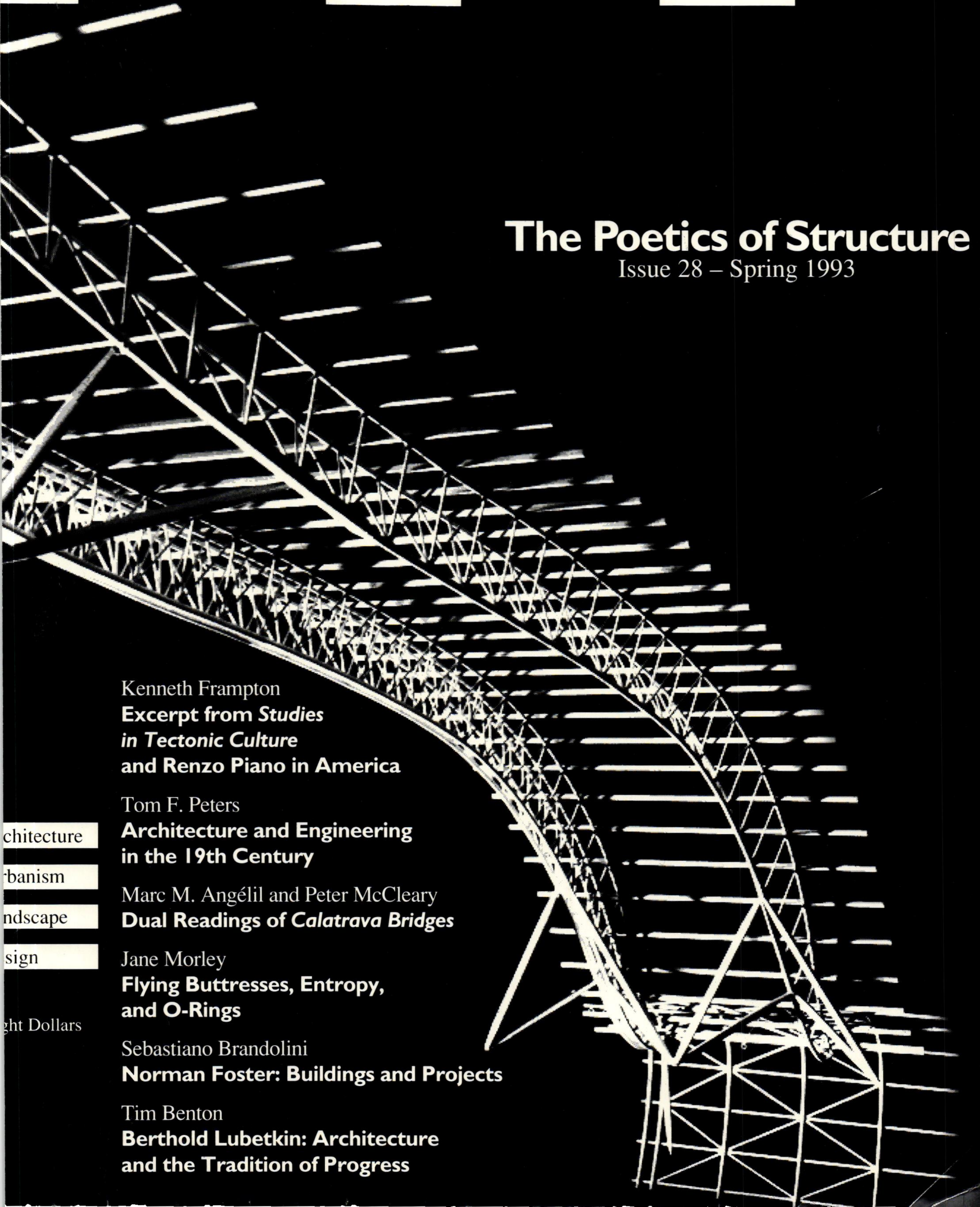
DESIGN BOOK REVIEW



The Poetics of Structure

Issue 28 – Spring 1993

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Spring 1993

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Front and back cover: Kansai Airport, Osaka, Japan; Renzo Piano Building Workshop and Ove Arup, currently under construction. (Photo by Masahiko Tanaka; courtesy Renzo Piano Building Workshop.)

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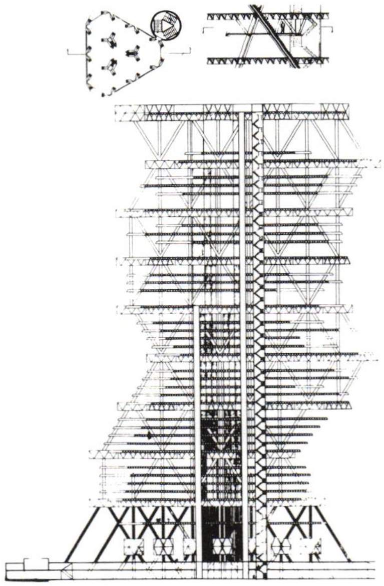

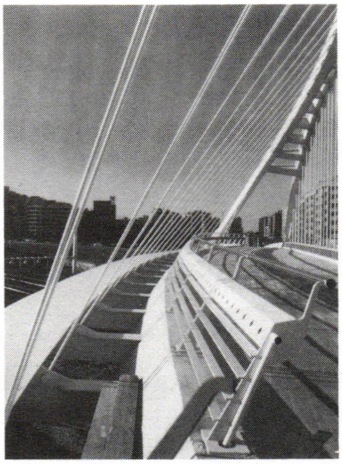

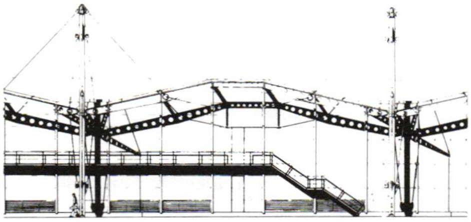

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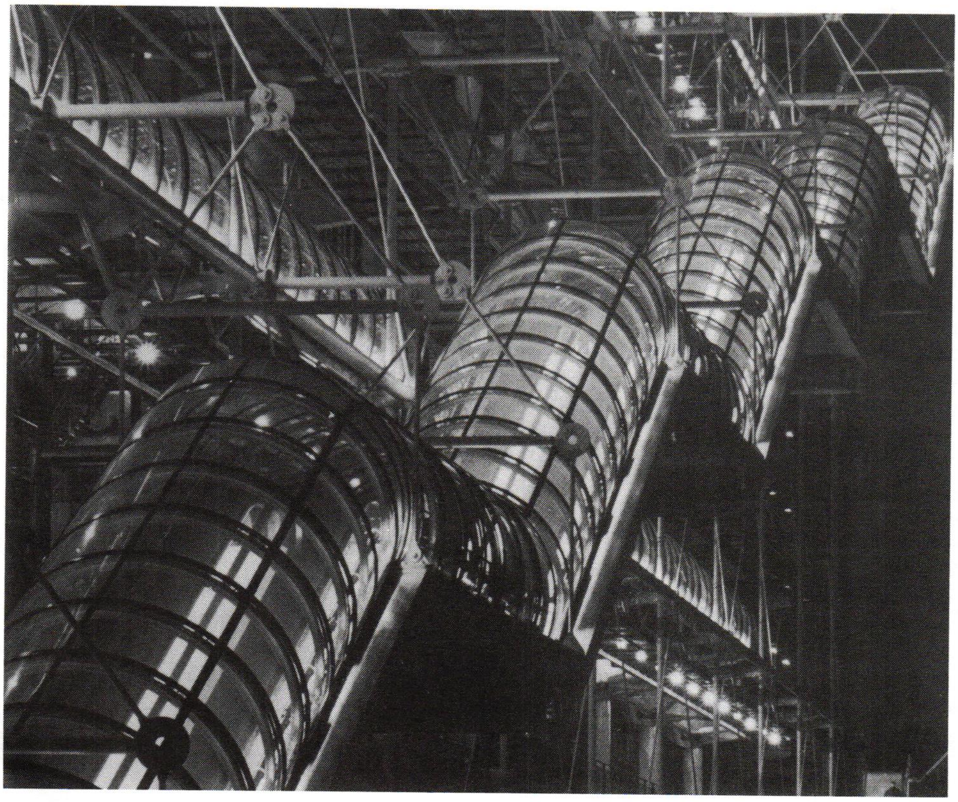
Peter Rice and the "New" Spirit of Architectural Knowledge

As the prestige of the engineer swelled during the 19th century, the self esteem of the architect dissipated. The engineer's detumescent status was mercilessly portrayed in Adolf Loos' parable in which the work of an architect in a subalpine landscape confronts that of the folk builder or of the bridge-building engineer: "Why does the architect always profane the lake?" Loos sneers. Much of the subsequent modernist architectural theory seemed analogous to erection anxiety; a desperate attempt to reassimilate the lost charisma of technological expertise. Le Corbusier's incantations about the engineer's aesthetic, Erich Mendelsohn's romantic photographs of industrial buildings, Gropius' libido for mass-produced housing, Hannes Meyer's cryptic presentation drawings that are mostly engineering calculations, all prepared the theoretical environment for an engineer-centered architecture. Instead of the truthful beauty of pure calculation, however, the environment was in for a dreadful shock from which it will probably never recover. Big modernism, roaring freeways, icy highrises on windy plinths, intimidating concrete canyons, storage-like housing, relentless paving everywhere, the assassination of nature—all intimate the end of the polite role of architecture.

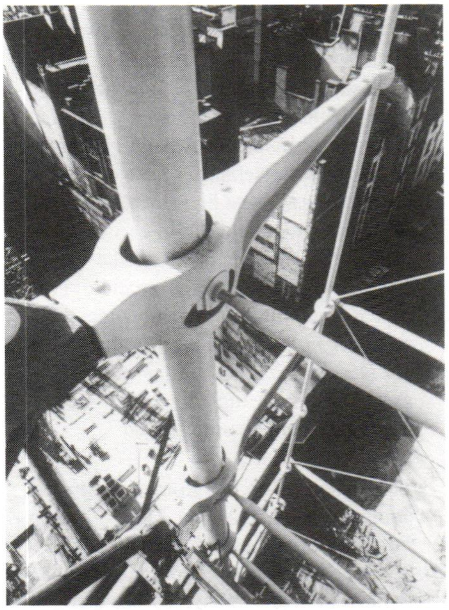
The necessary reactions to the sterility and insensitivity of the environment made possible through advanced engineering was in many cases a withdrawal into style. Neither Aldo Rossi nor Robert Venturi and Denise Scott Brown, who represent two leading theoretical directions of the postmodern emphasis on historical precedents, have any concern for engineering as part of their creative process of making architecture. The technology for Rossi's typologically derived designs or that for Venturi and Scott Brown's decorated sheds has been categorically predetermined rather than form giving. Theirs is a passive-aggressive strategy to regain authority by dropping out of the competition with engineers. The architecture of this "atechnological" approach is occasionally satisfying intellectually (Venturi and Scott Brown's design for the addition to the National Gallery in London, for example, is far more engaging that what Richard Rogers had planned for the same site), but it is almost always cynical and has the unfortunate consequence of corroding all values, even those of exchange.

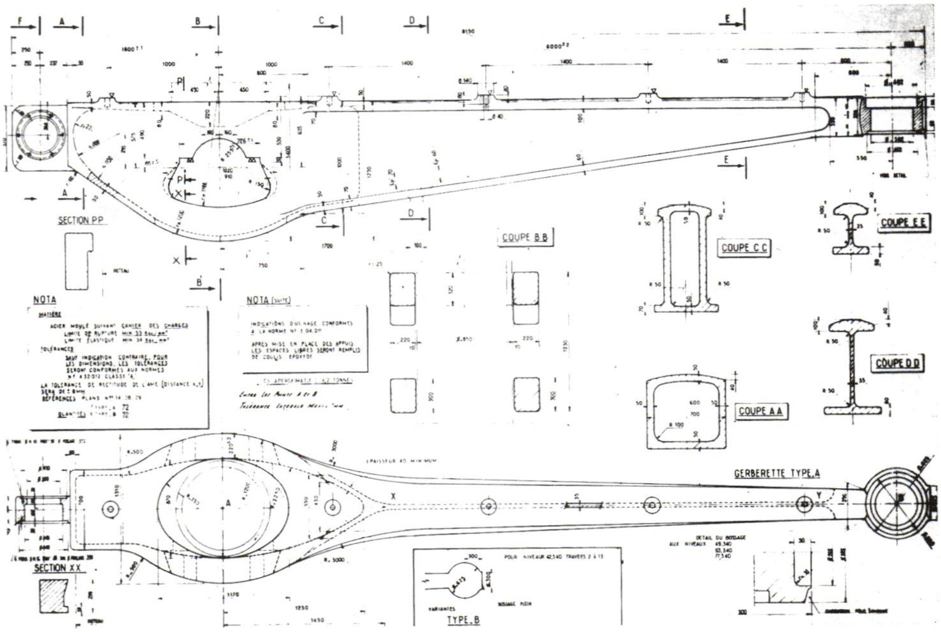
The technological realm, of course, was not seriously threatened by the retreat of architects into the discourse of style. The engineer continues to deal with gravity no matter how trifling things might appear. Some indication that the postmodernist attitude to technology is changing can be witnessed in the office of Ricardo Bofil, which now routinely calls upon the engineering services of Ove Arup & Partners during the first stages of design. If there is a new spirit abroad in the conception of architecture—and it certainly would be "new" and not new—it is lodged in a growing respect for tectonics, or the art of building. This may be due partly to Kenneth Frampton's frequent homilies about tectonic values in his lectures and writings, but it is surely also due to the great example given in the career of Peter Rice, a brilliant structural engineer who was a creative partner with the likes of Rogers, Renzo Piano, and Nicholas Grimshaw. Rice passed away in October 1992, and although this issue of *DBR* will be a little late, we would like to dedicate it to his memory.

Rice was born in Ireland in 1935, had a humanist education, and then specialized in mathematics. He was one of the first structural engineers to successfully apply computer technologies to design. His first great adventure in engineering for architects was on the team that produced the calculations for Jørn Utzon's Sydney Opera House. Rice was quite convinced that engineers are not creative but are merely inventive and need architects as imaginative partners. His inventions for Piano and Rogers' Pompidou Centre transposed knowledge from floating oil riggers, but went beyond mere assimilation: "At the time of the Pompidou Centre," he said in his acceptance speech for the



Centre Georges Pompidou, Paris; Renzo Piano, Richard Rogers, and Peter Rice, 1976.



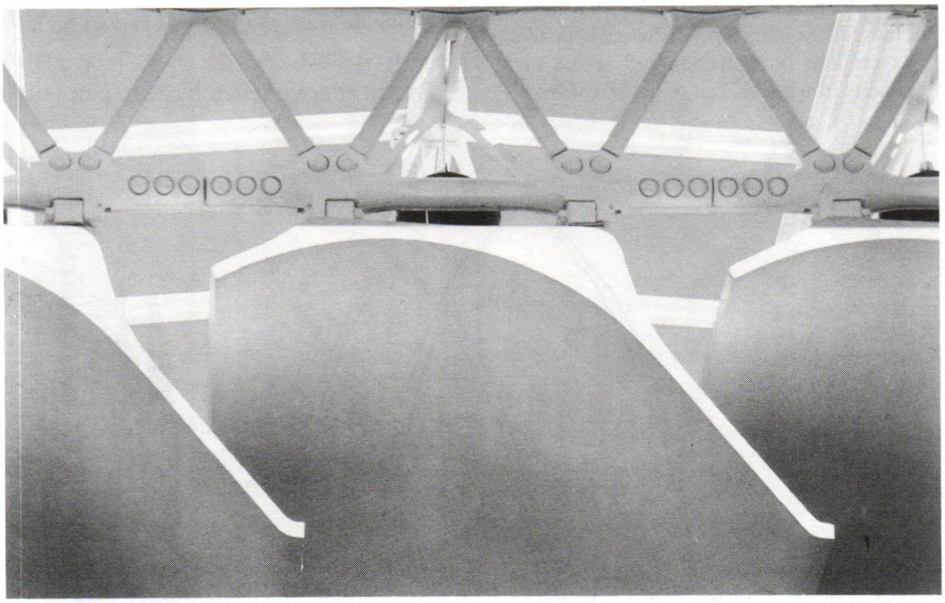


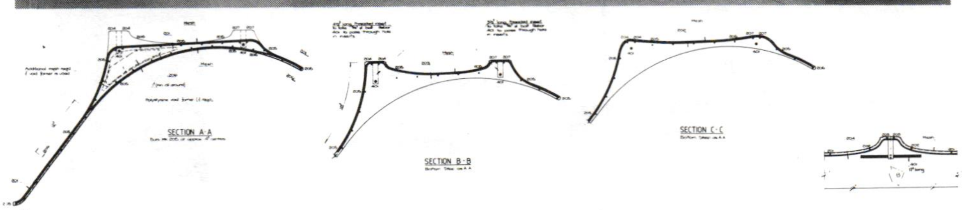
Cast-steel gerberette, Centre Georges Pompidou, Paris; Renzo Piano, Richard Rogers, and Peter Rice, 1976.

RIBA Gold Medal in 1992, "I had one very gratifying moment. We were building the steel structure and I was very concerned that the scale of the building and the nature and face of it could be intimidating. When people look at things, they carry with them prior prejudice; when you build a steel building, all the other steel buildings that people have seen become part of the way they react to what they're looking at. It was then that I conceived the idea of introducing cast steel because I wanted to break some of these prior prejudices and produce something which would be unexpected and, in being unexpected, would challenge people to look at it, and in the process of challenging them to look at it, it would actually make them think, What is it? What is it that I'm looking at?"

Such an observation is important to the life of architectural theory. It redirects critical attention to meaning, or poesis, being rooted in structural details. That the art of building has transcendent value posits a spiritual expectation for the most material aspect of architecture, and innovative engineers like Rice are succeeding at reintegrating it into architectural discourse. Toward the end of his life, Rice was concerned about the impact of computerization and the simulating capacities that it would provoke. When he says with some exasperation, "this is the first and most important reality of technology today: substance and image are separate," he accepts this as a problem area for the engineer supporting architectural design. Yet the material qualities of his leafy ferro-cement sunshades for Piano's de Menil Collection in Houston, or the sensuously arched bow ribs for Piano's soon-to-be-completed Kansai Airport in Osaka are artifacts of the "new" tectonic spirit, a gift of synthesis in an age of fragmentation.

Richard Ingersoll





Detail of the ferro-cement sunshades, de Menil Collection, Houston; Renzo Piano and Peter Rice, 1986.

KENNETH FRAMPTON

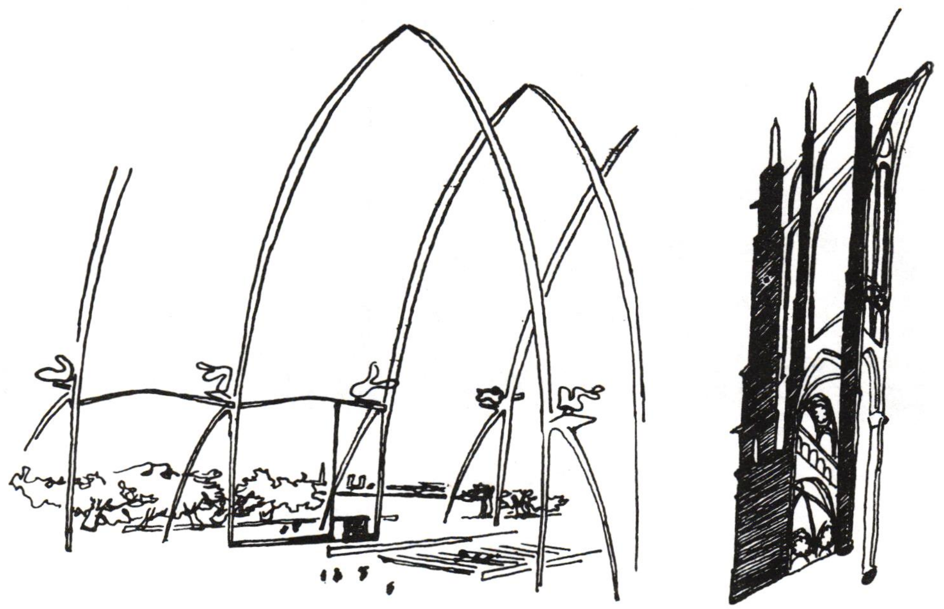
Louis I. Kahn and the New Monumentality, 1944–1972

Kenneth Frampton's forthcoming book, Studies in Tectonic Culture *(MIT Press, 1994) is an attempt to re-read the history of 20th-century architecture as the evolution of a "poetics of construction." In it, the author tries to show how modern architecture is invariably as much about structure and construction as it is about space and abstract form. In a series of monographic essays, including chapters on Auguste Perret, Frank Lloyd Wright, Mies van der Rohe, Louis Kahn, Jørn Utzon, and Carlo Scarpa, Frampton shows how both constructional form and material character were integral to an evolving architectural expression of the work; he also demonstrates that the way in which these elements are articulated from one work to the next affords us a basis from which to evaluate these works as a continuity. Frampton considers the conscious cultivation of the tectonic tradition in architecture as a key to the future development of architectural form. He has generously allowed us to excerpt a chapter from* Studies in Tectonic Culture *on the work of Louis I. Kahn.*

Modernization and monumentality may be seen as the dialogical theme running through the mature phase of Louis Kahn's career; the former being the singular processal character of the modern world with which he will struggle throughout his life, the latter being the institutional referent that will form the fundamental focus of his architectural system. Kahn's unique contribution in this regard stems from his conviction that tectonic structure, rather than mass form or type, must be pursued as the first condition of monumental form. To predicate the monument on architectonic expressivity was to take an entirely different approach from the sociopolitical attitude assumed by Sigfried Giedion, José Luis Sert, and Fernand Léger in their seminal and highly influential "Nine Points on Monumentality" written in America in 1943.[1] Shortly after this revisionist manifesto was first issued, the idea of a New Monumentality was in the air and within a year a symposium largely devoted to this theme was staged by Paul Zucker at Columbia University under the somewhat misleading title, "The New Architecture and City Planning."[2] Kahn's contribution to this symposium was to establish the basic thematic of his work. It was also one of the most revealing statements he ever made with regard to his conception of monumental form. Kahn approached the issue of monumentality in an unusual way, emphasizing the character of the tectonic aspect above all other considerations.

> Neither the finest material nor the most advanced technology need enter a work of monumental character for the same reason that the finest ink was not required to draw up the Magna-Carta. . . . In Greek architecture engineering concerned itself fundamentally with materials in compression. Each stone or part forming the structural members was made to bear with accuracy on each other to avoid the tensile action which stone is incapable of enduring. The great cathedral builders regarded the members of the structural skeleton with the same love of perfection and search for clarity of purpose. Out of periods of inexperience and fear when they erected over-massive, core-filled veneered walls, grew a courageous theory of a stone over stone vault skeleton producing a downward and outward thrust, which forces were conducted to a column or a wall provided with the added characteristic of the buttress. . . . The buttress allowed lighter walls between the thrust points and these curtain walls were logically developed for the use of large glass windows. This structural concept, derived from earlier and cruder theories, gave birth to magnificent variations in the attempts to attain loftier heights and greater spans creating a spiritually emotional environment unsurpassed.
>
> The influence of the Roman vault, the dome, the arch, has etched itself in deep furrows across the pages of architectural history. Through Romanesque, Gothic, Renaissance and today, its basic forms and structural ideas have been felt. They will continue to reappear but with added powers made possible by our technology and engineering skill.[3]

This passage is extremely revealing, for, reading between the lines, it is possible to discern not only the specific nature of Kahn's formation, as a student at the University of Pennsylvania under the Beaux Arts tutelage of Paul Cret, but also the terms in which he was to conceive his own architectural agenda. It says something for his French education that his own point of de-



Sketch of a modern cathedral in welded tubular steel (left), and section through Beauvais cathedral after Auguste Choisy (right); Louis Kahn, 1944.

parture was to recall the long debate surrounding the evolution of the Greco-Gothic idea. This may explain why he would adopt a totally different attitude toward the steel frame than that assumed by Mies van der Rohe, for where Mies readily accepted the rolled-steel joist as the structural norm of 20th century architecture, Kahn began his thesis on monumentality with an elaborate critique of this universal building element.

> The I-beam is an engineering accomplishment deriving its shape from an analysis of the stresses involved in its use. It is designed so that the greater proportion of the area of cross-section is concentrated as far as possible from the center of gravity. The shape adapted itself to ease of rolling and under test it was found that even the fillets, an aid in the rolling process, helped convey the stresses from one section to another in continuity. Safety factors were adopted to cover possible inconsistencies in the composition of the material of manufacture. Large-scale machinery and equipment needed in its fabrication lead to standardization.
>
> The combination of safety factors ("ignorance factor," as one engineer termed it) and standardization narrowed the practice of engineering to the selection of members from handbooks, recommending sections much heavier than calculations would require and further limited the field of engineering expression stifling the creation of the more graceful forms which the stress diagrams indicated.[4]

Kahn would follow this critique of standard engineering practice with a rather general advocacy of welded tubular steel construction.

> Joint construction in common practice treats every joint as a hinge which makes connections to columns and other members complex and ugly. To attain greater strength with economy, a finer expression in the structural solution of the principle of concentrating the area of cross-section away from the center of gravity is the tubular form, since the greater the moment of inertia, the greater the strength. A bar of a certain area of cross-section rolled into a tube of the same area of cross-section (consequently of a larger diameter) would possess a strength enormously greater than the bar.
>
> The tubular member is not new, but its wide use has been retarded by technological limitations in the construction of joints. Up until very recently, welding has been outlawed by the building codes. In some cases, where it was permitted, it was required to make loading tests for every joint.[5]

The above passages surely testify to the underlying influence of Eugène-Emanuel Viollet-le-Duc—in particular, the reference to over-sectioned members which do not reflect the stress variations to which they are subject and the double allusion to both graceless joints and a failure to consider the frame as a total system. Kahn is critical of the inorganic trabeated rigidity of the standard steel frame and so favors the more organic, one may even say Neo-Gothic, potential of welded tubular steel. Kahn was to clarify his position with a number of sketches which illustrate the essay. The first of these is an *esquisse* for a modern cathedral in welded tubular construction. This is directly related, as the drawing indicates, to Auguste Choisy's axonometric of the structure of Beauvais cathedral as this appears in his *Histoire de l'architecture* of 1899. Of this, Kahn wrote:

> Beauvais cathedral needed the steel we have. It needed the knowledge we have. Glass would have revealed the sky and become a part of the enclosed space framed by an interplay of exposed tubular ribs, plates and columns of a stainless metal formed true and faired into a continuous flow of lines expressive of their stress patterns. Each member would have been welded to the next to create a continuous structural unity worthy of being exposed because its engineering gives no resistance to the laws of beauty having its own aesthetic life.[6]

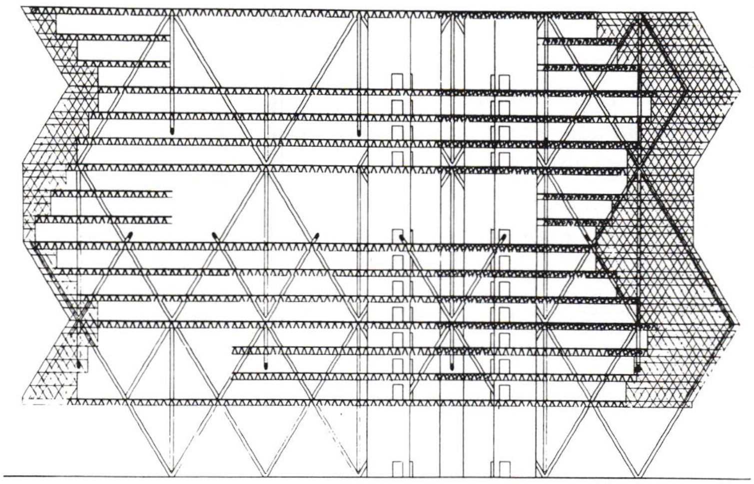
The Structural Rationalist nature of this argument is self-evident as is its relation to the production and statical limits of the materials involved. It is easy to see, for example, that Kahn's hopes for the future of welded tubular steel are not unlike those that he will later entertain toward reinforced concrete and this, in turn, will be close to the attitude assumed by Auguste Perret with respect to the same material. It was patently evident to Kahn and Perret alike that reinforced-concrete structural members could be easily modified in section in order to accommodate and reflect variations in stress. The organic potential of the material, in this regard, had already been amply demonstrated by Eugene Freyssinet in his bowstring factory roofs and by Robert Maillart in the storage shed that he erected in Chiasso in 1924. One should also mention Pier Luigi Nervi in this connection to whom Ann Griswold Tyng showed the City Tower project that she had designed with Kahn in 1953.[7]

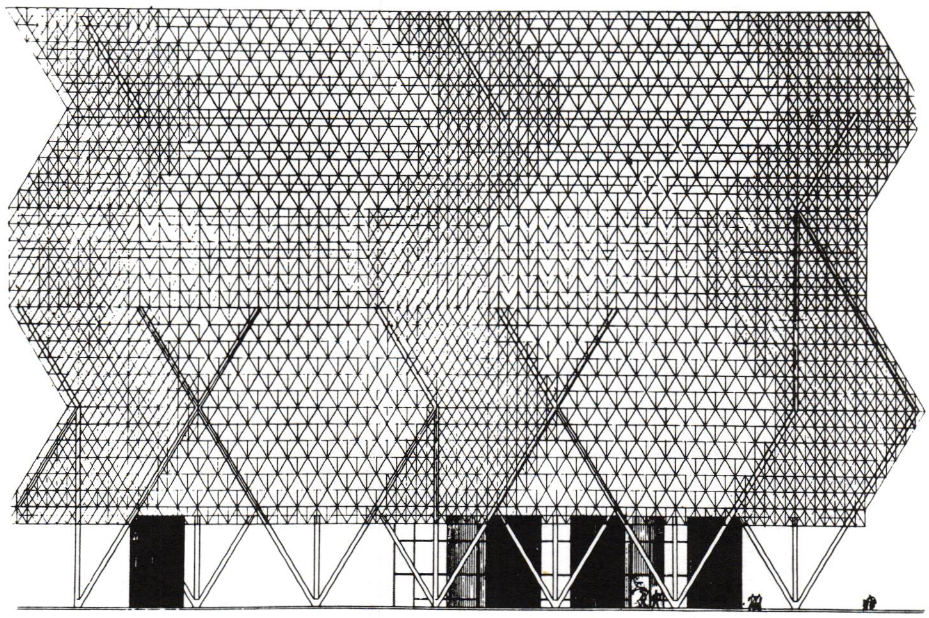
That Kahn did not immediately fix on reinforced concrete as the material of the New Monumentality testifies to Kahn's regard for the structural elegance of metal construction. He advocated welded tubular steel largely because of its lightweight modern industrial nature and the apparent ease with which it could be fabricated. In comparison to welded steel, reinforced concrete displayed a number of disadvantages. In the first place, there was the inelegance of having to build one structure in order to cast another; in the second, it possessed a tectonically ambiguous nature inasmuch as it was a "conglomerate"—that is to say, while it appeared to be compressive, it invariably concealed a tensile component. Welded tubular steel came close to Kahn's ideal building material, of which he spoke in later life to the effect that "I dream of space full of wonder. Spaces that rise and envelop flowingly without beginning, without end, of a jointless material white and gold. When I place the first line on paper to capture the dream, the dream becomes less."[8]

Although the oriental tone of this vision should not go unnoticed, it is clear that the paradigm evoked has much in common with the Gothic cathedral. The great advantage of welded tubular steel lay in its potential for achieving an ontological tectonic comparable in its expressive substance to the self-evident continuity of the Gothic stonework. What Kahn had in mind was the continuous flow of force that seemingly passes from vault to rib to pier, in one and the same material. While this modulated continuity could be achieved in reinforced concrete, as Perret had already demonstrated, for Kahn concrete lacked the intrinsic lightness and clarity of welded tubular steel and was in this sense less modern. Furthermore, it could not be erected as a constructional continuity since the process of construction did not allow its respective components, especially the steel rods, to *appear*, in their final and appointed place. The fact that it was a casting operation rather than an assembly made it categorically inimicable to the precepts of Structural Rationalism.

The shortcomings of reinforced concrete from a tectonic standpoint had long been perceived by Viollet-le-Duc's prime pupil, Anatole de Baudot, above all, in his church, St. Jean de Montmartre, under construction in Paris from 1894 to 1904. De Baudot, educated by both Henri Labrouste and Viollet-le-Duc, carried the legacy of Structural Rationalism into the 20th century. St. Jean de Montmartre, completed when de Baudot was seventy, was the most significant work of his life. No two works, ostensibly deriving from the precepts of Viollet-le-Duc, could be more opposed than Perret's 25 bis rue Franklin apartments and de Baudot's church in Montmartre. Where the one embraced the Hennebique's system of reinforced-concrete construction, the other categorically rejected it, not only because, unlike Gothic architecture, it failed to reveal the patterns of stress induced in its structural members, but also because it was incapable of generating an architectonic syntax arising out of the constructional process. It was for this reason that de Baudot's church was built out of a unique system of reinforced brick and concrete construction, developed in collaboration with the engineer Paul Cottacin and proposed under the name of *ciment armée,* in order to distinguish it from Hennebique's *bêton armée.* To this end, de Baudot and Cottacin deployed cement-reinforced, perforated brick arches, walls, and piers. These lean components were held in place by reinforcing wires that were painstakingly inserted into the perforated masonry. The interstices of these ligaments, laced with wire, were thereafter charged with cement.

While Kahn never alluded to de Baudot, it is almost certain that he would have been aware of his work through his teacher, Paul Cret. Cret gave his own public assessment of de Baudot in his famous and influential essay, "The Architect as Collaborator of the Engineer," published in 1927, three years after Kahn's graduation.[9] Although Cret takes pains in this essay to distance himself from de Baudot and to reassert the primacy of imitative form, Structural Rationalism nonetheless remained an important and seminal reference for him, and from this standpoint, de Baudot may be adduced as a possible influence on Kahn. The case for this being true is further strengthened by the space-framed, vaulted roof structure in *ciment armée* that de Baudot projected during the last decade of his life. Kahn's tubular steel–framed exhibition pavilion with which he illustrated his 1944 essay on monumentality is indicative of his technological naiveté with regard to the productional character of extruded-steel tubing since sections of diminishing diameter cannot be economically produced. Nevertheless, the didactic intent of the proposal is clear. The tapered components recall the cast iron members of Viollet-le-Duc's great hall featured in the *Entretiens*, where hypothetical variations in stress were to find reflection in the varying diameter of the cast-iron tubular cross-section. Moreover, Kahn's account of space-frame construction leaves no doubt as to his feeling for the difference between the *stereotomics* of the





City Tower, Municipal Building, Philadelphia, 1957; Louis I. Kahn and Ann G. Tyng, 1957.

earthwork and the *tectonics* of the frame. More importantly, this essay, dedicated to monumentality, concludes with an inventory of modern materials that reads, paradoxically enough, as though it had been compiled by a prewar functionalist.[10]

> Steel, the lighter metals, concrete, glass, laminated woods, asbestos, rubber, and plastics, are emerging as the prime building materials of today. Riveting is being replaced by welding, reinforced concrete is emerging from infancy with prestressed reinforced concrete, vibration and controlled mixing, promising to aid in its ultimate refinement. Laminated wood is rapidly replacing lumber and is equally friendly to the eye, and plastics are so vast in their potentialities that already numerous journals and periodicals devoted solely to their many outlets are read with interest and hope. The untested characteristics of these materials are being analyzed, old formulas are being discarded. New alloys of steel, shatter proof and thermal glass and synthetics of innumerable types, together with the material already mentioned, make up the new palette of the designer. . . . Standardization, prefabrication, controlled experiments . . . are not monsters to be avoided by the delicate sensitiveness of the artist. They are merely the modern means of controlling vast potentialities of materials for living, by chemistry, physics, engineering, production and assembly, which lead to the necessary knowledge the artist must have to expel fear in their use, broaden his creative instinct, give him new courage and thereby lead him to the adventures of unexplored places. His work will then be part of his age and will afford delight and service for his contemporaries.[11]

It is remarkable that Kahn's first theoretical statement would turn on a hypothetical synthesis between structural form and modern material technique, although he was to insist in conclusion that he did not wish to imply that monumentality could be attained scientifically, or that it could be simply derived from the application of engineering methods. However, Viollet-le-Duc was nonetheless an influence on the remarkable space-frame tower structure that Kahn and Ann Tyng were to project for Philadelphia in a number of different versions between 1952 and 1957. The architects would describe the first version of their proposal in terms that the French master of Structural Rationalism would have appreciated.

> In Gothic times, architects built in solid stones. Now we can build with hollow stones. The spaces defined by the members of a structure are as important as the members. These spaces range in scale from the voids of an insulation panel, voids for air, lighting and heat to circulate, to spaces big enough to walk through or live in. The desire to express voids positively in the design of structure is evidenced by the growing interest and work in the development of space frames. The forms being experimented with come from a closer knowledge of nature and the outgrowth of the constant search for order. Design habits leading to the concealment of structure have no place in this implied order. . . . I believe that in architecture, as in all art, the artist instinctively keep the marks which reveal how a thing was done. . . . Structures should be devised which can harbor the mechanical needs of rooms and spaces. . . . It would follow that the pasting over of the construction, of lighting and acoustical material, the burying of tortured, unwanted ducts, conduits, and pipe lines, would become intolerable. The desire to express how it is done would filter through the entire society of building, to architect, engineer, builder and craftsman.[12]

The influence of Structural Rationalism is revealed by the first sentence, while the degree of Kahn's involvement with modernization is indicated by his unprecedented attitude toward mechanical services. He becomes preoccupied with the idea that services should be accorded the same tectonic status as structural form. It is hard to overestimate the radical nature of this concern. Prior to Kahn's formulation of the theoretical opposition of "servant and served" space, contemporary architecture had failed to address the problems posed by the increase in the amount of services being installed in buildings in the second half of the 20th century. Centralized air-conditioning imposed a quantum leap in this regard, but, unlike Mies, Kahn could not accept the suspended ceiling as a normative method for the accommodation of ducts in the servicing of open floor space, largely because a false ceiling inevitably conceals the basic floor structure and this for Kahn was an unacceptable condition. As far as he was concerned, the fundamental structure of a building had to be made manifest both inside and out.

A transcendental strain is detectable in Kahn's thought at this juncture, a mode of beholding in which he appears to have become preoccupied with the latent order of nature, as this had been revealed through scientific research. This is partly what he had in mind when he wrote in 1944 of the purity of engineering form which has "no resistance to the laws of beauty having its own aesthetic life,"[13] or eight years later, in 1952, of forms which "come from a closer knowledge of nature."

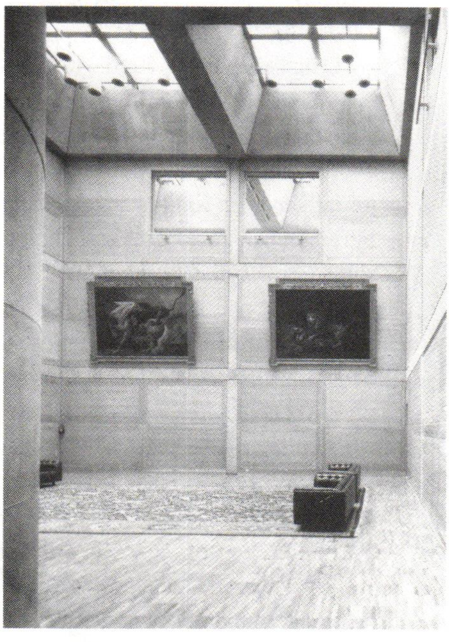
Tyng (who first worked with Kahn in 1945, in the office of Stonorov and Kahn and then, after 1947, in Kahn's own practice) clearly exercised a major influence on Kahn's development, introducing him to D'Arcy Thompson's *Growth and Form* in 1952. Between 1951 and 1953, Tyng designed two independent works employing octatetrahedron geometry—a prototypical school and a house for her parents built on the eastern Maryland shore in 1953. This triangulated space-frame building, left open for habitation, was of the same order as Kahn's Yale Art Gallery design of the same date, although by now Kahn was

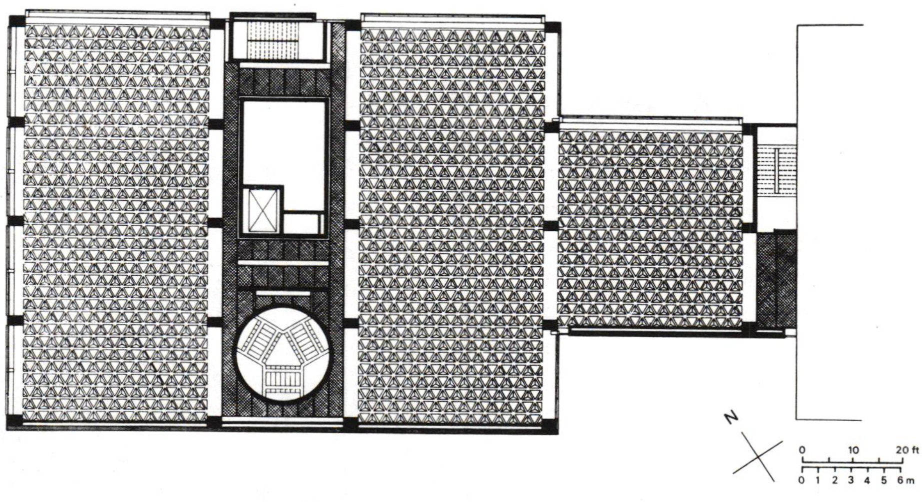
Yale Center for British Art, New Haven, Connecticut; Louis I. Kahn, 1951–53.

also familiar with the work of R. Buckminster Fuller whom he had met while teaching in the architectural school at Yale.[14] While Tyng played a major role in initiating the City Tower project both Kahn and Tyng were mutually influenced by the 1953 discovery of the presence of tetrahedral geometry in molecular form. This discovery encouraged them to propose such structures in advance of Fuller who would not design and test his octa-tetrahedral truss until 1959. The tripartite tetrahedral ordering principle of the final version of the tower was thus imagined by Kahn and Tyng as a millennialistic construction, all but identical in its form with natural crystalline structure. Kahn would first employ this geometry in combination with the interstitial mechanical services in his Yale Art Gallery under construction in New Haven between 1951 and 1953. In the final version of the City Hall Tower the term "servant space" would not only apply to the volume within the triagrid floors and of the tetrahedral capitals, used for the accommodation of lavatories, but also to the provision of catwalks for the purpose of maintenance and for the horizontal transfer of ducts and pipes. At this point, the Structural Rationalist principle of giving primacy to the joint and the transmission of stress is no longer solely a matter of careful detailing but is further amplified through geometry to include the provision of hierarchic space as well. In this way a clear separation was maintained between the secondary *servant* spaces, such as the elevators, service cores, lavatories, et cetera, and primary *served* volumes. As Kahn put it later, with regard to his penchant for interstitial servicing elements, "I do not like ducts; I do not like pipes. I hate them really thoroughly, but because I hate them so thoroughly, I feel they have to be given their place. If I just hated them and took no care, I think they would invade the building and completely destroy it."[15]

Although tubular steel gave way to concrete in all of the versions of the City Tower and indeed in all of his work thereafter, the precept of a hollow structural form will remain a perennial theme throughout his mature career. This, in addition to the tactile immediacy of subsidiary constructional elements, will become irreducible principles for Kahn, because they are based on the geometrical essences of archetypical, universal forms. For him they will appear as the ethical givens of building culture without which one cannot create anything. Kahn's concept of tectonic authenticity went beyond this to consider the experiential impact of the work on the subject. This much is confirmed by a statement he made about the tactility of the Yale Art Gallery. He clearly saw the pseudo-Brutalist interior of this work as embodying a kind of psycho-ethical challenge. "One might feel," he wrote, "that only persons who are in flight from themselves, who need plaster and wallpaper for their emotional security, can be uncomfortable in this building."[16] Despite the patronizing tone of this reflection, Kahn is nonetheless close in this work to the principles embodied in Auguste Perret's plaster-free Musée des Travaux Publiques and to Perret's equally tectonic concern for the integration of services into the hollow interstitial structure of his building.

The way in which Kahn comes to terms with orthogonal geometry in the Yale Art Gallery will be decisive for the rest of his development, as will the manner in which its reinforced concrete skeleton is both revealed and concealed by the continuity and discontinuity of its cladding. The solution adopted recalls the tectonic/stereotomic interplay in Kahn's City Hall proposal, for here, in contrast to the homogeneity of the principal street elevation in brick, the return curtain wall in glass is subdivided so as to read as a tessellated, translucent skin. In order to express the common hermetic nature of both, Kahn alternates the manner of the structural expression between the northern and southern faces, so that where the curtain-walled facade on the northwest and northeast elevations serves to conceal the concrete floor and to reveal the columns, the converse applies





Hall of the library on the second floor (left), and reflected ceiling plan and final structural concept (above) of the Yale Center for British Art, New Haven, Connecticut; Louis I. Kahn, 1951–53.

on the main Chapel Street front, where the columns are suppressed except at the returns and where the floors read continuously throughout. The floors are represented by horizontal string courses in stone, which are made of the same depth as the concrete ribs projecting from the tetrahedral floors. These string courses are of the same tectonic order as the metal facing plates that cover and represent the floors in the fully glazed facades.

Within this play, the triagrid floor functions both as a structural network and as a distributive membrane with tubular air ducts and electrical raceways running in the interstitial space of the monolithic but hollow concrete tetrahedrons which make up the three foot floor depth. That these triagrid floors ultimately had to be calculated as inclined structural beams, due to the kind of calculations required by the city building code, hardly discredits the inventiveness and inherent probity of the design. One needs to note that the volume of the octahedral space within the overall tetrahedral space-frame is four times greater in volume than the tetrahedron itself. The radically tectonic character of this geometry no doubt accounts for the auto-critical sketch that Kahn made after the completion of the museum. As in the space frame proposed for the floor and roof of the Adath Jeshurun Synagogue and School projected for Elkins Park in 1954–55, this post-facto sketch proposes to support the tetrahedral floors of the gallery on tetrahedral pylons. This hypothetical, idealized gallery appears in two versions, first as a square and then as an octagonal plan, fed in each instance by free-standing cylindrical cores. Against this sketch, Kahn would append the note, "a tetrahedral concrete floor asks for a column of the same structure." This may be read as an indication of the way in which his tectonic preoccupations would be at variance, at times, with the spatial and structural requirements of the work.

Kahn's sketch of an alternative tetrahedral structure for the Yale Art Gallery possibly derives from the fact that the floor as built was about 60 percent heavier than what would have been required for a normal forty-foot span, and while the finished ceiling possessed all the ethical and aesthetic attributes that Kahn desired, the revealed structure was not designed as originally envisaged. The initial tetrahedral unit, as designed by Kahn and the engineer H. A. Pfisterer, was to have been a two-foot-high pyramid having three-and-a-half-inch thick sides, cast integrally with a four-inch concrete floor. While this made for a heavy floor, the overall ingenuity of the concept lay in the integration of the mechanical services running in the octahedral spaces within the tetrahedrons.

Kahn's "servant versus served" theme is further articulated in the Yale Art Gallery, particularly where the floor of the middle *servant* bay is distinguished from the honorific volumes it *serves* by being made of flat concrete-plank construction rather than being cast in the form of the triagrid floors. At the next level of detail, this narrower structural bay accommodates three servant elements; a cylindrical tripartite stair, an elevator/bathroom core, and a standard dogleg escape stair. Of these, the first is the main public stair and this accounts for its honorific format comprising an equilateral triangular stair housed in a cylinder, as previously employed by Kahn in the City Hall design. The same honorific stair will appear in the designs for the Adath Jeshrun Synagogue projected for Elkins Park, Pennsylvania in 1954. Meanwhile, at Yale, a second servant bay accommodating another escape stair, adjacent to the existing neo-Gothic, Weir Hall, will also be simply rendered in concrete-plank construction.

That Kahn was always concerned with the specific appearance of the constructional elements employed is evident from the care with which the Yale Art Gallery was detailed. This is confirmed by William Huff's memoir dealing with the construction of the gallery particularly in the light of Kahn's concern for the quality of microtectonic elements.

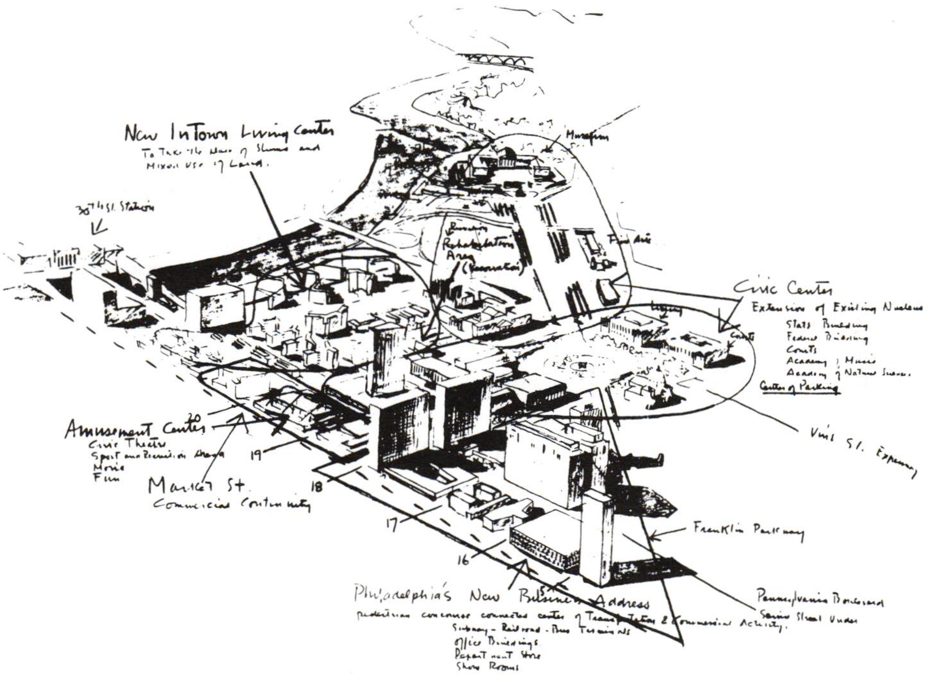
> In addition to his innovative handling of the basic concrete structural system, into which he deftly integrated the mechanical systems, and to the concrete's consequent exposure as one of the primary architectural finishes at the Yale Gallery addition, other major materials, such as the gallery floors and special concrete block, both of which played against the rugged concrete, evidenced his innate urge for the sensual. Other architects were using polished brick pavers or rubber tile or something like that for their floors. But in his free-searching survey of an inventory of imaginable, albeit viable, products, Lou stumbled upon the gymnasium floor, made up of carefully matched end-grain maple-strips—a wonderfully rich, as well as wonderfully comfortable and durable, material. And, saying that nothing looked more like a concrete block than the common 8 × 16 block, he had special 4 × 5 blocks manufactured, whose dimensions and proportions gave the walls wonderful scale and texture.[17]

Elsewhere, in the same memoir, Huff remarks on the recessed "shadow" joint adopted in the paneling of all of Kahn's interior cabinetwork.

> Lou's detailing of doors and wood wall panels was strictly out of the Elizabethan age; but he had his own profiles. It allows the breathing of the wood so that the wood doesn't crack or check. Lou's panel doors were uniquely his "look," but they acknowledged and incorporated the basic principles.[18]

Kahn's consciously archaic but critical, hyper-radical, anti-avant-gardist approach finds reflection in his intense awareness of the ontological distinction between column and wall, his Albertian reference to the primordial separation of the two, by virtue of light penetrating into the opaque impassivity of wall and thereby liberating the free-standing column from within its mass. This poetic intuition linked Kahn to the principle of structural articulation in Mies but at the same time distanced him from the Miesian free plan. In a 1957 interview given to the *Architectural Forum* he said: "You should never invade the space between columns with partition walls. It is like sleeping with your head in one room and feet in another. That I will never do."[19]

This tension between modernization and monumentality will assume a particularly dramatic form in Kahn's speculations about future urban development and above all, in the various plans that he projected for Philadelphia between 1952 and 1962. Kahn was to remain preoccupied with the myth and reality of Philadelphia throughout his life. For him, it could not be entered via the high-speed osmosis of the airport and the freeway; that is to say, by the experiential alienation pictur-



Plan for midtown Philadelphia; Louis Kahn, 1945–48. Isometric sketch showing the groups of various activities in the North Triangle Area; notes include: "30th St. Station"; "New In Town Living Center, To take the place of slums and mixed use of land"; "Civic Center, Extension of Existing Nucleus"; "Philadelphia's New Business Address, Pedestrian Concourse connected [with] center of Transportation & Commercial Activity"; and "Amusement Center, Civic Theatre, Sport and Recreation Arena, Movie, Fun."

esquely rationalized as a necessary condition in a 1963 publication entitled *The View from the Road* by Donald Appleyard, Kevin Lynch and John Myer.[20] As far as Kahn was concerned, Philadelphia had to be approached through that which had graced all cities since time immemorial, namely, through an honorific gateway, which, in Philadelphia's case, was the monumental Beaux Arts peristyle of the 30th Street Station. Something of Kahn's sense for the institutional and political continuity that is to be found in urban foundations may be gleaned from a text he wrote in the early 1960s:

> The city, from a simple settlement, became the place of the assembled institutions. Before, the institution was the natural agreement—the sense of commonality. . . . The measure of greatness of a place to live must come from the character of its institutions, sanctioned through how sensitive they are to renewed agreement and desire for new agreement, not through need, because it comes from what already is.[21]

By this date, twenty years after Kahn's initial essay on monumentality, the manifest destiny of monumental form had become amplified; it had evolved from an initial focus on tectonic expression to include within its scope the seminal character of the civic institution. Kahn was well aware that all traditional institutions, were threatened by the processal aspects of late metropolitan development. Thus, Kahn's concern for the continuity of the city as an assembly of institutions, is paralleled by his efforts to accommodate and overcome the contrary demands being made upon the traditional city by the ever-changing dynamics of modern locomotion. This much is clear from the way he was to conceive of the automobile in relation to the city. He wrote in 1961:

> The circumstantial demands of the car, of parking and so forth, will eat away all the spaces that exist now and pretty soon you have no identifying traces of what I call loyalties—the landmarks. Remember, when you think of your city, you think immediately of certain places which identify the city, as you enter it. If they're gone, your feeling for the city is lost and gone. . . . If because of the demands of the motorcar, we stiffen and harden the city—omitting water, omitting the green world—the city will be destroyed. Therefore the car, because of its destructive value, must start us rethinking the city in terms of the green world, in terms of the world of water, and of air, and of locomotion.[22]

From the scale of the tectonic element to the scale of megaurban form, Kahn constantly attempted to introduce into the fundamental structure both the necessary services and the character of a place-form in order to neutralize the destructive aspects of 20th century technology. Thus, his efforts to interpret modern space-frame construction in the light of principles derived from Structural Rationalism were to be paralleled by attempts to transform the elevated freeway into a new form of civic architecture. This preoccupation lay behind Kahn's paradoxical aphorism that "the street wants to become a building" and his later projection of what he disingenuously referred to as "viaduct architecture."[23] This was also the primary impulse behind his 1957 plan for Midtown Philadelphia, above all his so-called Civic Center Forum, surrounded by parking silos, of which he wrote:

> This strategic positioning around the city center would present a logical image of protection against the destruction of the city by the motor car. In a sense the problem of the car and the city is war, and the planning for the new growth of cities is not a complacent act but an act of emergency. The distinction between the two architectures, the architecture of the viaduct and the architecture of the acts of man's activities, could bring about a logic of growth and a sound positioning of enterprise.[24]

The ambivalent tension in Kahn's work between modernization and monumentality is perhaps never more evident than in the evolution of the cylindrical parking towers by which the city center was to have been surrounded. However even these elements would be abandoned when Kahn produced his last comprehensive plan for Philadelphia in 1961. On this occasion, Kahn would attempt to secure the form of the city by proposing to surround it with a perimeter wall comprising a bermed-up autoroute under which he placed various subterranean facilities, from parking lots to stadia. The form of the city was now reduced exclusively to its transportation systems, to the helicopter airport and the central bus terminal, and to one or two large structures dedicated to mass entertainment. However, sensing that all of this was ultimately unattainable, Kahn was to abandon urbanism *in se* and devoted the rest of his life to the design of one-off buildings, having monumental if not urban implications.

NOTES

1. Sigfried Giedion, José Luis Sert, and Fernand Léger, "Nine Points on Monumentality" in *Architecture You and Me* by S. Giedion (Cambridge: Harvard University Press, 1958), pp. 48–52.

2. Paul Zucker, ed. *The New Architecture and City Planning* (New York: Philosophical Library, 1944).

3. Louis I. Kahn, "Monumentality" in *The New Architecture and City Planning*, P. Zucker, ed. (New York: Philosophical Library,1944), pp. 578–79.

4. Ibid, pp. 579–80.

5. Ibid., p. 580.

6. Ibid., p. 581–82. However, as Pol Abraham was to observe, the cross ribs of a Gothic vault are at times structurally redundant and are deployed for formal reasons and to facilitate assembly. See Pol Abraham, *Viollet-le-Duc et le rationalisme mediaevale* (Paris: Vincent Freal et Gie, 1934).

7. Information given by Ann Griswold Tyng to the author in February 1993. When Tyng was in Rome in the fall of 1953 she showed the City Tower project to Nervi, who regarded the proposed structure as a three dimensional version of his two dimensional "pleated" and triangulated concrete structures. (Ann Tyng in a letter to the author.)

8. Louis Kahn, "Form and Design," *Architectural Design*, no. 4 (April 1961): 145–48. Kahn's distinction between form and design was to reverse in many respects the emphasis that Mies van der Rohe placed upon the "how" of architecture rather than the "what." That the "what" was of more importance to Kahn was largely due to his profound commitment to the institution, or what he called an "availability" in a civic and spiritual sense. In "Form and Design" he would write: "Form is 'what,' Design is 'how.' Form is impersonal. Design belongs to the Designer. Design is a circumstantial act, how much money there is available, the site, the client, the extent of knowledge. Form has nothing to do with circumstantial conditions. In architecture it characterizes a harmony of spaces good for a certain activity of man."

To these distinctions Maria Bottero would add the following illuminating gloss in her essay entitled "Organic and Rational Morphology in the Architecture of Louis Kahn" (see above): "The Psyche is the source of what a thing wants to be . . . the means that life (or the drive towards *being*) runs through us but does not belong to us individually, so that man finds himself curiously decentralized with respect to his own work: which as Kahn himself says, is an achievement all the greater, the less it pertains to *Design* (i.e. the contingent, measurable, and subjective) and the more it belongs to *Form* (i.e., the transcendental, immeasurable, and universal). Between *Form* and *Design*, the creative process takes place as an indefinitely repeated shuttling process, and by this the plot of the work is laboriously woven; a plot which is a strip stretched across the non-homogeneous, the non-continuous, or in the end—the unconscious."

9. For this essay see Theophilus B. White, ed., *Paul Phillippe Cret: Architect and Teacher* (Philadelphia: Art Alliance Press, 1973), pp. 61–65.

10. I have in mind Hannes Meyer's inaugural address as the director of the Bauhaus in 1928, given under the title "Bauen" (building) in which he itemizes a whole range of explicitly modern, nontraditional, man-made materials such as ferro concrete, wire glass, aluminum, asbestos, plywood, ripolin, silicon steel, cold glue, casein, cork, rolled glass and synthetic rubber, leather, resin, horn, and wood. See Claude Schmaiat, *Hannes Meyer: Buildings, Writings and Projects* (London: Tiranti, 1965), p. 95.

11. Louis Kahn, "Monumentality" in Zucker, p. 587. Kahn's interest in pioneering new materials was to continue throughout his life. See in particular his use of "pewter finish" stainless-steel cladding to the Yale Center for British Art, posthumously completed by Pellecchia & Meyers, Architects. This dull, variable surface is produced by omitting final baths in the fabricating process. That the revetment is a skin, a *Bekleidung* in the Semperian sense, is indicated by the weathering details.

12. Louis Kahn, "Toward a Plan for Midtown Philadelphia," *Perspecta* 2 (1953): 23. Kahn's relationship to R. Buckminster Fuller was complex, although both men were teaching at Yale University in the early 1950s. Despite Tyng's patent interest in Fuller at the time Kahn justly wanted to distance himself from Fuller's position in retrospect as he was to make clear in his 1972 interview with John Cook and Heinrich Klotz, when in referring to the Yale Art Gallery he pointed out that Buckminster Fuller's structural concepts were incapable of producing a flat ceiling. See *Conversations With Architects* by John W. Cook and Heinrich Klotz (New York: Praeger, 1973): 212.

13. Louis Kahn, "Monumentality" in Zucker, pp. 581–82.

14. As Konrad Wachsmann shows in his book *The Turning Point of Building* (New York: Praeger, 1961), this form of tetrahedral space geometry had been first explored by Alexander Graham Bell in his trussed aerial platforms and kites of 1905.

15. See Richard Saul Wurman and Eugene Feldman, *The Notebooks and Drawings of Louis I. Kahn* (Cambridge: MIT Press, 1973), (unpaginated).

16. Louis Kahn's reference to Brutalism alludes of course to the British New Brutalist movement, to which the art gallery was related by such critics as Reyner Banham. See "The New Brutalism" by Banham, *The Architectural Review* (December 1955): 355–62.

17. William Huff, "Louis Kahn: Sorted Reflections and Lapses in Familiarities," *Little Journal*, vol. 5, no. 1 (September 1981); published by the Society of Architectural Historians, New York Chapter.

18. Ibid., p. 15 and 18.

19. See Walter McQuade, "Architect Louis Kahn and his Strong-Boned Structures," *Architectural Forum*, vol. 107, no.4 (October 1957): 134–143. William Huff comments on the typical Kahnian use of the term "invade" in this comment. Clearly Kahn had in mind the column and (screen) wall arrangements in Mies van der Rohe's Barcelona Pavilion. See Huff's memoir in the *Little Journal*, cited above.

20. Donald Appleyard, Kevin Lynch, John R. Myer, *The View From The Road* (Cambridge: MIT Press, 1964).

21. Romaldo Giurgola and Jaimini Mehta, *Louis I. Kahn* (Boulder: Westview Press, 1975), p. 224.

22. Louis Kahn, "The Animal World," *Canadian Art*, vol. 19, no. 1 (January/February 1962): 51.

23. H. Ronner, et al, *Louis Kahn: Complete Works, 1935–74* (Boulder: Westview Press, 1977), p.31.

24. Ibid., p.29.

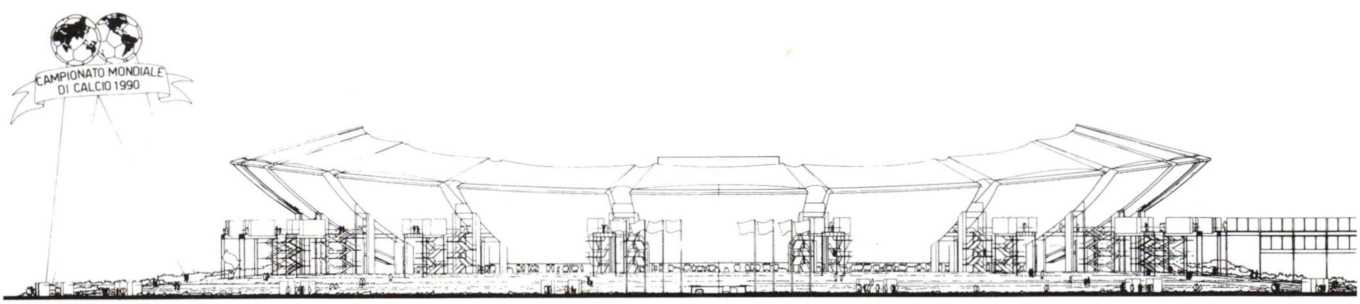
KENNETH FRAMPTON

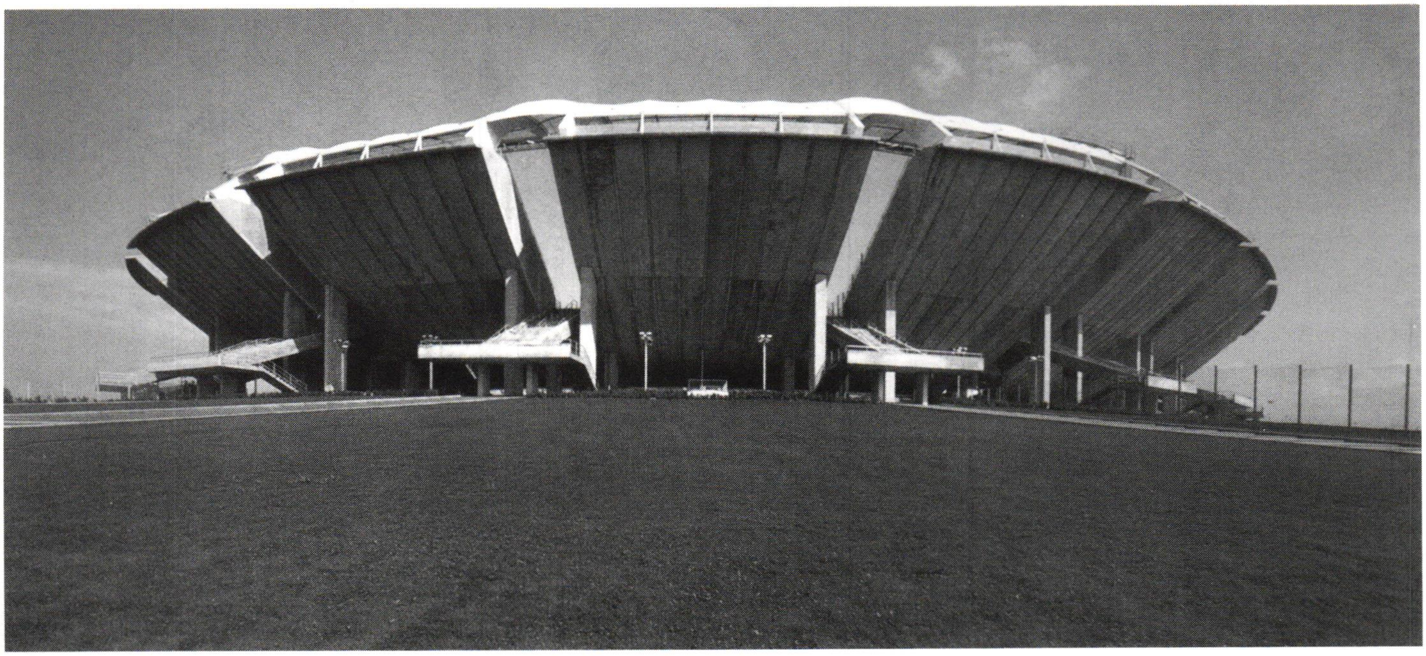
Renzo Piano in America

Amid the unending flow of arcane texts and the equally obtuse buildings that simultaneously provoke and sublimate the angst of the architectural scene, it is a relief to enter into the calm energy of Renzo Piano's Building Workshop exhibition that is touring the United States. Set up on table tops that are evocative of both drafting boards and workbenches, this is more like a library/study center than a typical exhibition. Nothing is on the walls but there is much to look at and, indeed, to work with. One is reminded of El Lissitzky's exhortation to children in his famous graphic parable of 1920, *The Story of Two Squares*: "Do not read, take scissors, cut, fold and paste." Here, visitors are invited not only to look but also to touch, to use, to study in the fullest sense imaginable. In this respect the exhibition evokes the infinite for it would take at least a week of continuous application to exhaust its immediate content—and even then the full dimension of its latent content would always be elusive. Something of the density and the multilayered aspect of this show is deftly conveyed by Peter Buchanan's introduction to the tabloid catalog that accompanies the exhibition.

> Here can be studied the local factors and the concepts that shaped the design, original construction documents and the assembly process, and some of the published critical reception. The building itself is evoked as vividly as possible in a specially prepared portfolio at the extreme left of each tabletop. Models and sometimes an actual component or the characteristic piece give some sense of the building's physical presence, emphasizing its sensuous tactility. On some tables, computers allow study of simplified versions of actual design investigations by the Building Workshop and Ove Arup & Partners. These offer insight into how structural assemblies are analyzed and shaped by the forces they resolve, and into the complex geometries that discipline the forms of some buildings. Just as computers help to unravel nature's secrets, so they help to create designs that follow ever more closely the laws and order of nature.

Within this spectrum of offerings, visitors might have a hard time choosing what to look at, particularly if their time is limited. This abundance of choice is, I imagine, even



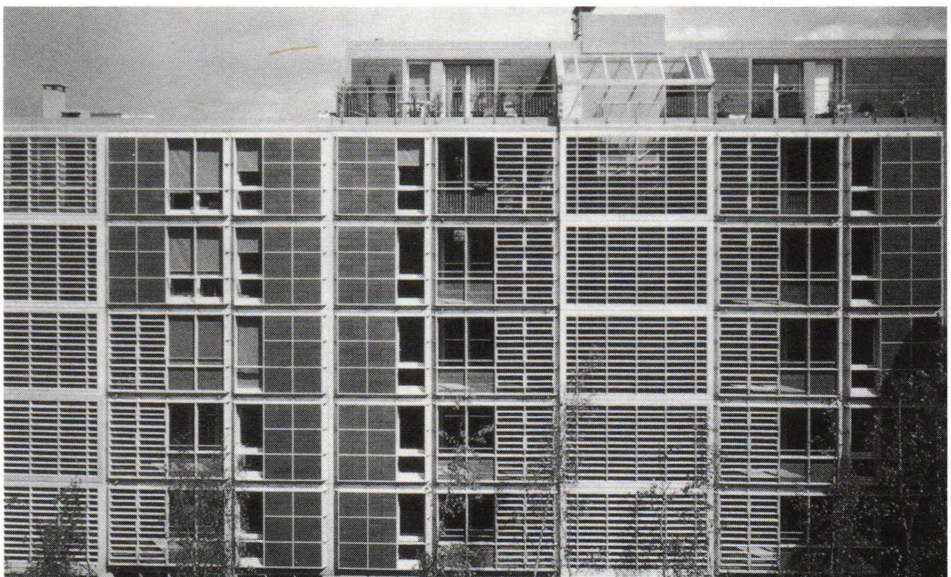


Elevation and general view of the San Nicola soccer stadium, Bari, Italy. The upper level consists of twenty-six independent petal-like segments; Renzo Piano Building Workshop, 1987–90.

more disconcerting in the De Menil Museum in Houston than in the New York Architectural League's version of the show because the number of projects displayed has grown from from six to twelve—confronting visitors with a stimulating but challenging surfeit of material. For example, there is the Kansai Airport table where one could study the evolution of the main structural components of what will soon be the longest terminal in the world. Or one delve into the amazing modular order of the modest perimeter housing block recently realized in the Paris. Should one marvel at the discrete reuse of the Lingotto factory, where a concert hall has been inserted into the existing reinforced-concrete frame with all the discretion and elegance of a violin carefully placed in its case? Or should one instead enjoy the portfolio of magnificent color photos of the gigantic reinforced-concrete San Nicola football stadium in Bari, whose space runs beyond the lip of its sunken amphitheater into the landscape? The feeling of the enormous weight of its cantilevered upper tribune, held clear of the bowl beneath, and that of the contrasting lightness of its canvas roof are beautifully conveyed by the remarkable photographs by the Japanese architect Shinju Ishida, who directs the Paris branch of the firm.

Indeed, this overload of information and visual stimuli elicits a passing frustration. Initially, it's difficult to know where to put oneself, but once caught by the genre of a particular piece, it's easy to settle in and let the didactic force of the exhibition take over. Every architectural student in the country should see this exhibition, because it displays so clearly what it takes to truly master the building process in our time.

If I were asked to select one display that is emblematic of the Building Workshop at the height of its powers, it would not be the daring reinforced-stone arches projected for the Padre Pio pilgrimage church, with their subtle inversion of what we commonly think of as "high versus low" tech construction. Instead, it would be the more modest—but more subtle and precise—infill perimeter housing block, designed for an inward-looking site off the rue de Meaux in Paris. Completed in 1991, this building is a tour de force on a number of levels: the extreme care with which it is inserted into the existing fabric; the sensitivity so manifest in the landscaping of the existing court; the brilliance of the tatami-like ordering principle that yields well-planned apartments within the constraints of a modular, prefabricated system; the delicate interplay between solid and void



(This page:) Elevations and view of housing project, rue de Meux, Paris; Renzo Piano, 1988–91.

in the handling of its internal facade, compounded by the subtle articulation of the fenestration; and last, but not least, the oversized red terra-cotta facing tiles hung like scales on brackets that are cast into the recessed glass fiber-cement panels with which the building is faced. Context, history, and the passage of time are brilliantly dealt with in this singular move, for the decorative facing of the building is clearly articulated, while the economy of a dry assembly process is never compromised. The glass fiber-cement panels, cast presumably from plastic molds, together with their tiles, attain a high level of machine-tooled finish and precision that is also traditional, except for the mode of fixing and the size of the tiles. Faced with a full-size mock-up of this component, one cannot resist moving the tiles in and out of the frame. It all seems so simple and subtle, so that one must ask, "What is the problem? Why do we make such a ridiculous fuss about the production of quality housing for society at large?" The sad answer to this question must that the average protagonist—whether politician, bureaucrat, builder, or architect—is invariably incapable of performing either individually or jointly at this level. So much for the relative decadence of our society, of the building industry and also of the profession, not to mention architectural schools that have fallen into a kind of somnambulism in this regard. Thus, when one realizes that Piano's de Meaux block is a marked exception and yet it does not look prohibitively expensive, one is left wondering why it can't be imitated. Such a question would be rhetorical were it not for the fact that the Japanese have arrived at their current standing in the industrial world by virtue of imitation. Through thoughtful imitation they have been able to constantly refine their production. Why does the building industry and indeed the architectural profession find this paradigm so difficult to follow, even in Japan? This question becomes all the more ironic when one realizes that there is very little that is handcrafted in the rue de Meaux housing project.

This exhibition is a must, in my view, for any architect who can find his or her way to it. Aside from its intrinsic merit, this is an exhibition of architecture where, for once, the architect has sufficient confidence and feeling for reality to accord credit not only to his many collaborators from different fields, but also to his engineering colleague and longtime friend, the late Peter Rice, of whom he writes with characteristic modesty: "Faced with the death of Peter, someone so important in my life, I feel the usual unconscious and involuntary selfishness one feels in these situations. Peter took with him a large part of my creative inspiration. I only hope to have learnt enough to carry on alone."

RENZO PIANO BUILDING WORKSHOP: SELECTED PROJECTS, presented by The Architectural League of New York and the Italian Cultural Institute: The Urban Center, New York, December 18, 1992–January 30, 1993; The Menil Collection, Houston, March 11–May 31, 1993.

SEBASTIANO BRANDOLINI

Industry and Nature

Among the personal monographic works of the last forty years, works that shed light on the working methods and self-representational attitudes of architects, the three recent volumes of *Norman Foster: Buildings and Projects* perhaps represent the latest important chapter. There exists a tradition of "complete works," which are never really complete; their commonality is that they have been conceived by the architect and are therefore projects themselves, like the projects they illustrate. Complete works are always important documents of introspection as well as courage, but they are also a sort of testament, a recommendation, which the architect bestows upon his public. Such works are quite different, in their character and aims, from complete works published posthumously or produced by others, which offer a more predictable image, filtered by "outsiders," with an accent on objectivity.

The classic reference point is still Le Corbusier's *L'Oeuvre Complète*. In it, very little space is devoted to the architect's writings; the focus is on visual representations, and there are almost no outside contributions. Projects are presented in brief, and many works are not even mentioned. Preliminary design phases are overlooked. *L'Oeuvre Complète* was designed, in no uncertain terms, to be a manual, a horizontal handbook similar to a sketch pad (in its most practical and noble sense). Many architects own two copies: one in perfect condition for their libraries, and another, handled and worn, for their work tables. This work was so successful that in 1967 a condensed version, affordable for students, was published.

Within the same context of the image and promotion of modernism, we find the three volumes by Alvar Aalto, published in 1963, 1971, and 1978, in the same format as those of Le Corbusier. The complete works of Louis Kahn (in a large, inconvenient format), edited by the architect but published after his death, seem to be based on a different intent; design ideology, as the starting point and goal of the publication, is lacking. Kahn's complete works are organized as a critical anthology of projects. Thus, instead of the history of a patient, uninterrupted career, as in the cases of Le Corbusier and Aalto, Kahn's complete works present several discrete histories that stand alone and are based on a few dry, purely documentary images. Like many general works or catalogs, the complete works of Kahn fails to satisfy the reader's curiosity, and doesn't do justice to the architecture as a field of experimentation.

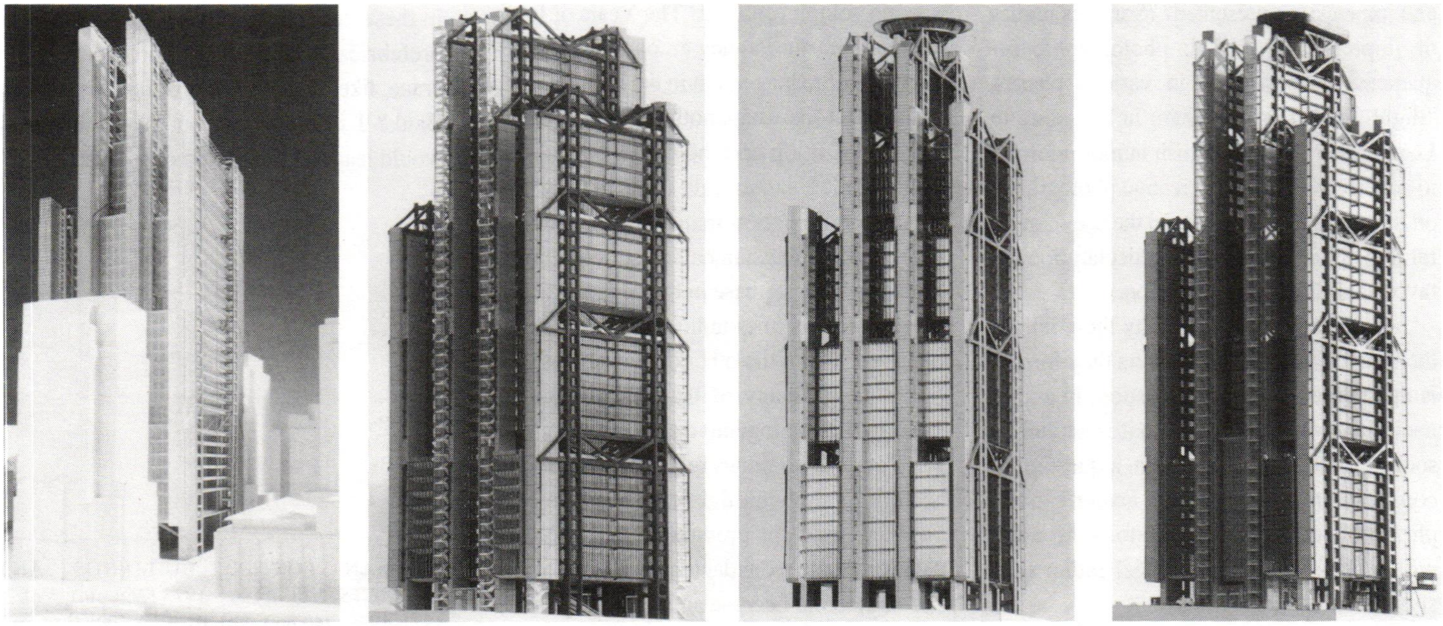
The complete works of Mies van der Rohe have yet to be published. The recent encyclopedia of his drawings published by Garland only partially fills the gap; most of the photographic images of his works convey a sad sense of déjà vu.

The absence of posthumous complete works of reinterpretation for Le Corbusier, Kahn, Hans Scharoun, Erich Mendelsohn, or Mies is somewhat compensated for by a proliferation of small, specialized or philological works, and many essays with banal illustrations. Their focus might be a particular work, a group of drawings, a particular period, a friendship or idea, a detail, a material. Among the published monographs, very few attempt to become genuine *summae*, and very few have the definitive character of a manual, which is still so necessary for communication, information, and education on all levels—from the critic to the student, professional to academician. This phenomenon reflects the high costs involved in the publication of "important" volumes, as well as growing specialization in the field of criticism, and a decline in critical interest regarding long-term architectural phenomena.

The trilogy on the work of Sir Norman Foster (1964–73, 1971–78, and 1978–85) is a far cry from the predictable, marketing-oriented monographs so often published today. This is an in-depth, well-documented work, pleasing to the eye and to the touch. It is also a hybrid editorial project: text and images are placed side-by-side with equal importance. The volumes contain both introspective and documentary figures; questions of method and building, technology-plant, and aesthetics are discussed in a combined catalog/coffeetable book/specialized volume. The graphics and the typography are excellent, creating a hierarchy of importance within a flexible framework. These volumes can be read at various interpretative levels: viewing only the images, without the texts and captions, or by concentrating on the many written presentations and comments, or by combining the two. This agile layout appears to have been borrowed from the graphics of certain architecture magazines.

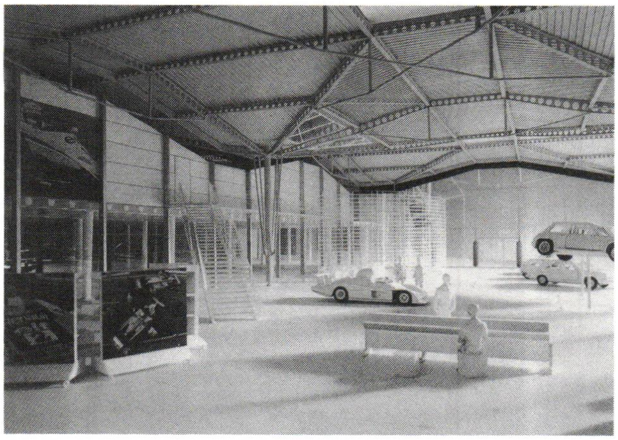
But beyond this communicative aspect, the books do not overlook in-depth analysis, which Foster considers the lifeblood of the design. This investigative approach has often made his work appear excessively technical and specialized, obscure even for many architects. So-called high-tech architecture has also suffered from a lack of critical attention, due to the absence of a clear theoretical or intellectual foundation. It is often recognized as an important branch of "architecture as construction," but from a critical/aesthetic point of view, what is there to say?

These volumes indicate that Foster intends to change this state of affairs, confessing his views without mystery and with a candor that also distinguishes his architectural style. Rather than formulate theoretical declarations for the use of others (as in the case of architects who insist on using one specific type of language), these volumes contain a declaration of practical principles. With optimism and faith in the logical and regulatory capacities of architecture, Foster leads us through the reasoning processes and techniques he has used during almost thirty years of work. The itinerary culminates in the last of the three volumes, which is almost entirely dedicated to the Hong Kong and Shanghai Bank, the first building higher than three stories designed and built by the studio.



Sequential study models of the Hong Kong and Shanghai Bank, from an early sketch version to the final version (left to right); Foster Associates, 1979–86. (From *Norman Foster: Buildings and Projects, Vol. III.*)

From an editorial point of view, it is certainly debatable whether this skyscraper in Hong Kong merits over a hundred and thirty pages, as opposed to the forty or so pages dedicated to edifices which are perhaps more incisive, such as the Willis Faber & Dumas building in Ipswich and the Sainsbury Centre for the Visual Arts in Norwich, both of the 1970s. Although this is a part of the in-depth approach, one senses that editor Ian Lambot has lost sight of the rapport between the quantity of material available (enormous, for the Hong Kong tower) and the significance of the edifice. There is a limit, in fact, to how much a book can communicate about a building, constructed or otherwise. An excessive number of pages (even without repetitions) can be counterproductive. This problem will probably reemerge in the volumes now in preparation, which will deal with complex edifices such as the Stansted Airport in London and large urban planning projects such as that for King's Cross.



Large-scale model of Renault Distribution Centre, Swindon, England; Foster Associates, 1980–82. (From *Norman Foster: Buildings and Projects, Vol. II.*)

What can we gather from this frank architectural manual, this unembarrassed exposition of archives? What can we learn from the many articles written by others scattered throughout the main "plot line"? What sort of fabric can we weave out of all the fragments and impressions presented? (Some examples of impressions offered: photographic sequences of work-sites in various phases, "flight 347" from Lyneham in Wiltshire to Leutkirch in Swabia, British humor referring to advertising imagery, creative photography on the theme of the plant and the use of natural light in architecture, and declarations in favor of collective participation.)

The questions are posed by the volumes themselves. One of the answers they furnish is that the technological question, in and of itself, does not exist because it is actually a social, psychological question, a question of construction and program. Foster's paraphrase of the modernist motto—"do more with less"—implies an ethical rather than stylistic aspiration.

The three volumes, thanks to their refined tone of introspection, explore and illuminate the high-tech movement, which, until today, had been considered almost extraneous to the noble culture of architecture, and in some way closer to the Anglo-Saxon tradition of pragmatic engineering. Perhaps unintentionally, Foster appoints himself the leader of a group of architects who, with a deep-seated passion for construction methods, have also been able to produce over the years a specific design aesthetic. If we then consider the younger talents that have matured while working in Foster's studio and then gone out on their own—Ian Ritchie, Jan Kaplicky, Ken Armstrong, David Chipperfield—Foster's role as a leader is reinforced by his role as teacher. In the introduction to the second volume, entitled "The Years of Innovation," Martin Pawley emphasizes the importance of management in the growth of the studio over the years, both in terms of internal organization and the capacity to obtain and complete large-scale commissions. For Foster, construction management does not represent the mechanical execution of a design, but the last phase in the design process. For this reason, the studio offers this service separately from the other design phases.

Although many of the images seem to bask in the photogenic quality of the structures and the luminous reflections of the new materials, although the volumes serve both for study and for promotion, and although there are some redundant images, these tomes are destined to become an important point of reference for architectural publishing.

Is the world that Foster places before our eyes one of industry or of nature? Probably both, superimposed. This is the basis of his optimism, his hopefulness, his introspection. The process of the growth of a building on a construction site is compared to that of biological growth. Many of the books' images place architecture and ecosystem side by side: the sections demonstrate how the building "breathes" the perspectives, how the internal spaces are invaded by climbing plants; the photos of the buildings include trees and sunsets; and the planimetric diagrams demonstrate how the architecture settles into the curves of the land surface. The foundation of all of this is a green idea of technology: the designer's job is to inject intelligence into each context and each architectural typology. We must look to the inevitable progress of the future and the miracles of industry: this is the working method, simultaneously materialist and minimalist, which is whispered to us and in which we are asked to believe.

A personal note, perhaps a prediction for the future, with a bit of nostalgia: since the days of Team 4 in the 1960s and Bean Hill in Milton Keynes in 1973, Foster no longer designs residences. This is a gap in his vision of the constructed environment. I would like to see houses or housing, designed and built, in these "complete works." Would they be prefabricated and dropped into place by a crane, like the bathrooms of the Hong Kong Bank? I don't know, but I am sure they would lead to unexpected complications.

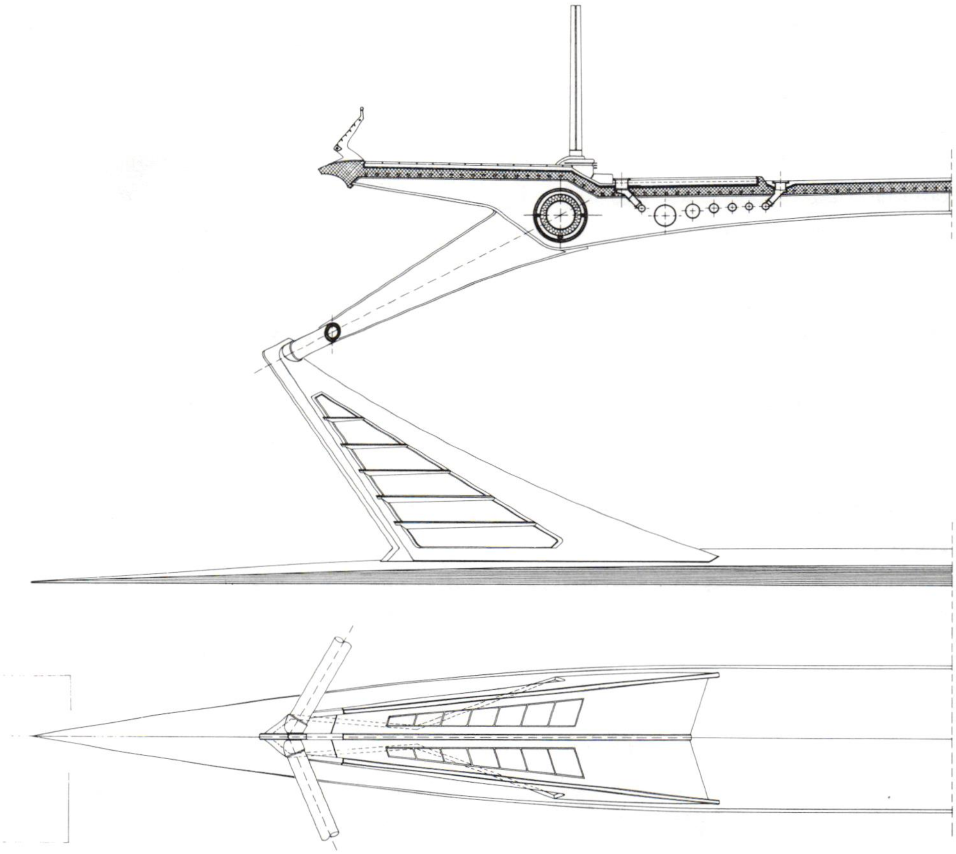
NORMAN FOSTER: BUILDINGS AND PROJECTS, Vol. I 1964–1973 (260 pp.); Vol. II 1971–1978 (240 pp.); Vol. III 1978–1985 (264 pp.), Ian Lambot, editor, Watermark Publications Ltd. (UK), 1989, 1990, illus., about $55.00 each.

MARC M. ANGÉLIL

Paradoxical Structures: Reading *Calatrava Bridges*

Santiago Calatrara, considered an *enfant terrible* by his fellow structural engineers, breaks with the long-established traditions of the profession, undermining its generally accepted code of performance. His work questions the fundamental tenets of a discipline that evolved in accordance with a puritan ethic essentially marked by positivistic traits. Structural engineering adheres historically to the development of a frame of consciousness based on the logic of rational thought and bound by unity of discourse. Economy of means and clarity of expression have been considered essential to a professional practice directed toward the efficient material application of strict and unifying principles. Restraint has been perceived as an engineer's virtue and a part of his code of conduct.

Max Weber's observations identifying the influence of ethical and economic structures on the development of science might



Side elevation of pier and part cross-section through deck, showing different levels (top), and above view of pier (bottom) of the Kronprinzen Bridge, River Spree, Berlin; Santiago Calatrava, 1991. (From *Calatrava Bridges*.)

PETER McCLEARY

Lineage and Themes in the Bridges of Santiago Calatrava

Santiago Calatrava is to my students what Pier Luigi Nervi was to me: an inspiration. Calatrava's and Nervi's influence, while not supernatural, appears based on fundamental engineering principles, and their work instills thought and feeling into our own productions.

Recently, in my bridge design studio, one-third of the students derived the essence of their design from themes in Calatrava's work—an indication that not only has he reached what George Kubler calls the "moment of his entrance" but also that the difference between mimesis and plagiarism needs clarification. It is the aura of invention rather than imitation that attracts students to Calatrava's bridges and me to Nervi's columns, and our beliefs that such inventiveness originates from an intuition of principles that are not arbitrary but accurate and true.

As a student, my peers and I had asked our teachers to reexamine the engineering of Robert Maillart, Riccardo Morandi, Nervi, and Eduardo Torroja; today, our students demand that we reconsider the works of Calatrava, Buro Happold, Peter Rice, and others. Of course, review can become revision; amending, improving, and correcting are mistaken for reexamining. Often the critic is not far from the judge. Where I see only the personal handwriting or *écriture* of Calatrava as the manifestation of a principle—contrasted to Eugène-Emanuel Viollet-le-Duc's understanding of "style"—the students believe that Calatrava's work, too, offers useful ideas, beginnings, and even principles.

Hermeneutics teaches us that a review, critique, or interpretation methodologically questions the text, context, intentions of the author, and the stance of the interpreter; and as Emilio Betti suggests, it finds a universality not lost in subjectivity.

Which text, here, is reviewed? The recently published *Calatrava Bridges*, or, if they can be called a text, the bridges themselves, or both? The book shows all of Calatrava's bridge designs from 1979 to 1992 (I counted thirty-three bridges excluding his projects as a student). Although the plethora of architectural publications, whether photographic monographs on individual projects or special issues of current production, will probably bankrupt all of us, this is an *oeuvre complète* that I welcome.

The photographs and drawings serve as a good introduction to the bridges. The site plans and bridge details are useful and necessary to interpret the scope of Calatrava's concerns, but the scale and the photo-reduction makes reconstructing either the site or the detail difficult, even with a magnifying glass. The notes on the plans, sections, and elevations are written in the original lan-

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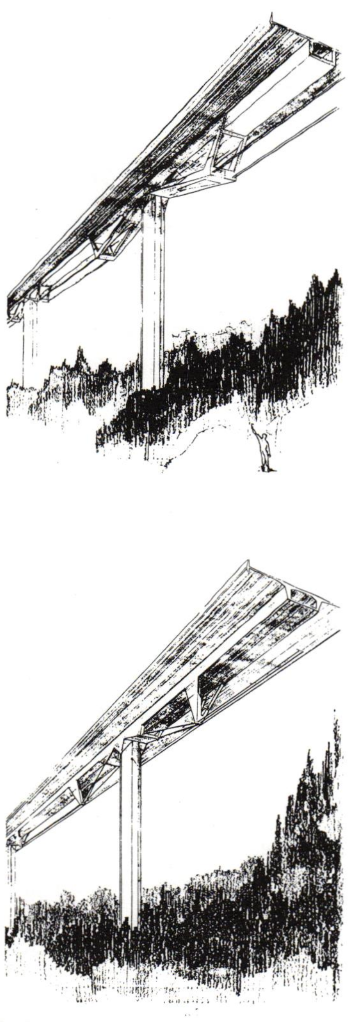
similarly pertain to the establishment of engineering as a seemingly objective discipline.[1] Established rules encompassing such criteria as utility, efficiency, and simplicity have not only contributed to specific modes of operation, but have essentially evolved as moral principles to be deployed in engineering works—the "apotheosis of technicity" at the service of capital investment determines a system of belief according to which a profession must perform.[2] To act in accordance with the axiomatic norms of the discipline is to uphold a commitment of truthfulness in engineering.

As demonstrated by the recently published monograph of his bridge designs, Calatrava discards many of the assumptions of his discipline. His work, as Marcel Meili has suggested, "stands as a criticism of a notion of science that has deteriorated into a chimaera."[3] The unity of structure, a dictum of traditional engineering, has, for Calatrava, given way to an amalgamation of principles and laws of statics. Material homogeneity, a generally observed rule in bridge construction, is replaced by the heterogeneity of material assemblies. The flow of forces, a principle of conventional structural mechanics guaranteeing the continuity of load transmissions, seems to be interrupted and torn apart. Kenneth Frampton, in an introductory statement to an earlier monograph on Calatrava's work, correctly observes a "swerving" of structural components, symbolically depicting a deviation from established rules of a long-standing *métier*.[4] An "acrobatic performance" is displayed in the work, substituting discontinuities for continuities, sometimes "irrespective of the structural matrix and the materials employed."[5]

Calatrava's approach can be considered both in opposition to traditional understandings of engineering and in terms of cultural conditions determining the operational basis of the design work. Frampton's and Anthony Webster's essays in the monograph *Calatrava Bridges* attempt a careful outline to identify possible frameworks for localizing the work, both historically and contemporaneously. Frampton's emphasis on the regional quality and contextual integration of Calatrava's projects belies an appreciation



Santiago Calatrava's externally prestressed bridge studies (1979–81) bear resemblance to the work of Eduardo Torroja. (From *Calatrava Bridges*.)

McCleary continued

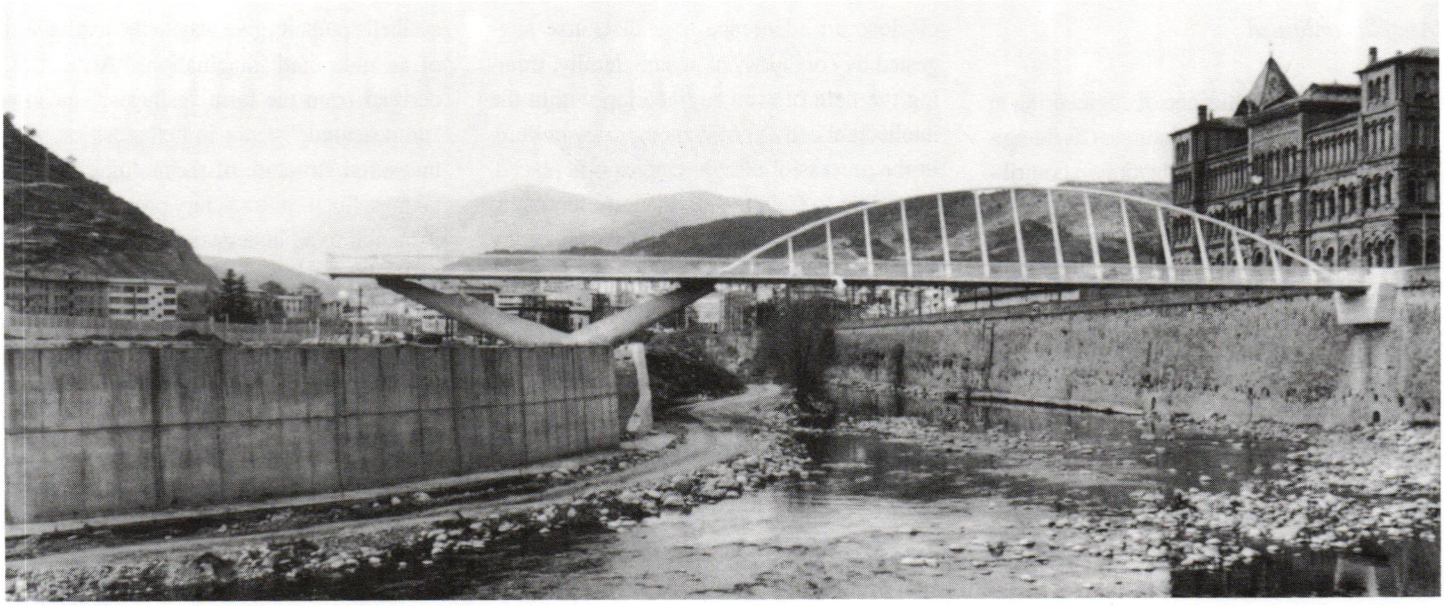
guage—French, German, or Spanish—although the book is published in English.

Kenneth Frampton's essay demonstrates that he, perhaps alone among contemporary historian-critics, uses and understands the principles of engineering, as did his late colleague, George Collins. Unfortunately, the other essay, by Anthony Webster contains several rather jarring mistakes. In his sentence, "Abraham Darby's pioneering use of wrought iron in his 30-metre Coalbrookedale Bridge of 1799 prophesied changes in the course of bridge design made possible by emerging, high-strength materials," I count five errors of fact and two conclusions with which I disagree.

Those of us who profess technology as the focus of our teaching, research, and practice can rarely claim scholarship in the humanities. We partially compensate for our lack of expertise in historiography, hermeneutics, philosophy, and language by our access to the sciences, with their insight into the logic of the natural world and languages of mathematics and scientific inquiry. Humanists who cannot differentiate among cast-iron, wrought-iron, and rolled steel protect their scholarly reputation by referring to "ferrous metal." Technologists who understand the differences discern that systems in cast iron in compression are analogous to stone, wrought-iron in flexure to wood, rolled steel in flexure to precast reinforced concrete, steel cable to rope, and so forth. Architects such as Leon Battista Alberti, Heinrich Hübsch, and Viollet-le-Duc have shown, in their work and beliefs, that materialized systems have spatial consequences, that a synthesis is possible between humanistic, practical, and scientific knowledge.

With few exceptions, the main structural elements of Calatrava's bridges are steel, both rolled plate and drawn wire and cable. The correlation between the materials and their configurations should not be a mystery. The surprise is that Calatrava's work is often related to that of engineers and architects with mastery in masonry (Antonio Gaudí and Rafael Guastavino); reinforced concrete (Maillart and Nervi); prestressed concrete (Christian Menn and Eugène Freyssinet); and only peripherally to Gustave Eiffel and hence to wrought iron. As with ferrous metals, masonry, be it brick, concrete, or stone, has a different structural language from that of reinforced concrete and prestressed concrete. It is also true that bolting, riveting, welding, precasting, pouring in place, pretensioning, and posttensioning, have their unique expressions.

Ortega y Gasset believed that each language carries its own particular image of the



La Devesa Footbridge, River Ter, Ripoll, Spain; Santiago Calatrava, 1989–91. (From *Calatrava Bridges*.)

world, and together with potentialities, it imposes a set of limitations on an author. He noted that when "the individual who wants to say something that is very much his own, and hence new, does not find in 'what people say' in the language a verbal usage adequate to express it, then the individual invents a new expression," which, if repeated by others, may become the established verbal usage. Calatrava attempts to say something new, neither limited to the languages of his teachers nor constrained by present expressions of structural materials and mechanics.

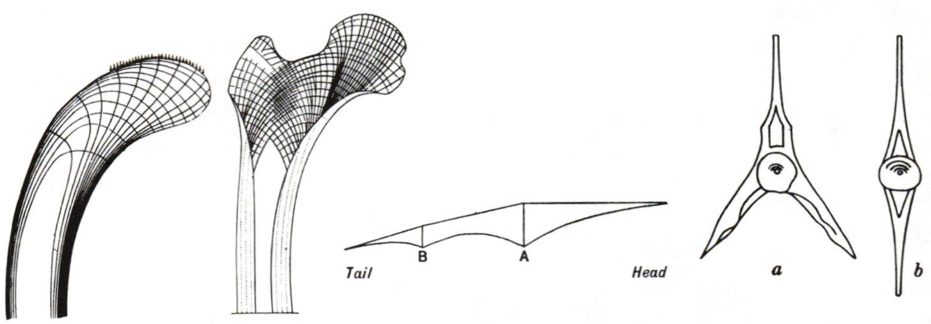
To make a significant "entrance" with a new language, Calatrava must divest himself of the expressions of the structural ideas of his predecessors. His bridge designs are the unfolding of that search for the "new," where either he will uncover a hidden principle or settle for the limited thematic expressions that will characterize his style.

Knowledge of the characteristics of ferrous metals is superficial compared to the insights revealed in the possibilities and limitations of iron, cast, wrought, puddled, rolled, and drawn. Similarly, to limit Calatrava's lineage to Gaudi, Felix Candela, Maillart, Menn, Freyssinet, and Eiffel would disclose in his work little more than thematic expressions.

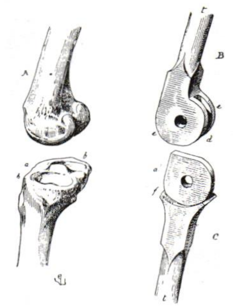
Calatrava's library must surely contain D'Arcy Wentworth Thompson's 1917 book, *On Growth and Form.* The chapter "On Form and Mechanical Efficiency" discusses many prototypical Calatrava themes; for example, the similarities between the stresses in the crane-head and femur, the stress-diagram of a horse's backbone, or the section of the dorsal spine and the caudal vertebrae of haddock. If Thompson is not a source of his ideas, then Carl Culmann, cited extensively in the same chapter, is surely known to him.

In 1855, the year that the Swiss Federal Institute of Technology in Zurich opened, Culmann became a professor of engineering sciences. In the United States he is known for his engineering journeys to America and Britain, his text on graphic statics, his studies of natural forms, and because his pupil and successor at Zurich, Wilhelm Ritter, taught Robert Maillart, who influenced Menn, with whom Calatrava studied. Another of Culmann's pupils, Maurice Koechlin, designed and analyzed the Eiffel Tower and other projects for Eiffel. The Zurich lineage of Calatrava is evident.

Calatrava's debt to the Spanish lineage of



The stresses in the crane-head and femur (left), in a horse's backbone (middle), and in a section of the dorsal spine (a) and caudal vertebrae (b) of haddock (right) are ideas that surface in many prototypical Calatrava themes. (From *On Growth and Form.*)



Similarly, Viollet-le-Duc's explorations of the mechanics of joints may have influenced Calatrava. (From *The Architectural Theory of Viollet-le-Duc.*)

Angélil continued

for the cultural significance of engineering in the production of infrastructures. Civil engineering fulfills a social obligation in contributing to the public domain—bridging, according to Frampton, into the realm of societal structures. Webster, on the other hand, recognizes the beginning of a "new paradigm for civil-engineering practice," a professional culture redirected by the potential of unprecedented methodologies, including the role of computational techniques for the representation of nonanalytic geometries and the calculation of indeterminate structures.

The preoccupation with complexities, inherent within Calatrava's approach, might disclose an adherence to a discourse suggested by conditions of postmodernity, framing the field of civil engineering within the intellectual context of contemporary culture. In the process of design, emphasis is placed, according to Calatrava in his introduction to the book, on an "integration of technology and aesthetics." His bridges are highly composed artifacts of strong iconographic presence. A free play with expressive form giving priority to the subjective will of the designer dictates the work. This subjectivity stands in contrast to the strict objective framework of technical exigencies. While technology relies on the specificity of material performance, the logic of structural behavior, and the precision of measurements, Calatrava's personal aesthetic pursuits give way to the exploitation of an unlimited imagination. "Aesthetics," derived from the term "esthesis," meaning "unmeasured," stands in juxtaposition to the measured structure of technological undertakings. Such contradictory propositions, fundamental to an understanding of Calatrava's work, form the basis of a mode of operation in which purity and impurities are allowed to coexist. The play of forces, apart from being read as a formal *tour de force*, underlies a sensibility that favors the deployment of paradoxical conditions which question the value of predetermined truths. Estrangement and bewilderment, constituents of contemporary culture, are implicit within the work.

Interpretations of Calatrava's designs seem

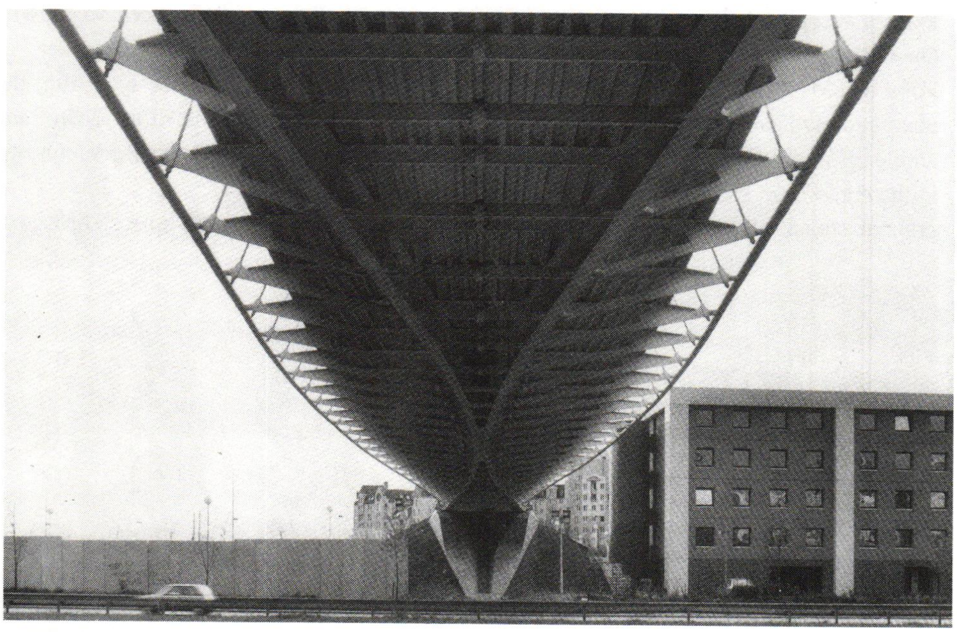
McCleary continued

Cuastavino and Gaudí is well known. The same is true of the friendship and mentorship of Candela. Less well known is the commonality with an earlier colleague of Candela—Emilio Perez Piñero, who, like Calatrava, was awarded the August Perret Prize. Piñero's research on foldable three-dimensional reticular structures generated an image of structural deployment akin to some of Calatrava's structures and his Zurich dissertation, titled "Concerning the Foldability of Frameworks." The work of remarkable Spanish structural engineer Torroja, *Philosophy of Structures*, bears comparison with Calatrava's, particularly in his use of asymmetry, the cantilever, and exposed prestressing cables. His 1925 aqueduct at Jerez de la Frontera and the 1956 project for half-mile-long aqueduct precede similar structures by Menn and surely are part of Calatrava's background.

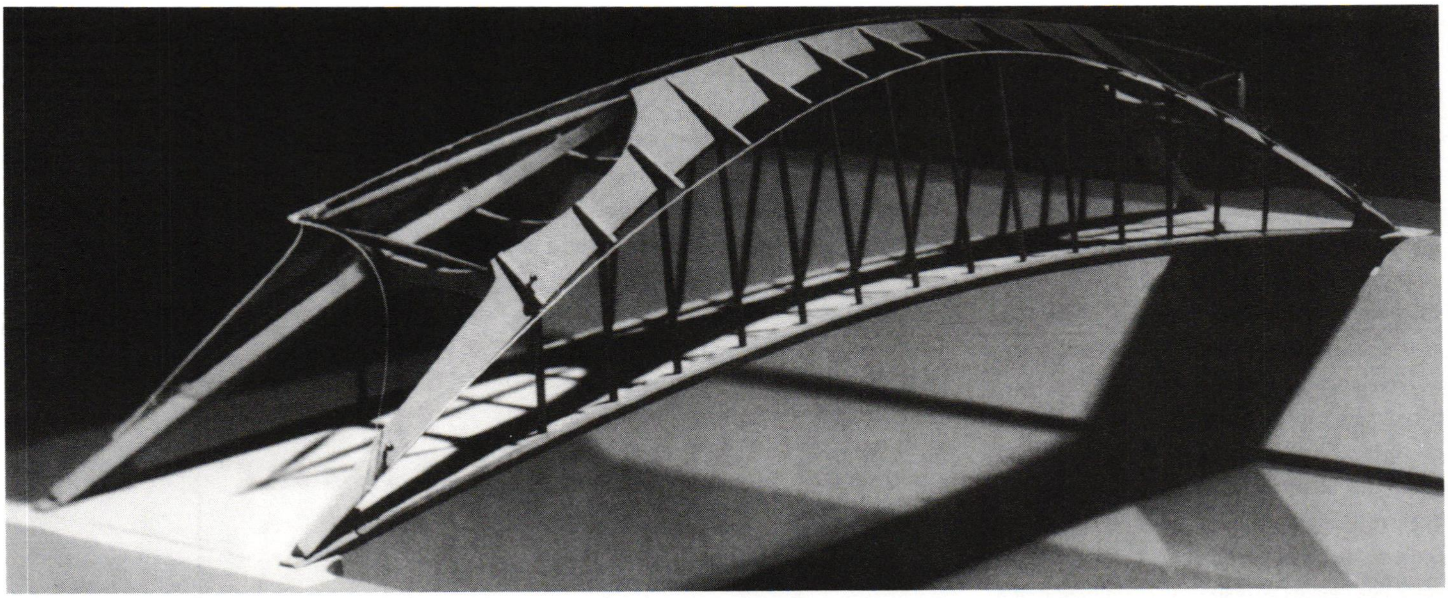
Calatrava's connection to Eiffel (and hence Koechlin), Freyssinet, and Jean Prouvé is often cited, but reference is not yet made to Camille Polonçeau. Viollet-le-Duc's thoughts on "how certain animal forms can be applied to mechanisms" is akin to Culmann's research, and may also have influenced Calatrava, either directly or indirectly, through Gaudí.

Nervi is reputed to be an Italian influence, although Michelucci is not. If Calatrava is immersed in the culture of engineering, then Morandi, like Torroja, is surely a kindred spirit. Morandi's "balanced torsion" cinema balconies in the 1930s, his underground car park in Valentino Park, Turin, and his viaduct projects at Jeddah and Carpinetto are worthy progenitors of Calatrava's engineering language. In truth, Morandi's large, precast, prestressed concrete elements are a more appropriate analogy for Calatrava's steel bridges than the fluid reinforced concrete structures of Maillart and Nervi.

Since a quarter of Calatrava's bridges are cable-stayed structures, he is probably aware of a German engineering tradition manifest in the bridges of Fritz Leonhardt, whereas the sublime structures of Ulrich Finsterwalder may have escaped his scrutiny. His interest in the visual instability of cable-stayed structures as opposed to the static repose of a suspension cable accounts for the lack of reference to the structures of Othmar Ammann (a student of Ritter at Zurich), John Roebling, David Steinman, Blair



The Oudry-Mesly Bridge in Créteil, Paris, shows the engineer's interest in the pointed oval form; Santiago Calatrava, 1987–88. (From *Calatrava Bridges*.)



Reuss Bridge, River Reus, Flüelen-Seedorf, Switzerland; Santiago Calatrava, 1989. (From *Calatrava Bridges*.)

Birdsall, and the so-called American tradition. As most of Calatrava's bridges are arch structures whose decks are either supported or suspended, a study of the bridges of Gustav Lindenthal (for whom Ammann worked) will prove fruitful. Lindenthal's lenticular trusses combine characteristics of both traditions—the back-stayed suspension cable and the arch with suspended deck—as does Isambard Brunel's bridge at Saltash.

Calatrava seems oblivious to the British tradition of Ralph Freeman, Fox, Oleg Kerensky, and Gilbert Roberts, with their emphasis on lightness. The influence of British, German, and American engineering seems minimal.

If Calatrava's bridge praxis develops toward lightness and an expression of force rather than mass (his present emphasis) then he might investigate the structures of Hübsch of Germany, Vladimir Suchov of Russia, and Robert Le Ricolais of France. However, he may have to abandon his interest in what he calls "the most beautiful quality of the novel material of concrete—its ability to take on any form, to be cast. You have an incredible freedom when working with it."

Umberto Eco warns us of the danger of overinterpretation. Thus, we should hesitate to expand Calatrava's context to include Santiago de Compostela; the Knights of Calatrava; Free Masonry; and the sacred geometry of the Moors and the Kabbalah of Spain. Many architects, but few engineers, have been subject to such overinterpretation.

Perhaps Calatrava himself does not know the source of his interest in the vesical or pointed oval form. He uses it repeatedly in his buildings and bridges, both as a complete vesica in plan and a half-vesica or aliform in section. The scientist will note that vesical form is similar to the path of a vibrating string and relates to Calatrava's interest in dynamic shapes, that it is found in sections of vertebrae and his interest in osteology. The aliform, or wing shape, can be derived from a minimum-volume A. G. M. Michell framework for an asymmetric cantilever, and Calatrava uses it in joining wing canopies to torsion beams. The humanist will note that the vesical form is used as an aureole in medieval painting; it is also the Egyptian hieroglyphic sign for the mouth or the name of the supreme being, Atum-Re. Only Calatrava can explain the true source of this formal theme and dispel overinterpretation.

Motivated in part by Friedrich Schleiermacher's idea that understanding is the reverse of composition, "for it starts with the fixed and finished expression and goes back to the mental life from which it arose," we may have gone beyond the relevant sources of Calatrava's ideas. At this point, we should return "to the things themselves," that is, his bridges. We know that hermeneutics suggests that interpretation is not contemplative reconstruction of text and context, but it is mediation, and as such there can be no authoritative interpretation of the data.

Existing critiques of Calatrava's bridges identify themes that characterize only the essential elements of his engineering language and not the essence of his work. By "essence," we mean the extent to which the philosophy of engineering, its principles and history, has impregnated his thinking and hence the form of his designs.

At the most elementary level, Calatrava makes much use of the "wing," or aliform, cantilevered from a torsion beam; the "leaf," or vesical-form simple beam; the "spindle" or lenticular column; and the "carrying hand" or femur-head-shaped capital. These unfamiliar elements, often in different materials, act as joints or punctuation to create an even less familiar composition whose hierarchical appearance is more characteristic of hybrid structures.

A reading at another level reveals his interest in automorphism, that is, the repetitive use of an element; and in folding, where the configurations either follow the bending moment diagram, as in Eiffel's Garabit bridge, or the manipulation of straight-line generators, as in Candela's hyperbolic paraboloid forms. Also at this level of explanation or understanding, we note the sculptural qualities of his structures, where the character of the details and the compositions tend more

Angélil continued

to be marked by similar ambiguities. Whether in support of or against the work, readers of *Calatrava Bridges* may be suspended between states of admiration and disbelief, perhaps caught between an overwhelming sense of wonder and exhaustion. An act of balance, performed by the author-engineer, challenges physical and mental conditions of equilibrium, achieved not only through a play of technical parameters but also by means of an abundance of form. Calatrava works with images of structures attempting, in his own words, "to achieve a certain exuberance."[6] Restraint and economy of means are not of primary concern; he engages instead in an exploitation of a visual realm, theatrical in its gestures, sometimes on the verge of an excelled mannerism. One might ask whether Calatrava's work stands for a new understanding of technology, a form of poetic expression, or whether it is excess, an expression of superfluous consumption, or a marvel in decadence. Regardless of the position taken, Calatrava has significantly contributed to the built environment and has positively impacted—with great rigor and audacity—the cultures of architecture and engineering.

NOTES

1. Max Weber, *Die protestantische Ethic und der Geist des Kapitalismus* (1904–5 and 1920), see *The Protestant Ethic and the Spirit of Capitalism*, translated by Talcott Parsons (New York: Charles Scribner's Sons, 1958), pp. 15, 24, 168, 249.
2. The expression "the apotheosis of technicity" is borrowed from Marcel Meili, "The Model and the Subject," in *Santiago Calatrava: The Daring Flight, Lotus Documents* 7 (Milan: Electa, 1987), p. 16.
3. Ibid., p. 17.
4. Kenneth Frampton, "Look No Hands: Santiago Calatrava and the Well-Tempered Reconstruction," in *Santiago Calatrava Engineering Architecture* (Basel: Birkhäuser Verlag, 1989), pp. 15–20.
5. Ibid., p. 16.
6. *Santiago Calatrava: Dynamic Equilibrium*, exhibition catalog edited by Anthony Tischhauser and Tristan Kobler, Museum für Gestaltung Zürich (Zurich and Munich: Artemis & Winkler Verlag, 1991). See the introductory text by Sutherland Lyall for Calatrava's use of the term "exuberance" for describing his work.

CALATRAVA BRIDGES, Kenneth Frampton, Anthony C. Webster, and Anthony Tischhauser, editors, introduction by Santiago Calatrava, Artemis (distributed in the U.S. by Rizzoli), 1993 , 222 pp., illus., $95.00.

McCleary continued

to subtraction of material than addition. This characteristic may result from Calatrava's stated fascination with the plasticity of concrete. He notes the Spanish name for concrete is *hormigón* or "moldable."

The prosthetic character of his structures is obvious, and much has been written on his interest in osteological analogy. While a tibia in compression and a fibula in tension, founded on an Achilles tendon and capped with the head of a femur, are characteristic of his early work, davits, cams, and cranks are more analogous to his recent designs. He interprets both the body and the bridge as mechanical devices.

An informing response to Hans Georg Gadamer's "need to see what is questionable on the subject matter and to formulate questions that question the subject further" might bring us closer to the essence of Calatrava's work. Is there, for example, a language of bridges that includes the concerns of both architecture and engineering? Such a language would reveal the fundamental principles of the perceptual interests of the viewer and the mechanical exigencies of the bridge. The archaic concepts of balance, proportion, and composition might present an elementary language of essence.

Clearly, Calatrava prefers to resist the weight of mass by the lightness of the cable force. His counterweight sculptures manifest this preference, and yet his concrete bridge decks appear to hold down his cables rather than the cables pulling up the deck. He does not resolve the visual balance between the supporting and the supported elements. This balance, between the strain energy of the support and the potential energy of the supported, is particularly difficult to achieve when the elements are of different materials and in different states of stress, and the confusion is compounded when the tension member is located above the compression member. This is a question of balance.

If Calatrava wishes to minimize potential energy, avoid superfluous material, and separate materials in tension from those in compression, then he can take advantage of the insights of Maxwell's lemma, which balances masses and forces, physically and visually. This is a question of proportion.

Both the pendulous character of cable-stayed configurations and the muscular quality of a tied arch imply movement. And whereas the architect might explain this in the spatial language of the horizontal and the vertical, the engineer will refer to the kinematics of potential energy. They agree, however, that the bridge has an actuality of position and a possibility of movement. Calatrava's interest in the kinetics of an arrested movement and its concomitant potential visual energy is inhibited by the stability of his ponderous, sculpted, reinforced, and prestressed concrete. This is a question of composition .

Balance, proportion, and composition are not limited to the fine art of bridge design, but are fundamental characteristics of its engineering language. The Calatrava bridges, presented in Artemis' well-illustrated survey of his research program, show that his analogies are a fruitful source of ideas. We must hope that his language of elements does not ossify into themes and that he will find in the principles of engineering characteristics as worthy of expression as those found in nature and in his own engineering lineage.

CALATRAVA BRIDGES, Kenneth Frampton, Anthony C. Webster, and Anthony Tischhauser, editors, introduction by Santiago Calatrava, Artemis (Zurich, Switzerland), 1993 (distributed in the U.S. by Rizzoli), 222 pp., illus., $95.00.

TOM F. PETERS

The Repercussions of Estrangement: Architecture and Engineering in the 19th Century

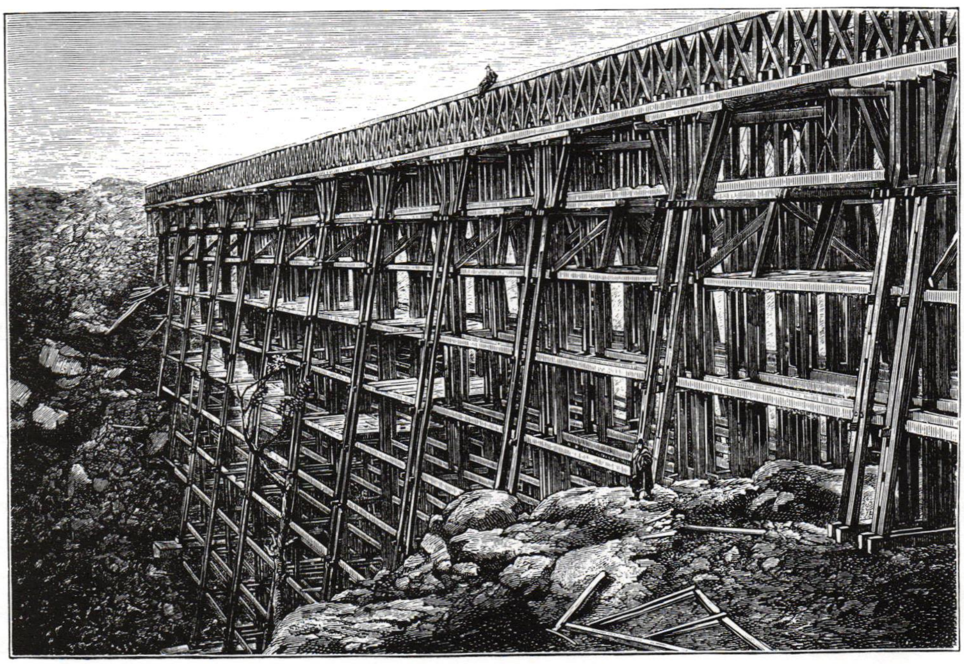
Tom F. Peters will soon publish a much-needed critical history of the impact of engineering on the built environment during the 1800s, entitled Building in the Nineteenth Century *(Princeton University Press, 1994). In the introduction he maps out the historical question of why building is split into architecture and engineering. The book proceeds from general themes of contextual knowledge, such as ideas of progress, commerce and transportation, new materials, and the question of manual work versus mechanization; to more specific chapters on the canonical engineering projects of the 19th century, supplemented with lesser-known but equally instructive projects. The Mont Cenis Tunnel, Britannia Bridge, Suez Canal, Crystal Palace, Langwies Viaduct, and Gatun Dam are among the landmark projects reviewed. He has kindly allowed us to excerpt these comments from his concluding chapter, "The Consequences of Thinking About Building as Process."*

Building is an empirical and usually "low-tech" process. Dealing as it does with men, mud, and machines, it has none of the antiseptic flashiness of less "earthy," cleaner technologies. What makes the topic of building intellectually so attractive is that, in spite of the earthbound nature of the process of making buildings, it crosses the cultural boundary between the high- and the low-brow, the abstract and the practical, the ideal and the pragmatic, and balances between *theories* of form and perception, *methods* of science and mathematics, and the practical *processes* of dealing with humans and materials. The form of thinking that corresponds to this wide range is the one that deals primarily with "how-to-make," or what I call "technological thought." Technological thought can have many modes, depending on the field. Thinking in dance differs from thinking in writing. Both are creative in the sense of making, and that is their common bond. Building is unusual in that it has two main modes of technological thought: the engineering and the architectural.

Architecture and engineering began to develop apart in the 16th century, and, for the last century, the chasm between them widened to a deep lack of understanding. A split between the two occurred in the Industrial Revolution when physics (a system of thought) replaced religion (a system of faith) as the basis of technology. Influenced by epistemological rationalists like most of the physicists, astronomers, and mathematicians of the 16th century, the development of engineering was tied in to the world of the French *encyclopédistes*. As a result, engineers now think largely in mathematical terms while architects have retained their visual language. This split is beginning to blur under the resurgence of visual language influenced by CAD technology and the strong orientation of our culture to television. In spite of the differences between them, both groups are concerned with building and both use the hitherto little-appreciated technological thought. Engineers mix it with strategic and scientific method to serve their process-orientation, while architects do not.

THE METHOD OF TECHNOLOGICAL THINKING

Technological thought is a mixture of deductive and empirical modes of thinking and it manifests characteristics that are invisible in its progenitors. Scientific method and the deductive, inductive, and analytical thinking on which it is based are well represented in our schooling while empirical and creative thinking are not. Empirical thinking is associative; it creates matrices of thought without hierarchy. We use it to design, as part of the creative process, and we cannot capture it deductively. The advantage of the scientific method is that it is independent of the scientist's value system. Claude Navier's generation introduced scientific method into structural design by developing models that were independent of scale and material, and the result was that engineers could objectively compare structures of different spans and loading conditions and deduce characteristics and derive principles from them inductively. This helped them understand structural behavior. However, in order to de-



Prefabricated wooden bridge in North America. (From *Time Is Money.*)

sign structures or processes using the information gleaned from analysis, engineers, like architects, need associative thinking, and such modes of thinking are subjectively conditioned by the value system particular to the designer. Associative thinking neither categorizes nor prioritizes; designers do that within their specific cultural context and subjectively determine the hierarchy of decision making and the relationships between the elements. The design of objects, which is the main concern of architects, and the design of processes, which is the main concern of engineers, use different mixes of the objective-deductive and the subjective-creative forms of thought. It is these mixes that constitute technological thinking, not through a dialectic process like that described by Peter Collins in his book, *Changing Ideals in Modern Architecture* (Montreal: McGill University Press, 1967), but as an independent and integrated form of its own. The deductive and inductive elements of scientific thinking are subjectively "impurified" by the value system of the technologist, while the associative element is "objectified" by cultural consensus.

Those who analyze rather than design strive to attain "purity" in a clear separation of their categories of thought, and quest for absolutes in the phenomenal world. They categorize those who make or design somewhat pejoratively as "pragmatists" and "opportunists." Technologists—in this instance builders—find intellectual "impurity" attractive. It serves them well in their urge to synthesize and create. It is not the purity of *logos*, but the impurity of *genesis* they use in their thinking.

The sciences and the arts, together with their ideals, form what we have labeled "culture." Our schooling stresses them and forgets the interstitial area of pragmatic technology. If technology is at all celebrated, then it is only indirectly, through industrial production. For the most part, however, it is counted as the lowly "applied science," or resisted as determinism. The first view is based on the analytical mode of technological thought, and the second on the directness of problem-solving that rarely transcends the object itself. But technology is neither application nor pure determinism. It is the creative thinking that drives our times and we cannot explain it away. All building professionals experience the conflict between "genetic" technological thinking and its idealistic parents.

Builders are literally and figuratively earthbound. They satisfy primarily physical functions by creating objects for human use and habitation that are bound to the earth. Any non-physical functions they may satisfy are beyond their primary mandate and touch the realm of art. Artists, who use associative thinking too, are also concerned with the world of making. But they are primarily interested in human reactions to the objects they create. The functions of their objects are primarily nonphysical and can be loosely characterized as psychological, spiritual, or cultural.

Construction work at the World's Fair, Paris; 1889. (From *Time Is Money*.)

The world of making sets architects and engineers apart from mathematicians and natural and social scientists, and they therefore speak a different language. In technology, the very word "system" changes its meaning from "ordering principle" to "functioning object" or "building set." The goal of technical thought is not that of the mathematicians and scientists, who pursue knowledge or insight, but is primarily the creation of objects, whose method is the complex activity of practical problem-solving. A partial problem can sometimes be more interesting than the whole to which it belongs, and, therefore, the word "detail" means "small-scale problem" in technological parlance, rather than "hierarchically subordinate part" as it does in the sciences. The structures of Gustave Eiffel, who contributed to the systematization of iron construction, or Robert Maillart, who researched the formal implications of monolithic structure in reinforced concrete, demonstrate the importance of both small- and large-scale design. The same is true for the buildings of Andrea Palladio, who created new relationships between layering, geometry, and space, or of Frank Gehry, who questioned the accepted relationships between material, form, and permanence.

Building professionals are basically uninterested in the sciences' preoccupation with the method of knowledge called epistemology. The proof of the correctness of a technical method lies in the functioning of the object rather than in the formulation of a systematic logic. That is why uneducated inventors continue to try and invent the *perpetuum mobile*, in spite of all proof of its impossibility. They argue, logically from their standpoint, that theoreticians and their theories have been proven wrong before, therefore, why should they not be wrong again! This example shows that the "proof" is in some measure self-referential, and it definitely is rationalist. Its logic is internal and in no way does it fulfill the criteria of the scientific tradition in which we all were trained. It is one of the issues that distinguishes technology from art and from the sciences.

Engineers of the 19th century were disturbed both by this and the lack of technological concern with epistemological questions, since they had just begun to draw their methods of analysis and dimensioning from physics. Mathematicians and scientists considered what engineers did to be a naive misunderstanding of theory, and as a result, engineers frequently suffered from a false sense of inferiority. They were neither architects, who had begun to bolster their own self-esteem by cultivating the protective self-image of "artists," nor were they scientists. They stood outside the pale of "culture" and felt under pressure to demonstrate legitimate artistic and scientific capabilities; they did the former by applying superfluous decoration to their objects, and the latter by pursuing presumed "truths" in partial problems, such as the precise computation of catenary form and chain cross-section for every conceivable loading condition.[1]

Architects, on the other hand, often try to argue a design decision objectively, where they should be using associative, subjective arguments. Both apparent "weaknesses" come from the desire to explain technological thought using scientific criteria instead of accepting its independence.

Theoreticians and practitioners of architecture lie closer to one another than in engineering. Not only has the history of engineering made the scientific component more prominent than architectural thought, but engineering practice is also strongly influenced by military thinking. This leads to internal stresses between engineering practitioners and theoreticians—especially noticeable in French and Anglo-Saxon cultures where practitioners often find theoreticians irrelevant and abstract, while theoreticians consider their colleagues to be fuzzy thinkers. There's nothing new in this. A hundred and sixty years ago differences of this nature led to the formation of the École Centrale in Paris in 1829 by a group of disenchanted practitioners who sought to distance themselves from the concepts of the École Polytechnique personified in Navier's successor, Gaspard de Coriolis. Coriolis abandoned project-oriented teaching, claiming that young engineers should be theoretically educated and that they would get practical experience when they practiced. However, the faculty was increasingly recruited directly from the classroom, thereby exacerbating the alienation between practice and theory from generation to generation. Among the best-known graduates of the counter-school were two of the most influential iron builders of the second half of the 19th century, Gustave Eiffel and William Lebaron Jenney, and three presidents of the Société des Ingénieurs Civils: Eiffel, the railway engineer Henri Mathieu, and Victor Contamin, engineer of the Paris exhibition of 1889.

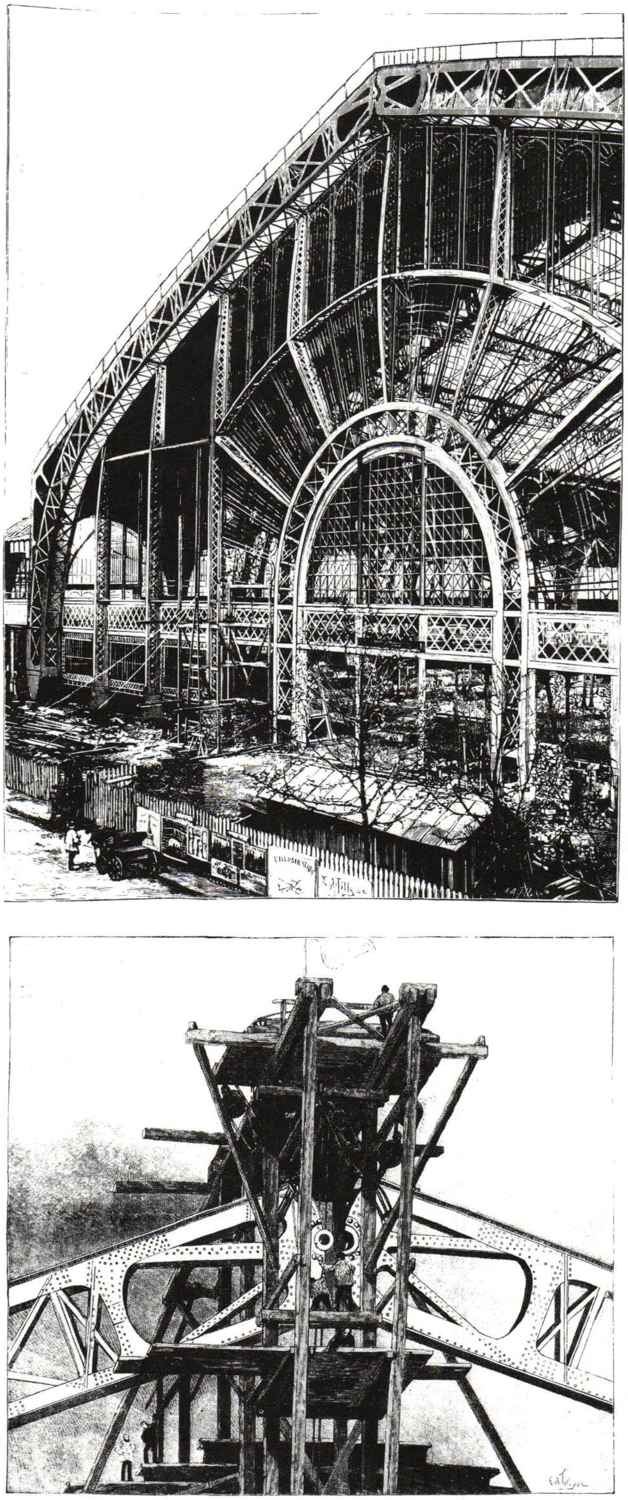
BUILDINGS AND MACHINES

Many practicing engineers like Robert Stephenson, Isambard Brunel, or Mathieu, built both structures and machinery. The introduction of cast and then wrought iron as a structural material for buildings at the beginning of the century blurred the distinction between buildings and machines. The same material was used for both, the way they were manufactured and assembled was identical, and the incorporation of more and more complex installations, such as heating, ventilating, and plumbing systems into buildings of all kinds brought them even closer. This was certainly true of factories where elevators and cranes became mobile parts of the building fabric itself, and it was even clearer in those buildings that were entirely determined by their mechanical parts. From the production point of view, the Sayn Foundry at Bendorf was really a machine for producing iron objects that contained space for humans to participate in the process. The Kew Palm House, the lily houses at Kew by Richard Turner and at Chatsworth by Sir Joseph Paxton, and the Crystal Palace were climate-controlled showcases, not palaces of culture. In taking on aspects of machines, train stations, hospitals, banks, and even elaborate and gaudy opera houses became true "facilities" and not works of architecture in the traditional sense. The naturalness of the crossover between the building as art and as machine was memorably illustrated by the architect Charles Garnier in the plates of his publication of the Paris Opera House in 1880, and by Eiffel in his book, on the Eiffel Tower, *La Tour de 300 Mètres* (1900).

This development was paralleled by the mechanizing of material manufacture and the distillation of controlled and manipulated material characteristics from those of the original raw materials from which they were made. It was also accompanied by the extension of the manual tool in the building machine. Just as the iteration of simple components and connectors changed the character of the American light-wood frame in the 19th century and the mathematical iterative process was to provide novel possibilities in computing in the 20th, the building machine opened new prospects in the design and construction of the built environment. The ultimate success of the Thames Tunnel was due to the machine that built it. But, in a certain sense, that machine was really the main development and the tunnel was simply its hole, its "casting" so to speak. In fact, that was the way Marc Brunel had come to the idea in the first place. So in this sense too, the built work was more a machine than a structure in the classical sense.

Large ships are both machines and complex, floating buildings. Sir William Fairbairn and Hodgkinson's expertise in the construction of iron ships stood them in good stead in the design and building of the Britannia Bridge in 1850. Horatio Greenough's comparison between ships and buildings, although flawed, does make the immediate connection.[2] Canal locks are even more ambiguous, since it is impossible to decide whether the static characteristics of the object are more prominent than its dynamic, mechanical ones or vice-versa. The use of reinforced concrete shifted the ambiguity to a more abstract level. Le Corbusier and the developers of the "Frankfurt kitchen" in the 1920s were thinking within a long tradition when they developed their *machines à habiter*. The contortions that architectural historians from James Fergusson to Collins went through to draw the distinction between architecture and machine design missed an important point when they aimed at the definition of beauty, at the traditionally static *object*, rather than at the dynamic *processes* of problem-solving or making.

The use of repetitive parts in building and the assembly of elements to a system came from machine manufacture. The very way we now put buildings together—by assembling them rather than constructing them on site—is a direct result of factory methods. This has influenced the aesthetics of buildings, but even more than that, it has influenced the processes of design, organization, and erection. The very way we conceive a building as an object in space and a process in time is indistinguishable from the way we view machines, and the only essential difference between them is that work is performed by the latter. The bridge between the analogy of the machine and that of the body is a short one. César Daly, editor of the *Revue d'Architecture*, made the comparison when referring to the incorporation of mechanical installations in Sir Charles Barry's Reform Club of 1840 in London, but the concept of life goes farther.[3]



Facade of the Galerie des Machines at the 1889 World's Fair in Paris, and detail of the ridge piece. (From *Time Is Money*.)

PROCESS AND LIFE

The concept of process is derived from the principle of life. Bodies change as life progresses and finally expires; similarly, buildings change as function, space, and meaning mutate and finally disappear with the object. The concept and the term "life-cycle cost" show how closely the building process and the principle of life are related. The analogy is one of concept, not structure: life is not the body any more than architecture or engineering are the building or structure. It goes deeper than the compositional anthropomorphism of Greek and early Christian traditions. The principles of composition derive from the "organic" theory of architecture that aims at beauty, while the principles of construction derive from the "functionalist" theory whose goal is viability.[4] So process and organization go hand in hand, and their connection is the principle of life. Contextualism, which runs the whole gamut from the naive "fitting a structure into the landscape," through climatological and material correspondence, to the subtleties of political, sociological, and cultural concordance, derives from the idea of the biotope or the environment and its relationship with the object.[5] Most theoreticians of architecture, including Collins who has perhaps produced the most profound ideas along these lines, were interested in the aesthetic import of the biological metaphor. I am more interested in facts and principles than in symbols, and find the conceptual and functional relationship of the principle of life to design and the act of building intense and revealing about the nature of our technological culture of space and time. The reduction of space into time that occurred with the proliferation of the telegraph, and the reduction of time into awareness that occurred through "live" coverage of "news" illustrated this intimate relationship. We can equate awareness with the principle of life, since perhaps the best transcendental definition of life is "sentient existence."

METHOD AND WAR

Parallel to and supporting this telescoping of space into time, and of time into awareness, building changed from a disorganized "making" to a process, from a pitched battle to an organized campaign. The military metaphor is apposite since those who changed the course of building construction were either themselves military officers or trained in a field that had arisen from military training. Strategy and its branches, tactics and logistics, the rationale of supply lines, and critical path thinking all formed part of the way they thought, and the clearer they followed the military model, the better and more rationally organized was their work. This was, of course, not a one-way street. Barton Hacker shows the influence that the general development of the technological world had on military engineering,[6] and President Eisenhower's famed term, the "military-industrial complex," coined before he left office in 1961, indicates that the conflation of the two areas continued into the mid-20th century.

In those projects we have examined that were built by empirically trained individuals, we noted a lack of procedural thinking, but in those that were organized by professionally educated engineers or military men, process was the main theme from the outset. As engineering academies grew out of military schools and proliferated in the course of the 19th century, their influence became more pervasive. So did the procedural bias in building.

Just as the machine and machine production of elements and whole systems influenced how we conceive of building as processes, so does the concept of industrial production and assembly emerge from military ordinance. And this is where the machine, life, and war come together in building.

The machine, life, and war were concepts that can be traced *a posteriori* in older building processes, at least from the medieval period on in Western culture where we have some documentation, and we can infer them in older ones too. But their conscious application to building dates from the period in which machine-making, biology, and war themselves evolved from "arts" to "technologies." In this way, building and the technology of building has participated in, not followed, the development of our culture. Although building trades may be among the last to adopt new techniques, building itself is conceptually very much a part of its time. Strangely enough, the implications that this has had for built form and for the concept of space-time-awareness in our built environment have not taken root in our engineering and architectural education until quite recently, when the emphasis began to shift from built objects to their life-cycles in the environment, and consequently to the processes of designing, building, maintenance, regeneration, demolition, and recycling. Building as an activity is an archetypal preoccupation. It mirrors human development on both a personal and a cultural level. Where do we go from here?

NOTES

1. See Tom Peters, "Guillaume-Henri Dufour and the Early 19th-Century Cable-Suspension Bridges," in *Transitions in Engineering* (Basel: Birkhäuser, 1987).
2. Peter Collins, *Changing Ideals in Modern Architecture, 1750–1950* (Montreal: McGill University Press, 1967), p. 160
3. Ibid., p. 99, and quoted in Cecil Elliott, *Technics and Architecture* (Cambridge: MIT Press, 1992), p. 199.
4. See Collins, p. 155, and Edward Robert de Zurko, *Origins of Functionalist Theory* (New York: Columbia University Press, 1957), p. 4, for the connection between functionalism and the biological metaphor.
5. See Collins, p. 157.
6. Barton Hacker, "Engineering a New Order: Military Institutions, Technical Education, and the Rise of the Industrial State" in *Technology and Culture*, vol. 34, no. 1 (Jan. 1993): 1–27.

JANE MORLEY

Flying Buttresses, Entropy, and O-Rings

James L. Adams

The Engineer in America

Terry S. Reynolds, editor

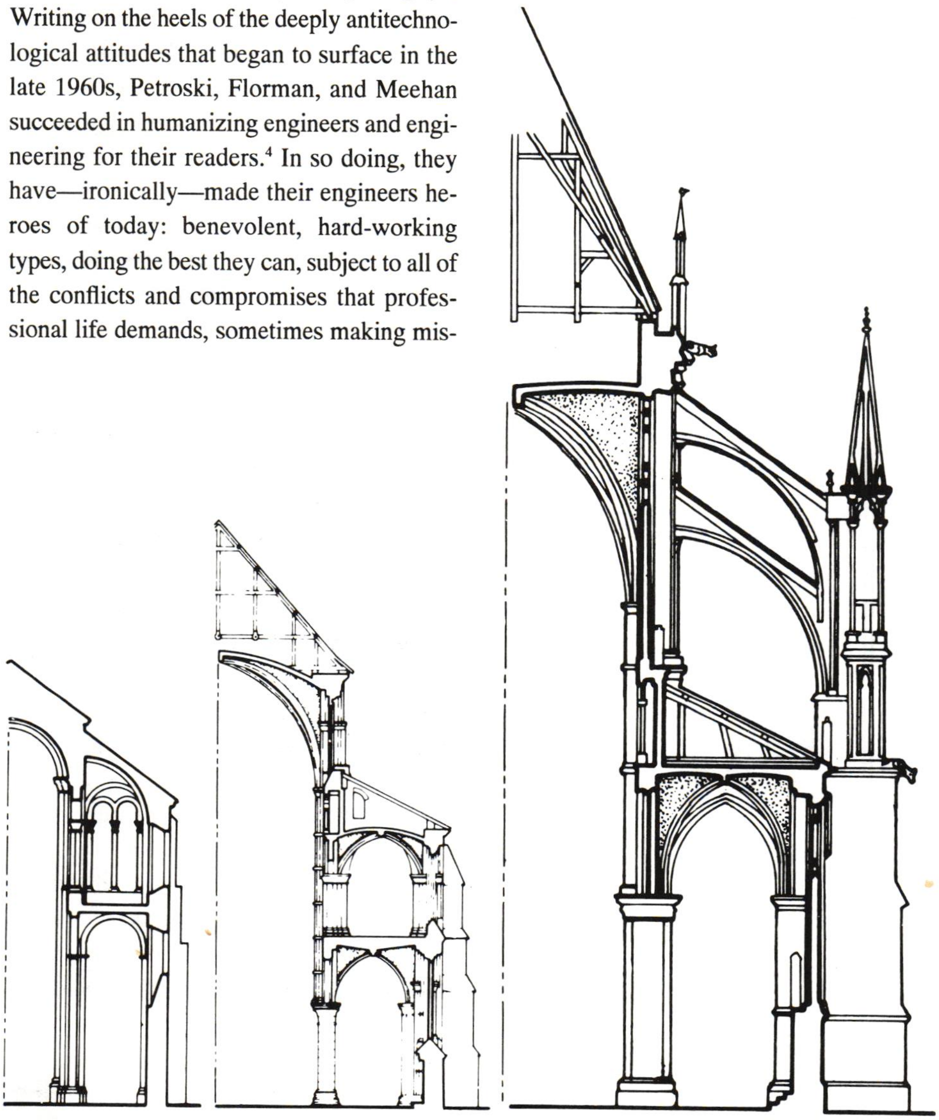
About twenty years ago, Stanford economist Nathan Rosenberg—no stranger to technology himself—leaned over lunch and asked aeronautical engineer Walter Vincenti, "What is it you engineers really do?" Vincenti spent the next two decades working out an answer. Recognizing that what engineers do is based on what they know and drawing upon his long experience as a researcher at NASA's Ames Research Center, Vincenti eventually wrote book that is now the starting point for anyone trying to understand engineering, especially the character of engineering knowledge.

Vincenti's book, *What Engineers Know and How They Know It* (Baltimore: Johns Hopkins University Press, 1990), takes a prominent place among books written by engineers trying to explain to general readers what it is they really do. One of the classic works of this genre, however, was actually written by an non-engineer, in the latter part of the 19th century, perhaps because during the later years of the British Industrial Revolution engineers in the United Kingdom had other work to do. In *Lives of the Engineers*, published in four editions between 1861 and 1904, Samuel Smiles used an adulatory biographical style to celebrate the accomplishments of engineers such as James Watt, Matthew Boulton, James Smeaton, and Thomas Telford in order to extol the value of self-discipline, thrift, individualism, duty, and perseverance—virtues he believed were the key to Britain's continuing industrial progress. Smiles intended that readers draw inspiration from the accomplishments of these heroic engineers, and *Lives* enjoyed an enduring popularity in Britain well into this century.[2]

More recently, civil engineers Henry Petroski and Samuel Florman have presented engineering as a quintessentially human endeavor fraught with as much frustration and failure as with success and progress, yet an activity possessing existential pleasures all its own. These themes are eloquently brought home in Richard Meehan's autobiographical accounting of the logic (or lack thereof) of his own career path in *Getting Sued and Other Tales of the Engineering Life.* Wanting to "tell something about what it was like to become an engineer" and "to convey the flavor of technological life," Meehan traces his mid-career transition from geotechnical engineering to forensic engineering as he was repeatedly frustrated with trying to practice in an increasingly litigious society.[3]

While Smiles' engineers are depicted as national heroes, the engineers of Petroski, Florman, and Meehan are just regular guys. Writing on the heels of the deeply antitechnological attitudes that began to surface in the late 1960s, Petroski, Florman, and Meehan succeeded in humanizing engineers and engineering for their readers.[4] In so doing, they have—ironically—made their engineers heroes of today: benevolent, hard-working types, doing the best they can, subject to all of the conflicts and compromises that professional life demands, sometimes making mistakes, and as prone to be victims of "the system" as you or me—not unlike Steve Douglas, the engineer-father on the TV series "My Three Sons."[5]

Viewers of "My Three Sons" will recall that Steve Douglas was a very nice but rather dull guy. Readers of James L. Adams' *Flying Buttresses, Entropy, and O-Rings* will find engineering portrayed in much the same way: a nice but dull profession. Le Corbusier wrote in *Towards a New Architecture* (London: Architectural Press, 1927 [Paris, 1923]) that "engineers are healthy and virile, active and useful, balanced and happy in their work," and David Billington has pointed out that "Le Corbusier's image of engineers as happy, unimaginative technocrats is now probably the popular view."[6]



Sections through Sainte-Foy-de-Conques, Laon, and Reims cathedrals, showing the evolution of the flying buttress. (From *Flying Buttresses, Entropy, and O-Rings*.)

Adams, a mechanical engineer and chairman of the Program in Values, Technology, Science, and Society at Stanford, has done little to change this unfortunate stereotype of engineers and engineering. Nor does he make the profession particularly interesting to me, but in all due fairness, the book was not written for specialists.

Adams intended the book for general readers, engineering groupies, or engineer-wannabees.[7] Its size and format give it a textbook look and, indeed, it could be well used in introductory technology studies courses. After a brief Plato-to-NATO rundown of technology's history, Adams turns to the complexity of modern technology, exploring problem definition; the relationships between engineering, mathematics, science, and research; the process of design, invention, development, testing, and manufacturing of new technology, as well as the product's business or government environment. The most interesting sections of the book, however, deal with engineering failures, the regulation of technology, and technology's future, although Adams' conclusions in these areas are somewhat disturbing.

After rightly identifying the ironic role of failure in technological progress, Adams examines a number of well-known catastrophes, such as the explosion of the space shuttle *Challenger* and the collapse of the Kansas City Hyatt Regency skyways, as well as the various technical and human reasons for failure. He concludes the chapter: "Granted that they were all tragedies, and tragedies should not occur. But most of participants were professionals, generally competent at their jobs, and I think concerned. Perhaps one can conclude that as long as we live with complicated technological systems . . . things will go wrong, despite wishes and efforts to the contrary." With this rather saccharine conclusion, Adams chooses not to deal with Steve Douglas' evil twin, whose character reflects what one structural engineering consultant has called "the four horsemen of the engineering apocalypse": ignorance, incompetence, negligence, and greed.[8]

Adams' optimism no doubt has its basis in his strong technological enthusiasm, expressed in its most undiluted form in the final chapter of the book.[9] As he speculates about future trends in engineering and technology and in our understanding of them, Adams wants us to believe that he is "a middle-of-the-roader when it comes to technology," although he confesses that "the extremists among my liberal friends . . . consider me dangerously pro-technology." No wonder, when he writes things like "as we become more sophisticated in our technology, we will, I believe, also become more sophisticated in the manner in which we use it." One need only consider modern weapons technologies (and sales of it to developing countries) in order to see the fallacy in Adams' optimism.

By virtue of its historical perspective, *The Engineer in America*, edited by Michigan Technological University historian Terry Reynolds, gives a richer, if not more satisfyingly accurate picture of the engineering profession in America and just what it is that engineers do. The fifteen articles that make up this anthology were originally published in the thirty-one volumes of *Technology and Culture* (*T&C*), the journal of the Society for the History of Technology (SHOT), which commenced publication in 1959 and is now the leading scholarly journal in the field.[10]

The first half of the book deals with American engineers in the 19th century and the second half deals with them in the 20th. Both halves are introduced with an essay by Reynolds, who, in broad strokes, outlines the major themes in the history of the engineering profession for the period, thus putting into historical context the articles that follow. For Reynolds, the appropriate midpoint for the book was the turn of the century because the nature of the engineering profession in America changed profoundly around that time: the empirically oriented, shop-trained, independent consultants and owner-engineers who dominated the profession prior to 1900 were displaced by salaried engineers who worked for corporations and whose academic training and professional practice were more scientifically and theoretically based. The social and professional prestige afforded to civil engineers throughout the 19th century was transferred at the beginning of the 20th, first to electrical engineers and then to others, all of whom have witnessed the steady decline during this century in the status of the engineering profession.[11]

For each half of the book, Reynolds has chosen one or more articles that serve as background for the case studies of American engineering institutions (mainly schools and professional societies) and engineering practices that follow. The editor selected articles that fit together well and that are some of the very best published in *T&C*, including: John Rae's "Engineers Are People" (first published in 1975), Martin Reuss' "Andrew A. Humphreys and the Development of Hydraulic Engineering: Politics and Technology in the Army Corps of Engineers" (1985), Edwin Layton's "Mirror Image Twins: The Communities of Science and Technology in 19th-Century America" (1971), Bruce Seely's "The Scientific Mystique in Engineering: Highway Research at the Bureau of Public Roads, 1918–1940" (1984), and Peter Meiksins' "The 'Revolt of the Engineers' Reconsidered" (1988).

Because of the high quality of the articles and the variety of subjects they address, *The Engineer in America* will remain useful to anyone seeking a better understanding of what it is engineers really do. I hope that James Adams will read it.

In 1895, the express train from Normandy could not stop as it arrived at the Gare Montparnasse in Paris. It went through the waiting room and exterior wall, and fell into the Place de Rennes, killing a newspaper seller on the sidewalk. (From *Flying Buttresses, Entropy, and O-Rings.*)

NOTES

1. Other fine books by engineers that deal with the nature of engineering include Eugene S. Ferguson, *Engineering and the Mind's Eye* (Cambridge: MIT Press, 1992), reviewed in this issue of *DBR* on page 32, and David Billington, *The Tower and the Bridge: The New Art of Structural Engineering* (Princeton: Princeton University Press, 1985).

2. The four editions of *Lives of the Engineers, with an Account of Their Principal Works; Comprising also a History of Inland Communication in Britain* were published in London by John Murray. For more on Smiles, see the editor's "Introduction" in *Selections from Lives of the Engineers, with an Account of Their Principal Works*, edited by Thomas Parke Hughes (Cambridge: MIT Press, 1966), pp. 1–29. There are a number biographical studies of important engineers written by (and in many cases, for) engineers; many of these are hagiographic in tone and lacking in substance and analysis. A notable exception is David Billington's study of *Robert Maillart's Bridges: The Art of Engineering* (Princeton: Princeton University Press, 1979).

3. Henry Petroski, *To Engineer Is Human* (New York: St. Martin's Press, 1985; paperback ed., New York: Vintage Books, 1992); Samuel Florman, *The Existential Pleasures of Engineering* (New York: St. Martin's Press, 1976) and *The Civilized Engineer* (New York: St. Martin's Press, 1987); and Richard L. Meehan, *Getting Sued and Other Tales of the Engineering Life* (Cambridge: MIT Press, 1981). Engineers write books like these because, as engineer/historian Robert Gordon points out, "there is a widespread and well-justified belief among engineers that their profession is underappreciated and misunderstood in the United States"; see Gordon's review of Henry Petroski's *The Pencil: A History of Design and Circumstance* (New York: Alfred A. Knopf, 1990), which appeared in *Technology and Culture* 33 (January 1992): 142–43. Historian Alex Roland believes that engineers are "driven [to write these books] primarily by the quest to understand [their] chosen profession"; see Roland's review of Vincenti's *What Engineers Know* in the *American Historical Review* 97 (February 1992): 317–18. One could also argue that they are attempting to define professional boundaries and/or enlarge their profession's sphere of influence.

4. On this trend, see *Changing Attitudes Toward American Technology*, edited by Thomas Parke Hughes (New York: Harper & Row, 1975).

5. Steve Douglas was portrayed by actor Fred MacMurray, the same actor who played the whacko scientist in the popular Disney films of the early 1960s, *The Absent-Minded Professor* and *Son of Flubber*. A number of writers of fiction, from Goethe to Thomas Pynchon, have explored both the existential pleasures and anxieties of engineering; see Theodore Ziolkowski's review essay, "The Existential Anxieties of Engineering," *American Scholar* 53 (Spring 1984): 197–218.

6. See "In Defense of Engineers," *Wilson Quarterly* 10 (New York, 1986): 93.

7. Another reviewer of Adams' book feels that "taking your favorite engineer out to dinner . . . might just be more worthwhile and more fun for the money." See Nancy M. Haegel in *Commonweal* 119 (April 24, 1992): 28–29.

8. Neal FitzSimons, "An Historical Perspective of Failures in Civil Engineering Works," in *Forensic Engineering: Learning from Failures*, edited by Kenneth L. Carper (New York: American Society of Civil Engineers, 1986), p. 38.

9. In *American Genesis: A Century of Invention and Technological Enthusiasm* (New York: Viking, 1989), Thomas P. Hughes writes that such technological enthusiasm, although characteristic of "an era now passing into history," survives among engineers, managers, systems builders, and others with vested interests in technological systems"; see especially pp. 1–12.

10. For the history of SHOT and a critical analysis of the contents of *Technology and Culture*, see John M. Staudenmaier, S.J., *Technology's Storytellers: Reweaving the Human Fabric* (Cambridge: MIT Press, 1985).

11. A special issue of *T&C* (edited by Robert Friedel) was devoted to "Engineering in the Twentieth Century," (October 1986); on the decline of engineers' status, see Samuel Florman, "An Engineer's Comment," pp. 680–82.

FLYING BUTTRESSES, ENTROPY, AND O-RINGS: THE WORLD OF AN ENGINEER, James L. Adams, Harvard University Press, 1991, 264 pp., illus., $24.95.

THE ENGINEER IN AMERICA: A HISTORICAL ANTHOLOGY FROM *TECHNOLOGY AND CULTURE,* Terry S. Reynolds, editor, University of Chicago Press, 1991, 437 pp., illus., $19.95.

W. BERNARD CARLSON

Engineering and the Mind's Eye

Eugene S. Ferguson

In my office in the School of Engineering and Applied Science at the University of Virginia is a large window that fills almost an entire wall. As a historian, I was curious why my office was graced with such a fine window, and I eventually asked a senior colleague who had graduated from the school in the 1940s. He explained that my office was located in what was once the main drafting room. There, he and other students had not only prepared plans for their required mechanical drawing classes but had also gathered to study and work together. The school has since shifted its focus to teaching students how to solve problems using mathematics and scientific theory, so the drafting room was converted to faculty offices and the students began spending their time in the computer center. Ironically, the computer facility is graced with the same large windows, but they are carefully covered with blinds to protect the computers from too much light or heat.

In *Engineering and the Mind's Eye,* Eugene S. Ferguson puzzles over the disappearance of drafting rooms and the appearance of computer centers in most American engineering schools. How is it that mathematical calculations have come to replace drawing and visual thinking as the intellectual core of engineering? What does this shift mean for the future of engineering and for a civilization highly dependent on technological systems? These questions should also be of interest to architects and design professionals; even though architecture schools still retain their ateliers, the advent of computer-aided design (CAD) poses a set of challenges and hazards for designers similar to those engineers have encountered over the last forty years.

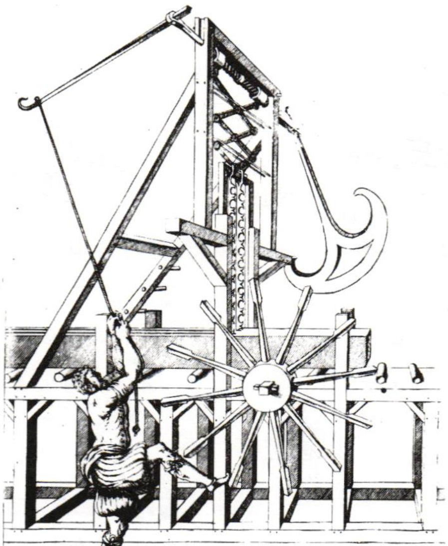
A distinguished historian of technology trained as an engineer in the 1930s, Ferguson is deeply concerned that the loss of visual thinking has rendered engineers impotent. For Ferguson, engineering design, the process of creating new devices and processes, is fundamentally a visual activity. An engineer pictures in his or her "mind's eye" a new design which is then realized through a series of visual representations, ranging from quick sketches on the back of a napkin to detailed blueprints. Mathematical calculations are necessary but only to verify what the designer has visualized.

Ferguson argues that visual thinking has been the essence of engineering in the Western world since the 15th century. Drawing on a marvelous range of examples and illustrations, he demonstrates how engineers have used their ability to create pictures to master and control the material world. In several short chapters, Ferguson recounts the origins of modern engineering in Renaissance Italy and the evolution of technical drawing. He also provides a fascinating discussion of how visual knowledge was disseminated in Europe and America, tracing how engineers and artisans learned about new devices by consulting model collections (such as the one developed by the U.S. Patent Office in the 19th century), and by using engineering thesauri that depicted thousands of arrangements for gears, pulleys, pumps, and other devices.

Once he has established by numerous examples how engineering has been based on visual thinking for the past 500 years, Ferguson then claims that the visual tradition has been abandoned in American engineering since World War II. Much of the blame, according to Ferguson, can be placed on the Cold War. Because government officials and the general public believed that World War II had been won largely through science-based technology (such as the atomic bomb and radar), they concluded that the Cold War could be won by investing in more science-based engineering (the hydrogen bomb, nuclear submarines, jet planes, missiles, and computers). Fueled by ample funds from the military (and later NASA), leading engineering schools shifted their emphasis away from preparing undergraduates to be general practitioners and toward sponsored research and graduate education. In the process, engineering researchers devoted their energy to developing engineering science that focused on mathematical and abstract techniques for solving problems. Within engineering science, emphasis was placed on developing techniques that could be readily transferred from one system to another; as a result, visual thinking, which often focuses on the specific nature of things, was downplayed or ignored in engineering schools.

Drafting room of Baltimore & Ohio Railroad, Baltimore, 1899. Despite the fact that visual thinking has been the essence of Western engineering since the 15th century, over the last four decades, instruction in drawing began to disappear from engineering schools, and emphasis was shifted to mathematics instead. (From *Engineering and the Mind's Eye.*)

For Ferguson, the most troubling example of the abstract nature of engineering science is the development of CAD. Because CAD programs are created by engineering theoreticians and not practicing designers, Ferguson fears that these programs embody numerous assumptions that may not be appropriate for a specific design task. As an example of what can go wrong with CAD, Ferguson cites the collapse of the roof of Connecticut's Hartford Coliseum in 1978. While the CAD program allowed engineers to design an elaborate space-frame truss for the roof and to perform calculations with six or more significant figures, the program failed to give the designers an accurate sense of what would happen when the roof was placed under a moderate snow load. Unless an engineer fully understands the underlying assumptions of a CAD program and can mentally picture the design, Ferguson fears that CAD programs will permit inexperienced engineers to design unnecessarily complex systems that will inevitably fail. For Ferguson, one good drawing is better than a thousand computer calculations.



Perspective view of a manually driven up-and-down sawmill from Jacques Besson's pioneering machine book of 1578, *Theatre des instruments mathématiques et mécaniques.* (From *Engineering and the Mind's Eye.*)

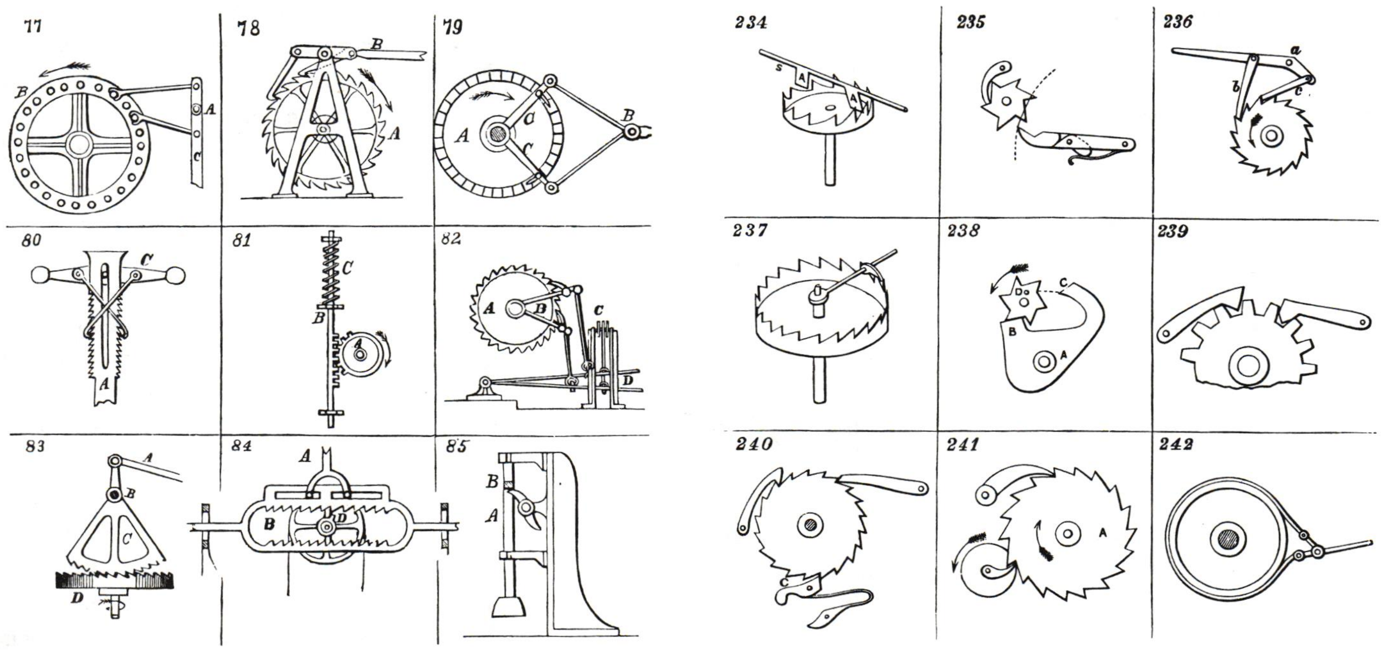
Ferguson's depiction of the visual impoverishment of contemporary engineering education is, unfortunately, largely accurate. American engineering schools now turn out thousands of undergraduate engineers who are proficient at solving complex mathematical problems but who are frequently limited in their ability to use common sense and simple visual techniques to solve rudimentary problems.[1]

However, I think it is too simple to blame the death of visual thinking in engineering on the Cold War. Engineers have continuously wrestled with how to integrate visual thinking, science, and mathematics as they have struggled to define themselves as a profession. Since the 18th century, many professions in the West have sought to base their claims to intellectual and economic privileges on science. As science came to be regarded as the objective and reliable knowledge possessed by gentlemen, various professions found it expedient to describe their activities as being science-based and thus forestall any criticism of the power and authority they arrogated to themselves.[2] Engineers have found this to be a useful strategy of professional development, especially in periods of economic and political unrest. For instance, the leaders of French engineering schools during the revolution and Napoleonic era shifted their curricula from drawing to mathematics as a way of coping with the loss of royal patronage and the emergence of criticism by radicals of all types of privilege.[3] Likewise, in the tumultuous decades after the Civil War, American engineering educators included science and mathematics in their programs in part so that their graduates could legitimize their claims to economic privilege in an otherwise democratic and egalitarian society.[4] Thus, engineers have a long history of downplaying visual thinking in preference for mathematics and science, in part because an emphasis on mathematics and science allows them to advance the social, intellectual, and economic claims of the profession.

Yet long-term efforts toward creating a profession are not the whole story; there is also a cognitive or intellectual dimension to the transformation of engineering. Although Ferguson portrays engineering design as being primarily visual, many engineers would argue that design involves a mixture of graphic and numerical techniques, of abstract concepts and specific details. This combination of techniques is necessary because a designer must not only create a new device, but he or she must also *predict* how it will behave in different situations. While pictorial representations can capture the form of a device, drawings are not especially effective for evaluating how a machine will operate. To be sure, there are some non-numerical techniques for studying the behavior of designs (for instance, Ferguson discusses how trusses used to be checked by using graphic statics), and engineers can build test models. However, because models can be expensive and dangerous to test, engineers frequently resort to mathematical and symbolic representations to predict performance. Moreover, by using the computer to simulate both the design and the conditions under which the design must function, engineers are now able to evaluate designs under much more complex conditions.[5]

Hence, Ferguson is correct in lamenting the loss of visual thinking in engineering science, but he overstates his case in insisting that the heart of engineering design is exclusively visual. The power of 20th-century engineering is that it is able both to create complex technological systems and to predict their performance. Engineers are effective in design only to the extent that they are able to integrate mathematical, theoretical, and visual representations of a product or process.

But to restore visual thinking to an honorable place in engineering will require much effort.[6] The old drafting rooms are gone and CAD programs are a staple of engineering teaching and practice. Corporate recruiters readily offer good positions to young engineers who are able to crunch the numbers in any sort of technical or financial problem. A restoration of visual thinking in engineering will only come about when we better understand what visual thinking is and how it is related to calculations and theory. We should



Diagrams from the 1868 book *Five Hundred and Seven Mechanical Movements*, by Henry T. Brown. (From *Engineering and the Mind's Eye.*)

not settle for explanations that simply posit, as Ferguson does, that visual thinking is whatever happens in the "mind's eye." While the "mind's eye" is a powerful image, it does not help us to understand how and why designers create representations in their minds and on paper. What happens when a designer draws sketch after sketch? How does the act of drawing help designers to combine their mental representations with physical components? Until we understand what goes on in the "mind's eye" we will not be able to teach engineering students how to integrate visualization with their mathematical and scientific skills in order to become effective designers.

NOTES

1. My favorite example of a simple problem that stumps mathematically minded engineering students is to ask them to calculate the compression on a diagonal guy wire that is holding up a telephone pole. It is always remarkable how many students will begin the calculations and not make a simple sketch which could show them immediately that the wire is under tension, not compression.

2. Samuel Haber, *The Quest for Authority and Honor in the American Professions, 1750–1900* (Chicago: University of Chicago Press, 1991).

3. Antoine Picon, *L'Invention de l'Ingenieur Moderne: L'Ecole des Ponts et Chausées, 1747–1851* (Paris: Presses de L'Ecole Nationale des Ponts et Chausées, 1992).

4. Burton J. Bledstein, *The Culture of Professionalism: The Middle Class and the Development of Higher Education in America* (New York: Norton, 1976); Terry S. Reynolds, ed., *The Engineer in America: A Historical Anthology from* Technology and Culture (Chicago: University of Chicago Press, 1992), reviewed in this issue of *DBR* on page 31.

5. For a thoughtful discussion of engineering knowledge, see Walter G. Vincenti, *What Engineers Know and How They Know It: Analytical Studies from Aeronautical Engineering* (Baltimore: Johns Hopkins University Press, 1990).

6. For a critique of current engineering design education and a program of reform, see John R. Dixon, "Engineering Design Science: The State of Education," *Mechanical Engineering* 113, no. 2 (February 1991): 64–67 and "Engineering Design Science: New Goals for Engineering Education," *Mechanical Engineering* 113, no. 3 (March 1991): 56–62.

ENGINEERING AND THE MIND'S EYE, Eugene S. Ferguson, MIT Press, 1992, 241 pages, illus., $24.95.

ANTHONY C. WEBSTER

Technics and Architecture: The Development of Materials and Systems for Buildings

Cecil D. Elliott

By almost any measure, the history of technology is alive and well. The catalogs of academic libraries, the organization of university departments, and the offerings of mainstream bookstores all evidence the continuing discussion of technology's role in shaping civilization's domestic, commercial, military, and political framework. The particular field of architectural technology, by contrast, has received scant attention in the recent past, and remains underdeveloped today. Works by Reyner Banham, David Billington, Carl Condit, and Rowland Mainstone, for example, are as notable for their relative isolation as for their contributions.

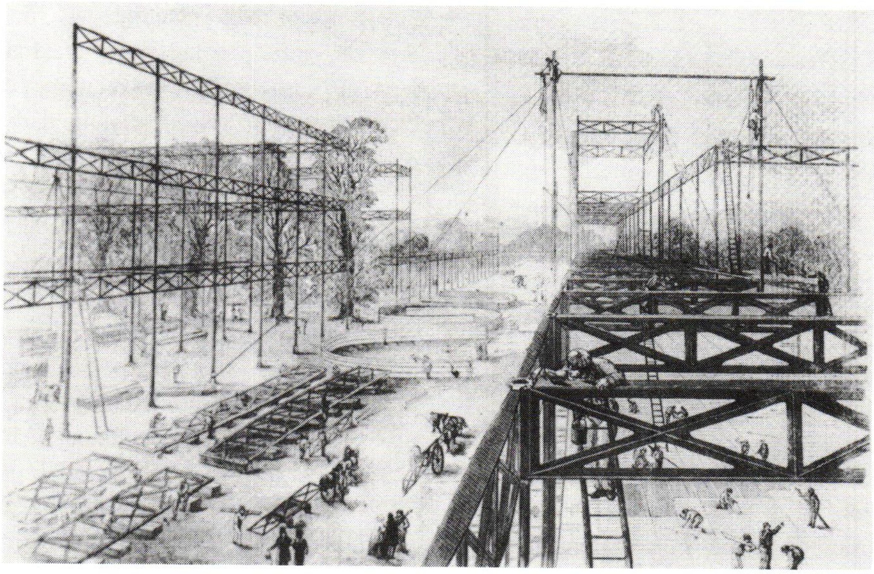
The limited amount of work in the field has focused on a small area, which has unduly amplified the relative importance of a few building technologies, and established a typological framework for technical analysis that is inappropriate for expanded discussion. Books like Edward Ford's *Details of Modern Architecture* (Cambridge: MIT Press, 1990) and Banham's *Architecture of the Well-Tempered Environment* (Chicago: University of Chicago Press, 1969) notwithstanding, much of the recent history of architectural technology has focused on structural systems. This is unfortunate because the importance of structure—as measured by technological advance, contribution to building cost, or perception by a building's users—has steadily dwindled during the 20th century.

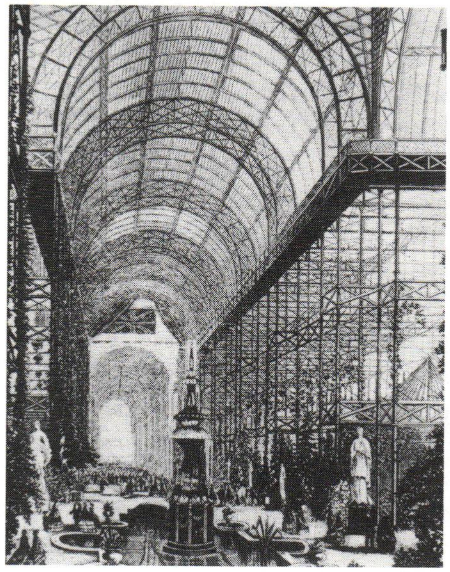
The penchant of historians and critics to parse building systems by material composition has further emphasized structure. Condit, Banham, Kenneth Frampton, and others have used this approach to trace the technological evolution and influence of early modernism. In *The Filter of Reason: Work of Paul Nelson* (New York: Rizzoli, 1990), for instance, Frampton neatly divides the work of European architects of the 1920s into camps of "heavy and light tectonic expression," corresponding to structural frames made of "ferro-vitreous" and reinforced concrete construction, respectively. Similarly, in *A Concrete Atlantis* (Cambridge: MIT Press, 1986), Banham explores the influence of American reinforced-concrete industrial blocks on Walter Gropius and others.

This typological organization—centered on structure and organized around materials—obscures the diversity of issues that a building's technical-utilitarian systems address, and ignores the evolution of even structural systems across material lines. These problems become increasingly acute when discussing new buildings. The concrete-clad steel connections of I. M. Pei's Bank of China, and the steel floor-beams cantilevered from the concrete core of Hugh Stubbins' Treasury Building in Singapore[1] are testament to the pervasiveness of composite and hybrid construction systems in use today. More importantly, works such as Norman Foster's Stansted Airport and Nicholas Grimshaw's British Pavilion at Seville's Expo '92 show that the interests of technically aware designers have broadened well beyond those of the early modernists to embrace environmental conditioning and building enclosure at least as enthusiastically as structure.

Cecil D. Elliott's *Technics and Architecture* is a serious attempt to compensate for the inadequately documented history of architectural technology, which presents an interesting typological organization of building technologies and deemphasizes structure. In a relatively short 430 pages, Elliott traces many primary building technologies from antiquity to the 20th century. The author fits the book's enormous scope into a single volume by keeping his discussions of preindustrial revolution advances brief, so they serve mainly as a background for further developments.

The book is cleverly organized into two parts: materials and systems. On one hand, Elliott's organization by materials allows him to trace the uses, forms, and construction methods of a relatively small number of materials over the period that they largely defined the physical makeup of architectural works. On the other hand, the systems sec-





Construction of the Crystal Palace was inexpensive and fast, thanks to prefabricated and standardized construction of iron and glass (left). After the Great Exhibition closed, the Crystal Palace was dismantled and moved from London's Hyde Park to a suburban site, where it was reassembled and filled with plants and fountains for paying visitors (right); Joseph Paxton, 1851. (From *Technics and Architecture.*)

tion allows him to highlight the expanding needs that a modern building's technical-utilitarian systems address. By including chapters on such diverse technologies as lightning protection, sanitation, lighting, heating, cooling, and fire protection, Elliott draws much needed attention to the plethora and complexity of 20th-century building systems. Set in this context, structural engineering, to which Elliott devotes a chapter, appropriately takes its place among other important technologies rather than overshadowing them.

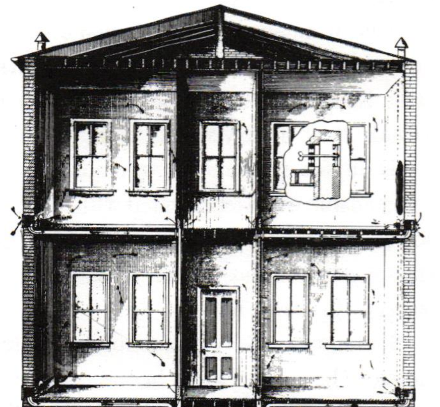
Interesting anecdotes are sprinkled throughout the broad range of topics addressed in *Technics*, making it virtually impossible for readers not to learn something. Specialists will complain of particular omissions in their fields of study or practice, but the same readers will appreciate Elliott's discussion of related subjects with which they are less familiar. Structural engineers and historians will notice that a few important masters, including Gustave Eiffel and Robert Maillart, are virtually ignored in Elliott's chapter on structures; but in his treatment of heating systems, the same readers will be pleasantly surprised to learn of the interdependence of structural, heating, and ventilation systems in many industrial revolution-era buildings. Some of the book's omissions, however, are disconcerting. For example, the building envelope is not considered a system worth its own chapter, although the extensive use of terracotta for cladding in the 19th and 20th centuries is detailed in the materials section of the book. Also left unexamined are the enclosure technologies that allowed the progression from a windowed wall to a wall of windows, and the thermal and waterproofing problems this transformation spawned.

Allowing the images of designers and builders speak for themselves wherever possible, the book's many illustrations are mostly drawn from archival sketches and photographs. Although the resolution of much of the visual material is poor, many of the images in *Technics* are compelling. Taken together, the book's graphics demonstrate the varying representational skill of architectural builders over time, and yields fascinating insights into the visual representation of technical information in architecture. An ornate drawing of a cantilever beam by Galileo, when compared to a contemporary engineer's sketch, shows as much about the evolution of structural illustration as it does about Galileo's understanding of engineering mechanics.

In this drawing from *Discorsi e dimonstrazioni matematiche* (1638), Galileo posed the classic problem of the cantilever beam. (From *Technics and Architecture.*)

The book's descriptions of technical concepts, though usually clear, are sometimes elliptical and confusing. Elliott's introduction to his chapter on structural design, for instance, concisely captures the essential truth that the discipline "must balance the realities of construction practices . . . [with the theories] of structural engineering." Soon after this statement, the distinction between wind-trusses and moment frames in tall buildings is muddled—not from misunderstanding on the author's part but rather by sloppy writing and editing. The book's clarity is further compromised by the occasional use of inconsistent units. In describing early air-cooling systems, Elliott measures heat transfer alternately by BTUs/hour and by horsepower, making it hard to compare the systems he discusses. Although the uneven descriptions and inconsistent data will not deter the technical *cognoscenti*, they are certain to discourage the uninitiated.

Technics also suffers somewhat from its lack of a critical voice, and by its frequent lapses into dreary reportage. Some recent historians of architectural technology, notably Banham and Condit, enliven their discussions with a stream of questions and frequent reference to "design" issues of program, site, and expression. Except in his introduction, Elliott leaves critical inquiry and technology's integration with related subjects unexplored. The terra-cotta skin of Raymond Hood's 1931 McGraw-Hill building is described in *Technics*, but the irony of cladding this forward-looking building with a material used mainly by Beaux-Arts practitioners to emulate historical forms is one of many engaging topics left undiscussed. Similarly, history's drama is largely lost in *Technics*. David McCullough, whose work on several technical subjects has captivated both lay and academic audiences, points out that one can enliven history by showing how a particular development could have taken any number



This diagram illustrates a residential heating system of the 1880s in which ducts were provided for both the supply of warm air and its return to the furnace. (From *Technics and Architecture*.)

of alternate turns. Ignoring this approach, Elliott lays down history in a series of linear strips, often abruptly terminating them. His discussion of the environmental problems caused by modern air-conditioning systems, for example, begins and ends with the statement, "sealed buildings in a polluted setting and subject to health and endangering emissions from their own interiors give rise to new definitions of 'air cleansing.'" The historical strips in *Technics* also frequently overlap and too often jump in time, making the book needlessly hard to follow.

In his dogged disregard for critical questioning and lively prose, Elliott misses an opportunity to clarify technology's influence on architectural design, and to instigate broader interest in the subject. Even so, his wide-ranging historical narrative and organization by technological systems make the book particularly useful to practitioners and teachers specializing in building technologies. *Technics* is a welcome foil to the academic training of these specialists, which usually underemphasizes historical evolution and context. Elliott's condensed, encyclopedic treatment provides a quick way to learn more about architecture's technical heritage. Innate interest in the subject should propel technologists through the book's dry prose. Those interested in making further headway into technical-critical history will also find Elliott's work useful as an idea-generating starting point for many subjects. The questions it leaves unasked are crying to be explored, while its typological organization offers a refreshing and obvious framework for further exploration.

NOTES

1. This building is discussed in detail in Deborah Gans et al., eds., *Bridging the Gap: Rethinking the Relationship of Architect and Engineer* (New York: Van Nostrand Reinhold, 1991).

TECHNICS AND ARCHITECTURE: THE DEVELOPMENT OF MATERIALS AND SYSTEMS FOR BUILDINGS, Cecil D. Elliott, MIT Press, 1992, 480 pp., illus., $65.00.

COLIN CATHCART

The Structural Basis of Architecture

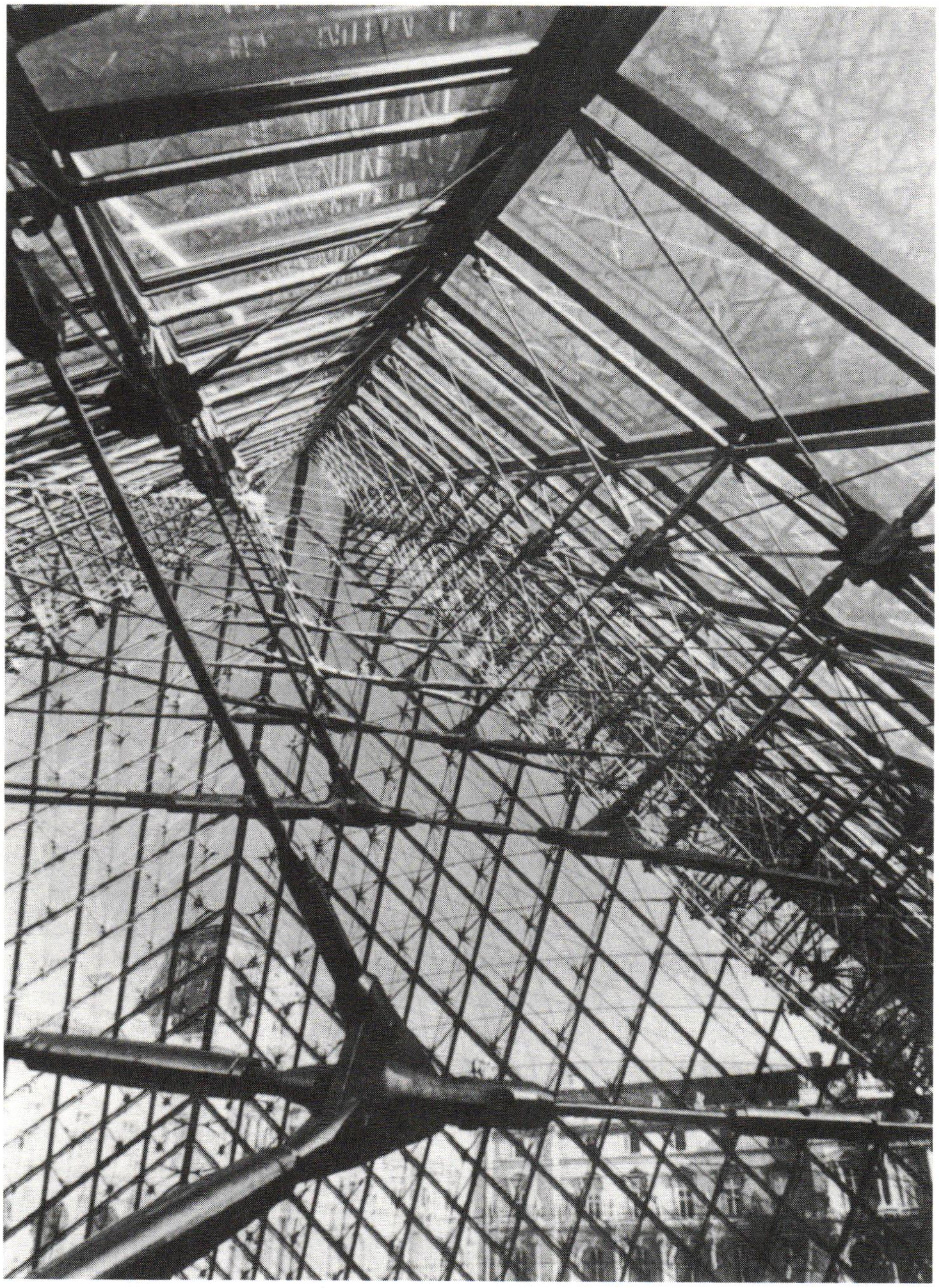
Byorn Normann Sandaker and Arne Petter Eggen

Structural theory may be the basis of just about everything. Likewise, linguists can say that all thought is based on language, politicians can argue that everything comes down to politics, and prostitutes can believe that everything starts and stops with sex; however, the structural engineer knows with the certainty of science that everything—including language, politics, and sex—has a structural basis. But is structure the basis of architecture?

The automatic resistance of matter to force is certainly its most useful property. Channeling natural forces around the spaces we reserve for ourselves is fundamental to our condition. The separation and cooperation of structure and envelope may have been present in humankind's first rudimentary shelters. In these ways, structure could be said to be the basis of all building; but this is not the sense offered by the authors of *The Structural Basis of Architecture*, Byorn Normann Sandaker and Arne Petter Eggen.

This book has a double intention: first, to provide a basic outline of structural theory; and second, to persuade the reader that the expression of structure in architecture is true, correct and exciting. The authors write, "A building structure can be said to have at least two aims of equal importance: the technical and the aesthetic."

Immediately, some reservations must be registered. A building that clearly displays its structure is not necessarily going to be great or even acceptable architecture. Our cities are filled with buildings that express technical values at the expense of interpreting programmatic or symbolic content. Where structural forces are conscientiously expressed, they may be intrusive or inappropriately didactic, or they may simply miss the point of the building. Acceptance of Richard Rogers' new Lloyd's of London build-



The complex bearing structure of I. M. Pei's pyramid at the Louvre. (From *The Structural Basis of Architecture.*)

ing has been hung up on this issue. Building occupants may not want to be constantly reminded of the great efforts expended by the structure to keep disaster at bay.

In pursuit of their themes, the authors have succeeded in illustrating a book of structural principles with inspiring and provocative examples of architecture. Where most introductory texts bury the visualization of structural forces in an avalanche of mathematics, each bit of theory and math presented in this book is preceded by science and architectural history, and followed by suggestions of architectural implications.

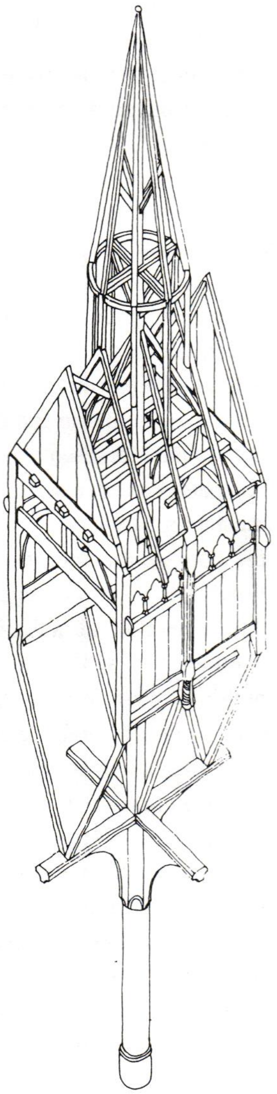
The chapter on statics is introduced with sketches from Leonardo da Vinci, a description of Beauvais Cathedral, and an aerial photo of five tugboats pulling a drilling platform in the North Sea. Mathematical calculations and diagrams support the text on Newton's Laws, static equilibrium, and bending moments, but more compelling illustrations of these principles are provided by a reconstruction of the Nes stave church in Hallingdal, Norway, photos of Aalto's trussed courthouse ceiling in Saynätsalo, Finland, and Claude Monet's painting of the cable trusses at Gare St. Lazare in Paris.

After the initial chapter on statics, structural concepts are presented in terms of architectural elements. The trusses of Renzo Piano and Rogers' Pompidou Center in Paris are solved and quantified. Beams are considered with help from Heinrich Gerber, Jørn Utzon, Santiago Calatrava, not to mention Stonehenge. Column buckling is demonstrated by Samson (the columns of the temple) and by Charlie Chaplin (his cane). Frames, arches, cables, and membranes are also presented, each in turn. The book concludes with a chapter on structural details from such varied sources as I. M. Pei's glass pyramid at the Louvre, a Windsor chair, Mies van der Rohe's Barcelona Pavilion, and an Olympic ski jump.

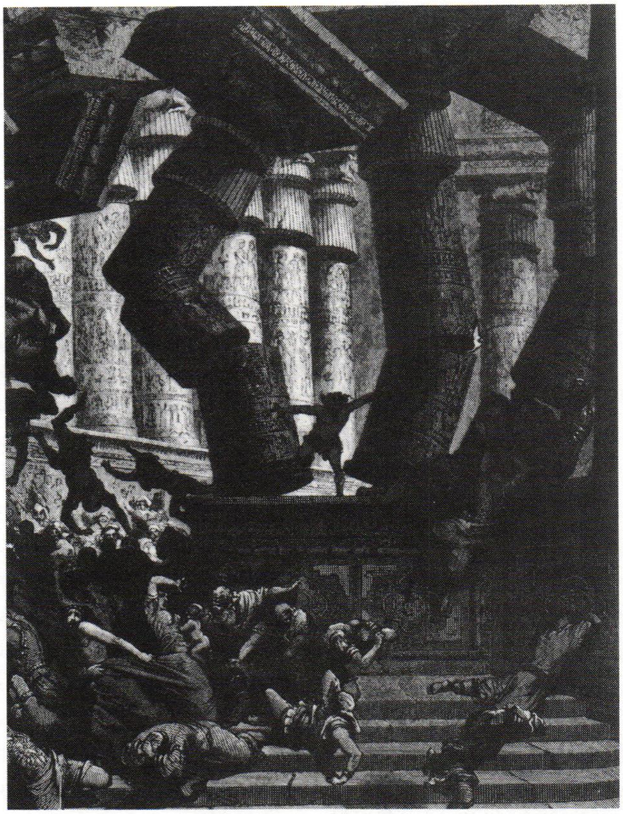
The presentation of structural theory through visual examples is the best way to introduce the subject to architecture students and interested laypeople, but the merit in this approach makes the shortcomings of this book all the more maddening. The diagrams are as repulsive as those in any engineering text, cluttered with mystifying abbreviations, misleading line weights, and clumsily drawn arrows. Diagrams and illustrations are captioned but not numbered, so it is often hard to guess if an accompanying image would have made an otherwise puzzling argument clear. Equations could be presented in a way to make them more visually communicative. Division, for example, is more quickly understandable when represented with the divisor all under the dividend, as opposed to showing a little slash sign (/) between long terms on the same line.

Sometimes the explanations are too simple. The authors jump in one page from an introduction of strain to the working diagrams of wood, steel, and concrete, and then leave the subject entirely; their cursory treatment of the subject is like suggesting that you know how to play the flute if you just blow in one end and cover the holes with your fingers. Equations are sometimes developed with baffling haste. Perhaps "$q=302/1.6=563\ N/m^2$," but most readers will fail to see the arithmetic. Metric units are quite distracting until one realizes the blissful clarity they bring to structural concepts. It may be that the imperial conversions are the distraction; one hopes that these are dropped in future editions.

It's hard to know if the imprecision of the text is the fault of vague writing, poor translation, or bad copyediting. Although most of the structural explanations are fairly clear, many sentences are awkward and must be read several times. The authors claim that during the Industrial Revolution "the materials were put to even greater use," and then leave the reader hanging. Punctuation errors litter every other page. And there are glaring mistakes: how credible is a structural analysis of Norman Foster and Ove Arup's Hong Kong and Shanghai Bank that constantly refers to its "double columns," when each virendeel mast clearly has quadruple columns?



Nes stave church in Hallingdal, Norway; ca. A.D. 1100, demolished in 1864. Drawn reconstruction by Håkon Christie for the Norwegian Central Office of Historical Monuments and Sites. (From *The Structural Basis of Architecture*.)



Death of Samson by Gustave Doré; Samson takes revenge on the Philistines and topples the temple's columns. (From *The Structural Basis of Architecture*.)

More than passing reference should be made at this point to Mario Salvadori's *Why Buildings Stand Up* (New York: W. W. Norton, 1990), now in paperback. This book arranges the subject similarly, but its crystal-clear text deals with it at much greater length, and at one-third the cost; unfortunately, it lacks the mix of photos, drawings, diagrams, equations, and sketches that Sandaker and Eggen use so well. All of Salvadori's explanations are in plain English, without equations, supported by a sprinkling of illustrations from the second generation of modernism. Sandaker and Eggen's explanations are carried by their illustrations, with a rudimentary text at best and some computational development.

The transparent relationship between structure and architecture proposed by Sandaker and Eggen is interesting but ultimately unidimensional. The expression of structural law is not the only relationship architecture can have to the perception and experience of natural forces. A broader base of case studies could have given greater depth to this proposal. How has Coop-Himmelblau made architecture by subverting our expectations of structural logic? How has Robert A. M. Stern suppressed structure yet distorted classical proportions with the capabilities of modern materials? How does Frank Gehry achieve such graceful awkwardness in steel?

Let's face it: as often as not, structure is not the basis of architecture. However, this book makes a compelling case for the visualization and consciousness of structure as a necessary part of the making of architecture. Most courses in statics, strength of materials, and structures are taught by engineers well versed in the computation of forces and tabular selection of members, but who have little aptitude for the visualization of information. Maybe this, in the end, is why the contemporary practice of architecture appears to have so little in the way of a "structural basis."

THE STRUCTURAL BASIS OF ARCHITECTURE, Byorn Normann Sandaker and Arne Petter Eggen, Whitney Library of Design, New York, 1992, 224 pp., illus., $35.00.

TED CAVANAGH

Visions of Cathedrals Danced

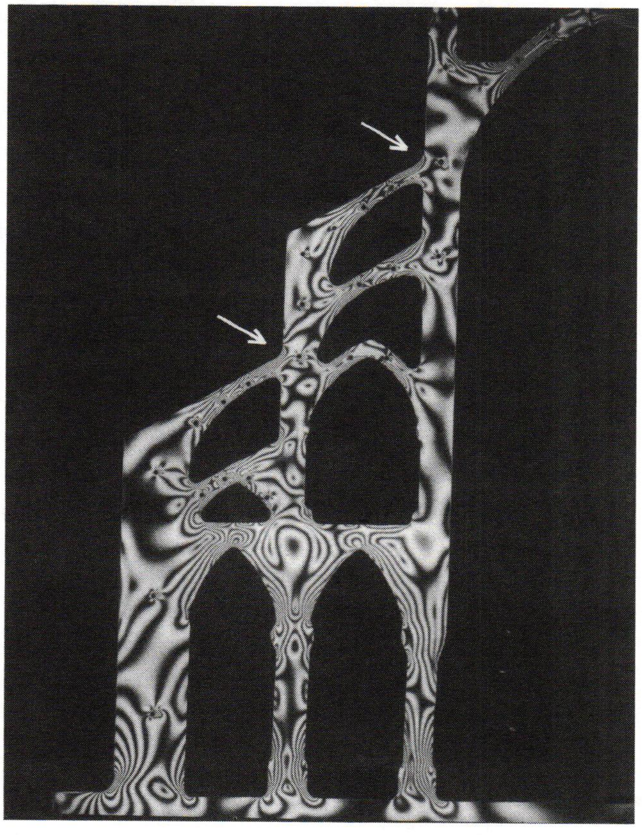
I do not know Robert Mark, author of *Architectural Technology Up to the Scientific Revolution*, nor did I at first recognize his name. But I do know his work. Years ago it inspired a student project of mine, prompting me and three other architectural students to seek out an expert on polarized light and lenses next to Ernest Rutherford's old physics laboratory at McGill University. We spent weeks shaping pieces of clear plastic with simple tools, nervously checking to see that we had not created any unwanted rainbows of stress during the milling process.

Our inspiration came from Mark's images of cathedrals in *Scientific American* (dated November 1972)—clear plastic cross-sections of Notre Dame displayed intense ripples of color where the structure was working hard and gentle eddies of low stress where it was not. How strange it was to us that buildings made of stone which seemed to defy gravity could be dematerialized into clear plastic. Somehow the plastic contains ever-changing rainbows that only cease moving when set by heat. How wonderful to study medieval buildings in the manner that science studies nature. How fitting that, for buildings often described as "structure in light," light could be used to study structure. These images of rainbow cathedrals rank with those of Eadweard Muybridge and Harold E. Edgerton as technical advances, as science, and as art.

In 1991 Mark invited a group of scholars, architectural historians, archaeologists, and engineers to a seminar sponsored by the National Endowment for the Humanities. Their goal, evident in *Architectural Technology Up to the Scientific Revolution*, edited by Mark, was to survey historical construction and to illustrate objectively "the art and structure of large-scale buildings." Mark is also coauthor of the book, and so, with apologies to Sheila Bonde, Lynn Courtenay, Clark Maines, Roland Richards, Jr., and Elwin Robinson, I shall refer to Mark as the author throughout the rest of this review.

This book examines three complex fields: structure, construction, and history. It discusses them in a way that is consistent with its stated objective: to be "a 'handbook' to aid both students and teachers in treating questions of technology in courses dealing with European architectural history before the Enlightenment." This modest goal supports current pedagogical practice and gently expands the discussion. The book is a series of thoughts on construction that build on each other, a three-dimensional array of historical era, construction principle, and building case study. It describes a time when the technology of construction is was slow to change, when practice and theory are were one.

The format of the book is strong and the chapters are based on the traditional separation of construction into the three components of foundation, wall, and roof. After an introduction to the principles of construction, each chapter is subdivided into historical eras. On closer inspection, each paragraph deals with a specific issue of construction such as silty soil or pozzolan concrete and then one or two buildings are named as examples. There is scant discussion of the building examples, although they are often illustrated. Perhaps this is a failing typical of all surveys where a surfeit of information is dealt with so quickly that one hears without listening and sees without observing.



Photoeleastic interference pattern in windward buttressing of the reconstructed nave of the Notre Dame under simulated wind loading; the arrows designate regions of local tension; Robert Mark. (From *Architectural Technology Up to the Scientific Revolution.*)

What is missing in the book is any dialogue between the text and the drawings. The drawings simply repeat what has already been said in the text—they merely illustrate rather than inform because they are not particularly detailed and most are not drawn accurately or to scale. This book would be much better if the individual examples were drawn accurately in a consistent format; a daunting task, no doubt, but one that Jean-Baptiste Rondolet, Eugène-Emanuel Viollet-le-Duc, Julien Gaudet, and, most notably, Auguste Choisy did not avoid.

The axonometric and the section are accurate representations that aid comparisons between buildings. The most informative type of drawing in the book is the "comparative section," which shows one side of the lateral section of a building and completes it with that of another building. This left side/right side split promotes both accuracy and comparison. It shows the area of the building cross-section, basic geometries, hidden structure, and contours of stress. A complete set of these sections could potentially act as templates for student analysis. If this book truly is a companion "handbook" to history courses, then many of the photographs similar to those already included in history texts should have been dropped in favor of more comparative sections.

Consistent with my earlier captivation with Mark's work, I have much praise for these important studies. Mark deserves to be recognized for his fundamental, original work that adds new analytical techniques and structural insights to the history of building technology. I might question, however, the form he has chosen for disseminating his analysis and insights, but these are questions for the entire field as much as for this particular book.

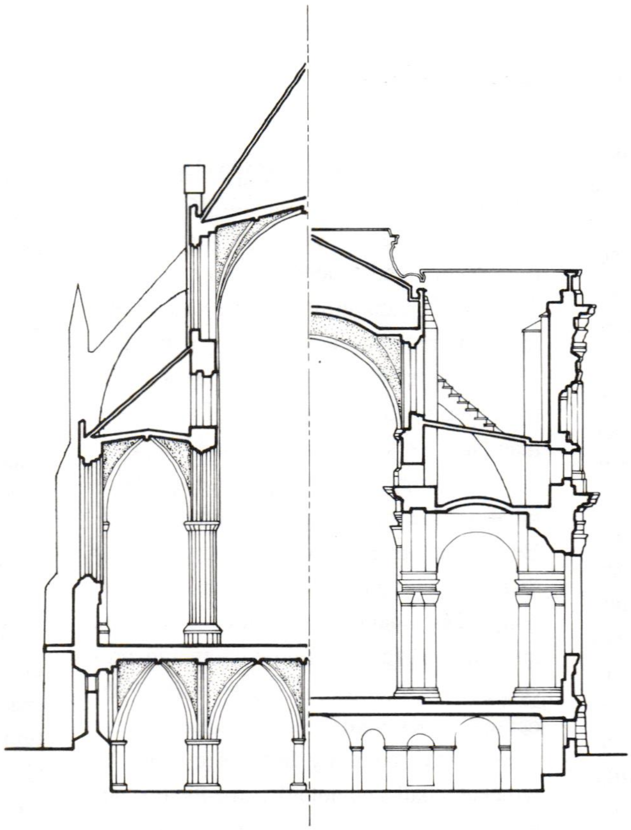
An argument must be made for a consistent method of discourse and representation suitable to the history of building technology in general. The accuracy of engineering and its methods of observation might be important standards, but even here there are problems. The analysis and description of structures is well established, consisting of equations, force diagrams, and models, but perhaps accurate description in construction is not yet considered essential. The precedents for the study of construction are less clear, probably because construction is fundamentally different from structure—whether in the radical distinctions between art and science, in their differing relations to technique and mathematics, or simply in their separation in the architectural curriculum.

To study a building completely, something can be gained by following a consistent method similar to the sequential investigations proposed by historian Jules David Prown in his essay, "Mind and Matter: An Introduction to Material Culture Theory and Method," which appeared in *Material Life in America 1600–1800,* edited by Robert Blair St. George (Boston: Northeastern University Press, 1988). Prown's method entailed: (1) *description*—substantial analysis, content, formal analysis; (2) *deduction*—sensory engagement, intellectual engagement, emotional response; (3) *speculation*—theories and hypotheses, program of research; (4) *investigation of external evidence*—quantitative analysis, stylistic analysis, iconography.

A particular building would be examined starting with "substantial analysis," and then step by step through the procedures listed above. Notice that structures and construction are considered in different steps, with construction in the first step and structure in the last. Mark has allowed the historical format to prevail, to the detriment of a step-by-step analysis which is important for a basic understanding of structure and construction.

Previous work by Mark and his collaborators clearly demonstrates the structure of the Colosseum, Pantheon, Hagia Sophia, Westminster Abbey, and Notre Dame Cathedral. Each building is the widest, tallest, or earliest structure of its type, challenging the forces of gravity and wind. Each has been tested by various forms of modeling. Mark explains significant new understandings of these buildings from a structural point of view, demonstrating them with convincing modeling results. His analysis would, I believe, be considered "quantitative analysis" by Prown because it is a program of research in an allied discipline.

On the other hand, analysis of a building's construction is clearly part of the first step, which describes physical dimensions, material, and fabrication. Describing construction within such narrow limits is difficult for one example, let alone several. Mark's survey is described within a historical narrative of a few hundred pages, so it cannot include facts as basic as precise dimensions or environmental performance. A contemporary "environmental" description, for instance, would have to catalog thousands of materials and assemblies of materials in terms of embedded energy, toxicity, pollution of manufacture, impact, performance, adaptability, reuse, and so on. Although *Architectural Technology Up to the Scientific Revolution* describes a simpler time, basic measurements of light, acoustics, temperature, and ventilation would add fundamental information to the book's descriptions of construction material and technique.



Comparative cross-sections of St. Paul's Cathedral, London; Gothic choir of the old cathedral (left), and Wren design (right). (From *Architectural Technology Up to the Scientific Revolution.*)

A designer faced with the field of construction—as when faced with the field of history—is searching for significance. Construction is a complex field, currently codified in sixteen standard sections, which are similar to periods of historical style—classifications that help map the field, locating specific buildings or building components within it, and, by their very inclusiveness, prompting questions and triggering responses. When construction and history are conflated, the possibility of a simpler version of history and a simpler version of construction is initiated, a radical departure that combines the eras of history into a nearly timeless way of building. With Rob Krier, for example, many perceive a simpler time, a time before Claude Navier and Joseph Paxton, when building materials were quarried or harvested rather than smelted or invented. This simpler time seems visually empirical and perhaps it is the best point for any design student to start in the study of construction.

The term "building technology" hides a fundamental distinction between structures and construction. The educator's overarching task must be to explain construction as a field distinct in itself—defining, in its own language, the same buildings and building elements that are part of the languages of history, structure, and architectural design. The discourse of construction is unlike the precisely limited discourse of structure, as well as the expansive discourse of architectural design. History has its various aspects—quantitative, cultural, social, economic, military, political, intellectual—and surprisingly, many of these aspects suit construction as well. Perhaps the discourse of construction is akin to that of history: a search for significance in a world of facts.

Beyond a critique of this particular book, it's important to question some of the implicit assumptions in the history of building technology. Although I understand the utility of explaining technology to history students, it is important for the field to stand on its own, with its own methods and integrity. *Architectural Technology Up to the Scientific Revolution* is a fine encapsulation of historical building technology and can become the foundation of a rigorous study of the relationship between history and construction.

In conclusion, I wonder if Victor Hugo might have revised his famous "this will kill that" homily if this were the book his character had been holding in front of Notre Dame, given that his comment deals with the destruction of wonder. The challenge is to find ways to reveal the rainbows within the construction of things—a new way of seeing that embodies technical advance, science, and art. Mark has started us on this search.

ARCHITECTURAL TECHNOLOGY UP TO THE SCIENTIFIC REVOLUTION, Robert Mark, editor, MIT Press, 1993, 280 pp., illus., $39.95.

GREGORY K. DREICER

Concrete Idol

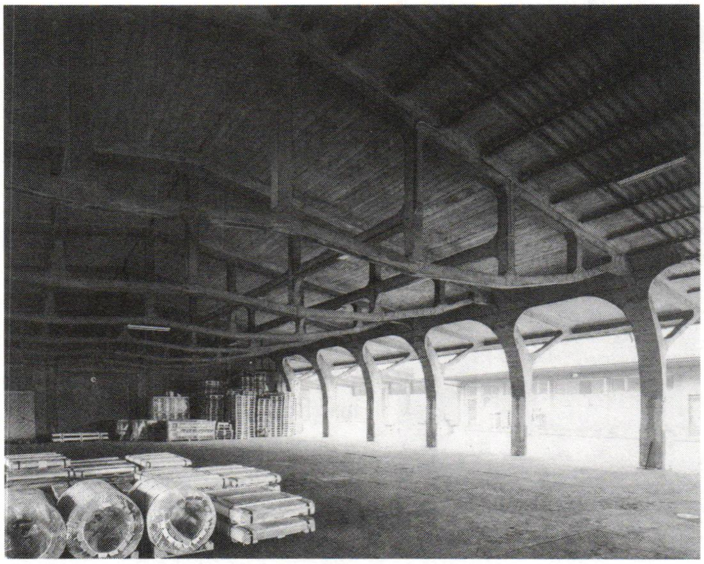
What do we know about the development of the structures we live on, in, and under? Very, very little. Framed systems? Elevators? Reinforced concrete? Civil engineers? Try to find a thoughtful, well-researched history that matches the scope of a work on a minor politician or an obscure painter! The pyramids of Egypt pose less of a mystery than New York's skyscrapers and bridges.

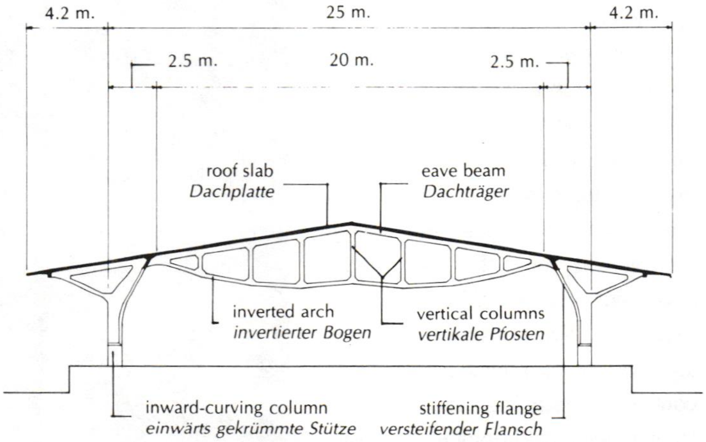
The history of building technology is almost without historiographical foundation. Because it was never considered worthy of serious attention, few historians have attempted to understand structures as complex and meaningful cultural artifacts and processes. Worse, most of the key, early 19th-century documents and structures have disappeared, taken by flood, fire, war, the wrecker's ball, and not infrequently, the garbage can. Moreover, most of the designers and builders of early modern structures can no longer speak for themselves: they are dead or soon will be.

Histories of building technologies have traditionally been written by engineers, occasionally by bridge fanatics. Of the few historians who have entered the field, most have typically been satisfied with a modicum of research, which they do not bother to document. They often reiterate the unfounded opinions of engineer-historians who were more concerned with defending their position in industry or university or society than in exploring the developments in which they took part. As a result, histories of bridges, railroads, and other "technological" accomplishments have often consisted of a parade of illustrations accompanied by macho claims of "firsts" and "biggests" which, when the buffs have gone home, leave the rest of us yawning.

The unique inventor-genius theory, while debunked in most fields, survives in civil engineering. The "Eiffelization" of construction history is all the more ironic because Gustave Eiffel was an entrepreneur foremost—his design input was minimal. Meanwhile, powerhouse engineers who built the infrastructure of Europe, such as Eugène Flachat and Karl Etzel and industrial giants like French firms Gouin and Schneider, remain virtually unstudied. Historians of art

Schwandbach Bridge; Robert Maillart, 1933. (From *Robert Maillart and the Art of Reinforced Concrete.*)





Chiasso roof-shed interior showing the inverted arches spanning the shed and the inward curving columns. The drawing shows the span dimensions and structural elements; Robert Maillart, 1924. (From *Robert Maillart and the Art of Reinforced Concrete.*)

and architecture have occasionally examined the formal aspects of structural design—and have neglected all the others. The monuments repeatedly discussed are ripped from their contexts and not seen as belonging to the "ordinary" structures we are led to believe they morally tower over. The souvenir-shop approach continues. But are the tourists still buying?

Some engineers write about bridges in order to raise their profession in others' eyes. This was a prime goal of David Billington in his book *Robert Maillart's Bridges: The Art of Engineering*, which won the Dexter Prize of the Society for the History of Technology in 1979. Billington is a professor of civil engineering at Princeton University and a specialist in concrete shell structures. In his *The Tower and the Bridge* (1983), he further developed a viewpoint based on unabashed hero worship.[1] Billington is a populist who has promulgated the concept of New Structural Art as a means of elevating the station of the civil engineer. He is concerned with celebration. *Maillart's Bridges*, is, in fact, a love letter to a Swiss engineer who designed a number of reinforced-concrete structures of unfamiliar form. Billington had the good fortune to discover documents that permitted him to track the history of the structures from initial conception to construction and beyond. Most of them still exist, enabling Billington to lead us on a chronological tour of the best of Robert Maillart (1872–1940).

Billington focuses on the design process and shows that it does not emerge from "theory" or mathematical calculations, which will come as a revelation to some. It is certainly unusual for an engineering professor to state this; "theory" is usually used in the attempt to squeeze the engineer onto the pedestal that the scientist already occupies. As Billington demonstrates, design comes from observation, experimentation, trial and error, personal taste, intuition, politics—and some math as well. The design process is shown to be a group effort, from its initial conception through interaction with governmental officials to contractors and consultants. Billington provides an enlightening discussion of "theory" and "practice," and instructs readers in the importance of reducing the difficulty of calculations and retaining traditional structural forms. Design is seen as a process, a series of choices. This approach is the great value of the book; it is unusual, short, and clearly written, and at its price, a bargain besides.

With his uncritical approach, however, Billington reveals his traditional roots. He expresses at every turn his admiration for Maillart (a comparison to Einstein is lobbed at the reader!) but never discusses why this engineer was only moderately successful. Sigfried Giedion, who first introduced Maillart to a wide audience, noted that many Swiss regarded the bridges as "positively hideous"[2]; Billington chose not to discuss the reception of the designs, which simplifies the story, but denies the reader vital information necessary to understand Maillart and his structures.

Billington devotes little text to the construction process, as is typical of engineering histories.[3] He does, however, present many photos and diagrams, including some of reinforcement design as well as construction. Some of the "new concepts" attributed to Maillart were in fact hardly new—except in concrete. One sometimes gets the impression that Billington is blind: but love, or at least sincere adoration, can be blind. This will dishearten the historian, but will hardly ruffle the general reader, who will be absorbed by the opportunity to discover the shadowy world of design.

Both the general reader and the historian will pass quickly over Billington's views on science ("In science, the data is taken from nature with as little human interference as possible") and art ("Visual form, like any artistic conception, can be judged by the aesthetic criteria of our culture")—viewpoints which may be politely termed highly personal.

The flaws of *Maillart's Bridges* may be seen as opportunities; indeed, the author announced the book as the first result of an ongoing examination of Maillart. It is all the more curious that in Billington's second effort, the recently released, large photo-filled hardcover book, *Robert Maillart and the Art* *of Reinforced Concrete*, Maillart virtually disappears from view. He becomes a cardboard figure, robbed of the life which he enjoyed in the earlier book. Furthermore, the technology of reinforced concrete also retreats into the background, except perfunctorily near the back of the book, and even less effort is made to explain it. The building process is again rarely mentioned; neither is the context of both Maillart's life and technological environment. Only one sketch from the engineer himself (of a beam bridge which was never built!) is provided; there is only one diagram showing the configuration of reinforcing bars.

Salginatobel Bridge; Robert Maillart, 1930. (From *Robert Maillart and the Art of Reinforced Concrete.*)

The impetus for the latest book was not Billington's own; it was suggested to him as a showcase for the photographs. The idea is excellent, as the bridges themselves are hard to find—and if found, hard to see. Most of the photographs, by Franziska Bodmer and Bruno Mancia, are beautiful. The grizzled, knotty texture of the concrete is portrayed with such clarity that one wants to reach out and stroke it. The images, however, reflect the attitude of the author that the structures are God-given. They are mostly formally composed portraits: the Salginatobel Bridge, lean, cool and aloof, spans a ravine; the Schwandbach span curves coquettishly into the wood. These are icons; Billington does not want us to know that from a close perspective the Salginatobel bridge can look clumsy.[4] Still, a book that provided various perspectives would have allowed readers to discover the beauty of Maillart's work for themselves.[5]

Billington ignores much of what made the previous book exciting. The coffee-table *Maillart* is organized chronologically, hardly an ideal format to explore specific design concepts. And Billington seems to step further from examination and closer to adoration. For example, in the earlier publication, Maillart's Chiasso roof shed is said to have "displayed not a straining for new effects, but a contemplation of old forms, used in new ways." In the second book, the description has become: "The entire spanning structure . . . is so extraordinary that precedents and rationale seem elusive." The author does not mention that such structures already existed in iron.

Intermittently, Billington presents short views on "aesthetics." This reviewer would prefer to look in the other direction, but the comments appear again and again, and are as gratuitous as they are inscrutable, often verging on parody. For example, despite an insistence on form, which is dryly and frequently described throughout the book, Billington explicitly rejects terms such as "harmony, symmetry, proportion, and order," because they are "confusing." In their place, however, he recommends "efficiency, economy, and elegance," as well as terms used by engineer Christian Menn, "transparency, slenderness, simplicity, and regularity." What is gained by this exchange of abstractions?

Twenty years ago, Billington criticized Giedion's comparison of a Greek temple to a Maillart bridge, stating: "The words are striking but the meaning is murky."[6] Now, Billington's "aesthetic" analogies seem to be inspired by Giedion, while lacking the latter's verve and insight. For example, Billington tacks on to a description of a bridge the following statement: "However unique Maillart's forms may be, they always refer to an engineering idea in the same way that a great poem refers to a verbal meaning yet can be unique and of surpassing beauty." The nonplussed reader who ponders the role of *verbal* meaning in great poetry will not be alone; the German translators of the *Maillart* text (which appears in both English and German, in an awkward layout) altered this engineering belletrism to read: "in the same way that a great poem consists of simple words . . . "! In another chapter, Billington compares a bridge to a Paul Klee painting (of which no illustration is provided). In his enthusiasm he likens the *underside* of the bridge—which is illustrated but will ordinarily be seen only by lucky maintenance workers—to the painting. It is not clear, however, why a comparison was not made to the *back* of Klee's canvas, which is similarly unavailable for public enjoyment. What is most odd about these verbal attempts to raise the stature of engineering is that they are rococo flourishes—precisely what Billington deplores in structure.

Billington's support of civil engineering as a form of art contains a bias toward concrete that obscures significant aspects of Maillart's designs. In 1926, Maillart was the consulting engineer on the destruction of the iron lattice-beam Grandfey Viaduct (Wilhelm Nordling, 1857–1862), one of the supreme achievements of early modern "structural art." Maillart's immuring of the viaduct in a banal, heavy series of concrete arches was tantamount to bricking up the Eiffel Tower. A photo of the arch bridge is provided, but Billington has no comment.

Fine and decorative arts, literature, and science are routinely studied in high schools and colleges as part of a standard humanities education. Engineering—the study of the environment we create—does not turn up. It is this that shocks Billington into action; for responding he deserves the highest praise. But something more than emotional response is needed. If engineering is to achieve importance in the humanities, its broader meaning must be examined in a way that can stand up to critical notions of history.

Maillart's talent is belittled rather than honored when removed from context, because creativity arises—and is hampered—through intercultural exchange. This process takes place within a community of designers, and within an environment that presents an enormous number of crosscutting alternatives and pressures. Billington is currently preparing a comprehensive biography of Maillart. One eagerly hopes for a critical examination of the life, structures, and times of the artist, in which the biographer overcomes his private passions and gives the public a broad and deep view of design.

NOTES

1. David P. Billington, *The Tower and the Bridge: The New Art of Structural Engineering* (Princeton: Princeton University Press, 1985; first published by Basic Books, 1983).

2. Sigfried Giedion, *Space, Time and Architecture* (Cambridge: Harvard University Press, 1941), p. 371. Later editions contained an expanded section on Maillart.

3. Concerning the construction process, see Tom F. Peters, *Time is Money* (Stuttgart: Julius Hoffman, 1981) or the forthcoming book by the same author (Princeton University Press), excerpted in this issue of *DBR* on page 25.

4. See photograph from Maillart's own publicity brochure, in George C. Collins, "The Discovery of Maillart as an Artist," in *Maillart Papers* (Princeton: Princeton University Press, 1973) from the Second National Conference on Civil Engineering: History, Heritage, and the Humanities at Princeton University. In this important discussion, Collins notes that the construction of Maillart the "artist" required "considerable editing" on the part of his admirers.

5. For this, the welter of views provided by an early champion of Maillart, the artist Max Bill, is recommended. Max Bill, *Robert Maillart: Bridges and Constructions* (first edition, New York: Frederick A. Praeger, 1949).

6. David P. Billington, "An Example of Structural Art: The Salginatobel Bridge of Robert Maillart," in Princeton University, Second National Conference on Civil Engineering: History, Heritage, and the Humanities, *Background Papers* (Princeton: Princeton University, 1972), p. 21.

ROBERT MAILLART'S BRIDGES: THE ART OF ENGINEERING, David P. Billington, Princeton University Press, 1979, 146 pp., illus., $14.95.

ROBERT MAILLART AND THE ART OF REINFORCED CONCRETE, David P. Billington, The Architectural History Foundation (distributed by MIT Press), 1990, 151 pp., illus., $60.00.

BO GÖRAN HELLERS

Rise, Go, and Gait

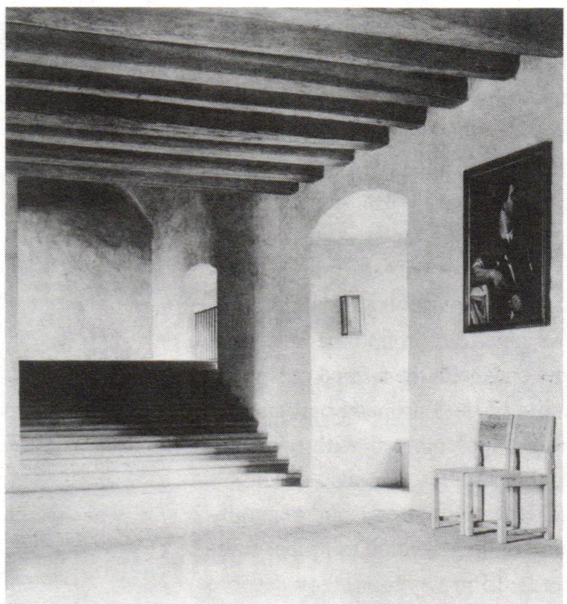
Last August the Society for the History of Technology (SHOT for short) held its annual meeting in Uppsala, the charming seat of learning that is home to the oldest university in Sweden. On the last evening of the meeting, after a banquet in the large Hall of State at Uppsala Castle, a charming American woman of my acquaintance somehow tripped as she descended the 400-year-old staircase leading out of the great hall. I am not normally a hero, but as I happened to be close by, I succeeded in breaking what could have been a disastrous fall, but not until some damage had been done. As she inspected her swelling and already painful foot, she remarked, "Obviously these stairs weren't built to code."

This incident came to mind as I was reflecting upon the message of the two fine volumes of *The Staircase—History and Theories* and *Studies of Hazards, Falls and Safer Design*—by John Templer, a well-known professor of architecture at the Georgia Institute of Technology. Even a cursory glance at these volumes confirms the fact that staircases—essentially in their present form—have graced structures for centuries, and that falling on stairs is not an uncommon event.

The designer of multistory buildings today must deal with the competition for space presented by the need for vertical transportation (supplied by stairs, escalators, and elevators), for horizontal transportation (through entrances and corridors), and for activities to be carried out in the building; a number of design constraints also come into play, such as allowances for emergencies or for the physically challenged.

As elevator technology has improved, staircases have been relegated to second-class status among the options available for vertical transportation, no longer viewed as a design challenge worthy of one's best efforts. In many buildings, stairs and stairwells have obviously not been intended for everyday traffic, but rather only to serve as a means of evacuation in emergencies. In Sweden it is now possible (by exemption) to install staircases only 65 cm wide; one can only hope that any emergency in buildings with such staircases is not too serious, so that an evacuation can take place in an orderly fashion—a crush of panicky people might never get down such a narrow passage. The tragic events that have occurred in sports arenas around the world, such as in the Heysel stadium in Belgium where, in 1985, some forty people were crushed to death, show the real danger of trapping people within a confined building space. Ironically, several of the casualties occurred near the opening of the wide, straight staircases. On the other hand, the recent bombing of the World Trade Center in New York did not seem to provoke uncontrollable panic. The buildings were evacuated in a manner that must have filled the designers with reassuring confidence that their design decisions regarding the stairs and stairwells were correct; casualties were limited to those people nearest the explosion.

Designing a staircase is no trivial matter. Many rules can be applied—all valid—but



Stairs leading up to the Hall of State at Uppsala Castle, Uppsala, Sweden; ca. mid-14th century, restored 1932. (From *Rikssalen: På Uppsala Slott.*)

with differing value and results depending upon the nature of the design problem. In general, there is no one best solution to the problem: a number of designs may be acceptable from a technical standpoint, thus leaving ample room for architectural conceptions.

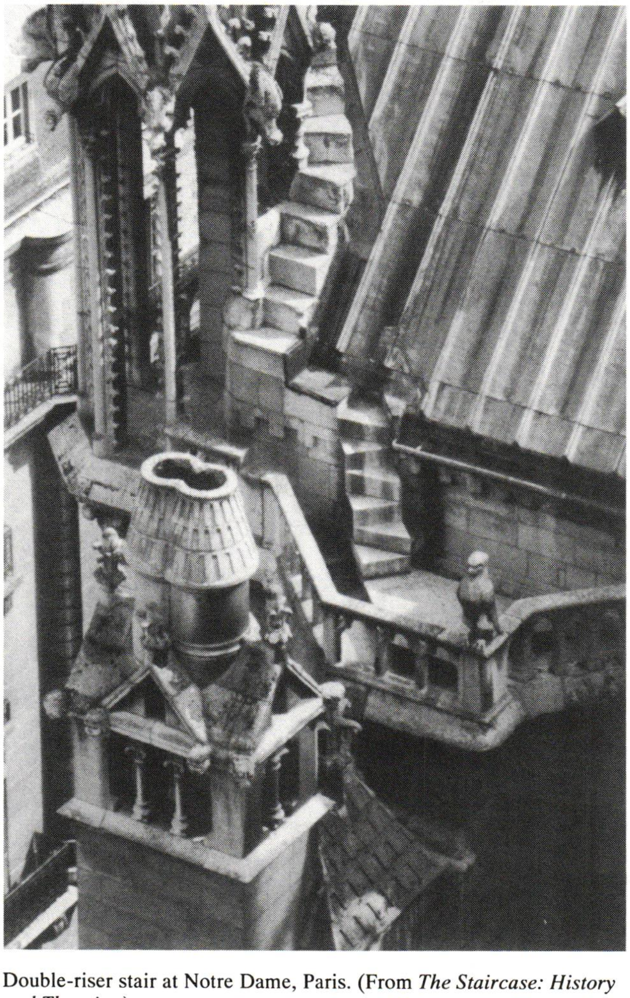
Given these circumstances, a staircase designer would hope to find a comprehensive, systematic textbook that brings together the wide range of information composing the science of staircases. Until now, such books hardly existed; books about staircases were largely anecdotal, usually overlooking one or another of the many important considerations for staircase design. In these two volumes, however, Templer has succeeded in bringing together the necessary factual information and historical data for a multidisciplinary, encyclopedic treatment of stairs, and he never forgets the fact that the *idea* of a staircase is one that is perfectly balanced between aesthetics and technology.

The first volume, *The Staircase: History and Theories*, begins with a magnificent statement by Italian architect and professor Gio Ponti: "The architect who does not conceive of a staircase as something fantastic is not an artist." How rarely one meets anyone nowadays who shares Ponti's passion for staircases! The potential artists seem to be lost in more mundane pursuits, such as manipulating technical constraints or complying with economic limits. How can they ignore the compelling message in the rich history of the staircase that invites them to imagine even more fantastic staircases?

Templer's well-documented history of staircases begins with primitive paths etched into the landscape and ends with the refined composite stairs of the European baroque period, supplemented with some recent examples. He also discusses ladders and ramps, but generally only in their relation to proper staircases. In my opinion, they deserve fuller treatment, perhaps in another book by Templer that would complement the present volumes.

Templer deals with three main types of stairs: straight flight stairs, helical or spiraling stairs, and composite stairs, which combine several design elements. As new forms of stairs evolve, older forms do not necessarily become extinct. Human physical dimensions and the characteristics of human gait (which, until the last half of this century, varied little in the past one thousand years) have encouraged the longevity of successful design concepts and their continuous repetition.

The historical prototypes of straight flight stairs are the climbing pole and the ladder. Through entertaining examples taken from around the world, Templer reveals a profound insight into the ethnography and art of climbing a building or other structural wall with a pole or ladder. He provides many examples of straight flight staircases where the treads are wide, requiring a leisurely gait that allows one to linger on the stair with time to experience and enjoy the setting and spatial qualities of the stairs. Staircases with high risers, requiring a more strenuous gait and offering no opportunity to stop, rest, and enjoy the setting—to my mind the very image of oppression—receive less attention, save perhaps the Mexican pyramids. Here, one might expect to see an illustration of the grim, never-ending staircase in Odessa, where the Cossacks assaulted innocent demonstrators in Sergei Eisenstein's 1925 film, *Potemkin*, but it is missing. But two other variations on the straight flight staircase are well covered: potential spatial manipulation and the diagonal accent. In our puristic times, one reads with admiration about Gianlorenzo Bernini's magnificent Scala Regia, a masterly example of squeezing in a flight of stairs and fooling the eye of the observer by diminishing the size of the embracing wall colonnade.

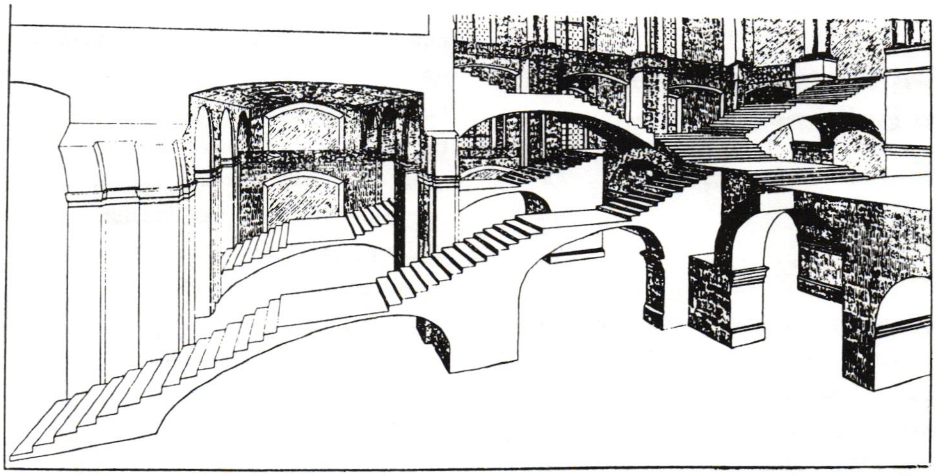


Double-riser stair at Notre Dame, Paris. (From *The Staircase: History and Theories*.)

The delightful examples of the helical stair form the best part of this volume. Templer presents the development of the winding spiral staircase as a fascinating, if not elegant, adventure, exploring such factors as a concern for spatial parsimony, military advantage, and fashion. The gradual replacement of the solid newel post, up to the complete omission of a center support, is brilliantly explained by Templer. In the course of his explanation, he examines the character of the steps close to the newel, the geometry of which may be altered to facilitate the gait and secure the foot during ascent or descent. Those of us who remember and still admire the slow descent of Rita Hayworth down a spiral staircase in *Gilda*, stretching out her leg to find safe support on the narrow treads, may find this alteration undesirable, but aesthetics and safety must sometimes compromise one another. Those who do not remember Hayworth's remarkable descent can find an analogy in modern art. Consider the elegance of Marcel Duchamp's "Nude Descending a Staircase"; the rotation of the nude's body as it descends seems to indicate a helical stair, all the more so in version two where the stairs are not shown.

In Renaissance Europe, staircases became more complex in form and Templer calls these composite stairs. Often used as symbolic displays of wealth, social standing, or political power, composite stairs might combine straight flights at different angles, helical, open stairwells, and numerous landings (for social intrigue?). Templer illustrates a variety of composite stairs, from the simple dog leg (which contains two straight flights between floors with an intermediary landing), to the grand imperial stair in which a straight flight is diverted half-circle, on the landing, into two parallel stairs. An alternative, and to my eye more beautiful, design is the T-shaped stair, which, regrettably, has never been given a more attractive name. From the seemingly endless examples illustrated and discussed, one might conclude that any configuration of composite stairs is already so burdened with history that today's designer can produce nothing comparable in elegance. This is not true. The definition of "composite" has been transformed as vertical transportation now includes not only various types of stairs, but also elevators and escalators. The broader range of available components challenge the architect to find aesthetically pleasing combinations; some department stores, such as Illum in Copenhagen, demonstrate that it can be done successfully. (At Illum, the escalators are exposed to the atrium opposite the main entrance; they are not set in a scissor pattern and the redundant stairwell is concealed in the rear while the large elevators are integrated in the side-wall structures.)

The second volume of *The Staircase* is devoted to safer design. Templer recognizes that as ancient as the form of the staircase may be, there still exists some risk in its use and this risk should be controlled and minimized. Insurance companies keep records concerning accidents (apparently to the last digit), and Templer tells us that one's chance of having a fatal accident is only one in 513,947,300 stair uses (the woman who fell in Uppsala will be relieved). Templer then discusses the various factors that can raise one's risk of an accident on the stairs: women fall more than men; divorced men tend to drink and fall, but on the whole, marital status is not an important factor; and age is critical to the outcome of a fall. It is especially interesting to know that physical and medical disabilities do not increase the risk of falling, evidently because people take better care when they must.



Composite stairs in Johann Balthasar Neumann's proposal for the Hofburg palace in Vienna. (From *The Staircase: History and Theories.*)

Most people do not fall on stairs, although some accident-prone people do with great regularity and Templer believes stair design should take this into account. In order to do this, staircase designers must understand the human gait, the way people walk on stairs and on level ground. Motion studies with medium-speed cameras have revealed that we use different modes of gait as we ascend or descend, and this difference is manifested in how we use our toes and heels. If body equilibrium is lost, it is virtually impossible to regain balance. A designer is wise to note that when falls do occur, it is best to have a surface material, carpeting, for instance, that will not exacerbate any injury. Proper riser and tread geometry is as essential to stair safety as it is to the comfort and ease with which the stairs are used. Here, Templer surveys several formulae and justifications, but adds the much more interesting question of human energy expenditure in relation to riser-tread geometry. These findings have important design implications.

Templer also explores the problem of crowding on stairs, a theme extremely interesting in the design of public spaces. His discussion of critical factors such as human territoriality and space needs—in congestion, queuing, walking, and on stairs—is an important contribution to design literature. At the very least, consideration of these factors leads to a more convincing flow analysis of pedestrians.

In *The Poetics of Space* (Beacon Press, 1969), French philosopher Gaston Bachelard writes that stairways play an important role in our dreams and in our memories. We remember going down the stairs to the cellar in our childhood home, or up the especially steep stairs to the attic, where we could find peace and quiet. In our dreams and memories, these ascents and descents remain alive to us. How much more memorable they would be if staircase designers (and builders, for that matter) read Templer's studies of the staircase.

THE STAIRCASE, John Templer, MIT Press, 1992; vol. I: HISTORY AND THEORIES, 170 pp., illus., $27.50; vol. II: STUDIES OF HAZARDS, FALLS AND SAFER DESIGN, 200 pp., illus., $32.50.

CAROLYN SENFT

On Weathering: The Life of Buildings in Time

Mohsen Mostafavi and David Leatherbarrow

Materiality and the craft of assembly have reemerged in architectural discourse. Such subjects had fallen into neglect during the heyday of postmodern historicism, which indulged in simulations of the material conditions of historical architectural elements. More recently, practitioners, educators, and students in the field of architecture have challenged this view by acknowledging not only the physical presence of materials—their tangibility and tactility—but also the craft of assembling the pieces. However, the media—drawings, models, and photographs that are conventionally used to both serve as tools in the creative process and represent the completed design—tend to freeze the building in time. These media treat the building as an object isolated from the physical reality of its immediate site and larger context and, ultimately, from the process by which ambient elements of the environment contribute to the building's temporality or transformation over time.

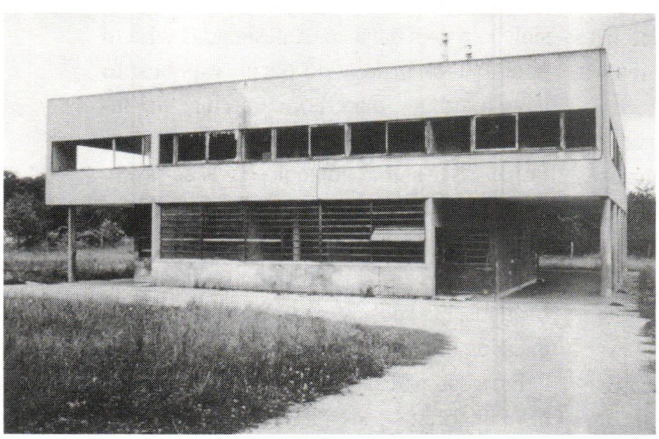
Temporality as a means of understanding and appreciating the materiality and craft of architectural expression is the focus of *On Weathering: The Life of Buildings in Time* by Mohsen Mostafavi and David Leatherbarrow. The authors' thesis is that weathering, which can be described as a literal phenomenon, need not be seen as a negative condition. Though it may physically detract from the building it can actually be a positive feature that adds to its architectural expression. Consider, for example, the eagerly anticipated weathering of the copper sheathing on a roof. Typically it is shown in renderings in its patinated state—an effect not characteristic of the newly constructed roof but one created over time by environmental and climatic conditions. The authors also argue that temporality is dynamic: a building will go through transformations indefinitely, though they may not always be perceived. Consequently, the completion of a building does not occur at the end of construction or even with initial occupancy but is, in fact, indeterminate. A passage from early in the text puts the authors' goals most succinctly:

> Our aim in the argument that follows is to revise the sense of the ending of an architectural project, not to see finishing as the final moment of construction but to see the unending deterioration of a finish that results from weathering, the continuous metamorphosis of the building itself, as part of its beginning(s) and its ever-changing "finish."

The authors introduce their discussion with the literal phenomenon of weathering—the effect of environmental and climatic conditions on both the functional integrity and aesthetic quality of the building. The former, referred to by the authors as "functional deterioration," acknowledges the necessity for experience with materials and associated methods of assembly. It is exemplified in the text by the early 20th-century work of Le Corbusier. His social agenda, embodied in the statement "the house as machine for living," resulted in the incorporation of new materials and methods of assembly—often appropriated from the field of industrial production. However, though this process may have been essential to Le Corbusier's ideology, lack of experience generated unpredictable results, often leading to what might be considered a premature physical deterioration of the building. The authors also cite two other aspects of the architectural production process for their contribution to the disfiguration of the building. These are the result of removing the building, both literally and conceptually, from the specific site. The first of these conditions, described by the authors as a "kit of parts," refers to a prefabrication of materials that typically occurs off site and, consequently, minimizes the amount of assembly or construction that must occur on site. The second condition, about the process of weathering, is less persuasive as an argument. It revolves around the Corbusian aphorism, a "single building for all nations and climates," which describes an environment that exists irrespective of its geographic setting and local climate. The authors support their argument with the well-known failure of the hermetically sealed, south-facing glass wall of Le Corbusier's Salvation Army Cité de Refuge in Paris. However, its connection to weathering remains tenuous at best.

The subsequent discussion, referred to by the authors as "aesthetic deterioration," suggests a physical alteration of the surface that reflects the architect's acknowledgment or even anticipation of the weathering process. Accordingly, both the process of weathering and the means by which weathering is controlled or inhibited are seen as opportunities to enhance the aesthetic quality of the building.

The authors also contrast the discussion of weathering as a literal phenomenon with what could be defined as a poetic interpretation. Here, they suggest a metaphoric use of materials, as illustrated by the Palazzo del Te in Mantua, Italy. For example, the preweathered surface of rusticated stone suggests the disfiguring effect of environmental and climatic conditions. In addition, the authors cite the use of rusticated materials in conjunction with smoothly finished materials to suggest the joining of "city and country" that they feel the Palazzo epitomizes. Further discussion of the use of rusticated stone and its appeal as a preweathered material is illustrated by the comparative examples of 15th and 16th century *palazzi* (such



Villa Savoye before restoration, Poissy-sur-Seine, France; Le Corbusier, 1928–31. (From *On Weathering*.)

Palazzo del Tribunale, Rome, Italy; Donato Bramante, 1512. (From *On Weathering*.)

as Donato Bramante's uncompleted Palazzo del Tribunale on Rome's Via Giulia) and the late 19th and early 20th century designs of Otto Wagner (such as St. Leopold's church at Steinhof). The materiality of the rusticated load-bearing wall of the Palazzo del Tribunale is seen in sharp contrast to the modernist interpretation which dematerializes it as a thin veneer.

The poetic phenomenon of weathering is clearly seen by the authors as predetermined and anticipated by the building's architect. However, as presented in the discussion of "aesthetic deterioration," weathering as a literal phenomenon can also be both anticipated and accommodated by the architectural design. Accordingly, the authors further acknowledge this stance toward weathering as they focus their discussion on ideology and its relationship to the processes of design and production. Again, the work of Le Corbusier is cited as a negative example. Neither Le Corbusier's social agenda nor the architectural manifestation of that agenda—i.e., the primarily white, undecorated, and relatively smooth surfaces of his façades—were compatible with the disfiguration caused by weathering. As a counterpoint, the authors present the work of Carlo Scarpa and Eero Saarinen—illustrated respectively by the Brion-Vega Cemetery and the John Deere Headquarters office building. In the former architectural details, or weathering elements, are designed specifically to control how water will disfigure the surface of the building. In the latter, the material Cor-Ten weathering steel was chosen, according to the authors, to "help the uniformity of the texture of the building, which was intended to blend into its surroundings."

The authors present their argument in a modest-length text, accompanied by seventy-five illustrations, many of which are photographs taken expressly for this publication. The brevity of the text suggests that one might anticipate a tightly presented argument sharply focused on a specific issue and which is well supported by organization and content. However, some aspects of the organization and the content obscure the reader's ability to appreciate the argument.

First, the aspects of weathering included in the discussion are, in fact, only loosely related to each other. They appear to be unified only by a comparatively broad definition of weathering. As a result, the text brings together rather disparate parts, creating an anecdotal, even idiosyncratic, quality and a disjunctive experience for the reader. (My use of the terms "literal phenomenon" and "poetic phenomenon" reflects my own need and effort to organize the argument.) The problem is further reinforced by the authors' strategy of treating the text as one continuous essay, with no clearly identifiable breaks between aspects of the argument. An alternative might have been to create two or more individual essays, each of which is more clearly focused on a specific aspect of weathering.

Second, careful consideration must be given to the content, i.e., rigorous selection and economical use of words and an awareness of where greater elaboration of an argument is essential. For example, the work of Louis Kahn is underrepresented by one photograph of the Yale Center for British Art. The photograph suggests a material quality also exemplified in other buildings such as the Salk Institute, Exeter Library, and the Kimbell Museum. Additional discussion concerning how the contrast in materials, their role in the creation of the architectural expression, and the transformation of their own characteristics due to weathering greatly enhance the temporal quality of the building would have been welcomed. The authors choose instead to draw a connection between Eero Saarinen and Frank Lloyd Wright which, though it may be valid, does not seem nearly as essential to their discussion. The text also includes words that are not clearly defined, such as "functional deterioration" and "aesthetic deterioration," which do not have established meanings that have evolved from widespread use.

In spite of these problems, raising the issue of weathering as both literal and poetic phenomena in published form brings it closer to the forefront of architectural discourse. The book makes no pretense of providing answers. Rather, it enables the reader—whether practitioner, educator, or student—to recover an awareness of buildings as material objects which exist in time as well as space.

ON WEATHERING, Mohsen Mostafavi and David Leatherbarrow, MIT Press, 1993, 144 pp., illus., $30.00.

TIM BENTON

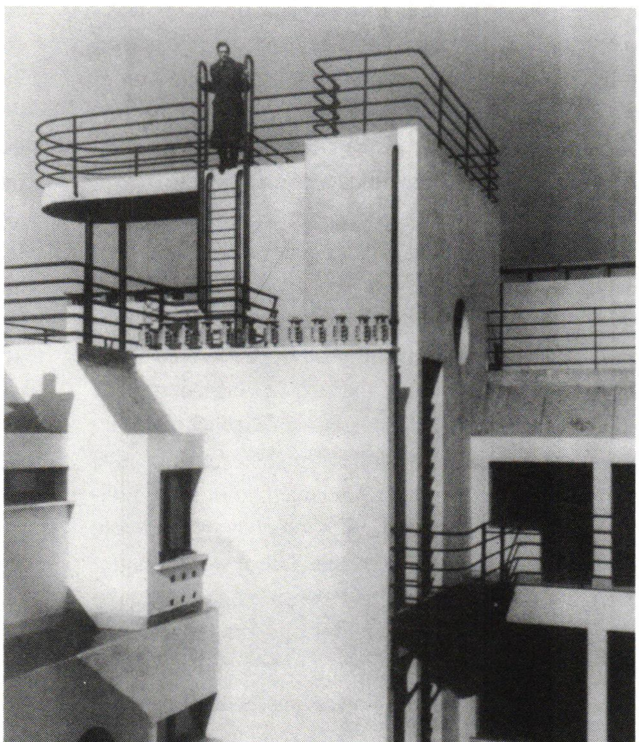
Brightening the Dream of Modernism

Berthold Lubetkin (1901–1990) was the most successful modern architect in Britain in the 1930s and the best. Like Le Corbusier, whom he greatly admired and from whom he learned much, his fascination today is as much his deviance from the confines of modernist dogma as his leadership role in promoting it.

Lubetkin's career provides, in itself, a paradigmatic trajectory. From a provincial background in the Caucasus, he experienced the events of the Russian Revolution and its heady aftermath in Moscow and Petrograd. He then went on his travels, to Germany (1922–23), Poland (1923–25), and France (1925–31) before finally settling in England. During this itinerary, he deepened his theoretical understanding with Wilhelm Worringer, saw some of the early examples of modernist architecture and housing in Berlin, Weimar, and Frankfurt, as well as some of Le Corbusier's early Parisian buildings and studied with Auguste Perret. Above all, he picked up the flavor, language, and ambition of modernism as a cause.

During the 1930s, his work, in the collective partnership Tecton (which he formed in 1932, initially with six young architects at the Architectural Association[1]) dominated the English modern movement, yet without fully sharing its ideals or tactics. After the second World War, his modernist practice continued, with increasing skepticism and disillusionment on Lubetkin's part, until the great disappointment of the master plan for Peterlee New Town (1947–50), at which point he retired to concentrate on farming. He reemerged only in the last few years of his life to reaffirm his ideals and challenge the architectural establishment that had begun to honor him as well as to restore some his most important early buildings.[2]

Born, as Lubetkin put it, "at the back of beyond" in Tiflis, Georgia, to a liberal Jewish family, he was already well-traveled when the Russian Revolution broke out. His father took him on business trips to Austria, Germany, France, and Belgium, and even to England (just before the first World War). A mastery of several languages and family connections in Warsaw stood him in good stead when, in 1922, he decided to leave Russia to try to make his way in the West. John Allan, author of *Berthold Lubetkin: Architecture and the Tradition of Progress*, used Lubetkin's personal recollections and documents to reconstruct this early period, providing much new information, though without substantially revising the impression Lubetkin had given of himself in earlier publications and reminiscences.[3] Later, researchers may uncover more corroborating detail to fill out the account of Lubetkin's activities within the Russian artistic avant-garde of the early post-Revolutionary period, on the fringes of SVOMAS (a system of "free workshops" established to counter traditional educational institutions) and the Vkhutemas.

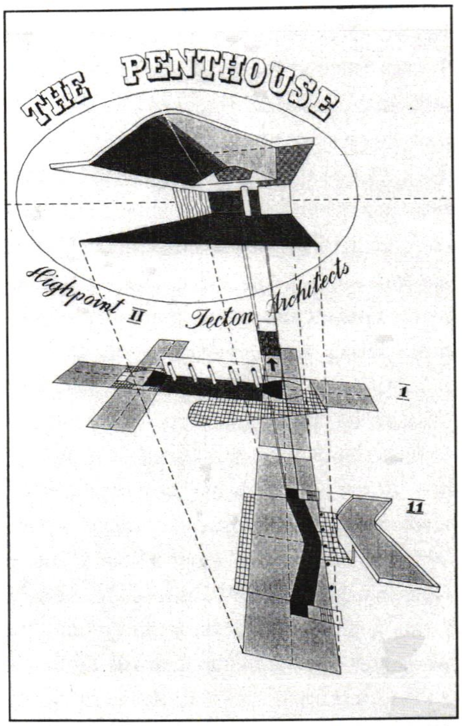


View of upper building from rear courtyard, showing setbacks and roofdecks, of the apartment project at 25 Avenue de Versailles, Paris; Berthold Lubetkin with Jean Ginsberg, 1928–31. (From *Berthold Lubetkin*.)

Nevertheless, the relative paucity of reliable documentation on these early years makes it difficult to determine with any precision Lubetkin's particular sources at any given moment. The model of an artist's studio, supposedly designed in Russia in 1922, might reflect a precocious interest in Russian rationalism, or the rather later influence of Le Corbusier, as Allan points out. Similarly, it is hard to believe the date of 1925–26 attributed to the drawings for the competition for a Polytechnic of the Urals, submitted by Lubetkin with Claude Manuel da Costa and Luis Itturalde, which include designs for tubular steel furniture that would seem to fit more closely with the years 1927–28 in light of recent scholarship on the development of tubular steel furniture.

Lubetkin benefited from seeing both Konstantin Melnikov's Russian Pavilion and Le Corbusier's Esprit Nouveau Pavilion at the 1925 Exposition des Arts Décoratifs in Paris. He developed his understanding of Constructivist architecture through his association with the Melnikov's work at that exhibition, and subsequently by designing demountable wooden structures for the USSR trade pavilions in France using forms heavily indebted to the Russian architect. He also kept in touch with events in the USSR, submitting designs for the Centrosoyns and Palace of Soviets competitions, the latter of which awarded him a small cash prize.

As for Le Corbusier, Lubetkin later admitted, "The boldness with which he manipulated space, his power of abstraction, the poetry of his paintings; I admit I simply worshipped him."[4] Elements of Le Corbusier's work of 1925–32 recur in Lubetkin's designs throughout the 1930s. He was particularly sensitive to Le Corbusier's use of curving walls to articulate circulation (Villa Stein-de-Monzie and Maison Cook)



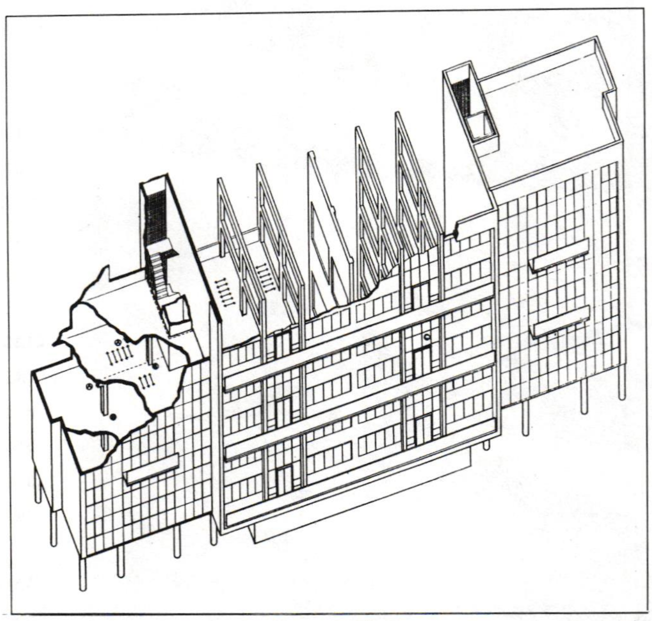
Tecton's presentation illustration of the Highpoint Two penthouse as schematically related to ground floor plans; 1930s. (From *Berthold Lubetkin.*)

and his use of brick or stone facings to differentiate different functions (e.g., compare the Pavillon Suisse to the apartment at rue Nungesser et Coli). But he never followed Le Corbusier's later departures from the canons of his first mature style, and he rejected Le Corbusier's work of the 1950s completely.

In the 1920s Lubetkin used the educational facilities of Paris, such as the Ecole Spéciale d'Architecture, which he attended for a time, and the atelier of Auguste Perret as well as the Ecole Supérieur de Béton Armé and the Institute d'Urbanisme at the Sorbonne. According to Allan's account, he also found time to sit in cafes such as Le Dome, La Coupole, and La Rotonde, and to participate in the activities of various avant-garde groups. But although Lubetkin's life in Paris—amongst the impoverished Russians, Poles, and South Americans who eked out a living working up diploma projects for wealthier architecture students at the Beaux-Arts—is well told, little explains the precise sources for the two most interesting projects of his Parisian period: the Club Trapéze Volant of 1927, designed in collaboration with his one-time scoutmaster in Moscow, Bob Roodionev, and the apartment block on the Avenue de Versailles, designed with Jean Ginsberg (1928–31). The latter, with its oft-remarked debts to Le Corbusier's Maison Cook, shows Lubetkin as a mature and meticulous designer well able to handle the aesthetic and practical subtleties of the international style. Lubetkin also showed himself adept at publicizing his work, not only in fine posters but also in an amusing cartoon presentation, "*Pages d'un journal du chantier*," published on his arrival in England.[5]

There is much interesting material in the pre-English period to follow up and investigate further. But the key to Lubetkin's fascination, and the mainspring of his artistic genius, developed from the particular conditions and contradictions of practice in England. Almost all the ingredients of his formal vocabulary had been absorbed by this time, and his theoretical position had already been formulated. But in the hostile culture of England, with its suspicion and incomprehension of theoretical speculation, its lack of a Beaux-Arts tradition, and its deep insularity from continental modernism, Lubetkin uncovered new depths of imaginative exploration. To explain why this is so does not emerge at first from the very detailed narrative of Allan's text. This is partly due to the structure of the narrative, which divides up the 1930s work thematically and necessarily misses some of the significant developments through time. For example, the gradual introduction of more and more popular and "kitsch" imagery into his work can be traced across the range of building types. And the increasingly ironic refusal of oversimplistic functionalism, about which Allan has some important insights, needs to be analyzed both in the theoretical pronouncements and in the built work. Instead, Allan tries bravely to draw together all the historical, critical, and theoretical strands in one chapter (entitled "World View") before proceeding to treat the houses ("House Style"), zoos ("Nature"), Highpoint One and Two ("Concrete Proof"), and the work for Finsbury Borough Council ("Social Services").

Allan sees an important clue to Lubetkin's imagination in his blend of Russian Constructivism and European Classicism, and this is undoubtedly true. Similarly, it is also true that Lubetkin's commitment to a theoretically grounded practice can neither be taken at face value as a programmatic and deterministic procedure, nor be denounced as a pose designed to disguise his formalism. The astonishing juxtaposition of technical research and apparently willful artistic impulse may disguise a flawed logic, or may make sense only as a kind of artistic statement. Lubetkin's own explanation, couched in historical terms, has a plausible ring to it:



Cutaway axonometric showing monolithic wings and framed center of Highpoint Two, north London; Berthold Lubetkin and Tecton, 1938. (From *Berthold Lubetkin.*)

> There are times in history when man feels he is the master of his fate, expressing confidence in rationality and perfectibility, in the necessity of cultural continuity between past and present. Conversely, in times of disintegration an distress, everything, including art itself, appears as a jumble of unrelated events, a fragmentary assemblage of happenings without reference to any past or future.
>
> But at a time of impending change, these apparently opposing attitudes can easily shade into one another, the

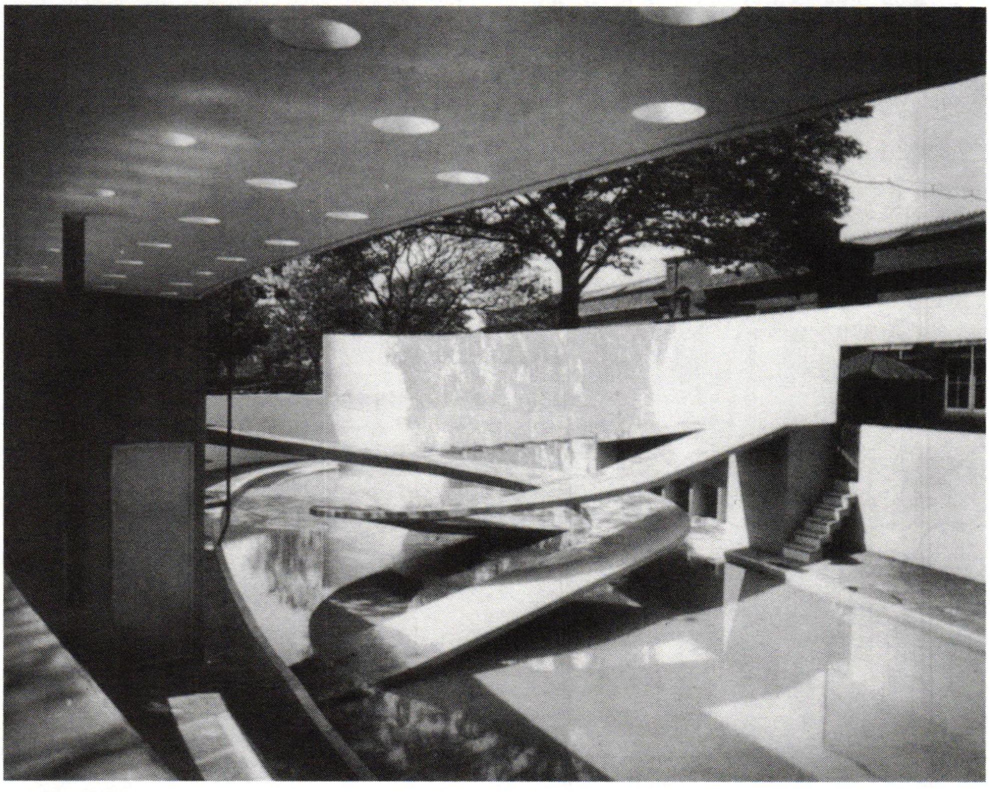
> very sense of uncertainty and foreboding sponsoring a deep yearning for rationalism and objectivity. It is only thus that one can begin to explain the simultaneous co-existence, in those early years of the 1930s, of the darkest, most destructive forces on the one hand, and on the other, the most radiant optimism.[6]

Put in more personal terms, a powerful motivating factor for Lubetkin was the sense of being up against an establishment and committed to its overthrow, while able to exploit its weaknesses and be nourished by influential sections of its intelligentsia. Faced with what he interpreted to be a philistine empiricism, Lubetkin's idealist aestheticism swelled up. Faced with formalistic whimsy he developed a rhetoric of strictly functional research. Genuinely committed to team work within a group of "equals," he was passionately autocratic by temperament and candid in the acknowledgment of his own ego.

Lubetkin was always vulnerable to being thought of as an outsider but adamant in his refusal to "join up" in the clubbable groups so beloved in English society. Although a hardworking member of the MARS (Modern Architectural ReSearch) group for several years, he kept his distance from CIAM (Congrès Internationaux d'Architecture Moderne) and preferred to form a more broadly based, political and "technical" grouping, the ATO, or Architects and Technicians Organization, in 1934.[7] Although many interpreted Lubetkin's Marxian rhetoric as that of a Communi st, Allan has found no evidence that he joined the Communist party (although ATO founding-member Francis Skinner, also of Tecton, was a keen member of the Communist party), and he maintained his distance from the excesses of Stalinism in his native country.

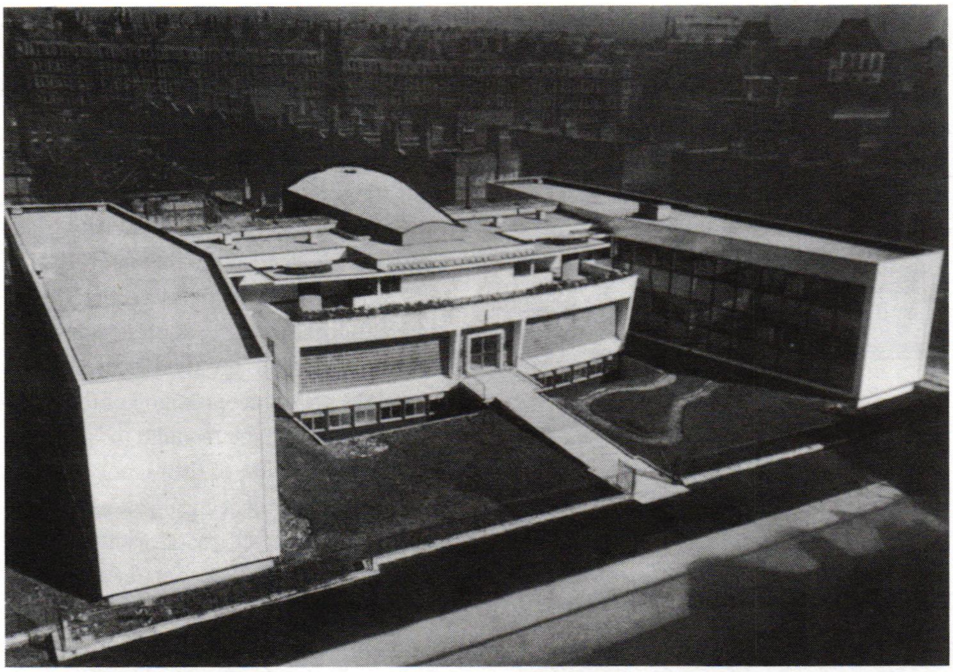
All this added up to a curiously fragile personality, reluctant to be pinned down and chameleon-like in his ability to adapt to his immediate surroundings. Within a few weeks of visiting London in 1932, he had written an article for *L'Architecture d'Aujourd'hui* in praise of the verdant grass and cream stucco of the urban scene and a remarkably sensitive understanding of Georgian architecture and the English tradition of liberal common-sense.[8] And yet it is difficult to see what lasting attraction London could have for him after the sophisticated delights of Paris or Berlin. One answer, of course, was that Tecton became the most successful of the modern architectural practices in England. In part, this was due to his hunger for work, so Tecton took on many modest jobs to keep the revenues coming in. Lubetkin had the natural entrepreneurial instincts of his father. During his early, lean years in England, he supplemented his income with a home-based business selling Kefir, a yoghurt made from mushrooms from Mount Kazbeck, sent from Warsaw by the father of one of Lubetkin's Polish friends who had joined him in London. At the end of his life, he is said to have made a steady income at the roulette wheel. When he bought the Upper Kilcott Farm in Gloucestershire in 1940, he took it seriously, farming the hundred acres throughout the war and at intervals until he finally moved to a small terrace house in Clifton, Bristol in 1969. Lubetkin was a survivor who, despite his high ideals and radical disposition, was supremely skilled at adapting to local conditions.

More than any other foreign architect working in England, Lubetkin was fortunate to have the ear, and the intellectual nourishment, of some of the great figures of the English intelligentsia, such as Julian Huxley, J. B. S. Haldane, Lancelot Hogben, and J. D. Bernal, with whom he briefly shared lodgings. These contacts meant that many of Lubetkin's commissions were located within the context of a pseudo-scientific ambiance. For example, his work for Regent's Park Zoo, under the patronage of Solly Zuckerman and Huxley, could be represented as both at the forefront of scientific research and in the public domain. Similarly, a chance contact with a consultant, Dr. Ellmann, led to the design of a tuberculosis clinic for East Ham Borough Council, which was presented at a British Medical Association centenary in November 1932. This in turn impressed Dr. D. L. Katial, who was then a councillor in the borough of Finsbury and later commissioned Tecton for one of their most important works, the Finsbury Health Centre (1935–38). In both cases, the first contact was through one of the Tecton partners, Godfrey Samuel, whose father was a leading government figure.



Penguin Pool, London Zoo, Regents Park; Berthold Lubetkin and Tecton, 1933–34. (From *Berthold Lubetkin.*)

Lubetkin developed a series of working practices during the 1930s that not only suited collaboration with clients who were intellectually curious, but that could make dramatic capital of the very processes of design and construction through which public attention could be focused on the client as well as the architect. Thus, the problem of how to house two new gorillas in the London Zoo captured the imagination of the popular press. The Tecton Gorilla House, supposedly designed in four days, was not only a technical solution to the problem of climate control in the summer and winter, but was also a constructional, mechanical, and zoological problem, and a problem of public education. The building led to his long association with the brilliant engineer Ove Arup, and to a long run of zoological buildings. The Penguin Pool became an icon of the 1930s, not simply because it was a supreme example of Constructivism and a fragment of utopian urbanism, but because it could be seen to be innocent of political radicalism. It was a "problem" solved (exercising and breeding penguins, environmental control, reinforced-concrete structure) in the form of a sculpture. In its work on the many buildings at London, and the Whipsnade and Dudley Zoos, Tecton made many friends and established the credentials of modern architecture to be both scientific and popular, highly technical and a little kitsch. It is not surprising that Lubetkin's first television appearance, with Julian Huxley, was in a prewar program explaining the planned Elephant and Rhino Pavilion at the London Zoo, in 1937. In particular, Dudley Zoo can be read as a metaphoric utopian city, with its blending of the geometrical and the organic. Although some of the buildings show signs of their hasty design and execution, Dudley provides a formal key to all of Lubetkin's work.

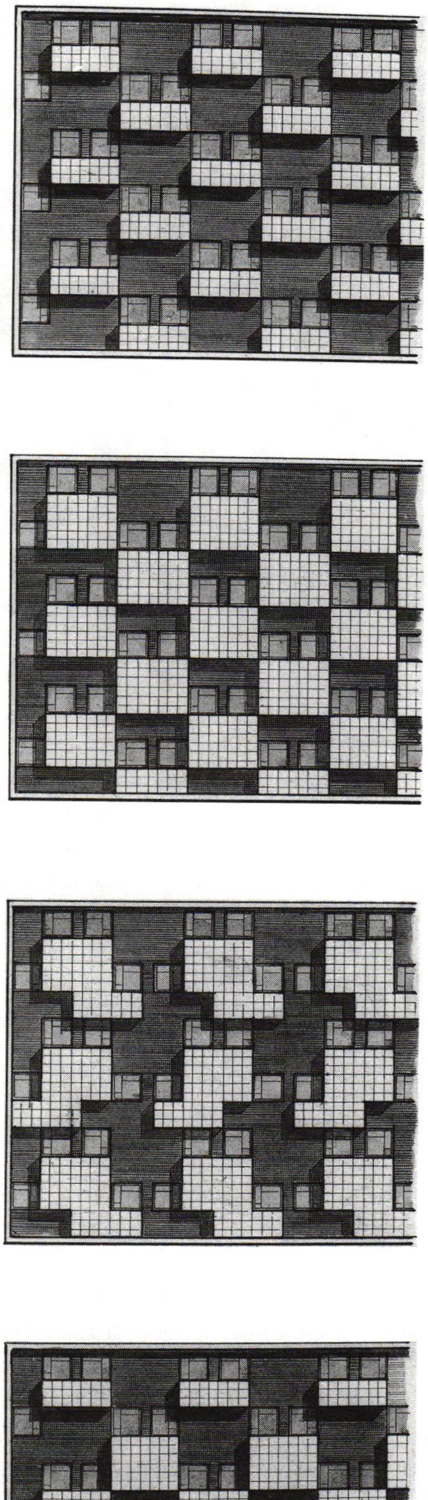


Finsbury Health Centre (in its Victorian context), "a modernist monument connecting Russian Constructivism with the British Welfare State"; Berthold Lubetkin and Tecton, 1935–38. (From *Berthold Lubetkin.*)

The brilliant drawings which Tecton produced throughout the 1930s and the photographs of these highly abstract structures were published in journals such as the *Architectural Review*, which were widely read outside the architectural fraternity and could be seen as a transferable metaphor of progress and social engineering. There is more to be said about this visual communication. Lubetkin did not draw himself, except in the form of ephemerally sketched instructions. The various "pens" at his disposal, however, embraced a range of languages, from the ultra-technical details to the almost childlike annotated explanatory sketches. The rendered plans and isometrics, with their sharp effects of shading and hard-edge lettering, gave the partnership's designs an appearance of hyper-reality, especially when compared to the very pedestrian form of most English modernist's drawings.[9] The sources of the array of styles used by Lubetkin's team, and their potential for carrying meaning, need more work. It is clear from Allan's text that Carl Ludwig Franek played a particularly important role, especially after World War II:

> I became Lubetkin's pencil. He hardly touched a pencil himself but worked through us. The solutions did not spring form his head like Minerva; they developed gropingly. Lubetkin used to say that the secret of architectural design lay in the ten-inch tracing roll. "Arbitrariness" was a word that stank with Lubetkin. We all worked very, very hard, and he wouldn't stop until he was satisfied. He has absolutely no regard for how we consumed the fees.

At its high point, supplemented with the cartoons of Gordon Cullen, the propaganda arm of Tecton, in its own materials supplied to students, exhibitions, and articles in Architectural Review and other journals, educated a generation of English architects and taught them how to engage with the public. It is at the iconic level of explanation and persuasion that Lubetkin best showed his mastery of the English character. The exploded diagrams, handwritten captions and explanations, witty detail, and personal touches stripped the functionalism out of modernism and replaced it with satisfying solutions and a generalized language of optimism and hope. They also gave his hard-won solutions the invincible air of certainty. One measure of the success of Lubetkin's visual propaganda can be seen in the interiors of the Finsbury Health Centre, where the style of architectural presentation carries over seamlessly into the public health murals designed by Cullen. The building itself achieved a symbolic resonance quite out of proportion to the relatively modest scale of the facilities provided, calling for comparison with Le Corbusier's Centrosoyus building or some other great engine of social change. The fact that an image of the building was used as part of the national wartime propaganda as a general symbol of hope tes-



Typical studies from Tecton's office evolving alternative elevations for identical plans, in attempts to approach repetition as a creative art. (From *Berthold Lubetkin.*)

tifies to the success of Tecton in penetrating the visual imagination of its contemporaries.

Allan has some interesting observations to make about Lubetkin's working method. His approach was that of the military commander, questioning, guiding, exhorting, deciding, but not himself undertaking the drawings. He needed the internal debate of the Tecton office, where different groups researched different aspects of a project and sometime worked up rival schemes. He needed the obdurate opposition of the building authorities, which required the presentation of a succession of different proposals. Furthermore, this dialectical process of considering a range of alternatives and selecting solutions was built into Tecton's explanations of their work. In the famous case of Highpoint Two, deception on a grand scale was practiced, with the Machiavellian presentation to the authorities of drawings by a friend outside the office, designed to break down resistance point by point. A series of drawings in a completely fraudulent style were presented in order to win permission for horizontal balconies, a free ground floor, frame construction, a broken skyline, and a projecting canopy. Then, when the completed scheme was presented, the Council could be shown that they had approved, in principle, all its characteristic features. The fact that this grand deception was then explained to the readers of *Architectural Review* made the tactic itself as important as the finished result.[10] Lubetkin's aim was to create a working method so exhaustive, so transparent in its logical processes, so compelling in its presentation, that the design would appear to result automatically. Like Le Corbusier and many other great architects, Lubetkin did not design easily. When some of the ingredients of the dialectical process fell away after the war, Lubetkin's design procedure began to let him down. For example, the victory of the modernists in the London County Council, in RIBA, and, to an extent, in the public imagination; the victory of the principle of central and municipal planning in the Beveridge Report and the establishment of the Welfare State; and the fragmenting of the issues all left Lubetkin somewhat stranded. He needed clear opposites. His work for Finsbury after the war lacked the great motivating idealism of his earlier work, worn down by the grind of dealing with building restrictions and shortage of materials but lacking the outright opposition of authority. His estates at Spa Green, Bevin Court, and Priory Green have many interesting features but seem heavy and depressing compared to the more exciting work of the new generation, such as Powell and Moya at Churchill Gardens or the "hard men" of the LCC at Roehampton. Interestingly enough, the attempt to discover new aesthetic permutations in literally hundreds of elevation drawings, attacked as formalistic by younger modernists, failed to generate the liberating design solutions which had characterized his 1930s work. A certain relativism in Lubetkin's method, never far removed from the arbitrary, emerges most clearly in the alternative elevation drawings that were produced as part of a pilot housing scheme at Peterlee (1949–50). Now ready to be reinterpreted in postmodern terms, these elevation drawings were, in part, a subtle diplomatic play of public acceptance, but also in part, I believe, a cry for help in conditions which Lubetkin felt increasingly unable to control.

Lubetkin's great disillusion with Peterlee, which triggered his final retirement from architecture, was made more acute because he felt trapped between the heroic needs of the Durham miners, his own will to create a totally planned environment, and the vacillations and betrayals of the various Ministries involved. I heard a version of the Peterlee story from Lubetkin himself in which the episode assumed titanic proportions, in which the calculated betrayal of the miner's hopes prefigured the whole road toward industrial decline and the Thatcher years. It is an epic saga, carefully and accurately told by Allan and too complex to go into here. For Lubetkin, it presented the Tantalus cup—an invitation to create a new town for a group of workers accustomed to living in close proximity to each other and their work, solid in their culture, their political aspirations, and their tragic history. The succession of events whereby this cup was dangled before Lubetkin and repeatedly snatched away marked him for life: Allan makes the claim:

> Berthold Lubetkin is preeminent among architects of the Modern Movement in Britain for his concern to relate the practice of architecture to a systematic theoretical program. His designs, especially when examined in parallel with his written commentary, clearly evince intentions of a higher order than simply the conscientious solution of specific building briefs.

Although this is undoubtedly true, the author has difficulty explaining some of the contradictions in Lubetkin's relation of theory and practice. A comparison with Le Corbusier is instructive. Le Corbusier's long list of books, and above all, his *L'Oeuvre Complète*, gave his admirers a constantly evolving insight into his thinking and practice. The connection between theory and practice often had to be intuited, since the built projects are left to speak for themselves with relatively brief explanations. Lubetkin never published a book but produced a stream of theoretical statements in lectures, magazine articles, and unpublished statements, most of which were never understood by his readers. But his projects were brilliantly explained and brought to life in the drawings and explanations produced for clients and building authorities and in the magazine articles which published his buildings. A great attraction in Allan's book is that he has reproduced many of these drawings and texts and given clear explanations of the genesis of the key projects. But there is still a Lubetkin to be explored. The man who insisted that every detail in a building should have a reason was also the man who could write, about the house he designed for himself on the chalk Downs at Whipsnade,

> It is not a "Modern House," a "shelter," which, according to professions, should be self-obliterating, unselfconsicous, and insignificant in its hygienic anonymity; a thing of which one can only say that it is made of reinforced concrete.
>
> It does not try to show that the plan was dictated by any trigonometry of the lines of kitchen, circulation, or by angry attempts to trap sunlight into some dust-proof corner, or by the standard length of reinforcing rods. It does not try to prove that its design grew "naturally" from the given conditions like an ordinary pumpkin, Victoria Regia, or deep-sea fish.
>
> The flat roof is not a sign of the exhibitionist tendencies of nudist inhabitants; the bathroom is not toplit in order that the bather may be more jealously guarded; the cornices are not specially designed for the local cats or for sleepwalkers; and the dishwashers in the kitchen has never been in working order.
>
> On the contrary, the designer admits that there is, on the walls of the WC, a collection of cold-blooded tropical butterflies, while the bedspreads have little bells sewn on them *TO BRIGHTEN THE DREAMS OF THE OCCUPANTS.*[11]

In fact, a study of Lubetkin's penthouse apartment at Highpoint Two shows how far removed his own taste was from the clinical austerity of some of his architectural designs. Although much in this apartment could be seen as echoing Le Corbusier's studio in the apartment at rue Nungesser et Coli, Lubetkin was not afraid of exposing his bourgeois taste for Kitsch—a very English kind of kitsch (with a small *k*)—and of distancing himself from his production. In a sense, this was his most radical contribution and greatest (unheeded) warning to the English avant-garde of the postwar era. It was the one-dimensional, oversimplification of English modernism in its glory days in the 1950s and 1960s which distressed Lubetkin as much as the failure of the imagination of the authorities.

Allan's book is a labor of love, indispensable for any student of modern architecture. His great knowledge of Lubetkin's buildings, many of which he has restored with his architectural practice, Avanti Architects, comes over clearly. If at times he is too close to the man whom he knew and loved in his last decade, he has provided many perspicacious and illuminating insights, and much material for a further reassessment. English architects must study this book closely, since to understand Lubetkin is to understand not only a restless and fascinating genius, but many of the imponderables of the English architectural dilemma today.

NOTES

1. Godfrey Samuel, Michael Dugdale, Valentine Harding, Anthony Chitty, Lindsay Drake, and Francis Skinner had all enrolled in the five-year course at the AA in 1927.
2. He was the recipient of an Honorary Doctorate, Royal College of Art (1973), the Royal Gold Medal for Architecture, RIBA (1982), and President's Invitation Lecture, RIBA (1985). By his death in 1990, most of his surviving buildings from the 1930s had been listed for conservation and many had been carefully restored.
3. Notably, his unpublished memoirs, *Samizdat by anArchitect* (sic).
4. Conversation with John Allan.
5. Published as "A Block of Flats in Paris," *Architectural Review*, vol. 73, 1932, pp. 135–38.
6. Open University, op cit.
7. Founding members also included a number of architects and engineers with Socialist sympathies, as well as scientists, sociologists, and others concerned with architecture, housing, or urbanism. Two issues of the journal, the *ATO Bulletin*, an exhibition of working class housing in 1936, and several specific campaigns in support of better housing conditions were the main achievements of the group.
8. "L'Architecture en angleterre," *L'Architecture d'Aujourd'hui*, no. 10 (1932): 3–23.
9. With notable exception of the Wells Coates and Denis Lasdun (who worked with both Coats and Lubetkin), most modern architects in England persisted in a heavily annotated and graphically uninteresting form of technical drawing.
10. "Modern Flats in Highgate," *Architectural Review* (October 1938): 161–64.
11. "Whipsnade Manifesto," in "Bungalows at Whipsnade," *Architectural Review*, vol. 81 (1937): 60.

BERTHOLD LUBETKIN: ARCHITECTURE AND THE TRADITION OF PROGRESS, John Allan, RIBA Publications, 1992, 629 pp., illus., $125.00.

LELAND ROTH

Gentlemen of Instinct and Breeding: Architecture at the American Academy in Rome, 1894–1940

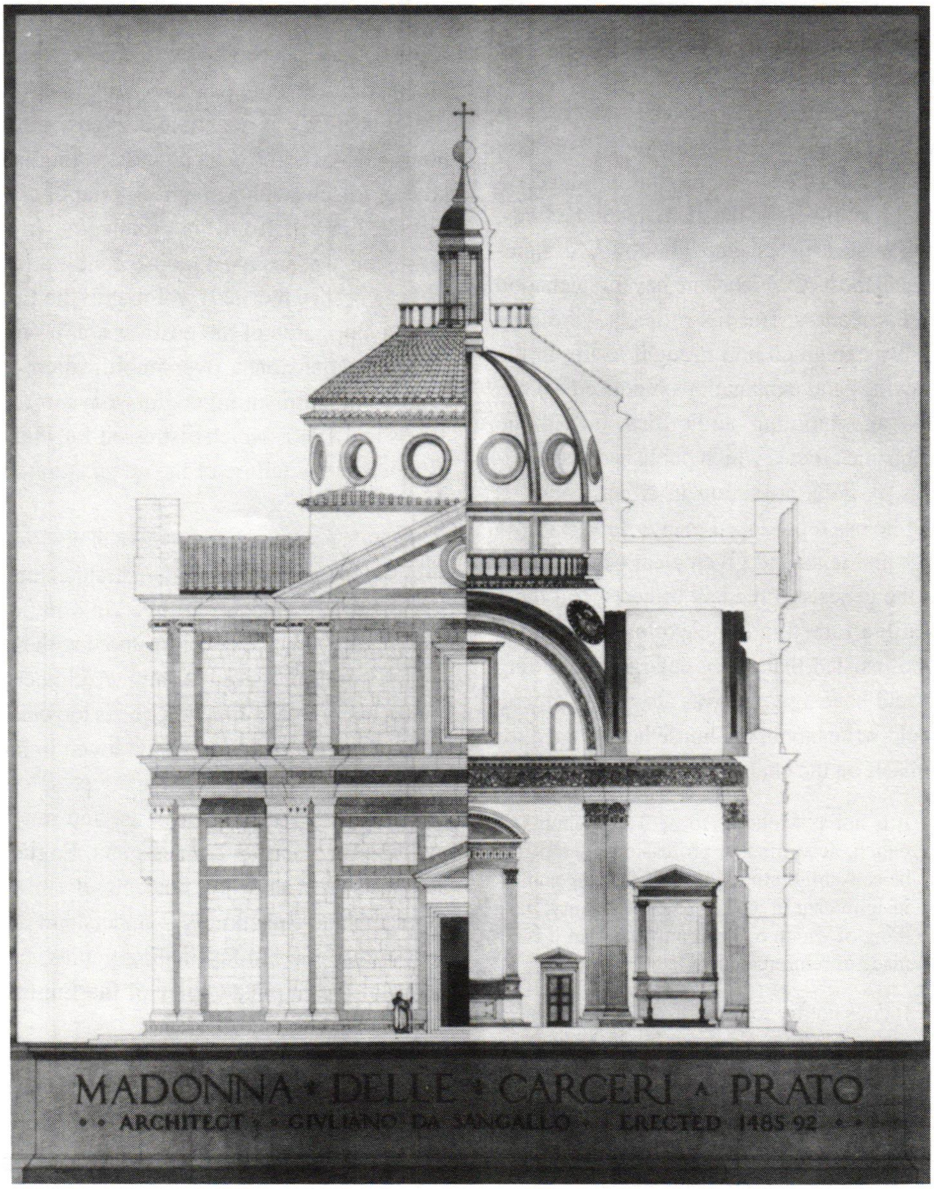
Fikret K. Yegül

With the appearance of books like those of the late Spiro Kostof, and judging from the critical acclaim given the postmodern architecture of Robert Venturi, Robert Graves, Richard Meier, and Stanley Tigerman (to name only four), the influence of the American Academy in Rome on its fellows has come to be seen in the late 20th century as salutary and beneficial. The Academy's influence was not always seen as such, even by some of the Academy's early architecture fellows, and most especially by proponents of modernism after the second World War.

Fikret Yegül's *Gentlemen of Instinct and Breeding* explores the study of classicism as promoted by the Academy from the time the first fellows went to Rome under the auspices of the newly formed Academy in 1894, and up until the time the Academy was closed during World War II. The picture he gives shows warts and all, and yet the story is told with a clear affection and sympathy for the study of classical architecture. Yegül, an architect and architectural historian, was himself a participant on archaeological digs led by Frank E. Brown at Cosa in 1963, and then, from 1964 through the early 1980s, worked under George Hanfmann on excavations at Sardis. Meanwhile he was a frequent visiting scholar at the American Academy in Rome where he came to admire the drawings of Rome's ancient buildings as restored on paper by the early fellows. Part of the impact of this field research is evident in Yegül's other recent books, *The Bath-Gymnasium Complex at Sardis* (Cambridge: Harvard University Press, 1986) and *Baths and Bathing in Classical Antiquity* (Cambridge: MIT Press, 1992).

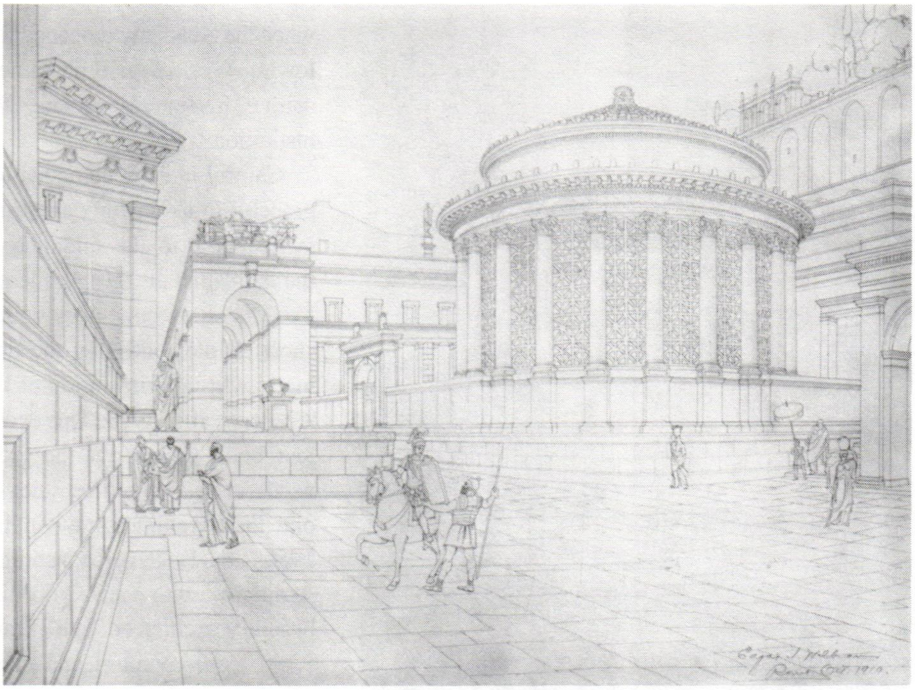
Yegül's initial plan was to mount an exhibition of these drawings, but when this project was indefinitely delayed, he opted for presentation in book form. Hence this study focuses on the "curriculum" in architectural design fostered by the Academy's directors and trustees.[1] The book is divided roughly in half, with the first section (in nine chapters) exploring briefly the creation of the Academy and then concentrating on the experiences of the architectural fellows from 1894 to 1940. The second half presents a hundred full-page black-and-white plates of architectural drawings made by fellows, selected in large part to illustrate the points raised in the first half of the book, which include archaeological studies as well as the culminating "Collaborative Problems," in which a team, made up of one fellow each in architecture, mural painting, sculpture, and landscape architecture developed an original Renaissance design in accordance with a program developed by the jury in New York.

Yegül set out to examine the influence of the pedagogical program of the Academy on its architecture fellows, to discover what they were encouraged to study, and, conversely, what was defined for them as existing outside the realms of good taste. The Academy's founders, especially Charles Follen McKim, intended it to be a distin-



Section/elevation of the Church of Madonna delle Carceri, Rome; George Fraser, fellow of American Academy in Rome, 1926–28. (From *Gentlemen of Instinct and Breeding*.)

guished postgraduate institute for the country's best and most promising designers, those who (it was hoped) would shape the character of American public architecture into the 20th century. Regrettably, as Yegül shows, except for Henry Bacon, the very first fellow at the Academy, hardly any of the subsequent early fellows rose to positions of significant influence. As Yegül also shows, the high-minded vision of the founders, particularly that of McKim and Austin W. Lord (the Academy's first director in Rome), changed dramatically after the first World War. Thereafter it became critical that only the right sort of young men be appointed fellows (there were no women as full fellows until after 1940). Only graduates from an approved list of universities and architectural schools were considered, and a rigorous program of personal interviews in New York screened out those deemed unsuitable. The title of the book, in fact, comes from a committee report of 1919 which emphasized this biased screening process, to ensure a high level of liberal education "among those only who will be recognized as gentlemen by instinct and breeding" (Yegül substitutes prepositions in his title). Potential candidate George Mitchell, we learn, was eliminated at an early stage because, wrote Edward R. Mellon, he was "a Jew—at least his looks and actions indicate it, and he is generally thought to be one."

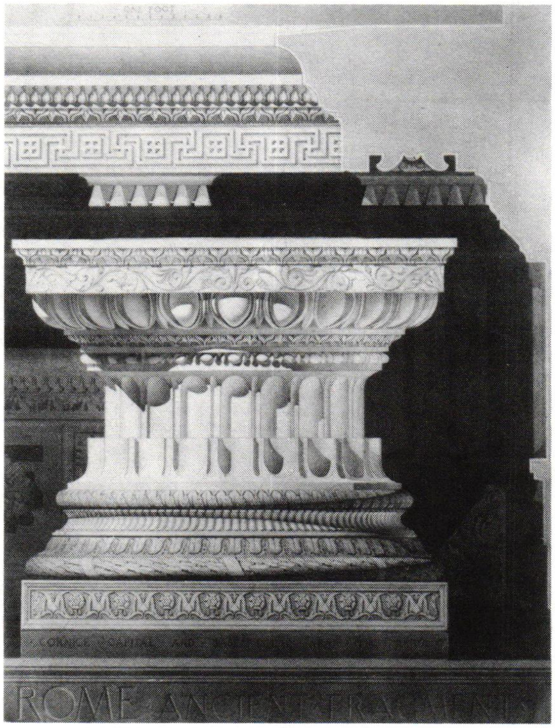


Perspective of the Atrium Vestae in the Forum Romanum, Rome; Edgar J. Williams, fellow of American Academy in Rome, 1910–12. (From *Gentlemen of Instinct and Breeding*.)

Increasingly, after 1918 the body of Renaissance work given the imprimatur for fellows was limited and codified. McKim himself had set the pattern in 1899 when he wrote Edwin Howland Blashfield that the work of Bramante, Peruzzi, San Gallo, and Vignola were acceptable, whereas Michelangelo, in his palace designs "deserves only curses." Was it not true, McKim opined, that in his other architecture Michelangelo "has left but little which is entitled to be considered amongst the masterpieces of the Renaissance in Rome"? Bernini's solemnly majestic piazza might be acceptable for study, but the unbridled license of Borromini in its ugliness was useful only to show how very "correct" the earlier architects had been. Inappropriate "liberties" taken by fellows studying unacceptable subjects resulted in the creation of an official "Bible" or credo drawn up 1925 clearly defining the unassailable supremacy of the arts of classical antiquity and the Italian Renaissance, to the exclusion of all other styles, and ending with this injunction: "It is the duty of every Fellow to become fully aware of the policy and to accept it as a governing law and without question. Guidance will be given to them, and that guidance must be accepted wholeheartedly." Somehow the studies of Mannerist Tuscan villas outside Florence by Philip Trammel Shutze (Fellow 1916–20) passed muster, led to an admired (and rather original) Collaborative Problem design, and eventually resulted in his Calhoun-Thornwell house, Atlanta, Georgia (1919–22).

Those named fellows were provided three years to study first individual Roman monuments, then Renaissance monuments, and lastly, more involved complexes of Roman or Renaissance buildings as well as Renaissance gardens. All of this led up to the Collaborative Problem, which was judged by a jury in New York. Like juries at the École des Beaux Arts, the members were appointed for life, and as jury members were selected by a self-perpetuating group of conservative classicists, the students knew generally what was expected if they desired to win a prize.

The fellows' dilemma, as Yegül described, was that if the team exercised too much originality and spirit, their designs were derided by the jury for violating the spirit of the Academy. When inventive liberties were taken by early fellows (who grouped themselves into teams), the Academy subsequently dictated who would constitute each team. During the 1920s and '30s the tension between the increasingly conservative trustees and the juries, and many increasingly restive fellows, resulted in disputes and open (although gentlemanly) rebellion. In 1930 then-director Frank Fairbanks wrote back to New York that the fellows were complaining "there is not outlet for original (God help the term!) work." (The error of "not" for "no" apparently is in the original, as noted by Yegül. Fairbanks was clearly vexed when he wrote.) The next year, the program for the Collaborative Problem spelled out in specific detail the requirements for a private garden gallery to house classical and Renaissance art gathered by a wealthy collector. In frustration, one



Captial and cornice, Forum Romanum, Rome; Edgar J. Williams, fellow of American Academy in Rome, 1910–12. (From *Gentlemen of Instinct and Breeding.*)

design team, headed by Cecil C. Briggs, submitted a pavilion flagrantly copied from Vignola's casino at Caprarola, which the jury found lacking imagination and spontaneity. Yet the jury could hardly protest, for William Mitchell Kendall (a founder and trustee of the Academy, as well as McKim's successor in the firm) had done exactly the same thing in designing the Butler Institute of American Art in Youngstown, Ohio, fourteen years before.

The dilemma of how to permit a modern classicism, as seen in the work of Paul Phillipe Cret, who was admired by many fellows, finally forced the Academy in 1935 to solicit the advice of a respected former fellow, Henri Marceau. (Marceau, incidentally, had caused considerable consternation in 1925 when, as architect-designer for his Collaborative Problem team, he asked director Gorham Phillips Stevens if he could design the required chapel in an Italian Romanesque style.) In his report Marceau boldly challenged the design strictures being imposed on the fellows, and urged the program to open up. Eventually, there was some relaxation of the rules, but only after 1948, when the Academy reopened following World War II and a new spirit of free inquiry pervaded the institution.

Careful in its documentation, graceful in its writing, and truly sympathetic to the dilemma of the students at the Academy, Yegül's study concludes with a short chapter outlining the dramatic, virtual reinvention of the Academy after 1948. This excellent book points out the great need for sequel to this study—one that examines how in the 1950s and 1960s a reconstituted Academy with new priorities brought architects like Louis Kahn, Robert Venturi, and a host of artists and art historians to Rome. This generation of fellows and artists- and scholars-in-residence quickly became the makers and interpreters of form in the United States, fulfilling the original dream of the founders if in a somewhat different vein. Yegül's book is most important in helping to explain how, in making Rome's breadth of architectural history available to these later architects, the Academy enabled them to make their peace with the past.

NOTES

1. Yegül's study was not intended to replace the authorized history of the creation of the Academy ably done by Lucia and Alan Valentine, *The American Academy in Rome, 1894–1969* (Charlottesville, 1973), which includes lists of fellows and other *dramatis personae*; Yegül also draws on but does not displace the studies of Mary N. Woods, which are referred to throughout.

GENTLEMEN OF INSTINCT AND BREEDING: ARCHITECTURE AT THE AMERICAN ACADEMY IN ROME, 1894–1940, Fikret K. Yegül, Oxford University Press, 1991, 242 pp. , illus., $49.95.

RICHARD BECHERER

Charles-Louis Clérisseau and the Genesis of Neo-Classicism

Thomas J. McCormick

Thirty years in progress, Thomas McCormick's long-awaited monograph on the French architect Charles-Louis Clérisseau has at last been published in great style by the Architectural History Foundation. As the book's preface indicates, it was designed in part to support the suggestion of such French historians as Louis Hautecoeur that Clérisseau was a central figure to neoclassicism and seminal to the eventual emergence of *style Empire*. It is also intended to address—at least in part—the low esteem in which Clérisseau is held by Anglophile historians like the American Fiske Kimball, who relegate him to little more than a footnote in their writings on neoclassicism. Despite McCormick's implicit belief that what he is doing is empirically factual and even-handed (it is hard to remain unmoved by the thoroughness of the author's daunting archival quest to find the real Clérisseau), one senses a certain revisionist tone resonating in the lower registers of this text. McCormick wishes to redress the wrongs done his subject, misdeeds that began early with his ill treatment by the Adam brothers in the 1760s, continued with his descent into relative obscurity upon his death in 1820, and linger today with his marginalization by the latter-day historical press.

The text is a strictly linear narrative—a forward-looking biography divided into ten chapters, each devoted to a major period or episode in Clérisseau's career. The first chapter, "Early Life and Studies, 1721–54," provides what few contextual discussions there are in the book. Due to the limited amount of documentary and visual evidence dating from this period, McCormick is forced to situate his material within the confines of contemporary painterly practice in France and Rome particularly, where Clérisseau relocates after winning the Grand Prix in architecture in 1746. McCormick writes that

Clérisseau becomes impatient with his early academic education in Paris under Gabriel-Germain Boffrand and Jacques-François Blondel. That impatience turns to outright resistance during his five years in the Roman Académie de France, an ill will that peaks when he lets his Jansenist tendencies be known. Parenthetically, McCormick regards Clérisseau's behavior at the academy as indicative of an acute personality problem that would afflict him throughout his professional career. Despite the *pensionnaire*'s early architectural inclinations, his interests quickly turn to the visual arts—particularly, painting, both history and genre. His specific predilection is view painting, initially the topographically accurate *vedute reale*, popularized by Giovanni Paolo Panini, whose perspective technique Clérisseau studied. Soon, however, he turns to the so-called *vedute ideate*, or idealized topographic views, and *vedute essate*, or fantasy views, on the order of those produced by Clérisseau's schoolmate Jean-Laurent Legeay and more importantly, his friend Giambattista Piranesi (the author argues that the etched-ideal architecture and decorations comprising Piranesi's *Opere Varie* of 1750 was an especially important visual informant here). McCormick makes much of what he sees as significant stylistic differences between Clérisseau and Piranesi in terms of technique during this period, e.g., the lightness and luminosity of the former versus the heaviness and sobriety of the latter. What the author fails consistently to address, however, are the ways that these different techniques reflect differing modes of artistic production as well as artistic ends, issues to which I shall return. Finally, McCormick touches upon Clérisseau's short-lived acquaintance with William Chambers, his first contact with the English architectural *dillettanti*, and his first commission: a garden folly at the Villa Passionnei outside Rome.

The second chapter, "In Italy with Robert Adam: 1755–57," commences with Clérisseau's departure from the French academy. Despite the political rupture, he does not return to Paris but remains in Italy, where he has been nurturing the friendship of people such as Joseph Wilton, who introduces Clérisseau to Chambers. Clérisseau opportunely meets Robert Adam in florence, who, in turn, employs the Frenchman as his tutor and cicerone, not to mention professional go-between. The contacts come quickly—with Piranesi, for example, with whom Adam quickly entered into a publication agreement for the Campus Martius plan. At the outset, Adam's intentions for his tutor are simple enough: he wants Clérisseau to fill his head with "images of invention" and assist him in acquiring good taste. However, his the Scot's aspirations for fame, so McCormick argues, grow as he too entertains plans for an archaeological treatise on a par with the Robert Wood and James Dawkins studies of Baalbek and Palmyra (1753 and 1757). After a false start with a revision of A. Desgodetz's *Edifices Antiques de Rome* (1755–56), it soon appears that their substitute study—of Roman baths (1756–57)—is also in trouble due to the sheer enormity of the task. Adam and Clérisseau travel about Italy pursuing their options. On one trip to the Adriatic coast, they pause at Spoleto where the Frenchman produces some very fine drawings (including the "Temple of Vertumnis"), which the author sees as a crossing of Panini and Piranesi. On another, to Hadrian's Villa, Clérisseau produces a series of landscape drawings, entitled "Waterfall at Terni," which recall the work of his fellow *pensionnaire*, the landscapist Claude-Joseph Vernet. McCormick exploits these occasions to compare Clérisseau's drawings to Adam's versions, and, invariably, Adam comes out on the short end. For instance, when Clérisseau and Adam produce drawings of the same subject at Hadrian's Villa, the author asserts, "in every case . . . [Adam is] . . . less refined, more finicky in detail, and lacking the solidity of Clérisseau . . . detail is misunderstood . . . the general effect is crude and flat by comparison with Clérisseau's original." There is no mistaking the matter of originality at stake in McCormick's study. The chapter ends with Adam's realization that completing the baths project (despite four assistant draftsmen including Allan Ramsay) would be impossible. He and Clérisseau then decide upon the third option—Diocletian's Palace at Spalato.

Diocletian's Palace is the central topic of a particularly dense chapter "Clérisseau and the Adam Brothers: 1757–64." The discussion acquires its distinctive texture by its wealth of archival materials as well as drawings from a number of hands, including Clérisseau's and Adam's. The chapter commences with their departure for Dalmata in April 1757. After a three-month pause in Venice, they leave for


Hadrian's Villa at Tivoli by Robert Adams (left) and by C.-L. Clérisseau (right), c. 1756. Asserts author McCormick, "The general effect [of Adam's work] is crude and flat by comparison with Clérisseau's original." (From *Charles-Louis Clérisseau and the Genesis of Neo-Classicism.*)

Spalato in July. During the next four months, Adam, Clérisseau, and assistants measure and sketch the palace's archaeological remains. Simultaneously, a major change occurs in Adam's and Clérisseau's working relationship: no longer student/tutor, they are now employer/employee. Almost immediately upon their return to Venice, Adam departs for England, leaving completion of the drawings and their engraving to Clérisseau. Once out of Italy, Adam claims full authorship of the enterprise, while concocting with his brother James, who also studies with Clérisseau in 1760, financial and legal arrangements that would leave the Frenchman unacknowledged in both the text and plates. Such underhanded treatment of Clérisseau, however, does not mitigate Robert Adam's criticism of the completed plates, with which, he claims, the Frenchman has taken far too much liberty. In 1761 the plans of the palace are prepared and forwarded to Robert Adam. The author provides a particularly interesting comparison between Clérisseau's and Adam's versions of the palace's site plans. Although Adam's plans indicate greater deviation from visible evidence in situ, suggesting Clérisseau's to have been more accurate in the archaeological sense (as seen in his handling of the Imperial Apartment), history has proven Adam's intuitive interpretation of the whole and of portions not visible to be closer to the historical fact. This eventuality, the author argues, suggests Adam's more sophisticated planimetric sensibility.

Court de la Palais de Diocletian by C.-L. Clérisseau, ca. 1764. (From *Charles-Louis Clérisseau and the Genesis of Neo-Classicism.*)

After the departure of his petulant English patrons, Clérisseau returns to Rome, reconnecting with some of his older acquaintances, specifically Piranesi and the Cardinal Passonei. The Cardinal introduces him to his protégé, Johann Winckelmann, who in turn, introduces Clérisseau to another of his patrons, the Cardinal Albani. Soon thereafter, Clérisseau is commissioned to design the so-called "Kaffehaus" at the Villa Albani, of which virtually no record remains. Winckelmann is also instrumental in securing for Clérisseau the design of what was to be one of the most remarkable interiors of the entire period—the painted Ruin Room or "Chambre du Perroquet" for Pères Le Sueur and Jacquier at Santa Trinità dei Monti. Another project—a garden, complete with ruins, for the Villa Farsetti in the northern city of Sala—comes to naught. Winckelmann is also important to Clérisseau, so the author argues, for redirecting his scholarly interests to Roman architecture in southern France (Pont du Gard, Arch of Orange), research that would benefit Clérisseau some years hence when he publishes the first volume of his Nîmes study. McCormick also notes that at this time Clérisseau marries and, want of income, intensifies his teaching activities and artistic productions. Among his students is Friederich von Erdmansdorff, and among his clients, *dilettanti* Charles and James Hope who buy a significant number of paintings.

Clérisseau leaves Italy in 1767 for southern France, where he amasses further materials for what becomes *Antiquités de la France: Première Partie, Monuments de Nismes* (1778). In this book, Clérisseau addresses problems of theory in a limited way—both extolling the virtues of the Maison Carrée at Nîmes, and speaking of the nonmimetic, interpretative, and strikingly modern perspective that must be accorded historical study and design. The only volume of this book appeared in 1778, though it was later expanded by Clérisseau's son-in-law Jacques-Guillaume Legrand in 1804. While he is in southern France, Clérisseau receives the commission for the Château Borély, the home of a rich Marseilles merchant. An austere design into which Clérisseau interjects panels, pediments, and entablatures rich in archaeological reference, it is found to be "too Italian" by the client, and is ultimately modified and executed by Marie-Joseph Peyre. Soon thereafter, in 1768, Clérisseau moves to Paris where he finds acceptance elusive. Although he is taken into the Académie Royale de Peinture as a painter of architecture, and exhibits in various salons the next year, he is forced to supplement his meager income by collecting and drawing for the Adams. So he moves again, this time to England.

Chapter six, "Clérisseau in England in the 1770s," deals with the portion of his career for which key information is missing—specifically, when and under what circumstances he was in England. During his on-again, off-again practice there, Clérisseau seems to have both displayed drawings with the Royal Society and worked as consultant in Adam's office. In 1777 the noted antiquarian Gavin Hamilton recommends Clérisseau to the Marquess of Lansdowne for a modification of a library in a house originally designed by Adam. Clérisseau is commissioned first to design a sculpture gallery within this space and then to redecorate the original library. What results is a single linear space dramatically subdivided into thirds by a suite of skylights and paired, giant order Corinthian columns—an interior with exterior architectural motifs. The author makes little of the room's skylights or modulation of spaces, although they were seminal to the project he proposed to Hubert Robert for the redesign of the Louvre's Grande Gallerie. The scheme seems also to have been important both to Henry Holland (who executed a triumphal arch Clérisseau designed for the garden), and, although the author doesn't suggest this, to John Soane, Holland's assistant, who knew the Lansdowne projects well, and seems to recall them in both the Dulwich Art Gallery and the gallery in his own house on Lincoln's Inn fields.

The next chapter focuses on Clérisseau's work in Paris during the peripatetic 1770s, examining the problems described by Hautecoeur involving the dating of Clérisseau's work for Laurent Grimod de la Reynière. The author determines that Clérisseau designed not one, but two distinct salons for Grimod—the first (ca. 1773), a lesser known version of the colonnaded plan Clérisseau devised for the Lansdowne project, and the second (ca. 1777), a grand room much admired by Archduke Paul and his wife Marie Feodorovna, utilizing a new fashion of painted arabesque *grotesquerie* then popularized by Piranesi's book on modern decor, *Diversi Maniere* (1769). Worthy of note is McCormick's argument that what had been thought to be Athenian Stuart's comparable paintings at Ashburnham Place are likely to be none other than those designed for the second Grimod salon. What remains unclear here, insofar as arabesque interior decoration is concerned, is the relationship of architect François-Joseph Belanger and his assistant Nicolas–François-David Lhuiller (Clérisseau's Italian assistant who had brought the Piranesi book from Italy) to Clérisseau at the earlier Hotel de Brancas' Pavillon de Lauraguais of 1769, sometimes called France's first neoclassical interior. Nor does he relate it to comparable interiors at Bagatelle, designed the same time as the second Grimod salon. These constitute knotty problems of attribution which casts doubt on McCormick's strictly ascribing authorship of *grotesquerie* to Clérisseau.

McCormick prepares readers for Clérisseau's Russian work at various points along the way. Chapter eight, "Clérisseau and Catherine the Great," discusses the "Roman House" Clérisseau prepared for the monarch. The contact is made in fall 1773 when Catherine, on the recommendation of court sculptor Falconet, recommends Clérisseau for the design of a summer house to be erected in the gardens at Tsarskoe Selo outside St. Petersburg. By Christmas time, she receives the project—a cross between Hadrian's Villa and the Baths of Caracalla—only to angrily dismiss it, shocked by the scheme's enormous scale, overburdening decoration, and climatic inappropriateness. She also refuses to pay Clérisseau for his work. A compromise, however, is struck when, in 1779, she agrees to purchase the nearly twelve hundred Clérisseau drawings now in the Hermitage. These drawings, however, do not pass into the royal collection unnoticed; indeed, Scottish architect Charles Cameron, in many of his interiors of the Empress's apartment in Tsarskoe Selo, is inspired by (and even copies) some of the decoration. Other architects studied Clérisseau's work for the Empress as well, including Giacomo Quarenghi, who, in building his own Admiralty Arch in Petersburg, refers directly to the squat, intensely horizontal triumphal four-sided Janus arch Clérisseau prepared for Catherine in 1780.

The last two chapters, "Clérisseau, Thomas Jefferson, and the Virginia Capitol 1785–90" and "The Later Years: Metz, the Weimar Project, and the Second Edition of the Book on Nîmes," constitute for the author Clérisseau's swan song. McCormick addresses Clérisseau's involvement with Thomas Jefferson and the Virginia State House, where he encourages the American legislator to look long and hard at that "most perfect and precious remain of antiquity in existence," the Maison Carrée. It is unclear, however, to what degree Clérisseau really affected the Virginia project, other than in its details, as Jefferson had come to Clérisseau—plans in hand—with the form of the temple already in mind. Only Clérisseau's model, and none of his drawings, survives. Between 1776 and 1778, Clérisseau is asked by Maréchal de Broglie, Gouverneur d'Evêches, to design the Palais de Gouverneur at Metz, now the Palais de Justice. Work is begun in 1773 and completed in 1778. The facades of this great U-shaped building clearly resemble the Château Borély, especially in a certain blandness of surface and overall ungainliness, a fact pointed up in a comparison with either Blondel's nearby Hôtel de Ville, or with other great U-shaped buildings like Ange-Jacques Gabriel's Château at Compiègne. The only relief from these forms (which today appear oppressively institutional) occurs in the moments of decoration attached to the building—trophies, panels, pediments, entablatures—derived from sources like Piranesi's Caffè Inglese or Santa Maria del Priorato as well as the Column of Trajan, drawn by Piranesi as well as Clérisseau. Lastly, in 1792, Goethe, at the suggestion of Friederich von Erdmannsdorff, solicits Clérisseau's help in redecorating the great hall and adjoining room of the Palace at Weimar. The drawings he submits in 1794 depict the room as a kind of Egyptian hall, lined with columns not unlike the schemes he had devised for the Lansdowne Gallery or the first Grimod de la Reynière salon. The walls, divided into panels like the surfaces of the "Roman House," are cluttered with profuse pockets of decoration similar to the decoration at Metz. The author portrays this last building apocalyptically—this project constitutes a replay of Clérisseau's entire architectural career, his personal history condensed into an instant.

As mentioned, one of the motivations behind McCormick's study is to redress the wrongs done to Clérisseau by professional competitor Robert Adam. Part of the demonstration is formalistic, and part is connotative. McCormick repeatedly compares Adam's drawing to Clérisseau's, and invariably finds Adam on the short end of the stick. Part of his criticism has to do with originality—how could Adam's be anything other than "anemic" when, in the end, he merely imitated Clérisseau's studied habits? McCormick implies that Adam is inferior to Clérisseau because of his tendency to appropriate the master's practices. Such appropriation notwithstanding, the author has little criticism for Clérisseau's own habits of imitation—whether of Giuseppe Bibiena, Panini, or Piranesi. The author sees that Clérisseau incorporates "influences" from all three, and that, in the end, he also fails to transcend them. Still, this inadequacy on Clérisseau's part fails to elicit the shelling of pejoratives that the author directs at Adam's derivations of and deviations from Clérisseau's style.

In fact, I believe that Clérisseau does display a radically different spirit—particularly in the *vedute ideate* and *vedute essate*—than that of his compatriots and this aspect has to do with the lingerings of rococo space-making in his drawings. Clérisseau's early drawings at Hadrian's Villa are filled with spatial ambiguity, internal framing, and rhythmic *repoussé* movements which call Piranesi to mind. Simultaneously, however, their atmosphere, spatial fluidity, and luminescence (due, in large part, to his ink-wash and gouache water-color techniques) suggest a comparison with a published, near-contemporary such as Antoine Watteau, despite obvious differences in technique and subject matter. In fact, Clérisseau's early interests in genre—for example, his early pen-and-ink "Polichinelle"—evoke the lesser genres of painting so dear to someone like Watteau, including allegorical landscape painting. This meeting of interests is perhaps better seen in another of Clérisseau's compatriots in Rome, Jean-Honoré Fragonard, whose Conte pencil drawings at Tivoli seem to combine auras of allegorical landscape, *fête galante*, and antiquarianism comparable to Clérisseau's creations. If anything, Robert Adam seems to take these rococo spatializing interests one step further. The spareness of his drawings and the prevalence of the paper surface seem to convey the atmospheric, neutral "ground" that academic English theorists such as Joshua Reynolds (and artists like William Gainsborough) regarded as essential for best displaying the painted figure. In a sense, Adam's drawings always seem to battle the ground, perhaps because of his inexperience in drawing, or simply because of his fascination with the primary drawing surface. For whatever reason, the austerity (anemia to some) of an Adam drawing stands in definite contrast to the densities of a work by Clérisseau, rife with spatial complexity. For the Scot, the neutral ground finds its laconic analogue in such Spartan wall surfaces as those at Kedleston, Adam's first English masterpiece; for the Frenchman, the dense interplay of forms in his drawings comes to rest in the saturated elevations of his "Roman House" project for Catherine the Great.

Clérisseau's interest in genre painting (in marked contrast to his single foray into the world of history painting) suggests not only his marginality vis à vis architecture and history painting, but also hints at his interest in blurring the boundaries between artistic disciplines. He is concerned not only with effacing the differences between high and low art—which his choice of gouache over oil, I believe, indicates—but also with high and low collecting interests. As a producer of art, his is a hybrid personality: he is not just an architect and archaeologist, but a painter, draftsman, decorator, and designer of sculptural elements (plaster) and *objets de vertu* (cameos, etc.). Needless to say, such myriad interests encourage some collaboration, and a method of design production that would necessarily make matters of specific authorship problematic. Moreover, he pursues his interests in ways that dramatically contrast the increasing specialization of art disciplines established by the academy. Instead, he more resembles the practices of outspokenly commercial artists like Piranesi (the Ralph Lauren of his day) whose artistic production (especially prints) gradually becomes geared to the collecting habits of a new, educated, moneyed, and mobile middle class. For them, antiquity provides an image to be consumed—it is a process of historical appropriation that allows the middle class to legitimate its emerging social position by associating itself with symbols of past power. To what degree Clérisseau is aware of his relationship to this class is, of course, never really addressed. In fact, McCormick leads us to believe that his life is given over to keeping the wolves at bay; nowhere does one ever suspect Clérisseau of being as financially adept or entrepreneurial as either Piranesi or Adam. Naturally, such ideological questions are of little interest in a study wherein provenance seems to the guiding imperative. Still, significant insights could have been gained had the author further explored the social and artistic ambient surrounding Clérisseau, and his place in it during his formative years both in Paris and Rome—a study on the order of Werner Oechslin's essay in *Piranèse et les Français* (Rome: Academie de France à Rome, 1976) and Steffi Röttgen's work in *Piranesi e la Cultura Antiquaria* (Rome: Multigrafica, 1983), among others.

McCormick's discussion is untroubled by any question concerning the period's major theoretical debate—that is, the originality of Greek versus Etruscan architecture. As the argument is generally under-

Ruin Room, Window Walls, room designed and painted in Rome by C.-L. Clérisseau to represent the ruin of an antique temple, c. 1766. (From *Charles-Louis Clérisseau and the Genesis of Neo-Classicism.*)

stood, the debate's major voices are Marc-Antoine Laugier, Pierre-Jean Mariette, and Winckelmann on the Greek side, and Piranesi on the Etruscan. Needless to say, Clérisseau's position seems to straddle the border. How, then, does his sole major published writing, *Antiquités de la France: Nismes* (1778), engage both sides of the debate, undertaken as it was at the encouragement of Winckelmann himself? Winckelmann, so we are told, is interested in the study in so far as it might apply to his *History of Ancient Art* (1764), arguably the period's single most important aesthetic tract. Despite Winckelmann's guidance, any hint of the Greek truth-claim seems forestalled as Clérisseau comes to regard such explicitly Roman works as the Maison Carrée as the very embodiment of perfection—a status Winckelmann had accorded only to Greek art. In displacing the truth-claim from Greek to Roman work, it would seem, then, that Clérisseau falls soundly into the Piranesian theoretical camp, as outlined in the Italian's dialogical introduction to the *Parere sull'architettura* (1765). Although McCormick seems to suggest that the subjectivity implicit in Clérisseau's archaeological study alludes to Winckelmann, it must be remembered that Winckelmann's subjectivity is a particularly scopic kind, eliciting an empathic, even erotic response, however displaced. Clérisseau's brand of subjectivity is of the same kind that mobilizes Piranesi, who claims that in examining Roman work, one must also confront the liberating, creative impulses that mobilize distinctly ancient deviations from the ideal type. These aberrant, classical impulses justify Piranesi's and Clérisseau's "modern" formal experiments. They also exhort modern artists to call upon their free and unfettered imagination in order to compensate for a lack of truth-claim. History does come to justify Clérisseau's practice: neither proscription nor prescription for form-making, it incites unfettered creation, a free play of design intended to disguise one's losses of culture and collective memory over time.

Why such questions are consistently avoided in this text is somewhat mystifying. Part of the answer, I believe, has to do with the style and method of the enterprise—ultimately, this is a provenance study interested in ascribing authorship in pursuit of originality. Instead of this approach, McCormick might have taken a hint from Piranesi, who sidesteps problems of originality in his invective to Mariette in the *Parere—aut in hoc* rather than *aut cum hoc*: history must come from within art rather than from without it. In this two-part epigram, Piranesi asserts the need for a theory that must somehow evolve from the internal making of art rather than the external contemplation of art and its origins. Clérisseau's life is a history of making—of making images, of professional and artisanal training, of learning from and with others, of sharing visual experience. And into this shared life and production are inscribed shared cultural practices and values. As a creature of culture, whether dominant or subaltern, Clérisseau's originality is less important than perhaps the ways and means by which he explores, appropriates, or resists practices that index these values. In broadening the scope of the study—despite the biographical imperative—this book might also have shed some ambient light on other individuals, institutions, or larger cultural concerns. With such an approach, the author might have produced a more compelling argument for Clérisseau's importance within the orbit of emergent neoclassicism, illuminating both the visual mementos of his past performances as well as the more elusive intentions that motivated them. This book could have been noteworthy to an audience larger than the curatorial. Indeed, one might have found an artistic personality less romantically remote and more realistically conditioned by the compelling circumstances governing not only his designs for the world, but also his submission to it.

CHARLES-LOUIS CLÉRISSEAU AND THE GENESIS OF NEO-CLASSICISM, Thomas J. McCormick, Architectural History Foundation and MIT Press, 1990, 284 pp., illus., $35.00.

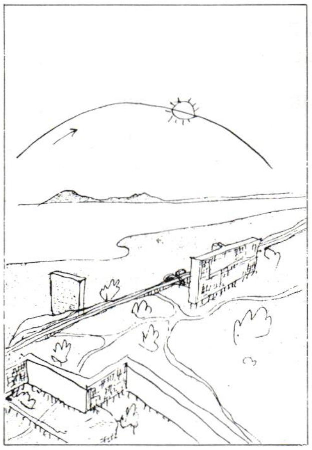
RICHARD INGERSOLL

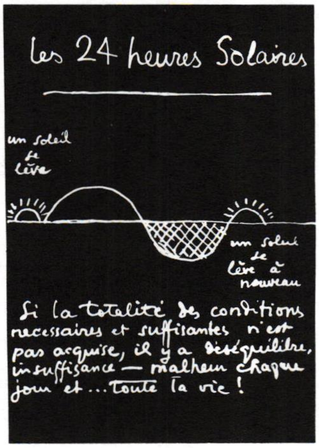
El fuego y la memoria: Sobre arquitectura y energia

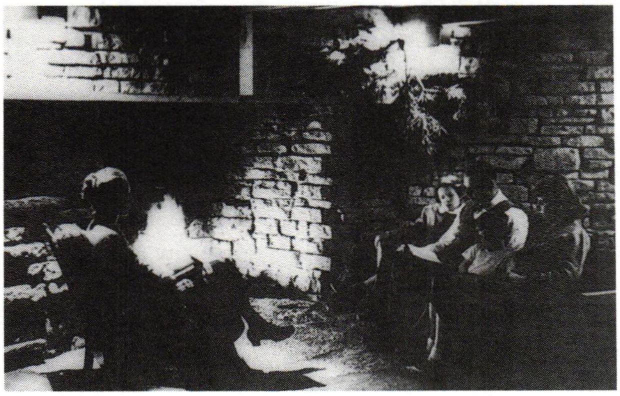
Luis Fernández-Galiano

El fuego y la memoria (Fire and Memory) concerns the timeless subject of Promethean fire as the source of one of the fundamental dilemmas of human consciousness, yet also addresses the more pressing ecological questions that will dominate political and cultural policy debates during the next decade. Profusely illustrated and scrupulously annotated, *El fuego y la memoria* is an erudite study of the mythological dimension of energy in Western culture. While almost every text about energy or ecology, and in particular those concerning architecture, has been written with a pragmatic agenda about what must be done, Luis Fernández-Galiano has composed an open work that spins history, philosophy, technology, economy, and architecture in interpenetrating orbits around the theme of energy in the discourse of architecture. Architecture as the most consistent consumer of energy is treated as both a symbol of humanity's struggle with nature and the practical object of the daily processes of entropy.

The book's structure is indicative of its spiraling method. Eight chapters, each of which has many subchapters, are collocated under five thematic sections. Their titles are given emphasis by the use of foreign terms, and possess mythic dimensions: "Ignis Mutat Res"; "Time's Arrow"; "La Bête Machine"; "Die Entropie der Welt"; and "Locus Foci." Next, the chapter headings (all in Spanish) indicate more specific arguments, including: "Architecture meets fire"; "Paradigms of life and thermodynamic architecture"; "Organisms and mechanisms, metaphors of architecture"; "Energy, the currency of nature"; "Thermal space in architecture." Finally, if one scans the subchapter headings, one gets a jaunty synopsis of the author's polemical inquiry. Take, for instance, some of the first chapter's subheads: "On matter and energy: architecture between mud and breath"; "The hut and the bonfire: The order of construction, the disorder of combustion"; "Fire in the childhood of architecture: The myth of origins, rites of foundation"; "The sun as a clock and unpredictability of fire: Cosmology and cosmogony"; "A philosophical building and two philosophers of building: Solar Le Corbusier and Fiery Wright."







The sun guides LeCorbusier's work: (top, left) the rule of the site, 1946; (top, right) the solar cycle, 1954. (Bottom) Frank Lloyd Wright places the hearth at the heart of the home; Jacobs House, 1946. (From *El Fuego y la memoria*.)

The book is assembled in such a way that it can be read straight through or in fragments out of sequence. Visually oriented people will appreciate it because the illustrations and their captions form a parallel text that can be read on its own. General audiences will find the book accessible as it is about the cultural underpinnings of architecture rather than the sectarian concerns of the field. Yet it is in no way a facile book—it is complex, layered, and requires a good background in cultural history to be thoroughly enjoyed. Fernández-Galiano is quite obviously influenced by the attitude of French scholarship in his determination to draw on heterogeneous strands of myth, history, and philosophy. It is the kind of historical reflection that until now has been missing from the discourse of architecture; the sort of text, with its erudition and quick interreferences that bears some comparison to Joseph Rykwert's 1972 book, *Adam's House in Paradise* (second edition, Cambridge: MIT Press, 1981).

Fernández-Galiano's text is not moralistic (as so many environmental books have been), but neither is it without a moral. Instead of preaching about how to resolve the ecological imbalance caused by architecture and urbanism, an undeniable problem, his query is more fundamental: energy has been recognized since at least the time of Vitruvius as the origin of architectural theory, yet has been scandalously absent from architectural theory since the reign of the "dictatorship of the eye." *El fuego y la memoria*, which returns to some of the topics dear to Lewis Mumford, such as the megamachine, is less an accusation of the sins of industrialism and science than a critical history of the mentality behind the Western approach to entropy.

Le Corbusier and Frank Lloyd Wright, the two most mythomanic architects of the century, are enlisted several times as exemplars because their respective obsessions about the sun and the hearth fit the symmetry of the treatment of energy. They are not presented in necessary opposition; the point is that the two most prominent protagonists in Western discourse—because of their cosmological pretensions and their mythic propensities—were (perhaps unintentionally) more conscious of the role of energy than their followers.

Fernández-Galiano thrives on reciprocated inversions. He notes in the first chapter, "Architecture can be understood as the material organization that regulates the flow of energy, and at the same time, as the organization of energy that establishes and maintains materials." This symmetry derives from the myth of the origins of architecture where building a fire leads to building a building for making a fire. Or wood, as the author points out, at one time the chief source of energy, was also the prime construction material.

The scope of the book is stimulating. The discussions always range from the commonplace to the recondite. On scientific theories about energy, such as those of Newton, the author is able to situate the introduction of modernist amnesia, while suggesting that architecture, despite its relationship to energy, has always been the "theater of memory," as taught by Frances Yates. Mathematician Pierre-Simon Laplace's Faustian certitudes about the progress of machine civilization meets its resistance in the entropy theories of Clausius and British physicist W. T. Kelvin, and parallel to this an unexpected echo is heard in the mention of Jacques Lacan's critique of Freud's mechanistic paradigm of the psyche.

Although there has been important research carried out in the last decade in the history of ecology (see Anna Bramwell's *Ecology in the 20th Century: A History* [New Haven: Yale University Press, 1989]), and the European Green movement has significantly changed the discourse on environmental politics, Fernández-Galiano's text is still fresh and has many original insights and interpretations, along with a few discoveries, for example, philosopher of science Ramon Margalef, who seems to have been submerged in an unintegrated Spanish culture. Indeed, Fernández-Galiano's book is an opening, as are so many cultural manifestations in Spain now, to a wider participation in European intellectual life.

EL FUEGO Y LA MEMORIA: SOBRE ARQUITECTURA Y ENERGIA, Luis Fernández-Galiano, Alianza Editorial (Madrid), (distributed in the U.S. by Lectorum), 1991, 256 pp., illus.

JAYNE MERKEL

Cincinnati Observed: Architecture and History

John Clubbe

Geography is destiny in Cincinnati, where the Ohio River brought the first settlers, encouraged abrupt early growth, and then led to a gradual decline in population and importance relative to other cities, when railroads replaced inland waterways after the Civil War. Tall surrounding hillsides compacted the city until the 1880s and restricted later development; they frame the pyramidal downtown skyline, provide breathtaking views, and separate neighborhoods by reinforcing racial and class boundaries.

The intriguing relationship between geography and history is what first attracted urban biographer John Clubbe to Cincinnati. Clubbe has never lived in Cincinnati. He was born in New York and teaches British Romantic literature at the University of Kentucky, and fell in love with Cincinnati on weekend excursions.

But even in Cincinnati, where development took place from the river outward, historical events did not unfold along the route of a tour. The geographic ordering of a guidebook like *Cincinnati Observed* can leave the reader with a head full of disassociated facts. For example, the reader is often stranded at a building site while Clubbe digresses for two or three pages on tales such as the Courthouse Riots of 1884 or the character of public art in the late 20th century.

Organization is more problematic in *Cincinnati Observed* than in other guidebooks, because the format keeps Clubbe from explaining what drew him to the city, though it is revealed in the places he visits, his literary sources, careful prose, and the pace of his narrative. The book really ought to be read in a leather chair at a gentlemen's club. It is, in many ways, a self-indulgent book. Although he has studied Cincinnati's history painstakingly and wandered its streets insatiably, Clubbe takes his readers only on tours of the places he likes and then describes them in minute detail. If not a thousand, at least several hundred, words often appear where a single picture would do.

The illustrations are far too limited and the graphics are poor; individual monuments are designated only in bold face, often in the middle of a paragraph. The editors might have encouraged Clubbe to make more use of his talents of historical scholarship instead of trying to turn his labor of love into a guide, especially when four other guidebooks, albeit not completely satisfactory ones, already exist.

Clubbe is at his best when he brings the historic city to life by means of literary references, anecdotes, and comparisons with other cities. He colorfully explains the city's nickname, "Porkopolis," with observations of "Mrs. Houston, an English traveler of 1849" who "found Cincinnati to be 'literally speaking a *city of pigs* . . . a monster piggery' where 'grunts and . . . squeals meet you at every moment'"; and of Mrs. Frances Trollope who wrote in *Domestic Manners of the Americans* (1832): "The chances were five hundred to one against my reaching the shady side without brushing by a snout fresh dripping from the kennel."

Similarly, he draws on an article by the 19th-century journalist Lafcadio Hearn when discussing Henry Walter's St. Peter-in-Chains Cathedral of 1845:

> In 1876 . . . decorations were placed atop St. Peter's cross. Three experienced steeplejacks undertook the job of taking them down. Hearn covered the story. The assignment included climbing the steeple. . . . He presents himself as the terrified novice of the party. Gas jets fitfully illumine green mold on the walls. As Hearn climbs, the "solemn pulsations" of the steeple's clock (since removed) become gradually louder. His beating heart echoes the ticking. One hundred-fifty feet above the terra firma the party scrambles out onto a ledge; for the remainder of the ascent they will use a rope ladder. Fortified by a shot of whiskey, Hearn begins to climb the swinging ladder. We agonize with him as, rung by rung, level by level, he pulls himself up . . .

Clubbe condenses, paraphrases, and leads a reader through another text artfully. I wish he had done so more often and not tried to describe every banal late-20th-century building in the downtown. As a guide to the city today, his book is peculiar anyway because he confines himself to a very small area. Al-

A trolley crosses one of the many bridges over the Miami and Erie Canal, ca. 1916, which was filled in three years later. Central Parkway now occupies the site. Mount Adams is in the distance. (From *Cincinnati Observed.*)

though Cincinnati is no longer much of a walking city, *Cincinnati Observed* contains twelve walking tours totaling 382 pages and only one driving tour covering 70. Clubbe devotes more than half the text to the not very healthy downtown, conducts two long walking tours through quaint but decrepit nearby Over-the-Rhine and one each to the old hilltop neighborhoods of Mt. Adams, Mt. Auburn, and Clifton. His drive takes in bucolic Spring Grove Cemetery, the impressive Cincinnati Zoo, the fine 19th-century Procter & Gamble factories in St. Bernard, the elegant 1851 railroad suburb of Glendale, and Mariemont, a pretty new "town for the motor age," founded in 1923 on the model of an English village. It is the only area visited built in the 20th century.

None of the recent outer suburbs are mentioned, not even the famous progressive planned community of Greenhills, begun in 1936. Neither are those that started out as 19th-century towns, such as booming Montgomery, Sharonville, and Terrace Park. Nor is the city's fanciest suburb, Indian Hill, where business leaders built country estates in the 1920s and 1930s. Not even Walnut Hills and Hyde Park, historic residential areas in the city where the rest of the local Establishment lives in grand old houses, many overlooking the river. Walnut Hills was an important "station" on the Underground Railroad. "Hyde Park Square," actually a charming esplanade with an old-fashioned fountain in the middle, is the locus of the city's most fashionable shops—the kind of place almost any tourist would want to see. Also, a driving tour eastward from the downtown, through Mt. Adams and the neighborhoods along the Ohio River, would have shown the progression in space and time that settlement of this area followed. Clubbe's only driving tour circumvents the parts of the city that are thriving today.

Surprisingly, the geographic range of *Cincinnati Observed* is narrower than that of the 1943 *Cincinnati: A Guide to the Queen City and Its Neighbors*, sponsored by the Works Progress Administration. This still-useful 570-page, clothbound book, despite some factual inaccuracies, has some features Clubbe and his editors might have emulated: a "Profile" section, a roughly chronological 38-page discussion of the city's early history and over a hundred pages of essays on events, institutions, and themes in Cincinnati's past, along with sharp black-and-white, full-page photographs. This format would have given Clubbe room to consider how the city's history has made it the kind of place it is now—without impeding the progress of any tours he chose to offer.

Cincinnati's never-used subway. Begun in 1919, running underground the excavated bed of the former Miami and Erie Canal, work continued until 1926 when the project was abandoned. (From *Cincinnati Observed*.)

Unfortunately, the 1980 American Institute of Architects convention in Cincinnati did not inspire a revised edition of the WPA guide, as similar meetings did elsewhere. The local AIA Chapter produced a perfectly silly little book, *Fascinating Spirited Cincinnati*, instead. Filled with pink-tinged interiors shot with a fisheye lens, hackneyed "people pictures" and glowing night-lit cityscapes, and set off with captions like "A city getting younger every year," "Spirited designs for houses of the Spirit," and "Incredible edibles," it seems more like a chamber of commerce brochure than an architectural guide—even at 176 pages. Architects' names and building dates were not included, and no buildings were singled out for praise or derision, so that no one would be favored or offended—except those who cared deeply about architecture.

A few AIA members tried to atone during the city's bicentennial when the AIA-funded Architectural Foundation of Cincinnati published the pocket-sized, 195-page, black-and-white *Architecture and Construction in Cincinnati: A Guide to Buildings, Designers & Builders* in 1987. Although many errors in the WPA guide remain uncorrected, the Architectural Foundation's book does bring the central city up to date, and the format—with clear maps, a photograph and paragraph on one or two buildings per page—is legible and useful as a reference.

The Cincinnati Historical Society produced a far more substantial publication for the bicentennial. Originally intended as a successor to the handy WPA guide, *The Bicentennial Guide to Greater Cincinnati* of 1988 by Geoffrey Giglierano, Deborah Overmyer, Frederic Propas, and a whole team of academic advisors (including this writer) grew to fill a nine-by-twelve-by-two-inch-thick volume that could only be taken on a walking tour in a little red wagon, though its graphics and organization make it easy to use. Like Clubbe's book, it is stronger on 19th-century material than recent building and a bit long-winded, but it has a broad geographic sweep and a wealth of fascinating information.

To Clubbe's credit, he has managed to add a great deal even to the Historical Society's massive tome. And he has done so with obvious joy. His loving portrait of Cincinnati bears his stamp to such a great degree that the Queen City appears to be more of a genteel dowager than it actually is.

CINCINNATI OBSERVED: ARCHITECTURE AND HISTORY, John Clubbe, Ohio State University Press, 1992, 531 pages, illus., $24.95.

AMY SLATON

Measure of Emptiness: Grain Elevators in the American Landscape

Frank Gohlke

Tinged with Gold: Hop Culture in the United States

Michael A. Tomlan

There is something particularly haunting about deserted industrial structures. Factories, water towers, and docks represent such large investments in time, effort, and money that to see them in a state of disuse is to somehow witness the failure of an entire economic system—perhaps even a whole social ethic. Empty homes may evoke sadness or sympathy, but abandoned workplaces seem to chasten. It is this mixed sense of awe and discomposure that Frank Gohlke attempts to capture in his book of photographs of American grain elevators, and, by and large, he succeeds.

Visual or written accounts of grain elevators, first constructed in America in the 1840s, are few. They may have inspired European modernist architects, as Reyner Banham showed in his book *Concrete Atlantis* (Cambridge: MIT Press, 1986), but the physical settings of commerce and agriculture have not been favored subjects among American artists and historians. Some regionalist and precisionist painters of the 1920s and 1930s, such as Grant Wood, Thomas Hart Benton, Charles Demuth, Charles Sheeler, and Louis Lozowick, turned their attention to farms and factories to convey a variety of ironic and celebratory themes, but few other fine artists come to mind. Historians of vernacular architecture have examined farmhouses, and a handful of historians of architecture, business, and technology have considered the design of factories. Gohlke contributes to both disciplines with *Measure of Emptiness: Grain Elevators in the American Landscape*, a book of forty-six of his black-and-white photographs from the mid-1970s, sandwiched between a personal introduction by the photographer and a historical essay by geographer John C. Hudson.

Measure of Emptiness is part of the Johns Hopkins University Press series on the North American landscape that also includes profoundly moving photo essays of such underexamined American industrial locales as bomb test sites (see review of photographer Richard Misrach's *Bravo 20* in *DBR* 27). Without question, Gohlke's photographs live up to the series' standard. He exploits the formal simplicity of grain silos with great sensitivity; in every case, his images, presented one to a page, are exemplary in composition, range of values, and relationship of open space to detail. In some cases the featured elevator looms to fill the entire frame; in others it is just a speck on a distant horizon, interrupting the otherwise featureless expanse of the Texas or Kansas plain.

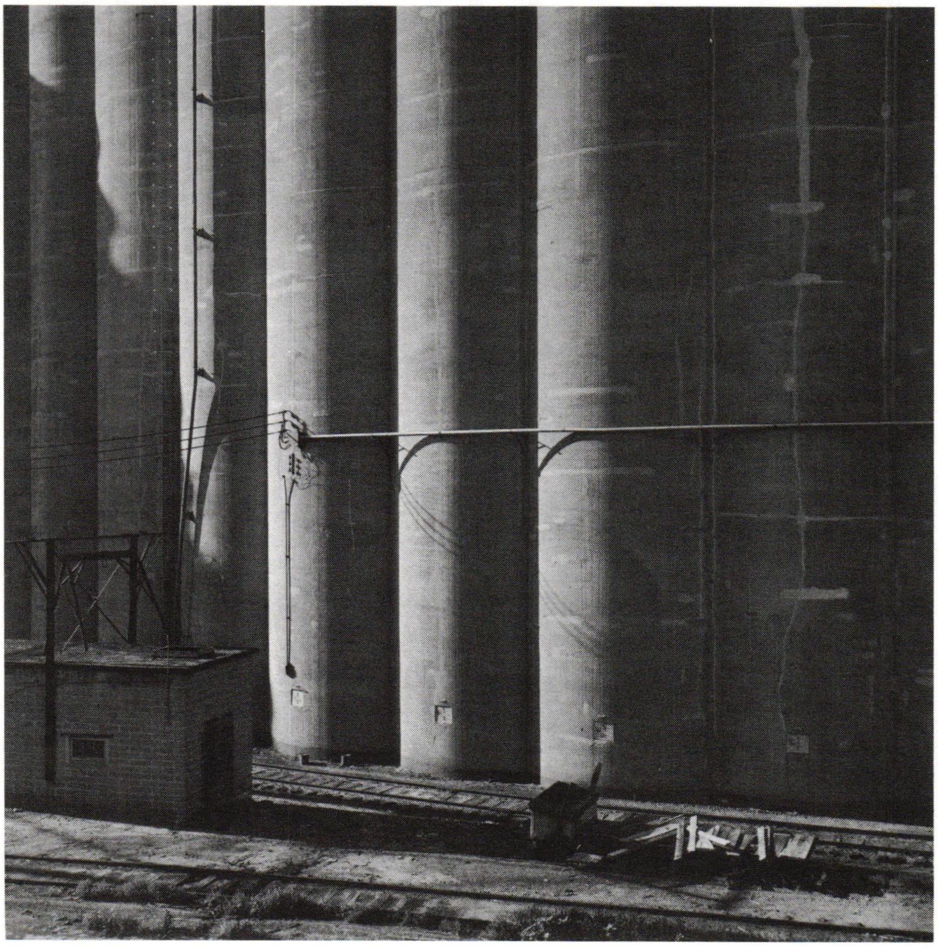
Unlike Bernd and Hilla Becher's deliberately affectless, identically composed, frontal images of water towers, Gohlke's photographs capture the potent gothic mystery of the grain elevators, which tower beside sprawling docks or on the edges of small towns. There are virtually no people in any of these pictures, so it is impossible to tell which elevators were still in use at the time Gohlke photographed them, but all show signs of wear, if not encroaching ruin. On even the tidiest examples, grass grows from cracks in concrete silos and the logos they sport are old-fashioned and faded. If these photos were presented in a museum or gallery, they would qualify as fine works of art that bring on a carefully orchestrated *frisson* about, in Gohlke words, "what passes and what endures."

But Gohlke wishes to create more than elegiac artistic renderings of the grain elevators. According to his essay, he hopes to cre-

Grain elevator, Bay City, Wisconsin. (From *Measure of Emptiness*.)

ate both an artistic interpretation and a historical document in one stroke, because he believes that the "meaning" of the elevators is in itself compound—that is, both symbolic and practical considerations figured in the creation of the grain elevators, and together give them their monumentality. Gohlke did not understand his strong response to the structures until he recognized this duality, guided in part by the work of geographers such as J. B. Jackson, who propose that landscapes are dynamic entities resulting from ongoing interactions between humans and the world. Gohlke came to understand that the grain elevators were the products of their makers' "inner needs and external constraints." Among the inner needs were the "symbolism to community" embodied in the sheer size and verticality of these vessels that brought pride to their builders, income to farmers, and inexpensive bread to Americans. Among external constraints that shaped grain elevators were business and logistical ones recounted by Hudson, who traces the origin of grain elevators to the expansion of railroads, detailing dramatic statistics on elevator capacity and grain consumption, and the complexities of elevator construction and operation.

After studying grain elevators over a period of years, Gohlke realized that the boundaries between the daily labors of commercial or technical work and symbolic self-expression are porous. No undertaking can be technical without being in some way social, and every social experience is in some way conditioned by the physical world or by the larger institutional system in which it occurs. Gohlke brings an enriching perspective to the study of industry, technology, and architecture, and, not incidentally, to the machine-based medium of photography. *Measure of Emptiness* asks us to consider the contingencies of the shape of our built world, and how definitions of art and technology, or perhaps science in its broadest sense, become solidified. Neither grain elevators nor photographs stand purely in one realm or the other, because their makers do not live only in one realm.



ADM grain elevator, Minneapolis, Minnesota. (From *Measure of Emptiness*.)

While this construct provides an extremely appealing analytical tool, it presents difficulties if applied to the creation of a work. Despite its merits, *Measure of Emptiness* demonstrates how difficult it is to break down the boundaries between disciplines. Gohlke strives for the emotional impact of art and the intellectual resolution of science, but somehow the result suggests that he is not quite clear on when he is practicing one enterprise or the other. Certainly these photographs are based on his far-reaching curiosity and empirical research about the history of grain elevators and their place in the landscape, but the images selected from that history display only attributes of the grain elevators that dovetail with Gohlke's own, highly visual approach to the world. It is no accident that the elevator worker or wheat farmer is almost absent from these images: the "essential view" of the grain elevator Gohlke offers is the one that passing motorists see.

The elevator of *Measure of Emptiness* is, as he states in his essay, a visual presence given meaning by its spatial context, embodying the contrast between rolling plain and tower, or between open and contained space. This is not the meaning of the grain elevator to everyone, however; and more precisely, it fails to explain the technical and commercial origins of the grain elevator's form—the very subject Gohlke claims to pursue. To those who worked at the grain elevators, designed them, owned them, or relied on them to store their grain its way to the market, the elevators were surely not primarily visual or even vertical, but, rather, dusty, challenging, burdensome, profitable, or a myriad of other things. But these experiential features of the elevators do not engage Gohlke, who tells about his frustration at the discrepancy between the "ordinariness of the facts" he learned from talking with elevator workers and the "intensity of [his] emotional response to the objects themselves." Thus, even recalling the contents of Hudson's essay in mind, we can't reach through Gohlke's photographs the variety of meanings the elevators held relative to the land, some of which are suggested by William Cronon in his recent book, *Nature's Metropolis* (New York: W. W. Norton, 1991).

Cronon recounts the huge conceptual transformation of wheat from farm product to agricultural commodity that accompanied the spread of the grain elevator in the 1850s and 1860s. When farmers ceased to transport grain in sacks and shipped it instead in a pourable stream, a "Golden Shower," via railroads, ships, and grain elevators, wheat became an abstract commodity, detached from its producers' identity and control. As wheat from different farms flowed together in the grain elevators, it was first graded, and then mixed for the profit of elevator operators, who could move the physical partitions between elevator bins. In this way the elevator stood between the growing of wheat and the economic return to the growers. With the advent of new storage and transport technologies, wheat prices became subject to speculation; the Chicago futures market grew around this concept in the 1860s. Grain began to function as a kind of money, and the willingness of remote capitalists to invest in such a "currency" had a direct bearing on the fortunes and plans of wheat farmers.

Notions of market control, economies of scale, and economic opportunity spurred the proliferation of the grain elevator, and, ironically, in achieving their mature form over the decades, those notions made many small-town elevators and small farms obsolete. Gohlke's images do not recount this part of the grain elevator's history, which would be admissable except that his agenda (as presented in his introductory essay and implied by Hudson's essay) purports to give a comprehensive or essential picture of the structure. The burden would seem to fall on Hudson's essay, but unfortunately, that too fails to convey the cultural shifts surrounding industrial technologies (the essay's many fascinating but disjointed facts notwithstanding). It may be that the task of combining expressive imagery and factual "scientific" information brings with it the problem of one narrative mode making the other appear to be missing something. Perhaps in his genuine enthusiasm for this rich, dual-faceted way of looking at the built world, Gohlke resisted the idea of qualifying his goal. Certainly further experimentation with this hybrid of representational genres is called for, and one hopes that Gohlke will continue his effort.

The biggest problem with *Measure of Emptiness* is not the images themselves or Gohlke's basic interest in combining poetic renderings and their factual basis in a single book, but his promise to provide a definitive historical view of the grain elevator. His images offer us only one aspect of the ecological life of the grain elevator—that "obtained through the windshield of a car"—but it is an important aspect nonetheless. His perspective accurately reflects the increasingly abstracted relationship that most Americans have with the sources of their food, and to the land and people that produce it. Gohlke's huge, silent grain elevators are emblematic of the changing position of the farm and farmer in America, and if his photographs make people pause to consider the passing of an American enterprise, that is no small accomplishment.

Tinged with Gold: Hop Culture in the United States also puts the design of agricultural buildings in its broadest context, providing a compendium of social, economic, and technical activities that have surrounded the growing of hops in this country. The American hops industry grew most rapidly between the mid-19th century and the start of Prohibition, and author Michael Tomlan illuminates the evolution of hop houses (in which hops were dried by heating, cooled, and stored) in this period, correcting the idea that these buildings were "manifestations of some folk tradition." Instead, he proposes that the design of hop kilns and barns (often

Grain elevator, Wellington, Kansas. (From *Measure of Emptiness*.)

a single structure) were "the result of carefully calculated commercial motives."

The text and several period photographs reveal that these motives had much to do with relations between growers (almost always white men) and pickers (first women who lived at home while picking, then Native Americans and Chinese itinerant workers). Conceptions of gender and race determined which group would be the "preferred" (read: the most cost-effective) pool of workers at any given time, and what services and amenities growers would offer their pickers. The perspectives of the pickers are also presented, as are detailed descriptions of the nature of work on the hop farm. Precise discussion of the construction of hop houses is confined to a final chapter that reads more like conventional (although thorough) architectural preservation literature, with descriptions of buildings, construction methods, and the geographical incidence of different designs.

Tomlan's book is a fine model for writing historic preservation studies and the history of architecture in general, providing a range of ideas about the sources of technological change. In a way that might appeal to Gohlke, *Tinged with Gold* is rich in details that connect practical decisions to social agendas. For example, when hop growers found it economically advisable to become wholesale handlers of their own wares, it was partly because they could rely on family connections to provide information from distant markets. Tomlan also details the mechanization of hop growing: automated picking machinery was designed to fit existing vine trellis systems, indicating that in technological progress, some elements of a process may yield to change before others.

He also describes the human culture of the hop business. For example, the pickers' choice to work for hop growers is shown to have had many causes. Young women enjoyed the chance to leave behind domestic chores while earning money. When Native American pickers gathered at farms for their seasonal employment, they brought along baskets and other craftwork to sell to tourists who came to witness the spectacle of itinerant work camps. Some families approached hop-picking season as a chance for a paid vacation in the country. Tomlan reminds readers that throughout its evolution, the labor of picking hops was divided among women, men, children, and workers of different races according to prevailing notions of strength and agility. The nature of work is foremost in Tomlan's story. We learn how the workers shuffled through drying hops in a kind of dance to stir them up, and how at one point, the favored method for pressing the dried crop was to drop a man over and over again into a suspended bag of hops.

Tomlan intended the book to be encyclopedic, although he admits in the conclusion that many important general themes of the hop culture story are better left to social historians. Nevertheless, I cannot help wishing that he had considered a greater portion of his material from a longer perspective. He knows the subject thoroughly, and it is clear that hops offer an excellent case study of the changing nature of agriculture, and even mass production, in this period. For example, many nonfarming professions seem to have contributed to the transition of hop growing from a small-scale commercial enterprise to an "agribusiness." The book is filled with examples of advertisements from a long list of growers' journals, and tidbits about agricultural legislation and insurance, all of which suggest heterogeneous commercial forces in America's trend toward large-scale agriculture. Similarly, the point at which architects and engineers became involved in the design of hop-processing plants in the early 20th century coincided with their booming professional involvement in many other fields: Tomlan's data suggests that their presence could have been not merely an effect but also a cause of expanding agricultural operations.

The fact that Washington state and other regions so carefully documented their hops industries with photographs of facilities and workers is intriguing, as is the level of detail with which a sociologist studied hop pickers' camps in 1907. Like the presence of tourists at the workers' camps, these events point to some public identity, or identities, for the hops industry. Did this public attention shape the growth of the industry in some way?

Several relevant questions arise about the connection between vernacular architecture and social conditions. Could farmers have learned about each other's building practices without growers' journals and machinery salesmen? What did it mean for farmers to invest capital in new buildings? Tomlan often mentions experimentation as a source of architectural form. What made hop growers willing to experiment—an excess of capital, or a shortage of it?

If Tomlan had addressed such questions, he could have shed light on such important aspects of vernacular architecture as how design influences work or how tastes spread. Hops captured the imagination of many Americans, and this book could have been an opportunity to understand just what makes a cultural or economic craze. Tomlan's impulse to learn about social relations from architecture, to "let every structure present its story," is admirable. He comes tantalizingly close to his goal.

MEASURE OF EMPTINESS: GRAIN ELEVATORS IN THE AMERICAN LANDSCAPE, Frank Gohlke, with essay by John C. Hudson, Johns Hopkins University Press, 1992, 108 pp., illus., $29.95.

TINGED WITH GOLD: HOP CULTURE IN THE UNITED STATES, Michael A. Tomlan, University of Georgia Press, 1992, 273 pp., illus., $35.00.

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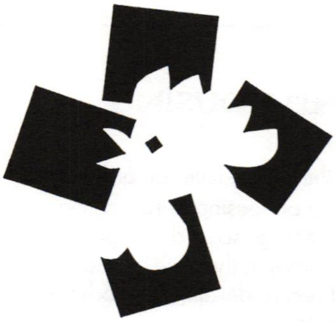


Design, Form, and Chaos

Paul Rand

"To have the preeminent graphic designer in America—the leading proponent of the Modern—intelligently and forcefully speak out makes this a document for today and the ages. Rand's book is a classic." —Steven Heller 64 b\w + 60 color illus. $45.00

"The English Journey"

Journal of a Visit to France and Britain in 1826

Karl Friedrich Schinkel
Edited by David Bindman and Gottfried Riemann

In 1826 the great German architect Friedrich Schinkel traveled to England and Scotland, visiting not only the usual tourist attractions but also the factories, bridges, and warehouses that were under construction at the time. This book contains the first complete translation into English of Schinkel's journal, the drawings he made while he was traveling, and a full introduction and explanatory notes. 220 illus. $45.00

Published for the Paul Mellon Centre for Studies in British Art

Redesigning the American Lawn

A Search for Environmental Harmony

F. Herbert Bormann, Diana Balmori, and Gordon T. Geballe
Lisa Vernegaard, Editor-Researcher

"It's about time someone examined the effects—environmental, medical, and aesthetic—of our odd addiction to manicured greensward. The freedom lawn described herein is a great step forward; one hopes the authors will turn their attention to golf courses next."—Bill McKibben 38 b/w + 10 color illus. $19.95

Theoretical Perspectives in Architectural History and Criticism
Mark Rakatansky, editor

Architecture and the Text

The (S)crypts of Joyce and Piranesi

Jennifer Bloomer

This profoundly original book addresses important philosophical questions concerning the relation between writing and architecture. Drawing together two cultural fantasies from different periods—one literary and one architectural—Bloomer uses the allegorical strategies she finds in James Joyce's *Finnegans Wake* to analyze three works of Giambattista Piranesi. 16 illus. $30.00

Architecture and Nihilism

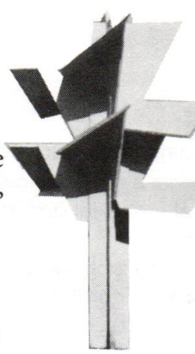
On the Philosophy of Modern Architecture

Massimo Cacciari
Translated by Stephen Sartarelli
Introduction by Patrizia Lombardo

This book introduces the writings of one of the most influential social philosophers in Italy today to an English-speaking audience. Massimo Cacciari studies the relation between philosophy and modern architecture and applies the thinking of avant-garde architects, artists, and writers to the social and political problems raised by technological society.
45 illus. $35.00

The Modernist Garden in France

Dorothée Imbert



Garden with Concrete Trees, Robert Mallet-Stevens, Jan and Joël Martel

The modernist garden, which flourished in France between the 1910s and the 1930s, mirrored the geometries and cubist aesthetics familiar to the decorative and fine arts of the period. This handsomely illustrated book presents for the first time–in word and image—a comprehensive study of these arresting architectonic gardens. 272 b/w + 18 color illus. $50.00

New in Paper

Constructing Chicago

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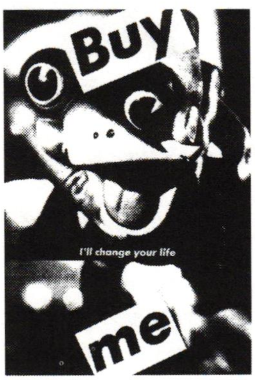

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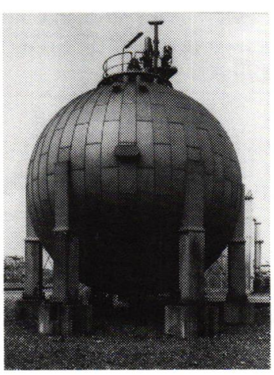

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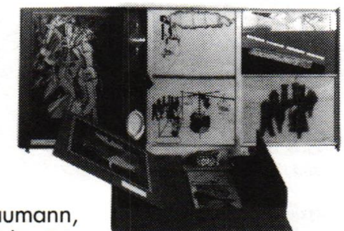

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