical treatment, and amplification systems, as well as the cost of the partition as delivered to the site. (Some cost data are offered in the text of the report.) Installations marked with an asterisk were planned with grant support from EFL.

Boulder City High School Auditorium*
Boulder City, Nevada
Clark County School District

Opened: September, 1961
Capacity: 500—220 fixed and 70 portable seats in main hall, 105 fixed seats in each of two alcoves
Organization: Grades 7-12
Partition type: panel-type folding, mechanically operated, pneumatic seals
Partition manufacturer: Silent Wall Division, Koppers Company, Inc.
Architects: Zick and Sharp
Acoustical consultants: Bolt, Beranek and Newman
Superintendent: Leland B. Newcomer
Superintendent during planning: R. Guild Gray
Principal: William McCormick
Principal during planning: Elbert Edwards

Science Lecture Halls
Valley High School and Edward W. Clark High School
Clark County, Nevada
Clark County School District

Opened: September, 1965
Capacity: 326—one section of 118 seats, two of 104 each
Organization: Grades 10-12
Partition type: sliding panels, manually operated, neoprene gasket seals
Partition manufacturer: Glide-A-Wall Company
Architects: Zick and Sharp
Superintendent: Leland B. Newcomer
Principals: James Smith—Valley
William Beitz—Clark

Darien Senior High School Auditorium*
Darien, Connecticut
Darien Public Schools

Opened: January, 1964
Capacity: 1,200—800 in main hall and 200 in each of two alcoves
Organization: Grades 10-12
Partition type: double coil, mechanically operated, friction and sweep seals
Partition name: Coil-Wal
Partition manufacturer: Coil-Wal Partitions Company
Architects: Sharp and Handren
Acoustical consultants: United Acoustic Consultants
Audio-visual consultants: Technifax Corporation
Superintendent: Gregory C. Coffin
Principal: Stewart B. Atkinson

Ridgewood High School Auditorium
Norridge, Illinois
Ridgewood High School District Number 234

Opened: September, 1962
Capacity: 830— 430 in main hall and 200 in each of two alcoves
Organization: Grades 9-12
Partition type: triple coil, mechanically operated, friction and sweep seals
Partition manufacturer: Coil-Wal Partitions Company
Architects: Orput-Orput and Associates
Acoustical consultants: Bolt, Beranek and Newman
Educational consultant: J. Lloyd Trump
Superintendent-Principal: Eugene R. Howard

Tupelo High School Auditorium*
Tupelo, Mississippi
Tupelo Public Schools

Opened: September, 1965
Capacity: 1,500—700 in main hall, 200 each in two alcoves on orchestra floor and two alcoves on balcony
Organization: Grades 10-12
Partition type: panel-type folding, manually operated, mechanical seal
Partition name: Acoustiseal 51
Partition manufacturer: New Castle Products, Inc.
Architects: E. L. Malvaney and Associates
Acoustical consultants: Bolt, Beranek and Newman
Superintendent: C. E. Holladay
Principal: B. L. Rieves

Howard B. Mattlin Junior High School Lecture Hall
Plainview, Long Island, New York
Plainview-Old Bethpage School District

Opened: December, 1963
Capacity: 600—two 150-seat sections and one for 300
Organization: Grades 7-9
Partition type: panel-type folding, manually and mechanically operated, pneumatic seals
Partition manufacturer: Torjeson, Inc.
Architects: The Perkins and Will Partnership
Acoustical consultants: Bolt, Beranek and Newman
Superintendent: Robert F. Savitt
Principal: William J. DeGennaro

John F. Kennedy High School Auditorium
Plainview, Long Island, New York
Plainview-Old Bethpage School District

To open: September, 1966
Capacity: 600 — two 150-seat sections and one for 300
Organization: Grades 10-12
Partition type: panel-type folding, mechanically operated, mechanical seals
Partition manufacturer Brunswick Corporation
Architects: Eggers and Higgins
Acoustical consultant: Michael Kodaras
Superintendent: Robert F. Savitt
Principal: William J. DeGennaro

Candlewood Junior High School Auditorium
Half Hollow Hills, Long Island, New York
Half Hollow Hills School District

Opened: September, 1965 (Auditorium, December, 1965)
Capacity: 764 — four sections of 191 seats each
Organization: Grades 7-9
Partition type: panel-type folding, mechanically operated, pneumatic seals
Partition manufacturer: Torjeson, Inc.
Architects: Frederic P. Wiedersum Associates
Superintendent: Dr. Zaven M. Mahdesian
Principal: Anthony Agoglia

Foothill College Auditorium
Los Altos Hills, California
Foothill Junior College District

Opened: September, 1961
Capacity: 980 — one section of 350 seats, one for 630 seats
Organization: community college
Partition type: double accordion, manually operated, sweep seals
Partition name: Modernfold Soundmaster
Partition manufacturer: New Castle Products, Inc.
Architects: Offices of Ernest J. Kump and Masten and Hurd, a joint venture
Acoustical consultant: Dariel Fitzroy
President: Calvin C. Flint

Fine Arts Center*
Montgomery County Junior College
Rockville, Maryland

Opened: February, 1966
Capacity: 756 — 110 fixed and 250 movable seats in main hall, 132 seats in each of three alcoves
Organization: community college
Partition type: panel-type folding, mechanically operated, mechanical seal
Partition name: Richards-Wilcox 380-2
Partition manufacturer: Richards-Wilcox Manufacturing Company
Architects: McLeod, Ferrara, and Ensign
Acoustical consultants: Bolt, Beranek and Newman and Harold Burris-Meyer
Theatrical consultants: Kelly Yeaton and A. McLeod
Audio-visual consultant: Frank V. Emanuel
President: George A. Hodson, Jr.
Dean during planning: Donald Deyo

Longmont Senior High School Auditorium*
Longmont, Colorado
St. Vrain Valley School District Number RE-1J

Opened: August, 1964
Capacity: 750—574 in main hall and 88 in each of two alcoves
Organization: Grades 10-12
Partition type: to be selected and installed later
Architects: Bunts and Kelsey
Acoustical consultants: Bolt, Beranek and Newman
Theatrical consultant: James Hull Miller
Superintendent: Merle V. Chase
Principal: Cley Richendifer

Recital Hall
Fine Arts Center
University of Rhode Island
Kingston, Rhode Island

To open: Late 1966
Capacity: 528—432 fixed seats in one section, 96 movable seats in the other
Organization: university
Partition type: accordion, mechanically operated, sweep seals
Partition manufacturer: undetermined
Architects: Millman and Sturges
Acoustical consultant: Helmuth Etzold
President: Francis H. Horn
Dean of College of Arts and Sciences: Jerome Pollack

Loretto Hilton Center for the Performing Arts*
Webster College
Webster Groves, Missouri

To open: April, 1966
Capacity: 1,200—500 fixed seats and 200 movable seats in main hall, 250 seats in one alcove, and 125 in each of two others
Organization: four-year women's college (co-ed in fine arts program)
Partition type: bipartient steel garaged above ceiling and below floor, mechanically operated, compression seals
Partition manufacturer: not a standard, manufactured item; steel fabricated and erected by Pittsburgh-Des Moines Steel Company
Architects: Murphy and Mackey
Acoustical consultants: Bolt, Beranek and Newman
Theater design and engineering consultant: George C. Izenour
Color consultant: Franz Szymanski
President: Sister M. Jacqueline, S.L.
President during planning: Sister M. Francetta, S.L.
Drama department: Sister Marita, S.L., Wayne Loui

Veterans Memorial Auditorium
Marin County Civic Center
Marin County, California
Board of Supervisors of Marin County

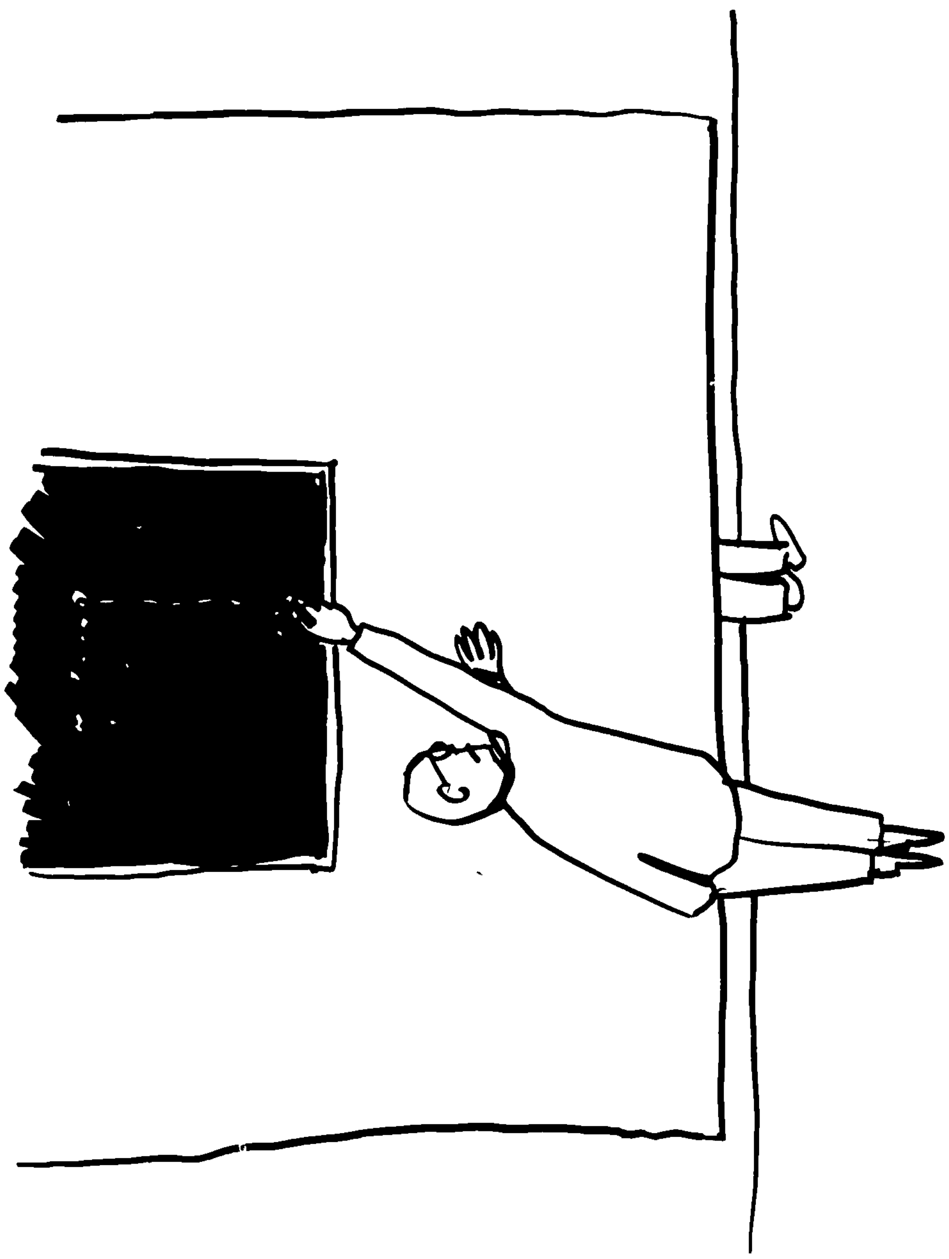
To open: 1968-69
Capacity: 2,400—880 in main hall, balance in telescopic seating behind partition on orchestra floor and in balcony
Partition type: bipartient steel garaged above ceiling and below floor, mechanically operated, friction seals
Partition manufacturer: undetermined
Architects: Taliesin Associates Architects Ltd. of the Frank Lloyd Wright Foundation
Acoustical consultant: Vern O. Knudsen
Theater design and engineering consultant: George C. Izenour
County administrator: Alan Bruce

Performing Arts Center
Grosse Pointe High School North
Grosse Pointe, Michigan
Grosse Pointe Public School System

To open: September, 1968
Capacity: 830—430 in main hall, 200 each in two rear seating areas
Organization: Grades 9-12
Partition type: "Y" shaped, bipartient steel garaged above ceiling and below floor, mechanically operated, compression seals
Partition manufacturer: undetermined
Architects: Harley, Ellington, Cowin, and Stirton
Acoustical consultants: Bolt, Beranek and Newman
Theater design and engineering consultant: George C. Izenour
Superintendent: Charles Wilson

Multi-Use Learning Center
South Mountain High School
Phoenix, Arizona
Phoenix Union High School System

To open: Date undetermined
Capacity: 1,400—600 in main hall, 200 each in four rotating lecture halls
Organization: Grades 9-12
Partition type: None; lecture halls mounted on mechanically operated turntables. Curved rear walls act as partitions when lecture halls are turned away from main hall. No seals. Acoustically treated labyrinths around turntable and top and ends of walls provide for sound transmission loss.
Partition manufacturer: None. Walls of conventional construction, labyrinths to be job fabricated.
Architects: Cartmell and Rossman
Superintendent: Howard C. Seymour
Principal: Forrest Darsey



Acoustical consultant: Ranger Farrell

Designed by: Chermayeff & Geismar Associates, Inc.
Illustrations by: Ivan Chermayeff
Architectural drawings by: Yuri Kersamagi
Printed by: Publishers Printing-Admiral Press, Inc.

[illegible] available without charge from [illegible] Avenue, New York, New York 10022.

[illegible]. A guide for the decision-makers in [illegible] can provide enough space [illegible] how the space can be [illegible] in the decades ahead. ([illegible] Additional copies $1.00.)

[illegible] report on the what, why, and [illegible] involved in planning, building, and [illegible].

The Cost of a Schoolhouse. A review of the factors contributing [illegible] of schoolhousing, including planning, building, and [illegible].

Design for ETV—Planning for Schools with Television. A report on facilities, present and future, needed to accommodate instructional television and other new [illegible] programs. Prepared for EFL by Dave Chapman, Inc., Industrial Design.

[illegible] *School Facilities.* A survey of portable, [illegible] in use in the United States and a plan for the future.

[illegible] *for Computer/The Story of GASP.* [illegible] to help colleges and high schools [illegible]

[illegible]

[illegible] information on some of the latest developments in school planning and design.

[illegible], Holland, Michigan
High Schools 1962—educational change and architectural consequence
Schools Without Walls—open space and how it works
Middle Schools—controversy and experiment

A series of reports which provide information on specific solutions to problems in school planning, design, and construction.

4. *A Divisible Auditorium/Boulder City, Nevada.* Case study of an auditorium that can be converted to instructional spaces by the use of soundproof, operable walls.

5. *New Campuses for Old: a Case Study of Four Colleges That Moved.* What the decision to move means from an economic, academic, social, and physical point of view.

6. *A College Health Center.* Case study of a model center for small private colleges; architectural design by Caudill, Rowlett & Scott.

7. *New Building on Campus: Six Designs for a College Communications Center.* Graphic representations of the results of an architectural competition for a new space to house the accouterments of instructional aids and media.

8. *The Schools and Urban Renewal.* A case study of the Wooster Square renewal project in New Haven, Connecticut.

9. *Air Structures for School Sports.* A study of air-supported shelters as housing for playfields, swimming pools, and other physical education activities.

10. *The New Campus in Britain: Ideas of Consequence for The United States.* Recent British experience in university planning and its implications for American [illegible], academics, and planners.

[illegible]

3. [illegible] *of School Buildings* by John Lyon Reid and Dariel [illegible] of academic space in schools. An analysis of the statistical [illegible] study.

CASE STUDIES 11 OF EDUCATIONAL FACILITIES