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"A Different Kind of Beauty": Scientific and Architectural Style in I. M. Pei's Mesa Laboratory and Louis Kahn's Salk Institute

ABSTRACT

I. M. Pei's Mesa Laboratory for the National Center for Atmospheric Research in Boulder, Colorado, and Louis Kahn's Salk Institute in La Jolla, California, are rare examples of laboratories as celebrated for their architecture as for their scientific contributions. Completed in the mid-1960s, these signature buildings still express the scientific style of their founding directors, Walter Roberts and Jonas Salk. Yet in commissioning their laboratories, Roberts and Salk had to work with architects as strong-willed as themselves. A close reading of the two laboratories reveals the ongoing negotiations and tensions in collaborations between visionary scientist and visionary architect. Moreover, Roberts and Salk also had to become architects of atmospheric and biomedical sciences. For laboratory architecture, however flexible in theory, necessarily stabilizes scientific practice, since a philosophy of research is embedded in the very structure of the building and persists far longer than the initial vision and mission that gave it life. Roberts and Salk's experiences suggest that even the most carefully designed laboratories must successfully adapt to new disciplinary configurations, funding opportunities, and research priorities, or risk becoming mere architectural icons.

KEY WORDS: Laboratory design, laboratory architecture, I. M. Pei, Louis Kahn, Salk Institute, National Center for Atmospheric Research, Walter Roberts, Jonas Salk, biomedical research, climate modeling

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The following abbreviations are used: HAO, High Altitude Observatory; KC, Kahn Collection, Architectural Archives of the University of Pennsylvania, Philadelphia, PA; NBS, National Bureau of Standards; NCAR, National Center for Atmospheric Research, Boulder, CO; NIH, National Institutes of Health; SP, Salk Papers, Mandeville Special Collections, UCSD, La Jolla, CA; UCAR, University Corporation for Atmospheric Research, Boulder, CO; UCAR/NCAR Archives, Boulder, CO; UCSD, University of California, San Diego; UPenn, University of Pennsylvania.

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> Laboratories should look like laboratories and the scientists who will live in them must wage war to make them so if the imprint of the scientist is to prevail. Otherwise, they must settle for a monument to an architect, which may or may not happen to be a workable laboratory.[1]

Laboratories measure their success by Nobel Prizes rather than Pritzker Prizes, the architectural equivalent of a Nobel. Indeed, many of the world's most renowned laboratories, such as Cambridge's Cavendish, MIT's Rad Lab, UC's Los Alamos, and Bell Laboratories' Murray Hill, rank among the least architecturally distinguished. Only rarely does a laboratory earn equal acclaim for its contributions to architecture and to science.[2] I. M. Pei's Mesa Laboratory at the National Center for Atmospheric Research (NCAR) in Boulder, Colorado, and Louis Kahn's Salk Institute in La Jolla, California, capture the essential tension between an imaginative client and an inspired architect.[3] As active collaborations between visionary scientists and architects, these laboratories gave concrete expression (literally) to distinctive philosophies of research. If founding directors Walter Orr Roberts and Jonas Salk did not exactly "wage war" with their architects to put the appropriate scientific imprint on their laboratory, they certainly shared Winston Churchill's belief that in science, as in politics, "We shape our buildings, and afterwards, our buildings shape us."[4]

A signature laboratory building can provide prestige, visibility, and a collective identity. Much like a corporate headquarters, it says who its denizens are, what they do, and how they do it.[5] Ideally, the architecture brings the

1. David Allison, "Places for Research," *International Science and Technology* 1, no. 9 (1962): 20–31, on 30.

2. Peter Galison and Emily Thompson, ed., *The Architecture of Science* (Cambridge, MA: MIT Press, 1999), provides a good overview but does not mention either Pei's Mesa Lab or Louis Kahn's Salk Institute.

3. See Lucy Warner, *The National Center for Atmospheric Research: An Architectural Masterpiece* (Boulder, CO: UCAR, 1985). Prepared for NCAR's 25th anniversary, *An Architectural Masterpiece* provides a comprehensive history of the Mesa Laboratory and is considered an essential work on the subject. See also Carter Wiseman, *I. M. Pei* (New York: Harry N. Abrams, 1990), the standard Pei biography, which includes a perceptive chapter on NCAR (pp. 72–91).

4. P. Thomas Carroll first called attention to Churchill's quote in an important unpublished article on Roger Adams and his organic chemistry laboratory at the University of Illinois. P. Thomas Carroll, "Buildings and Bildung: Preliminary Speculations on How Laboratory Facilities Figure in the Evolution of Chemical Knowledge," presented at the Department of History of Science and Technology, Johns Hopkins University, 1 Mar 1989.

5. Alexandra Lange, "Tower, Typewriter, Trademark: Architects, Designers and the Corporate Utopia" (PhD dissertation, New York University, 2005), provides an instructive analysis of how Connecticut General, John Deere, IBM, and CBS reinvented themselves through architecture and design.

organization, and the organizational chart, to life both symbolically and pragmatically. Should the administration be conspicuous, or conspicuous in its absence? Will the design encourage independence or interdependence? Should scientists be grouped by discipline or by project? How will people and ideas circulate within? How will the building accommodate the ebb and flow of funding and fast-moving scientific fields? Questions that in old spaces gradually sort themselves out over time become pressing issues in the design of a new laboratory. In order to explain to an architect the kind of space required, a laboratory's leaders have to think carefully about what kind of institution it is and what it seeks to become, and put that vision into clear, concise language. Watching a laboratory take shape reveals what may otherwise remain hidden as scientists and architects struggle to give form and shape to their ideas and ideals. A new building becomes an opportunity to reconsider how a laboratory understands and represents itself to the scientific community and the public.[6]

Mesa Lab and the Salk Institute offer an instructive comparison of how two entrepreneurial scientists, in close collaboration with world-class architects, created new laboratories in their own image. Until these commissions, laboratories had rarely attracted distinguished modern architects. And when they had—the notable exceptions being Frank Lloyd Wright's Research Tower for S. C. Johnson Wax and Eero Saarinen's corporate laboratories for General Motors, IBM, and AT&T—the architects had such forceful personalities that the scientists essentially found themselves guests in their own homes.[7] Roberts and Salk had strong ideas about the kind of places where scientists could do their best work, and they ended up becoming partners with their architects rather than working with them as conventional clients. Their laboratories offered a rare opportunity to rethink traditional disciplinary boundaries and imagine

6. The sociologist Thomas Gieryn has done more than anyone else to open up the architectural features of laboratory design in a series of articles on biotechnology laboratories. See Thomas Gieryn, "What Buildings Do," *Theory and Society* 31, no. 1 (2002): 35–75; Gieryn, "Biotechnology's Private Parts (and Some Public Ones)," in *Making Space for Science: Territorial Themes in the Shaping of Knowledge*, ed. Crosbie Smith and Jon Agar (New York: Palgrave Macmillan, 1998), 281–312; and Gieryn, "Two Faces on Science: Building Identities for Molecular Biology and Biotechnology," in Galison and Thompson, *Architecture of Science* (ref. 2), 423–55.

7. See Jonathan Lipman, *Frank Lloyd Wright and the Johnson Wax Buildings* (New York: Rizzoli International Publications, 1986); Scott G. Knowles and Stuart W. Leslie, "'Industrial Versailles': Eero Saarinen's Corporate Campuses for GM, IBM, and AT&T," *Isis* 92, no. 1 (2001): 1–33. Robert Cumming cites the common aphorism about Wright's residential clients in his online article, "This Bold House—Five Architects Who Defy Convention," http://www.neatorama.com/2007/07/20/this-bold-house (accessed 28 Mar 2008).

new scientific disciplines; they allowed Roberts and Salk to become architects, in a different sense, of the atmospheric sciences and of molecular and neurobiology. They had to envision an intellectual structure as ingenious and robust as any architectural plan. As sociologist Thomas Gieryn has pointed out, architecture stabilizes scientific practice, though never permanently, since a building, like the science it houses, is always under construction, negotiation, and interpretation.[8]

For Pei, the Mesa Lab marked his passage from journeyman to master craftsman and would convince future clients, notably the National Gallery of Art and the Louvre, that he was an architect of the first rank. For Kahn, the Salk Institute would be his magnum opus.[9] At the same time, these would be unfinished masterpieces. Budget cuts at NSF forced NCAR to abandon the south tower that Pei thought would have completed his architectural composition and provided room for future laboratory expansion. At the Salk Institute, the south laboratory building remained a shell, to be fitted out gradually as funds became available. Worse still, Kahn's plans for the Institute's Residences and for the Meeting House, which he considered the heart of the Institute, never left the drawing board.[10]

In their mid-forties when they began working with their architects, Roberts and Salk, too, learned the hard way how demanding a great building can become. For their founding directors these laboratories represented not only an enormous personal investment, but lasting legacies. They sought laboratories that would reflect and reinforce an interdisciplinary style of science, at the appropriate scale. Roberts thought the secret would be small-group collaboration with minimal administrative interference. Salk preferred the "star system," hiring individually accomplished fellows with a track record of ignoring conventional wisdom and disciplinary boundaries, hoping that "outsiders" would bring

8. Gieryn, "What Buildings Do" (ref. 6), 36.

9. David Brownlee and David De Long, *Louis I. Kahn: In the Realm of Architecture* (New York: Rizzoli International Publications, 1991), is the most comprehensive source on Kahn, drawing from the Kahn Collection at the Architectural Archives of the University of Pennsylvania. See also Thomas Leslie, *Louis I. Kahn: Building Art, Building Science* (New York: George Braziller, 2005). Leslie offers an architect's view of Kahn's major projects, drawing particular attention to structural engineering. The noted critic Vincent Scully's *Louis I. Kahn: Makers of Contemporary Architecture* (New York: George Braziller, 1962) is an early appreciation.

10. Kent Larson and William Mitchell, *Louis I. Kahn: Unbuilt Masterworks* (New York: Monacelli, 2000), 48–77, using Kahn's detailed plans and sophisticated computer modeling, provides a vivid sense of how these spaces would have looked.

FIG. 1 I. M. Pei's Mesa Laboratory, Boulder, Colorado, set against the backdrop of the Flatiron Range. Note the deceptive scale, the hooded towers, and flat roofs. *Source:* Ezra Stoller, Esto Photographics Inc.

a fresh perspective.[11] Roberts and Salk agreed, however, that when a laboratory exceeded a few hundred researchers and staff, it faced the law of diminishing returns. They hoped to avoid the increasingly impersonal and bureaucratic science exemplified for Roberts by the National Bureau of Standards (NBS), which had built a branch laboratory in Boulder in the early 1950s, and for Salk by the National Institutes of Health (NIH) and major medical school research campuses.

Roberts and Salk had as much confidence in the power of place as their own architects, but that confidence sometimes undermined their own goals. Roberts, who preferred a light managerial touch, expected the building itself to carry some of the administrative load, to draw together atmospheric science by design rather than by memorandum. (Fig. 1) Paradoxically, NCAR could only foster the collaborative model of atmospheric research Roberts had in mind by overcoming some of the architectural constraints designed into the laboratory. Meteorologist Robert Fleagle's ringside seat at NCAR convinced him that "the NCAR building, designed around isolated towers, reflects [Roberts's] vision

11. Nicholas Wade, "Salk Institute: Elitist Pursuit of Biology with a Conscience," *Science* 178, no. 4063 (1972): 846–49.

for the institution as a collection of researchers pursuing individual projects of their own choice. That constitutes a continuing cost that should be weighted against the inspiring beauty of the building and the site."[12] While that assessment downplays Roberts's enthusiasm for interdisciplinary collaboration, it accurately underscores his assurance that the right architectural vision could advance the laboratory's scientific mission. Similarly, the Salk Institute's splendid isolation had to come to terms with its role in a wider web of biomedical research. As private funding faltered, the Salk Institute's scientists had to compete with their colleagues in more conventional settings. Without financial independence, Kahn's cloister could not provide the scientific sanctuary Salk had envisioned. "It has become anything but that early vision of a think tank or an Institute for Advanced Studies," Stanford Nobel laureate Paul Berg asserted. "They're scratching to survive just as much as the rest of us."[13] Its architecture, however much admired, preserved an ideal increasingly at odds with contemporary scientific practice.

WALTER ROBERTS'S "ACADEMICAL VILLAGE"

Much as Thomas Jefferson envisioned his University of Virginia as an "academical village," for Roberts the guiding metaphor for NCAR was the village, a self-directed community of peers. NCAR would never be a single laboratory in the traditional sense, though plenty of bench-top science would be done there. Rather, it would be a place that would bring together observational data from across the globe to be analyzed, interpreted, and built into models by the NCAR staff, visiting scientists, and even distant collaborators, a community increasingly linked by networks of computers. The Mesa Lab would be its village green. Roberts sought a space of complexity, communication, and creativity, something close to Jane Jacobs's idea of an urban "ecosystem" sustained by diversity and interdependence.[14] "There are twenty different ways to go from my office down to the chemistry laboratory," Roberts mused, meaning endless

12. Robert G. Fleagle, *Eyewitness: Evolution of the Atmospheric Sciences* (Boston: American Meteorology Society, 2001), 86. Thanks to Joseph Bassi for alerting me to this reference.

13. Quoted in Ann Gibbons, "The Salk Institute at a Crossroads," *Science* 249, no. 4967 (1990): 360.

14. Jane Jacobs, *The Death and Life of Great American Cities* (New York: Modern Library, 1993), xvi–xvii. See also Peter Hall, *Cities in Civilization* (New York: Pantheon, 1998). Hall makes a similar point about cities as "crucibles of culture" (pp. 193–97).

opportunities for serendipitous encounters and exchanges. Like Jacobs, he had more confidence in grassroots community building than in master plans.

Roberts's early career as a solar astronomer fundamentally shaped his ideas about how science should be organized and practiced. In 1940, when Roberts was a graduate student in astronomy at Harvard, his advisor sent him to Climax, Colorado, to set up a solar observatory. There Roberts mapped the corona's changing patterns of brightness, its rotation, and its prominences, the spectacular arch-shaped eruptions most visible in the corona. Most significantly, a few days later he observed the unexpected connection between a bright corona on the east limb of the sun and radio interference in the earth's ionosphere, a finding of sufficient military importance to keep him at Climax for the rest of the war as an army of one in the battle for clear communication. After the war, Roberts established the High Altitude Observatory (HAO), with improved instruments at Climax and headquarters in Boulder, to take advantage of connections with the University of Colorado.[15] He made an influential ally of Edward Condon, the newly appointed head of the NBS, whom he lobbied hard, and successfully, to relocate the NBS's Electronics and Central Radio Propagation Laboratories to Boulder.[16] Architect William Pereira's design for NBS, however, with its endless corridors, sprawling wings, cookie-cutter offices, laboratory modules, and indifference to local geography, became for Roberts a classic example of the pitfalls of a government-issued laboratory.

Roberts had an ambitious research agenda for HAO, but only a shoestring budget. He turned out to be an effective salesman, and by 1960 HAO had a home of its own on campus in a building adjoining the Sommers Bausch Observatory, which also housed the department of astro-geophysics, which Roberts had founded. Roberts believed that for laboratories, small was beautiful. Arranged on a rectangular plan with offices on the exterior, laboratories on the interior, and an encircling corridor in between, the HAO building offered an ideal compromise between the dilapidated Temporary Building 8, HAO's first location (which Roberts liked because he could drill through the floors and knock holes in the walls), and something as overwhelming as the NBS. The HAO building comfortably accommodated its scientific staff of fourteen

15. Elizabeth Lynn Hallgren, *The University Corporation for Atmospheric Research and the National Center for Atmospheric Research, 1960–1970: An Institutional History* (Boulder, CO: UCAR, 1974), 58.

16. Joseph Bassi, "From a 'Scientific Siberia' to 'AstroBoulder': The Beginning of the Transformation of Boulder, Colorado into a City of Knowledge," unpublished, traces in detail Roberts's role in the relocation of the NBS laboratory.

PhDs and forty-five staff members, plus graduate students. Roberts took a modest corner office. He favored austerity (no rugs or carpets on the floors, even in the director's office) and informality. He noticed that people tended to gather in the stairwells and in the relatively short corridors, something that would guide his thinking about the design for NCAR.[17]

Meteorology, always a stepchild of American science, got an enormous boost in prestige and potential funding from a 1958 National Academy of Sciences study.[18] The committee members included Carl-Gustaf Rossby (the father of American meteorology), John von Neumann (who considered weather modeling to be one of the most challenging tests for the electronic computer), and Lloyd Berkner (a key organizer of the International Geophysical Year), and their report urged serious consideration of a "national effort in atmospheric research." A subsequent study by top academic meteorologists, organized as the University Committee on Atmospheric Research, later the University Corporation for Atmospheric Research (UCAR), drafted a "Blue Book" that set out a detailed research agenda. It included a generic, strip-mall-style design for a National Institute for Atmospheric Research.[19] Who would head it, where it should be located, and how it would be organized remained open questions.[20]

Roberts, a UCAR trustee-at-large, had followed the planning process closely, discussed it with his HAO board, and made no real secret of his ambition to head the proposed institute, under the right conditions. UCAR's site committee had narrowed its search to four general regions—Colorado, Ohio, New York, and North Carolina—but understood that the preferences of the director would trump any other considerations. The nominations committee, meanwhile, having unsuccessfully courted James Van Allen (University of Iowa) and Herbert Friedman (Naval Research Laboratory) discovered that "Dr. Roberts is the only one on our top list of four candidates who really wants the job. He is ready to start to work for us at once. He is at a very productive age,

17. Mary Andrews and Ed Wolff, interview by Stuart W. Leslie, 20 Jan 2005.

18. Hallgren, *Institutional History* (ref. 15), 66–67; Karl Hufbauer, *Exploring the Sun: Solar Science since Galileo* (Baltimore, MD: Johns Hopkins University Press, 1991), 129–35. See also Allan A. Needell, *Science, Cold War, and the American State: Lloyd V. Berkner and the Balance of Professional Ideas* (Amsterdam: Harwood, 2001), 297–324. Needell covers the origins and aims of the IGY.

19. Hallgren, *Institutional History* (ref. 15), 3–23.

20. "Preliminary Plans for a National Institute for Atmospheric Research," UCAR, Second Progress Report (Feb 1959), 75–83.

forty-four, and is known as a man who can accomplish the impossible."[21] The committee held a long meeting with Roberts at the end of March 1960, at which he explained his enthusiasm for the position, but only if the board agreed to locate NCAR in Boulder and make HAO a separate division. The committee agreed that HAO might actually be a bonus for NCAR and could see no real liability in placing NCAR in Boulder.

Only one member, P. Stewart Macaulay of Johns Hopkins, raised serious objections. Macaulay wondered if Roberts fully endorsed the fundamental principle behind NCAR, that as a national resource it should complement, rather than compete with, university research and address research questions beyond the scope of a single university. He feared that Roberts might

> perhaps gradually and stepwise—create a center in his own image, which is very far from the kind of organization and function which we had contemplated. The thing that Roberts wants to create may be just as good as that which we have been talking about, but I read into all of his observations the desire to have a close, self-centered group to which scientists from the universities could gain access, if at all, only by sufferance. The idea of creating a facility at which university scientists could find facilities not available at home, and at which they could pursue, in collaboration with resident staff, research of their own interest, seems to have disappeared entirely.[22]

The committee approved Roberts's appointment as NCAR director, and NCAR would turn out to be quite different from the "close, self-centered" institution Macaulay feared it might become.

Roberts already knew exactly where NCAR should be built. He could literally see the site from his living room, a spectacular mesa in the shadow of the Flatiron range, right next to the NBS. He had long coveted the property for a Colorado version of Caltech, an idea he had discussed seriously with the Ford Foundation.[23] Convincing UCAR to select Boulder was a mere formality. Securing the mesa would prove more challenging. Roberts and his administrative assistant Mary Andrews (Wolff) arranged meetings with the university,

21. H. R. Byers to the Board of Trustees, 15 Apr 1960, UCAR/NCAR Archives, Henry Houghton Records, Collection 8623, Box 1, Folder 28 April 1960.

22. P. Steward Macaulay to Horace Byers, 11 Apr 1960, UCAR/NCAR Archives, Henry Houghton Records, Collection 8623, Box 1, Folder 28 April 1960.

23. David DeVorkin, interview with W. O. Roberts, 28 Jul 1983, Sources for the History of Modern Astrophysics, Center for the History of Physics, American Institute of Physics, College Park, MD.

the local chamber of commerce, and the governor, urging them to move fast to finalize the site with the UCAR board. If the state offered the land to UCAR, Boulder would have a clear advantage, since it already met all of the other criteria set by the board.[24] Following a recent precedent in which the state purchased land for the Air Force Academy in Colorado Springs, the governor committed the state to purchasing the mesa if NCAR agreed to locate there. The final hurdle was convincing the city of Boulder to amend its so-called "Blue Line" above which the city would not supply water or sewer lines, intended as a limit to development in the foothills overlooking Boulder. In March 1961, the city approved the exemption for NCAR, which in turn agreed to preserve virtually the entire 565-acre mesa as open, public land.[25]

For the time being, NCAR had to make do with temporary quarters in the HAO building, in two rented buildings on the university's east campus, and in Cockerell Hall, a converted dormitory some distance from the other sites. Meteorologist Edward Lorenz remembered his visits to Cockerell Hall as "the golden age of NCAR." He actually preferred its long halls, with their endless opportunities for random encounters, to either the Pei-designed Earth Sciences Building at MIT, where he spent most of his career, or the Mesa Lab, where he would be a frequent visiting researcher. A horizontal orientation, he decided, encouraged community, while a vertical orientation discouraged it: "You just don't see people who are three floors away from you . . . very much."[26]

Having settled the question of its future site, NCAR still had to decide what kind of laboratory it should build and who should design it. Roberts, understandably, had strong opinions. He tended to look at the big picture and appreciated the building's symbolic importance. "In keeping with the prominence of the Table Mountain site," he explained, "the building or buildings placed there must also represent the dignity and importance of the Center as a national scientific laboratory. They should also express their function as research laboratories—they should look and feel like a research center to the public, but even more important, to the scientists who work there." He felt keenly that the building must complement rather than compete with the natural beauty of the site, and must be constructed from compatible materials, with proportions

24. Mary Andrews to W. O. Roberts, 6 Jul 1960; Mary Andrews, Memo to Files, 12 Jul 1960, UCAR/NCAR Archives, Collection 8731, Box 1, Folder 5, Site Acquisition, 9/60–7/63.

25. Warner, *Architectural Masterpiece* (ref. 3), 4; and *Remembering Walt Roberts* (Boulder, CO: UCAR, 1991), 88.

26. Dialogue between Phil Thompson and Ed Lorenz, 31 Jul 1986, American Meteorological Society, UCAR, 6.

"that do not suggest monuments, and building forms that are not reminiscent of industrial structures."[27]

Tician Papachristou, an architect on the university faculty, and Andrews served as Roberts's architectural scouting party, setting out to discover the features an ideal laboratory should have. They started by talking with scientists at HAO and the NBS and got plenty of advice on what, and what not, to do. People insisted on quiet, private offices within convenient walking distance of their colleagues. The experimentalists wanted offices next door or directly across the hall from their labs. Everyone expected a room with a view, natural light, and working windows, though open windows had their drawbacks. "HAO scientists would like their desks protected from the wind when their windows are open," they reported. "In warm weather occasional very high winds in Boulder force staff members to choose between heat and swirling papers. Valuable computations have been [known] to be sucked out the window."[28] They sought advice from Jack Bartram, a colleague at the University of Colorado who had extensive experience in campus planning. Bartram told them that the mountains would dwarf any building NCAR could imagine, so that the architect they chose must "be essentially humble and be a master of accommodating a building to a setting if he is to do a successful job here." He urged them to consult with Pietro Belluschi, the dean of architecture at MIT, and William Wurster, Belluschi's counterpart at Berkeley, who represented two very different schools of thought. Bartram gave Papachristou and Andrews frank thumbnail sketches of possible contenders, including Philip Johnson; Minoru Yamasaki ("He would do a jewel-like building [that would] be extremely expensive"); and Eero Saarinen ("Each building that he does must exceed the previous one and is likely to be full of experimental design ideas that make it difficult for a contractor to bid at a reasonable rate").[29]

Belluschi and Roberts met in Boulder at the end of October 1960. Roberts explained his goal of a laboratory that would, on the one hand, encourage contemplation, and on the other, a sense of tension, and asked Belluschi for suggestions. Belluschi briefly discussed possible architects, including Louis Kahn, Richard Neutra, and Alvar Alto. Papachristou and Andrews then set out to gain some first-hand impressions of current best practice. They met with ten

27. W. O. Roberts, Prospectus for a Laboratory, 25 May 1961, UCAR/NCAR Archives, Collection 850215d, Box 2, Folder Book 15J, Prospectus for a Laboratory.

28. T. Papachristou notes, undated, UCAR/NCAR Archives, Collection 8731, Box 2, Folder 10.

29. Mary Andrews, "Talk with Jack Bartram about Selection of Architect," 26 Sep 1960, UCAR/NCAR Archives, Collection 8731, Box 2, Folder 21.

architectural firms in California and toured several new laboratories recently completed by some of them. Nothing really impressed them. They did admire the design for the Center for Advanced Study in the Behavioral Sciences at Stanford: "Human scale and warmth were achieved together with simplicity and functionalism. But it is not a 'science' laboratory, with due apologies to the social sciences." William Pereira's new laboratory for General Atomic in La Jolla, much like his earlier design for the NBS in Boulder, seemed "mammoth scale and machine-like."[30] They heard plenty of talk about the importance of the campus as the appropriate model, but concluded that, "if by campus feeling they mean a home for individuality and humaneness, combined with intellectual endeavor, they have, in our opinion, fallen far short of the goal we have set for ourselves at the Center." What seemed to be missing at every laboratory they visited was a "soul." If they could not find a proper prototype for NCAR, then the best strategy would be to find an architect with sufficient imagination and "a philosophy of design sympathetic to our goals."[31] Perhaps looking for inspiration, Papachristou assigned the NCAR laboratory as the final project for his architecture graduate students, who used the Blue Book as a guide. Roberts personally judged the projects, awarded a $25 prize to the winner, and put the models on display at the HAO.[32]

Though they had not yet identified the right architect, Andrews and Papachristou did have some sound advice for Roberts on how to preserve the best qualities of HAO in the new laboratory: "A scale of intimacy rather than grandeur"; "dispersed buildings rather than tall, massive ones"; "a sense of restraint and simplicity, a certain 'Spartan' quality"; "as little distinction as possible between administrative and research areas"; and "offices large enough for one scientist and small enough so that offices cannot be shared."[33]

Despite some pressure to hire a Colorado architect for a high-profile project backed by a significant state investment, the UCAR board of trustees insisted on considering a national pool for a national facility. Since eight UCAR-member schools had deans of architecture, Belluschi thought they could serve

30. Mary Andrews and T. Papachristou to NCAR Building File, 5 Apr 1961, UCAR/NCAR Archives, Collection 8731, Box 2, Folder 22.

31. Mary Andrews and T. Papachristou to W. O. Roberts, 22 Feb 1961, UCAR/NCAR Archives, Collection 8731, Box 2, Folder 21.

32. Architecture 458, Problem 3, 28 Nov 1960, UCAR/NCAR Archives, PFS 1, Notebook "UCAR Building File."

33. Mary Andrews and T. Papachristou to W. O. Roberts, 13 Mar 1961, UCAR/NCAR Archives, Collection 8731, Box 2, Folder 21.

as a committee to provide Roberts and UCAR with expert guidance. Belluschi asked each of his counterparts for a list of five names (one declined because his own firm hoped to win the commission). The deans collectively whittled the list down to six architects, each young, ambitious, and the personal favorite of one of the deans. Roberts stressed that what mattered most was commitment: "We want the kind of guy who will give us more than money can buy, who will give this job part of his soul."[34] Andrews arranged a picnic luncheon for the deans on the mesa, complete with card tables and gingham tablecloths hauled up by jeep, so Roberts could showcase the grandeur of the site, as well as its architectural challenges.

"PEI IN THE SKY"

After meeting with the deans, Roberts and his staff drew up a detailed "Prospectus for a Laboratory" for the architects, summarizing his views and those of his most trusted lieutenants. It underscored the importance of NCAR's mission: "No field of science—even atomic energy or medicine or space exploration—offers a greater potential for the good of all mankind than does the field of atmospheric science . . . the sky is quite literally the limit." Roberts then described the philosophy that should guide the laboratory's design, borrowing freely from Philip Thompson, his recently hired associate director. Thompson, a pioneer in computer modeling with the Air Force who had worked with von Neumann at the Institute for Advanced Study, had the mind of a mathematician and the soul of an artist and philosopher. Better than anyone else, he could articulate a unique, if frankly romantic, vision for NCAR:

> The most impressive feature of any top-notch research center is an intangible air of ferment and intellectual coherence that does not depend on any formal mechanism of cohesion. A building that is most symbolic of this feature, and which is best designed to nurture it, is one that is clearly designed for sustained intellectual, spiritual and aesthetic life—and is not intended for the daily grind. The ideal is not a monument or a temple, but a place where a variety of people can meet, privately or semi-privately, can be alone, or can be distracted by a different kind of beauty.[35]

34. Draft summary of minutes of meeting of UCAR Planning Committee and Advisory Committee of Architectural Deans, 21 May 1961, UCAR/NCAR Archives, Collection 8731, Box 1, Folder 8 UCAR Planning Committee, Jan–Jun 1961.

35. Roberts, Prospectus for a Laboratory (ref. 27).

Roberts's experiences, drawn from HAO, convinced him that no one could predict the future of an emerging field with any certainty, and so NCAR should avoid any kind of architectural or organizational straitjacket. "The scientist must feel free to tack things on the wall, or anchor things to the floor, or tear out a part of a wall to house some piece of equipment he is using, or create a clutter . . . an air of incompleteness, of non-finality, is essential to a good scientific environment," he stressed. He recognized the virtues of austerity, financial and otherwise. NCAR, Roberts said, "should be in my view monastic—that is, ascetic but hospitable."[36]

To discover which of the architects on the list would be most sympathetic to this vision, Roberts wrote each asking for detailed information on past and present projects, and he invited them to Boulder where they could share their approach with the staff and study the site for themselves. Each of the five principals came to Boulder in June 1961 for an interview with Roberts, the associate directors, and Roberts's staff, which now included Edwin Wolff, a journalist whose writings about NCAR's move to Boulder had caught Roberts's eye and whose administrative savvy would find a perfect home at NCAR. The visit included a walking tour of the mesa. In casual conversations with the candidates, Roberts perhaps best expressed his personal preferences for NCAR. He explained to one architect how important it was for scientists to eat in small groups, in "a kind of faculty club atmosphere."[37] To another he emphasized "complexity, surprise, diversity of shapes and sizes of things" and warned against having a wing marked "Administration."[38] He told another architect to avoid "the Hollywood-version laboratory" with its long corridors, and he rhapsodized about the human scale of Greek island towns, which gradually adapted to change over time. Scientists, he said, would likely work in groups of three to ten people and would need easy access to blackboards, "the real instrument of interdisciplinary work." They would also enjoy spending time in the library and being able to "get at the computer, even if only to walk by to see it at work."[39] He advised another architect "to avoid the feeling of frenzy one finds in most laboratories. Even the buildings look nervous. A more

36. Ibid.

37. Notes on conversation with Paul Kirk, 2 Jun 1961, UCAR/NCAR Archives, Collection 8731, Box 1, Folder 13 Kirk, Wallace, McKinley.

38. Notes on conversation with William Caudill, 7 Jun 1961, UCAR/NCAR Archives, Collection 8731, Box 1, Folder 17 Caudill, Rowlett, Scott.

39. Notes on conversation with Harry Weese, 17 Jun 1961, UCAR/NCAR Archives, Collection 8731, Box 1, Folder 14 Harry Weese and Associates.

restful feeling is needed."[40] With Pei, a protégé of Belluschi, Roberts reiterated his insistence on a design "complicated enough so that the proper space could be found for any given function." He said he did not want air conditioning, so he could "hear the birds, the sound of the wind, and smell the outside air." Asked how much time he would personally devote to the project, Pei told him: "I'm going to be very frank. I'm going to be very selfish with the project. This is the kind of thing I've been looking for, both professionally and personally." Pushing a little, Roberts said: "Ask ten scientists what kind of atmosphere is best, and you would get six answers." Pei replied that perhaps he would "come up with a seventh."[41] (Fig. 2)

Pei clearly made the strongest impression on the committee, and Roberts, with the approval of the UCAR board, offered him the commission on July 18, 1961. In Pei's favor was his enthusiasm for the project, his demonstrated architectural imagination, his track record with large-scale projects, his mastery of structural concrete, successful recent commissions in Colorado, and a list of satisfied clients, notably Henry Houghton, an MIT meteorologist and chairman of the UCAR board, as well as one of the officials for whom Pei was completing a new Earth Sciences Building at MIT. Against these assets had to be weighted Pei's limited familiarity with laboratory design and his limited experience in rural settings. On balance, Roberts had confidence that Pei could deliver the laboratory NCAR envisioned and would give it the personal attention it deserved.[42] Roberts announced his choice to the staff in one of his informal memos, under the title "Pei in the Sky," a pun he could not resist, even at the cost of mispronouncing the architect's name.[43]

NCAR had its architect, though its architect did not yet have a clear plan. Roberts had some imaginative, if wildly impractical, ideas. Rather than deciding in advance how large the laboratory should be, he and Thompson thought they should "take the top 50 senior scientists they would like to have come to NCAR, figure out what kind of groups, lab, and shop facilities each one would need, and then from that figure out square-foot office, lab, and shop needs for

40. Notes on conversation with Edward Larabee Barnes, 9 Jul 1961, UCAR/NCAR Archives, Collection 8731, Box 1, Folder 16 Edward Larabee Barnes.

41. Notes on conversation with I. M. Pei, 14 Jun 1961, UCAR/NCAR Archives, Collection 850215d, Box 2, Folder Book 15C, Pei corr. 1961.

42. W. O. Roberts, "Choice of Architect for NCAR," 17 Jul 1961, UCAR/NCAR Archives, Collection 8731, Box 1, Folder 12 Architect selection memo.

43. Diane Rabson, UCAR, "Staff Notes Monthly," Feb 1998, http://www.ucar.edu/communications/staffnotes/9802/here.html (accessed 28 Mar 2008).

FIG. 2 North Tower of Mesa Lab. Notice the hoods at the top of the towers, above the entrance, and along the row of small windows. The penthouse laboratory and the clutter of antennas that bothered Pei are clearly visible. Notice also the vertical orientation, the actual scale (as measured by the figures at the base), and the "crow's nest" at the top of the tower. *Source:* Ezra Stoller, Esto Photographics Inc.

each." They told Pei to avoid "conventional patterns" of organizing the laboratory by discipline or by size, and they urged him instead to encourage serendipitous encounters by including "a place to pace" and "nooks and crannies and irregular places where people can wander or sit and think."[44] Their model was the "beehive," without the rigid symmetry. Even the "queen bee" would need

44. T. Papachristou to Henry Cobb, 18 Sep 1961, UCAR/NCAR Archives, Collection 850215d, Box 2, Folder Book 15C, Pei corr. 1961.

some privacy: "People can't see you at work. You have to be able to move around a little, even while people are waiting outside to pounce on you. That's why you need a john in the director's office."[45] Since Roberts had always considered the mesa "a sacred site the ancient Greeks would have envied," what more appropriate model than a modern version of the agora? Papachristou did a rough sketch of the "Grecian village": one-story research laboratories set apart from one another around village squares, with the library at the center.[46] Such a plan would provide the NCAR laboratory the relative isolation and autonomy Roberts and Thompson sought, and would help blend it into the landscape. As Pei politely pointed out, however, it would leave an enormous footprint on the fragile mesa and require a daunting number of stairs, given the mesa's six-percent grade.

Instead of a village, Pei proposed a concrete monolith more akin to his Earth Sciences Building (then under construction at MIT) than anything Roberts and Thompson had in mind, though at nine rather than twenty-one stories. Given Pei's prior experience designing urban high-rises, a tower should have been an entirely predictable first draft.[47] Andrews, Wolff, and Papachristou made a preliminary visit to Pei's New York City office and found him to be a charming host, a careful listener, a "smooth operator," and exasperatingly secretive about plans and costs.[48] Wolff, who had lived through many brutal Colorado winters, suggested that some time on the site would be time well spent: "We have been having this cold, bitter weather for a couple of weeks now . . . a few days of this kind of weather might be good for you in designing the laboratory."[49] Roberts, knowing that anything above $25 per square foot would put the project over budget, pushed for some hard numbers. Pei, in turn, explained that he had "never run into a project that had demanded so much of his time and so many hours of working out," and that NCAR would just have to be patient.[50]

45. Notes on discussion of permanent laboratory among Roberts, Rex, Thompson, Papachristou, and Wolff, 11 Aug 1961, UCAR/NCAR Archives, PSF 1, "NCAR Building File."

46. Diagrammatic plan, Sep 1961, UCAR/NCAR Archives, PSF 1, "NCAR Building File."

47. Wiseman, *I. M. Pei* (ref. 3), 66–67.

48. Ed Wolff to W. O. Roberts, 14 Nov 1961, UCAR/NCAR Archives, Collection 850215d, Box 2, Folder Book 15C, Pei corr. 1961; Mary Andrews and Ed Wolff, interview by Leslie (ref. 17).

49. Ed Wolff to Richard Weinsten, 19 Jan 1962, UCAR/NCAR Archives, Collection 8731, Box 2, Folder 22.

50. Mary Andrews to Files, 25 Dec 1961, UCAR/NCAR Archives, Collection 850215d, Box 2, Folder Book 15C, Pei corr. 1961.

Pei brought his first model to Boulder at the end of January 1962 for a presentation to the NCAR staff. He emphasized the advantages of a tower over a "village" design, explaining how he would give the building a human scale by breaking up the interior space into "houses," one atop the other, connected by semi-circular stairways. He also included "crows' nests" on the top floors—individual retreats with small balconies that could be reached only by enclosed circular staircases. Since Pei did not intend to air-condition the building, except where absolutely necessary, he put hoods on the roofs, kept the windows small, and gave careful attention to shading in order to block the glaring, high-country sun. Pei estimated he could construct the 250,000-square-foot building for $5.6 million.[51]

While the NCAR staff liked the density and complexity of the design, many of them objected to its bulk, its height, and its "air of finality, the sense that the building is not really attached to the mesa."[52] Thompson may have been the most outspoken critic. Convinced that the tower would blot out a view of the Flatirons, he went up on the mesa in the snow to triangulate the visual impact of the building.[53] He told Roberts: "I was disturbed to find that a sizeable fraction of our present scientific staff have rather strong feelings about the kind of buildings they work in, and that their tastes diverge so widely from Mr. Pei's concept of the laboratories."[54] Too imposing a building would end up looking "pretentious" and would force, rather than merely encourage, interaction among different groups, at the expense of seclusion and contemplation, a problem that rearranging space within a single large building could never solve. Theorists, at least, might prefer a "Think Farm," a Spartan retreat some distance from the main building. For Roberts, the biggest concern was that Pei's design would be an all-or-nothing proposition. Uncertainties about projected NSF budgets meant that NCAR would have to consider building the laboratory in stages. Either Pei would have to scale back the design, or come up with something entirely different. As Roberts explained to the staff, NCAR would need to "Pei as you go" or risk ending up going nowhere at all.[55]

51. Report of the Planning Committee meeting, UCAR Board of Trustees, 31 Jan 1962, UCAR/NCAR Archives, Collection 8731, Box 1, Folder 9, Jul 1961–Jul 1962.

52. Daniel Rex to W. O. Roberts, 5 Apr 1962, UCAR/NCAR Archives, Collection 850215a, Box 1, Folder 3082-1-11, 1962.

53. Mary Andrews and Ed Wolff, interview by Leslie (ref. 17).

54. P. Thompson to W. O. Roberts, 10 May 1962, UCAR/NCAR Archives, Collection 850215d, Box 2, Folder Book 15B, Pei corr. 1962.

55. Rabson, "Staff Notes Monthly" (ref. 43).

To solve what it called "The Increment Problem," the NCAR staff took a hard look at its space requirements, group by group and lab by lab. Could NCAR build a facility within the means of the NSF budget that could accommodate 350 people and still be entirely self-sufficient, in case the second increment was never built? Roberts, who got along well with Pei and preferred to avoid a direct confrontation, arranged for Wolff and Andrews to conduct subsequent architectural negotiations. Wolff eloquently explained the self-image to which NCAR hoped Pei could give proper architectural expression: "Not as a tightly controlled organization with all members serving a single goal, but an alliance of independent souls, working in groups of various sizes, and related to other groups in various degrees of closeness (or in some cases, hardly at all), each pursuing separate goals which may or may not overlap or interact—and served by an administration which, in order not to appear to dominate this multi-faceted, diffuse effort, must itself be inconspicuous and decentralized."[56]

For the first time, Pei seemed to recognize that something more would be required than subtle variations on a theme. He rose to the challenge by pulling apart the monolith and reconfiguring it as a series of three five-story towers arranged around a terrace and interconnected by a plaza at ground level, a two-story core building, and a basement underneath. By spreading out the buildings, Pei explained, the different parts of the laboratory "could now talk to each other."[57] The core building housed communal spaces, including the lobby, meeting rooms, cafeteria, and library. The towers had laboratories and offices, with the machine shops and heavy floor-load laboratories (which included computers) in a two-level basement. Though coupled at the core level and in the basement, the towers would be otherwise independent, with clusters of labs and offices "giving each scientific group its own bailiwick."[58] In keeping with NCAR's philosophy of complexity and surprise, Pei kept the corridors short, with small offices, in several sizes, grouped around a central administrative space. On the top floors of the towers he placed the "crows' nests," appropriately austere though with full glass fronts and a tiny perch for inspiring views and a breath of fresh air. Reached by a "castle-keep spiral staircase," the "crows'

56. Ed Wolff to I. M. Pei, 29 May 1962, UCAR/NCAR Archives, Collection 850215d, Box 2, Folder Book 15B, Pei corr. 1962.

57. Minutes of meeting of UCAR Planning Committee with Advisory Committee of Architectural Deans, 1 Aug 1962, UCAR/NCAR Archives, Collection 8731, Box 1, Folder 10 UCAR Planning Committee, Aug 1962–May 1963.

58. Memo, Brief description of NCAR Table Mountain plans, 21 Nov 1963, UCAR/NCAR Archives, Collection 850215d, Box 2, Folder Book 15H, Selection of Architect.

nests" offered all the solitude anyone could ask for. To take full advantage of the site, Pei opened the cafeteria onto an outdoor patio and included a walkway from the staff lounge onto the mesa. The distinctive hoods over the "crows' nests" and the small windows remained as architectural echoes of Roberts's lack of enthusiasm for air conditioning, though the NSF would ultimately insist upon it.[59] For impromptu discussions, Pei added a few small patios at strategic points along the corridors. And with a nod to the Alhambra, which Pei had mentioned to Roberts as a perfect example of a compact, contemplative space, Pei included a courtyard with a central fountain, leading to a tree-lined plaza suitable for private conversations or larger public gatherings. The first increment could accommodate up to 400 people (at an estimated cost of $4.7 million) while the second increment, the south tower, would add sufficient space for 100 more. Roberts declared the new plan "a magnificent solution."[60]

NCAR had hired Pei in part because of his mastery of concrete, and on that score he did not disappoint. From the start, he had considered a number of options for giving the building the feel of the mountains behind it, including leaving the concrete rough from the forms. At Dulles Airport, Eero Saarinen had specified bush hammering to give concrete a completely different look. Pei liked the look, and so he erected a set of test panels on site to gain some direct experience with different finishing treatments and to evaluate color and texture.[61] A pneumatic bush hammer, driving a five-pointed chisel, broke rather than cut the concrete surface, down to a depth of half-an-inch or so, exposing the aggregate underneath and leaving a three-dimensional surface that looked hand-tooled. Bush hammering would be labor intensive and add as much as $200,000 to the construction cost, but it could turn what would otherwise have been reddish brown concrete into something resembling "reconstituted stone." Pei eventually chose a pinkish aggregate from a Colorado quarry, with sand from the same stone for permanent color. Since the bush hammering would be done after the pours, it would visually unify the building with strong vertical lines, and so achieve the monolithic effect Pei sought, without the bulk or height of a single tower. (Fig. 3)

Once the NCAR scientists got a look at the final design, they worried that the recessed windows in their offices would be too narrow, while the floor-to-ceiling

59. Lucy Warner, interview with W. O. Roberts and I. M. Pei, 17 Sep 1985, UCAR/NCAR Archives.

60. Mary Andrews, Notes on meeting with Pei, 14 Jun 1962, UCAR/NCAR Archives, Collection 850215d, Box 2, Folder Book 15B, Pei corr. 1962.

61. Minutes, 1 Aug 1962, UCAR/NCAR Archives (ref. 57).

FIG. 3 NCAR's Mesa Laboratory under construction. Workers at the lower left are bush hammering the concrete for a uniform texture. Compare finished concrete with rough form finish to the right. *Source:* Martin Eby Construction.

corner windows in their laboratories would create glare and heat "and will become covered with aluminum foil as a result."[62] A full-scale mock-up convinced them that their offices would have sufficiently generous views, and air conditioning and tinted glass at least reduced excessive heat and glare. What Pei considered one of the building's architectural signatures, its distinctive flat roofs, the scientists took for granted as just another workspace. Wolff warned Pei, "the appetite of atmospheric scientists for roof space is insatiable."[63] Once the building had been completed, the rooftops would sprout antennas, probes, sensors, domes, and compressors, which in Pei's eyes marred the building's deliberately stark profile. He adamantly opposed the two penthouses that scientists insisted be placed on the main tower roofs for immediate access to observational equipment, though he ultimately allowed one on the north tower.

62. Ed Wolff to I. M. Pei, 7 Nov 1962, UCAR/NCAR Archives, Collection 850215d, Box 2, Folder Book 15B, Pei corr. 1962.

63. Ed Wolff to I. M. Pei, 16 Jan 1963, UCAR/NCAR Archives, Collection 850215d, Box 2, Folder Book 15D, Andrews-Pei correspondence.

Pei presented the plan to NSF in January 1963 in what NCAR called a "masterful" performance. No one challenged the design as eccentric or extravagant, as NCAR had feared; reviewers instead seemed impressed and curious.[64] NSF's decision to cut NCAR's budget caught Pei (though not Roberts) by surprise. A $2 million shortfall meant leaving off the south tower altogether, and bleeding as much cost out of the rest of the first increment as possible. With some creative redesign and strict budgetary supervision, Pei got the project budget to $4.5 million, for a no-frills laboratory of just under 200,000 gross square feet with space for 350 people. At $23.50 per square foot, the building was something of a bargain. Thankfully, the test panels persuaded Pei that, aesthetically, bush hammering was well-worth its cost. To economize, all of the wet lab space went into the east tower and a majority of the offices into the north tower. The proposed conference center fell to the budgetary axe. So did "Thompson's Retreat," though it got a proper send-off as the tail of a celebratory balloon attached to a replica of the final laboratory design, which was launched from Roberts's backyard. Pei later designed a small additional building on the mesa, funded by and named for the Fleischmann Foundation, though it ended up becoming UCAR's headquarters, not the Advanced Study Program that Thompson had originally envisioned.

Martin Eby Construction of Wichita, Kansas, won the bid, and it broke ground for the laboratory in April 1964. In announcing the groundbreaking to the staff, Roberts said: "I firmly believe our building will prove as functionally excellent as it is architecturally distinguished. Mr. Pei has succeeded in achieving an intimate and personal character in the plan, yet at no sacrifice of flexibility and economy. The design is austere and yet bold. It has a diversity of heights and scales that gives it a campus-like quality, and yet all parts of the building are connected at the lowest level . . . I predict that the building will be a source of pride and satisfaction to NCAR."[65] Roberts took genuine delight in watching his building go up. Visitors recalled his forced marches up the mesa in the mud to survey construction progress and explain the design in sometimes excruciating detail. "Walt was a Pharaoh overseeing the construction of his Pyramid!" one recalled.[66]

64. Memo, Site and architectural planning information supplementary to that in the director's report, 8 Jan 1963, UCAR/NCAR Archives, 8731, Box 1, Folder 10 UCAR Planning Committee, Aug 1962–May 1963.

65. W. O. Roberts to NCAR Staff, 4 Jun 1964, UCAR/NCAR Archives, HAO Collection, W. O. Roberts Staff memos.

66. *Remembering Walt Roberts* (ref. 26), 183–84.

Architectural critics generally applauded the design. Speaking more to the laboratory's architectural rather than its scientific style, *Architectural Form* titled its preview "High Mountain Monastery for Research."[67] The staff collected some less flattering descriptions, including "Latter Day Lamasery" (from *The New York Times* science writer Walter Sullivan), "Instant Stonehenge," "Chinese Monument," and "Monolithic Monstrosity on the Mesa."[68] Still, when completed and occupied in 1966, the laboratory gave NCAR the distinct personality Roberts expected from it. Prominent architectural critic Peter Blake called it Pei's "best building to date," and "a sight, as stark and imposing as the view of any medieval monastery on a rock in Catalonia or in Tuscany." He dismissed staff complaints about wind, ice, snow, and glare with the suggestion that at some level they enjoyed braving the elements. As for their comments about the layout itself: "The plan, like all plans for research facilities, is frequently criticized by those who use it; but research scientists are congenitally incapable of predicting their own future needs, and [are] chronic complainers whenever their unformulated needs are not met."[69]

A "MODEL" LABORATORY

Roberts memorably told Phil Thompson, head of the Laboratory for Atmospheric Sciences, that once NCAR grew to 500 people, he would resign.[70] He considered a staff of 300 to be about the right size, and anything larger than that likely to become too bureaucratic for its own good. Architecturally and administratively, dealing with the limits to growth would be perhaps the laboratory's greatest challenge. Generally, the architectural style suited Roberts's managerial style. Roberts ran Mesa Lab as he had run HAO, with a light, personal touch. He continued the tradition of taking his division heads on annual retreats to the mountains. Instead of formal reviews, he preferred keeping up with his scientific staff through occasional informal chats.[71] He spent enough

67. "High Mountain Monastery for Research," *Architectural Forum* 120 (Jan 1964), 82–84.

68. Handwritten notes, NCAR's Permanent Laboratory, [Staff] Notes, Jan 1964, UCAR/NCAR Archives, PFS 1, "NCAR Building File."

69. Peter Blake, "Towers in the Sky," *Architectural Forum* 127, no. 3 (1967): 31–43. Blake's *The Master Builders: Le Corbusier, Mies Van Der Rohe, Frank Lloyd Wright* (New York: Knopf, 1960) is still one of best surveys of its subjects.

70. *Remembering Walt Roberts* (ref. 25), 102.

71. Earl Droessler, interview by Warren Washington, 8 Oct 1990, UCAR Tape 73–74, pp. 2–3.

time in the shop to earn an honorary "Instrument Maker V," searched out a new group to eat lunch with each day, tried his best to remember an ever-growing list of staff names, and made parking "first come, first served," for employees regardless of job title.[72] He arranged string quartet concerts in the lobby and took questions for the staff from the musicians. He could not convince many of the senior scientists to work in the "crows' nests" (they complained of too much wind noise and said that the spaces were often too hot, too cold, and too isolated), so the postdoctoral fellows got them. Pei pronounced the "crows' nests" to be a success, to which Roberts replied, only half in jest, "It also proves that scientists can work anywhere."[73]

Not everything worked according to plan, of course. Buffeted by fierce Colorado winds, the fountain at the center of the Alhambra-inspired courtyard sprayed passers-by in summer, left sheets of ice in winter, leaked into the workspaces below, and had to be shut off entirely. What Pei imagined as a vibrant Mediterranean courtyard ended up being all but deserted most of the time. On pleasant days, the tree plaza could be an inviting place for lunch or conversation and a site for special events, though the wind could often be uncomfortably strong. Pei, invited to share his recollections with laboratory members, could hardly hear the questions above the wind noise. The tree plaza also leaked and had to be rebuilt and replanted. The "weather-proof" membrane on the flat roofs failed and some of the concrete cracked. People did not circulate vertically in the towers, as Roberts had expected, but instead oriented themselves horizontally, along the hallways. The nooks and crannies Pei placed at random intervals for casual conversation got little use. Even the library, a space that Robert considered especially striking and a natural meeting space, ended up being "grab and go," and with increasing reliance on electronic resources it attracted less and less traffic. The cafeteria, on the other hand, provided just the kind of social space for spontaneous conversations that Roberts thought it would.[74]

One of the architects Roberts first consulted about the Mesa Lab had confidently assured him that while "calculating machines" might need some space, "they will never replace the slide rule."[75] Roberts knew better, but even he could

72. Mary Wolff, in *Remembering Walt Roberts* (ref. 25), perfectly captures the Roberts style (pp. 207–11).

73. Interview with W. O. Roberts and I. M. Pei (ref. 59).

74. "Essays—I. M. Pei, Program for a Building," film, I. M. Pei Collection, Library of Congress, Box 40.

75. Harry Weese, "Philosophy for NCAR's Architect," undated, UCAR/NCAR Archives, Collection 8731, Box 1, Folder 14 Harry Weese and Associates.

not imagine how much computer models, and the increasingly powerful machines required to run them, would redefine the study of the atmosphere and in turn transform Mesa Lab.[76] Even the fastest computers could not keep pace with the increasing complexity of the models needed to understand atmospheric and ocean circulations and general climate change. Ultimately the computers ended up costing more than the laboratory itself. The staff needed to administer and operate the computers and to analyze the data grew from forty people when Mesa Lab opened to more than a hundred twenty years later.[77] As they became increasingly powerful, computers required more and more space, including a 15,000-square-foot underground addition in the late 1970s and a second annex in the mid-1980s. A laboratory envisioned for conventional atmospheric chemistry and meteorological observation increasingly became a virtual laboratory, whose Community Climate System Model was available worldwide.[78] In one sense, then, the best view at NCAR may have been from the basement. (Fig. 4)

Mesa Lab embodied the contradictions of complexity, architecturally and scientifically.[79] Like other national laboratories, such as the Stanford Linear Accelerator Center or Fermilab or the NIH, NCAR had to weigh its in-house research program against the demands of its external constituencies, which competed as well as collaborated with NCAR's scientific staff. It had to reconcile its founding vision of small teams of self-directed researchers with increasing pressure for more tightly focused and formally managed research projects. It had to grow beyond the limits of its signature laboratory while trying to preserve the sense of community the building sought to encourage. In defining atmospheric science, it had to think globally and act locally. It had to decide what NCAR could do on its own, what it should do collaboratively, and what it must leave to other laboratories. Architectural photographer Ezra Stoller,

76. Frederick Nebeker, *Calculating the Weather* (New York: Academic Press, 1995), provides the best history of the "Computer Era" in meteorology.

77. Paul Rotar, "The Evolution of Supercomputing at NCAR," NCAR report, 10 Mar 1989, reference courtesy of Roy Jenne.

78. Climate and Global Dynamics Division, "CGD Modeling: WACCM," NCAR, Earth and Sun Systems Laboratory, http://www.cgd.ucar.edu/research/ (accessed 28 Mar 2008).

79. Robert Venturi's *Complexity and Contradiction in Architecture* (New York: Museum of Modern Art, 1966), one of the defining manifestos of post-modernism, argues for the uniquely complex architectural problems of contemporary architecture, citing the research laboratory and the hospital. Venturi would later have the opportunity to put his preaching into practice at the Lewis Thomas Laboratory at Princeton University. See Gieryn, "Two Faces on Science" (ref. 6), 27.

FIG. 4 Chemistry laboratory at NCAR. Designed as wet labs for small teams of conventional atmospheric chemists, these laboratories would become increasingly obsolete in an era of satellite imaging and computer modeling. *Source:* Ezra Stoller, Esto Photographics Inc.

who could read people as well as he could read buildings, sensed the toll this balancing act took on Roberts:

> The National Center for Atmospheric Research (NCAR) was for me a job of special significance. About twenty years earlier, while doing a story on cosmic rays for *Fortune* magazine, I met a young solar scientist who was living with his family, including an infant, in a makeshift structure on the grounds of the Climax Molybdenum Company. We became friends and I enjoyed a pleasant few days with one of the brightest people I ever met. So I looked forward with pleasure to meeting Walter Orr Roberts again. While he still seemed to be wearing the same Sears Roebuck suits, the many battles he'd had to fight and the stress and strains of God-knows-what sort of administrative infighting had toughened him considerably.[80]

Roberts stepped down in 1973 and joined the Aspen Institute as the head of its program in science, technology, and humanism.[81] To honor him, and over

80. William S. Saunders, *Modern Architecture: Photographs by Ezra Stoller* (New York: Harry N. Abrams, 1999), 156.

81. James Sloan Allen, *The Romance of Commerce and Culture* (Chicago: University of Chicago Press, 1983), captures the founding spirit of the Aspen Institute.

his objections, the UCAR trustees placed a small bronze plaque to the right of the laboratory's main entrance bearing a photograph of Roberts and the Latin phrase, borrowed from architect Christopher Wren's epitaph in St. Paul's Cathedral, "Si Monumentum Requiris, Circumspice": roughly, "If you seek his monument, look around." Roberts did not want Mesa Lab to become a monument, and certainly not a monument to him. All the same, the laboratory gave atmospheric science national visibility. Its idiosyncratic style seemed fitting for a scientific maverick. It became an icon for NCAR that transcended, without diminishing, its importance as a scientific workspace. NCAR survived, and even thrived, under subsequent directors. It became a world center for atmospheric chemistry (especially collecting and identifying trace gases) and for global climate modeling. For better or worse, Roberts's style—"working in small groups, with a wide-open door to the world"—left a permanent mark that administrative reorganizations could not entirely erase.[82] So deeply embedded in NCAR is the Roberts philosophy that perhaps only an entirely new laboratory could dislodge it, and at the risk of destroying the "subtle cement" that has held it together all these years.

JONAS SALK'S "MODERN MONASTERY"

Jonas Salk would never win the Nobel Prize that the public, if not the scientific community, thought he deserved. But he and Louis Kahn would together envision and build a laboratory that would attract and nurture a dozen Nobel laureates. (Fig. 5) Salk took as his model the monastery, perhaps the earliest planned community and a place of retreat for the select few. Deliberately elitist, the Salk Institute would free its half dozen or so fellows from grant-writing, teaching, and administrative distractions. As masters of their own laboratories, the fellows could set independent research agendas. Salk, directly inspired by the cloister of St. Francis of Assisi and by its *carceri* (cells), provided the fellows with individual studies, places for reflection connected to, yet buffered from, the bustle of laboratory life. The Institute was intended to be supported by private philanthropy rather than the public purse, and it would hold its fellows accountable only to their colleagues in the scientific community, not to any

82. Wolff, in *Remembering Walt Roberts* (ref. 25), 108.

FIG. 5 The Salk Institute from the west. The studies, arranged so that each has an unobstructed view of the Pacific, flank the courtyard, connected to the laboratories by staircases visible on the far right. The watercourse empties into the pool just below the center of the courtyard. *Source:* Ezra Stoller, Esto Photographics Inc.

government agency.[83] As a physician, Salk expected significant medical breakthroughs from his Institute, but he thought direct oversight would be counterproductive.

As for the architect to whom Salk would turn, Louis Kahn was an equally articulate advocate of monastic models for science. Above all, Kahn's Richards Medical Research Building (1960) for the University of Pennsylvania School of Medicine put him on the architectural A-List, attracting critical attention to a laboratory as nothing else had since Frank Lloyd Wright's Research Tower for S. C. Johnson Wax and Eero Saarinen's General Motors Technical Center a decade earlier.[84] Vincent Scully, an early champion of Kahn, proclaimed the

83. In their respective views on the public engagement of the laboratory, Roberts and Salk echoed a longstanding debate between the active life and contemplative life of science, highlighted in Owen Hannaway, "Laboratory Design and the Aim of Science: Andreas Libavius versus Tycho Brahe," *Isis* 77, no. 5 (1986): 585–610, and subsequently challenged by Jole Shackelford, "Tycho Brahe, Laboratory Design, and the Aim of Science: Reading Plans in Context," *Isis* 84, no. 2 (1993): 211–30.

84. Brownlee and De Long, *Louis I. Kahn* (ref. 9), 435. See also Leslie, *Louis I. Kahn* (ref. 9). Leslie devotes a full chapter to the Richards Medical Research Building, with special attention to its structural innovations.

Richards Medical Research Building "one of the greatest buildings of modern times."[85] And Philip Johnson organized a rare "one-man/one-building" show at the Museum of Modern Art for what curator Wilder Green agreed was "probably the single most consequential building constructed in the United States since the war . . . simultaneously a building and a manifesto."[86]

Kahn had come to the Richards Building having completed almost nothing of consequence. He had nevertheless built a cult-like following among his graduate students at Yale and Penn, drawn to his enigmatic philosophy that was often framed as memorable aphorisms ("what a building wants to be"), unexpected juxtapositions ("silence and light"), and thought-provoking syllogisms ("science finds what is already there, but the artist makes that which is not there"). Architecturally, he grouped laboratories with churches, schools, monasteries, and other "houses of inspiration." Thus monasteries, for Kahn, too, represented the ideal space for learning and teaching. He had studied monastic design in some detail, visiting and sketching some famous examples, including Assisi, and would later design two monasteries of his own.[87] Scientists, like architects, he believed, needed spaces of contemplation. "Science laboratories," he wrote, "are essentially studios."[88]

That idea was his guiding principle for the Richards Building, as it would be for the Salk Institute. His realization of the idea points equally to his visionary imagination and the practical difficulties that followed in its train. Given the crowdedness of the Penn campus and only a small footprint for the building, Kahn had turned the prevailing idea of the laboratory on its head, or, more correctly, on its side. Virtually all postwar laboratories had a horizontal orientation, with long corridors where, Kahn complained, "the only distinction between one man's spaces of work from the other is the difference of the numbers on the door." Instead, Kahn arranged the Richards laboratories in three eight-story towers hung off a taller, central tower, "the spinal column to the stacked pavilions around it."[89] On the advice of his newly hired structural engineer, August Komendant, Kahn replaced conventional steel I-beams with a

85. Alex Soojung-Kim and Preston Thayer, "Alfred Newton Richards Medical Research Building, University of Pennsylvania," in Brownlee and De Long, *Louis I. Kahn* (ref. 9), 435.

86. Wilder Green, "Louis I. Kahn, Architect: Alfred Newton Richards Medical Research Buildings," *Bulletin of the Museum of Modern Art* 28, no. 1 (1961): 3.

87. Brownlee and De Long, *Louis I. Kahn* (ref. 9), 151–53.

88. Alessandra Latour, ed., *Louis I. Kahn: Writings, Lectures, Interviews* (New York: Rizzoli International Publications, 1991), 118.

89. Ibid., 119.

grid of interlocking concrete columns, girders, and trusses. Structurally, the cantilevers opened up the floors of the laboratory "plates" so that, at least in theory, each studio would have a clear span of forty-five feet, with glass on the corners where a structural column otherwise would have been.[90] Aesthetically, Kahn offset each of the studio towers so the scientists had views of one another and of the surrounding campus, in line with his notion that "the scientist works alone or in a small group, but may require psychological and actual contact with other groups."[91]

Future occupants seemed less enthusiastic than architectural critics and structural engineers, who may have appreciated the brilliance of the design but did not have to live in it. The scientists found their "studios" awkward and uncomfortable. They fought excessive heat and glare with screens, blinds, insulating board, and aluminum foil (just as Wolff had warned Pei the NCAR scientists would do).[92] The scientists may have been able to see one another, but they worked in solitary confinement. Kahn's design paid more attention to the circulation of air and exhaust than it did to the circulation of people, within their individual laboratories, from floor to floor, or from tower to tower. Komendant, who heard many of these complaints first-hand, vividly recalled the scientists' impression "that Kahn had designed a monument for himself but not a functional laboratory building."[93] All the same, with the Richards Building, Kahn made the leap into the first rank of architects of scientific spaces, attracting wide attention, including eventually Salk's.

"THE GREAT NEW DREAM OF DR. SALK"

To a grateful nation, Jonas Salk was the crusading physician who had beaten polio. He was the face on the cover of *Time* magazine, the man whose vaccine had proven, after "the biggest public health experiment ever," to be "safe, effective,

90. August Komendant, *18 Years with Architect Louis I. Kahn* (Englewood, NJ: Aloray Publishers, 1975), explains Kahn's design for the Richards building in clear detail.

91. Green, "Louis I. Kahn, Architect" (ref. 86), 4.

92. William H. Jordy, *American Buildings and Their Architects*, vol. 4, *The Impact of European Modernism in the Mid-Twentieth Century* (Garden City, NY: Doubleday, 1972), 410–20. Jordy details the laboratory's design flaws. Jordy, whom Kahn consulted on the Salk Institute, concluded his survey with an entire chapter, generally laudatory, devoted to the Richards Medical Research Building.

93. Komendant, *18 Years* (ref. 90), 19–20.

and potent."[94] Whether he shunned publicity, as some claimed, or sought it out, as others insisted, Salk became the most famous medical researcher of his generation, as much a poster child for the March of Dimes, his biggest financial backer, as the iconic images of polio survivors it had so creatively fashioned. Fellow virologists may have considered Salk's contribution a triumph of virus typing and testing rather than as any real scientific breakthrough, but that did nothing to tarnish Salk's scientific celebrity.

Salk had come to the University of Pittsburgh in 1947 to head its virology laboratory, part of an ambitious steeple-building program launched by the university's new dean of medicine, William McEllroy. The medical school had bold plans but few resources, and Salk quickly discovered that his laboratory would be a bootstrap operation. Befitting a self-made man, Salk embraced the blue-collar science so central to developing successful vaccines. From his basement empire in the Municipal Hospital for Contagious Diseases, in space cobbled together from the abandoned wards, an old morgue, and other unclaimed real estate, Salk built one of the best-funded and most respected laboratories of its kind. There he and his growing staff undertook the tedious and time-consuming task of identifying the separate strains of the polio virus. There they perfected the art of growing the polio virus in tissue cultures. And there Salk's team developed the killed-virus vaccine that would secure his medical immortality.[95] It was a "factory," as one technician described it (aptly enough, given its scale and routine), though "monkey business" would have been equally accurate (given the 500-member colony essential for the typing studies). Salk's laboratory was strictly business: no seminars, no brown bag lunches, and little mentoring. It was an autocratic organization whose boss "would speak to us through a wall of notes and memos" and often take more credit than his assistants considered appropriate.[96] But even if the pace was considered punishing, Salk's laboratory got the job done, and ahead of its rivals.

With polio effectively vanquished by 1957 (though the debate over live versus killed-virus vaccines would continue for decades), Salk faced a tough question—what to do next. Thanks to the March of Dimes, he had the resources.

94. David M. Oshinsky, *Polio: An American Story* (New York: Oxford University Press, 2005); and Jeffrey Kluger, *Splendid Solution: Jonas Salk and the Conquest of Polio* (New York: Putnam Adult, 2005), are the best and most recent accounts, each placing a strong emphasis on the "race" between Salk and Albert Sabin, who championed a live virus vaccine.

95. Oshinsky, *Polio* (ref. 94), 108–17, carefully describes the start-up and growth of Salk's Pittsburgh lab.

96. Ibid., 174–75.

"What is needed," he mused, "is not more money—but having money in the right places and for the right things—and especially sanctuaries where green birds can migrate and lay their eggs and hatch their young—a place to work in peace and not have time broken by all sorts of distractions."[97] Like so many academics, Salk hoped to turn his fame into freedom from deadlines, bottom lines, and research agendas imposed by others. The polio project had been rewarding professionally, but it had often necessitated sixteen-hour days and seven-day weeks, as taxing to Salk as to his staff. Salk dreamed of organizing his own Institute of Experimental Medicine, and in May 1957, he drew up what he called its "Magna Carta." He gave it the loftiest of goals, not merely to cure disease but to address "the problems of humanity that are the most important of the day." Perhaps in reaction to the packinghouse model of the vaccine laboratory, he imagined an alliance of like-minded colleagues who valued "the freedom, integrity, and independence of the individual," at a scale that would preserve "flexibility and freedom" and reward "boldness and courage." Unlike traditional research institutes, this one would include humanists as well as scientists, who had "a deep understanding and feeling for the problems of each other, and for the problems of humanity."[98] Its senior members would be fellows for life, a self-governing body able to devote its attentions not only to pressing matters of health and disease, but also with "unencumbered time for contemplation and for action."[99]

Salk, however, doubted that such an unconventional idea would find a home in a conventional medical school.[100] He received excellent counsel from his long-time colleague, the psychiatrist Henry Brosin, who offered some shrewd observations on the group dynamics Salk should anticipate and plan for. Brosin stressed the importance of clear purpose, collective identity, and solitude. "We are only now beginning to comprehend the enormity of the forces released in silence, isolation, and loneliness," Brosin told him. "A cocktail party or a country club dance may at first be thought to be a much freer setting for emotional interaction than a lonely study, but the constraints imposed in the former are

97. Jonas Salk, "Ideas for Salk Institute," undated but circa 1957, SP, MSS 1, Box 334, Folder 9.

98. Jonas Salk, Memo to the file, undated, SP, MSS 1, Box 344, Folder 1.

99. Jonas Salk, "Suggested Additions to Foregoing for Consideration at Meeting of February 22, 1958," 22 Feb 1958, SP, MSS 1, Box 344, Folder 3.

100. News release, "Pitt Appoints Advisory Committee for Top Research Institute," 18 Jan 1958, SP, MSS 1, Box 344, Folder 3. See also Oshinsky, *Polio* (ref. 94), 257–61. Oshinsky provides a close look at local politics at the University of Pittsburgh.

extremely powerful."[101] Instead of worrying about the details of who and where and how much, he advised, Salk should keep his eye on the big picture: "A research institute is a human stage where the actors play out their inner lives, each in his own way." The appropriate balance of communal and solitary life would profoundly shape Salk's vision for his Institute.

Salk realized that his connections with the March of Dimes and his celebrity status would open doors almost anywhere. Even rumors of the Institute brought inquiries from a dozen cities. Salk toured prospective sites during the summer of 1959, with Palo Alto and San Diego at the top of his list. Palo Alto had Stanford University, which had a revitalized medical school, a pair of recently recruited winners of the Nobel Prize in the biomedical field, Joshua Lederberg and Arthur Kornberg, and an aggressive provost, Frederick Terman, who was determined to turn Stanford into the Harvard of the West.[102] San Diego had approval for a major new campus of the University of California, the world-class Scripps Institution of Oceanography, and a growing high-technology industry anchored by General Dynamics. Moreover, San Diego mayor Charles Dail and local boosters had a goal that Salk could heartily endorse: "Let's Make San Diego the Scientific Capital of the World."[103] Mayor Dail, a polio survivor, also had a personal stake in convincing Salk to select San Diego. He offered Salk a choice of the city's best real estate and sold voters on a complicated proposal that gave Salk twenty-seven breathtaking acres of shoreline adjoining Scripps and the future campus of the university.[104] Much as Boulder had done with Roberts at Table Mesa, San Diego clinched the deal by offering Salk a prime parcel of the Torrey Pines Mesa, a spectacular, if architecturally challenging, site of cliffs and canyons, which gave an unmatched view of the Pacific.

Privately, Salk conceded that he did not yet have a staff, a board of trustees, a firm research program, or secure funding beyond start-up money pledged by the March of Dimes. What he did have, he told himself, was the kind of setting "I have cherished for many years. The proposed opportunity in California

101. Henry Brosin to Jonas Salk, 27 Jan 1958, SP, MSS 1, Box 344, Folder 3.

102. Rebecca Lowen, *Creating the Cold War University: The Transformation of Stanford* (Berkeley: University of California Press, 1997), gives the best overview of Stanford's rise to national stature.

103. Neil Morgan, *Westward Tilt: The American West Today* (New York: Random House, 1961), 26–41, provides a firsthand account of science and industry in postwar San Diego. See also Frederick Whitney to Jonas Salk, 10 May 1960, SP, MSS 1, Box 369, Folder 9.

104. Nancy Scott Anderson, *An Improbable Venture: A History of the University of California, San Diego* (La Jolla, CA: UCSD Press, 1993), details the complicated and often contentious negotiations between Salk and the city.

promises to make that cherished idea a reality. This is not an offer; it is a man's dream."[105] To sell the idea to San Diego voters, Salk needed something more than promises and a prospectus. As a public relations man assigned to the project reminded him, "the name Salk is almost magical . . . In the minds of the public, an institute, and the concept behind it tend to be vague intangible ideas. A person, however, is quite real and understandable to the public."[106] Calling it the Salk Institute, rather than the Institute for Biological Studies, would give it instant brand-name recognition.

For Salk, biomedical research at its best was exemplified by the Rockefeller Institute. The Rockefeller Institute succeeded by recruiting top people and funding them generously.[107] Following the Rockefeller Institute's example, Salk would build his institute "around individuals, rather than subjects or departments," focus on fundamental research, and trust it would eventually lead to significant medical applications. "A shot in the light," Salk called it.[108] Salk also recognized that his Institute's future depended on convincing Nobel-caliber scientists to leave established universities and join the equivalent of a venture capital laboratory. He sought advice from Leo Szilard, whose shift from physics to molecular biology and his attention to the social consequences of science seemed to Salk the very model of the scientist he should be after.[109] Salk methodically tracked his quarry—Seymour Benzer at Purdue, Melvin Cohn at Stanford, Renato Dulbecco and Matt Meselson at Caltech, Edwin Lennox at NYU, Herman Kalckar at Johns Hopkins, Theodore Puck at Colorado. Some had strong opinions about other names on Salk's list—Dulbecco, "a bit cynical"; Benzer, "playing it safe"—and others questioned the value of making humanists full fellows, unless the scientists chose them.[110] Still, everyone shared Salk's enthusiasm for a self-governing laboratory sufficiently well-funded that its staff would not have to chase research grants. Salk did remarkably well at recruiting. His first Resident Fellows included Cohn, Dulbecco, Benzer, and Lennox along with Jacob Bronowski as resident humanist, and Francis Crick,

105. Jonas Salk, "Summary Statement—Confidential," undated, SP, MSS 1, Box 369, Folder 9.

106. Frederick Whitney to J. Salk, 6 May 1960 and 21 May 1960, SP, MSS 1, Box 369, Folder 9.

107. J. Rogers Hollingsworth, "Institutionalizing Excellence in Biomedical Research: The Case of the Rockefeller University," in *Creating a Tradition in Biomedical Research*, ed. Darwin Stapleton (New York: Rockefeller University Press, 2004), 17–63.

108. "Facts About the Salk Institute for Biological Studies," undated, KC, 030.11.A107.27.

109. Minutes at time of conversation with Szilard, 3 Oct 1959, SP, MSS 1, Box 344, Folder 1.

110. Jonas Salk to M. Meselson, 7 Jul 1960, KC, 030.11A107.24. See also Bill Glazier to Jonas Salk, "Subject: Matt Meselson," SP, MSS 1, Box 345, Folder 5.

Jacques Monod, and Leo Szilard as Non-Resident Fellows, to add luster and offer guidance.

Warren Weaver, vice-president of the Rockefeller Foundation and an early and strong supporter of molecular biology, agreed to serve as the chairman of the Institute's board, bringing to it invaluable administrative experience. At the Institute's first meeting, Weaver told the founding Fellows that collectively they had a unique opportunity to "free ourselves from the inertia of past educational institutions" and from the "burden of tradition" carried by universities.[111] Weaver prepared the official announcement of the Institute for *Science*, which praised its freedom and flexibility, its long-term perspective, and its interdisciplinary character, a spearhead for "the conquering forward surge of biology" that would define the next scientific era.[112] *Life* gave the "The Great Dream of Dr. Salk" lavish coverage, with plenty of photographs of Salk at his summer retreat ("a jaunty sailor and cautious skier") and praised the Institute as "an intellectual venture almost without equal in the history of science."[113]

To bring life to his vision, "to serve and to celebrate the process of creativity," Salk needed an architect.[114] Almost by accident, he found exactly the right man for the job. Salk had learned about Louis Kahn from two friends who had heard Kahn discuss the Richards Medical Research Building in a panel on "The Arts and the Artist and Society" hosted by the Carnegie Institute of Technology in October 1959. Kahn had appeared with the composer Aaron Copland, the astronomer Harlow Shapley, and others in a memorable session moderated by literary critic Lionel Trilling.[115] Salk went to meet Kahn in Philadelphia that December and toured the Richards Building, which was still under construction. The Richards Building was about the right scale Salk sought for the Institute in La Jolla, and if its urban character did not immediately impress him, its underlying philosophy did. As Salk later recalled, "Our discussion convinced me . . . that Kahn was the architect who understood the concept and could create an architectural statement which would convey this."[116]

111. Summary of Organizational Meeting of the Salk Institute for Biological Studies, 19 May 1962, SP, MSS 1, Box 345, Folder 4.

112. Warren Weaver, "Institute for Biological Studies at San Diego," 1 Jun 1962, SP, MSS 1, Box 345, Folder 4.

113. Albert Rosenfeld, "The Great Dream of Dr. Salk," *Life*, 8 Feb 1963, 78–90.

114. Jonas Salk, "The Architecture of Reality," 5 Apr 1984, SP, MSS 1, Box 651, Folder 15.

115. Program for "The Arts and the Artist and Society," Carnegie Institute of Technology, 9–10 Oct 1959, SP, MSS 1, Box 373, Folder 6.

116. Jonas Salk to John Holbrook, 22 Apr 1966, SP, MSS 1, Box 369, Folder 2.

Salk considered the Richards Building confining, with too little separation among research groups. He did, however, appreciate the studios and how they echoed the contemplative world of the monastery that would become the model for his institute. Salk had visited Assisi in 1954, and he romanticized his recollection of how "the spaces, the play of light and shadow, the colors, and the very stones" had opened his eyes to new ways of producing his polio vaccine.[117] "I remembered the cloister there," he said, "and I conveyed to Kahn the idea that this is what I would like—the cloistered garden."[118] The monastery at Assisi had moved Kahn as well. He had visited, studied and sketched it thirty years earlier, telling architectural historian William Jordy, who would later warmly applaud the Richards Building, that he was considering a return visit to "Northern Italy, to see again the wonderful monasteries which have a bearing on what I am doing for Dr. Salk in San Diego."[119] Sensing a kindred spirit, Salk invited Kahn to join him in La Jolla in early February 1960 to size up the site. Kahn sketched it in some detail, taking special note of the lay of the land, its ravines and cliffs, and its striking colors.[120]

Kahn's first model drew heavily on the Richards Building—far too heavily for Salk's taste. Kahn's two clusters of towers seemed as much at odds with its site as Pei's original tower, an architectural conceit dwarfed by the landscape. Encouraged by Salk to think of the Institute as a community, not merely a laboratory, Kahn included residences on either side of the canyon, and a meeting house overlooking the cliffs nearest to the ocean. Salk appreciated the larger concept, but he told Kahn to rethink the details, especially the laboratory complex. He thought Kahn would better understand what the scientists expected from their laboratories if he met some of the future Fellows in their current laboratories, where they would have a chance to "communicate to him ideas for [their] laboratory on an as-if basis."[121]

For Kahn, the architecture had to express Salk's philosophy, to "convey a way of life."[122] Serious architects had rarely designed laboratories and consequently

117. Norman Koonce, "Erasing the Boundary Between the Physical and the Spiritual," *AIA Journal of Architecture*, July 2006, http://www.aia.org/nwsltr_aiaj.cfm?pagename=aiaj_a_20050730_from_the_ceo (accessed 3 Mar 2008).

118. Ester McCoy, "Dr. Salk Talks About His Institute," *Architectural Forum* 127, no. 5 (1967): 31–32.

119. Louis I. Kahn to William H. Jordy, 1 Aug 1960, KC, 030.11 A 9.8.

120. Daniel S. Friedman, "Salk Institute for Biological Studies," in Brownlee and De Long, *Louis I. Kahn* (ref. 9), 330, 338.

121. Jonas Salk to Matt Meselson, 1 Jul 1960, KC, 030.11A 107.24.

122. Louis I. Kahn to Jonas Salk, 14 Aug 1961, SP, MSS 1, Box 369, Folder 2.

had made little progress in improving them. "It is the intent to develop spaces more appropriate to the ways of science and to evoke a will to work, discuss, and study," Kahn wrote in his early notes on the project.[123] As he revised his plans over the following year in light of Salk's criticisms—some of which were sufficiently harsh that a "telephone conversation with Dr. Salk was so upsetting that Mr. Kahn was unable to work effectively for three days"—Kahn came up with a plan that matched Salk's ambitions.[124] Kahn divided the project into three elements, each with its distinctive purpose and form: the Laboratory Group, the Meeting House Group, and the Residences. The monastic character of the spaces, as specified by Salk and interpreted by Kahn, came across most clearly in his early "abstract" for the complex.

The laboratories would be divided into enormous open workspaces, which emphasized "the architecture of the clean air" (or "the pipes"), and studies, which emphasized "the architecture of the oak table and the rug." The studies invoked an image of the humanist studio familiar to Salk from his knowledge of Johannes Vermeer's paintings such as "L'Astronomie" and "Le Géographe." Salk paid particular attention to the character of the studies, places he described as "private rooms for contemplation and work, free from distractions and from outside activities," isolated from the laboratories and arranged above a colonnade "as a necklace adorning the outside of the buildings and also the periphery of the garden."[125] Each would have chairs, sofas, bookcases, chalkboards, a private toilet, and a stunning view. In the center of the gardens would be a plaza, modeled, like Pei's, on the Alhambra's Patio of the Lions.[126] (Fig. 6)

The Meeting House would be the center of this secular priory: it would be the place for conversation, reflection, and recreation, "the building which symbolizes the purposes of the Institute," according to Kahn. It would include a communal dining room (the secular refectory) a library, seminar rooms, an auditorium, a gymnasium with exercise machines, steam rooms, a sundeck, and a residence for the director (the secular prior). The Meeting House would have its own ambulatory, with a pool at the entrance leading along a watercourse to a fountain and to a shaded grove. Across the canyon would be a group of residences, which would hold as many as fifty short-term visitors. For Kahn and Salk, the Laboratories and the Meeting House defined one another: the Laboratories

123. Louis I. Kahn, notes, undated, KC, 030.11.A.27.6.

124. Charles Wilson, Summary of meeting with Louis Kahn in Philadelphia, 28 Dec 1961, SP, MSS 1, Box 358, Folder 9.

125. Jonas Salk to Louis I. Kahn, 8 Aug 1962, SP, MSS 1, Box 358, Folder 9.

126. Mary Harrington Hall, "Gift from the Sea," *San Diego Magazine* (Feb 1962), 43.

FIG. 6 The "architecture of the oak table and the rug" exemplified in one of the Salk studies, with oak paneling and teak shutters. The modernist furniture completes Kahn and Salk's vision of the scientist as humanistic philosopher. The open book near the chair and ottoman, obviously staged, suggests the contemplative mood Kahn had in mind, though the room is appropriately empty, since few active researchers saw any reason to retreat to their studies. *Source:* Ezra Stoller, Esto Photographics Inc.

for independent discovery, the Meeting House for collective reflection. These spaces drew attention to their shared belief in "the importance of the Question and not the preoccupation constantly with answers."[127]

Bronowski, as resident humanist, had Alexandrian ambitions for the library. He wanted to see, in the care of a young historian of science, a superlative collection focused on biology, evolution, psychology, linguistics, philosophy, and, of course, the relationship between science and the humanities. The library, he imagined, could also become a repository for "living history" (recorded autobiographies of distinguished scientists) and a laboratory for "the new technology" of library science.[128] Salk, for his part, thought a small reference library would be sufficient, as long as it included a collection of detective fiction. "After intense, severe work," he explained, "the mind was still busy with daily problems and the only way to stop it was to read [about] 'bloody criminals.'"[129]

127. Louis I. Kahn, "Abstract of Architectural Program for the Salk Institute for Biological Studies," undated, KC, 030.11.A.27.16.

128. J. Bronowski, "Expansion of the Library," Apr 1968; and Douglas Bryant to J. Slater, 20 Apr 1968, KC, 030.11.A.26.36.

129. Komendant, *18 Years* (ref. 90), 44.

Kahn's second plan, perhaps driven as much as anything by Salk's insistence that each Fellow have equal laboratory space, turned the original towers into four two-story buildings. As he had done with the Richards Building, Kahn clearly defined "served" and "servant" spaces: service towers sat along the outside of each laboratory; studios overlooked the gardens on the opposite side; and the laboratories sat in between, with animal quarters and storage space in the basement. For maximum flexibility, Komendant, working with Kahn on the project, designed a structural system of pre-cast and pre-stressed concrete trusses and folded plates that could support the laboratories almost entirely as a clear span, while leaving plenty of space for running utilities between the floors.[130] The service lines could then be dropped down from the ceiling at any point. Kahn called the upper laboratory a "loft space" because portable lab benches and partitions made it possible to subdivide it into any imaginable configuration, from "the smallest cubicle up to 17,220 square feet."[131] The design's only weakness was cost.

Salk often described the laboratory as having a life of its own: "We have approached our building as a living organism of concrete, machinery, and steel pipes. Like a living organism, its working space, supplied by a heart, lungs, blood vessels, and nerves, is capable of differentiation in response to evolving needs."[132] But a laboratory runs on money, and Salk was running out of it. The March of Dimes had expected Salk to raise matching funds, and that prospect began to look far more difficult than Salk had anticipated. The George Fuller Company, the general contractor, pushed to cut costs and urged Salk to consider hiring another architect.[133]

Salk later claimed that he had an epiphany about how twin laboratory buildings, joined by a single garden, would be more visually powerful than the four-lab arrangement, and so asked Kahn for another plan, with two buildings instead of one. That Salk had had this epiphany may well have been true, but serious questions about construction budgets and deadlines surely forced his hand.

Turning a potential crisis to an advantage, Kahn redesigned the laboratory from the ground up, keeping its best features while significantly reducing its total cost. Kahn and Komedant came back with plans for a matching set of

130. Leslie, *Louis I. Kahn* (ref. 9), 138–144, explains the design clearly. Komendant, *18 Years* (ref. 90), offers a personal perspective (pp. 44–48).

131. Notes, KC, 030.11.A.27.16.

132. SP, MSS 1, Box 345, Folder 6.

133. Komendant, *18 Years* (ref. 90), 47–49.

three-story laboratories, slightly wider and longer than the originals. Giant Vierendeel trusses opened up the laboratories to take on football-field dimensions and left nine feet of service between floors. Five massive service towers flanked each of the laboratories on the outside, which were balanced by the study towers directly opposite. The studies, thirty-six in all, were set off from the main building by bridging stairways, which had a saw-tooth arrangement that offered ocean views for all. The "portico of studies," as Kahn called it, had an open walkway at ground level and so provided a cloister for the courtyard.[134] Always attentive to light, Kahn gave the laboratories glass walls and controlled the Southern California glare with a careful placement of overhangs and walls. He dropped the third laboratory below ground to meet local zoning restrictions, with light wells for natural illumination.

Kahn, like Pei, did his best to turn concrete into stone. "Concrete really wants to be granite," he often said. For a consistent look, he specified how the contractor should sand the plywood forms, coat them with a polyurethane plastic, symmetrically space the reinforcing rods, cap them with lead plugs, and bevel the edges for a precise fit.[135] He also set up test panels so he could get just the right concrete mixtures for color and texture. Instead of Pei's Spartan "crows' nests," Kahn's studies had oak floors, cabinets, and bookshelves, teak window frames and shutters, and slate blackboards. Where Pei bush hammered the concrete, Salk left it just as it was, which was more demanding since every blemish would show. As one of his on-site architects explained, "You will see a pattern that shows how the form works in the buildings. The materials will speak for themselves and the design will appear almost monastic."[136]

Salk, having learned something from Kahn's earlier experience in designing the Richards Building, hired Earl Walls as a consultant "to assure that the laboratory building design is based upon good principles of laboratory practice," at the suggestion of Fellow Edwin Lennox.[137] Walls met with the Fellows and constructed a mock-up of a laboratory bay for their evaluation and comment. Earl Walls would serve as a guide, but each Fellow would be free to arrange his laboratory as he pleased. Making his job easier was Kahn's design for portable

134. James Steele, *Salk Institute: Louis I. Kahn* (London: Phaidon Press, 1993), 20. Steele, an architect, provides a succinct and lucid description of the Salk design, with accompanying plans and photographs.

135. Leslie, *Louis I. Kahn* (ref. 9), gives the best description of the process.

136. Galen Schlosser, quoted in Hall, "Gift from the Sea" (ref. 126), 105.

137. Earl Walls to Jonas Salk, 19 Jul 1962, SP, MSS 1, Box 358, Folder 7.

FIG. 7 Kahn's structural innovations opened up the laboratories to football field dimensions. The interstitial space above allowed quick change out and an endless variety of laboratory designs. For the most part, the scientists arranged their labs conventionally, with services at the center and benches around the perimeter. *Source:* Ezra Stoller, Esto Photographics Inc.

lab benches that could quickly be attached to utility lines through service portals in the ceiling. (Fig. 7)

Attention to detail had its costs—in missed deadlines and mounting expenses. Kahn kept changing the drawings or failed to deliver them at all. As Komendant noted, a new drawing may seem a trivial matter for the architect, but it often proves to be a big headache for the engineers who have to implement it.[138] At one point an exasperated Salk wrote to Kahn: "I have been called to account by the Board of Trustees and others regarding the responsibility for the present demoralized state of the Institute building program. The seriousness of the situation demands the following. Stop."[139] Warren Weaver, who had as much administrative experience as the rest of the Fellows combined, understood the paradox of having a conventional contractor paired with an architect such as Kahn, "who is extremely talented, very widely known and appreciated, sensitively aware of the unusual nature of this enterprise, devoted to designing a building that will be serviceable both to the scientific function and to the broader intellectual and aesthetic purposes of the Institute—but something

138. Komendant, *18 Years* (ref. 90), 57.

139. Jonas Salk to Louis I. Kahn, 16 Nov 1962, SP, MSS 1, Box 358, Folder 6.

of a dreamer who is bored by time schedules, who loves to keep thinking of new and better ideas, and who is therefore very hard to pin down to the calendar . . . We are paying a price—namely a disappointingly slow start—for the architectural beauty and for the functional convenience which, over the long haul, will certainly justify the price."[140]

To compound the matter of rising expenses, the March of Dimes, facing its own financial exigencies, renegotiated its contract with Salk. Instead of the $15 million it had originally promised, it cut its pledge to $8 million for construction, plus $10 million in operating costs spread over ten years.[141] Salk faced some tough decisions. He put the Meeting House and the Residences on indefinite hold and fitted out only the north laboratory building, with half a floor for each of the Fellows. The south building would remain a shell, pending future funding. Wherever possible, he reconsidered and replaced extravagant material, selecting thinner slate, concrete instead of tile, simpler doors. Just to finish what he had already started, Salk had to seek $10 million in bank loans.[142]

Salk broke ground for the laboratory in June 1962. By the end of the year, the first concrete footings had been poured. Kahn's design demanded close attention to the details, but even so, by the summer of 1965, the concrete work was done. Kahn saved his signature courtyard for last. Though he and Salk had been guided in their early thinking by Assisi, with its paved piazza surrounded by a cloister, they had imagined the courtyard for the Salk Institute as a tree-lined garden. Inspired by Mexican architect Luis Barragan, who visited the site at Kahn's invitation in February 1966 and advised a "hard-surfaced Plaza," Kahn proposed paving the courtyard entirely with stone. Salk got a second opinion from landscape architect Lawrence Halprin, who suggested several ways of "softening Barragan's idea." In the end, however, he considered Kahn's architecture "pure poetry" and advised leaving well enough alone.[143] To save money, Kahn chose travertine limestone instead of the San Miguel stone he initially specified. The austere courtyard, bisected by a single channel of water dropping into a pool at the western end of the building, opened up what Vincent Scully later called a "cosmic corridor."

Faced with sobering financial shortfalls, the Institute's Board of Trustees brought in professional managers and money-raisers, first Joseph Slater, an

140. Warren Weaver to Fellows, 11 Feb 1963, SP, MSS 1, Box 345, Folder 6.

141. Stephen Ryan to Gibson Fuller, 31 Jul 1963, SP, MSS 1, Box 358, Folder 4.

142. Notes, 15 Nov 1963, KC, 030.11.A.27.11.

143. Louis I. Kahn to Jonas Salk, 19 Dec 1966, SP, MSS 1, Box 369, Folder 2; and Lawrence Halprin to Jonas Salk, 2 Dec 1966, KC, 030.11.A.26.5.

economist at the Ford Foundation, and later Frederic de Hoffman, founding director of neighboring General Atomic. Like the Salk Institute, General Atomic had been established with high ideals—"a timeless institution, a thing of the mind and spirit, devoted to man's progress"—only to run into unforgiving economic realities.[144] De Hoffman balanced the Institute's budget by courting wealthy donors and by recruiting established stars such as future Nobel laureates Robert Holley and Roger Guillemin, who could, in turn, attract large research grants on their own. With a relatively meager endowment and no increase in the annual contribution from the March of Dimes, the Salk Institute had to become as attentive to changing federal funding priorities as any university.[145] When President Richard Nixon and the NIH declared a "war on cancer" in 1971, so did the Institute. It simply could not afford high-risk research programs, even in the basic sciences. Under de Hoffmann, the Institute all but abandoned the idea of bridging the "two cultures," though Bronowski took a sabbatical to complete his "Ascent of Man" television series for the BBC. The Fellows ran their laboratories just like their academic counterparts, independently and sometimes jealously. In the absence of traditional departments, the scientists created new ones, in their own image, some traditional (cancer or genetics), some hybrids (computational or molecular neurobiology), and a few unique to the Institute (chemical evolution) organized around a senior Fellow, much like traditional German universities. The scientists certainly learned from one another, but they hardly defined themselves as a collective. "The idea of having a group of talented people who will inspire each other is one of those myths," a Fellow explained to a visiting reporter from *Science*. "I often expect that people who don't have anyone else to talk to just have to get on with their work."[146]

And they did. An architectural plan intended to encourage communication and contemplation could just as easily foster insulation and isolation. From the beginning, almost no one sat in the courtyard. Salk had confidence they would learn: "New generations will grow up to recognize the architecture and use the outdoor spaces."[147] That never happened. Who had time for philosophical reflections in the midst of a race for a Nobel Prize? Active Fellows often turned

144. George Dyson, *Project Orion: The True Story of the Atomic Spaceship* (London: Henry Holt and Company, 2002). Written by the son of Freeman Dyson, one of General Atomic's top consultants, *Project Orion* offers a fascinating look into General Atomic's idealistic early years.

145. Gibbons, "The Salk Institute at the Crossroads" (ref. 13), 360–62.

146. Wade, "Salk Institute" (ref. 11), 848.

147. McCoy, "Dr. Salk Talks" (ref. 118), 32.

their studies over to their postdocs, just as their counterparts at NCAR had done with their "crows' nests," preferring small offices in their laboratories that were closer to the action. Kahn's trusses and service portals had opened up unencumbered laboratory space, which the scientists promptly filled in with conventional arrangements of benches around the perimeter and services in the center.[148] Architectural critic Allan Temko noted that only the older scientists, Salk in particular, showed appropriate "respect" for the building. Recent hires appeared content with "happy squalor: books tumbling on floors, furniture pushed every which way, snacks on the laboratory tables and enormous sheets of aluminum foil (in a couple of cases, white paint) masking big windows where the sun strikes between the projecting studies and service towers."[149] Temko, along with many other architects and critics, fixated on what might have been, on the "poignant sense of incompletion and broken hopes" that the unbuilt Meeting House and Residences symbolized. Yet those aspirations had already become as archaic as the Roman villa on which Kahn had modeled the Meeting House. Salk, still clinging to his original vision of a science informed by humanistic vision, welcomed anthropologist Bruno Latour's study of "laboratory life" at the Institute and wrote an introduction for Latour and sociologist Steve Woolgar's book on the subject.[150] Latour's fieldwork, done in Guillemin's laboratory, unwittingly revealed just how little of Salk's "great new dream" remained, even in the 1970s. The Salk Institute had become virtually identical to the academic and government laboratories that it had sought to transcend and with which it now competed for grants and prizes. It was a place of grueling and often tedious work, with little time for quiet meditation on the meaning of life.[151]

The Institute barely had a place for its own founder. Salk once commented on how the visibility and reputation of the Institute "will quickly expose what an individual is good for. In that sense it's tyrannical, it's cruel."[152] And so it was. Not long after the Institute opened, Salk stepped down as president to

148. Leslie, *Louis I. Kahn* (ref. 9), 154.

149. Allan Temko, "Evaluation: Louis Kahn's Salk Institute After a Dozen Years," *AIA Journal* 66, no. 3 (1977): 42–49, on 48.

150. Bruno Latour and Steve Woolgar, *Laboratory Life: The Social Construction of Scientific Facts* (Beverly Hills, CA: Sage Publications, 1979).

151. Nicholas Wade, *The Nobel Duel* (New York: Doubleday, 1981) contrasts the patrician style of Salk's Roger Guillemin with the blue-collar science of Andrew Schally in his Veterans Administration laboratory in New Orleans—though the pace, pressure, and single-minded perseverance of the two seem scarcely different, despite their utterly different architectural styles.

152. Wade, "Salk Institute" (ref. 11), 847.

become titular director. He subsequently surrendered his laboratory space to younger scientists and put his energy into writing books for a popular audience on intuition and reason, human evolution, and the future of man. When he briefly came out of scientific retirement determined to develop an AIDS vaccine, most colleagues at the Institute and elsewhere considered him out of touch with current biomedical research.[153] He married Françoise Gilot, Picasso's former muse and an accomplished painter in her own right, who turned one of the studies into her studio. Salk had famously said that he wanted a laboratory where he could invite Picasso. So even if Picasso never paid a visit, at least something of his creative spirit did. Some of Gilot's paintings still hang in the studies of long-time Fellows, small tokens of Camelot.

The Institute survived and thrived, much the way NCAR did, by becoming a conventional academic laboratory in an unconventional building. University and government scientists also recognized that many of the most important challenges could be found at disciplinary boundaries and could be best attacked by multidisciplinary teams on a scale that the Institute could not match. The very isolation Salk had sought, and which Kahn had exploited so masterfully, might well have been a fatal flaw if San Diego had not made good on its promise of becoming a "scientific capital of the world." The University of California, San Diego (UCSD) grew into the science and biomedical powerhouse its boosters had envisioned and became a crucial resource for the Institute. What began as courtesy appointments at UCSD for senior Salk Fellows turned out to be a vital link between the two campuses. A large number of Salk faculty took joint appointments in related departments in the university and its medical school. Hundreds of UCSD graduate students trained with Salk faculty, providing the laboratory labor on which modern biomedical research depends. The university contributed its share of the prize-recipients after whom Nobel Drive, which runs just south of the campus, takes its name. The Institute became a significant catalyst in the emergence of San Diego as a world center in the biomedical sciences (a complex that includes corporations, other private foundations, and UCSD), much as NCAR was for Boulder. Outreach and collaboration replaced the inward-directed gaze of Kahn and Salk's monastic cloister.

Perhaps nothing better highlighted the tension between architectural and scientific distinction than Salk's decision to expand the laboratory, over the serious objections of Kahn's students and admirers. Since its opening, architects

153. Oshinsky, *Polio* (ref. 94), 275–76.

FIG. 8 Ezra Stoller's photograph perfectly captures the complexity of Kahn's design. Note how light and shadow play across the beautifully finished concrete, with its symmetrical plugs. The teak shutters of the studies contrast with the smooth concrete beside them. The light well in the center opens the basement laboratory to the sun. *Source:* Ezra Stoller, Esto Photographics Inc.

exalted the Institute as an American masterpiece. The building so moved the music critic Leonard Burkat that he told the Institute's president that it "should be photographed by one of the great photographers of nature . . . The site is Acropolitan and the buildings a kind of Parthenon, a temple of wisdom with a secret geometry and a poetic life of its own."[154] He thought Ansel Adams might do it justice. Ezra Stoller so admired Kahn's work that he photographed it on his own time. He appreciated the complexity of Kahn's design, which powerfully captured the play of light and form.[155] (Fig. 8)

Salk, mindful of his obligation to the icon he had commissioned, as well as to the Institute that bore his name, hired Jack McAllister, Kahn's project architect for the original building, to design the addition. McAllister's plan, which included twin buildings set back from and below the eastern end of the courtyard (connected by tunnels to one another, and to the original laboratories), added a lobby, an auditorium, laboratories, and administrative offices, totaling more than 100,000 square feet in all, at a cost of $15 million. Neither Salk nor McAllister ever claimed the addition would take the place of Kahn's hallowed, though unbuilt, Meeting House; they merely claimed that it would provide

154. Leonard Burkat to J. E. Slater, Apr 1968, KC, 030.11.A.27.27.
155. Saunders, *Modern Architecture* (ref. 80), 154.

desperately needed space, while being respectful to Kahn's intent. Whatever the architectural objections from "the purists," the addition faithfully expressed what the Salk Institute had become by the early 1990s: another node, however significant, in a global network of biomedical laboratories.

HOW LABORATORIES LEARN

In his thought-provoking study of "how buildings learn," Stewart Brand identified three kinds of architecture—the "low road," the "high road," and the "no road." MIT's celebrated Building 20 took the "low road." Intended to provide temporary quarters for the Rad Lab during World War II, Building 20's makeshift, jerrybuilt style inspired generations of faculty and graduate students, who considered free-spirited improvisation to be one of MIT's defining strengths. Its long corridors, echoing the "infinite corridor" of MIT's central academic building, encouraged the kind of casual encounters Roberts had found so valuable in NCAR's own temporary building, just as its plain wooden construction provided similar opportunities to drill holes in the floors and walls. By contrast, I. M. Pei's third MIT building, the Media Lab, where Brand spent a year in the 1980s, took the "no road" of magazine architecture. It played to the camera but inadvertently cut its occupants off from one another. "It may have been my familiarity with MIT's homely, accommodating Building 20 just across the street that made the $45-million pretentiousness, ill-functionality, and non-adaptability of the Media Lab so shocking to me," Brand reflected.[156] The Stata Center, Frank Gehry's $300-million-plus replacement for Building 20, sought to recapture some of the old magic by designing in flexibility and serendipity. He (in)famously looked for organizational inspiration in what he called the "Orangutan Village" and the "Prairie Dog Town," and wound up with spaces that all too often reminded the faculty of a disorienting zoo.[157]

156. Stewart Brand, *How Buildings Learn: What Happens After They're Built* (New York: Viking Adult, 1994). See also Stewart Brand, *The Media Lab: Inventing the Future at MIT* (New York: Viking, 1987).

157. Nancy Joyce, *Building Stata: The Design and Construction of Frank O. Gehry's Stata Center at MIT* (Cambridge, MA: MIT Press, 2004), offers a comprehensive overview of the Stata Center's construction. For more critical perspectives, see Alex Beam, "After Buildup, MIT Center is a Letdown," *Boston Globe*, 4 May 2004; and Kathleen Richardson, "Let's Play Nicely Together, Shall We?" *Times Higher Education Supplement*, 24 Feb 2006.

The Mesa Lab and the Salk Institute took Brand's "high road," buildings admired and respected by their inhabitants, who learned to make the best of flaws, foibles, and constraints. The pitfall on the architectural "high road" is letting a building become a monument, a memorial, or a shrine. As Roberts once explained to Pei, uncertainty, not finality, had to be the guiding principle for science. A laboratory, like the scientists in it, must be able to make, as well as learn from, mistakes. Ideally, it should allow room for contingency, to be as open-minded and open-ended as science itself. By design, signature buildings set limits on learning, although those limits are only discoverable in practice. At some point, form begins to stress function, since the philosophies embedded within the design endure far longer than the founding vision and mission. If the architecture does not stunt intellectual growth, it does channel it in some directions rather than others. At NCAR and the Salk Institute, the buildings still define a shared culture, and have become so emblematic that their profiles appear on laboratory business cards, a graphic shorthand for the larger enterprise.

The Mesa Lab and the Salk Institute still reflect the personal preferences of their founders, and while those prejudices may now be out of fashion, they nevertheless provide an intellectual coherence absent when no one pushes back against the architect's preconceptions. Only active intervention by a laboratory director keeps a designer laboratory from running off the "high road" into a dead end. When architects ask bench scientists what they want, the scientists nearly always describe an improved vision of what they already have, which architects take as providing them with a license to design a building that will somehow challenge conventional thinking and "get researchers to envision their work lives differently."[158] Having an individual rather than an institutional client makes all the difference. Despite a large number of recent laboratory commissions given to famous architects, scientists do not seem entirely convinced that a prize-winning design will lead to prize-winning science.[159] In different spaces, Mesa Lab and the Salk Institute would be different places. The future challenges facing atmospheric science and biomedicine will undoubtedly require fresh thinking about disciplinary boundaries, as well as architectural styles able to nurture new organizational and scientific identities.

158. Joyce, *Building Stata* (ref. 157), 24.

159. Jon Cohen, "Designer Labs: Architecture Discovers Science," *Science* 287, no. 5451 (2000): 210–14; and Laura Bonetta, "Lab Architecture: Do You Want to Work Here?" *Nature* 424, no. 6950 (2003): 718–20.

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