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THE DESIGN OF A NATURAL HISTORY MUSEUM

near

Billings, Montana

By John M. Devitt

Under-graduate Thesis
for
the partial fulfillment of requirements
for a Bachelor of Architecture Degree

Montana State University

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To

My Wife,

Elinore

FORWARD

In compiling data for the research on natural history museums, many problems were confronted. Little has been written that was of help. What was, was hard to find. Without the help of those people and organizations that I encountered, very little could have been accomplished in the short period of time that was allocated for research.

My advisor, Professor John DeHaas Jr. was helpful in setting up appointments both with the thesis committee and research scources. I am very appreciative of the Fish and Game Department, the present caretakers of the Indian Caves State Park for the information they made available to me, for their interest and for their encouragement which helped give this thesis more meaning.

I cannot thank the curators enough for their contributions and the valuable time they gave. Bob Morgan, former curator for the Montana State Historical Museum, helped to develop much for the feeling of a museum. Dr. Les Drew reviewed the design as well as contributed much valuable information to the museum's development. Last a special thanks must go to Bob Gant, assistant curator of the Montana State Historical Museum, for the considerable time and information he gave to me. He took the time to review the preliminary design, dug out considerable information and was very inspirational.

The personal involvement of these curators was very instrumental in this thesis's development. They were very unselfish with their time and very enthusiastic about

the museum design's development. Not enough can be said for their contribution.

I am grateful to Sam Gilully, director of the Montana State Historical Museum for his contribution to this thesis. He took me on a personal tour of their very fine museum and gave me considerable insight into the function of a museum. His time is valuable and he gave it to me unselfishly. His enthusiasm was very inspiring to me.

I am very thankful to all, those mentioned and those that are not. They made this a very inspired and valuable learning experience.

"How rich is the man who has all of the gold in the world, if he has no where to spend it?"

John M. Devitt

introduction

A

INTRODUCTION

The word museum comes from the Greek word mouseion, meaning the house of Muses. In Greek mythology the muses were nine gods who presided over literature and the arts and sciences. The word muse means a source of genius or inspiration.

This book deals with the development of the design of a museum under these pretenses. That is to say, a museum should be more than a collection or an exhibit. It should be what it was in the beginning, a place of interaction between people inspired by the history of the past.

Much of what will be concluded in this book was derived at by my research of museums and my interpellation of a variety of viewpoints. In previous three years, I have visited museums in both Canada and the United States for the purpose of this thesis. Some of these were old and some were very new. On one occasion I was able to view an old museum being replaced by a new one. From this I was able to draw some conclusions both from the point of view of a visitor and of a designer in developing a museum design.

Several interviews were also conducted, both with museum directors and their staff. Much of the technical and building requirements were brought out at these meetings along with considerable amount of the philosophy of design.

The rest of the research was done in the libraries and through interviews and meetings with other individuals or groups responsible in specific areas of the museum and its site. Unfortunately the library offered little in the way of helpful material considering what is available.

The development of this design was a combination of this research along with the formation of a design philosophy for this building. This obviously is not the only approach to a museum design and may not even work in another area or culture. But I feel it is valid for the situation that it was intended for.

School of Architecture
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Bozeman, Montana

Thesis Proposal I:

The state of Montana contains large quantities of natural resources. Much of what has been found in the many archiological diggings have been taken out of state.

My proposal is to design a Natural History Museum for the state of Montana located in Billings. The state of Montana does not have a museum of this type. It has many area museums that are very small and contain little.

Most museums that now exist are not very interesting in themselves and do not compliment what they contain. One of the major problems to be solved will be in creating complimentary spaces.

In this pursuit I hope to develop my presentation techniques through the use of photography.

My thesis advisor will be John DeHaas.

My resource people will be: Dr. Leslie Drew, curator of Museum of Rockies, Dr. Robert Chadwick, Earth Science, others as I get more into it.

John Devitt

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Thesis Proposal II:

In order to design a museum of any type, one must first define what a museum is. The 'thesis' of my project will be to define the idea of a museum, then apply this definition to the designing of a natural history museum to be located in Billings, Montana.

Many museums today are merely warehouses for artifacts and relics. Their appeal is limited only to the curious and the inquisitive. If someone finds something that intrigues them they usually have to go somewhere else to find more information on the subject. There are many things which a museum can be: educational, fun, and relaxing. They should be more than a store house for dead things.

My thesis advisor is Prof. John DeHaas and the resource people: Dr. Leslie Drew, curator of Museum of the Rockies who will advise me on the operation of museums along with his personal feelings as to what a museum should be; Dr. Robert Chadwick, Earth Science, who will share his expertise in his field with me. Others will be added as found. We will meet together or individually at least once a week or as their time will allow. A record of such meetings will be kept as will all other developments throughout the project.

This quarter will be devoted to research, carried out by studying what has been done in other areas and developing definition from which a design can develop. Site orientation will begin about mid-quarter where both research people and thesis committee can become familiar with the site. One or two preliminary designs will be submitted towards the end of the first quarter for the purpose of orientation.

Spring quarter, approximately the first half will be devoted to design with the next quarter used for finalizing the design and the last quarter used for presentation.

My final presentation shall be a written program with graphic and photographic representation, a written solution with graphic and photographic representation and a model and drawings.

John Devitt

local conditions



LOCAL CONDITIONS

CLIMATE: Climate is an important contributor to Billings' graceful environment. Community residents are eager to quote the often used phrase, according to the Billings Chamber of Commerce, "While the rest of the world endures weather, Billings enjoys climate." We have extremely mild winters, exemplified by the fact that the City of Billings owns no snow removal equipment. (Billings also has some of the worst streets in the state). The humidity is generally low and the warm sunny days turn to enjoyable pleasant cool nights. In January, our coldest month, the average daily high is +38.3 degrees. Because of the semi-arid climate there's lots of summer sunshine at a pleasant normal 87.9 degrees in July. The record low in the Billings' area is -38 degrees, reported in February, 1936, and the record high is 106 degrees, reported in July, 1937. The average precipitation for January is 0.99 inches and for July 1.69 inches with a total for the whole year of 14.73 inches.

GEOGRAPHICAL: Located 3124 feet above sea level, 45.47 north latitude, 108.30 west longitude, lies Billings. Resting in the fertile Yellowstone Valley, it is the gateway to the Rocky Mountains in the westerly direction and the Great Plains in the other direction. Yellowstone Park is only 120 miles going in a south-westernly direction.

Water is supplied by the Yellowstone River, which flows through the valley and borders the south edge of the city. Rising 200 feet above the valley floor are sandstone cliffs known as the rims. Not only do these cliffs enclose the city on two sides but much of the valley's history is inherent within their perimeters.

HISTORY: Within the rims, the stories of Sacrifice Cliff, Kelly Mountain, the Immel and Jones Massacre, and Boothill Cemetery have taken place.

Sacrifice Cliff--About a hundred years ago, the scourge of smallpox swept through the Indian tribes of the northwest. It has been estimated that 150,000 Indians, or approximately half of the total population of these tribes succumbed.

Sacrifice Cliff, which rises 200 feet above the Yellowstone River is so named because of the Indian legend that here a number of Indians rode horses over the cliff to their deaths as an appeasement to their gods.

The cliff is a few rods south of U. S. 10 east, 1½ miles east of Billings.

Kelly Mountain--Known in early days as Skull Butte, or the Place of the Skulls. Here were the skeletons from Indian burials of those who died from the smallpox epidemic of 1837 and other causes. This was nearest place to the Indian camp suitable for Indian burial.

This butte is the extreme east end of sandstone rim-rocks which line the valley for twenty-five miles west. In the early days there were several graves in the trees surrounding the bluff.

The last known burial was a child who died during the first Yellowstone County Fair.

Immel and Jones Massacre--On the 31st of May, 1823, a party of 29 trappers of the Missouri Fur Company, returning from the Three Forks of the Missouri, were attacked by 400 Blackfeet Indians on the Yellowstone. Site of this incident is on Alkali Creek, at the eastern edge of Billings, at that time a small canyon, described by one of the party as a defile. Michael Immel and Robert Jones, leaders of the party, were both killed. Five of their men were killed and four others wounded. All of the horses, about 50 in number, their trade goods, 20 packs of furs and their traps were taken by the Indians.

The survivors of the party crossed the Yellowstone on rafts of driftwood and made their way east to a friendly Crow camp on Pryor Creek, a distance of 10 miles.

The stolen furs later found their way to the British possessions and were traded to the Hudson's Bay Company. Appearing on the London market, they were recognized by their markings and a claim was made by the Missouri Fur Company, bringing on an international incident.

After several exchanges of diplomatic notes the claim was finally amicably settled.

Boothill Cemetery--This is burial ground of two score residents of Coulson, Montana most of whom "cashed in with their boots on."

Tradition has it that the cemetery was started when a 'gent' in a Coulson saloon called another a liar. Nearly all the others interred at Boothill met violent deaths, and side by side lie peace officers, victims of Indian massacres, and a woman who committed suicide in the river.

The most famous personage to be buried here is Muggins Taylor the scout who carried the news of the Custer Battle to the world. He was later killed in the line of duty while Coulson's constable. The last burial was in 1862.

The monument, which was erected in 1912, is built of stones picked up from the burial ground.

Government surveys began in 1851 and in 1864 Montana became a territory. In 1889, Montana became the forty-first state of the Union. The steamer Josephine made her way to the present day site of Billings in 1875. The soldiers, scientists and scouts on her deck met only friendly Indians that year even though Indians were rampaging in the 1870's.

Coulson was the first town of the area, about two miles downstream from the present site of Billings, Coulson was replaced by the town of Billings with the first building completed May 1, 1882. By October 250 homes were built and the boom continued. When the first shipment of 700 cattle left Billings September 11, 1882,

the town was on its way to becoming the trade center it is today. By 1886 Billings had a water plant, a flour mill and private telephone lines. The first sugar beet refinery opened in 1906, following the development of a dependable irrigation system. Billings was firmly founded on agriculture, trade and manufacturing. The Huntley Irrigation Project, completed in 1907, was the first of seven federal projects in the Yellowstone Basin which brought stability to agriculture.

When the first permanent structure was completed in May of 1882 to accomodate railroad engineers, Billings rose almost overnight to a population of 1,500 to 2,000 citizens. Growing so rapidly it gained fame as the "Magic City." As Billings continued to develop into a trade center the population continued to climb.

YEAR	POPULATION
1930	16,380
1940	23,261
1950	31,834
1960	52,850
1964	58,100
1970	61,581

In 1970 the metro area was tabulated which includes the population within a 4 mile radius. It was 74,848, with 87,367 in Yellowstone County.

ECONOMIC: Today, Billings is the largest city in a 500 mile radius, and area of over 36,000 square miles. It serves as a distribution, retailing, medical, cultural and entertainment center for over 250,000 people. Because

of the location, tourism contributes increasingly to the economy with over 60 dude ranches located within 200 miles. Yellowtail Dam and the Big Horn Canyon, ghost towns, deserted mining camps, buffalo jumps and several mountain ranges are close by. Montana is famous for its hunting and fishing opportunities. Two interstate highways three major airlines, two major rail lines, two transcontinental bus lines and thirty seven trucking companies make Billings the transportation center for this entire region.

Billings Logan Field is located just two miles from the business district and provides fifty-six flights a day to all major points east, west, south and north. We are served by three major carriers with feeder lines to the small communities of Montana and Wyoming. Because of the consistently sunny weather, Billings Logan Field is one of the lowest in the United States in the number of hours per year it is closed due to weather. Some years the airport has 365 complete flying days.

Each week 289 carloads of goods and merchandise are shipped into Billings and are either distributed to communities throughout the region through the 274 Billings wholesalers or through the retail network.

Agriculture contributes significantly as an influence of Yellowstone County's economy. The estimated cash receipts are approximately twenty-three million dollars. This comes from livestock, feed lots, sugar beets, and other small grains. 73% of the cash receipts are spent

locally to purchase goods and services by 1,200 farm and ranch businessmen to produce the total receipts.

EDUCATION: Billings has 31 public and 8 parochial schools, providing instruction in grades 1 to 12. There are two 4-year colleges, Eastern Montana College, a state operated institution, and Rocky Mountain College, a private school. The enrollment in grades 1 to 12 is approximately 20,000. The colleges have almost 5,000. Besides these schools we have a Vo-Tech program supplemented by many fine private trade schools like a business college, beauty schools and nursing programs.

CULTURAL: Eighteen parks and recreational areas, three swimming pools. Ice-skating and sledding in the winter. Five bowling alleys, three golf courses, indoor and outdoor tennis courts, YMCA, YWCA and two ski areas nearby. Two museums, three drive-in movies, three theatres, art center, little theatre, Little League and Babe Ruth Baseball, American Legion Baseball and Billings Mustangs Professional Baseball Team. Lake Elmo and the nearby Cooney Dam offer aquatic sports from leisurely sailing to speedboating and water skiing. Two television stations and cable television, four AM and two FM radio stations, one daily newspaper, one legal newspaper, two farm newspapers and an oil journal.

site



MUSEUM SITE



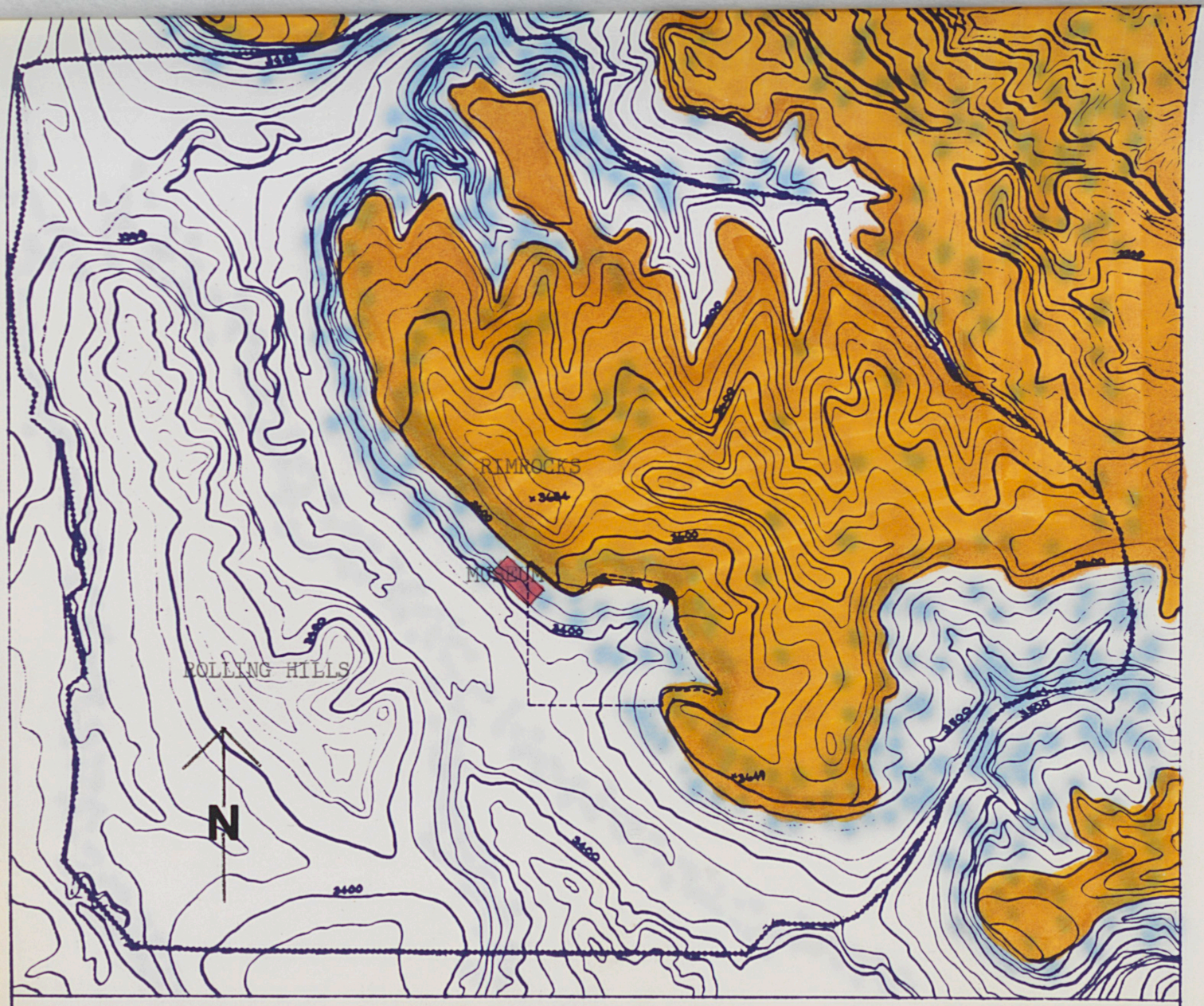
VISTA FROM MUSEUM

SITE

The selected site is located approximately five miles south east of Billings in the Pictograph Caves State Park, more commonly known as the Indian Caves. Selecting a location out of the city enables people to get away from the rush of the city and have a place to go to relax. The selection was also based on the idea of the preservation of the area against uraban development which has already destroyed much valuable farm land; development is already creeping into the area now. Soon it will be too late.

The boundaries of the park should be enlarged to include enough area both above the rims and below on the grass land to protect it from visual pollution. It will also insure that a large enough park will exist in the future to serve the people of the Midland Empire.

The soil condition was observed to be sandstone and top soil. The vegetation consists of cottonwoods, pine, and scrub brush.



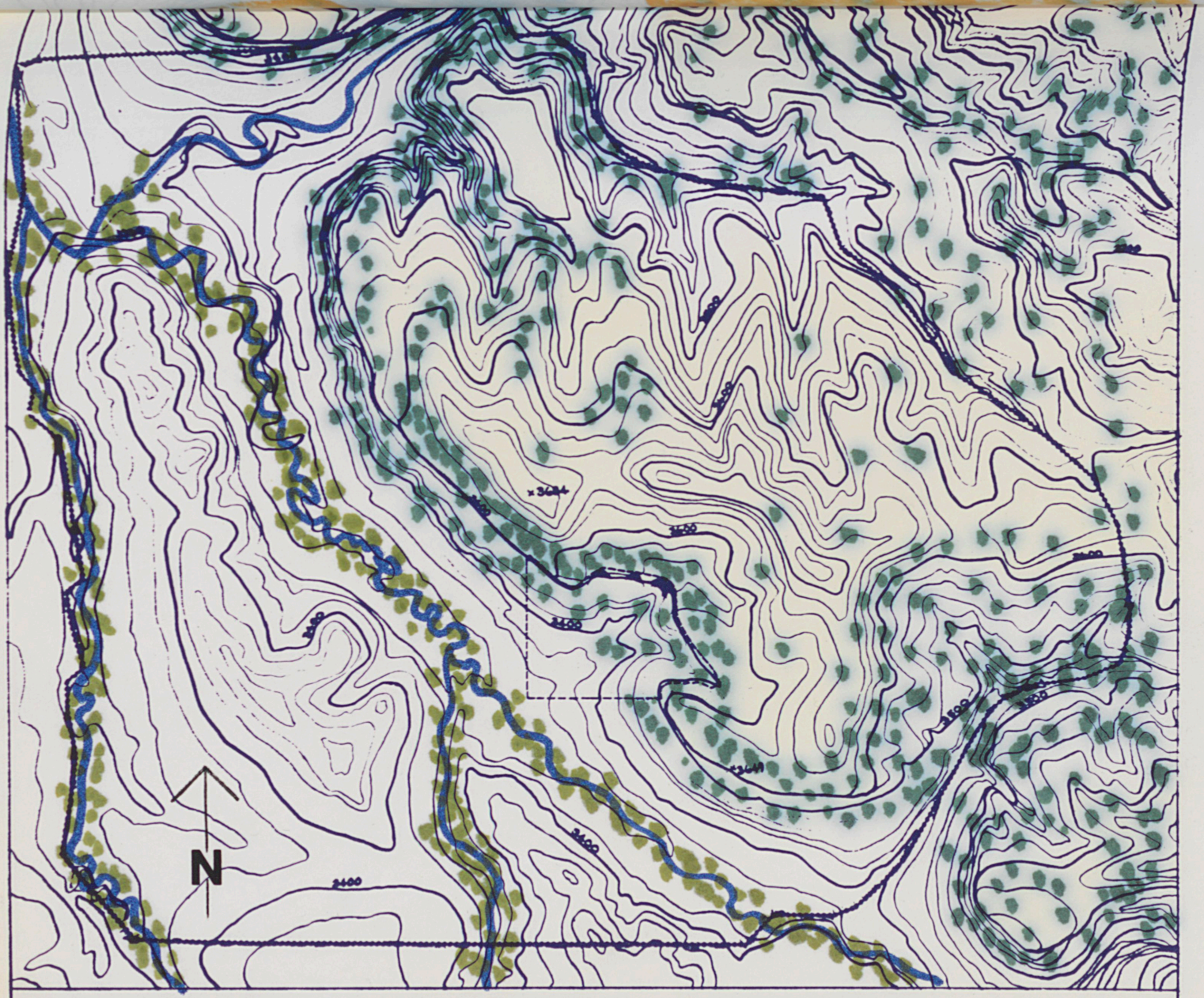
A NATURAL HISTORY MUSEUM
INDIAN CAVES STATE PARK

[illegible], MONTANA

SITE: TOPOGRAPHY:

SCALE: 1 IN. = 830 FT.

c. 4



A NATURAL HISTORY MUSEUM
INDIAN CAVES STATE PARK

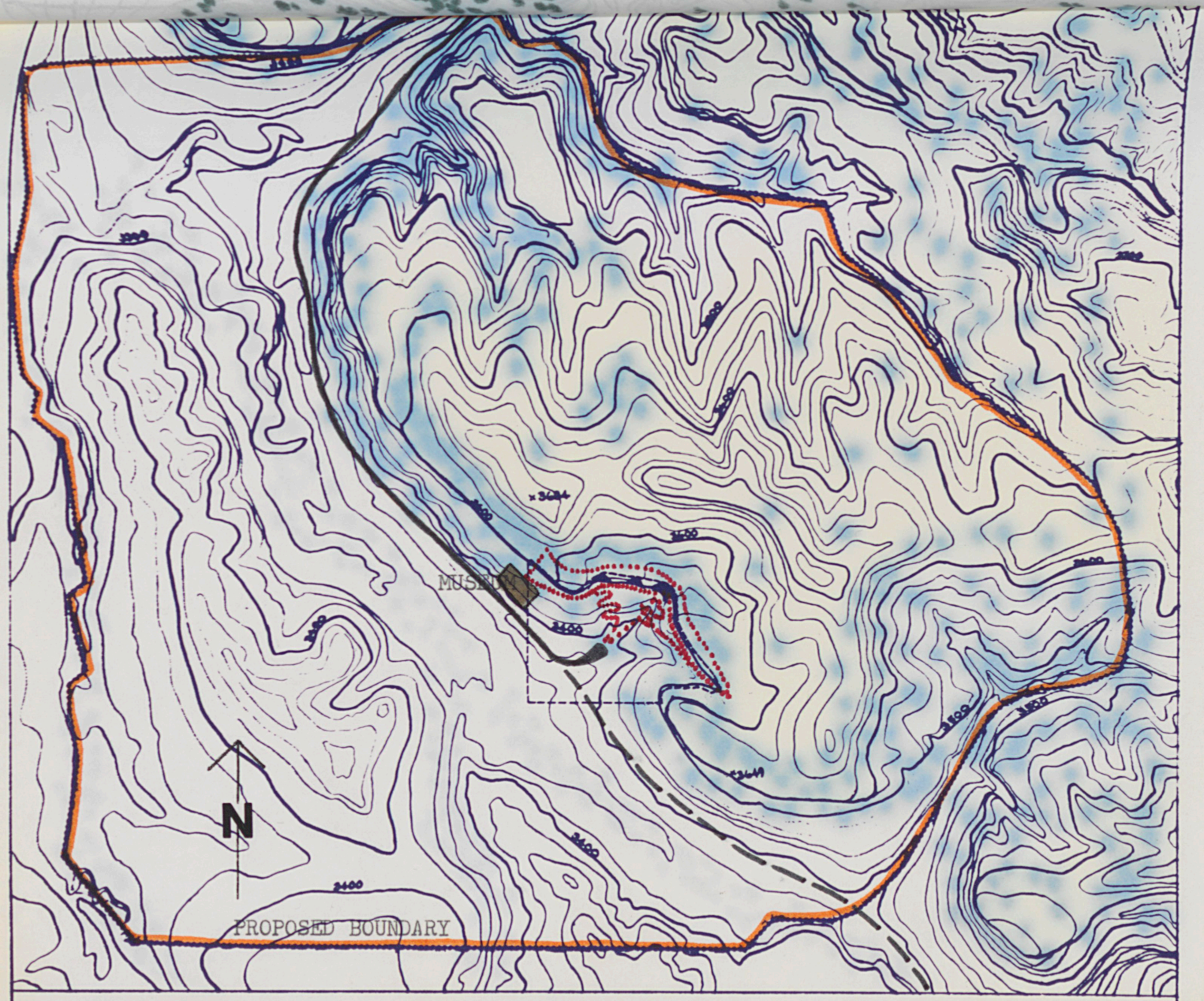
SITE:

VEGETATION & WATER WAYS
Deciduous Trees
Coniferous Trees

MONTANA

SCALE: 1 IN. = 830 FT.

C.5



A NATURAL HISTORY MUSEUM
INDIAN CAVES STATE PARK

BILLINGS, MONTANA

SITE:

PROPOSED PARK BOUNDARY
and TRAFFIC PATTERNS
Vehicular ——
Pedestrian .....

SCALE: 1IN.=800FT.

c. 6

D

museum philosophy

MUSEUM PHILOSOPHY

Collecting is a natural human activity. How natural and how deeply embedded it is, is shown by the fact that there are various animals that share this penchant with man. A museum's success or failure will depend on the public's involvement with the collections that it exhibits.

> The people of America come from the different quarters of the world. They are diverse in their traditions and backgrounds. They represent cultures not only various but often conflicting. Yet they have one trait in common. They want to learn. They are bent on self-improvement.
>
> We are all engaged in what may be called the romance of living. And this, even at its very simplest is an affair that has three sides. For the first side, it has its hero, a role that every one of us privately sees himself as playing. For the second side, no such brief and unambiguous identification can be formulated, for it involves all with which the hero has to cope in meeting the manifold problems imposed upon him by his own conditions and by outside circumstances--the setting, the personalities, the vicissitudes, all being endlessly variable. The task ordinarily includes a number of such things as responsibilities to others, preparation for and pursuit of a career, maintenance of a social and economic statue, and so forth. The third side of the romance of living about which our happiest daydreams are wont to linger. It is the heart's desire of each of us. The heart's desire is protean. It may be almost anything. It differs from person to person and from time to time. This third side is obviously the furlough from the stern campaign of life.[1]

It is the museum's role to furnish guidance and inspiration for the successful channeling of pent-up energies,

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1. Alice Millard Stowell, The Living Museum, New York: Vantage Press, Inc., 1956.

and to provide the place for mentally healthful pursuits. The museum is not a place to learn virtue of its exhibiting strange and unheard-of things, but rather by its presentation of the familiar and the near-familiar. In fact, learning is not accomplished by coming into contact with totally unfamiliar things. They must be associated with the familiar to be intelligible at all.

The museum does its teaching best by presenting in an orderly way exhibits that include the familiar, but that show it is systematic relationships and that introduce what is less familiar where it belongs so that the new element is clear and pertinent. To things within the range of our experience we can gradually add factual information which will fill in the gaps and round out the corners.

The nineteenth century became the epoch of the public museums. People wanted to know about the past partially because the United States was a young country but very large and vast. In Europe where tradition was handed down, little changed but in America there was little tradition and even less of a past. A desire for "roots" became of the utmost importance.

This is also the period of time which first created the public impression which has become so disheartening in subsequent years to those who frequent the "houses of the muses." The word museum, instead of seeming to imply a center of learning came to mean something ponderous,

dull, musty, dead, a graveyard of old bones of the past.

It is generally considered that museums fulfill three main functions. They serve as depositories devoted to the preservation and conservation of objects of particular value--treasured for their association with events and personalities of history, for their significance in representing human excellence in terms of scientific ingeniousness or of artistic achievement, and for providing samples of the natural environment or objects related to human ways of living at different times and in different societies. They are centers of research and educational agencies. Some institutions are mainly or exclusively devoted to a single function; others endeavor to serve two of them or all three.[2]

A characteristic of museums, of whatever content or scope, is their flexibility; they are all a wide gamut of differences in the use people make of them.

As every other environment of research, learning, or recreation, museums have their congenital strengths and limitations. Their prime assets are the direct appeal to the eye and to the sense of touch, and the potential capacity to present a number of facts simultaneously and in palpable content. They are unique in offering to people immediate encounters with authenticity.

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2. Alma S. Wittlin, Museums: In Search of a Usable Future. Massachusetts, The MIT Press, 1970.

Museums are not ends in themselves; they are means in the service of man and of his cultural evolution. To accomplish their mission they have to excite people as will as to inform them.

Curiosity is a human characteristic. While the animals that surround us seem, on the whole, content with recognizing what is good for them and getting it--and with recognizing what is bad for them and avoiding it--man wants a fuller life. He wants to know about everything, regardless of its status of being good or ill for him.

In the selection of a museum's activities there is more to be considered than the distribution curve of needs. For needs have another dimension--that of intensity. What is wanted is important, but how much it is wanted is equally important even if more difficult to judge.

Exactly as every animal has to be in some measure adapted to its environment to assure its well-being, even its survival, so every museum needs to be so adapted if it is to flourish. At some museums this adaptation is accomplished by extensive exhibits of local fauna and flora. Besides mere increase in the number of species represented, there are two other directions for expansion. One is to supplement the showcase specimens with actual living examples. The expansion of exhibits of fauna and flora in another

direction--the exploitation of which is unusually rewarding. Living things go through conspicuous stages. The living things at the museum show these stages, of course, but only over a more or less long period of time, and sometimes only for the benefit of those visitors who have the opportunity, and capacity of, close observation. It is more practical to have showcase specimens to represent different states in the life development.[3]

The local museum, regardless of its nature, has many materials that supplement the studies of pupils in schools and that give additional or new meanings to considerations of history, geography, social science, nature study, general science, and other studies. Museums have two ways in which they can use their materials to teach school pupils. On the one hand, they can teach about the materials themselves, or, on the other hand, they can emphasize the meanings of the materials in terms of greater understanding either of the school-area of thought, or of the pupil's contemporary living.

One of the more insistent problems in most museums is that of providing the concomitant facilities for taking care of groups, particularly children. A second element that makes difficulties for the museum teachers is the set of conditions under which teaching must take place. The way a class goes into a museum has many of the aspects

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3. Stowell, op. cit.

of a holiday excursion. Normal classroom controls are usually left behind; the pupils are leaving undone many classroom tasks; they are prepared emotionally for a museum trip; and if they have had experience either with their parents or by themselves in a museum it has generally been a recreational venture. A third element that makes teaching difficult in a museum is the competition that the teacher and the subject have with almost every other element in the museum. If the museum teacher is serious, he has a definite problem and a definite goal. The museum teacher deals with a changing group and an ostensibly static curriculum. The purpose of planning a complete program for elementary schools is to make possible a proposal to the schools and to the teachers that will enable them, efficiently, to make the maximum of the museum's opportunities, and enable the museum to use its facilities to their fullest desirable extent. The first set of factors that are involved concern the museum and the amount of offering it can make. A second factor in determining the museum offering is the selection of the subjects to be dealt with in the program.[4]

Sometimes museum visitation by pupils is so stimulating that a few pupils return to the museum later to follow on with what was done in their class visit.

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4. Charles Russell, Ph. D., Museums and Our Children, New York: Central Book Company, Inc., 1956.

The first step in developing the daily schedule is that of notifying teachers of the opportunities that are available.

First of all, the pupil should know why he is going to the museum; second, he should know what is expected of him in the visit; third, the limited time at his disposal should be planned and directed so as to bring about the most fruitful results; and finally, there should be some attempt to synthesize the results so that they can have lasting effect on his thinking.

The individual child in the community who is desirous or can be encouraged to pursue his own ends in the way of learning, and do so under the gentle guidance of adults who are able to smooth over the roughest portion of the road, constitutes the main objective in children's work in any community museum.

Almost all museums maintain collections of various kinds of surplus materials have a wide variety of use, and the technics for dealing with them are being increasingly organized and the services are being increasingly broadened. The greatest use of these materials is made by the schools in the vicinity of the museum, since it is difficult for schools with their limited space and the tremendous breadth of their work to keep, store, and distribute any great amount of real material that is supplementary to the studies of their pupils.

There are many ways in which museums try to similate reality by making models, miniature dioramas and cutouts, or when possible, enhance reality by making small habitat groups for exhibition or use outside of the museum.

The use of slides and films is almost universal in the development of explanatory or supplementary aspects of teaching, and the variations that have come about within recent years through the addition of film strips, recordings, radio, and even television, are spreading rapidly.

The elements of astronomy are most difficult to bring within the range of children's experiences. The earliest planetarium, was invented in Jena, Germany. This instrument is generally housed in a separate building of its own, the characteristic feature of which is a huge, hemispherical dome. It is mounted in the center of this dome where the horizon line is on the level of the center of the instrument. Seats for visitors to view the performance of the instrument are usually ranged in circular rows around the instrument, and are arranged so that a viewer can lean backwards and scan the dome. Domes for these instruments range upwards to one hundred feet in diameter, and the seating capacity of some of these planetariums is upwards of seven hundred. The instrument is operated from a console at one side of the room or chamber, and is controlled by a lecturer who is provided with special equipment, such as a light-pointer, for indicating the part of the heavens under discussion.[5]

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5. Russell, op. cit.

The instrument itself consists of many separate parts, arranged so as to move in relation to one another in set ways to simulate various star and planet positions at different times. The fixed stars are projected in different degrees of magnitude through apertures and the planets are arranged in a series of special lenses that operate to project the images on the dome, moving through their proper orbits at their proper relative speeds. The position of the viewer with respect to the sky can be set at any point of the globe, and any aspect of the heavens can be simulated for any time in a cycle of more than two hundred thousand years.

Projection of the stars on a hemispherical dome is just one of the many interesting demonstrations which can be done with a planetarium instrument and its many special attachments. The stars can be made to move across the sky though the motions of course, are faster. The sun can be traced in its path as it slips silently through the ecliptic constellations. The north and south migration of the sun from season to season can be vividly and accurately portrayed. The moon can be shown in its various phases.[6]

And now the planitarium, with the advent of the imax can present other worlds like that of microbiology. Areas which because of their size or dimension can now be viewed through specially prepared movies.

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6. Russell, op. cit.

Perhaps the most difficult problem now confronting museums is how does the museum stimulate ones interest to the point where his level of awareness is raised. Those who are involved with the design development of a museum often overlook this very real problem, primarily because they are generally susceptible to the museum's offerings. They are already scholars. The problem lies in making the museum comfortable to those who are not scholars, and finding ways of drawing them into the museum--to raise their level of awareness.

International Council of Museums (ICOM) defined a museum as an establishment in which objects are the main means of communication. Museums are man-made institutions in the service of men; they are not ends in themselves. Museums are not islands in space; they have to be considered in the context of life outside their walls. The truism becomes a verity under present conditions of accelerated change and at a time when every institution has to take measure of itself as a means to legitimate survival. It is the three-dimensional reality and the authenticity of objects that matter, and the stimulation they offer to eye and hand. Most of man's traffic with his environment in the course of his perplexingly brief existence on earth has been directly through the senses; historically, written language is an invention of yesterday, and spoken language is comparatively new if we consider it as a means of communication in the context of the entire organic sector

on earth. Another quality that endows museum materials with high potential as a medium of communication is the opportunity they offer to present a number of facts simultaneously and in context. A museum exhibition can merely offer skeleton information and may light up interest with regard to a single point or to a few points, but if such impact is achieved with the help of the somewhat primordial forces of objects. One of our blind spots, in all manners of educational environments, is the assumption that the exposure of people to experiences necessarily results in learning and stimulation. A museum, every single museum hall, every individual exhibit is a man-made environment; it is not a natural phenomenon resisting change; it can be changed.[7]

Museums have resisted change; they exist for the scholar only, with their doors left open to all but their appeal is only to a few.

> The grand opening, attended by an 84-piece band, two combos, and a block party with speeches and klieg lights, took place on September 15, 1967. A local group of Trail Blazers had painted the nearby fence separating the museum from the next property with a stylish "primitive" mural of life in Africa. The desolate surrounding lots were spruced up, and one of them decorated temporarily with Uncle Beazley the dinosaur, hero of the story The Enormous Egg. One of the striking byproducts of the opening was the improvement in the appearance of the block. Several storefronts and houses were newly painted. The local utility company branch, with friendly and unexpected solicitude was hastily painted and landscaped with

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7. Wittlin, op. cit.

shrubbery, greatly enhancing its previously dreary-looking brick premises. The whole place began to look almost as smart as the swagged bunting draped on the old theater marquee, now rechristened as the Anacostia Neighborhood Museum.

There are no guards at the Anacostia Museum, and there has been no vandalism. Not a feather or a fossil has been stolen. What is the mystery of this equation: No guards=no losses and no vandalism? The only valid answer of course is "because it is their museum, not ours, and they can be proud of it."

Curiously enough, many people who at the very least belong to the Book-of-the-Month Club find all this singularly uninteresting. "You have no business fooling around with all this stuff," one man told me. "I'd as soon burn them as lend you any of my masterpieces."

I was tongue-tied, as most people are when harangued suddenly, or perhaps the word hectored is a better one. But I did try to tell him one thing which pleased me about our experiment. I wanted to keep the Neighborhood Museum rather individual, just itself, different from the rest of the Smithsonian. It is their Museum in a real snese, not ours. However, after a while I had wanted to have a small discreet sign put up, saying in effect, "If you want more of this, take the such-and-such bus line over to central Washington and go to Consitution Avenue Northwest between Fifth and Fourteenth Streets and you can see more of it, on the Mall." I didn't know quite how to put it unobtrusively, but the idea haunted me. How to get people who never went anywhere to go to a museum where somehow change and evolution in their own lives might be set in train? Surely, if museums of the future are to be valid, they must be of use, must communicate to the very people who need them most.

One day I took Harold Howe II, then United States Commissioner of Education, to see the Anacostia Museum and then to have a sandwich in the little noisy

restaurant next door. We entered the vestibule of the old theater, past the ticket booth, now gaily decorated with posters and exhibition news. Inside John Kinard was standing with a group of several men to whom we were introduced. Suddenly one of them, a giant of a man in a rough jacket, turned to me and said:

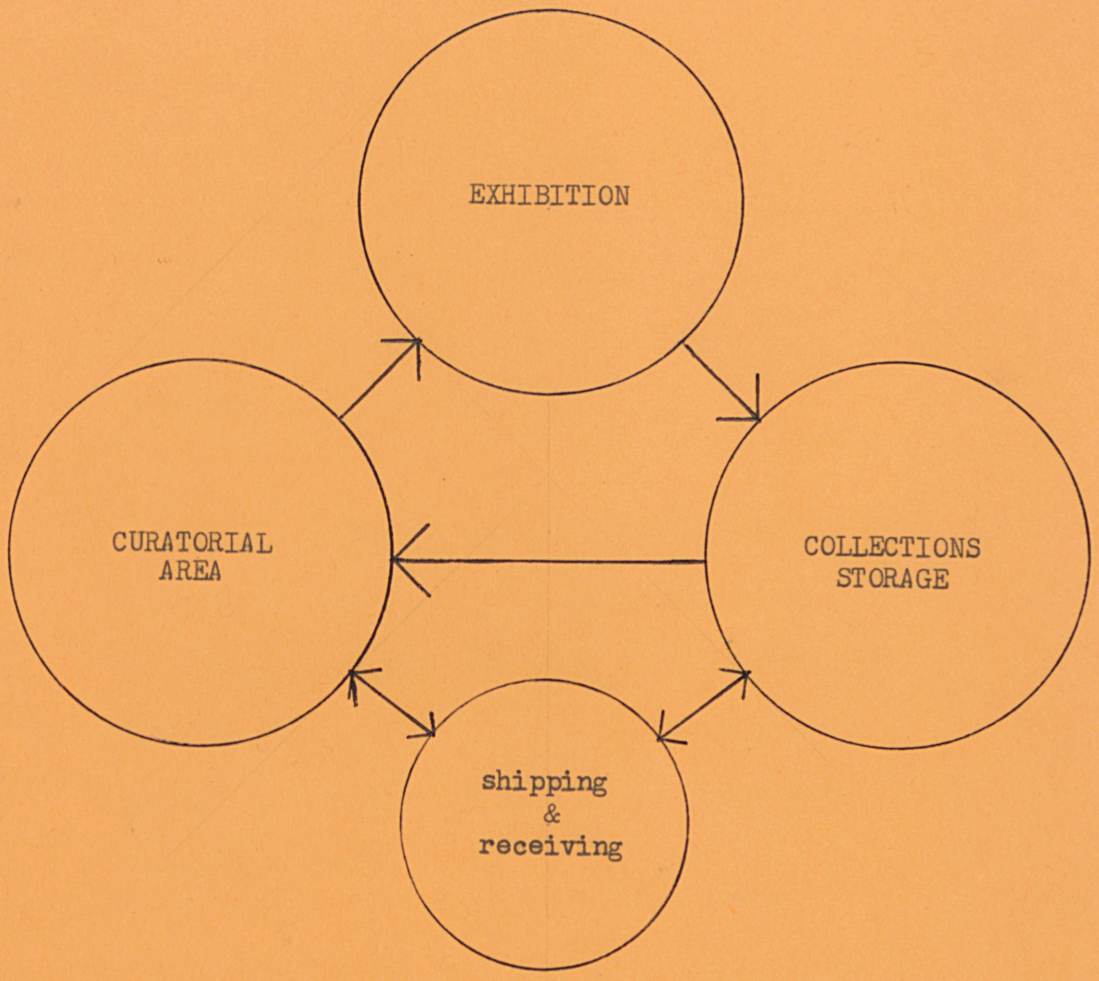
"You know, Mr. Ripley, I've lived my whole life right here. I drive a truck, see, and I go everywhere. I been up and down that old Constitution Avenue all my life. I've never been in those big (accented) buildings. I'd be scared to. But now--you know, I'm going into that old Smithsonian of yours. Yes sir, you're getting me cultured before I know it."

And so I heard what I had come to hear.[8]

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8. Dillon Ripley, The Sacred Grove, New York: Simon and Schuster, 1969.

function



MUSEUM FUNCTION

flow diagram

FUNCTION OF A MUSEUM BUILDING:

1. Functional Organization. "Form follows Function" is the basic premise for successful museum design. The location and space organization of functions through flow diagrams is the first step for a efficient and practical design.

2. Separation of Function. The grouping and organizing of functions into particular placement is desirable to create a functional organization. Public areas have to be separated from private areas. These then can be separated into their respective areas.

3. Efficiency. Efficiency will be the result of careful planning. This will result from grouped functions interaction with other functions, such as the distance exhibits have to be moved, pedestrian traffic, security control, etc..

4. Display Relationships. The museum should tell a story from beginning to end. When a visitor enters an exhibit, he should have a story line to follow that is in a natural sequence that can be followed without confusion.[1]

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1. Interview with Robert Morgan, former curator of Montana State Historical Museum.

Each display area should be independant of the others so it can be closed off for repair or for an exhibition change.

These displays should provide stimulation on several levels too. They should be interesting for the very young as well as the very old.

The exhibits should be directly accessible by the staff as they are readily accessible by the public.

COLLECTION STORAGE: Artifacts and collections must receive proper care and not dumped into a room. They must be arranged and classified into groups, easily available for reference, research, display and restoration.

These objects must be protected from heat, cold, humidity, light, and pollution. Any one of these elements can cause damage to various artifacts.

Preservation of collections requires proper storage equipment. A wide variety of shelves, bins, trays, racks, cupboards, and files will be needed. These should be mobile and flexible.

If a museum does not take care of its collections and use the proper methods of preservation, worthwhile items will become much more difficult to acquire from donors. These artifacts will find their way into other museums, whence they will be lost forever.

CURATORIAL AREA: In this area the exhibitions for the gallaries are conceived, designed, and constructed. Laboratories and equipment for research will also be located in this area. Studios for illustrators, artists, and designers as well as office space for curators and their various personnel will be required.

Equipment most commonly used in this area will be small power tools, work tables, hand tools and painting equipment. Other items required will be a stove, sinks, deepfreeze, gas, compressed air, water, cabinets, storage bins and shelving.

This area should have easy access to both the gallaries and the collections storage area. Without this relationship the museum would have great difficulty in running smoothly.

EXHIBITION AREA: Control is one of the most important factors in this area. This area must have access to the curatorial area and the collections storage without being obtrusive. Traffic flow is important both to the security and to the museum's interest.

Versatility and adaptability are important considerations also. This is a space that is developed by the curator and continually changing. The space must be designed to be left open while a portion may be closed off for repair or change.

SHIPPING AND RECEIVING: Activities within this area include the loading, unloading, recording, cataloging, and storage of all items brought through the museum. Its primary function is to serve the curatorial area and collections storage. As artifacts are received, they are immediately checked for damage and the presence of vermin. They usually are photographed before they make their way to collections storage.

Secondary functions of shipping and receiving are to receive and ship goods for the gift shop and the publication. It will serve the administrative area also.

FUMIGATION AREA: This room is specifically designed to fumigate objects infested with vermin. It should be large enough to handle bulky items, but not so large that it becomes difficult to control its use efficiently. This facility should be located near shipping and receiving, and needs to be vented to the outside.

STORAGE AREAS: It is imperative that each individual department have their own storage areas designed specifically for its use. Ample provision of storage space is often neglected in museum design which causes inefficient operation.

ADMINISTRATION: The administration is the museum's link with the community as well as the overseer of the

museum operation. Its activities include routine business transactions, reports of museum functions, payroll requirements, general information and requests, and other operations normally found in an administration office. Office space will be needed for the administrative personnel and clerical help together with space for office machines.

PUBLICATION: This is the museum's advertising agency. It is responsible for informing the community and the surrounding area on museum happenings. It is also responsible for keeping the museums contributors and subscribers up to date with the museum developments. Contributions to the field of natural history may be presented to the community from this service too. Office and layout space will be needed along with photographic and printing facilities.

PUBLIC AREAS OTHER THAN THE EXHIBITION

LIBRARY AND ARCHIVES: The heart of the museum is the library.[2] It allows a person to reach beyond the museum collection. Not only will the staff who is doing research find it accessible but so will educational institutions and the general public.

The principle function of the library is to compliment the museum's collections. When someone who visits the museum finds something in the collection of particular

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2. Interview with Sam Gilluly, Director, Montana State Historical Museum.

interest, he usually has to go elsewhere to find more information. Now he will simply go to the library within the museum.

AUDITORIUM: It will provide the facilities for presentation of lectures to large groups, making use of projection equipment. A desirable feature in the design of an auditorium of this type would be the accessibility directly from the lobby without the need of passing through exhibit areas. Access to the stage should be direct and not through the audience seating area. The design of the room should include all of the criteria set up for any auditorium.

SEMINAR ROOMS: These rooms would function similar to the auditorium at a smaller scale. Used mainly by smaller school groups and adult groups, projection equipment should also be included. Locating seminar rooms near the auditorium is desirable.

These rooms could also be used for exhibition also. An example would be displaying school projects here like science fair projects, etc..

GIFT SHOP: No museum seems complete without one. Visitors who are impressed with the complex will want to take something home to remember their visit by. So not only is the gift shop a fund raising portions of the museum but it is also good promotion for the area.

This should be located close to the entrance and close to the lounge area so people have the freedom to browse leisurely without pressure.

CAFETERIA-LOUNGE-BALLROOM: This area is a multi-purpose area which is relatively new to museum planning but which plays a very important role. A museum of this size would take a long time to see. The addition of an area where one could go and get a drink and something to eat and relax would help relieve museum fatigue. It also gives a place where people can go and discuss what they have experienced. It becomes the social asset that most museums are missing--a place where people can meet and socialize.

This area should be located near the front entrance so that the exhibition could be closed off from it to allow it to remain open for receptions, lectures, etc..

PLANETARIUM: This is an area whose function has changed recently. In its conception, the planetarium was a theatre with a dome-like ceiling containing a machine (now called a star ball) that projected the stars and planets on the ceiling. This machine itself was called a planetarium. More recently, however, this term has come to mean the theatre since the function of its operation has expanded. The modern planetarium contains a star ball and planet projections, imax, and projection room. The imax is a projector with a fish eye lens. Special scientific movies are made for this projector. The planetarium has become

so complicated that a computer is required for its operation. Special seating is required to view the domed ceiling.

OBSERVATORY: This is not usually found incorporated into a museum design. Its function, together with the planetarium, is to educate people in the field of astronomy. It will afford the average person the opportunity to view the operation of a large telescope. Students will be able to use it for research and study. But most of all it will bring the people in close contact with this facit of natural science that they seldom have the opportunity to see. A separate building will be needed because of the special requirements regarding the telescope.

design considerations



DESIGN CONSIDERATIONS

SITE: There are two ways in which to handle the building on the site. One may design it so that it will blend in to the site so that it looks as if it is part of it. Or one may design the museum so that it stands apart as a man made object placed in nature. Either way the design has to compliment the site; it should not destroy it.

STRUCTURAL: The structure of the museum should be of a type that is substantial and permanent. Concrete is probably the best choice. A two-way waffle slab offers both the stability and also economy in a large structure. It also fits the site better than steel. Wood is not durable or economical enough in this situation.

MECHANICAL: The mechanical system is an important consideration in the design of a museum. A high velocity duel duct system is the most desirable because of its inherent characteristics. The air should be electrically filtered. That in itself will require an air system. Air temperature should not vary, particularly in the exhibition areas. Humidity control is also very important. The elements of heat, cold, humidity, and pollution can destroy artifacts.

BUILDING MATERIALS: For the exterior treatment, concrete would be most ideal. A concrete surface tinted the same as

the cliffs would make the building look as if it were molded out of the cliffs themselves. The smooth geometrical surfaces would contrast with the rough ground and weathered cliffs showing unmistakably the human element involved.

The interior walls would be exposed concrete with a textured surface. The exhibition areas' wall treatment would be left up to the curator's treatment of the area. If the walls are left exposed they reveal textured concrete. The floors would be a combination of terrazzo for its durability and carpet for its physical and psychological relief. Wood will be used as an accent. It can create a decorative pattern without an extensive increase in cost.

The ceilings will be furred down in the public and office areas. All others will be left exposed and painted.

LIGHTING: Improper lighting can destroy an exhibition. In the exhibition areas a form of special plug-in lighting with a low deterioration factor will be incorporated. This will allow the curator a variety when he changes an exhibit. This would be accomplished by a plug-in grid in the furred down ceiling. In the storage areas, a filtered fluourescent would be used since the lights would be on quite often, therefore detrimental to the collections. These lights have fairly low deterioration values with a reasonably high efficiency. Fluourescent lighting would be used in the other areas because of their economy except in areas when special lighting is used to create a mood or special effect.

WINDOWS: Natural light has about ten times the deterioration factor that artificial light has. Therefore it is even more important to control this light. It is undesirable as a light source in the exhibition area except as a visual relief or as a directional guide. Besides its deterioration factor, natural light is continually changing in color and intensity making it impossible for the curator to set the mood for a particular display.

In other areas sun screens may be used where they will not impair vision. Draperies will also be used to control light.

GALLERY DESIGN: The galleries are a space to be designed for the curators to design. This is a negative space--a void to be filled. Entrance and exit as well as the security factors are important in developing this space.

OBSERVATORY: This is a space with some major design problems. This is an unheated space that is raised off the ground. It cannot be located near any structure and it should have a clear visability.

SECURITY: In designing a museum good or poor, security can be determined by the floorplan. For example it is not good practice to locate the gallaries near the entrance. There should be only one entrance and exit. A public space should exist between the entrance-exit. More on

museum security can be found in A Primer on Museum Security by Caroline K. Keck, etal.

Security at night is not the problem that it is during the day. The museum is generally empty and an eletronic device, usually a sound detector is incorporated into the building. The detector can be used to protect a portion of the building that is not in use while other portions are open to the public.

space requirement

NATURAL HISTORY MUSEUM, BILLINGS, MONTANA.

PROPOSED BUILDING PROGRAM OUTLINE

AREA NO.	DESCRIPTION	AREA REQUIRED
I	PUBLIC AREAS	
1.1	Lobby and Orientation	1,500
	Function--Control of entrance area for all visitors; provide general information on the museum, its current exhibits, programs, purpose, and special facilities.	
	Equipment--Checking facilities and storage for parcels, electronic counting device, information desk, public telephones, and informal lounge facilities.	
	Relationship: Direct: 1.2, 1.3, 1.4, 1.7, 1.8, 2.1, 3.1, 4.1, 4.4, 4.5. Indirect: Group V.	
1.2	Sales	300
	Function--Display and sales of books, periodicals, prints, slides, and related objects.	
	Equipment--Counter and display cases, cash register.	
	Relationship: Direct; 1.1. Indirect: 8.2, 8.6.	
1.3	Auditorium	5,000
	Function--Lecture demonstration requiring projection equipment; multi-purpose activities.	
	Equipment--Theatre seating for 300 persons; raised stage; permanent projection equipment; booth and storage.	

AREA NO.	DESCRIPTION	AREA REQUIRED
	Relationship: Direct: 1.1, 1.4, 1.5. Indirect: 1.7.	
1.4	Seminar Rooms 4 required	1,200 1,200 600 600
	Function--Lectures to small groups on special tour of museum; multi-purpose activities.	
	Equipment--Some type of projection equipment; chairs.	
	Relationship: Direct: 1.1, 1.3, 1.5. Indirect: 1.6, 1.7, 2.3.	
1.5	Tour Guide's Office	200
	Function--Preparation of gallery talks, guided tours, and lectures.	
	Equipment--Office furniture; storage space for research material, slides, and projection equipment.	
	Relationship: Direct: 1.3, 1.4, 4.1, 4.2, 4.4, 4.5. Indirect: 2.3.	
1.6	Cafeteria	2,000
	Function--Provision of refreshments to visitors and staff; light lunches, coffee, etc..	
	Equipment--Kitchen facilities, and storage.	
	Relationship: Direct: 1.7. Indirect: 1.4.	

AREA NO.	DESCRIPTION	AREA REQUIRED
1.7	Lounge-Ballroom	12,000
	Function--Multi-purpose, eating area for cafeteria, relaxation, etc..	
	Equipment--Typical small cafe equipment, lounge chairs, lounge equipment.	
	Relationship: Direct: 1.1, 1.6. Indirect: 1.3, 1.4.	
1.8	Public Services	1,000
	Function--To provide restrooms for museum visitors.	
	Equipment--As required by National Building Code.	
	Relationship: Direct: To all.	
II	ADMINISTRATION	
2.1	Reception and Waiting	300
	Function--Receiving persons wishing to see Director or Assistant Director.	
	Equipment--Seating, reading material storage, display cases, reception desk.	
	Relationship: Direct: 1.1, 2.2, 2.3. Indirect: 2.4, 2.5.	
2.2	Secretarial Office	700
	Function--Stenographic, record and accounting functions for Museum.	

AREA NO.	DESCRIPTION	AREA REQUIRED
	Equipment--Two secretarial desks and chairs, filing cabinets, and other miscellaneous office equipment. Relationship: Direct: 2.2, 2.3, 2.4. Indirect: 2.5.	
2.3	Director's Office	400
	Function--Individual and small group conferences and work space. Equipment--Desk and chairs, bookshelves, files, work-table. Relationship: Direct: To all.	
2.4	Assistant Director's Office	350
	Function--Individual and small group conferences and work space. Equipment--Desk and chairs, bookshelves, files, work-table. Relationship: Direct: 2.3. Indirect: To all.	
2.5	Conference Room	600
	Function--Meetings of museum personnel and visiting dignitaries. Equipment--Conference table, 14 chairs, display panels, bookshelves. Relationship: Direct: 2.3, 2.4. Indirect: 2.2, 2.1.	

AREA NO.	DESCRIPTION	AREA REQUIRED
III	LIBRARY	
3.1	General Collections	2,400
	Function--Material pertaining to museum displays for public use.	
	Equipment--Bookshelves, reading tables and chairs.	
	Relationship: Direct: 1.1, 3.2, 3.3, 3.4. Indirect: 2.3.	
3.2	Restricted Collections	400
	Function--Technical research material for research purposes.	
	Equipment--Bookshelves, reading tables, and chairs.	
	Relationship: Direct: 3.1, 3.3, 3.4. Indirect: 2.3, Group V.	
3.3	Control Area	200
	Function--Book check out, general library control, etc..	
	Equipment--Desk, chairs, general office equipment.	
	Relationship: Direct: 1.1, 3.1, 3.2, 3.4.	
3.4	Librarians Office	150
	Function--Individual conferences, and work space.	
	Equipment--Desk, chairs, bookshelves.	
	Relationship: Direct: 3.1, 3.2, 3.3. Indirect: 2.3.	

AREA NO.	DESCRIPTION	AREA REQUIRED
IV	GALLERIES	
4.1	Permanent Exhibition Area	50,000
	Function--Presentation of material pertaining to natural history.	
	Equipment--Controlled lighting.	
	Relationship: Direct: 1.1, 4.3, Group V, 6.1. Indirect: 4.2, 4.4, 4.5.	
4.2	Traveling Exhibition Area	10,000
	Function--Presentation of traveling exhibition material.	
	Equipment--Controlled lighting.	
	Relationship: Direct: 1.1, 4.3, Group V, 6.1, 6.2. Indirect: 2.3, 4.1, 4.4, 4.5.	
4.3	Outdoor Display	
	Function--Display of exhibits which can be displayed outdoors. Also provides relief from monotony of indoor galleries.	
	Equipment--Facilities for maintenance of the space, special lighting.	
	Relationship: Direct: 4.1, 4.2, Group V, 6.1. Indirect: 2.3.	
4.4	Planetarium	6,400
	Function--Presentation of educational films on astrology, natural sciences, and natural history.	

AREA NO.	DESCRIPTION	AREA REQUIRED
	Equipment--Astronomy exhibits, star ball, imax, projection room, computer room, seating, and special domed screen. Relationship: Direct: 1.1, Group V. Indirect: 1.5, 2.3.	
4.5	Observatory	2,000
	Function--Public and scientific usage of astronomical telescope. Equipment--Telescope, dome, and miscellaneous equipment. Relationship: Direct: 1.1, 4.6. Indirect: 2.3.	
4.6	Astronomer's Office	200
	Function--Researchers' preparation and work area. Equipment--Desk, chairs, office equipment. Relationship: Direct: 4.5. Indirect: 2.3.	
4.7	Lounge Areas	1,000
	Function--Rest areas within exhibition areas on the order of 100 sq. ft. per 1,000 sq. ft. of exhibition space. Equipment--Lounge chairs, and etc. as required by design. Relationship: Direct: To all.	

AREA NO.	DESCRIPTION	AREA REQUIRED
V	PROFESSIONAL TECHNICIAN STUDIOS	
5.1	Curator's Office Function--Routine administrative problems. Equipment--Desk, chairs, work table, bookshelves, etc.. Relationship: Direct: Group V. Indirect: 2.3, 4.1, 4.2.	400
5.2	Assistant Curator's Office Function--Routine administrative problems. Equipment--Desk, chairs, work table, bookshelves, etc.. Relationship: Direct: 5.1. Indirect: Group V.	200
5.3	Laboratories 5 required Function--Research study area with space to confer with individuals, scholars, or small groups. Equipment--Desks, chairs, work tables, bookshelves, laboratory equipment, storage, etc.. Relationship: Direct: Group V. Indirect: 6.1.	8,000 300 300 300 300
5.4	Preparation Shop Function--Carpentry shop for preparation of cases and background material.	2,000

AREA NO.	DESCRIPTION	AREA REQUIRED
	Equipment--Miscellaneous carpentry tools, and painting equipment. Relationship: Direct: Group V. Indirect: 6.1.	
5.5	Preparation Studio	1,000
	Function--Area for taxidermist, dioramists, and others constructing displays. Equipment--Stove, deep freeze, sink, gas, compressed air, water, cabinets, and storage bins, hand tools, some power equipment, small paint booth with exhaust fan. Relationship: Direct: Group V. Indirect: 6.1.	
5.6	Designer's Studio	400
	Function--Production of drawings for exhibit design. Typical drafting room activities. Equipment--Drafting table, work table for model building, miscellaneous storage facilities. Relationwhip: Direct: Group V. Indirect: 2.3, 4.1, 4.2, 6.1.	
5.7	Illustrator's Studio	400
	Function--Production of exhibit labels and descriptions, charts, graphs, etc.. Equipment--Drafting table, work table, layout table, miscellaneous storage facilities.	

AREA NO.	DESCRIPTION	AREA REQUIRED
	Relationship: Direct: Group V. Indirect: 2.3, 4.1, 4.2, 6.1.	
5.8	Artist's Studio	400
	Function--Production of all art requirements, reproductions and illustrations.	
	Equipment--Drafting table, easels, scaffolds, and miscellaneous storage.	
	Relationship: Direct: Group V. Indirect: 2.3, 4.1, 4.2, 6.1.	
5.9	Photographic Studio	2,000
	Function--Complete photographic process including developing, printing, etc..	
	Equipment--All items and spaces found in a typical photographic studio.	
	Relationship: Direct: 4.4, 4.5, Group V, VII.	
5.10	Collaborators' Offices 2 required	400 400
	Function--Areas reserved for visiting researchers and consultants.	
	Equipment--Desk and chairs, work tables, bookshelves, laboratory bench and equipment, and miscellaneous storage.	
	Relationship: Direct: 5.1, 5.3. Indirect: 6.1.	

AREA NO.	DESCRIPTION	AREA REQUIRED
5.11	Assembly Area	800
	Function--Final assembly point of all sub-assemblies.	
	Equipment--Layout tables, electrical outlets for tools and lighting tests.	
	Relationship: Direct: Group IV, V, 6.1.	
5.12	General Storage	400
	Function--Storage area for miscellaneous materials such as lumber, shipping crates, etc..	
	Equipment--Storage racks.	
	Relationship: Direct: Group V. Indirect: 6.1, 8.2, 8.3.	
5.13	Service Facilities	1,000
	Function--Rest-rooms, lockers, and showers for staff of this department.	
	Equipment--As required by the National Building Code.	
	Relationship: Direct: Group V.	
VI	EXHIBITION STORAGE	
6.1	General Storage	30,000
	Function--Organized area for storage of material used in various portions of the museum.	
	Equipment--Shelving.	
	Relationship: Direct: Group IV, V. Indirect: Group VII, 8.2.	

AREA NO.	DESCRIPTION	AREA REQUIRED
6.2	Short-term Storage Function--Storage of traveling exhibition material. Equipment--Shelving, etc.. Relationship: Direct: 4.2. Indirect: 8.2.	400
6.3	Vault Function--Storage of rare and valuable items. Equipment--Maximum security and must be fireproof. Relationship: Direct: Group II, V, VII. Indirect: 8.2.	300
VII	PUBLICATION	
7.1	Production Area Function--Layout and design of publication. Equipment--Desk, typewriters, office equipment, etc.. Relationship: Direct: 5.9, 6.1, 6.3, Group VII, 8.1, 8.2. Indirect: Group II.	600
7.2	Printing Room Function--Produce museum publication, advertisement, etc.. Equipment--Printing press, and equipment, etc.. Relationship: Direct: Group VII, 8.2. Indirect: 2.3.	400

AREA NO.	DESCRIPTION	AREA REQUIRED
7.3	Storage Area	200
	Function--Storage of materials necessary for publication.	
	Equipment--Shelving.	
	Relationship: Direct: Group VII, 8.2.	
7.4	Publisher's Office	150
	Function--Individual conferences and work space.	
	Equipment--Desk, chairs, bookshelves, and files.	
	Relationship: Direct: Group VII. Indirect: 2.3.	
7.5	Conference Room	400
	Function--Meetings of publication personnel.	
	Equipment--Conference tables and chairs.	
	Relationship: Direct: Group VII.	
VIII	GENERAL SERVICES	
8.1	Mailing Room	300
	Function--Service area for preparation of outgoing material.	
	Equipment--Work tables, reproduction machines, miscellaneous cabinets and shelves.	
	Relationship: Direct: 1.2, Group II, V, VII, 8.2. Indirect: 8.3, 8.4.	

AREA NO.	DESCRIPTION	AREA REQUIRED
8.2	Shipping and Receiving Room	2,000
	Function--Inspecting incoming and final packing of outgoing materials.	
	Equipment--Workbench, power and hand tools.	
	Relationship: Direct: 1.2, Group II, III, IV, V, VI, VII, VIII.	
8.3	Loading Platform	
	Function--Access to shipping and receiving room.	
	Equipment--Protection from weather for items during transfer to and from trucks.	
	Relationship: Direct: 8.2, 8.5. Indirect: 8.4.	
8.4	Recording and Inventory Office	500
	Function--Contains records of all material moving through the museum. Each item is cataloged and inventory periodically taken.	
	Equipment--Desk and chairs, filing cabinets.	
	Relationship: Direct: Group VIII. Indirect: 2.3.	
8.5	Fumigation Room	200
	Function--Decontaminate incoming materials and materials housed in the museum.	
	Equipment--Tightly sealed openings, fumigation equipment, and exhaust to outdoors.	

AREA NO.	DESCRIPTION	AREA REQUIRED
	Relationship: Direct: 8.2, 8.3.	
8.6	Security Office	300
	Function--Responsibility of security of all collections of museum, library, and archives.	
	Equipment--Electronic detection systems.	
	Relationship: Direct: To all.	
8.7	General Storage	3,000
	Function--Organized area for storage of material used in various portions of the museum.	
	Equipment--Shelving.	
	Relationship: Direct: As needed.	
8.8	Janitorial Services	700
	Function--Facilities and storage of materials for janitorial personnel.	
	Equipment--Storage shelves, racks, miscellaneous cleaning equipment.	
	Relationship: Direct: To all.	
8.9	Service Facilities	400
	Function--Rest-rooms and lockers for personnel working in general service area.	
	Equipment--As required by the National Building Code.	

AREA NO.	DESCRIPTION	AREA REQUIRED
	Relationship: Direct: As needed.	
IX	STAIRS, CORRIDORS, MECHANICAL ROOM	12,000
	TOTAL NET SQUARE FEET	171,850

In the final design a few of the area requirements were found to be incorrect. The lounge was oversized; this area was given at 10,000 sq. ft. and was cut to 8,000 sq. ft. This was more than adequate. Exhibition storage was another area with an improper space allotment. Further research revealed that the exhibition storage should equal or surpass the area given to display. This area was increased from 30,000 sq. ft. to approximately 65,000 sq. ft.

Most other areas were found to be reasonably accurate. Some spaces were slightly reduced in area by using the space more efficiently.

cost

COST ANALYSIS

1. Square-foot Cost Method. This method involves the determination of a per-square-foot cost of a typical museum, or similar building type, and applying this figure to the total floor area of the building being estimated.
2. Cubic-foot Cost Method. In this method, the total volume of the building is determined and a cost per cubic-foot of a typical museum, or similar building, is found and then multiplied by the total number of cubic feet within the building being considered.
3. Segregated Cost Method. Here, the costs of the various components which make up the total building are calculated separately, until all parts have been accounted for, and are then added together to determine the total construction cost. This method is the most exacting, but is also the most difficult. During early design stages, too many unknowns exist to take advantage of this method and, therefore, should only be used when the design of the building is nearing its final stages.

The square-foot cost method will be used in this report owing to the fact most of the information presently available, with regard to the building, is in terms of square feet. The

source of cost information will be the Marshall Valuation Service estimating handbook.

Included in the square-foot cost are architect's and engineering fees, contractor's profit and overhead, permits, and other miscellaneous costs.

Although museum buildings are not listed specifically, a category of "good, class-B public building" will be used as an equivalent. A brief description of this building type includes the following:

1. Construction: reinforced concrete columns and beams; floors and roofs of concrete, or concrete covered steel decks--fireproofed.
2. Exterior walls: special architecture, good metal and glass, face brick, stone, concrete.
3. Interior finish: best plaster, terrazzo and vinyl floors.
4. Lighting, plumbing, and mechanical: high-level lighting, audio-visual wiring, good plumbing.
5. Heating: opened air-conditioning.

Deviations from this description, if not too great, can be made without any major change of base cost.

The cost for this category is listed as $26.33 per square-foot based on an average height of 12 feet. If the average height is more than the base height, a multiplier needs to be applied to the base square-foot cost. The following tabulation lists the multipliers for several average heights:

Height (ft.)	Multiplier
14	1.046
16	1.092
18	1.138
20	1.184

An average height of 18 feet will be used for this estimate.

Because of possible temperature drops to -30 degrees F, an additional $0.90 per square foot must be added to the base cost.

In addition, three other multipliers need to be applied to the resulting figure above. These are:

1. Floor area-perimeter multiplier. This takes into account the variation in proportion of exterior wall perimeter to floor area. For this building, an interpolated value of 0.850 will be used as the multiplier.
2. Current cost multiplier. This multiplier is revised monthly and reflects fluctuations in construction costs. For February 1967, the current cost multiplier for western regions stands at 1.00. 1.25 will be used to estimate the cost due to the rapid inflation.
3. Local multiplier. This multiplier makes an adjustment of current local fluctuations in construction costs. In Billings for 1967, the multiplier is 0.96.

Applying all of these refinements to the base cost, a final figure of $27.76 per square foot is obtained. This figure can now be used to estimate the building cost.

The estimated building area is approximately 238,550 square feet, therefore, the cost of the building will be

approximately $6,622,148.00 not including site improvement costs and equipment. Approximately $1,000,000.00 can be added for the planetarium and observatory bringing the total to 7.6 million dollars.

To estimate the cost of site improvements, more detailed information would be required than is available at this time. Many of these details will not be available until the actual design of the building and site has been started and is nearing completion. A breakdown of individual costs of site improvement is included in this report which gives and indication of costs of various items relating to site improvement.

SITE IMPROVEMENT: The following tabulation indicates the estimated average costs of items related to landscaping:

Excavation (per cu. ft.)	$0.08
Fill (per cu. ft. of compacted earth). . .	0.09
Site grading (per sq. ft. of site)	0.06
Walks (reinforced concrete per sq. ft.). .	0.45
Paved asphalt roads (per sq. ft.).	0.29
Paved asphalt parking (per sq. ft.). . . .	0.29

Trees and shrubs will vary in price depending upon type, size, and number.

Exterior lighting costs of the site will also vary depending upon type and size and, can range from $60 to $100 per unit. If a streetlight type unit is to be used the cost will be around $600 per unit.

MUSEUM DESIGN

MUSEUM DESIGN

In developing a design for a natural history museum near Billings, Montana, two problems were confronted. First was the relationship of the building to the site. The second was the relationship of the visitor to the building.

Two methods may be used to solve the first problem. One may blend the building into the site or one may contrast it to the site. Above all, the building must be harmonious with the site.

The proposed building protrudes from the site. Its smooth surfaces and geometrical forms contrast with the rugged, irregular surface. Yet its soft color, the color of sandstone, and its unsymmetrical forms capture the feeling of the inherent characteristics of the sandstone. The building is set away from the cliffs, humbling itself in their overpowering setting.

The second problem was not so easy to solve. The solution is open to considerable conjecture, since the relationship is determined, by a particular museum philosophy. Therefore, the design criteria cannot be less wrong nor more right than the design criteria set by another philosophy.

In my opinion, a museum exists only through an interaction between people, who through this interaction increase the level of their awareness. This is the basis for this design.

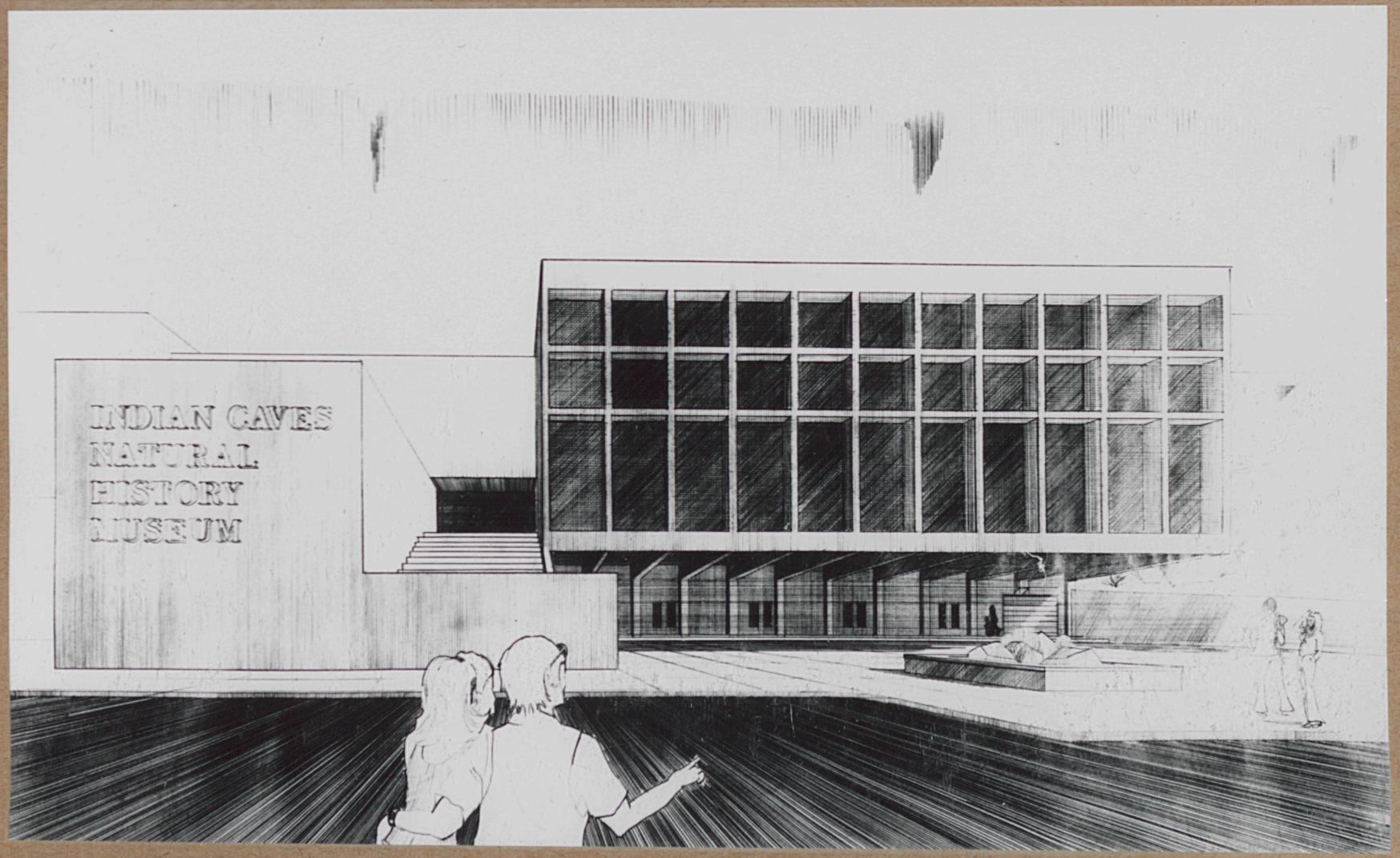
The lounge is used for the focal point. After all it is the center of the museum. This is surrounded by the areas where knowledge is gathered: the galleries, the library, the planetarium, the observatory, and the lecture hall. These areas supply the interest, but the lounge serves as a catalyst, an area where a person or a group of people may go to digest what the museum has to offer.

As these other areas hold an aloofness about them, where one tends to withdraw into himself, the lounge affords a person the place where he can relax--open himself to the stores of knowledge he has confronted.

PROPOSED DESIGN



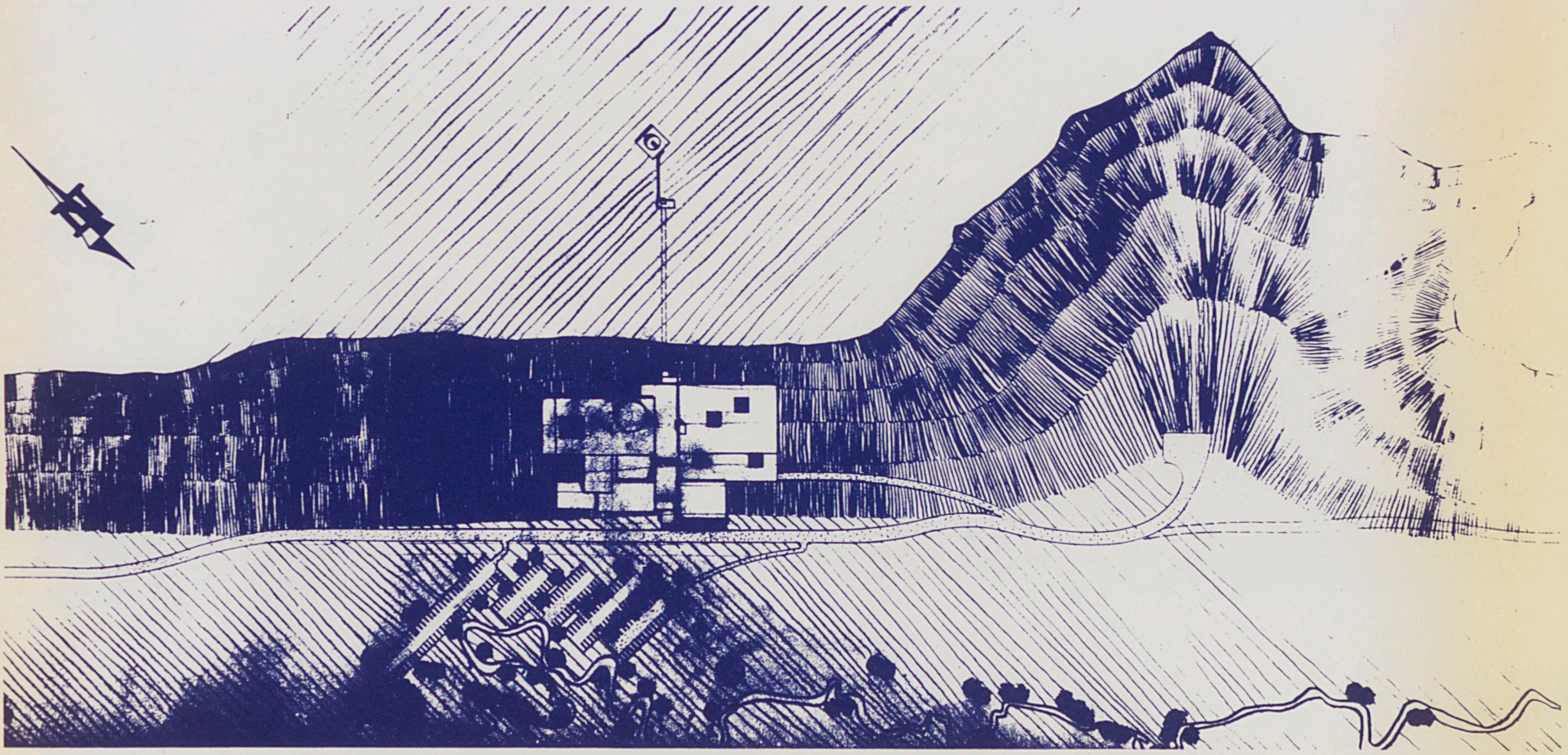


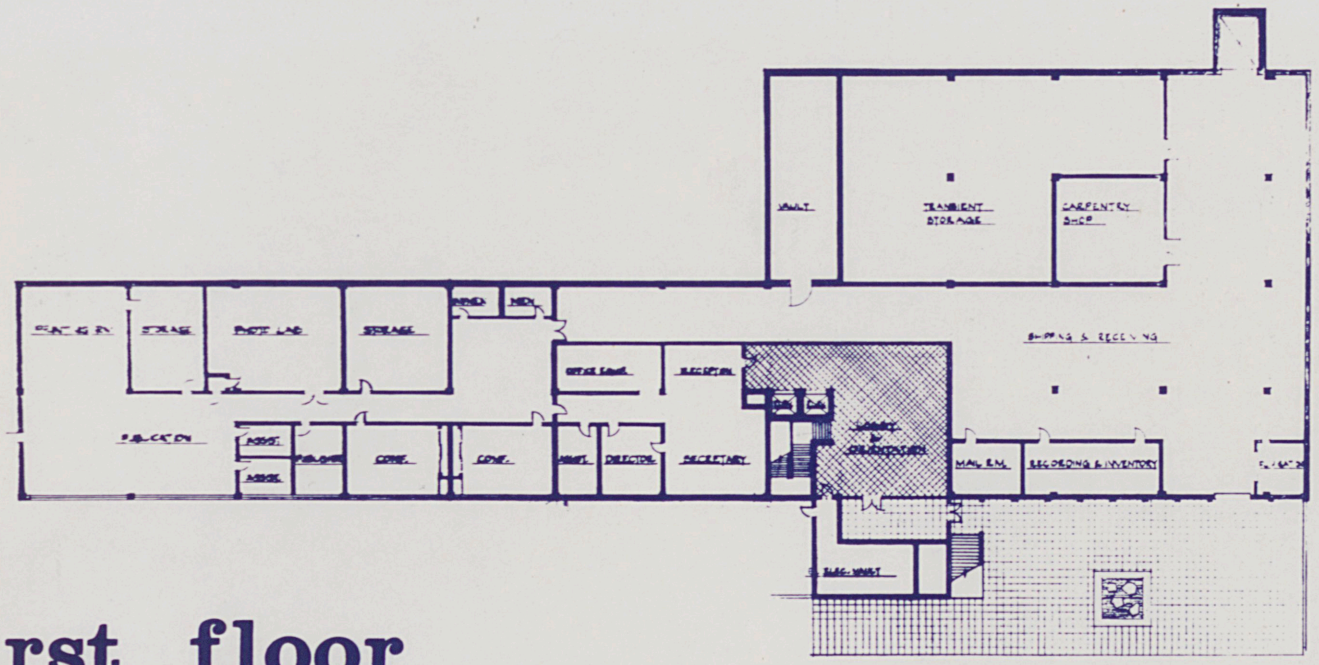

INDIAN CAVES
NATURAL
HISTORY
MUSEUM

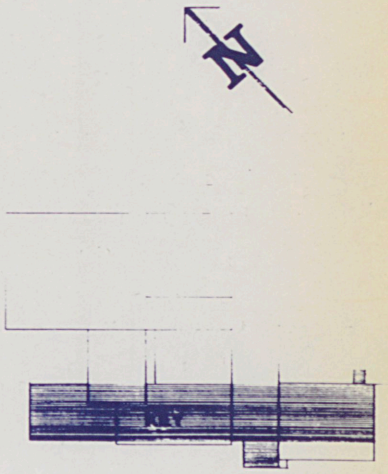
HISTORY
MUSEUM

SITE: MUSEUM & CAVES

SCALE 1 INCH : 100 FEET





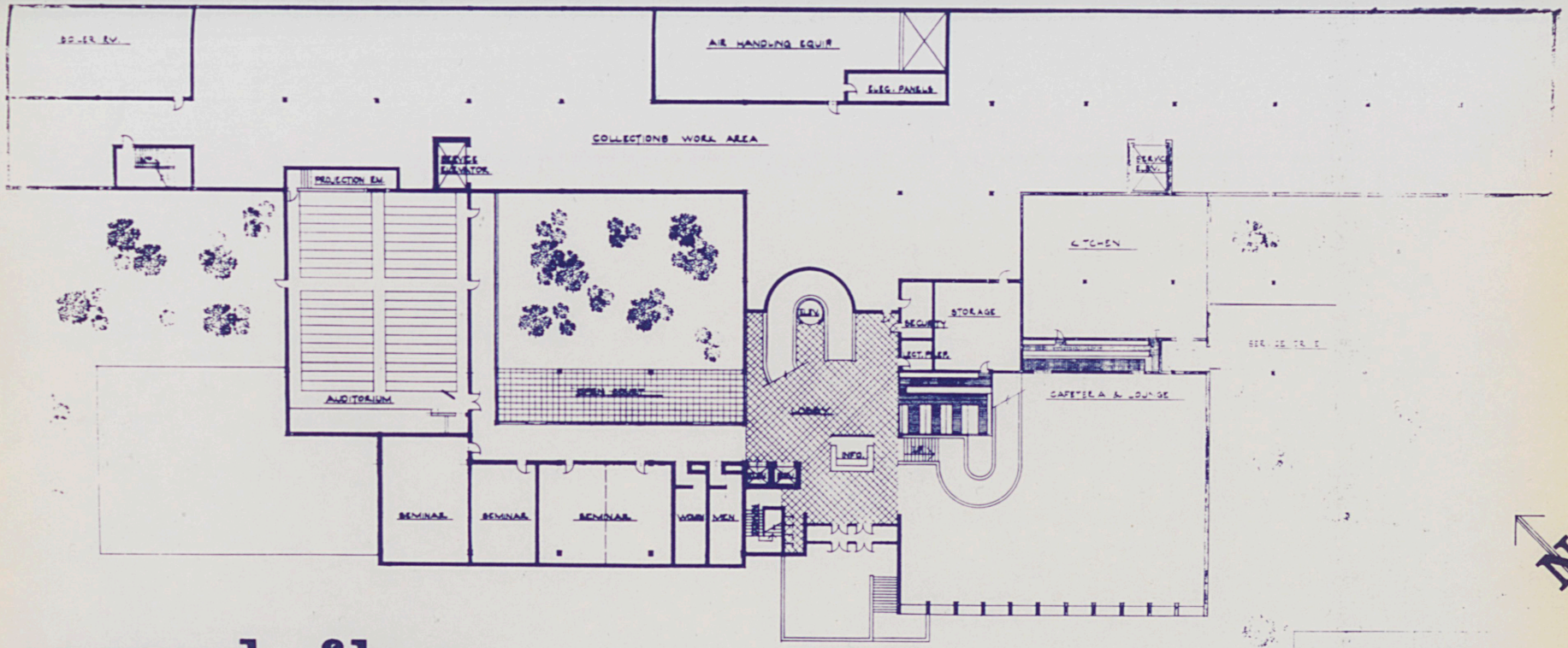


first floor

SCALE 1/16"=1'-0" no scale

PUBLICATION, ADMINISTRATION, ORIENTATION LOBBY,

and SHIPPING & RECEIVING

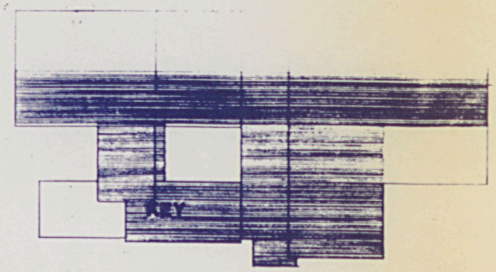


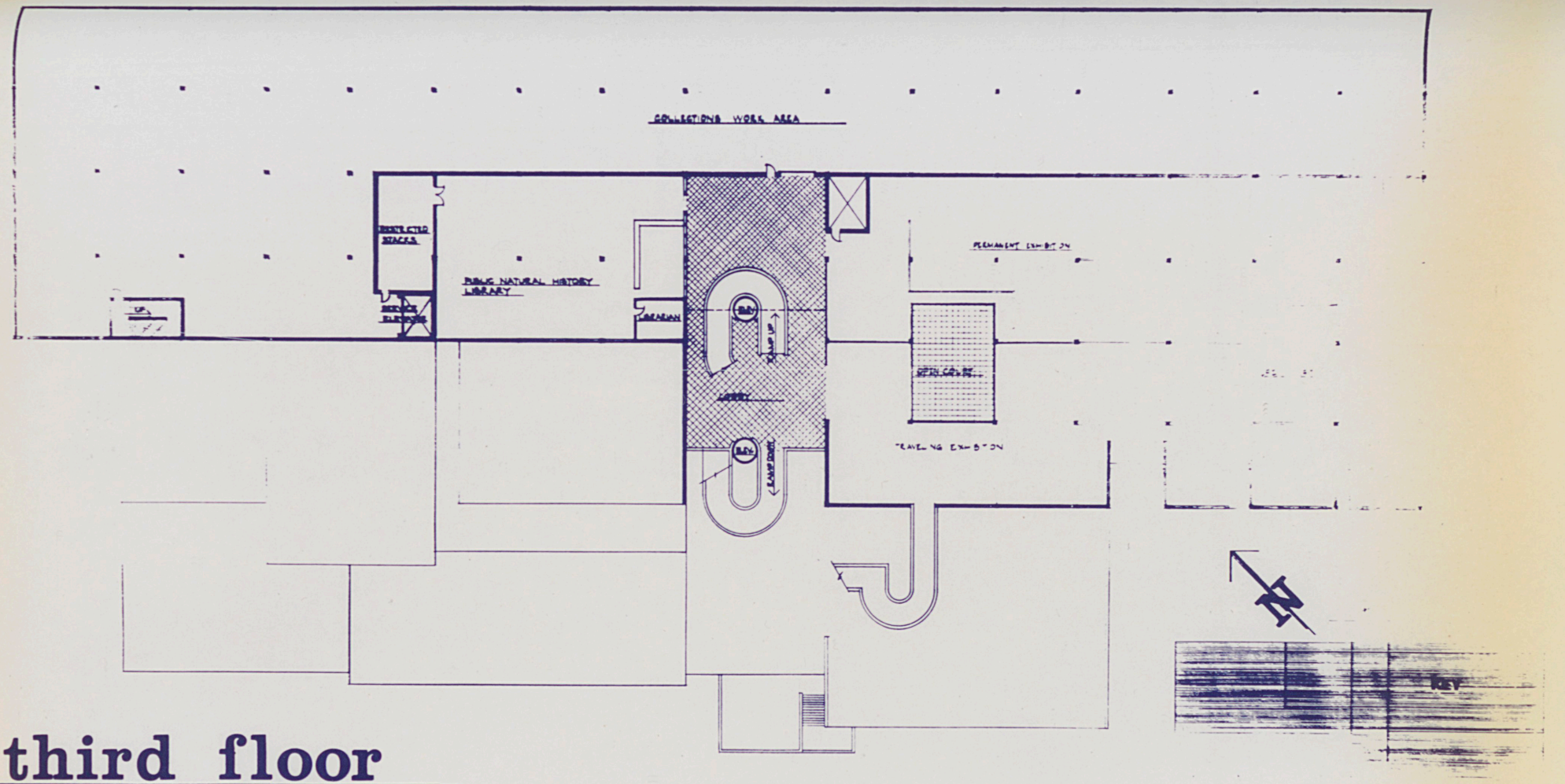
second floor

SCALE ~~1/16"=1'-0"~~ no scale

CAFETERIA & LOUNGE, GIFT SHOP, SEMINAR ROOMS,

AUDITORIUM, and COLLECTIONS WORK AREA



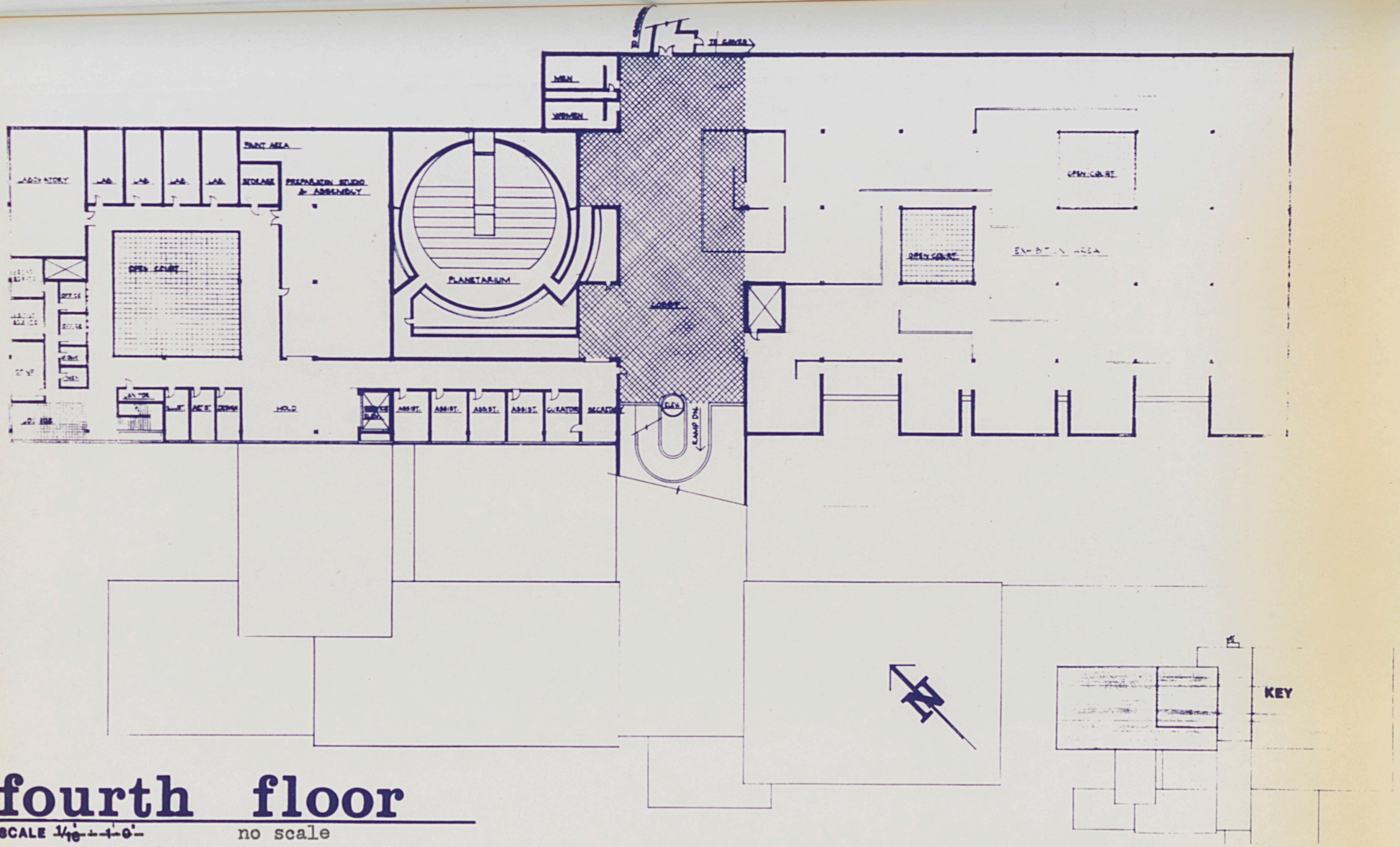


third floor

SCALE ~~1/8"=1'-0"~~ no scale

PUBLIC NATURAL HISTORY LIBRARY, TRAVELING EXHIBITION,

PERMANENT EXHIBITION, and COLLECTIONS WORK AREA



fourth floor

SCALE ~~1/16" = 1'-0"~~ no scale

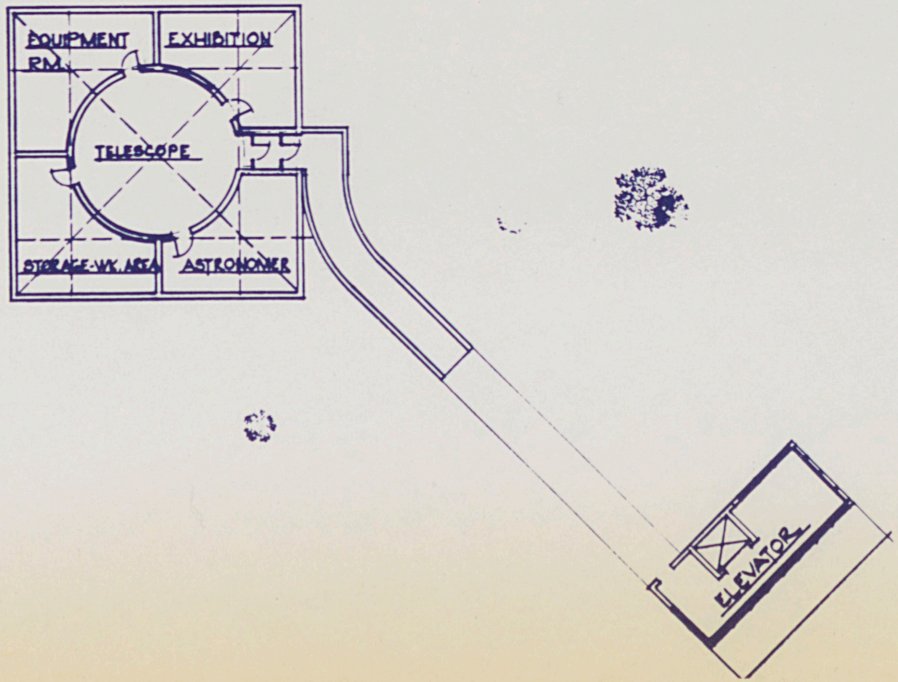
PERMANENT EXHIBITION, PLANETARIUM,

and CURATORIAL AREA

OBSERVATORY

SCALE 1/16" : 1'-0"





section

SCALE 1/16" : 1'-0"

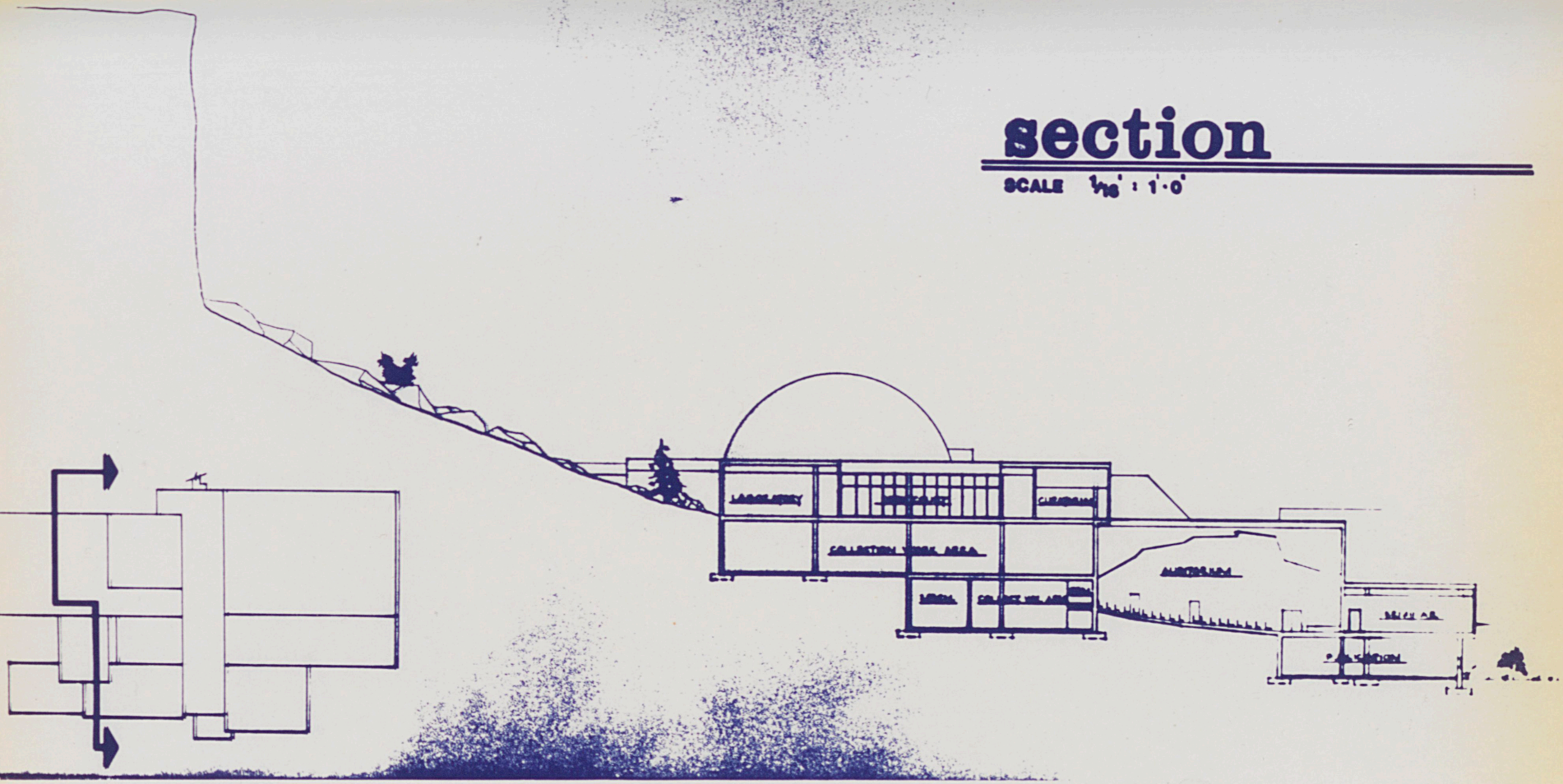


section



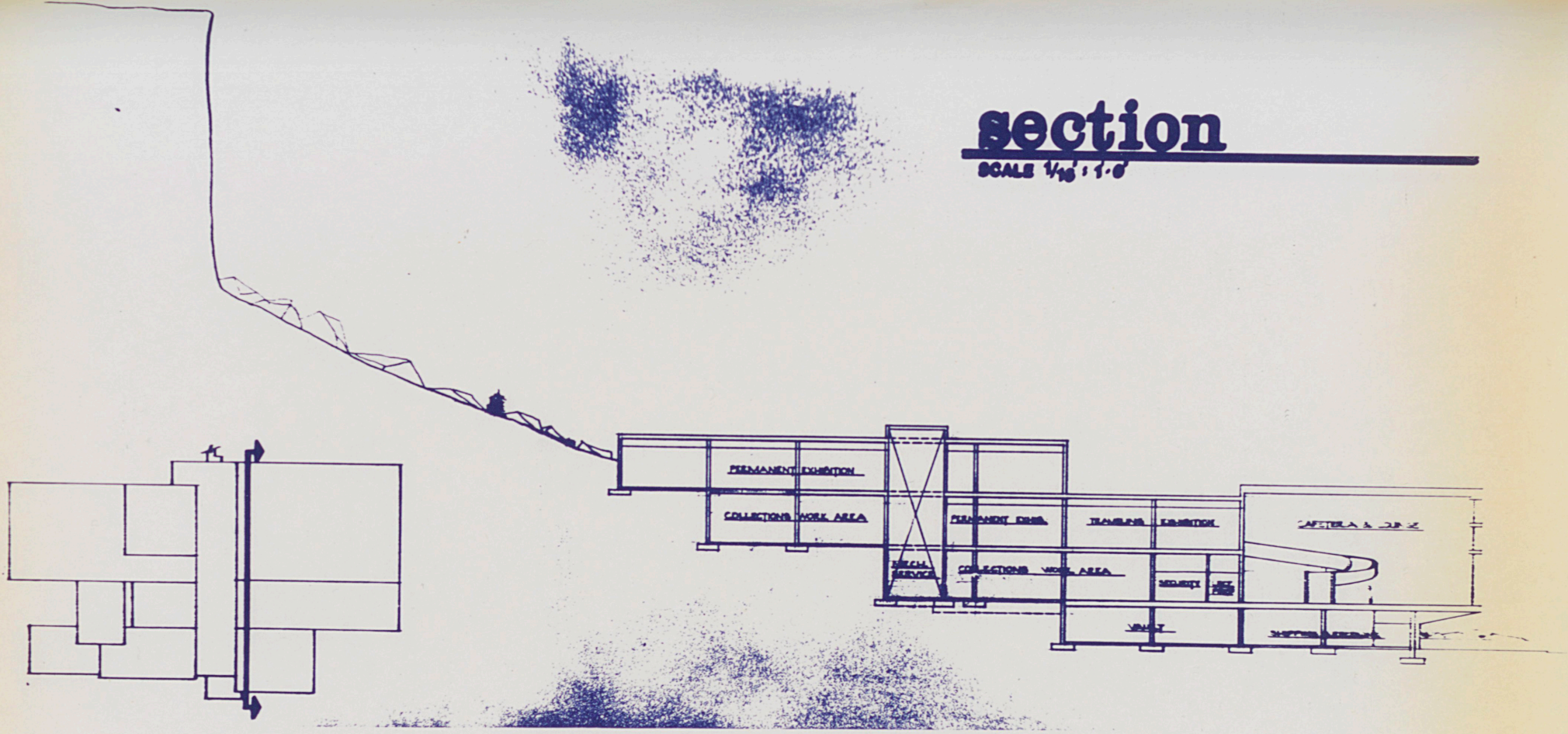
section

SCALE 1/16" : 1'-0"



section

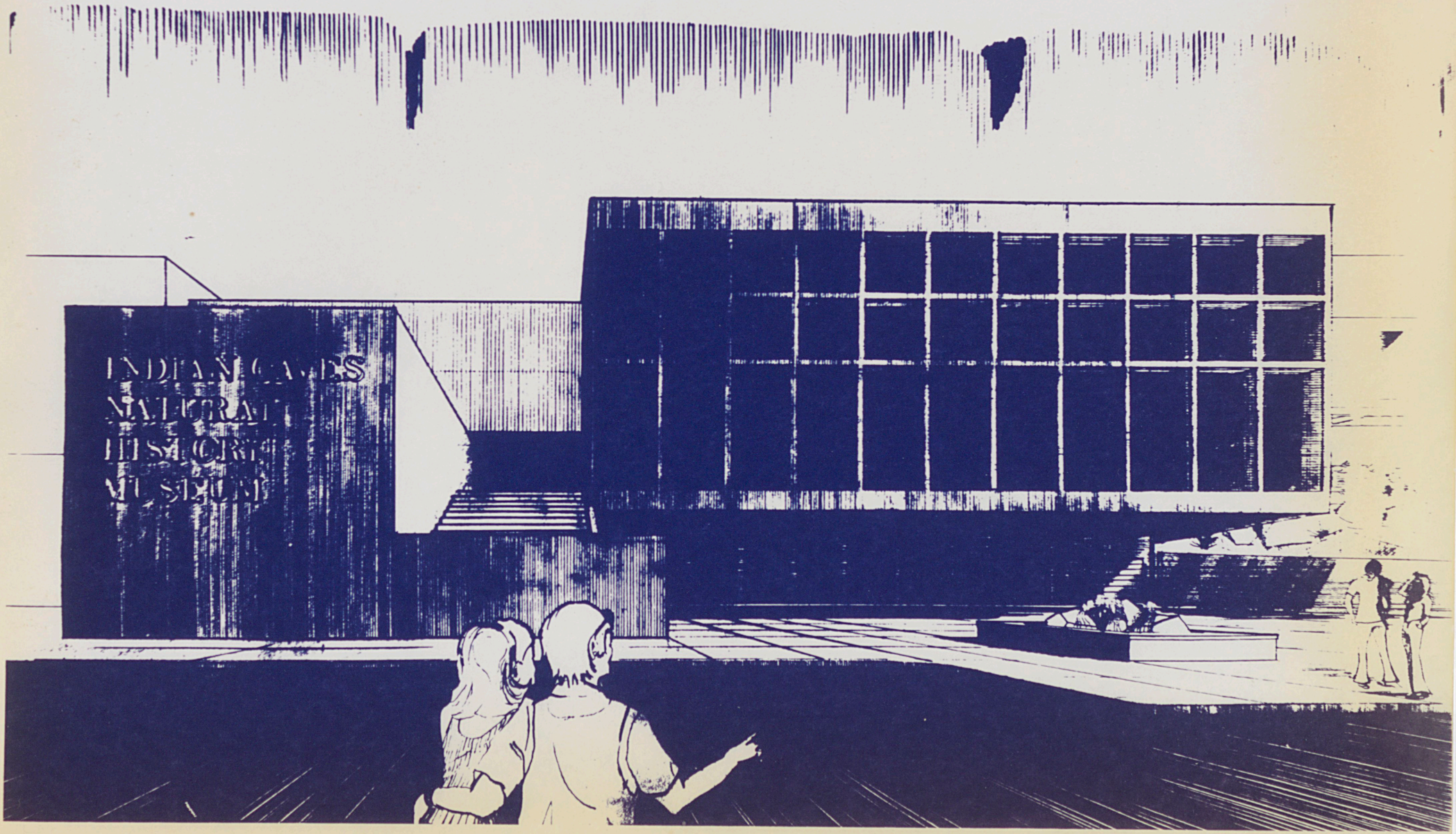
SCALE 1/16" : 1'-0"

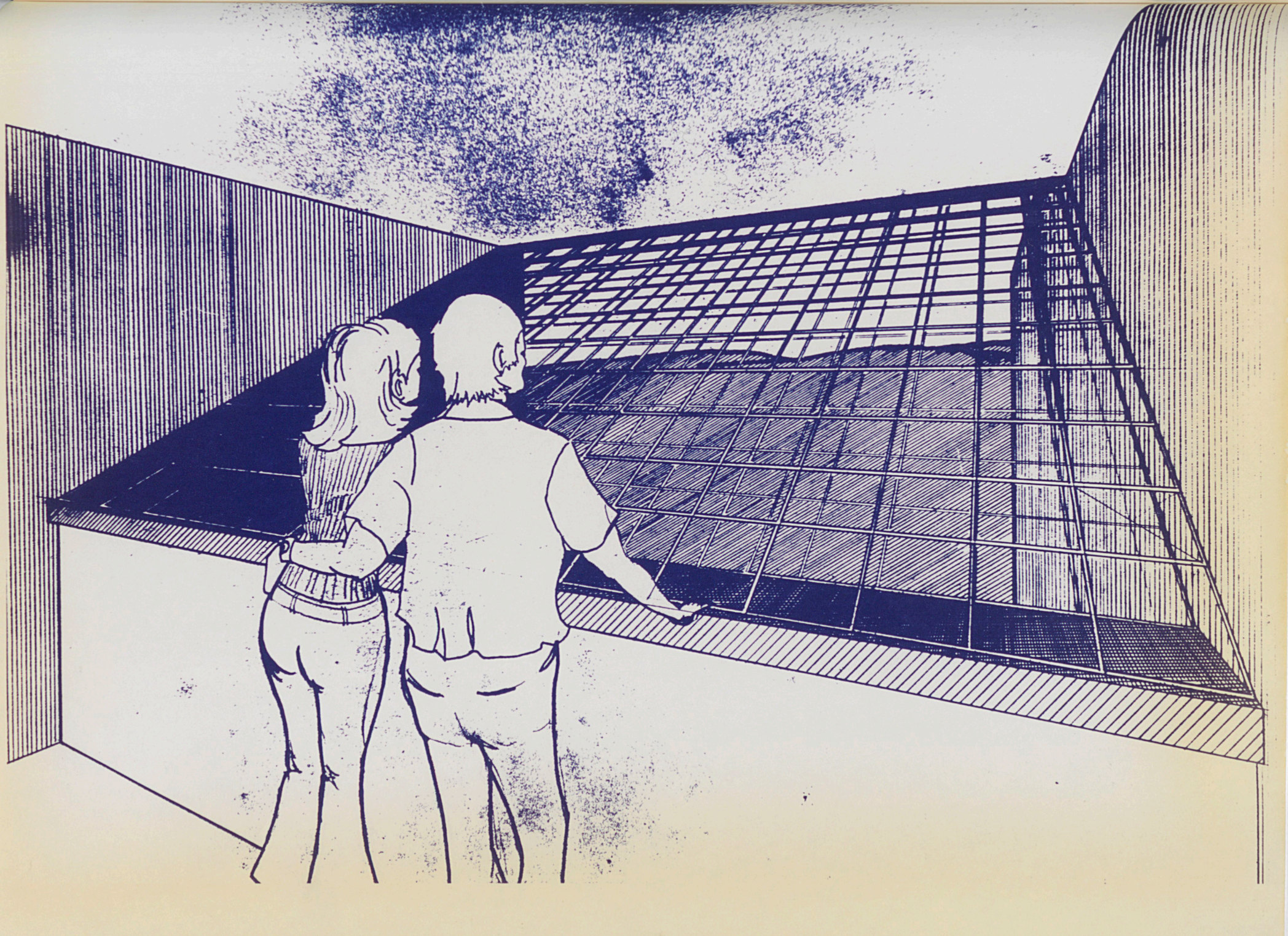


section

SCALE 1/8" : 1'-0"







SUMMARY



SUMMARY

The museum building, I feel, was successful in fulfilling the role of a thesis, that is, it expanded the role a museum plays in our society. It expressed itself as a socially oriented facility rather than being an object oriented facility as most museums exist today. For some people this concept may be difficult to accept since to them it is felt that a museum ought to express its contents as most museums do today. To me this is a form of object worship rather than the reason why museums exist or the purpose they were meant for.

A museum is created by people drawing together to study their past in order to find their future. It was not born out of a desire to hoard and collect artifacts as it has now become. In placing the emphasis on the collections, we limit the involvement and interest primarily to the scholar and those directly involved with the substance of the museum.

This situation is being corrected to some extent by the curatorial staffs in many museums by improving their exhibits so they are more clear and have more universal appeal to people of all ages and backgrounds. Where the curators have realized this situation and have taken steps to improve it, the architect has not done so. He still is insistant upon designing great temples to honor the collections held within.

In my proposed design solution, I feel that I solved this problem to some extent. In giving the people a variety of areas to socialize in, they can feel more free. It affords them more of a chance for discourse--interaction between themselves. Museum visitors will not be so apt to rush through the museum and be on their way, remembering only that it was large and had a lot of interesting exhibitions, only never remembering what they were. Maybe the visitor would, after viewing the exhibitions, stop and get a bite to eat or something cold to drink and give himself some time to think about what he has experienced. Most people will not give themselves the time unless an ample opportunity presents itself.

This museum of natural history, located outside Billings presents the gateway to Montana. Then when the visitor continues on his journey, he will be a little more familiar with what he will see as he visits the state. And he will remember where he saw it first.

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APPENDIX

M

The Total Design Concept

MacDonald Becket, A.I.A.
Welton Becket and Associates

Architects are problem solvers. By training and tradition, they look at every architectural project as a problem requiring a solution. The concept of "total design," pioneered and practiced by Welton Becket and Associates, is one such solution. It is the creation of an architectural project in its entirety, from original vision through final supervision. It includes, in addition to the development of a master plan and the exterior design, such vital—and inseparable—elements as engineering, interior planning and design, exhibit and graphic design, furnishing and decorating and landscaping. From experience, our firm has found that it is far from satisfactory for a client to hire one firm to design a building shell and then bring in another firm to make the interior space function effectively.

A museum—perhaps more than any other structure—should work and look like unified wholes. Yet surprisingly few museums have utilized the unifying concept of total design.

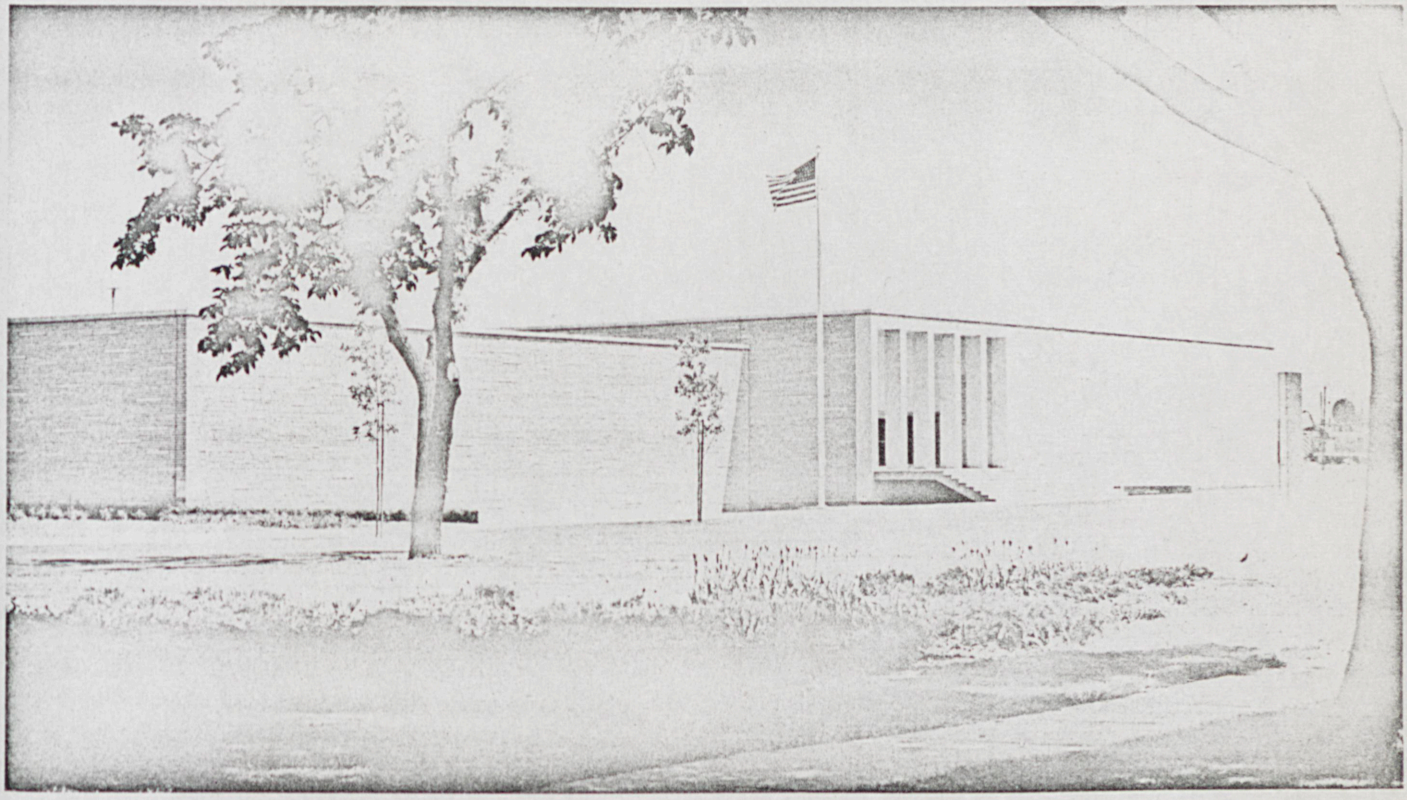
When a museum is in need of a new building or an addition to an existing structure, it has a problem. The museum needs space but, more important, it needs space in which to *do* something. Proper solutions to the architectural problems of a museum begin inside the structure for it is there that the major functions of the museum will be accomplished. The type and size of exhibits, anticipated visitor traffic, staff requirements for work and storage space, the need for meeting and classroom facilities and the need for security, change and flexbility—all will influence the internal plan. The exterior design and the manner in which the site is utilized will be influenced by the internal plan, by the museum's location in the community and other environmental factors.

Carrying out a total design extends from the landscaping concept that unites the museum to the community on the exterior to the graphic arts which unite the interior of the museum and its visitors. In total design, even the uniforms of the security force can be created to complete the feeling of design unity.

Perhaps the concept of total design in museum architecture can be best understood by going through a building program step-by-step. In so doing, it will become apparent that the architect does more than create a cosmetic exterior to enclose a space of fixed size.

Initial Decision

The time to consult an architect is as soon as the need for a new building, addition or renovation has been considered. The architect can help determine whether a new building is actually required or if the problem can be solved by enlarging or renovating the existing structure.



Wayne Wright

The Museum of the Dwight D. Eisenhower Presidential Library, Abilene, Kansas, designed by Welton Becket and Associates.

Programming

The architect is experienced in helping to assemble the program for the building. The program evolves from studies of current space requirements for exhibitions and ancillary facilities and the need for possible future expansion. Too frequently, an architect is handed a pre-set program and, while he is skilled in translating that program into a set of drawings, he could have developed a program that would not overlook a museum's present and future requirements.

Space Planning

This is a relatively new art which has taken on the form of a "science" through the use of computers. Space planning begins with a survey of present and future space requirements. These spaces are then integrated vertically and horizontally for the best possible spatial relationships. Good space planning is what makes a building "work" inside.

Site Selection

An architect is challenged when he is handed a difficult site. He can be of far greater help if he can work with the client in the site selection process. Often a site believed unusable can be utilized to advantage by an architect. An architect who offers total design services can determine the problems and costs involved in utilizing a certain site and can determine which of several sites would be most beneficial for the client.

Master Planning

After a site is selected and the programming and space planning are completed, an architect develops the master plan. In this process, the architect determines how to utilize the site for immediate and future needs. Consideration should be given to the relationship of the building or buildings to the community as well as to the use of the outdoor areas of the site.

Architectural Design

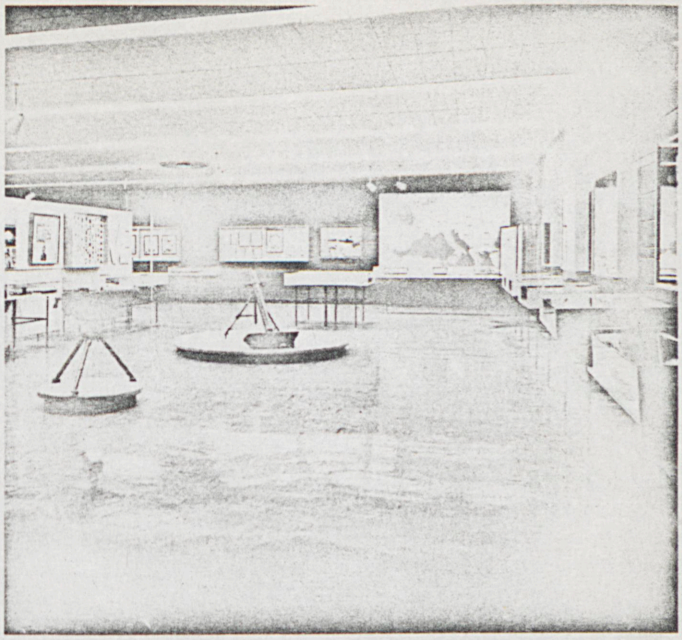
Museums are frequently fearful of a total design approach because they believe that the architect will impinge upon their specialized fields and interfere with the arrangement and presentation of exhibits. In reality, the architect normally plans a museum from the inside out, taking into consideration the needs of the client as interpreted by the program and space plan. Function and flexibility are his major considerations. Far from hampering the presentation of exhibits, the architect using the total design concept will work to improve exhibition possibilities. A museum requires complete flexibility to permit a broad range of exhibitions. Thus, the shape of a museum and its exterior appearance will reflect its functions.

Interior Design

Total design is particularly beneficial for integrating architectural and interior design. These two disciplines are inseparable in the development of a building. The interior and architectural designers work as a team from the outset, each influencing the other as they work toward a common, unified goal. It is this relationship which gives the totally-designed museum a unity that is not only aesthetic but functional as well.

Interior Furnishing, Decoration and Graphics

According to the client's desires, total design includes furnishing, decoration and graphics. In a museum, this would include the design of exhibit cases, the selection or design of all furnishings (including purchase and placement), the selection or design of floor and wall coverings and the design of a complete graphics program. These services are encouraged by the design team for the sake of continuing the total concept.



Wayne Wright

Interior, Museum of the Dwight D. Eisenhower Presidential Library

Lighting

It is impossible to overlook the importance of proper lighting in a museum. Lighting plays an important role in total design. The architect works with lighting as a design element to provide the proper amount and quality of light for each area. As in the design of the museum itself, the best lighting system is one that offers flexibility for changing exhibitions and programs.

Air Conditioning

Only a few years ago, air conditioning was considered a luxury. Today it is no longer a luxury, but it is still quite expensive. By designing the museum's mechanical system as part of the total facility, the design team can reduce the cost of the system and increase its efficiency.

Electrical and Structural Engineering

Perhaps electrical engineering is not thought of as part of the total design package, but it should be. When the electrical engineer is involved in the original building concept, he can design a system that will be flexible yet serve the present needs of the museum. Requirements for power, lighting and communications media should be considered as parts of the building, not as afterthoughts. The structural engineer working as part of the total design team can provide the museum with more column-free space and areas that can be easily altered.

Landscaping

An initial landscaping concept might be developed as part of the master plan for the site, but the final elements will be designed concurrently with the design of the building. Landscaping should be a unified whole which relates to the building and to the community. The achievement of this unity should not be difficult, because the total museum design will be consistent with its environment.

What does the totally-designed museum offer? It creates a unity for today's activities and the flexibility for change that is an integral part of the museum's operations.■

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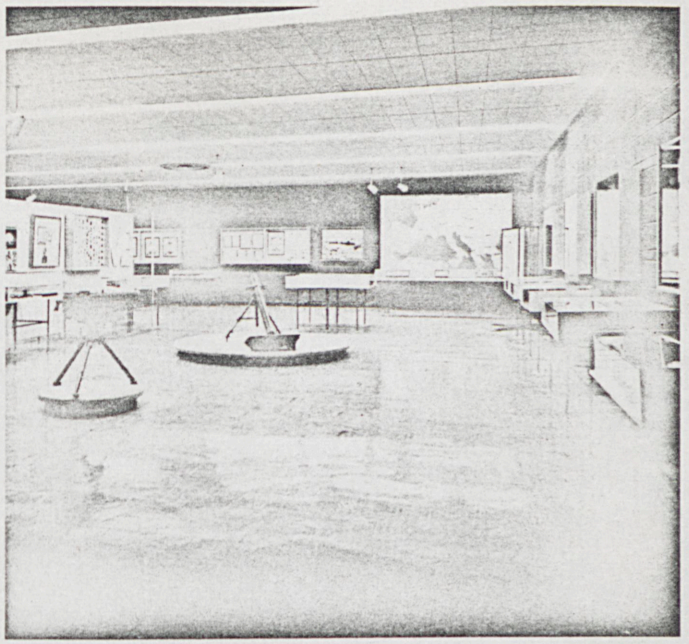
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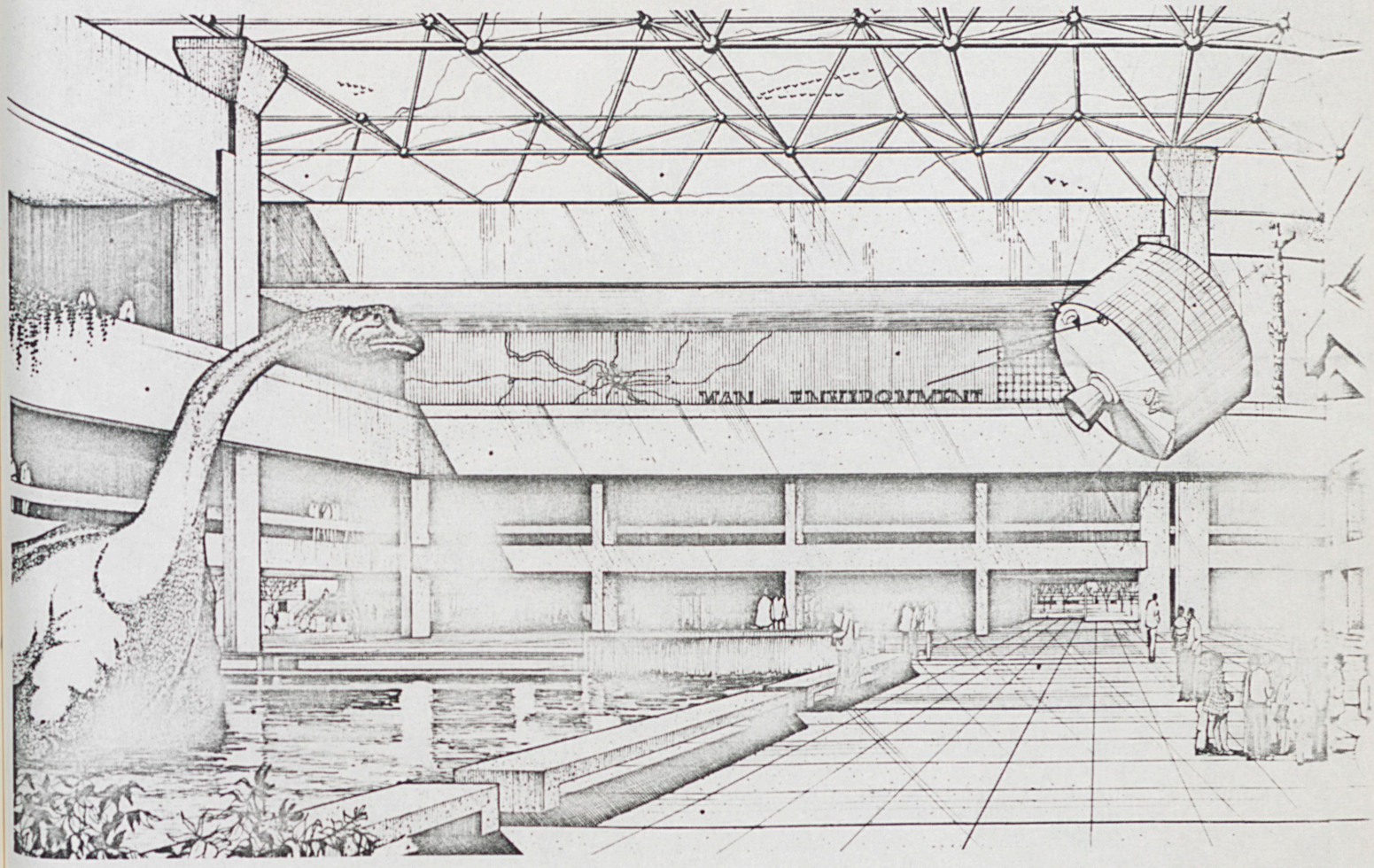
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Early in 1970, the D. M. Ferry, Jr. Trustee Corporation, a Detroit philanthropic foundation, made known its intention to provide an initial grant of $2.5 million to be used for the development of a science center/museum. The interest of the Ferry foundation in this enterprise soon resulted in the establishment and staffing of an experimental storefront science museum in the central city, two and one-half miles from the downtown Detroit business district. The storefront center, in operation since 1971, is housed in a leased facility that was formerly an automobile showroom. Total usable space is about 9,000 square feet, with about two-thirds of the space devoted to exhibits, a 50-seat demonstration theatre, a small conference area and related support facilities. The remaining space serves as an exhibit design and shop area where virtually all of the exhibits (built by staff and students) now in use have been constructed.

A Unique Science Museum

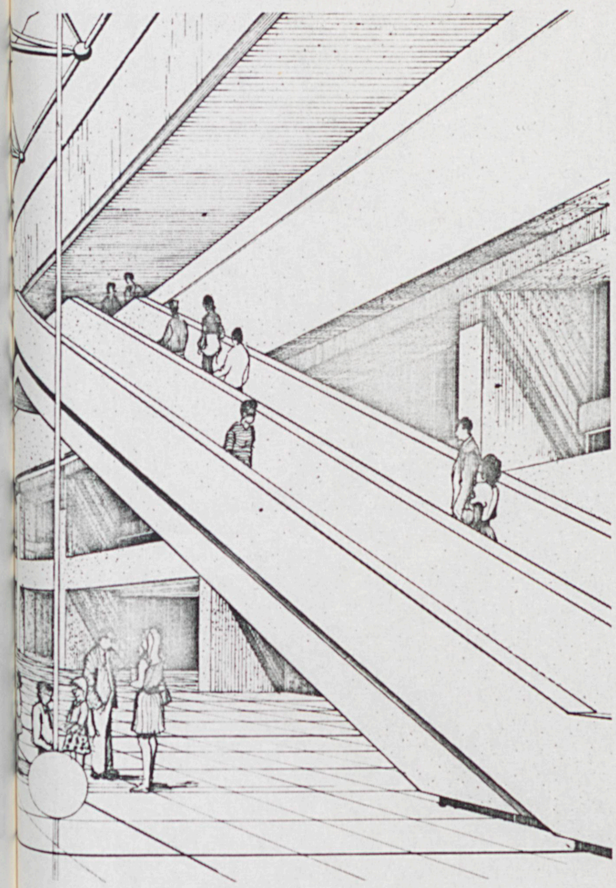
The new Detroit Science Center will be constructed on an eight-acre site adjacent to the Detroit Institute of Arts and the Rackham Memorial Building, both of which are close to the Wayne State University campus. The storefront center is located three blocks south of the building site. Apart from the donation of land by the City of Detroit, the Science Center is privately-funded and independent of city, state or Federal government.

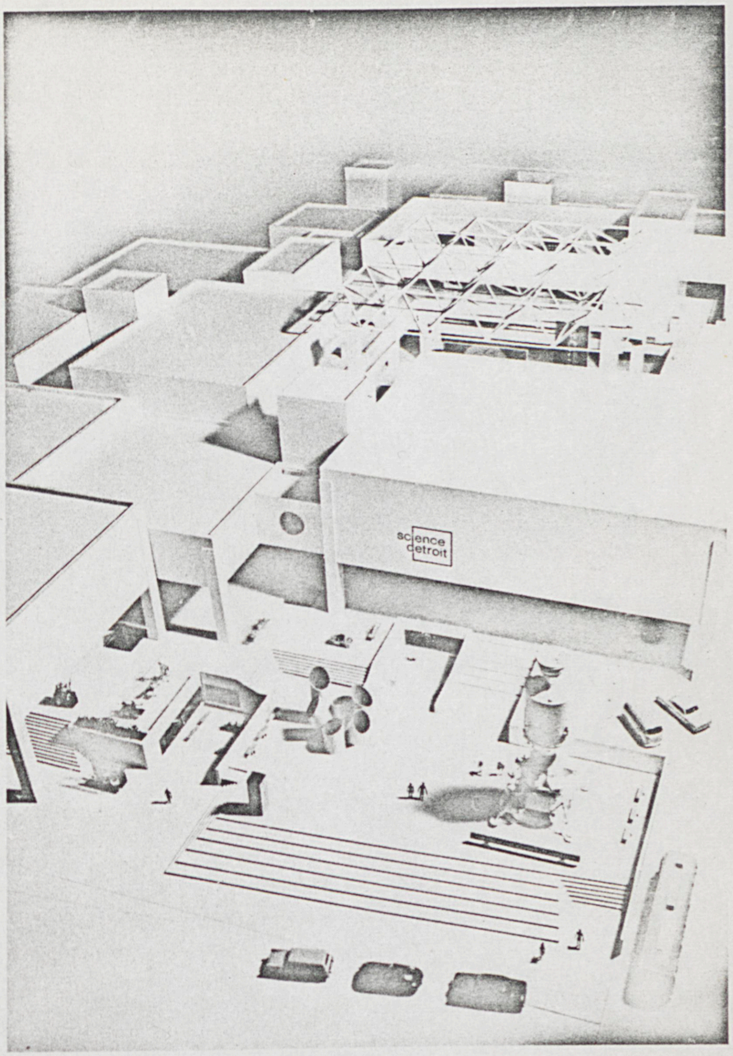
The architectural firm of William Kessler and Associates has worked diligently to design not only an attractive addition to Detroit's cultural center area, but a science center that will be unlike any other in existence today. Prior to the programming and planning of the proposed Science Center, the architects initiated a symposium sponsored by the Ferry Foundation to analyze new currents and directions emerging in the museum field. Participants included Robert Hatt, Duncan Cameron, John Kinard, Ian McLennan, Taizo Miake, Michael Butler, Francis Miller, Robert Weiss and the late John Anglim.

The new Center is expected to become a significant community educational resource for the benefit of the people of the region it serves. Although there is nothing unique in the total concept of a science center, the Detroit Science Center will be, in every sense of the word, a visible science museum. It will not house static exhibits in glass cases, but will instead invite the visitor's sensory participation for learning and pleasure.

As might be expected, those engaged in planning the Center have been influenced, in varying degrees, by existing science centers in the United States and Canada. Perhaps no

Model *(right)* of the Center indicates the flexible plan of modular exhibit halls and utility towers designed to permit expansion. The enclosed atrium *(below)* will provide access to the exhibit floor via escalator and will accommodate special exhibitions.





single science center has had more profound influence on the planning than the Ontario Science Centre. Its creative designers, Taizo Miake and John Voskuil, have made significant contributions to the storefront operations, which will undoubtedly have a continuing and beneficial impact that will be evident in the Phase I building complex and in subsequent development.

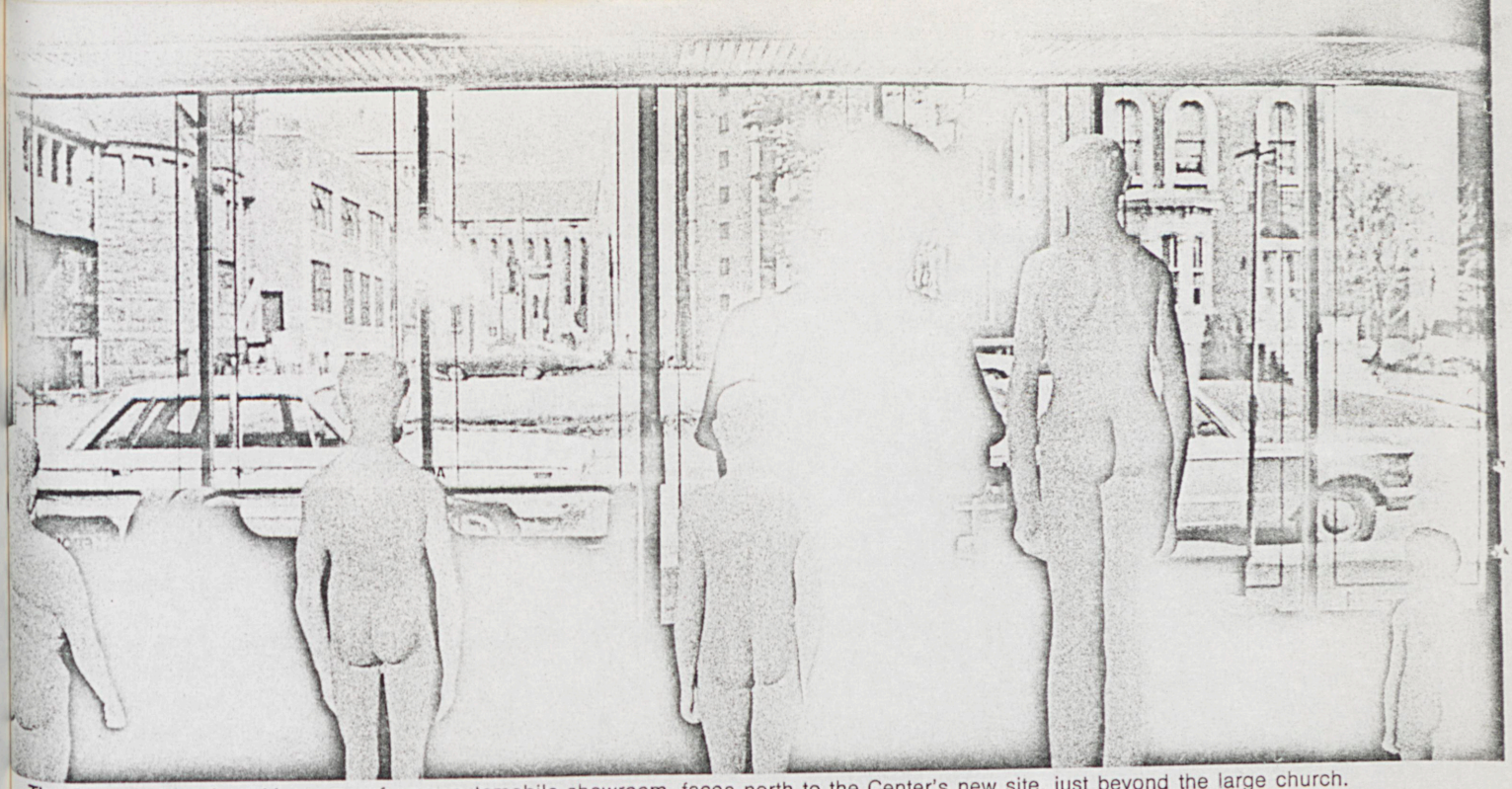
According to its architects, the design for the Detroit Science Center represents the creative synthesis of the needs and aspirations of community residents, industrialists, technicians, scientists and internationally-known, professional museum consultants. It embodies the "idea" of a science center facility unique in the world today.

What Makes Us Tick

In most museums, production shops, telecommunications and ancillary equipment and other back-stage exhibits production areas have been buried in remote or out-of-the-way areas, with public accessibility difficult and usually discouraged. We expect the Detroit Science Center to be different, not just for the sake of being different, but because the Center staff believes that in a science museum visitors are equally interested in what makes the institution tick.

At the storefront center, for example, we made the entire exhibits design, production and shop areas open for public viewing. Going a step further in the Phase I building, we will provide large viewing walls and corridors (or at the very least, windows or viewing ports) in every possible place: model shop, woodworking shop, telecommunications center, mail room, etc.

At this point in the Science Center planning, it seems quite likely that we will have a telecommunications center located within the building complex. Such a facility would have as its more obvious missions the preparation of audio and video cassettes for exhibit use, staff training, public information, etc. These facilities are most frequently located outside the normal traffic patterns for the public and almost always are enclosed by opaque walls or drapes. We expect to alter this situation by incorporating glass walls in the telecommunications center. We will place transparent sides on the television cameras and on any gear where the display of inner workings of the equipment is possible and will serve an educational purpose. And telecommunications is only one of many areas where such planning can be carried out. Visible and see-through telephone switching apparatus, copy machines, even typewriters, lend themselves, in varying degrees, to helping visitors learn more about science and technology. We shall endeavor to take off the mysterious wraps from the commonplace as well as the exotic



The Center's Storefront Museum, a former automobile showroom, faces north to the Center's new site, just beyond the large church.

hardware for all to see—and to handle and manipulate wherever possible.

Planning Details

The physical structure of the Center includes three floor levels—ground, main and exhibit. The main floor area has been carefully designed to serve as an extension of the urban fabric. It will be open for public circulation, permitting anyone access to ground level facilities and services such as gift, print and model shops, meeting space and, ultimately, a restaurant. A special student entrance lobby complete with an orientation area is also incorporated in the initial planning stage in order to accommodate school and other group demands.

One of the more notable features of the main level will be the first of two Sensoria. The Sensorium, as the name implies, is an up-to-date adaptation of the planetarium. It is an auditorium which is being specially designed to emphasize the phenomena of the natural and physical worlds. The 70-foot domed structure will accommodate a traditional planetarium presentation of the classical earth view of the heavens. In addition, however, we will be able to simulate rocket travel through space, shifting star patterns viewed from the moon and beyond and developing weather fronts viewed through the use of time-lapse photography. Individual earphones, sensing devices and response systems will provide the equipment necessary for programs of an unlimited nature covering all fields of scientific investigation.

The main floor of the Science Center will also contain a large, enclosed atrium for special, full-scale exhibition purposes. Access to the exhibit floor, located 35 feet above the main level, will be via escalators. The exhibition level has been designed with clear spans and interstitial floors, thus producing spatial and utility flexibility, and giving the design staff a free hand in developing significant visual, tactile and spatial sequences between major exhibition areas.

Project architect Edward Francis adds this note of interest: ". . . museum fatigue, a somewhat common problem in traditional facilities, will be minimized by psychological pace setting through controlled views to the exterior, changes in color, texture, temperature and volume, along with new vistas of the central orientation space."

The basic structure will include square circulation utility towers which can be arranged in a variety of ways to permit unlimited expansion. In addition, a series of variable-sized modular exhibit halls, enclosed by a dia-grid roof and floor framing system, will permit additional flexibility for expansion.

Present schematic drawings for Phase I of the three-phase building complex aim at an initial facility just over 60,000 square feet. Of this area, 33,000 square feet will be allotted to the exhibits areas and the Sensorium.

Several years ago, I had the opportunity to visit a number of film presentation areas that were often referred to as "science theatres." Most of them had several things in common: they seated fairly large groups of viewers; they were dark; and the films were at least of 15 minutes' duration, although quite often the films were 30 to 60 minutes in length. At that time my own thinking about "science theatres" was channelled in this direction—until I had the opportunity to see what the Ontario Science Centre was doing. Rather than relying upon a single, large theatre, Ontario has a number of "mini-theatres" scattered throughout exhibit areas. They seat only a few visitors and the films viewed are of short duration—three, five, or possibly eight minutes. The films are tailored to the subject matter and match the attention span of live audiences in a given setting. We expect to go Ontario one better by benefiting from their experience and expertise and by utilizing hardware and software not available when they began their operation. We are studying the possible use in our mini-theatres of video cassettes as replacements for the film loop cartridge.

The Detroit Science Center is not yet a reality. We project that groundbreaking for the institution will take place in the summer of 1973. With planning, construction and occupancy schedules being what they are, you will have to wait another 18 months or so before seeing how accurate this forecast is. However, if you're curious about how the visible museum works in our storefront, you won't have to wait. It's here today.■

Modular Walls

Robert Buck
President, Presentations South

Fifty years ago, almost all museums, both hardware- and art-oriented, mounted their exhibits on permanent plaster walls attached to ornate, moulded plaster ceilings. Moving walls, track lighting and lightweight, easy-to-store partitions have changed all this in most art museums. This has been accomplished not only for the convenience of the curators, but also to meet the widely diversified demands placed on a museum by some of the modern media.

While these natural changes have taken place in many art galleries and museums, what has been happening in more hardware-oriented institutions such as science, natural history and history museums? In most cases, the answer is, discouragingly, nothing. Of course, in newer institutions the complex, three-step installation of plaster walls has been replaced by more modern dry wall (plaster board) techniques—with some sacrifices in quality and soundproofing. Ceilings are now acoustical tile since the ornate plaster ceiling is a lost art form in itself and worthy of presentation as a display in a "nostalgia" exhibit. But, the permanent walls, wiring and case structure have changed very little since New York's Museum of Natural History opened its doors in 1877. As a result, the displays have not changed much either.

In spite of advances in lightweight, modular construction over the past 20 years, usually every display case and diorama is built as a permanent, intrinsic part of the building. The reason given for such complex structural work is that: (a) the exhibits need the structured cases to support weight and bulk, or (b) protection from vandalism requires sturdy housing for valuable exhibits. In either case, a lesson is to be learned from the commercial world. In the realm of the trade show, complex technical displays have utilized lightweight, modular construction for years. The travelling museum exhibits prepared by industry and government have also gone a long way in this direction. Yet, when one of these rapid set-up units is delivered to a museum, a major crisis arises over where to find the space to set up the exhibit, or how to jam it in between permanently-fixed, existing cases and other structures

In a day of partitioned walls, modular trade show exhibits, tracked, quick-changing lighting and the other conveniences of furniture-like interior construction, there is no reason for museums to cling to outmoded construction techniques. And, in almost every case, it is the museum that clings to the outmoded methods—certainly not the people who have to work in the museum. The fate of their facility is usually decided without consultation (in the case of new museums) or long before they arrive on the scene (in the case of established operations). Thus, we find a director of interpretation objecting to a limitation of four display cases, two island stands, and 12 feet of wall panel in his ornithology section, forever and ever. And what curator of Indian artifacts wants to be stuck with top lighting by two cool white fluorescent tubes on every item that he will ever put on display? Certainly no museum director wants to know that every time an



Exhibit area around step-like base of Statute of Liberty. Built-in alarm, power, fire extinguisher and phone are all included in the versatile, modular wall system.

exhibit is changed it means that a wing (perhaps a whole museum) is closed down. What finance committee wants to have to authorize a major construction job every time a new utility line has to be run to a display area—at $10 or more an hour for labor?

The people who live and work in a facility on a day-to-day basis can identify these problems. They do not always have an answer, but in most cases the staff can isolate potential hazards in museum design. So why not ask them in order to assure functional effectiveness in design.

New Construction

In the case of the new museum, these problems can be avoided by following a few basic steps. The most basic is to design utilization into the museum before you begin the decorative aspects. In short, function before fun. This search for function begins with cooperation among the architect, industrial designer and staff. Until now, the last two have had little or nothing to say about museum interior design. With their assistance, the architect can have the information needed to provide the ultimate in easy maintenance, utilization of area and equipment and human factor design.

This is not to say that the architect is the villain in these instances. Quite the contrary. Much of the time he receives minimal input from the staff and it is usually poorly organized when it is offered. The staff must take the initiative to review carefully all of their requirements. Fixture or furniture specialists (industrial designers) should be brought in to consult at this time. Their help will be a necessity in the next stage.

The second step is to use these functional requirements and organize them as the basis for a system of modular, versatile exhibit "furniture." This furniture will include almost all of the interior structure of the museum. Treat the entire interior as a modular structure, working out amounts and types of curved and straight wall panels; special connection and access door panels; a variety of case structures; light boxes; structural supports for special settings; and whatever else is deemed necessary for proper presentation by the interpretation and curatorial staff. Once you accept the fact that a wall or a case need not be permanently placed, you will begin to understand the "furniture" concept used in most of the partitioned office areas in newer commercial buildings.

Once presentation needs are established, the maintenance and service elements must be added to the system. Here, the architect and the industrial designer make the system liveable.

First, the more obvious marriages between the building's subsystems and the furniture system should be established. Floor and ceiling connections for the wall system must be worked out. Service and storage areas for wall and case sections must be established. Simple interlocks with building utilities for power, sound and water must be established on a level so that house maintenance crews can make all installations. At this stage, you will be developing a floor plan for opening exhibits and typical exhibit situations to come.

This simplified series of steps actually represent an immense amount of careful research, planning and design by the architect/industrial designer/museum staff team. The results of this effort will provide the hardware-oriented museum with an exhibit system as versatile as the most modern art museum. And one more advantage of a system of this type is its ability to correct errors rapidly and at a low cost. If, after the museum is opened, you discover that a wall is hampering traffic flow, it can be moved. The maintenance staff can do it without expending a dime in construction costs. And what if a protective barrier or moat is not wide enough to keep hands off an easily damaged display? Simply shift the room around until the correct degree of protection is attained—once again, at no added cost to the museum, other than a few man-hours.

Existing Museums

But, thus far we have been talking about the new museum. What about the existing museum structure? The very same technique was recently applied to the third floor of the Statue of Liberty for the new American Museum of Immigration, to open this fall in New York Harbor. The entire Museum was prefabricated over a thousand miles away, set up, checked out and shipped to New York, where a four man crew installed over 1,000 feet of wall, 55 transparency boxes, more than 60 display cases and 250 mounted art plaques.

The actual installation was fairly simple due to careful pre-planning and contractor coordination by the contractor and Parks Service engineering staff. The prefabricated walls were plotted so that all clearances could be pre-planned and access to existing facilities would allow for easy servicing. Since the ceiling was dropped and not modular, it was added after the wall system to allow adjustments for variances in the floor. Since the walls were true, it would have been quite expensive to true up the floor. Thus, the tile ceiling took up all slack—at no extra cost.

The entire wall system, cases and art plaques can be removed and replaced with a minimum of effort by the museum staff simply by unlocking a panel and a quick disconnection from utility lines.

What about cost? The answer is equally interesting. Modular wall systems cost from 25 to 50 percent less than a conventional plaster installation. For instance, raw cost for one square foot of regular plaster-on-gypsum lath wall with vinyl covering would be about $2.70. A vinyl-covered double dry wall section would be $2.50 per square foot. A Foam-core, modular, vinyl-covered panel will cost about $2.15 per square foot.

If this can be done in a structure as old as the Statue, think of how this technique would solve remodeling problems in existing museums and how well it could be utilized in expansion. In fact, such modular "furniture" systems actually hold just as much advantage for the existing structure as for the new.

Many museums hold back on redecoration or alteration due to a pending building drive and the possibility of moving into a new structure in a few years. With a modular wall system, there is no reason to hold off. The walls and cases can be moved into the new building along with existing lab equipment, desks and chairs. (One of the largest exhibit design contracts of the past year was for the design of six exhibit modules at Kennedy Space Center. The competition was based on a design that would work in the existing Visitors' Information Center while being able to move into their proposed museum structure to be completed in the next few years.) Of course, it takes added design effort by the architect and industrial designer to create a system that will fit in two different structures, but it is not as difficult as it seems. For years, designers have created extremely versatile structures for trade show exhibitions. These complex, technical exhibits must be able to "live" in a wide variety

of convention hall situations. Their connectors adapt to variations in floors. Their backwalls adapt from two stories to one story. Their panels can be rearranged from lineal layouts to shaped arrangements, etc.

Another advantage of the modular wall system is that redecoration can be accomplished somewhere else without closing the existing facilities. A crew moves in and removes the old, unwanted structure. Walls and partitions that require removal are torn out by a wrecking contractor. Any support or shoring-up can be done at this time. Wherever possible, the new system is simply laid in front of the existing wall as a "skin." Down time is kept to a fraction of what conventional reworking would require.

Currently such remodelling is being conducted in the American Stock Exchange Visitors' Gallery, a small museum featuring the story of the Exchange from the days of the 'Curb" to today, with emphasis on trading on the modern Exchange floor. Not only are the walls and displays being replaced, but a ceiling is being added to dampen the extremely high noise level from the adjacent trading floor. A six man crew will install the entire museum system in a week or less! The ceiling, as well at the walls, must be modular in order to replace or alter exhibit sections later as the need arises. In fact, the main museum, including the ceiling, will be raised for inspection by the AMEX staff at a remote location prior to its installation in New York.

In this case, the walls and ceiling are constructed from Foam-core panels. The panels are wood and aluminum frame-ups, about one inch thick with self-extinguishing foam filler. Most of the panels are finished in laminated plastic for maintenance ease. Connections are made by key-locks to assure compression between panel sections. Wiring is prefabricated into panels and channeled in conduit tubing.

Transparency boxes and animated displays are quick-release for ease of repair and for rapid change of information.

Though not a factor in this installation, seams could prove a problem in this type of panel installation. Special lapping techniques can be used to avoid seam lines where vinyl coverings are used. The large photo panels at the Gallery will also require special on-site finishing and special handling. Despite these problems, the wall systems are easier to work with and assure a flatter, smoother surface for such "wall paper" type finishes.

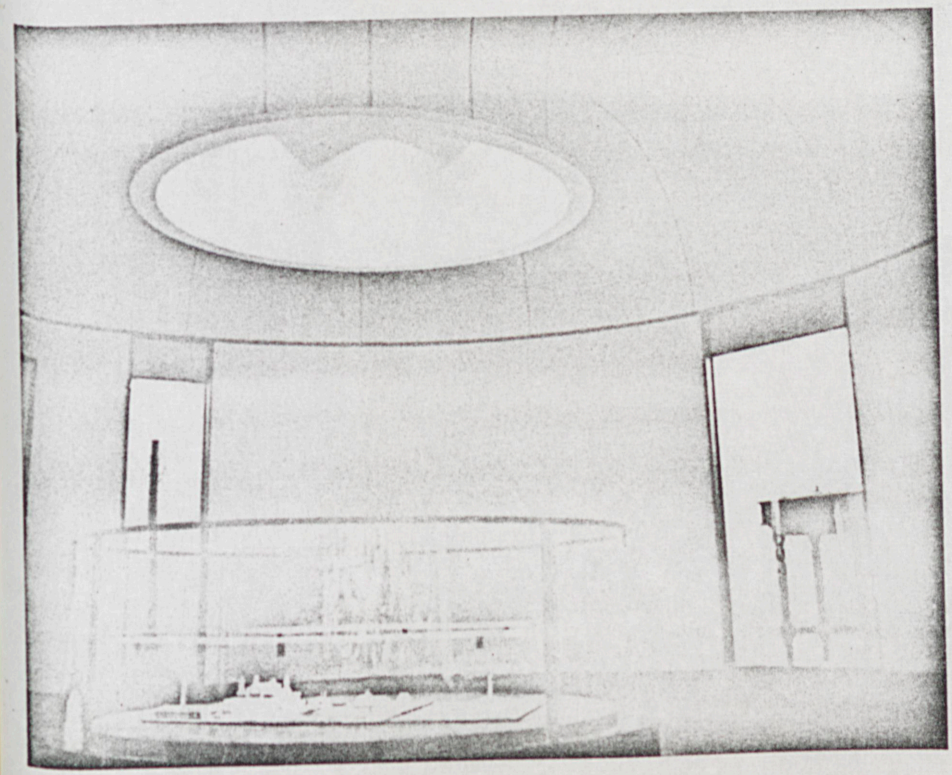
There are several mass-produced wall systems on the market, but most people find the custom approach more functional (for obvious reasons) and less costly (you only buy what you need—no waste). Regardless, each installation has its own special problems. If part of your display or work areas can be handled by an off-the-shelf system, by all means, use it.

Most museums have unique utilities requirements. Only through custom design and fabrication can all of these needs be built-in. In every case, the individual city codes for wiring and fire-proofing must be followed In every case, it is best to have your plans checked by the city Building Department prior to construction.

Bypassing the Obvious

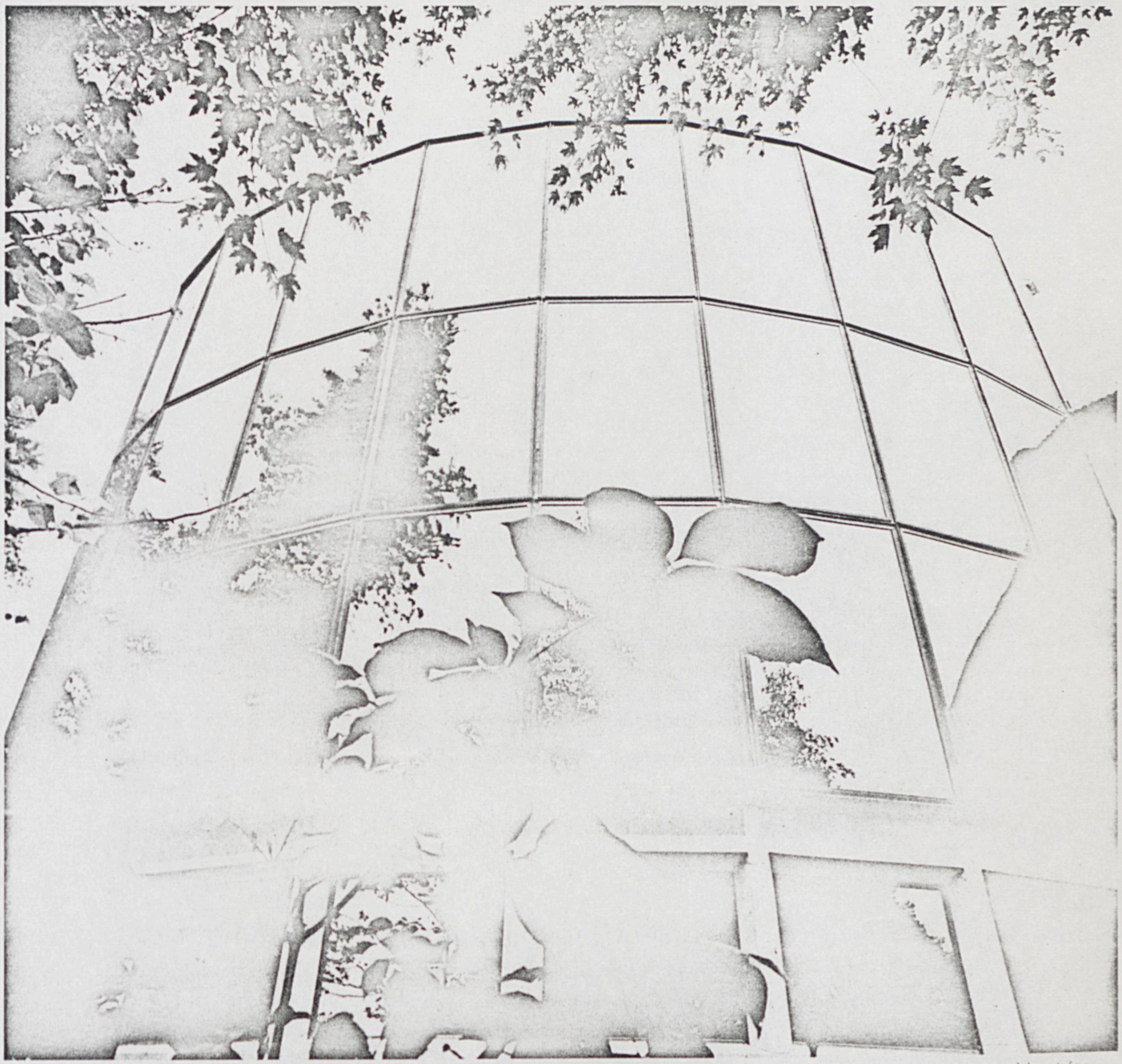
Although most "museum involved" people assume that there is a better way, why hasn't a different path been followed? The answer can only be that we have been *bypassing the obvious*. We have bypassed the staff! The director and the board are naturally concerned with funding, architectural acceptance by donors and the community and the basic needs of the public (traffic flow, wash rooms and parking). But much of this falls into the background after opening day. Once the reviews are in, and the contributors are satisfied with the more obvious impact of their donation, then come the years and years of day-to-day operation to contend with.

Because it costs no more not only in the long run, but in the short run, too, why not design an exhibit system for the staff? Since five years after the opening day of a museum or its new wing, the public and profession will judge the museum on its exhibits and not on its landscaping, why not design an exhibit-oriented museum? Since a well-attended museum is much more likely to attract donations and grants, why not design toward this end? And when such design can cut your overall costs (building, maintenance and exhibitions) by at least 25 percent, it is certainly worth consideration. ■



A lightweight fiberglass ceiling supported by curved modular wall panels.

What's New in Glass



Double-glazed reflective glass used for the tower of the Brandywine River Museum blocks much of the sun's brightness and heat for visitor comfort and protection of paintings. The glass units also reduce the load on the building's heating and cooling systems.

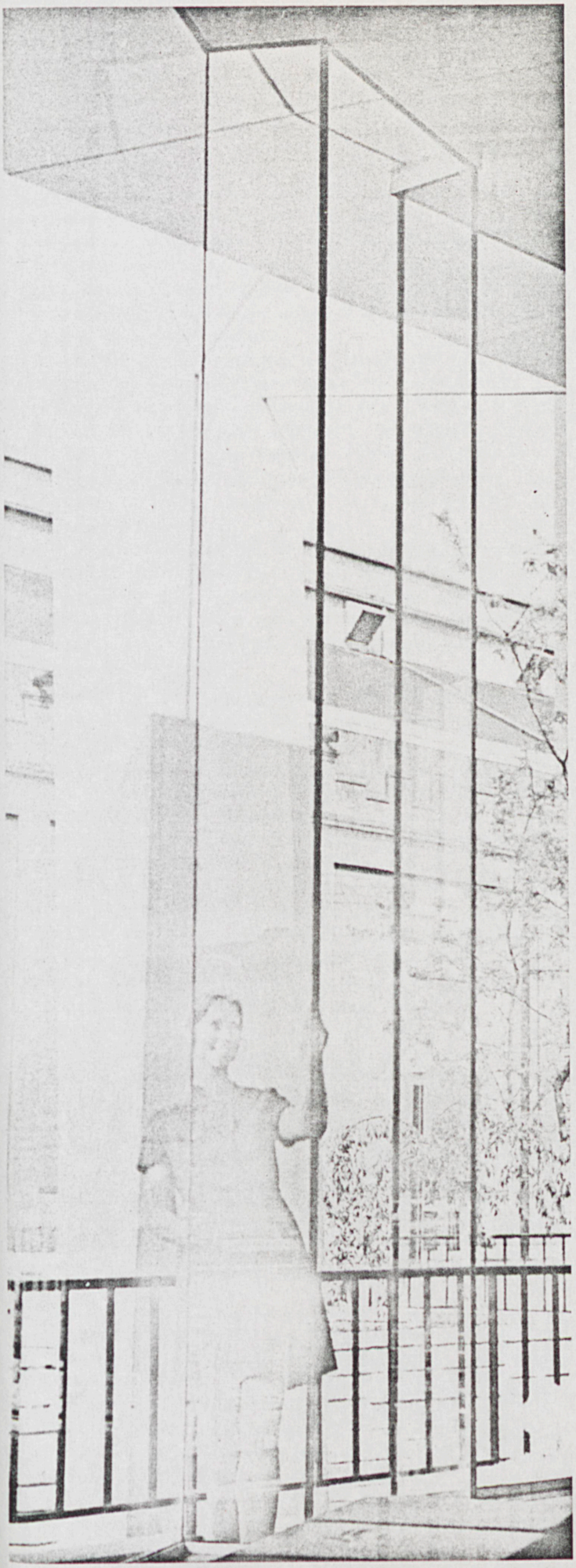
Donald C. Hegnes
Manager, Architectural
and Construction Services
PPG Industries

In the past few years, more innovative architectural glass products have been introduced than in any period since glass was discovered some 5,000 years ago. Many of these new products are especially suited to museums, art galleries and exhibit centers for they can give exteriors an inviting appearance and make interiors safe for visitors, staff and museum collections.

The newest generation of architectural glasses is the reflective glasses, which have grown rapidly in acceptance by architects, consulting engineers and museums, since their introduction in the late 1960s.

In only a few years, about 100 buildings throughout the country have been glazed with reflective glasses. The new products have thin, transparent metallic coatings that provide a muted, mirror-like appearance and usually high comfort conditioning performance.

The new environmental control glasses, which reflect much more solar radiation than ordinary tinted glass, make interiors more comfortable by reducing heat gain and ap-



parent outdoor brightness. Their lower emissivity helps keep building occupants comfortable in winter just as the bright metallic surface of space suits keeps astronauts comfortable in outer space.

Architects and builders also are specifying reflective glasses for their contribution to a building's appearance. Reflective glasses, which are available in bronzes, grays, greens and metallic tones, can enhance the color scheme of virtually any building, and their reflectivity adds depth and dynamics to a building's appearance.

Reflective glasses provide the best performance available when part of a double-glazed window. Some reflective glass units of this type provide insulating performance equivalent to three panes of clear glass without the added thickness and weight. Performance of a reflective double-glazed unit depends on the combination of glasses used, including tinted, clear or both, and the number, type and placement of the reflective metallic coatings.

Additional process steps make coated glass more expensive initially than clear or tinted glass, but a reflective insulating product often minimizes total building costs by reducing both initial and operating expenses for the heating and cooling systems. These savings are revealed when careful cost comparisons are made by consulting engineers.

Reflective coatings are applied to the surface of glass products by wet chemical deposition of metals or by the firing on of metal oxide films. Each process provides different and distinctly improved performance capabilities.

Both types of coatings can be applied either to clear or tinted glasses. The metal oxide coating, which is as durable as the base glass, can be used in either single- or double-glazed units on indoor or outdoor surfaces. The metal-coated glass is used only in double units, with the coated surface in the air space between glass panes, where it is protected from moisture and abrasion.

Glass for Museum Use

The first use of the newest double-glazed reflective glass was in an ultramodern tower which, along with a 107-year-old grist mill, makes up the Brandywine River Museum in Chadds Ford, Pa., near Philadelphia. The Museum was created by the Tri-County Conservancy of The Brandywine, Inc., to preserve the artistic and historic heritage of the Brandywine Valley.

In restoring and expanding the mill, architect James R. Grieves of Baltimore blended old and modern materials for appearance and performance. The rustic environment was enhanced by the addition of a Belgian block courtyard and steps and terrace floors made of old paving brick. The four-story curved tower addition, with a three-tier window wall of reflective insulating units, affords space for exhibits, rest areas, walkways and elevators. The neutral gray glass harmonizes with the natural environment by softly reflecting the tree-lined Brandywine River and surrounding meadows, as well as the changing sky coloring and cloud patterns.

The architect also selected environmental conditioning glass units to help maintain the carefully-controlled temperature and humidity inside the Museum to protect the paintings and to provide thermal and visual comfort for visitors. The new high-performance glass also has contributed to lower initial and operating costs for the Museum's heating and air-conditioning systems.

The clear glass walls of Louisville's Founder's Square civic pavilion are free of vertical metal framing members as a result of the new Total Vision System glazing method.

For entrance lobbies and similar areas, there has been a growing trend to achieving an "open," inviting appearance, which has led to ever larger expanses of clear glass. Until recently, however, the open effect architects sought was marred by the use of opaque, vertical supports between the transparent glass vision units. To meet the demand for a total glass look, PPG Industries has introduced the Total Vision System (TVS), a unique custom glazing concept that departs from conventional glazing techniques by replacing opaque metal, wood or masonry structural supports with vertical transparent glass "fins." In TVS glazing applications, structural support for wind-load resistance is provided by long, narrow transparent glass members which are bonded with silicone sealant to the edges of adjoining vision panels to provide suitable stiffening.

The TVS glazing concept was developed to offer the architect wall-to-wall glass fronts that provide an unobstructed view from both indoors and outdoors. The system affords a more open appearance for entrance lobbies, display fronts, galleries, reception rooms and other public traffic areas. Used on partitions indoors, the all-glass system furnishes a unique combination of visual freedom and acoustical privacy.

A dramatic variation of the TVS glazing concept was employed by Louisville architect Lawrence P. Melillo in the 12-sided Founder's Square civic pavilion in Louisville. The pavilion, behind a wide moat set with water jet fountains, houses a tourist information center, arts and crafts gallery, theater and civic offices.

Large float glass transparencies, each 15 feet high and 10 feet wide, are separated by recesses consisting of a glass fin, a glass vision unit and another glass fin. From some angles, visitors look through several glass pieces simultaneously, providing a jewel-like appearance. The open, uncluttered building helps make viewers aware that the 100-ton, cable-suspended roof is unsupported by walls or columns. A special slip joint permits the roof to move up or down slightly to adjust for snow loading, expansion or contraction of the support cables, settling or other loading changes. Free of the usual opaque vertical supports, the pavilion's all-glass exterior gives passersby an unobstructed view of interior displays, and appears as inviting and completely open as the block-long park that surrounds it.

Recent Florida field tests—involving some of the tallest glass units ever produced—have verified the TVS glazing concept's suitability for the dramatically high glass fronts now on architects' drawing boards, and PPG presently is considering window units involving heights up to 42 feet. The successful field tests pave the way for impressively high lobbies and other first floor areas having a completely open look to harmonize with their environments. The obstruction-free, expansive glazed areas also furnish a prestigious appearance at a cost comparing favorably with similar monumental construction using stainless steel or bronze glass-holding members.

Safety Considerations

Another important trend in use of glass for building or remodeling is the growing concern for the safety of occupants and visitors. Nineteen states in the past three years have enacted laws requiring the use of safety glazing as new or replacement material in hazardous locations in residential, commercial and public buildings. The Consumer Safety Glazing Committee (CSGC)—a cooperative effort of safety, labor, government and industry representatives—is encouraging passage of upgraded safety glazing requirements in 13 additional states in 1972. The U.S. Public Health Service and the Food and Drug Administration's Bureau of Product Safety, both CSGC members, estimate that 250,000 persons—about half of them children under 15—are injured or killed each year in accidents involving ordinary glass in hazardous locations. These locations include framed or unframed glass entrance doors and adjoining fixed glazed panels which might be mistaken for doors, as well as storm doors and sliding glass doors.

Principal safety glazing materials are tempered glass, laminated glass, wire glass and rigid safety plastics. A special controlled-tempering process gives tempered safety glass three to five times the strength of ordinary glass of the same thickness. Even if it breaks under extreme impact, tempered glass crumbles into small particles to reduce the chance of serious injury.

Tempered glass offers increased resistance to vandalism as well as accidental breakage. Because of its ability to be flexed to higher limits than ordinary glass, tempered glass bends or deforms to absorb greater impact. Tempered glass also offers a significant cost-performance advantage over other safety glazing materials.

For glass selection and cost analysis service, architects and engineers should consult with regional architectural representatives of the glass industry early in the building design stage. Representatives are highly qualified to provide specific design and application data for products.

In addition to architectural applications, glass also is used extensively in museums for exhibit cases, many of which are custom-made. For most cases, where undistorted viewing and protection from handling and dust are the main concerns, clear float glass makes an excellent choice. Formed in a continuous ribbon in a molten tin bath, float glass combines the high optical quality and parallel surfaces of plate glass with the fire-finished brillance of the finest sheet or window glass.

However, some objects on display require special protection. Jewel collections may require a break-resistant glass, and textiles, documents and similar materials may require a light-and-heat filtering glass to prevent fading or decomposition. For these types of displays, no one or two standard products will satisfy all conditions.

Where special measures are required to protect collections from theft or deterioration, it often is advisable to retain a professional consultant. If the collection is perishable, he can analyze the room lighting, atmosphere, temperature and other ambient conditions and recommend suitable protective glass. Similarly, for valuable collections, a consultant can analyze overall security needs and recommend the proper break-resistant glass, perhaps with attached or built-in devices which connect it to the building's alarm system.

Of course, the biggest "showcase" of all—and the first one potential visitors see—is the museum itself. Architectural glass products now available can help establish an inviting, dramatic exterior and provide a comfortable and safe indoor environment for all who accept the invitation. ■

I Wonder Who's Hearing It Now

Robert B. Newman
Bolt Beranek and Newman Inc.
Consultants in Acoustics

We usually think of a museum as a place where visitors go to "look" at something, and if so, why worry about anything but the visual aspects of the environment? Museum designers are greatly concerned with lighting and the control of climate for the preservation of collections. But acoustics—what has that got to do with a museum? There is little argument that the lecture rooms or auditorium should have good acoustics. Most architects stop there. Unless a gallery or entrance hall is to be used occasionally for concerts, the general acoustical environment in a museum is usually left to chance. The results, predictably, range from poor to intolerable.

It should be possible for visitors to converse with one another as they walk around in a museum without bothering other people. It should be possible to have gallery talks for small groups without disturbance to others. With an increasing emphasis on the use of all media for exhibitions, the museum often uses sound as a part of the exhibits. The presence of sound in the museum environment cannot be ignored.

To make no provision in the museum's design for the control of the acoustical environment is to disregard one of several attributes that will make it successful. It may simply result in unpleasant, noisy spaces. At worst, it can result in spaces in which visitors can hardly see the exhibits for the acoustical distractions. In one well-known museum, a series of small, cylindrical exhibition rooms are covered with domed plaster ceilings. The acoustical environment is overpowering, with almost unbelievably weird whispering gallery effects.

Gallery Acoustics

A room (a gallery, an entrance hall, a washroom or any other space) that is finished entirely in hard, sound-reflecting materials (marble, concrete, brick, plaster or glass) is likely to seem noisy to its occupants. Any sound generated in such a room will be reflected back and forth many times from these hard surfaces. The duration of the sound is thus prolonged, and it seems to come from all directions. Every little sound in such a space becomes a major episode. One cannot always tell where the sound source is, because the sound is reflected many times from the surfaces of the room. This in itself is annoying. Such an environment calls attention unpleasantly to any sounds made there, and deprives the viewer of the opportunity of "being alone" or of feeling the freedom to speak to others.

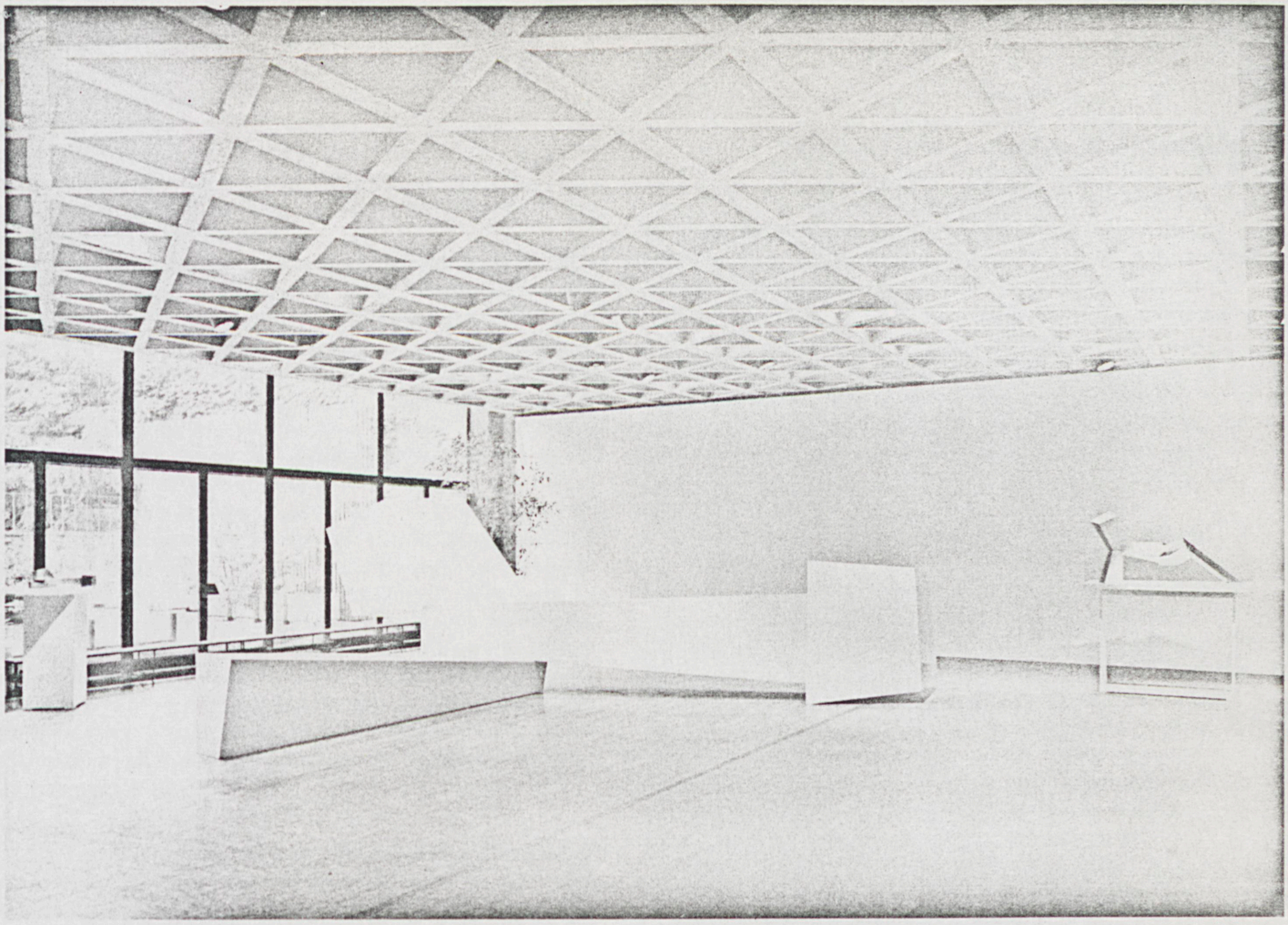
Most people have entered an empty house or an apartment and noticed an unpleasant reverberant quality. It changes, however, when there are furnishings such as carpets, upholstered chairs and draperies. These materials do not reflect sound but absorb it. Like all good sound absorbers, they are porous and non-reflective. They keep the sound from bouncing around endlessly, and the space takes on a more comfortable feeling. The same thing can be done in a large exhibition area by adding materials and finishes to the room that absorb rather than reflect sound energy. This can be achieved by carpeting the floor, by treating the ceiling with a sound-absorbing material or by introducing non-reflective materials in a variety of locations.

But a gallery with a sound-absorbing ceiling does not have to look like a supermarket! The Yale University Art Gallery is an excellent example of the use of a sound-absorbing ceiling treatment that "doesn't show." The concrete ceiling grid is made up of a triangular pattern of beams and struts, penetrated by the ductwork serving the space and accommodating the lighting. Over this structural grid is the floor slab of the space above. The floor slab was poured on top of a sound-absorbing formboard which was simply left in place. When visitors look up through the triangular grid, they see this material as the actual ceiling of the gallery. It absorbs sound in the room but does not obscure the structural system. Early in the design of the Gallery, someone suggested that the complex shape of the ceiling alone would "break up the sound," and that sound-absorbing material would not be necessary to produce the kind of quiet acoustical environment the Gallery wanted. Rubbish!

Sound absorption takes place when the molecules in the air moving to and fro (i.e., sound waves) arrive at a porous sound-absorbing material and enter the interstices of the material. There, in the interior, the moving molecules scrape on the fibers of the material and lose energy through friction. The moving air molecules that carry sound must be able to penetrate the porous materials to give up energy. No amount of re-direction of sound by concrete surfaces can use up much sound energy. The sound will persist as long in a room finished entirely in concrete with a beamed or coffered ceiling as it would in the same room finished with smooth concrete surfaces. One cannot "break up" a sound wave by irregularizing a concrete surface. Impervious surfaces—from wood to marble—reflect sound. They *do not* absorb it, no matter what the shape, because they are not porous and contain no mechanism for energy dissipation.

Sound Absorbers

What materials are available to absorb sound in a museum? An answer often proposed by the designer is acoustical plaster. This material has been used many times in museums as a gesture toward providing the needed sound-absorbing treatment. It seldom works as a sound absorber



The Yale University Art Gallery ceiling

when initially installed because it is dependent on the method of installation and finish. It is often painted at the outset to make it look attractive and, if not then, it is always painted within a few years in order to restore its original appearance and to cover accumulated dirt. When it is painted, it is *always destroyed* as a sound absorber because the paint seals the surface pores and the molecules of the air can no longer enter the material. It behaves like any other hard plaster surface. The museum then discovers that it can't glue any sort of acoustic tile to the material because it has no strength. It must be scraped off and a legitimate sound absorbing material must be applied.

A sound-absorbing material is porous, and thus it invites dirt as well as sound waves. These materials are often placed behind more serviceable open facings—a wide variety of which are available commercially. Draperies, carpets and many manufactured sound-absorbing materials of glass, mineral wool or wood fiber are useful sound absorbers.

To provide adequate reverberation control in a gallery, there should be an area of sound-absorbing treatment approximately equal to the floor area of the room. If the entire floor is carpeted, there is probably no need for other treatment. On the other hand, if the floor is to be hard-surfaced, the entire ceiling might be covered with a sound-absorbing treatment. If both floor and ceiling are hard-surfaced, some wall areas must be treated.

Gallery walls are often finished in fabric. This material is usually stretched directly over plywood or some other hard material and allows almost no sound absorption. To be effective for sound absorption, porous material at least one-half inch thick is needed. If fabric wall panels are used, they should be stretched over hair felt or glass fiberboard, at least one-half inch thick. Wood strips can be placed at appropriate intervals behind the fabric and between the areas of sound absorbing material to permit hanging.

The new National Gallery in the Victorian Arts Centre in Melbourne, Australia uses large areas of carpet, sometimes on the floors and sometimes on the walls, for control of the acoustical environment. On the floor, the carpet serves the dual functions of foot comfort and sound absorption. These galleries are very pleasant, and visitors experience a minimum of "museum fatigue."

The addition of a sound-absorbing treatment to an existing gallery sometimes poses a difficult architectural problem. If the space has a flat ceiling, or a number of flat areas between beams or coffers, it is relatively simple to apply attractive, commercially-available materials. But if the gallery has a dome or barrel-vault ceiling and the ceiling is the only logical place to put sound-absorbing treatment, there are no easy-to-apply sound-absorbing treatments. A sprayed-on asbestos or cellulose fiber material (that is very messy) can be used, but this gives a rather rough texture to the surface. One can resort to a custom-made, curved, perforated metal facing with a glass fiber blanket behind it. Other facings, such as an open lattice-work of wood or metal, can also be used to face a sound-absorbing board that has been cut to conform to the curved surfaces. This type of treatment may be quite expensive, but it may be

the only answer to the problem of improving the acoustical environment in such a space. The essential part of any acoustical treatment is the porous, sound-absorbing board or blanket. The facing that covers it for appearance or durability must be open enough to allow the sound wave to flow into the material. There should usually be no solid elements in such a facing larger than about two inches and the open area will vary from 10 to 30 percent depending on the scale of the elements.

For new construction, the museum client must be firm with the architect. The architect must be aware that the galleries should be not only a visual delight, but an acoustical delight as well. This will happen *only* when proper amounts of sound-absorbing finish are incorporated into the design, rather than being applied later out of desperation and necessity. No matter how famous the architect, if he ignores acoustics, the result is always the same for the user—an acoustical nightmare.

Another problem often overlooked is noise from air-conditioning systems. While the air conditioning need not be totally silent and, in fact, should make a moderate amount of noise to increase the masking of minor sounds from other parts of the space, it should not sound like Niagara Falls. This requires careful attention on the part of the mechanical engineers to such matters as the velocity of delivery of air at grilles, the design of the grilles themselves and the treatment of ductwork leading back to the fans. Here again, ordinary commercial supermarket practice is not good enough!

Auditorium Acoustics

At the other end of the range of acoustical environments in a museum is the space where one wants to hear other people—the lecture room or auditorium. These spaces vary widely in size and design, from fairly large auditoriums (like the Grace Rainey Rogers Room in the Metropolitan Museum of Art) and more modest auditoriums (like the one in the St. Louis Art Museum), to the many smaller rooms with fixed or movable seating used for lectures, motion pictures or concerts in museums throughout the country.

The most important characteristic of a room in which one *wants* to hear is that there be no audible background noise from the mechanical ventilation system, the projection equipment, outside traffic, or from other activities in the building. Any noise that provides masking decreases the audibility of the program.

An auditorium designed primarily for lectures and chamber music should not be highly reverberant. This means that there must be a number of sound-absorbing surfaces in the room, in addition to the sound absorption contributed by the audience, for reverberation control. For the uniform distribution of sound, however, there should *always* be a hard, sound-reflecting ceiling.

The sound-absorbing treatment so highly desirable in the ceiling of a gallery to reduce the spreading of sound from one part to another is not desirable in an auditorium. Auditorium ceilings are often covered with sound-absorbing materials. This is always wrong. Plaster, concrete, glass or wood are all appropriate materials for these ceilings. These reflecting surfaces should, of course, be designed to distribute sound uniformly to the seating area. For this reason, barrel-vaults, domes and all forms of concave geometry are completely out of the question because they focus sound to particular areas in the audience.

Flat ceiling surfaces, either horizontal or tilted as may be appropriate, can give quite uniform sound distribution throughout the seating area. If beams, coffers or other irregularities are introduced, the scattering or diffusion of sound will be increased, and this is desirable; but the essential attribute of the ceiling is that it be hard.

In the St. Louis Art Museum, the ceiling over the main part of the auditorium is smooth, hard plaster, while the ceiling over the stage where chamber music may be performed is of a zig zag section which gives diffuse reflection of sound from the musical instruments. For the control of reverberation in this room, the seats are fabric-upholstered to make the characteristics of the room constant whether or not an audience is present. This makes it possible to use the room with large or small audiences with little change in reverberation time. In addition, sound-absorbing panels are incorporated in a checkerboard design along the side walls. The absorptive areas, covered in wood slats, have glass fiberboard behind them. In addition to these sidewall areas, the back wall is treated with a sound-absorbing material to minimize any echo from the rear of the room.

Often in an auditorium of this size (between 400 and 500 seats), a lecturer may feel that he needs the assistance of a sound reinforcement system. Anyone who makes a little effort to speak in a raised voice can be easily heard in a carefully-designed auditorium of this size without the need for amplification. However, an amplification system is required for motion picture sound and other uses, and occasionally it can serve for live-voice reinforcement. In the St. Louis Art Museum auditorium, there is a grille above the center of the proscenium opening. Behind it are the loudspeakers for sound amplification. The loudspeaker system should *always* be placed above the center of the speaking position. It should *never* be placed, as is so often done, at the two sides of the proscenium opening or platform area. The latter type of installation gives decidedly inferior results because of the dissociation of the amplified source from the real source. Only when the loudspeaker is located where its sound arrives at every seat in the room *after* the sound from the real source does it sound realistic. The sound-reinforcing system must be carefully designed for the room in which it is to work and must always use only the highest quality components if excellent results are to be expected.

In the smaller lecture room or auditorium, perhaps with a flat floor and flat ceiling, the same basic principles apply for achieving good acoustics. There should be no intruding background noise and the ceiling must be hard and sound-reflecting. For the control of reverberation, it is often desirable to incorporate areas of sound-absorbing treatment on the walls. This is especially important to prevent back and forth reflection of sound between walls. This reflection often gives an annoying "flutter echo" which can be detected not only with a sharp hand clap, but with voice sounds as well.

The details of design will vary from room to room depending upon its particular configurations and requirements, but there are certain basic principles that must be followed in any room to provide good hearing conditions. If the room seats fewer than 200 people, it is almost always best not to use a speech reinforcement system and there is absolutely no need for such a system if the room is carefully designed.

Something can and should be done to control the acoustical environment in every museum space. Acoustics need not be left to guesswork or, worst of all, to that familiar "we hope it will work" approach. The acoustical environment will be as good or as bad as we make it through *design*, not guesswork or chance. ■

Planning For Action and Growth

Raymond O. Harrison, Director
Provincial Museum and Archives of Alberta

Ten years ago the government of Alberta embarked upon a completely new program to establish a Provincial Museum and Archives in Edmonton, Alberta. It was the first phase of long-range heritage resource development, and brought together museum, archives and historic sites functions in one institution. The project to preserve and depict the human and natural heritage of Alberta was completed in Canada's Centennial year, 1967, at a cost of about $9 million, and has a gross area of a quarter million square feet. As director, I had a rare opportunity to play a leading role in creating a large, completely new institution from its beginning, and to apply both museum and architectural experience to its development.

The Concept

My concept was that a museum and archives is a complex of dynamic human activities, rather than a static building, for each aspect of its operations involves people both visiting and working. Looking into the future 10 years ago, I saw it as pulsating with life, characterized by the continual movement of visitors, collections, exhibits, materials and personnel. I saw it as an expanding, growing organism. I would like you to look at PMAA in this way; then perhaps you may see the museum you are planning, or would like to plan, from a different point of view.

Imagine the PMAA building as completely transparent. Visualize well-defined activities taking place in distinct groupings. In particular, note the clear separation of different major activities and the patterns of movement. Think of these activities and patterns in a time sequence, fluctuating and changing during the 24 hours of the day, by the week and throughout the seasons of the year. In much longer projection, consider some activities expanding and changing in character, new functions being added and the building responding to changes in society at large.

Let's examine the transparent PMAA building a bit more closely. You will recognize five distinct groupings of activity taking place inside—public activities, exhibition, curatorial and production, archival and, below ground, certain mechanical functions.

Five Major Activities

Public Activities

These include reception, education, meeting, dining and sales functions. These activities take place during the day, as well as at night, without intruding on other functions. They also can be seen as changing in the sequence of time.

Exhibition

Two distinct activities are evident here. There are visitors absorbing information from and being enriched by the exhibits. Also there is the continual flow of exhibits—those which change monthly, or annually, galleries which have a 10-year turnover and which change according to new social and educational needs, and habitat exhibits with a 25- to 50-year turnover.

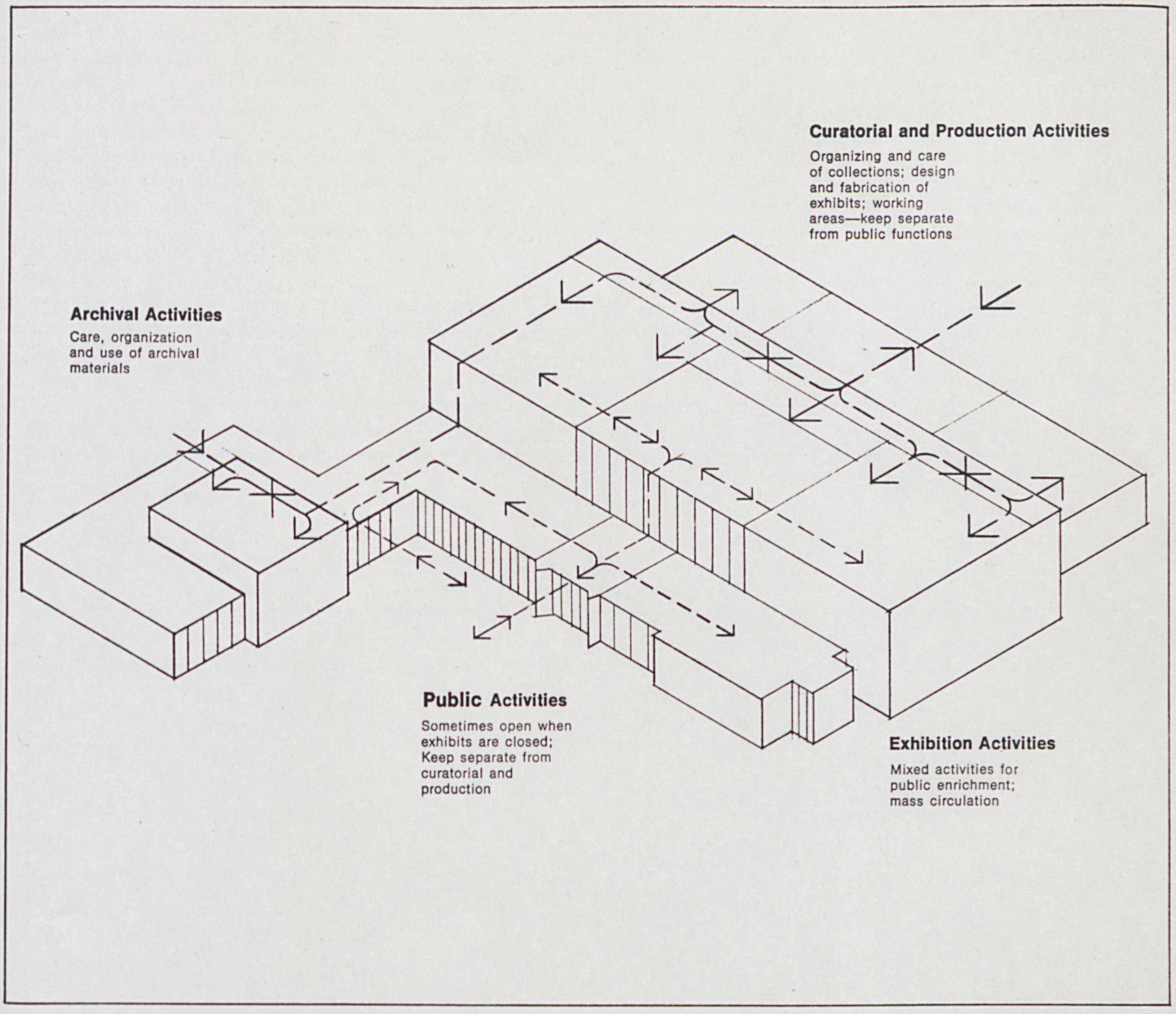
You will notice a clear flow of visitors following a story sequence. They move in and out of the galleries from a central area on both floors. They start with the preview in a central orientation gallery. They tour the four natural regions of the province via the habitat gallery, and then move through the story in the Indian and fur trade gallery. Via escalators, they pass to the second floor, rest in the central lounge, and later go through the natural history interpretive exhibit galleries. Finally they move on to pioneer history.

Two very different types of activity are involved in the exhibit block—the flow of the public, and the flow of exhibits and staff.

Curatorial and Production

In the third distinct block are concentrated the Museum's internal operating functions. We see here many facets of what might be described as a production plant. There is a central core in which all exhibits are designed, prefabricated and pre-assembled, so that only installation is required in the galleries. This core is flanked by the activities of two distinct curatorial areas: natural history and human history (including historic sites). Here is a flow of specimens and artifacts from accessioning, documentation and preservation, to preparation, then into reserve study storage, and out again for exhibition and research.

In this working block, one of the outstanding characteristics is movement of volume, weight and diversity in materials, exhibits and collections. There is a two-way stream of these activities following major traffic arteries—coming into the loading bay, passing to curatorial areas, then on to exhibit production, to exhibit galleries and back again, as well as out of the building to serve the province. This traffic is horizontal through a straight, wide, high corridor on each of three floors, and vertical through a central



core which includes a huge freight elevator, staff passenger elevator and stairways.

Extensive areas, commensurate with a major production operation, are provided for exhibit production and preparation of objects. Here there are quite different kinds of activity: large areas assigned to organizing collections, research by staff and scholars, exhibit planning and publication writing. A distinctive feature is the protection given to collections through access controls implicit in the building plan. An important provision in the building is the Security Centre, strategically located at the delivery and staff entrance. Here all of the complex protection systems of the building are being monitored.

Archives

In the fourth major block is located a vital element in Alberta's heritage resource: our archives of public records, private papers, photograph collections and maps. Two separate groups of activities occur here: the flow of records coming in, being preserved, recorded, arranged and filed; and the use of these resources for broad public enrichment —for private research and museum work, for exhibits and for publications and audio-visuals.

Mechanical

This normally-hidden function provides for environmental conditioning—lighting, atmospheric controls, cleaning and communications—required by the different kinds of activities. There is the flow of electric power and light, conditioned air, vacuum and compressed air systems and water. There is the flow of information via telephone, intercom, security systems and pneumatic tubes. The mechanical plant, located centrally, feeds through a vertical core to distribute these services throughout the building via the ceilings of the major traffic arteries. In this central core is also located the equipment for vertical movement.

Interrelationships and Future Growth

Let's look at the building as the interrelationship of all these activities. At present, there are four major groups of

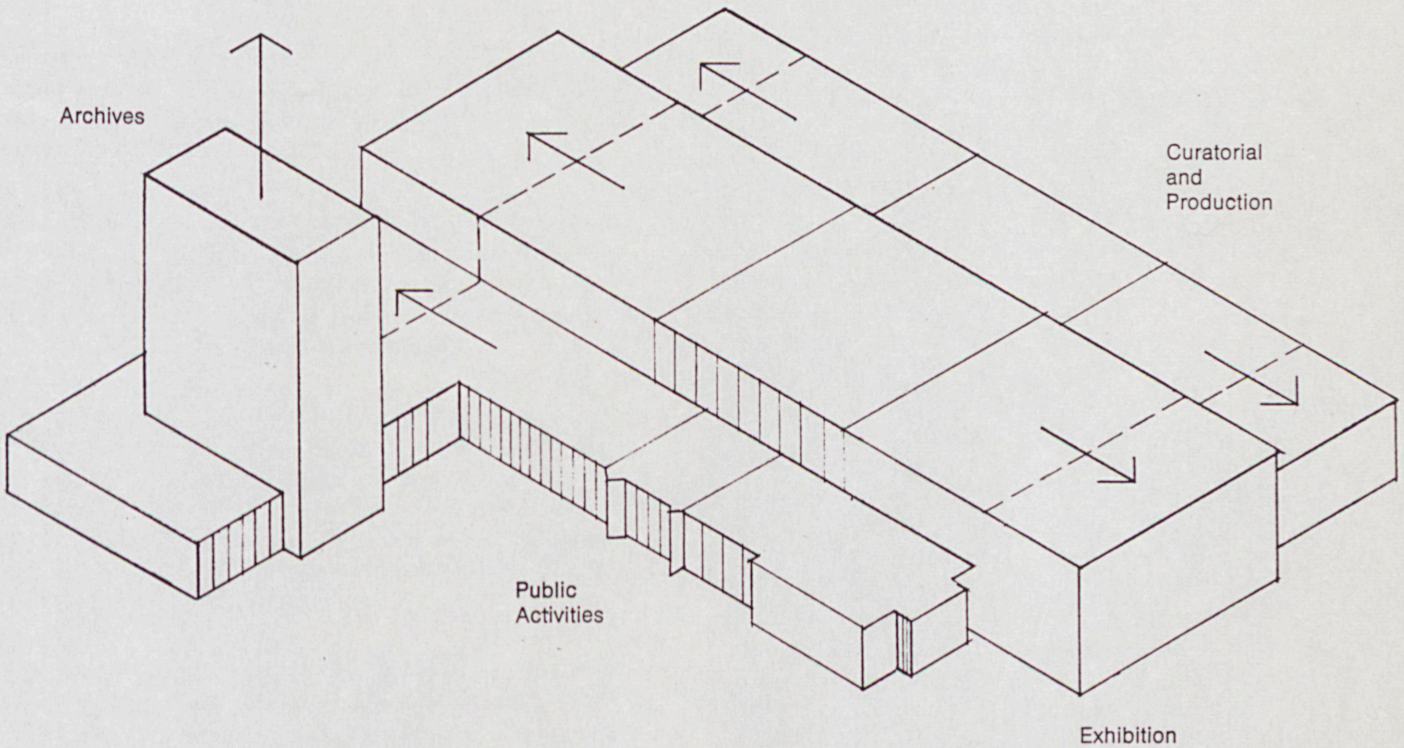
activities above ground which are reflected in four distinct units in the architectural massing. This concept results in a minimum of confusion and intrusion of extraneous activities, a minimum of "traffic" congestion and a maximum of protection to the collections and exhibits. General public activities can be conducted at any time of the day or night without adversely affecting other activities. In the exhibit block, the public flows in and out from the front, while the exhibits flow in and out through the rear. The curatorial and production activities are conducted without intrusion by the public; yet access to the curators for information and collections is still available.

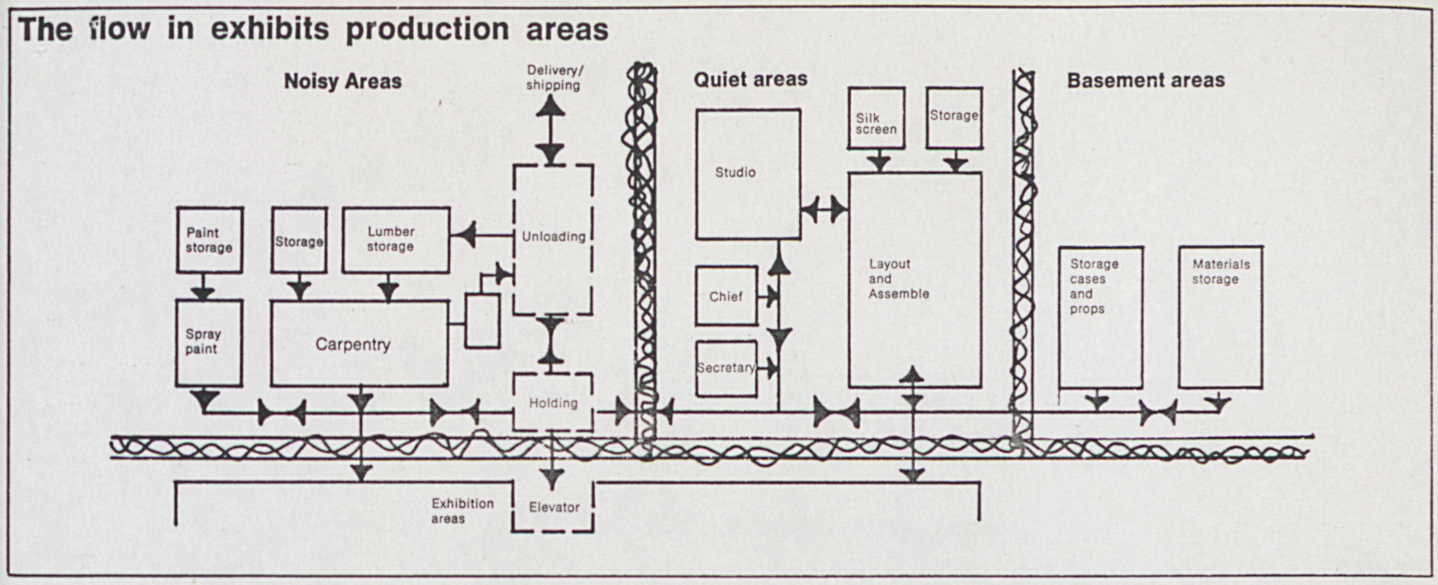
The Archives' functions are noticeably contiguous with human history curatorial functions. In Archives too, preservation functions are clearly separated from the public services of reference, exhibition and education.

What could happen to the volume and type of activities in each major grouping over the next 30 years? The collections will have burgeoned in quantity, diversity and comprehensiveness. The natural history and human history collections will greatly expand, while research and preparation will likewise grow. Province-wide historical and archaeological sites administration will become a major function. This growth now can take place adjacent to the original activity —a longitudinal expansion at each end, which thus doubles the curatorial space. Turning to our archival block, an immense growth in collections will take place vertically in a ten-story collection tower—a vast heritage resource of records and manuscripts for wide and imaginative public use. The exhibit block will expand longitudinally, contiguous with the curatorial areas, and will double in area. Three decades will see a vast increase in the collections and therefore greatly increased potential for telling the Alberta story. Further, a new federal National Museums loan policy will result in an addition, to enable the story of the nation to now be related to the Alberta theme.

In the public activities block, changes will have taken place also. Meetings of groups, instructional classes and in-

Expansion: Year 2002





formal groups will grow. Increased attendance will require changes in food service. All these will occur in a longitudinal expansion.

Looking at the institution as a whole, we foresee that the annual visitation will double in response to vast population increases, more leisure time and greatly increased educational demands. The parking area, which originally provided for 200 cars on the surface, will now add parking for 400 cars underground to cope with peak attendance. As a satellite view of the institution, PMAA will have changed from one of largely internal services, to a great heritage resource center radiating exhibits and services around the Province.

Planning Your Museum

What does all of this suggest to you? It suggests that in planning a new museum building, your approach could be as follows:

Envisaging

Have a clear idea in your mind of the distinct and different kinds of activities which will take place. Analyze them; group those activities which have common features; visualize the kind and magnitude of movement which will take place within and between the groupings.

Long-Range Projections

Try to picture not only what may take place in the immediate future, but what might happen in the more distant future, 25-50 years hence; what existing functions may change or expand and what new functions may be added. Try to imagine the size and kinds of movement and services which might take place inside, and how your museum will serve the region beyond.

Charting

Lay out on paper the sequence of actions in any major or minor activity. Then, delineate the flow between them, and chart the organization through which these activities will be achieved. Indicate where expansion and additions will occur in the distant future. List the space required for each activity in the near and far future. Now cut up the concept into as many phases as you may feel desirable for the plan to be achieved, over a stated period of time.

Physical Planning

Apply the following concepts to physical planning:

a. Ensure that the four basic functional units—public activities, exhibition, curatorial and production and mechanical—are clearly distinguished and separated. If you have a major archives, this too should be expressed in mass.

b. Relate these units and the major elements within them, to provide for maximum operational effectiveness.

c. Separate completely public circulation from working circulation. Create major traffic arteries. Separate the movement of the public from the movement of objects and personnel. Closely relate curatorial areas to exhibition areas, yet make them accessible, under control, to the public.

d. Make provisions for long-term expansion.

e. With this concept of functional separation, you will then have also laid the basis for fire separation to meet building codes and security control.

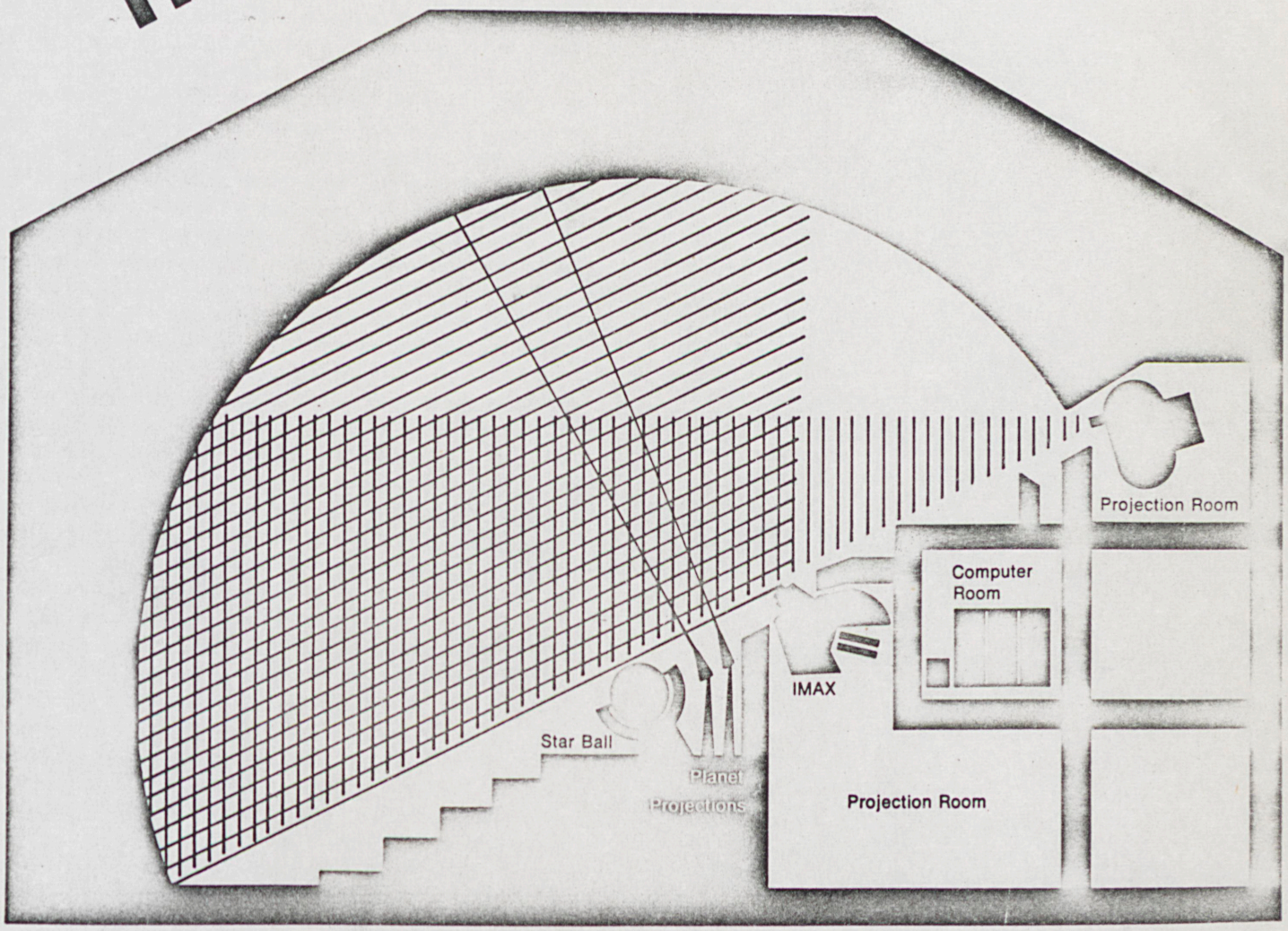
f. Place your architect and/or museum consultant on your planning team at an early stage. On the basis of such concepts as these, the architect will be able to undertake meaningful architectural massing and aesthetic expression, reflecting the distinct nature of your growing organization, rather than just creating an abstract work of art. He will also be in a far better position to interpret your needs in building plans and specifications.

g. Provide for a central mechanical center from which ductwork, piping and raceways may rise in a central core and radiate throughout the building. Install such items in the ceiling or in separate rooms adjacent to major traffic arteries, thus keeping mechanical equipment and maintenance crews out of curatorial and exhibition areas as much as possible while enhancing conservation. Often the mechanical center is located in a basement, but you may wish to give architectural expression to it as a distinct feature (for example, if you are planning a science museum).

h. Provide for mobility in exhibit areas—in partitioning, display units, lighting, electrical and air-conditioning outlets. Growth and change will make flexibility essential.

Realize that this excursion into the image of your future building does not detail the technical requirements for each activity. Nor does it preclude that there are other ways of conceiving and planning museum buildings. It does suggest, however, that you might take another look at the creative planning of your own proposed museum building. Try it. You may find that it opens up fascinating new insights and provides you with a better plan.■

Planetariums Flip Their Lids



Michael Sullivan, Executive Director
San Diego Hall of Science

San Diego has been described as a park surrounded by city. Beautiful 1400-acre Balboa Park is the center for culture and recreation in California's second largest city. The Park contains seven museums, the Old Globe Theatre, and, of course, the world-famous San Diego Zoo. This remarkable park will soon become the home of the country's largest planetarium. The Reuben H. Fleet Space Theatre of the San Diego Hall of Science will open in early 1973, at a cost of some $4 million ($1 million for Space Theatre hardware alone) and after five years of basic research and planning.

For the last 44 years, the design of planetarium chambers has remained relatively unchanged. Since the first projection planetarium was built in 1928 by the Zeiss Works in Jena, Germany, there have only been slight modifications in the seating arrangements and virtually no changes in the interior architecture of the planetarium's domed theatre.

For some time now, it has been known that a new planetarium design was needed. This need is due in part to a growing sophistication on the part of the planetarium audience, the expanded use of media in planetarium pro-

grams and the desire of planetarium directors to diversify by offering programs not only in astronomy, but in related fields as well. The Reuben H. Fleet Space Theatre will be a major departure from the traditional planetarium design.

The San Diego design is a unidirectional tiered-seating arrangement or amphitheatre, enclosed by a hemispherical projection dome. There are no walls. The 76-foot dome comes all the way to the floor, and it is tilted 25° from the horizon. The slope of the floor, or rather the seating risers, is slightly less than that of the dome. The height of the individual risers was carefully selected to allow for sight lines. There is an unobstructed view of the entire dome from every seat in the Theatre. Unlike the traditional planetarium, the projection hardware will be difficult to observe.

Planetarium Design: Then and Now

The first planetarium built in this country was Chicago's Adler Planetarium. Its doors opened to the public in 1934 and the Adler was an immediate success. Its Zeiss Instrument has the ability to project the night sky as seen during any season of the year, at any time of the night, from any place on the earth, be it Chicago or Bethlehem. Of course, the massive projector surrounded by row after row of concentrically-arranged seats dominated the room. In the original planetariums, the projection hardware often became the dramatic focus of the program. There will always be a certain magic associated with a planetarium projector. Even today's kinetic sculptures have difficulty capturing the grace of movement of a planetarium projector turning about one or more of its axes of rotation. It was a good theatre and for a quarter of a century that was enough.

We must remember that these original planetariums were built in a day when radio was king. Early planetarium programming resembled radio: a darkened theatre, little in the way of visuals and a good amount of copy offered by the planetarium lecturer. In the 60s, more than a decade after television, planetarium directors were belatedly developing more visual programs. The planetarium instrument and star field were slowly replaced by special effect projectors and pre-recorded narration and music.

In 1964, when the United States and Russia were in the throes of the space race, Michigan State University in East Lansing opened the Abrams Planetarium. It was the first planetarium that was not bound to the earth. The Abrams installed the first Space Transit Planetarium (STP) developed by Spitz Laboratories. The STP rotated about three mutually perpendicular axes and it was driven by an analogue computer. The instrument had the ability to simulate orbits about the earth, moon and planets, to present the stars as seen from any body in the solar system, and to reproduce the roll, yaw and pitch of the space craft in flight. Because of the space simulation capabilities, the STP Theatres had to have unidirectional seating. For the first time, every member of the audience looked in the same direction. This was a major step forward.

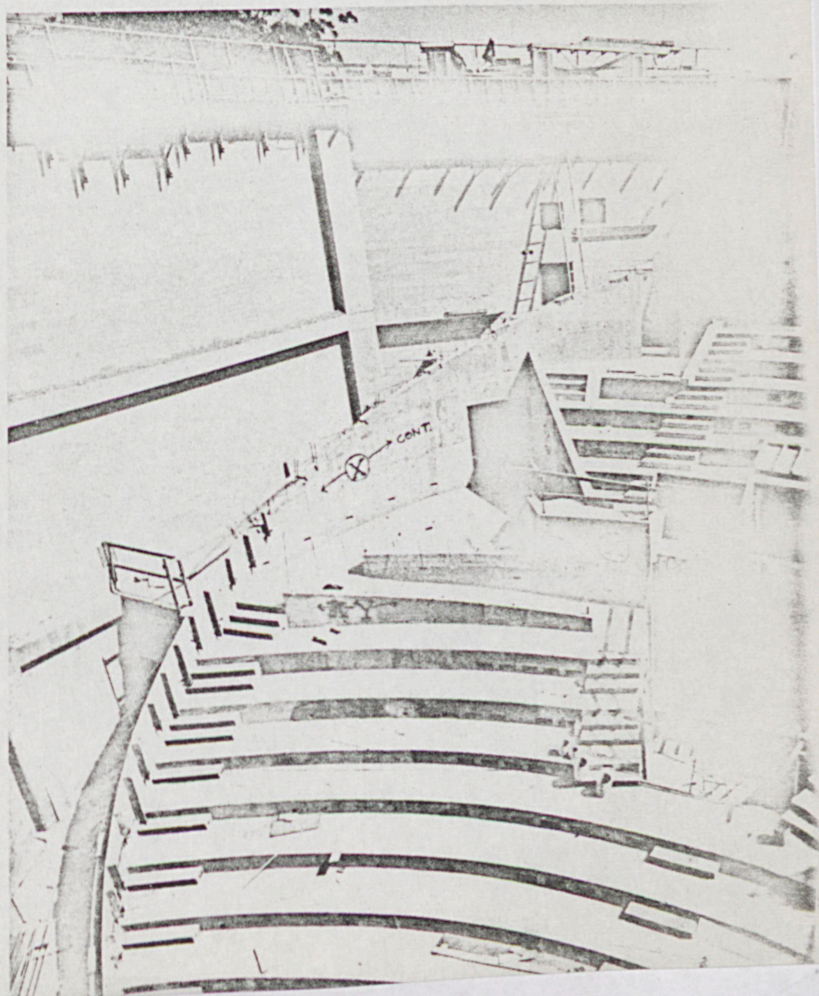
Hampered by concentric seating, it was difficult for the early planetarium lecturer to reach and hold the entire audience. A portion of the planetarium audience always faced the wrong direction. The successful planetarium director quickly found that he had to tell an episodic story, e.g., a sequence on a nova located in some western constellation and then on to Mars rising in the east. Unidirectional seating allows the planetarium writer to tell a story from start to finish.

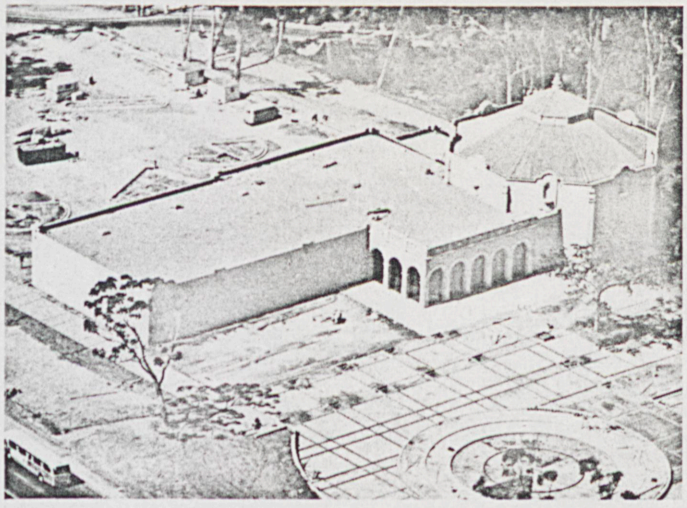
The designers of the Fleet Space Theatre were presented with several unusual problems. Their job was to create a

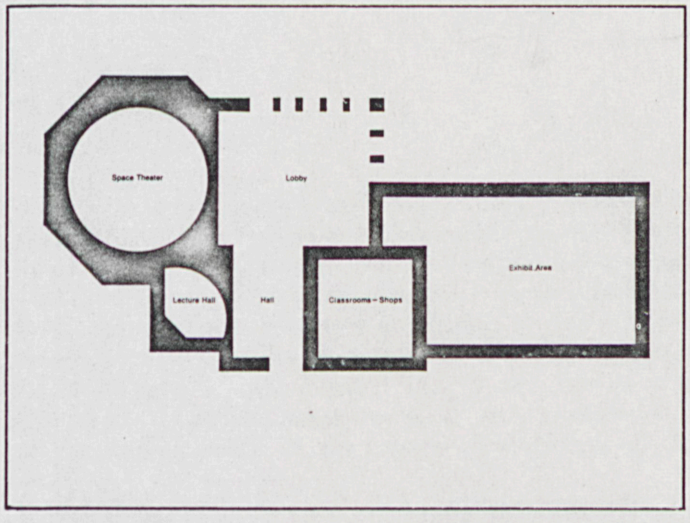
Aerial view of the Hall of Science complex.

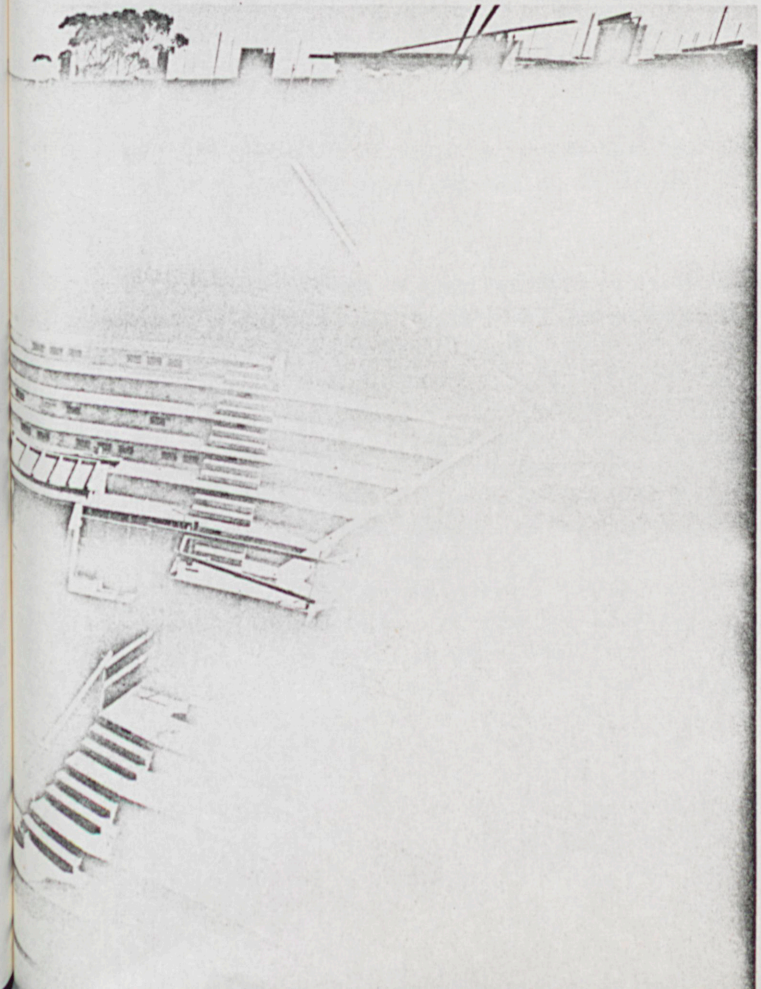
Floor plan shows the relationship of the Space Theater to the rest of the Hall of Science.

The Theater under construction—planetarium dome will set on the circular wall; the Star Ball will be found at the center of the circle; the IMAX projection port is immediately above Star Ball platform; and the rear projection port is located behind the last row of seats.









planetarium environment to simulate space flight; therefore, the horizon was eliminated. The facility also had to offer a high degree of flexibility for extensive use of 70mm film. The Space Theatre also has to function as a conventional planetarium for educational programs and traditional public programs like the "Star of Bethlehem." This can be done by projecting art work horizons onto the lower section of the dome.

The tilted-dome design allows for two large projection rooms. One booth located on the top level behind the last row of seats will house standard 70mm, Cinerama-type projectors. A lower projection room will have a 70mm IMAX Film Projector with a fish-eye lens. The image of this unusual projector will cover some 80 percent of the dome surface. The film travels through the IMAX projector horizontally at a rate of six feet per second. Each frame is 15 perforations wide and the circular-image format has a diameter of 70mm. The projector uses a 25,000 watt projector lamp.

Located at the geometric center of the dome is the four-foot diameter Star Projector, the first of a new generation of planetarium projectors developed by Spitz Laboratories. The Star Ball is one element of a highly computerized audio-visual system called the Space Transit Simulator. Behind the Star Ball, but not physically attached to it, are the planet projectors, image projectors (earth, moon, sun) and two additional zoom projectors. These are all part of the STS system, and can be programmed from a control console located at the rear of the Theatre. Beneath the console, on the middle level, is the computer room that will hold the heart of the system, a Digital PDP-15 computer.

A Multi-Purpose Facility

Because the Reuben H. Fleet Space Theatre is really both a planetarium and a film theatre, there were many technical and architectural problems that had to be sorted out. It seemed that all the projection equipment had to be located at the geometric center of the Theatre. One by one these conflicts were resolved, and the systems as they will now be located are compatible.

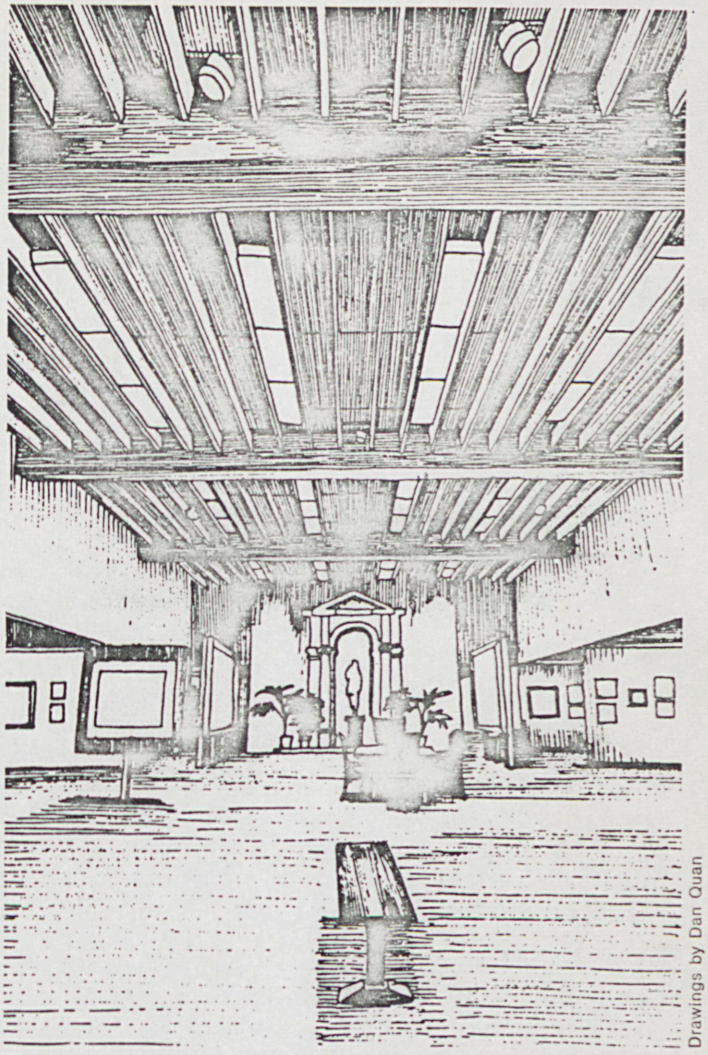
Since the dome was to serve as a motion picture and planetarium screen, it was necessary to meet both of these needs. It had to be made acoustically transparent to handle the high sound pressure levels of the modern film theatre and the new planetarium programming. This required increasing the void area of the dome surface from the usual 13 percent to 22 percent, and was accomplished by decreasing the diameter of the individual holes and greatly increasing the total number of perforations. The dome also had to appear seamless for high intensity film projection. This appearance was achieved by using butt joints and taping the seams with material perforated in the same pattern as the rest of the dome.

The Reuben H. Fleet Space Theatre is the first major installation to have a tilted dome, the first planetarium to install the Spitz STS system and the first to wed the IMAX projector to the fish-eye lens and a spherical projection screen. All of this has been accomplished at the expense of both money and research and development time.

Two other domed amphitheatres are now under construction—the McGraw-Hill Planetarium in their World Headquarters Building in New York and a facility at the Pacific Science Center in Seattle. There is no question that the Reuben H. Fleet Space Theatre will be the first of many. It is not only a new generation of planetariums, it is a beginning of a new medium. ■

Public Reaction to Museum Interiors

Peter S. Kimmel
Mark J. Maves



Drawings by Dan Quan

The main gallery of the Oakland Museum successfully integrates two lighting systems.

An art museum visitor's experience is related not only to the quality of the art works exhibited, but also to the manner in which they are presented. Paul J. Smith has stated that a successful work of art communicates on its own, wherever it is.[1] Although this statement may apply to the art connoisseur, it is not necessarily applicable to the public at large. For this reason, a seven-member team at the University of California[2] undertook a study concerned with the experience of the general public in the interior environment of the museum.

Most research on museum environments has focused on reinforcing the quality of the works exhibited. Numerous studies have dealt with the arrangement of works of art in museums and the color-rendering properties of various types of light sources. However, little research has been completed on the interior appearance of the museum. One reason for this is that it is difficult to stimulate "user" response in any one museum and even more difficult when several institutions are being tested.

The Experiment

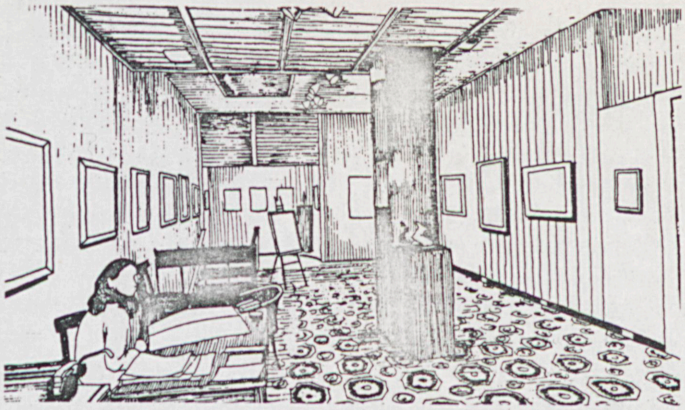
The study was based on user response to 12 different museums and galleries in the San Francisco-Oakland area. Although commercial galleries exhibit works of art in a manner different from museums, they aided the researchers in measuring a cross-section of ways to present works of art.

The research emphasized feedback from the general public, not the connoisseur. A random group of people, predominantly between 20 and 35 years of age, were invited to visit all 12 museums and galleries. In order to obtain responses from users on a controlled basis, the research team developed a questionnaire for evaluation of the visual environment in the selected museums and galleries. Questions dealt with the overall impressions of the spaces, the type and arrangement of light fixtures, the color rendering of lights, the color and textures of surface materials, perceived glare and the readability of the works of art.[3]

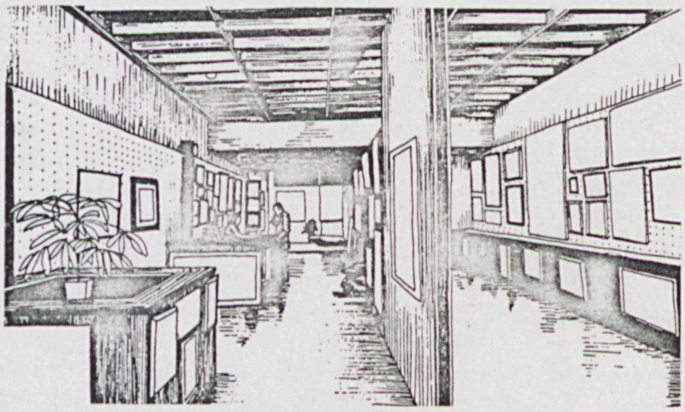
The method of analyzing the data was different from methods that have previously been employed for similar research. Most methods compare only two of the three basic variables—the environments, the questions and the people—inherent in an experiment like this, and assume that the third variable remains constant. Usually, questions are related to the environments, and it is assumed that the users perceive the environments in the same manner. Unfortunately, this does not take into account individual user differences. For example, one person may feel that a light level in a gallery is too low; a second person may feel that the light level is too high. Previous methods of analysis would average the scores and conclude that the people felt that the light level was just right.

Multidimensional scaling of the environments, on the other hand, compares differences among all three variables simultaneously.[4] By statistically differentiating the scores, it provides for the situation where a given condition or characteristic is perceived differently by two or more people. An advantage of maintaining these distinctions is that the data can be used to interpret *why* a condition or characteristic was perceived differently by two or more users. To use this feature to advantage, the team asked the subjects to evaluate each of the 12 environments and the research team studied the pattern of response of all participants. By multidimensionally scaling the responses, the team was able to study differences among environments, people, questions and a combination of these.

Because the study was, in essence, comparative, the researchers arrived at a set of relationships. The study does



Textured wall coverings such as wood paneling **(above)** and pegboard **(below)** can change the apparent size of the gallery and be distracting.



not arrive at a conclusive set of rules; rather it helps establish a range of acceptability for each design variable (walls, lighting, textures, etc.) as well as indicate which combinations of variables produce certain effects. For example, it does not establish that painted burlap is the *best* wall covering to employ. However, the researchers could determine that burlap is successful if utilized in a room of sufficient size, and that a different wall covering might be equally successful.

Before describing the results of the experiment, it is necessary to point out some of the limitations of the experiment and the reader should keep these in mind. First, the subjects were from the general public, and by no means were qualified experts in the fields of art or museology. The report does not attempt to draw conclusions about the successful rendering of a work of art, but rather about the exhibit space as a whole. Second, the majority of works of art viewed were paintings, with few pieces of sculpture. Finally, no effort was made on the part of the users to distinguish types and styles of art. The museum and gallery spaces evaluated exhibited a wide range of art from the Renaissance to the present. This was a bias that could not be removed from the experiment. However, by asking users certain questions twice on the questionnaire—as the subjects entered the gallery or museum before they could see the works of art in detail, and then after they had evaluated all 12 spaces—the data indicated that the perceptual responses to the spaces did not differ strongly accordingly to the style of the works exhibited. Evidently the users primarily evaluated the total visual environment, not the works of art.

The conclusions described below deal with surface finishes used in museums and galleries, lighting fixtures and the quality of light measured in all spaces.

Light Sources

If one were to state an overall design goal for museum-type spaces as a result of this study, it would be that no element of the space should be so prominent that it detracts from the works of art. For example, users found that if the museum contained strong structural elements, it became difficult to concentrate on the paintings. Therefore, if the structure of the space is a strong architectural element, the lighting of the space should be designed to de-emphasize the structural elements.

In this study, the user impressions of the art galleries were closely related to the arrangement and types of lighting fixtures and to the wall finishes. Users preferred lighting systems that were integrated with an already-established element of the space, such as the structure. One reason for this could be that one dominant element protruding into the exhibit space provided more than enough distraction from the art works; it was not appreciated when the lighting system created another distraction.

Similarly, mixed systems of light fixtures, if not well-integrated, were perceived as a distraction. The mixed lighting systems in the Oakland Museum and the Reese Palley Bird Room were viewed by users as the best. The art gallery area of the Oakland Museum has fluorescent lamps integrated with spotlights concealed above them. The users interpreted this mixed system as *one* lighting system, inconspicuous enough not to interfere with viewing the paintings. The Bird Room has totally indirect cove lighting with supplementary recessed fluorescents. The reader should take note: the lighting systems most preferred by those participating in the study do not necessarily render works of art in the best ways possible. For example, lighting in the Bird Room was very even and did not bring out any three-dimensional qualities of the figurines. All art work appeared to be very flat. Also the light color provided by the fluorescents was unnatural. (Readers should refer to other articles published on the color-rendering qualities of lights.) The other 10 museum and gallery environments evaluated utilize spotlights or clear incandescent bulbs. (Not enough of the sampled spaces contained incandescent bulbs for any conclusions to be drawn.)

The spotlights in one gallery evaluated are mounted on tracks on ceiling joists running horizontally under a pitched roof. The lighting system is well-integrated with the structure of the space and was not considered distracting by users. Ceiling mounted spotlights in a room with a ceiling high in relation to the floor area were favorably viewed as acceptable, for they were out of the subjects' 35 degree cone of direct vision. If the spotlights were mounted on tracks, the subjects preferred those that were more shielded from view. This reaction was related to the amount of glare perceived from the light source rather than from light patterns. Another distraction to the viewers was the arrangement of lights without any apparent order or symmetry and the interruption of light patterns (for example, by a missing light fixture).

Users perceived natural light as a distraction if it was in a direct field of view with the art works. Natural lighting is an important factor in creating the tone of the space with artificial lighting providing basic illumination levels. What is particularly difficult and important to control is the balance between the two. Recessed skylighting and clerestory lighting offer two successful solutions because they introduce

natural light outside the immediate field of view.

According to user response, the quantity of light in the exhibition spaces seemed to be less important than the balance of illumination levels between the works and the remaining space. The brightness readings taken in all of the galleries were below 20 footcandles (much lower than the 30 footcandles recommended by the Illuminating Engineering Society[5]). Users felt that 10 to 20 footcandles were adequate for the perception of detail in the works of art. While it is possible that one type of art requires more illumination than another, no indications of this were revealed by the study.

Surface Finishes

A wall surface has two properties that affect the viewer—color and texture. As is true with lighting systems, the properties of wall surfaces in an exhibit area should not be a distracting element. This becomes critical since the walls are the backdrop for the exhibition of paintings.

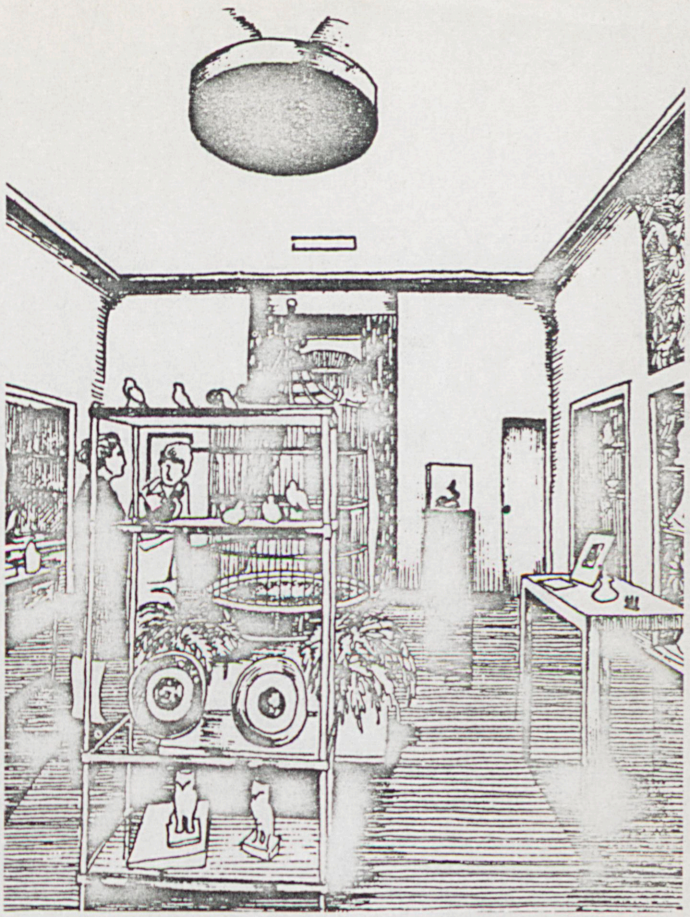
Wall color may have two adverse effects on art works: it can set off the work too much or too little from the background and it can compete or blend in with the work being viewed. Wall colors should be selected for their overall ability to provide a successful background surface.

Users preferred light, muted colors such as tan, grey and beige. However, if a wall becomes too light, the art work can begin to compete as a single object rather than as content. If the wall is darker (Munsell value around 5), such as a medium-valued concrete or khaki, it becomes difficult to distinguish the art works from the background. Brilliant primary hues (blue, red and yellow) often bring too much attention to the wall itself, especially when they are all employed in the same space, and become a visual distraction.

The texture of wall coverings was perceived by users in relation to the art works and to the apparent size of the exhibition space. The subjects found it difficult to view a painting when the background wall surface was highly textured, such as the texture found in carpeting, wood paneling and pegboard. The degree of distraction was related also to the type and size of paintings exhibited. Generally, more texture was found acceptable if the paintings exhibited were large. Linear patterns, such as those made by wood paneling, were perceived to compete with any works containing strong lineal elements. While wood paneling is acceptable as a wall surface for certain exhibitions, its versatility is limited.

Those textures most preferred by users were light aggregate concrete and grasscloth. Some textures, such as painted sheetrock, were viewed as too plain. This kind of background can set off a painting as much as a wall color that is too light and should be employed only with certain types of graphic media where such contrast would be desirable.

The texture of walls was perceived by the users as related to the apparent size of the space: more texture appeared to make the space seem smaller. In selecting the texture of a surface material, one should consider the size and kinds of works that will be exhibited in the space. If the room is small, highly textured walls can make the room appear to be even smaller and more cramped. If the room is large and untextured, it can appear to be too large in relation to the works exhibited. Texture can be used to advantage to make a small room appear to be larger, or a large room smaller. The size of one art gallery at the Oakland Museum has been scaled down by the use of heavily textured wall coverings. This could be done because the gallery exhibits large paintings.



Even lighting in the Reese Palley Bird Room did not bring out any of the three-dimensional qualities of the figurines.

Conclusions

The study was made to acquaint the designer with various criteria for designing interior spaces in museums. Most of the criteria presented are related to distractions found in viewing two-dimensional works of art, not to the color-rendering properties of lights or to the arrangement of works. There are many visual trade-offs that the museum designer should consider when planning exhibition areas. By having subjects participate in the University of California study who were typical of the general, museum-going public, this survey offers the museum designer relevant criteria for planning interior environments that will be conducive to visitor learning and enjoyment. ▣

Notes

1. "An Interview with Paul J. Smith," MUSEUM NEWS, February, 1972, p. 15.
2. The study was made by Ralph Buell, Susan Landay, Mark Maves, Rene Mendez-LaPierre, Dan Quan and Doug Young under the supervision of Peter Kimmel in a graduate lighting and acoustics course taught by Hugo Blasdel.
3. The experiment is described in detail in *An Application of Multidimensional Evalution of Subjective Building Performance*, a Master of Architecture thesis at the University of California by Peter Kimmel. This method was adapted for the use of multiple rating scales in computing environmental differences from Hugo G. Blasdel, "Multidimensional Scaling for Architectural Environments," Environmental Design Research Association Third Annual Meeting, Los Angeles, 1972.
4. Carroll, J. D., and Chang, J.-J., "Analysis of Individual Differences Via an N-Way Generalization of Eckhart Young Decomposition," *Psychometrika*, Volume 35-3, 1970, pp. 283-318.
5. Illuminating Engineering Society, *I.E.S. Lighting Handbook*, I.E.S., New York, 1972, 5th edition, pp. 9-81.

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