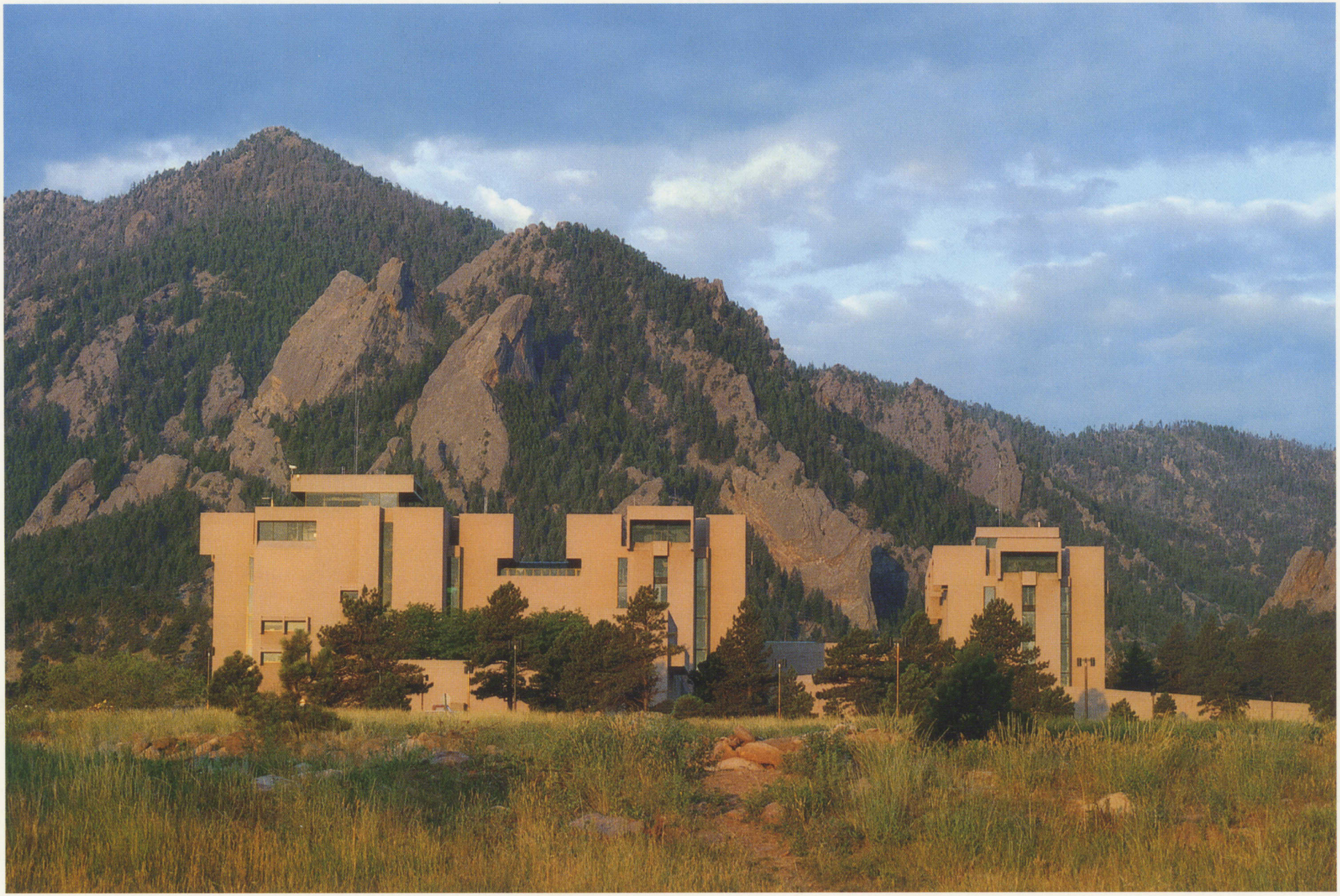
The National Center for Atmospheric Research: An Architectural Masterpiece

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UCAR
NCAR
25th ANNIVERSARY

The National Center for Atmospheric Research: An Architectural Masterpiece

Contents

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The author is deeply indebted to I.M. Pei, whose gracious cooperation turned a pleasurable task into a once-in-a-lifetime assignment. This work would not have been possible without the help of many of the principals involved in the design of the NCAR headquarters; particular thanks are due to Walter Orr Roberts, Tician Papachristou, Philip Thompson, and Mary Wolff.

A major piece of American architecture stands beneath the craggy foothills at the southwestern edge of Boulder, Colorado. It is Ieoh Ming Pei's headquarters for the National Center for Atmospheric Research, or NCAR, an organization devoted to the study of fundamental atmospheric processes. In the 20-odd years since the building's completion, Pei has become one of the world's foremost architects. The NCAR headquarters not only remains one of his favorite creations, it marks a turning point in his career.

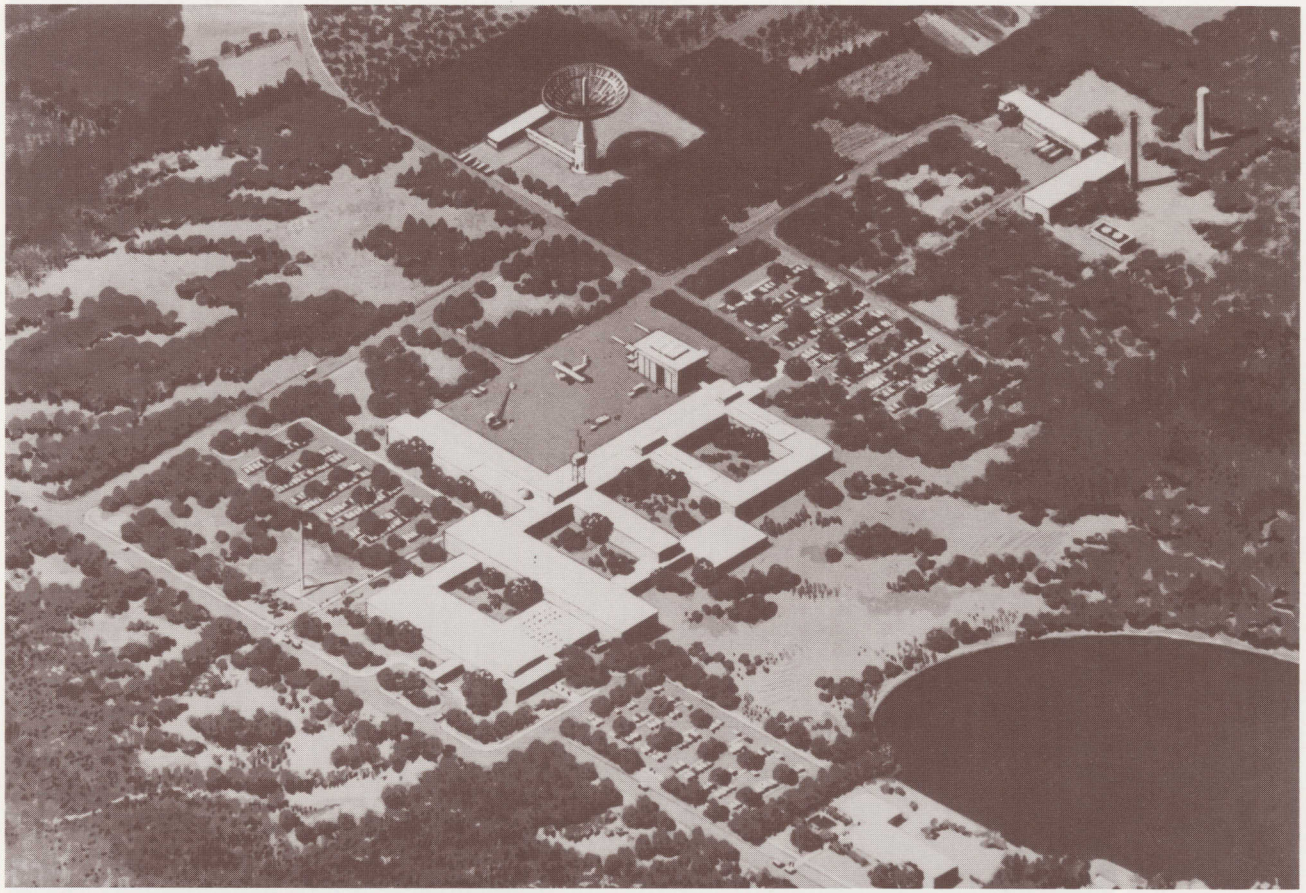
The building has been compared to many things—a medieval fortress, a walled town, a modern-day Stonehenge. Yet despite these historical echoes, it is most likely to strike viewers as futuristic. Its pink turrets were created to be a world of their own, a sophisticated scientific enclave set in contemplative surroundings far from the hustle and bustle of the world below.

The Mesa Laboratory, as it is called, is much more than a functional set of offices and research facilities. Staff draw inspiration from their unspoiled setting. Windows and glassed hallways capture breathtaking views—of the mountains, of the evergreen-studded mesa surrounding the building, and of the town and plains below. The varied and broken plan of the building gives its 550 occupants a sense of privacy and of individuality. More importantly, its imposing presence provides them with a feeling of pride, a constant physical symbol of the unique and significant role that the center plays in the world of modern science.

The Founding of NCAR

These architectural achievements did not come by chance. They grew out of many years of planning, and are the result of a complex collaboration between a gifted architect and a group of scientists with a clear idea of what their workplace should be. While it took the artistry of I.M. Pei to put form to their vision, the founders of NCAR began to speculate about the physical headquarters of the organization at the same time that they were formulating its scientific makeup. NCAR grew out of a proposal from the National Academy of Sciences in 1958 for a national atmospheric research institute. In 1959, a committee drawn from interested universities submitted plans for the center to the National Science Foundation (NSF), which was to become the primary source of funding for NCAR.

In its prospectus, the university committee outlined some principles for an institute building: It was to be flexible and asymmetrical, in order to allow for expansion. It was to be suitable for both theoretical contemplation and practical research. Although these early speculations came remarkably close to describing the character of the future structure, the accompanying drawing shows a spread of low-lying offices radically different from what Pei was to invent. When the contract founding NCAR was signed in 1960 and Walter Orr Roberts appointed its first director, these vague initial musings coalesced into plans to establish a national headquarters that would be significant not only scientifically but architecturally.



The proposed "National Institute for Atmospheric Research," as depicted in a prospectus prepared in 1959 for the National Science Foundation.

The NCAR Site Selection

The undeveloped site, from above and below.

Roberts was and is a visionary, both professionally and artistically. He had high aspirations both for the new center and for the structure that was to house it. Roberts and the staff he assembled felt that they were on the threshold of a new era in scientific inquiry into the atmosphere, and they were determined to create a suitable environment for the great minds of their day, not simply a practical or beautiful laboratory.

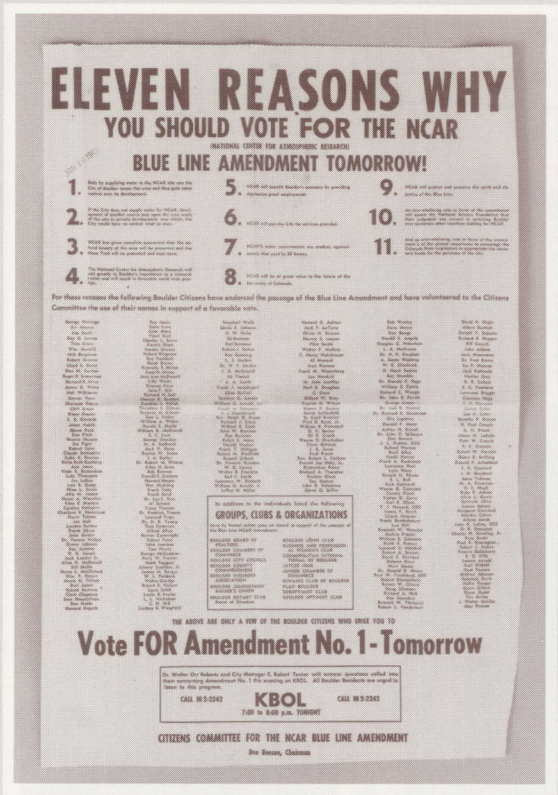
At the time of his appointment, Roberts was based in Boulder as head of the University of Colorado's High Altitude Observatory. His selection tipped the scales toward the choice of Boulder as the site for NCAR's headquarters. (Four geographic areas had previously been singled out as potential locations.) Some of the many reasons cited were Boulder's central location for scientists at atmospheric research and training centers, its excellent research environment, and its advantages for studying particular atmospheric phenomena such as storms and mountain air currents.

Of the possible land parcels available, the dramatic Table Mesa top was the clear favorite. Roberts could see the spot from his living room window. Tician Papachristou, then a Boulder architect and consultant on the NCAR headquarters, recalls, "One day I was visiting Walt Roberts at home and we began to wonder who owned that hillside. I put my baby on my back, and we immediately hiked over to take a look. When we

mounted the top, it was like magic—a sacred site the ancient Greeks would have envied." Surrounded by undeveloped land, the mesa's dry western landscape was covered in juniper, pines, and wild flowers and frequented by a large herd of deer. Yet it was accessible to the university and to other research facilities such as the nearby National Bureau of Standards. Its dramatic presence suggested, as Roberts put it, "the dignity and importance of the future center as a national scientific laboratory."

The 565-acre mesa was made up of five privately owned parcels of range land ripe for commercial development. A site-selection committee contacted the owners and put together a potential package encompassing the 28-acre mesa top and the hillsides leading down to town and back toward the Flatirons, the dramatic sandstone outcroppings to the west. However, before NCAR could lay claim to the site, a major political hurdle had to be surmounted. In 1959, Boulder voters had amended the city charter to include a "blue line" above which city water would not be supplied, a tactic designed to control development in the city's foothills. The NCAR mesa was located above this line. The months between selection of the site in November of 1960 and purchase of the land in March of 1961 saw what amounted to a popular referendum on the desirability of the center. The result was not only agreement to supply city water to NCAR but a resounding endorsement of the organization in more general terms.

Perhaps because they had so much to protect, Boulder citizens were at the vanguard of the burgeoning environmental movement. A system of mountain parks was already in place,



ELEVEN REASONS WHY

YOU SHOULD VOTE FOR THE NCAR

(NATIONAL CENTER FOR ATMOSPHERIC RESEARCH)

BLUE LINE AMENDMENT TOMORROW!

1. 2. 3. 4. 5. 6. 7. 8. 9. 10. 11.

For these reasons the following Boulder Citizens have endorsed the passage of the Blue Line Amendment and have volunteered to the Citizens Committee the use of their names in support of a favorable vote.

GROUPS, CLUBS & ORGANIZATIONS

THE ABOVE ARE ONLY A FEW OF THE BOULDER CITIZENS WHO URGE YOU TO

Vote FOR Amendment No. 1-Tomorrow

KBOL

7:00 to 8:00 p.m. TONIGHT

CITIZENS COMMITTEE FOR THE NCAR BLUE LINE AMENDMENT

ABOVE: *Strong popular support for the blue line amendment, allowing the city of Boulder to supply water to NCAR, is illustrated in this newspaper advertisement, featuring endorsements by individual citizens and a variety of local organizations. (Courtesy of the* Boulder Daily Camera.*)*

RIGHT: *Walter Orr Roberts (left) and I.M. Pei, at the dedication of the newly completed Mesa Laboratory.*

dating back to 1898, and public concern over future development of the city's mountain backdrop was high. Although NCAR could theoretically have sought water from other sources, an amendment to the blue line regulation was put to the vote in January of 1961. NCAR officials pledged that the area would remain a natural preserve and that the building would be environmentally sensitive. A coalition of citizens' groups ranging from conservationists to the Chamber of Commerce and the League of Women Voters all backed the amendment, which passed by a margin of more than three and a half to one. The consensus: NCAR's presence would be an asset to the city and would harmonize with and protect the natural beauty of the mesa. Following this referendum, in March of 1961, the Colorado state legislature voted $250,000 to purchase the land and donate it to the National Science Foundation for NCAR's use.

The public mandate for a building that would harmonize with the site was foremost in the minds of the selection committee when it began searching for an architect a few months later. Seven member universities of the University Corporation for Atmospheric Research, NCAR's parent organization, had schools of architecture, and the deans of these departments formed the committee, which began by drawing up an ambitious slate of six nationally known architects in May of 1961. NCAR staff members were heavily involved in the interview process, which culminated in the unanimous selection of I.M. Pei two months later. It was a decision that was to profoundly affect the futures both of Pei and of NCAR.

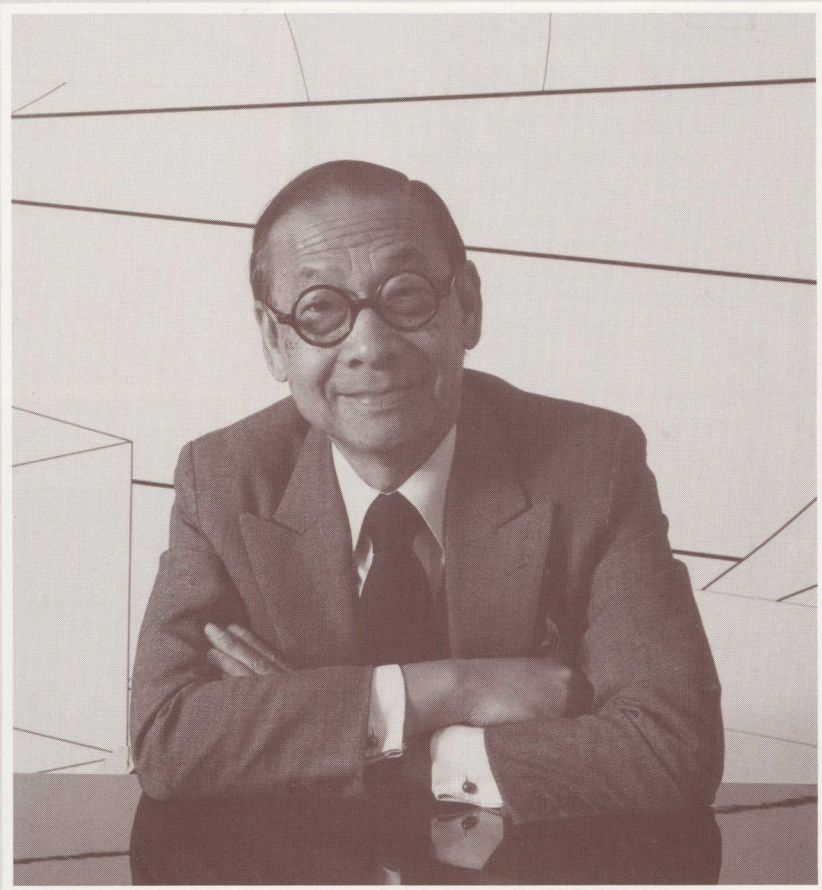
I.M. Pei

Pei has become one of the foremost architects of our time, creating designs that have altered the city-scapes of the United States, Europe, and the Far East. However, at the time, he was not an obvious choice for the NCAR commission. While widely respected, he had made his reputation as a designer of large urban renewal projects for developer William Zeckendorf's firm, Webb & Knapp. He had created Denver's Mile High Center, Kips Bay Plaza in New York City, and Society Hill in Philadelphia, but he had never tackled a project set off from an urban setting. Prophetically, the NCAR selection team saw this inexperience as an advantage. As one memo put it, "The project would be for him a quite new challenge and would provide personal and professional advantages and satisfactions that could lead him to be tremendously involved."

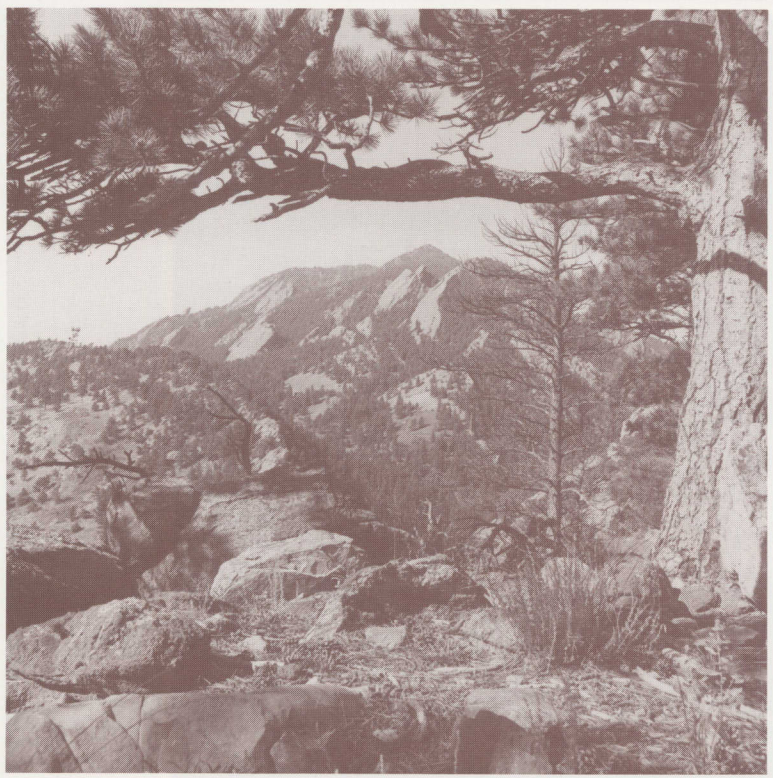
In addition, Pei's reputation as a man who dealt easily with clients, his charm and sensitivity, his imagination in design, his experience within tight budgetary constraints (notably with the use of structural concrete) all contributed to his selection. For his part, Pei was openly eager to tackle the creative demands of the NCAR assignment. "Very few architects are ever given the opportunity to work with a site like the NCAR mesa," Pei has commented. "I saw it as a once-in-a-lifetime opportunity." As both the NCAR staff and Pei had hoped, the Mesa Laboratory was to mark a breakthrough that was to change the direction of the architect's career.

The son of a prominent banker, Pei was born in Canton, China, in 1917 and raised in Hong Kong, Shanghai, and Suzhou, his family's ancestral home. He came to the United States in 1935 to study at the Massachusetts Institute of Technology, where a perceptive dean persuaded him to transfer from engineering to architecture. After World War II, Pei joined the fertile creative environment of the Harvard Graduate School of Design during one of the most exciting eras in American architectural education. He studied under Walter Gropius and Marcel Breuer, the primary exponents of the Bauhaus movement, who had emigrated to the United States during the war. Never an adherent of the Bauhaus's strict functionalism, Pei nevertheless thrived under the stimulation of Gropius and Breuer. "Breuer was a great influence on me," he recalls, "particularly his interest in light, texture, and shadow," interests that were to become notably apparent in the design of NCAR.

Pei stayed on at Harvard for two years as an instructor and then made a dramatic break, setting up a design group for developer Zeckendorf that grew into a 75-person office producing half a billion dollars' worth of construction by 1960. During these years, Pei became known for his innovative work with the latest in glass and concrete technology, an area of expertise that was to serve him well on the NCAR project. He left Webb & Knapp in 1960, although he continued to take commissions from the group. He was ready to go in new directions, for which NCAR provided the timely impetus.

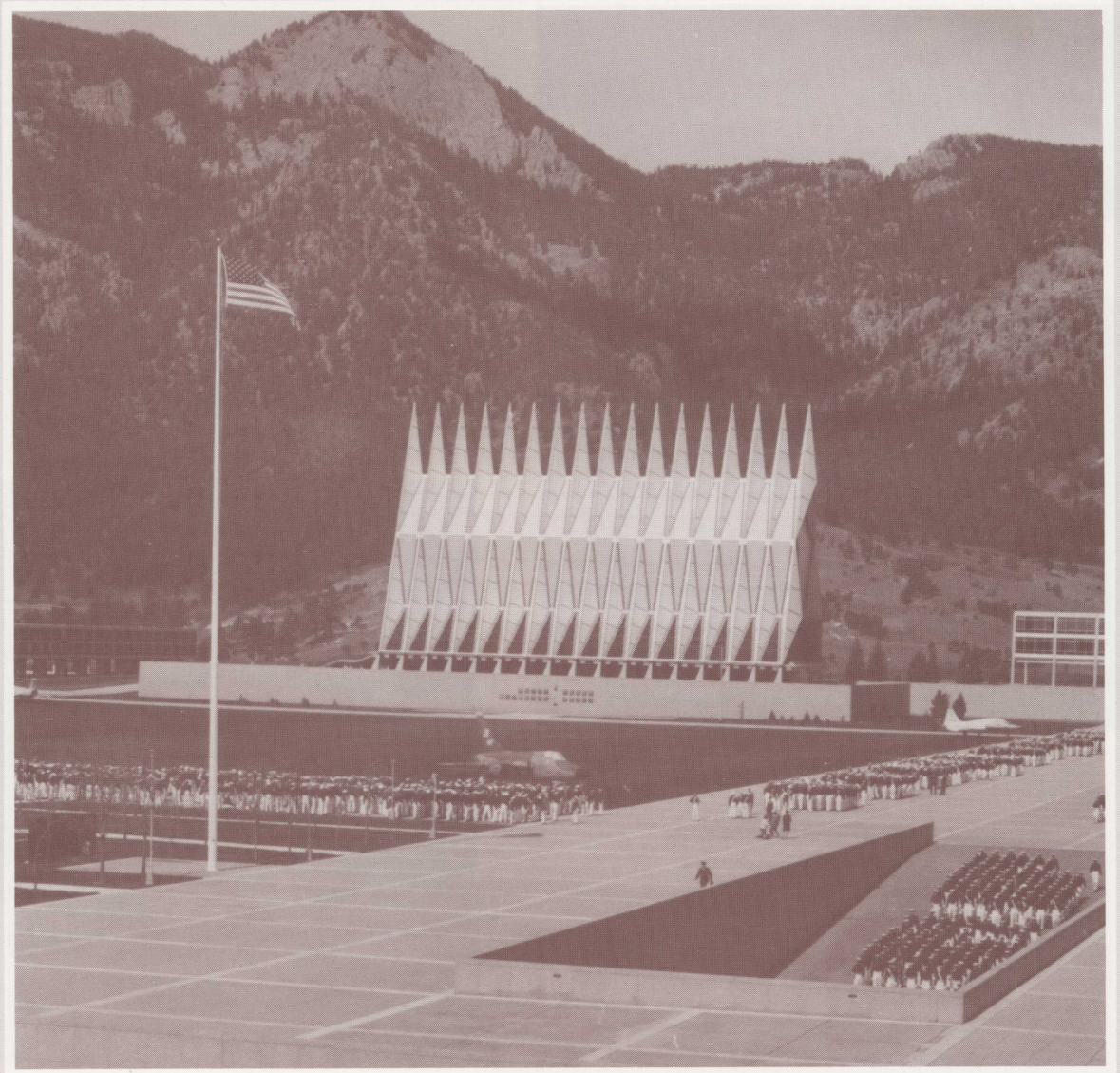


I.M. Pei. (Photo by Evelyn Hofer.)



Pei describes the early days of work on the NCAR commission in almost religious terms. The site, to him, suggested a spiritual dimension that stretched and challenged all of the preconceptions he had developed in his career to that time. Pei spent a tremendous amount of time on the mesa. He hiked it at all hours of the day and evening, watching the sun hit its stony crags, sitting among the grazing deer. He picnicked there; he camped overnight. "I had to rinse my brain," he has said. "It was a very intensive period, and for a long time the design was amorphous in my mind, but it was a wonderful kind of search."

The core of the challenge was to create a man-made structure bold enough to live up to the immensity of the setting and yet compatible enough not to try to compete with it, a competition any building was bound to lose. Pei had visited Skidmore, Owings & Merrill's Air Force Academy, recently built against the mountains of Colorado Springs. Its contemporary design using industrial materials posed a useful foil to his emerging ideas. The Air Force Academy solution to the architectural puzzle, while a viable one, was not the one he wanted. "Being different from nature, you are less likely to be compared to it," he explains, "but you lose the spiritual dimension I wanted to capture."



The U.S. Air Force Academy in Colorado Springs, Colorado, also built against the Rocky Mountain foothills, demonstrates a radically different architectural approach from the one Pei was to adopt. (Photo courtesy of the U.S. Air Force.)

ABOVE: *The monoliths at Ollantaytambo. (Photo by Jane Wheeler.)*

RIGHT: *Stonehenge. (Photo by Robert MacQueen.)*

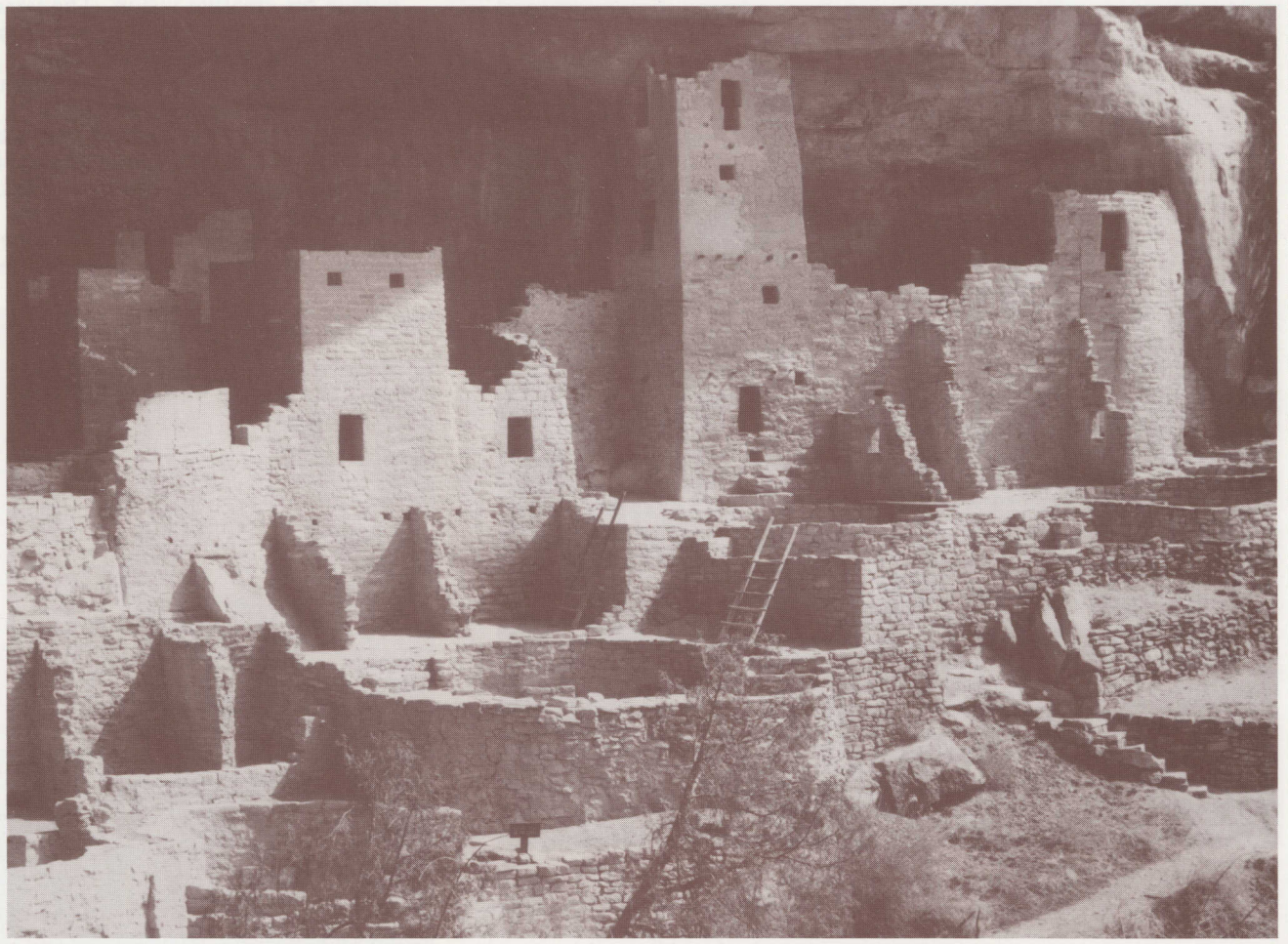
One image at the back of the architect's mind gave him the courage to pursue his creative vision. The year before, in 1960, he had visited an archaeological site in Peru: Ollantaytambo, an Inca settlement perched on the steep slopes of the upper Andes. Among the terraces and rubble walls of Ollantaytambo stand six gigantic stone slabs. The monoliths, only a few yards wide, tower over the rest of the ruins. As with Stonehenge, another of Pei's favorite sites, the function of the monoliths and the manner in which they were brought to their remote location are unknown. These monumental yet simple stones continue to inspire Pei to this day. While they look nothing like the pink NCAR towers, their imposing presence, combining natural and man-made beauty, gave Pei the conviction to search for a comparable achievement in the vocabulary of modern architecture.

The Influence of Mesa Verde

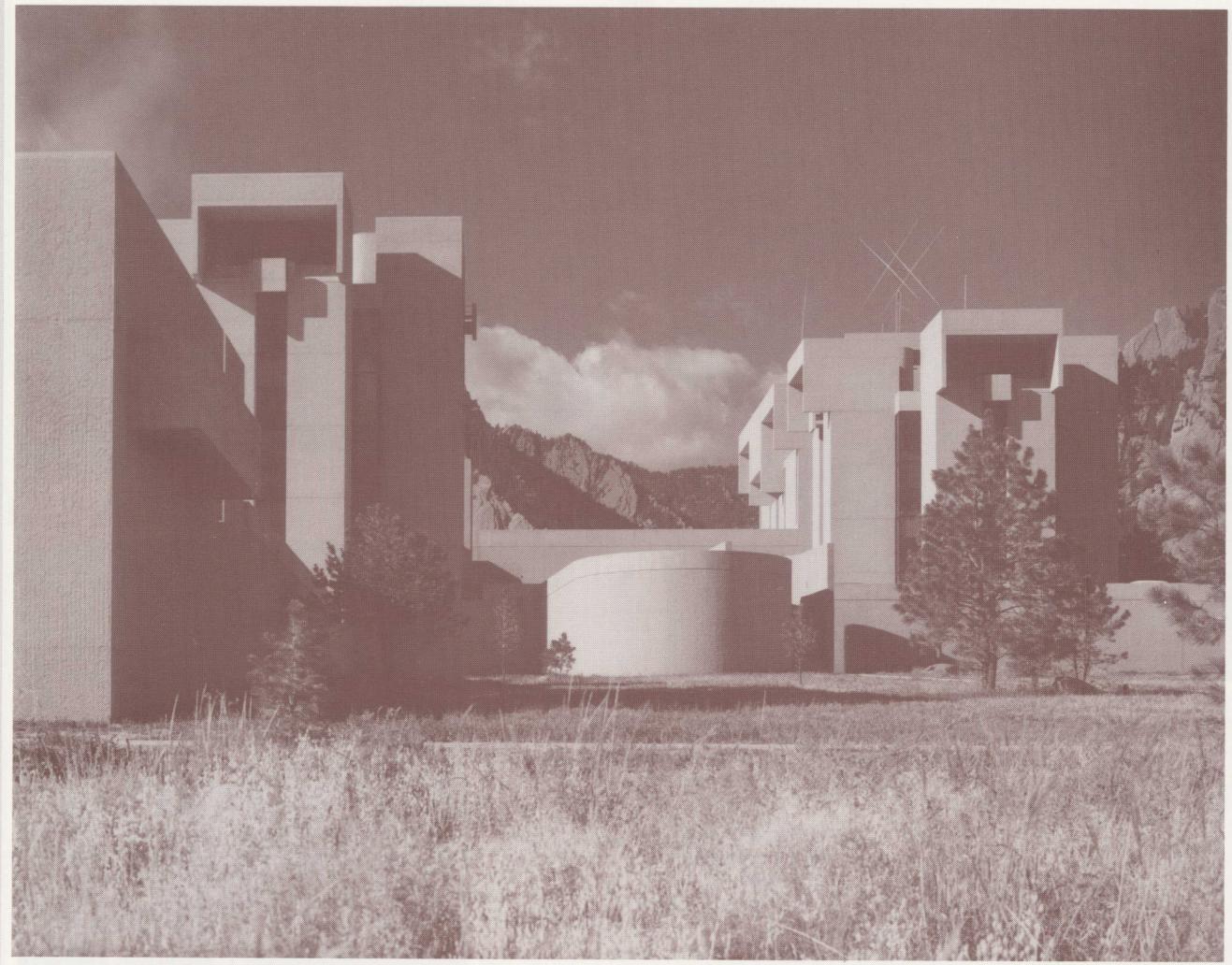
With Ollantaytambo in mind, Pei decided to explore the indigenous architecture of the American Southwest. He and his wife rented a car and set out on a journey that was to take them from Albuquerque, New Mexico, to Boulder, stopping at numerous Indian settlements, ancient and modern, on the way. When Pei reached Mesa Verde, in the southwestern corner of Colorado, he knew he had found what he was looking for.

Built by the ancient Anasazi Indians, Mesa Verde is best known for its 12th- to 14th-century cliff dwellings, towers that hug the sides of precipitous rock walls, sheltering beneath stony overhangs. In these crude but impressive structures, Pei saw the solutions to three problems that had haunted him. First, by using indigenous building materials, or at least materials that reflected the natural setting, he could achieve a structure that would blend with its surroundings. The stone and mud of Mesa Verde were obviously not economical or practical for a contemporary structure, so Pei's modernistic solution was to use reinforced concrete composed of aggregate drawn from a nearby quarry. (The Flatirons area itself is no longer quarried, so the stone for the NCAR headquarters was taken from Lyons, a few miles away.) To color the cement, Pei hit on the innovative technique of using sand ground from the same stone, rather than commercial pigments.

The second design principle for which Pei credits Mesa Verde is the use of what he calls "elemental" forms, in this case primarily vertical rectangles offset by occasional curves. Futuristic as these geometries were to become in Pei's hands, their source is



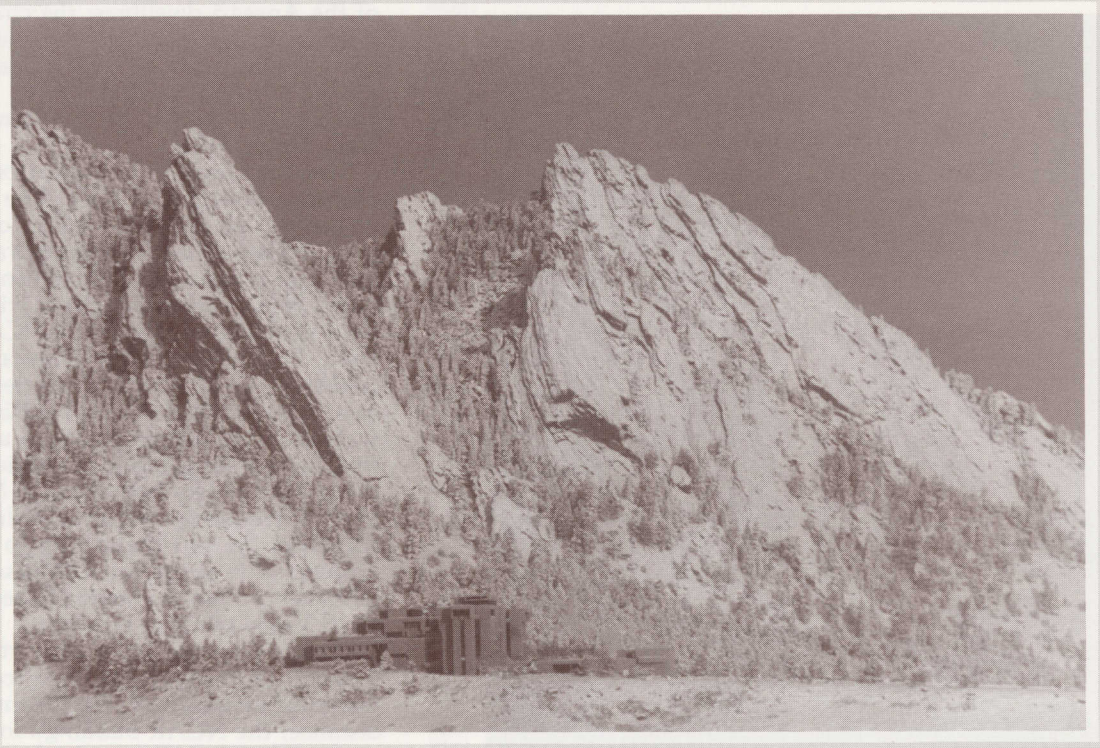
Many design features of the Mesa Laboratory were inspired by the geometries of Mesa Verde. (Photo of Mesa Verde Cliff Palace by Fred Mang Jr., courtesy of the National Park Service.)

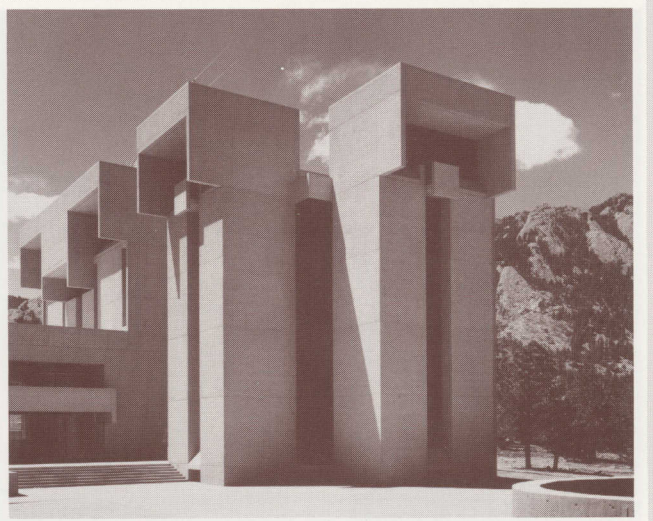


clearly visible in the Anasazi structures. NCAR's towers are reminiscent of the Anasazi dwellings; the circular stairway at the front of the building hints of the Indian ceremonial centers known as kivas; the building's hooded tops suggest the overhanging Mesa Verde cliffs.

The third and most abstract of Pei's dilemmas was that of scale. The "articulation," as architects call it, or subdividing, of most contemporary buildings is based on the conventional story. In his early attempts to visualize a structure on top of the NCAR mesa, Pei quickly realized that a succession of easily identified stories gave a human scale to his building, a scale that was inappropriate to and dwarfed by the gigantic dimensions of the peaks and sky behind it. In Mesa Verde's irregularly placed and shaped windows, Pei saw the answer to this problem. His design for the Mesa Laboratory borrows some of the Mesa Verde window designs—keyholes, slits—but more importantly it profits from their absence of conventional articulation. Seen from a distance, the NCAR building's long narrow shafts of glass and other unconventional windows do not speak of stories; the height of the building is as impossible to guess at as that of the Flatirons behind.

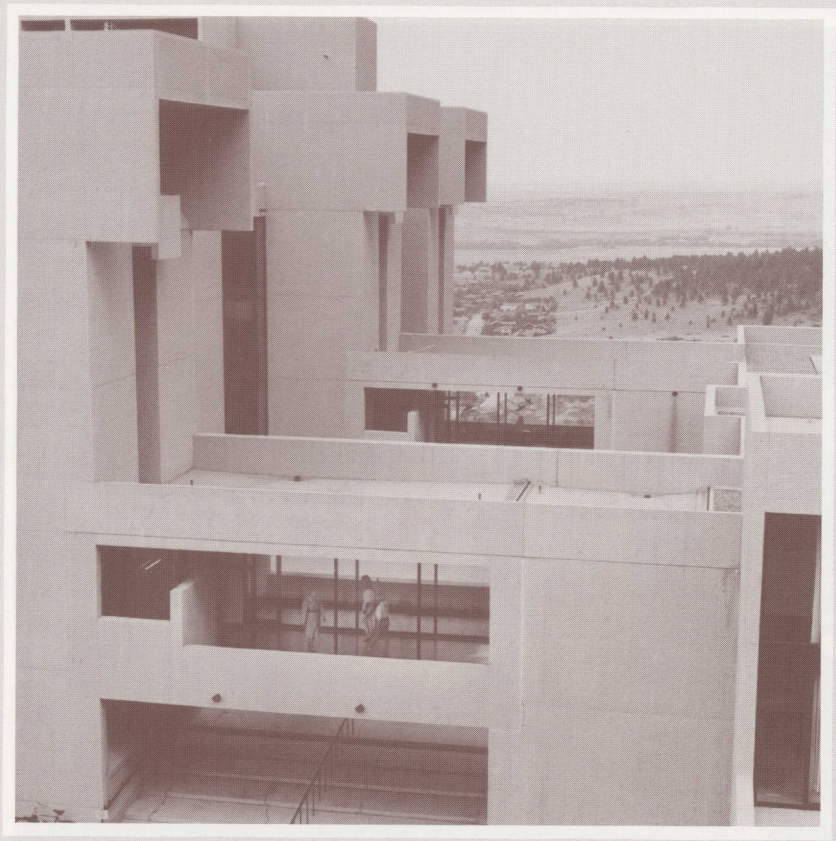
Pei also sees some echoes of Scottish castles in his design, an influence that comes not directly but through Louis Kahn. Kahn's Alfred Newton Richards Medical Research Building at the University of Pennsylvania, a building influenced by Kahn's love of Scottish castles, came to mind at Mesa Verde and may have been at the back of his mind in his deliberations over the NCAR design. "I sensed that there was some kinship of elemental forms," he says.





ABOVE: *The Mesa Laboratory holds its own against the massive Flatirons behind it without seeming to compete with them.*

RIGHT: *Pei avoided giving the Mesa Laboratory a human scale by masking the building's subdivision into stories. Even from close range, as above, the height of the towers is difficult to guess; the number of floors can be seen in the photograph (right) of the building lit at night. (Photo above by Ezra Stoller, ©ESTO.)*



Thanks to the building's complex floor plan, staff have to descend from one cluster of towers and cross the central section of the building to reach the second set of towers.

The Collaborative Process

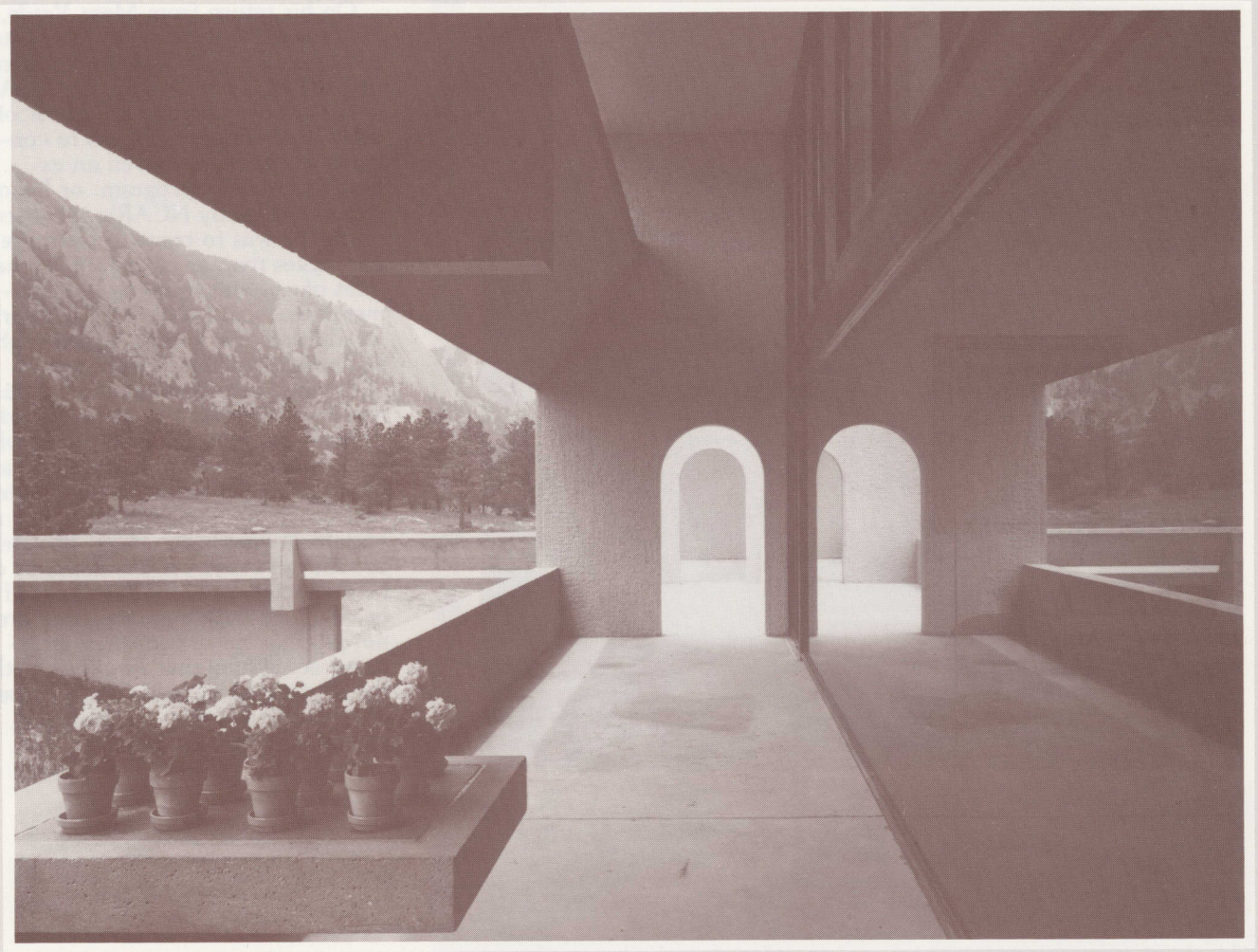
On his return from Mesa Verde, Pei realized that he could live up to what he saw as the spiritual challenge of creating a building for the NCAR site. However, he had a number of additional design problems to confront. He had been given an extremely complex program, or list of requirements, by NCAR's scientists, whom he was to come to see more as colleagues than as clients. "They had a lot of wisdom to impart," Pei remembers, "and I took it all to heart." In addition, the natural rigors of the site posed their own dilemmas.

During the process of selecting an architect, Roberts and his staff had drawn up a prospectus detailing what the center should be. It spoke of "an intangible air of ferment and intellectual coherence, . . . a place where a variety of people can meet, privately or semiprivately, can be alone, or can be distracted by a different kind of beauty"; of "building forms that are not reminiscent of industrial structures; something that expresses both the contemplative and exciting aspects of scientific activity . . . monastic, ascetic, but hospitable."

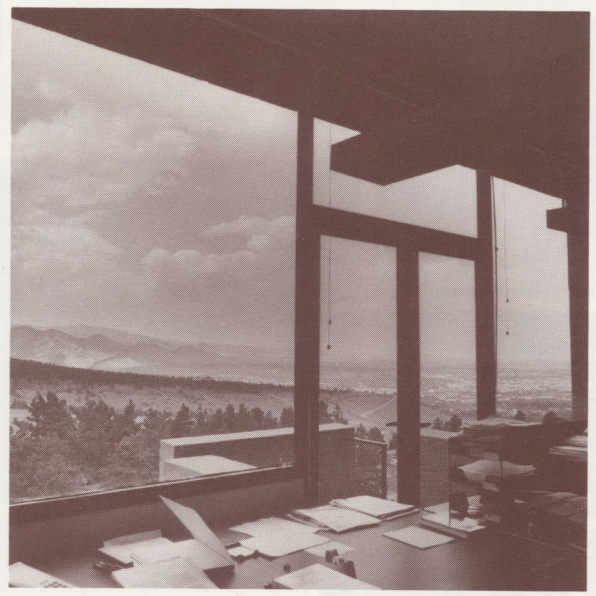
The staff did not want to feel like cogs in a large machine. They did not want offices along endless corridors where each room was distinguishable from the next only by a number or a name on the door. They wanted a complex floor plan that would allow privacy for contemplation, the chance to confer with a few colleagues, and the freedom to escape from unnecessary interruption. In responding to this injunction, Pei created a building where there are multiple ways to get from any point to any other—but only if you know the way. The casual visitor is virtually unable to find his or her way around the building without a guide. Thanks to the clusters of tall, narrow towers, "vertical circulation" takes the place of conventional horizontal hallways. Translated into practical terms, this means that a staff member in one tower may have to go down several flights of stairs, cross the central section of the building, mount another stairway, and then step out of doors and in again to confer with a colleague in another tower. The building's central hallways are designed with intentional twists and turns simply for the sake of avoiding monotony.

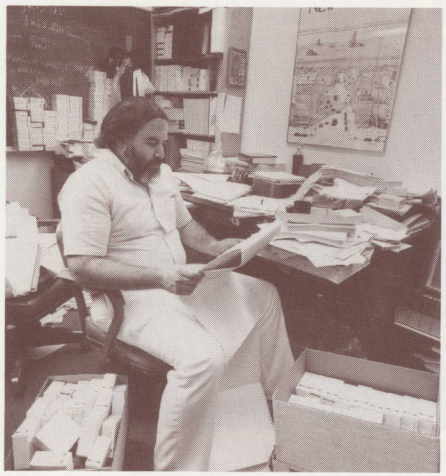
Perhaps because they were so deeply immersed in the study of natural phenomena, NCAR's scientists also wanted to be able to look out from their day-to-day research activities and gain inspiration from their surroundings. Despite the civilization and sophistication that are necessary trappings of any complex research enterprise, they wanted a sense of isolation, of the simplicity of unspoiled nature. Pei was struck by the image of the monastery. At the back of the building, leading west toward the mountains, he set a long ramp pointing toward what is now the Mesa Trail. The staff lounge, the Damon Room, faces the Flatirons, and between it and the ramp a set of archways inspired by medieval cloisters suggests and invites meditation. The building's windows and glass doors also lead the eye and the mind out to many breathtaking views of the mountains and plains. In addition, Pei designed over 30 varied balconies to grace public areas and offices, some barely large enough to stand on, others relatively spacious.

Many of these design principles, and the structures that they inspired, conjure visions of the theoretical scientist in his ivory tower. This metaphor is nowhere more apparent than in the "crows' nests," which epitomize the contemplative isolation attempted in Pei's design. Sitting above the conventional office spaces, each of the six crows' nests is accessible only from a spiral staircase beginning on the floor below or from an outdoor roof ramp. Their spartan fittings are offset by the large windows framing spectacular images of mountains and plains, and their original intent was to be temporary retreats rather than permanently assigned offices.



Archways outside the staff lounge, the Damon Room, conjure visions of medieval cloisters. (Photo by Ezra Stoller, ©ESTO.)





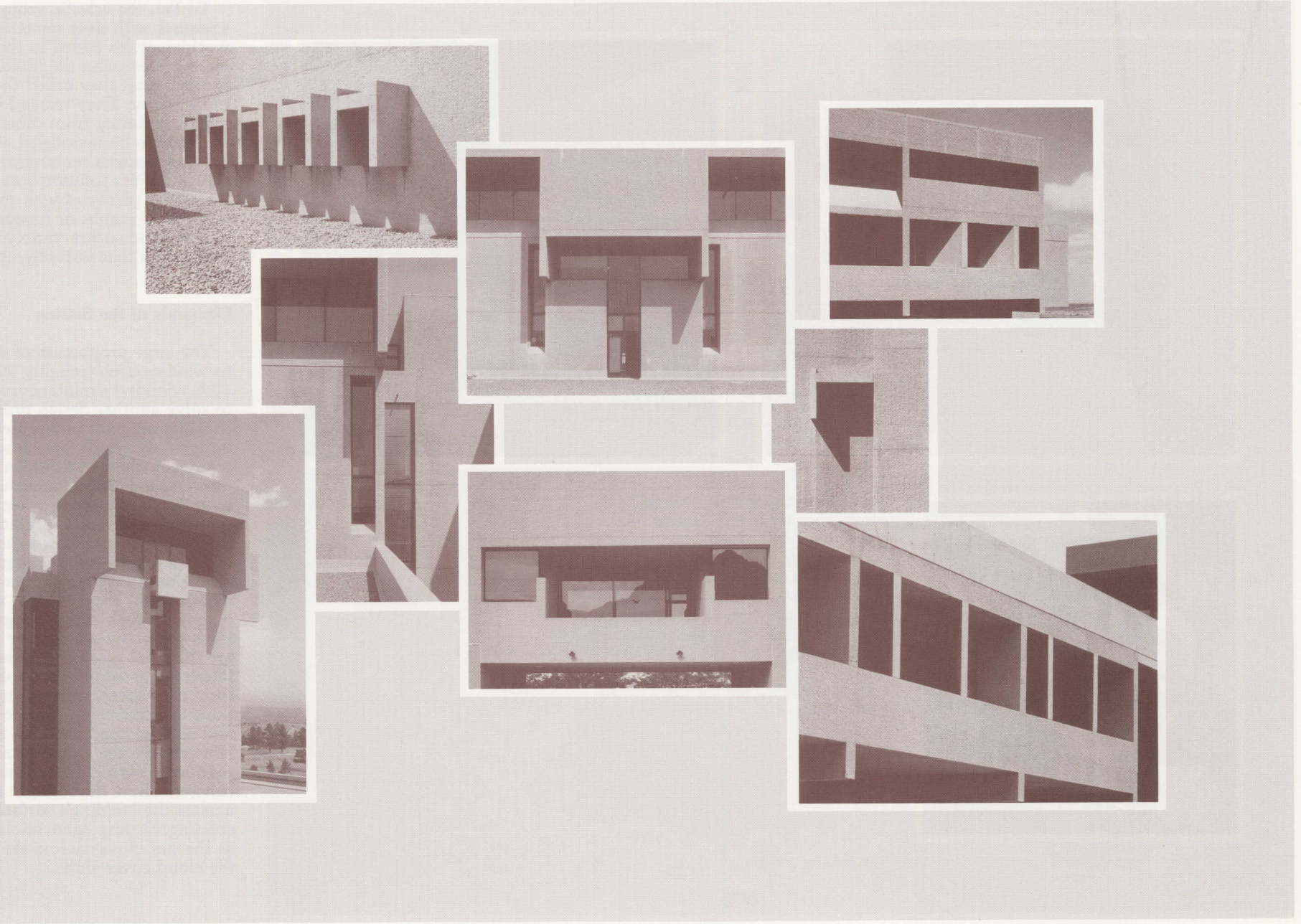
ABOVE: *Perhaps the most unusual of the Mesa Laboratory's office spaces, the crows' nests are accessible only by crossing an outside roof ramp (left) or by mounting an interior spiral staircase from the floor below. From their positions on top of the towers, the crows' nests afford spectacular views of the mountains and plains (right).*

LEFT: *Pei designed the building's varied office spaces to give scientists the freedom to be messy.*

To Pei, the eclectic group of NCAR scientists with their unconventional working styles added to the excitement of designing the building. They wanted what they called the freedom to be messy. They wanted varied spaces, differing from other offices and able to be remodeled as personnel and research requirements changed. Pei's solution was to give the offices plenty of wall space (for tacking up graphs or hanging bookshelves) and such a variety of sizes and shapes that virtually no two are alike.

Demands of the Setting

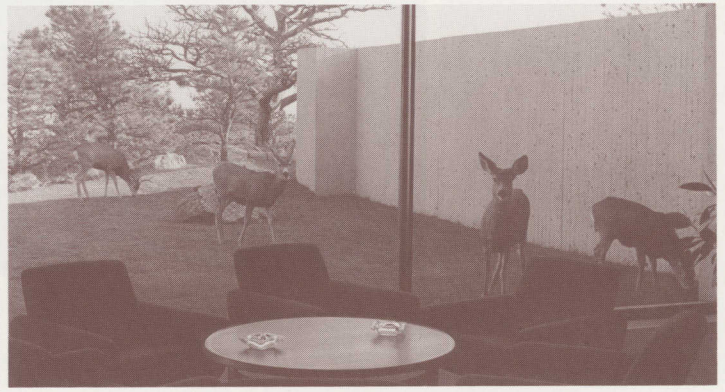
The large proportion of wall space to window area (roughly 90% wall to 10% window) simultaneously helped to solve another design problem. The building needed to be protected from both strong winds, which sometimes reach 125 miles an hour on the mesa top, and unusually harsh sun. Pei used tinted glass to provide protection from glare, while capitalizing on the small window area to minimize overheating during the height of the day. Despite the small area taken up by windows, their profuse variety highlights the exterior design and provides the many spectacular views that are the focal point of the building's interior. For additional protection from the elements, many permutations of cantilevers, other overhangs, and vertical concrete slabs act as buffers between the windows and the outdoors. Both glass and textured concrete allow the sunlight to play against the building's surfaces, creating varying lights and shadows as the sun moves across the sky and the cloud cover shifts.



The headquarters combine a campus-like compound with unspoiled nature, which comes right to the walls of the building.

While Pei himself denies being influenced by European walled towns in drawing up the NCAR design, several of the NCAR staff with whom he worked did have such precedents in mind. They wanted a sense of nature coming up to the edge of the building, of a campus-like interior compound and an unspoiled surrounding world. The uncompromising approach to site preservation has fulfilled this vision. According to Pei, "The building wiggles and twists and turns to avoid damaging anything." A special "NCAR mixture" of indigenous grasses was used to reseed the entire area after construction, leaving the natural site apparently undisturbed up to the walls of the building. Trees, wild flowers, and grazing deer come right to the balconies of the ground-floor offices, and employees who stray from the pathways can pick up cactus prickles or Rocky Mountain ticks simply walking to their cars.

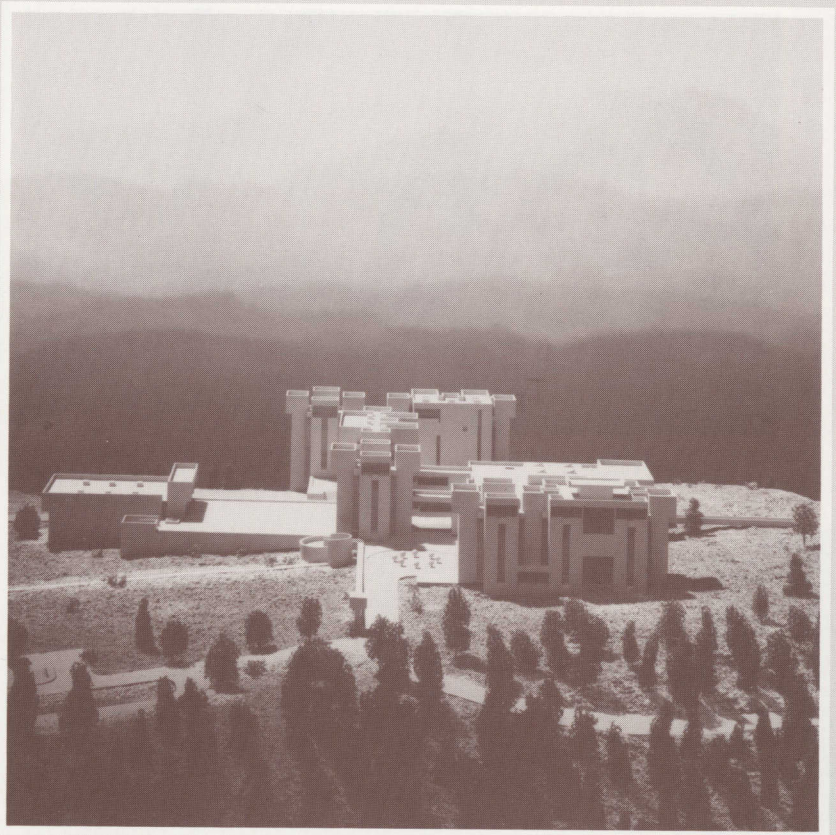
Pei also paid a great deal of attention to the design of the approach road, which he considers a particular triumph. His intention was to create what he calls a "grand gesture," a sweeping entrance that disturbs the landscape as little as possible and gives a sense of conquering the top of the mesa by surprise. In conjunction with a consultant landscape architect and engineers, he designed an entrance road that curves up through meadowland, presenting grand mountainous vistas before creeping up between trees and onto the mesa top from behind. The building, in fact, is virtually invisible from the approach road until one is at the entrance gate.



ABOVE: *Communal areas include the staff lounge or Damon Room (left), looking out onto the Flatirons; the tree plaza (center), a popular spot for lunch and coffee breaks; and the library, with its spiral staircase (right).*

RIGHT: *The sweep of the entrance road, which Pei considers a particular triumph.*

FAR RIGHT: *Deer occasionally eavesdrop on staff meetings.*



A model of the Mesa Laboratory, including the never-completed third tower at the rear. (Photo by Lionel Freedman.)

The Final Design

These basic elements of the NCAR design were established early in the creative process. Between 1961, when Pei accepted the commission, and 1964, when ground was broken, the plans went through a number of permutations dictated by both changing budgetary projections and refinements in the scientific requirements of the NCAR staff. An early drawing, reflecting many features of the final design, was rejected as too compact. Pei broke its symmetrical towers into more complex and sophisticated shapes. Estimates of laboratory requirements shifted. Throughout this process, the sense of collaboration between client and architect continued harmoniously.

By the time construction bids were solicited in March of 1964, the project had suffered one major setback; construction of a third tower, designed to hug the southern edge of the mesa and provide 50,000 to 60,000 square feet of "net assignable" or working space, had been postponed due to budget cuts. It was never built. The loss of this third tower, an anchor to Pei's original design, is a major disappointment to its creator. As he explains it, the southerly tower, which would have come down below the brow of the hill and clung to the mesa's edge, would have given the building a sense of rootedness, much as the Mesa Verde structures are anchored to their cliffside perches. That firm sense of "tapping the soil," as Pei calls it, is lost in a building that simply sits on top.

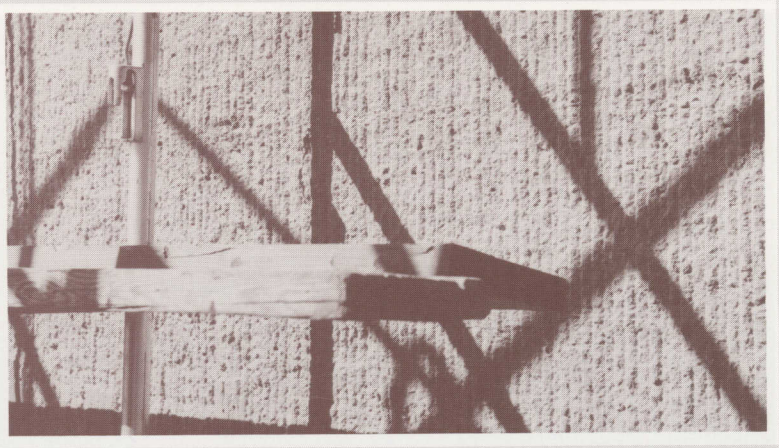
The building was also meant to have a large conference area west of the parking lot, connected to the main building through an interior corridor. While this feature was not central to Pei's design, he does bemoan the absence of a heart to the building, a focal meeting point for staff and visitors.

The seeming complexity of Pei's final plans belies a simple design. The building is composed of three parts, two clusters of towers linked by a lower-lying central section. The towers contain six stories above ground and the central section two. Below the entire complex run two basement levels. The towers, one to the north and one to the east, are referred to within the organization as the "A" and "B" towers, respectively. The east, or B, tower is "wet," designed to provide laboratories with piped water, compressed air, and other gases and to vent fumes through exhaust hoods. Duct work in accessible shafts and open ceilings allows these experimental uses to shift with minimal remodeling. The north, or A, tower is "dry" and contains only office space. The two-story central section of the building was designed for communal functions. It houses the library, cafeteria, staff lounge, and meeting rooms, as well as the large entrance area that doubles as a public exhibit space.

Construction

Ground was broken at the NCAR site in June of 1964 under a $4.5 million contract with the Martin K. Eby Construction Company of Wichita, Kansas. The cost of approximately $24 a square foot was a considerable bargain for the time, especially in view of the complexity of the architecture. Construction of the poured-in-place concrete walls, nine inches thick, was described by the construction superintendent as "like building a dam." Through this period, Pei continued to be heavily involved in the project. He was concerned that the finished walls have a stony, roughened texture. To this end, he ordered a series of sample slabs erected at the site, on which he tried various innovative finishes.

The experiment resulted in a technique pioneered at NCAR and used extensively by Pei in subsequent concrete constructions. Called bush hammering, it involves combing the dry concrete with a fork-like tool driven pneumatically. Bush hammering had been used for roughening concrete to which another finish was to be applied but had never before been used as a finish in its own right. On the Mesa Laboratory, it produced a series of narrow vertical grooves, invisible from a distance, that prevent the smooth, sidewalk look characteristic of many concrete constructions. To Pei, the success of bush hammering is exemplified by the fact that the aggregate itself is chipped away, allowing the mica in the stone to shimmer in the sun. He likes to joke that in 5,000 years, the surface of the building will be indistinguishable from the mountains behind it. Overhangs and parapet walls were sandblasted to give a contrasting, smoother texture.



ABOVE: *Bush hammering gives a textured surface to the Mesa Laboratory walls.*

LEFT: *While the building was under construction, concrete slabs were erected so that Pei could experiment with finishes. Here, the architect discusses a possible mottled texture.*

The Fleischmann Building

The Fleischmann Building (above). At right, a meeting in the building's conference room.

When the Mesa Laboratory was initially occupied, a number of projects remained to be built. The third tower and the conference center are the most significant of these, but early plans had also called for a small retreat on the west-facing slope of the mesa. Of all these incomplete plans, the only one to be realized was the Fleischmann Building. A refinement of the original retreat idea, it was initially intended to house part of the Advanced Study Program of NCAR and later used as headquarters for NCAR's parent organization, the University Corporation for Atmospheric Research. The building takes its name from the Max C. Fleischmann Foundation of Nevada, which contributed a major portion of the funding, all of which was private. Sited on the northern edge of the mesa, a two-minute walk from the main building, it was designed by Pei in 1968 and occupied in 1969. Its 4,300 square feet are lean on office space (it was designed with nine single-occupancy offices) and focus on a large two-story conference room now used for corporate meetings. The building's small gem-like proportions and low-lying facade complement its towering neighbor on the mesa.

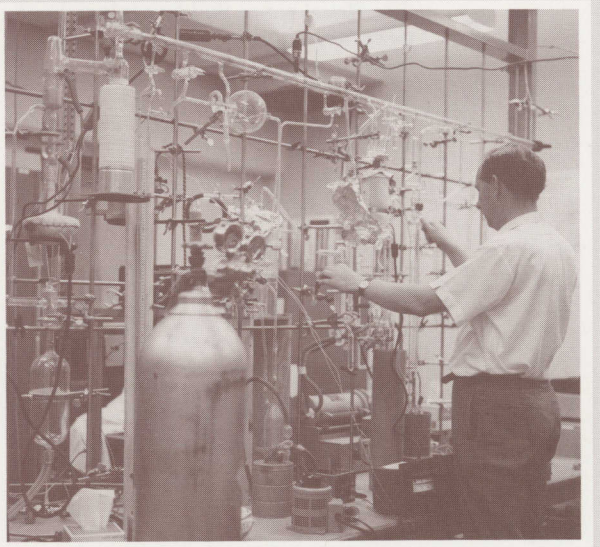
Additions and Remodeling

Although the Mesa Laboratory was formally completed in 1966, work on the building has never stopped. Laboratory and office spaces are in a perpetual state of flux as research and staffing needs alter. The building accommodates not only permanent staff but also an ever-changing influx of scientific visitors. NCAR's facilities must be adaptable to the developing research needs of this varied and dynamic interdisciplinary group. For example, a large vertical wind shaft in which droplets could be studied in suspension once ran from the fourth floor through the penthouse of the B tower; it was removed in 1977. A cold room capable of going to −40° Celsius, used to study snow and ice and originally housed in the Mesa Lab, has been moved to an off-mesa location. A neutron generator once located beneath the circular stairs by the front entrance has been carefully dismantled and converted to conventional lab space.

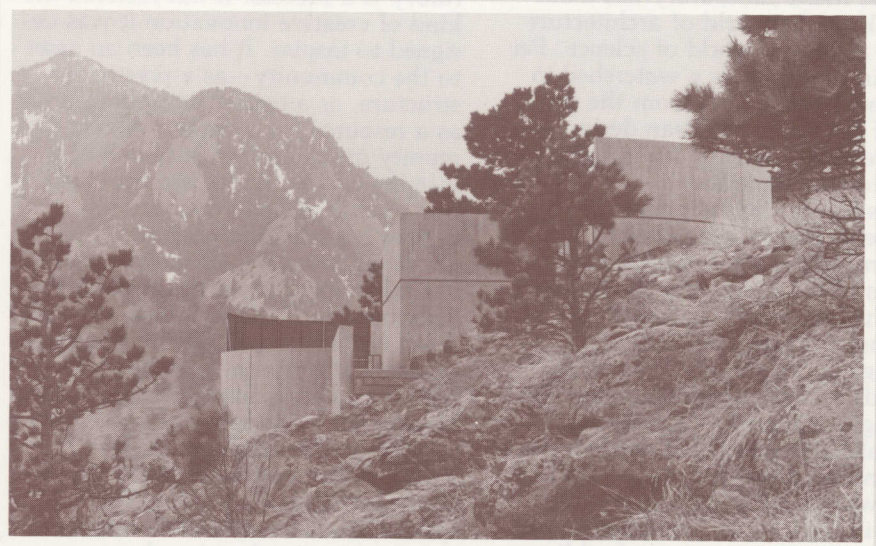
Remodeling affects an estimated 5 to 10% of the building each year, much of it aimed at reclaiming and altering office space as overcrowding continues to intensify. The structure originally contained 97,000 "net assignable" square feet (of working space—excluding areas such as hallways and balconies) and now boasts roughly 127,000. Approximately half of the extra space has been chiseled away from areas such as the lobby and cafeteria. The rest comes from two unobtrusive additions—the computing center and the High Altitude Observatory annex. Neither of these was designed by Pei, and both are substantially underground so as not to interfere with the integrity of the original structure.

The computing addition, completed in 1977, reflects changes in technology not foreseen when the building was designed. Its 15,000 square feet hold NCAR's multimillion-dollar CRAYs, among the world's most sophisticated supercomputers. The machines and the expertise of NCAR's computing staff are at the disposal of both in-house scientists and close to 1,500 researchers at universities and scientific facilities around the country. Creating the extra space involved extending the west wall of the lobby and adding a computer room in the first basement below that extends out into the mesa. Eighteen inches of soil cover the roof, which has been reseeded to camouflage the addition almost entirely.

When the High Altitude Observatory moved from the University of Colorado to the mesa in 1980, another underground addition was begun to make room for its experimental equipment. This 5,500-square-foot annex, completed in 1981, encompasses offices and labs tunneling out from the second basement. These include a vacuum chamber to test instruments destined for use in satellites and equipment that measures the diameter of the sun through daily readings. The semicircular lines of the High Altitude Observatory annex parallel those of the circular stairway and drive at the front of the building.

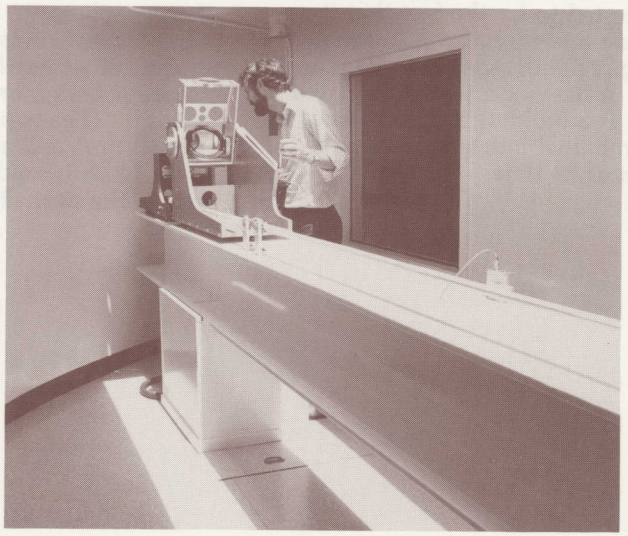


Laboratory spaces. The cold room (above) is used to study snow and ice. Chemistry labs like the one at right allow scientists to examine atmospheric gases.



The computing addition contains NCAR's multimillion-dollar CRAY computers (right). Built almost entirely underground, the annex appears from the outside as a sunken rectangle of grass (seen in the foreground, above left).

The High Altitude Observatory addition (above right) was designed to mirror the curves of the circular stairway. It contains office spaces, labs, and the solar diameter instrument (far right), which measures the dimensions of the sun.



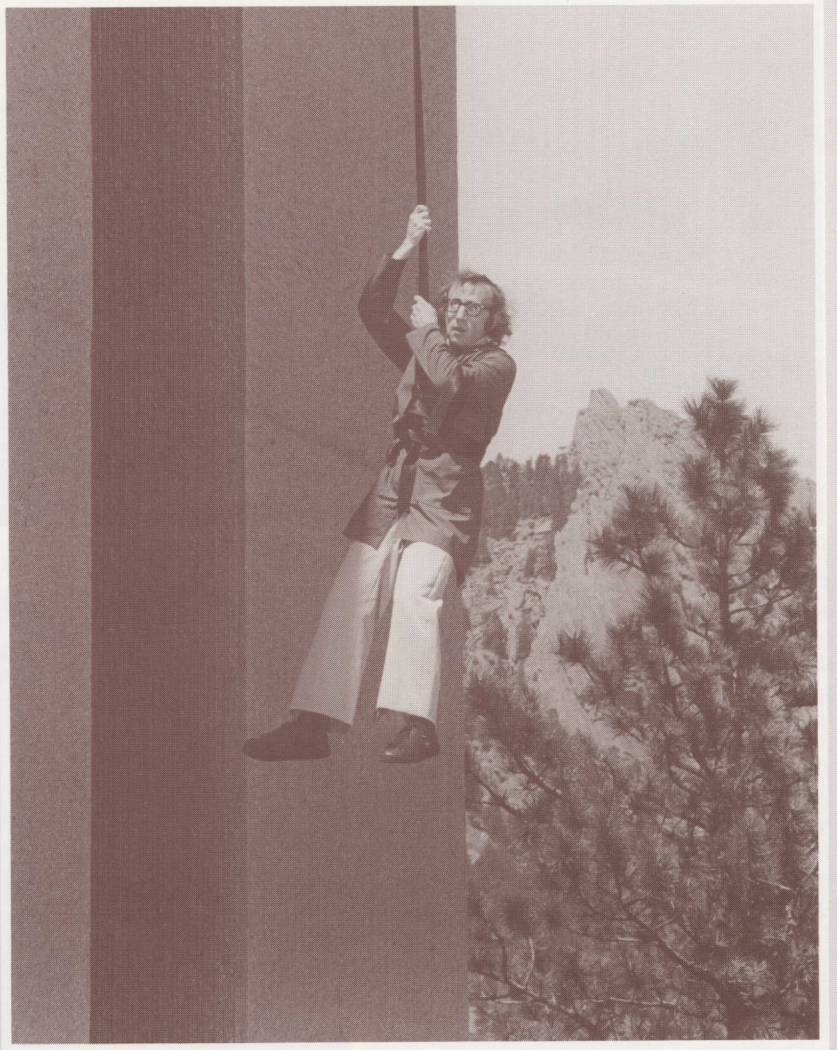
Significance of the Building

In the decades since its construction, the Mesa Laboratory has made its mark on the world of architecture as well as on the world of science. Pei sees it in hindsight as a watershed in his career, freeing him from the confines of his previous urban design experience and stretching his imagination into new dimensions.

Stylistically, the building is impossible to pigeonhole. Philip Johnson, one of the foremost exponents of the postmodernist movement, has reportedly called the structure "the first postmodernist building," a designation Pei himself responds to with a baffled shrug. The building is featured in architectural textbooks and surveys of modern design, and is considered one of Pei's major works. Its influences may be visible in the broken, complex geometries of other contemporary buildings. But it is above all a unique creation, as is attested to by the fact that it appears first and foremost a "futuristic" building, even decades after its completion. It has not unwittingly dated itself; it is a building that continues to betray minimal indebtedness to the fashions of its time.

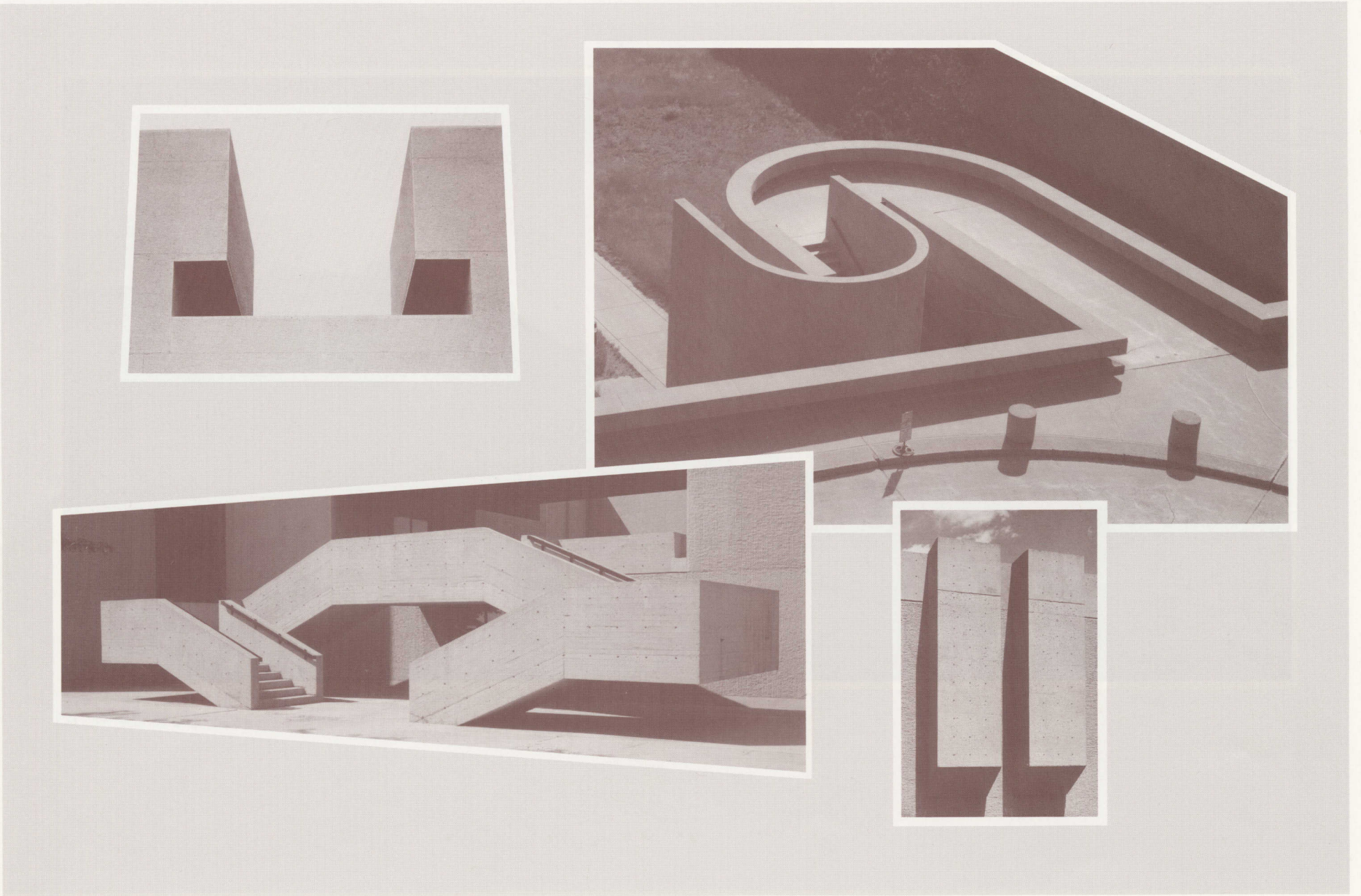
In practical terms, the Mesa Laboratory is a success. It has fostered the kind of creative innovation it was designed to inspire. It has been an asset to the community—as a prestigious structure, as a tourist attraction, and as a resource for a variety of community organizations in search of meeting spaces, which are provided free of charge when they are not needed for scientific purposes. But above all, Pei's NCAR headquarters has taken its place in the popular imagination. In the film *Sleeper*, Woody Allen hurled himself off the building's parapets attempting to escape with the nose of an infamous future leader, leaving the building's pink towers imprinted on the imaginations of millions who may never have heard of the National Center for Atmospheric Research. It makes occasional appearances in television documentaries and as a backdrop for magazine photographers.

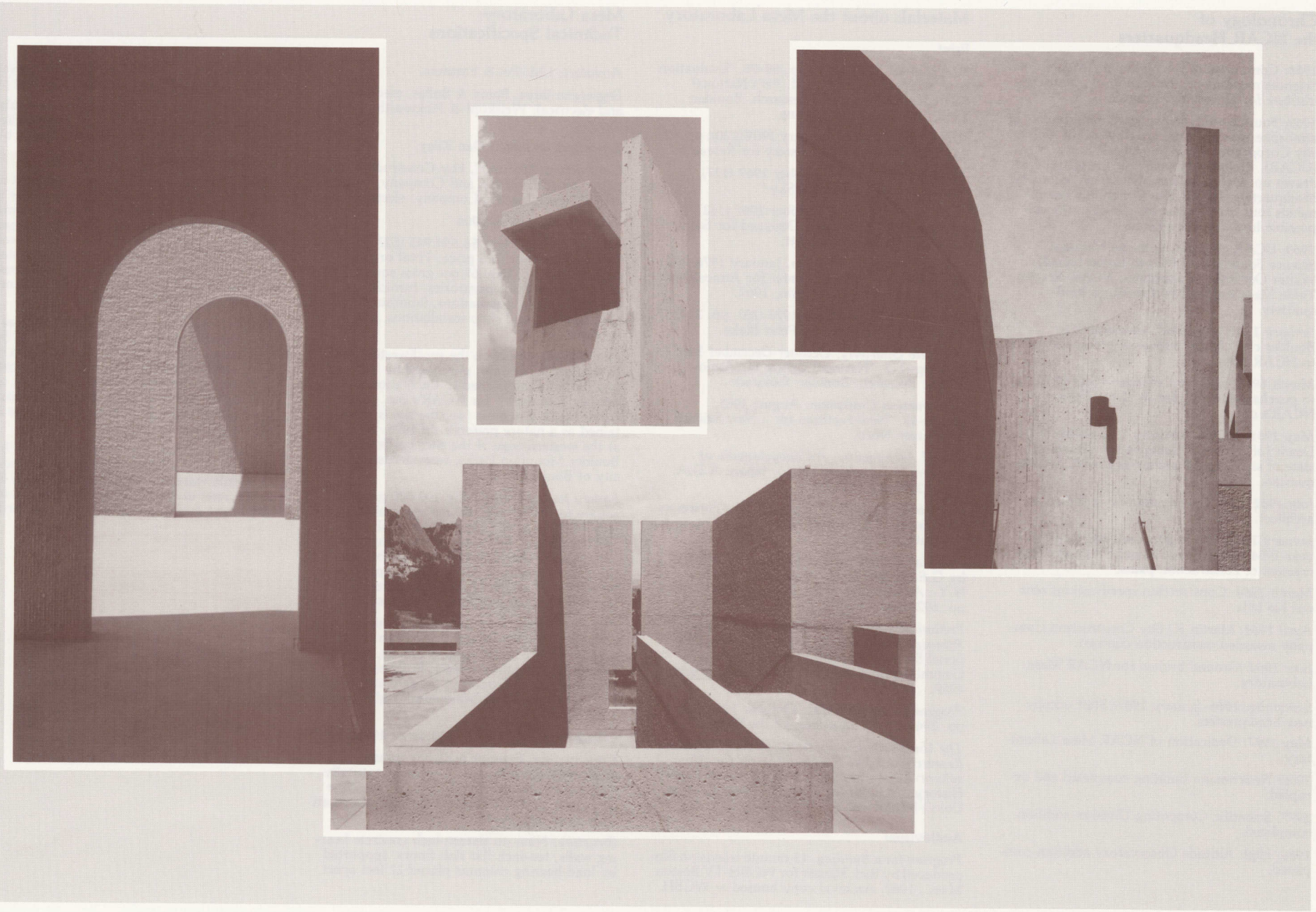
Pei himself sums up the building's impact rather neatly. "I think its influence is seen more in its forms than its spirit. The shapes have been cribbed time and again. But the spirit of the NCAR building is in the context, in the site. That you cannot copy."



Woody Allen hurls himself off one of the NCAR towers in the film Sleeper.

Photo by Ezra Stoller, ©ESTO.





Appendixes

Chronology of the NCAR Headquarters

1958: Committee of the National Academy of Sciences recommends formation of a national institute for atmospheric sciences.

1959: Fourteen universities with departments of atmospheric sciences incorporate as the University Corporation for Atmospheric Research (UCAR). Preliminary plans for the institute are drawn up, including tentative specifications for headquarters. UCAR Site Committee recommends four broad areas for consideration as possible locations for a center.

1960: UCAR contracts with the National Science Foundation (NSF) to found NCAR. Walter Orr Roberts appointed NCAR director. Table Mesa site selected for future headquarters.

January 1961: "Blue line" amendment to Boulder city charter allows city to supply water to NCAR site.

March 1961: State of Colorado votes $250,000 to purchase site and donate it to NSF for NCAR's use.

May 1961: UCAR Advisory Committee of Deans [of schools of architecture] draws up slate of six potential architects for NCAR headquarters.

July 1961: I.M. Pei unanimously selected as architect.

January 1963: Cut in proposed NCAR fiscal year 1964 budget; third tower cut from first increment of construction plans.

March 1964: Construction specifications sent out for bids.

April 1964: Martin K. Eby Construction Company awarded construction contract.

June 1964: Ground broken for NCAR Mesa Laboratory.

September 1966–January 1967: Staff occupy new headquarters.

May 1967: Dedication of NCAR Mesa Laboratory.

1969: Fleischmann Building completed and occupied.

1977: Scientific Computing Division addition completed.

1980: High Altitude Observatory addition completed.

Materials about the Mesa Laboratory

Print

AIA Journal, June 1979, pp. 68–75. "Evaluation from Context to Form: I.M. Pei's National Center for Atmospheric Research, Boulder, Colo.," by Bernard P. Spring.

Architectural Forum, January 1964 (120), pp. 82–85. "High Mountain Monastery for Research."

Architectural Forum, October 1967 (127), pp. 29–41. "Towers in the Sky."

Architectural Record, October 1967 (142), pp. 145–154. "A Building Designed for Scenic Effect," by Jonathan Barnett.

Architecture and Urbanism, January 1976 (61), pp. 148–153. "National Center for Atmospheric Research, Boulder, Colorado, 1967."

Architecture Plus, March 1973 (23), pp. 21–25. "I.M. Pei & Partners," by Peter Blake.

Concrete Quarterly, October-December 1968 (79), pp. 2–5. "National Centre for Atmospheric Research, Boulder, Colorado."

Construction Craftsman, August 1965, pp. 10–12. "New Facilities for a New Science," by Warren Nord.

Global Architecture: An Encyclopedia of Modern Architecture. Tokyo, Japan: A.D.A. Edita, 1976, pp. 2–25.

Life, 16 April, 1971 (70), pp. 74–75. "Fortresses for Science: A Dramatic New Look in Laboratories."

Pictorial History of Architecture in America, by G.E. Kidder Smith, vol. 2. New York, N.Y.: American Heritage Publishing Co., 1976, pp. 692–695.

Preliminary Plans for a National Institute for Atmospheric Research, prepared for the National Science Foundation by the University Committee on Atmospheric Research, February 1959.

Progressive Architecture, October 1967 (48), pp. 194–197. "Atmosphere of the Sixties."

The University Corporation for Atmospheric Research and The National Center for Atmospheric Research, 1960–1970: An Institutional History, by Elisabeth Lynn Hallgren. Boulder, Colo.: NCAR, 1974.

Audiovisual

Program for a Building. 13-minute television film produced by Rick Hauser for WGBH-TV Boston, Mass., 1969. Archival copy housed at WGBH.

Mesa Laboratory: Technical Specifications

Architect: I.M. Pei & Partners.

Engineers: Jaros, Baum & Bolles, mechanical and electrical; Weiskopf & Pickworth, structural.

Landscape architect: Dan Kiley.

Contractors: Martin K. Eby Construction Company, general; Natkin and Company, mechanical; Sturgeon Electric Company, electrical.

Year of completion: 1966.

Cost of construction: $4,558,943 ($23.99 per gross square foot) bid price. Total original cost: $5,827,111 ($30.67 per gross square foot) including built-in laboratories, furnishings, computer room installations, laboratory utilities, cafeteria and shop installations, and other services.

Site: 565-acre mesa on the southwestern edge of Boulder, Colorado, purchased by the state of Colorado and deeded to the National Science Foundation for NCAR's use. Apart from the 28-acre mesa top, the site is maintained as a nature preserve. In 1975, 120 acres at the western edge of the site, bordering the Boulder Mountain Parks, were deeded to the city of Boulder.

Square footage: Originally 190,000 gross square feet (GSF), 97,000 net assignable square feet (NASF); as of 1985, 219,000 GSF, 127,000 NASF. Additions account for roughly 31,000 GSF, 13,000 NASF; conversions account for the remainder of the reclaimed space. 60,800 NASF of the building as currently used are in the first and second basements.

Building height: Two underground levels, two connecting above-ground levels, two tower clusters of five above-ground stories, each topped by a penthouse level. Building, therefore, varies from four to eight stories, two to six above ground. Maximum height: roughly 100 feet.

Occupancy: As of 1966, 400; as of 1985, 550.

Construction: Exterior walls are poured-in-place concrete composed of cement naturally tinted with pink-hued sand and of limestone aggregate. Exposed concrete surfaces pneumatically bush hammered or sandblasted.

Structure: Nine- to sixteen-inch concrete bearing walls, ten-inch flat slab floors, supported by load-bearing columns placed 22 feet apart.

Interior walls: Concrete block with gypsum plaster, metal studs with metal lath and plaster.

Flooring: Lobby, terrazzo; offices and labs, carpet and vinyl tile; cafeteria, rubber tile; kitchen and toilets, quarry and ceramic tile.

Ceilings: Acoustic plaster and tile.

Heating and air conditioning: Dual-duct and multizone systems with constant-volume air handling units. Single-zone backup perimeter hot water heating system. Two low-pressure 500-horsepower steam boilers, one 500-ton absorption chiller. Existing mechanical systems due to be upgraded for more modern heating and cooling equipment and a building energy management control system.

Electrical system: Building served by dual 13.2-kilovolt feeders supplied by Public Service Company. Tranformed to 208/120 volts for basic building requirements. 480-volt power operates air conditioning for computing center and motor generators, which in turn provide three-phase 208-volt power at 400 cycles for supercomputers.

Utilities: Electrical and telephone cables buried so as to cause minimal disruption to landscape. Domestic water storage tank located on hilltop to the west of the building and pumped from city water mains in the valley to the north.

The Works of I.M. Pei

U.S. National Bank of Denver, Mile High Center, Denver, Colorado, 1955.

Luce Chapel, Taichung, Taiwan, 1958.

Government Center Plan, Boston, Massachusetts, 1961.

Kips Bay Plaza, New York, New York, 1962.

Washington Square East, Society Hill, Philadelphia, Pennsylvania, 1964.

Green Center for the Earth Sciences, Massachusetts Institute of Technology (MIT), Cambridge, Massachusetts, 1964.

Central Business District Plan, Oklahoma City, Oklahoma, 1964.

School of Journalism/Newhouse Communications Center, Syracuse University, Syracuse, New York, 1964.

University Plaza, New York University, New York, New York, 1967.

National Center for Atmospheric Research, Boulder, Colorado, 1967.

Air Traffic Control Tower/Federal Aviation Administration, various U.S. airports, 1967–1970.

Everson Museum of Art, Syracuse, New York, 1968.

Des Moines Art Center addition, Des Moines, Iowa, 1968.

Bedford-Stuyvesant superblock, Brooklyn, New York, 1969.

Master Plan, Columbia University, New York, New York, 1970.

Wilmington Tower, Wilmington, Delaware, 1970.

Camille Edouard Dreyfus Chemistry Building, MIT, 1970.

Trans World Airlines domestic terminal (formerly National Airlines terminal), Kennedy International Airport, New York, New York, 1970.

Cleo Rogers Memorial Library, Columbus, Indiana, 1971.

Mellon Art Center, The Choate School, Wallingford, Connecticut, 1972.

Canadian Imperial Bank of Commerce complex, Toronto, Canada, 1972.

Herbert F. Johnson Museum of Art, Cornell University, Ithaca, New York, 1973.

Chemical Engineering Facility/Ralph Landau Building, MIT, 1975.

Oversea-Chinese Banking Corporation Headquarters, Singapore, 1976.

Dallas City Hall, Dallas, Texas, 1977 (in collaboration with Theodore J. Musho).

National Gallery of Art, East Building, Washington, D.C., 1978.

John Fitzgerald Kennedy Library complex, Boston, Massachusetts, 1979 (in collaboration with Theodore J. Musho).

Museum of Fine Arts, West Wing, Boston, Massachusetts, 1981.

Fragrant Hill Hotel, Beijing, People's Republic of China, 1982.

Texas Commerce Tower, Houston, Texas, 1982 (in collaboration with Harold Fredenburgh).

International Business Machines Corporation (IBM) office building, Purchase, New York, 1982.

Sunning Plaza, Hong Kong, 1982.

Arts and Media Center, MIT, 1984.

Raffles City, Singapore, completion date 1986.

New York Exposition and Convention Center, New York, New York, completion date 1986 (in collaboration with James Ingo Freed).

Gateway Complex, Singapore, completion date 1986.

IBM Group Headquarters, Somers, New York, completion date 1986.

Dallas Symphony Hall, Dallas, Texas, completion date 1987.

Bank of China Tower, Hong Kong, completion date 1987.

Le Grand Louvre, Paris, France, completion date (phase 1) 1987.

Mt. Sinai Medical Center complex, New York, New York, completion date 1988.

Major Awards of I.M. Pei

Arnold Brunner Award, National Institute of Arts and Letters, 1961.

Medal of Honor, New York Chapter, American Institute of Architects, 1963.

Thomas Jefferson Memorial Medal, 1976.

Gold Medal for Architecture, American Academy of Arts and Letters, 1979.

Mayor's Award of Honor for Art and Culture, New York City, 1981.

Gold Medal of Alpha Rho Chi, 1981.

American Institute of Architects Gold Medal, 1979.

French Académie d'Architecture Grande Medaille d'Or (Grand Gold Medal), 1981.

Pritzker Architecture Prize, 1983.

Photo by Ezra Stoller, ©ESTO.