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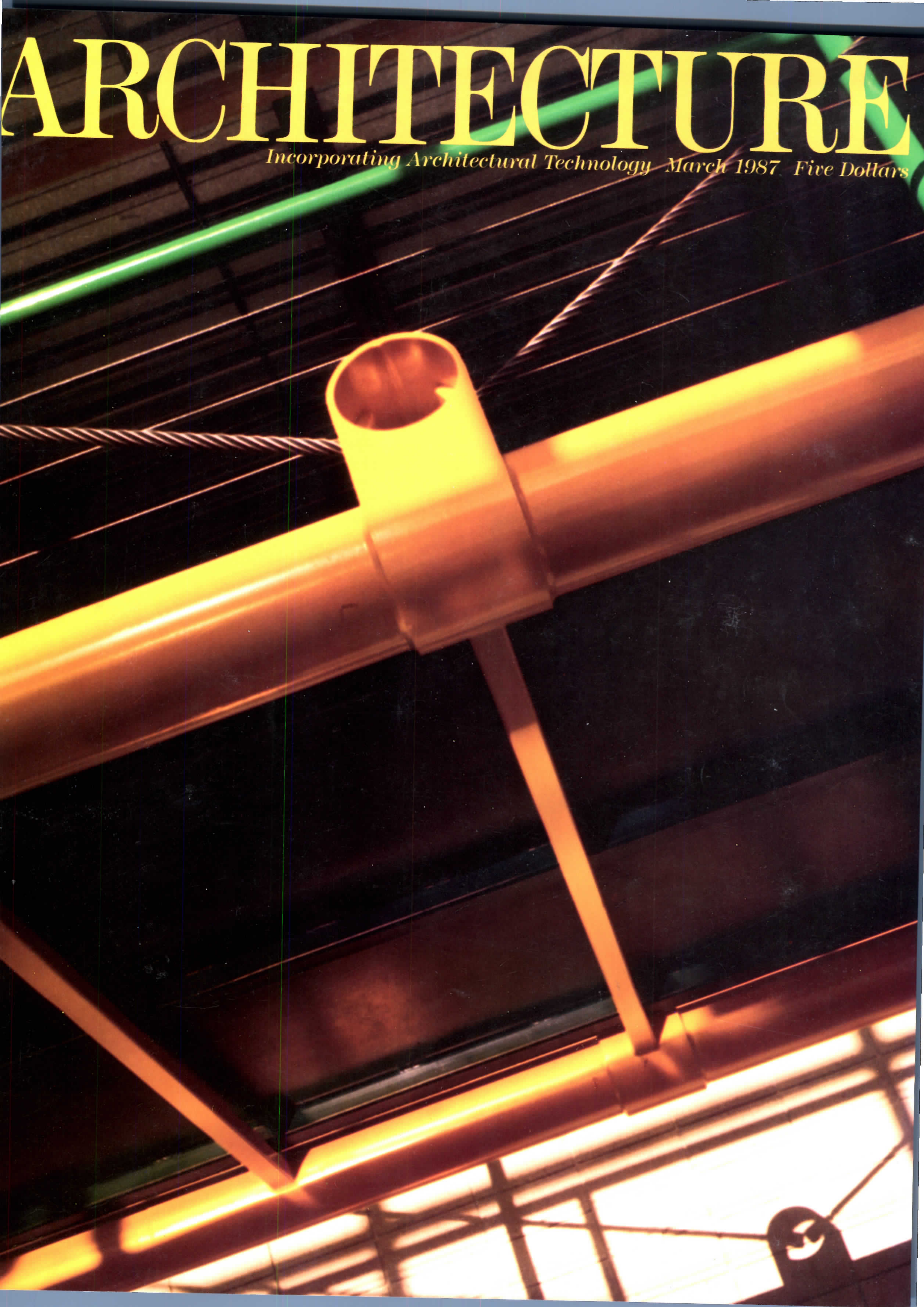

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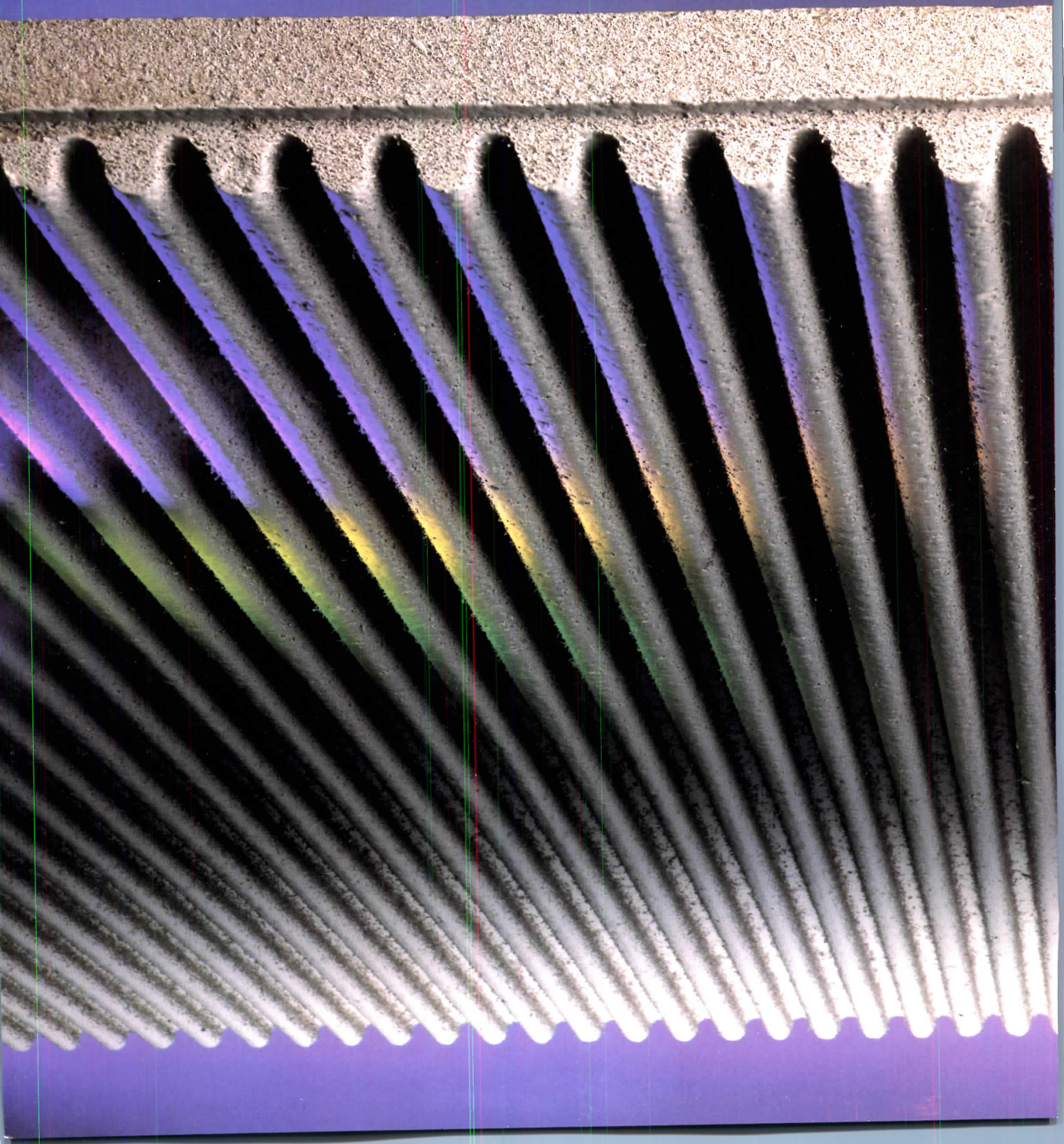


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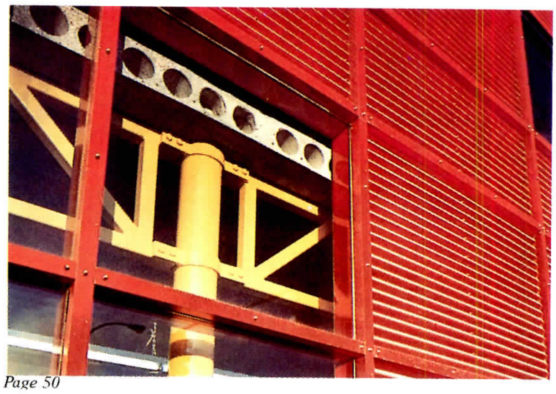

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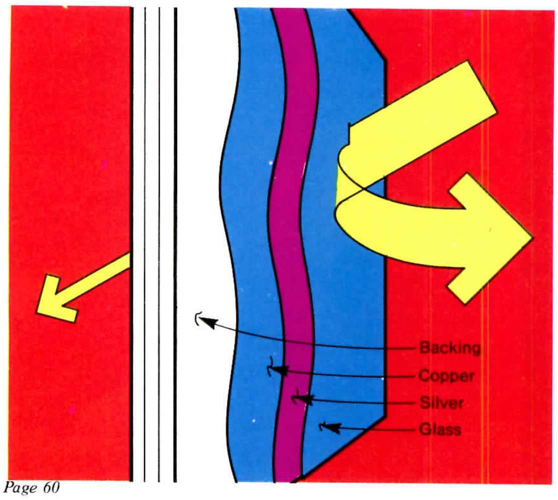

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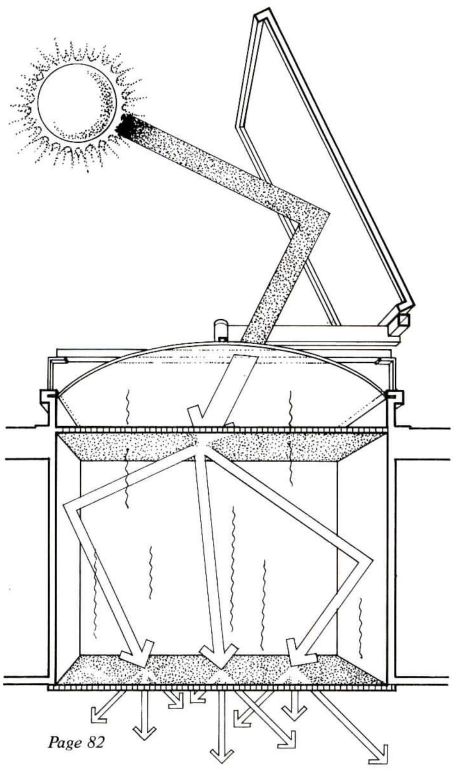

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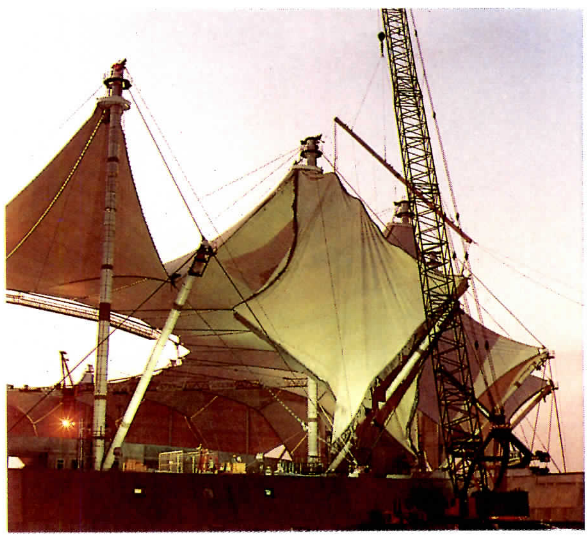
Cover
Provincial Center in Flin Flon, Manitoba, Canada, by the IKOY Partnership (see page 50). Photograph by Gerry Kopelow.



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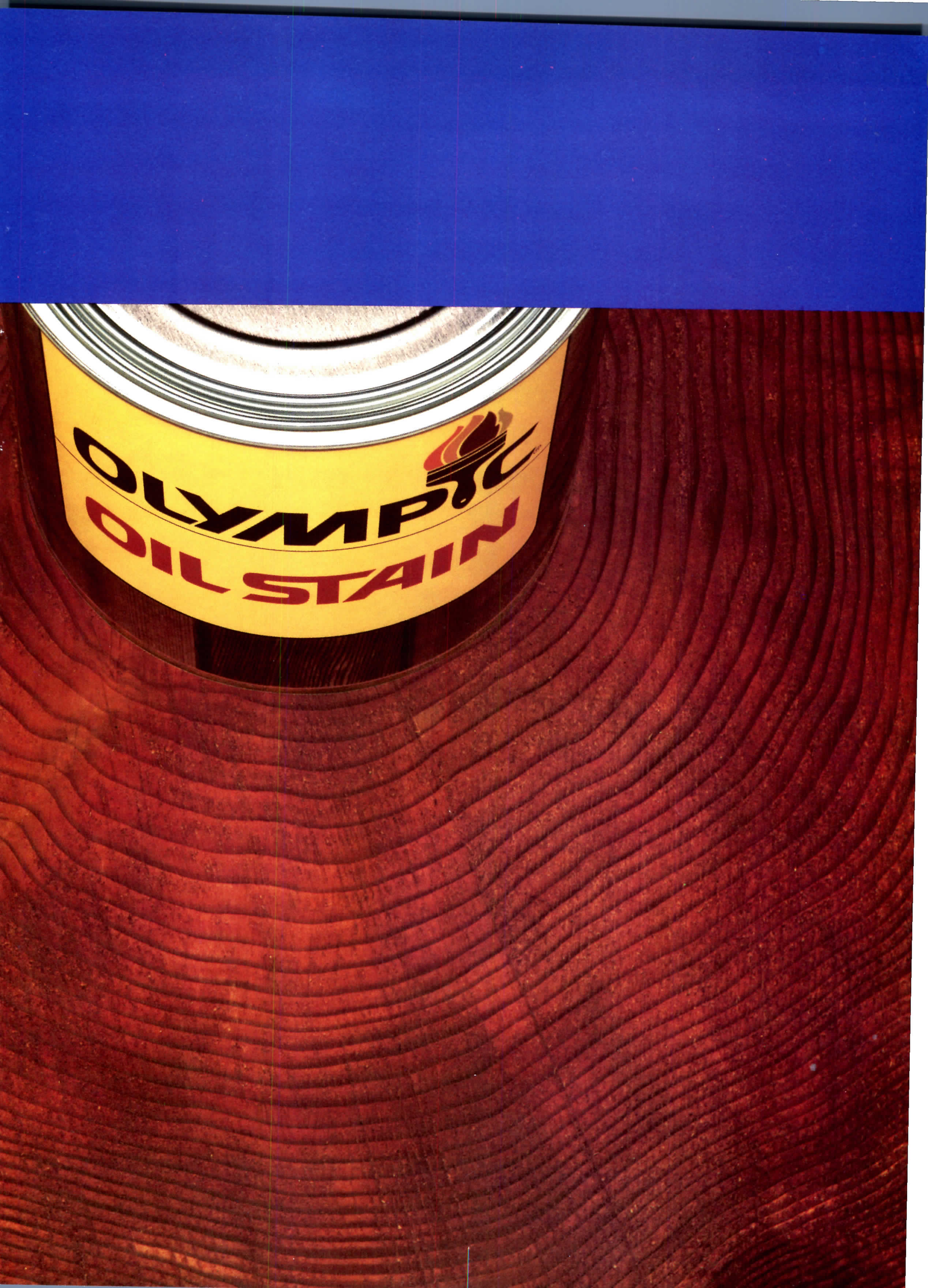
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EVENTS

Apr. 1-3: Seminar on Engineering Economics, Madison, Wis. Contact: Rolf T. Killingstad, Dept. of Engineering Professional Development, University of Wisconsin-Madison, 432 North Lake St., Madison, Wis. 53706.
Apr. 6: Lecture by Charles D. Breitel on New York City Landmarks Preservation Law, Columbia University, New York City. Contact: Michael Kwartler, Historic Preservation Program, Graduate School of Architecture Planning and Preservation, Avery Hall, Columbia University, New York, N.Y. 10027.
Apr. 6-10: Course on the Application of Infra-Red Scanners to Detect Building Energy Losses and Roof Moisture, Burlington, Vt. Contact: Paul Grover, Infraspection Institute, Box 2643, Juniper Ridge, Shelburne, Vt. 05482.
Apr. 9-10: AIA Housing Committee Seminar on the Architect as Developer, Washington, D.C. Contact: Ravi Waldon at Institute headquarters, (202) 626-7429.
Apr. 9-12: Conference entitled "The Wright People," a Study of the Relations of Frank Lloyd Wright with his Clients, Ann Arbor, Mich. Contact: University of Michigan, Conference Dept., 200 Hill St., Ann Arbor, Mich. 48104.
Apr. 10-12: Monterey Design Conference, "People and Architecture: Is Anyone in There?" Contact: Simone Ramel, CC/AIA, 1303 J St., Suite 300, Sacramento, Calif. 95814.
Apr. 11-July 20: *Die Revision Der Moderne: Postmodern Architecture 1960-1980,* drawings, paintings, and models, Williamstown, Mass. Contact: Zelda Stern, Williams College Museum of Art, Main St., Williamstown, Mass. 01267.
Apr. 14-17: Course on Practices and Procedures in Asbestos Abatement, Denver. Contact: RMCOEH/CE, Registration Coordinator, University of Utah, Bldg. 512, Salt Lake City, Utah 84112.
Apr. 16-17: Annual Conference of the National Roofing Contractors Association, Gaithersburg, Md. Contact: Bennett Pistoria, NRCA, 1 O'Hare Center, 6250 River Road, Rosemont, Ill. 60018.
Apr. 17-July 26: American Art Deco, an exhibition of 180 works of glass, textiles, sculptures, furniture, and silver, Smithsonian Institution, Washington, D.C. Contact: Margery Byers, Office of Public Affairs, Smithsonian Institution, Washington, D.C. 20560.
Apr. 21: Seminar on Emerging Technologies and New Products, Chicago. (Repeat seminar Apr. 23, Boston.) Contact: Bob Popovic, Predicasts Seminar Dept., 11001 Cedar Ave., Cleveland, Ohio 44106.
Apr. 23-24: AIA Building Performance and Regulations Conference, Washington, D.C. Contact: Dave Bullen at Institute headquarters, (202) 626-7448.
Apr. 25-26: Seminar on Corrosion of Artistic Works and Historic Structures, Cambridge, Mass. Contact: Technology & Conservation, 1 Emerson Place, Boston, Mass. 02114.
Apr. 25-26: Seminar on the Contemporary Development of Baroque Influences in Architecture, Music, and Art, San Francisco. Contact. Carolyn Walker Davis, San Francisco Architectural Club, P.O. Box 5688, San Francisco, Calif. 94101.
Apr. 25-29: American Planning Association National Planning Conference, New York City. Contact: Vicki Groat, APA, 1313 E. 60th St., Chicago, Ill. 60637.
Apr. 26-28: AIA Committee on Design Conference on Examining the Impact of Technology and Architectural Detailing in Design, Chicago. Contact: Ravi Waldon at Institute headquarters, (202) 626-7429.
Apr. 29: Symposium on Building Performance and Indoor Environmental Quality: Professional Responsibilities and Liabilities, Vancouver, British Columbia. Contact: Dr. Ray Cole, School of Architecture, University of British Columbia, 6333 Memorial Road, Vancouver B.C. V6T 1W5.
June 19-22: AIA Annual Convention, Orlando, Fla. Contact: John Gaillard at Institute headquarters, (202) 626-7397.

LETTERS

Architecture for Health Care: The [January] issue on health represents another typically excellent and useful piece of journalism. It gives us a wide range of very well presented coverage on building types that we encounter in day-to-day life. Major planning issues are covered. The projects portrayed are successful and ambitious without being so idiosyncratic that they do not inform us of practical possibilities. It is a remarkable achievement.

I do want to assure you, however, that I am not an FAIA. I certainly hope that I have never given anybody that impression. I am old enough but not smart enough. *Herbert McLaughlin, AIA*
San Francisco

Health Care Design: It is rewarding to see the progress architects have made in the quality of health care design over the last 10 years.

We are pleased to be in such distinguished company in your January issue. It is heartening that Architecture and the profession are recognizing the health care building type with such fine coverage.
Julia Thomas
Michael Bobrow, AIA
Los Angeles

Preservation Technology: The group of articles on rehabilitation and preservation in your November 1986 issue prompts three responses.

First, Valerie Sivinski, in "Preserving Historic Materials: Ferrous Metals" (page 108), misrepresents the nature of concrete and its interaction with metals when she states that "hollow iron objects should never be filled with concrete since concrete retains moisture and contains corrosion-inducing salts." Good quality concrete is relatively impermeable. It can be saturated; however, if it is not surrounded by a material that prevents ventilation, it will quickly dry, at least to the extent permitted by ambient air conditions. Especially when fresh (plastic) and in its early hardened life, concrete is a very alkaline material that effectively prevents corrosion of metals. This alkalinity is lost through carbonation over many years, but if the concrete is of good quality and integrity it will continue to protect covered or embedded metals from free oxygen and moisture, the two necessary constituents for most corrosion. I do not mean to defend the filling of hollow metal objects; they should be drained and vented. However, the culprit is not concrete per se.

Second, as a member of the American Concrete Institute's Committee (364) on Rehabilitation, I was distressed that the group of articles did not directly address concrete. Certainly its structural and architectural application in older buildings is widespread.

Our own practice has involved the evaluation and design of repairs for many concrete structures. This work is at least as technically demanding as the rehabilitation of wood, clay masonry, stone, and iron or steel. ACI is directly addressing the rehabilitation of concrete through the work of its technical committees (such as Committee 364), the distribution of special publications, and the sponsorship of regular regional seminars. In addition, ACI has begun to address the next generation of rehabilitation by its focus on the im-
continued on page 12

Corrections: In our December issue, the interior views of the Franciscan friary shown on page 71 should have been credited to photographer Robert Lautman. The captions for two of the photographs in the article "The Unique Hilltowns of France" (page 78) were transposed. The photograph on page 85 was the fortified village of Perouges, and Gordes was shown on the top of page 84.

In January, photographs of the Cleveland Clinic on page 49 were taken by Timothy Hursley/The Arkansas Office. The photographer for the Tacoma Area Center for Individuals with Disabilities (page 71) is Gayle Rieber, and photographs of the Wheeling Senior Center (page 76) were taken by Howard N. Kaplan.

Amplification: For Fountain Plaza at the base of Allied Bank Tower in Dallas (Dec., page 44), WET Enterprises Inc., of Burbank, Calif., designed and engineered the water features. The Fountain Place credits on page 142 should have listed as manufacturers whose products are incorporated in the installation: Kim Lighting, Berkley & Weinman, Fluid Filtration System, WET Labs, Victaulic, and Neoguard.

Landico Inc., Minneapolis

Letters *from page 10*
provement of concrete durability.

Third, with genuine deference to Hugh C. Miller's credentials, accomplishments, and long service, I found his analogy of design professionals to health care professionals ("A Health Maintenance Program for Older Buildings," page 96) one step beyond credibility. I sincerely believe that the exercises, studies, and understanding of "organic" architectural design make real contributions to the quality of our built environment. However, the philosophy of evaluation that regards buildings and their occupation as an organic process carries superficial functional similarities to a confusing extreme. Moreover, I will vehemently argue against the "mystique" that Mr. Miller subliminally suggests in his description of evaluation and rehabilitation. Such work is demonstrably dirty, frequently frustrating, and mandatorily methodical. I am not trying to strike a balance by suggesting the other extreme. I will be the first to declare that rehabilitation projects are richly rewarding. My point is simply that, as with most endeavors, the effort is comprised of 90 percent perspiration and 10 percent (or less) inspiration.

Finally, so not to appear too much of an engineering curmudgeon, I agree fully with Mr. Miller's call for design professionals to be the leaders in the service of timely (better yet, preventive) building maintenance. *Michael Johannes Paul*
AIA Associate Member
Wilmington, Del.

Valerie Sivinski responds: While much of what Mr. Paul says about concrete is true, there are several factors that make filling hollow metal objects with concrete unsuitable. First, filling a hollow object, such as a column, with concrete is not the same as embedding a solid object, such as rebar, in concrete. It is difficult to install and verify a good quality pour in an existing, installed component.

Second, many concretes shrink as they dry, opening up a space between the metal object and the concrete core. The metal skin is relatively impermeable, and water, finding its way into the object through cracks and joints, is the driving force of the corrosion process. It is not always possible to drain and vent this narrow space, due to the surface tension of water. Not only can trapped water result in saturation of the concrete and corrosion of the interior of the metal object, but expansion of the water in freeze/thaw cycles can crack this relatively brittle metal.

Third, concrete inside a metal object is extremely difficult to remove without dismantling and causing damage to the object, if and when the concrete is subsequently found to be causing problems. It is best not to create potential future problems for the hollow, ferrous metal objects that we are trying to preserve. □

The Institute

ACSA/AIA Honors Ralph Rapson For Excellence in Education

Ralph Rapson, FAIA, head of the school of architecture and landscape architecture at the University of Minnesota from 1954-84, is this year's recipient of the Topez medal for excellence in architectural education, presented by the Association of Collegiate Schools of Architecture and AIA.

On selecting Rapson, the jury wrote, "The many brilliant students who graduated under his mentorship, going on to the finest graduate schools and then to distinguished architectural careers in their own name are testimony to Dean Rapson's compelling capabilities. He raised the perception of his school to that of international recognition, and through the vehicle of his architectural practice was seen to be a paradigm par excellence."

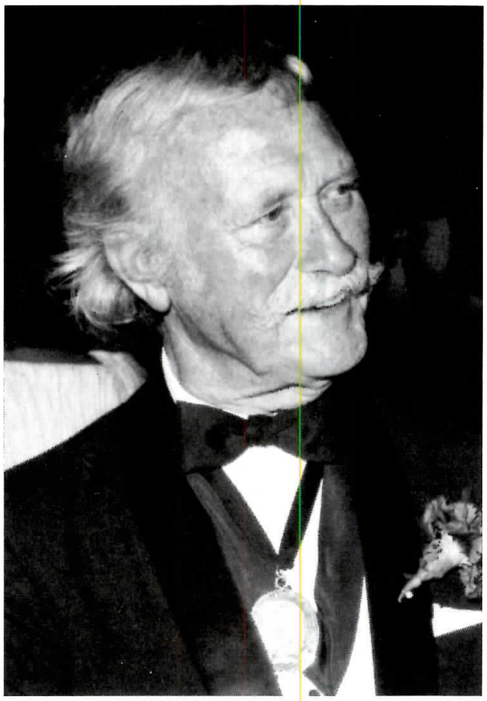
Rapson was born in Alma, Mich., in 1914 and graduated with a B. Arch. from the University of Michigan in 1938 before studying urban and regional planning under Eliel Saarinen during the golden years of Cranbrook Academy. His fellow students there included Eero Saarinen, Harry Weese, FAIA, and Charles Eames.

Rapson said that during his two years Cranbrook was a thriving environment—not exactly a school in the sense of classes and curriculum, but a place where young people came to work with talented masters.

Only later did Rapson fully realize the significance of his experiences at Cranbrook. "At the time, a lot of us thought of Pappy Saarinen as a little old-hat. It wasn't until I had left Cranbrook that I came to fully appreciate the elder Saarinen and his superb campus design and the dynamic environment with the collaboration between architecture, planning, landscape architecture, and the arts," he says.

From 1942-46, Rapson taught at the architecture department of the Institute of Design in Chicago alongside Lazlo Moholy-Nagy. Rapson also acknowledged Moholy-Nagy as a great influence. "Ideas just flowed out of him," Rapson recalled. "He bubbled constantly with 90 percent nonsense and 10 percent real significant ideas."

During his years in Chicago, Rapson also became acquainted with Mies, whose approach to both education and practice was very different from Moholy-Nagy.



"Although they had both come out of the Bauhaus, the two were not compatible at all and sparks would fly when they were together," he says.

After Chicago, Rapson joined the faculty at MIT, where he taught with Walter Gropius, Marcel Breuer, Alvar Aalto, and Pietro Belluschi, FAIA. In a speech at the presentation of the Minnesota Society's gold medal in 1979, Belluschi praised Rapson's accomplishments as a person, architect, artist, and educator. Belluschi also recalled some of the more lighthearted experiences with Rapson at MIT in the early '50s. "What I remember most vividly now is the perplexing occasion, soon after my arrival in Cambridge, when Ralph, with the help of other unnamed conspirators, succeeded in pressing my footprints soaked in bright red paint on the ceiling of his Cambridge apartment—a shattering experience, that of being lifted head down and wondering what kind of world was I getting into. I felt better when I found that Aalto's footprints were also on that ceiling, as well as Gropius's, Bucky Fuller's, and many other more notable people than myself. I am still wondering what happened to that landmark."

At the age of 40, Rapson was named head of the school of architecture and landscape architecture at the University of Minneosta. That same year, 1954, he formed his practice, Ralph Rapson & Associates, in Minneapolis, a consistent winner of design awards. During the 30 years he headed the school, Rapson maintained an active practice and served as a visiting professor or critic at more than 50 universities, including Princeton and the University of Virginia.

Rapson maintains the importance of finding a compromise between the reality of architecture and the theory of architecture. Unlike some schools of architecture, the University of Minnesota has maintained a diverse faculty with a balance of academics and practitioners.

Over the years, the school has had a very consistent faculty with visiting teachers but by and large a stable of eight or 10 professors teaching the advanced courses. "Although we were constantly bringing in younger and new people, our school had a continuity," Rapson says, "But some people may argue whether that is good or bad."

Rapson has continuously stressed the importance of a twofold process in the formal education of an architect—developing both a mature philosophy and the technical knowledge to achieve the coordinated whole product.

During his career as an educator, Rapson has witnessed changes in emphasis and amount of information available in a variety of subjects. In his opinion, however, the basic process and fundamentals of education have not changed. Rapson believes what you teach is not as important as how you teach it. "I have always emphasized the basics relative to the process of obtaining information and knowledge, while remembering that everyone responds differently," he said.

Rapson's nominators called him a "teacher of teachers." Thirteen of his former students have headed or now are heading architecture programs: these include Robert L. Bliss, FAIA, University of Utah; Norman Day, University of Pennsylvania; Bernard P. Spring, FAIA, City College of New York and Boston Architectural Center; and Michael Gelick, University of Illinois, Chicago.

In a letter of support, Leonard S. Parker, FAIA, who was first a student and later a colleague of Rapson, wrote, "He has that rare combination so critical to effective teaching—a complete understanding of and enthusiasm for his subject, combined with the ability to articulate and communicate ideas effectively. Ralph is also a 'gentle'

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The Institute *from page 17*
teacher in the finest sense. . . . His unique ability to criticize student efforts without destroying student confidence was appreciated by those exposed to his teaching."

William Huntress, a graduate thesis student under Rapson in 1980, wrote in support of the award that one of Rapson's highest achievements as head of the school was his "commitment to a process and faculty that encourages students to approach problems in a rational, disciplined manner, while retaining the creative freedom to deal with the art of architecture."

The award jury was comprised of Stanley Tigerman, FAIA, (chairman); Franklin K. Mooney, AIA; Wilmot G. Gilland, AIA; John De Monchaux; and Scott Norberg.—LYNN NESMITH

AIA Institute Honors to Ten for 'Distinguished Achievements'

AIA has announced 10 recipients of 1987 Institute honors recognizing "distinguished achievements that enhance or influence the environment and the architectural profession." The honors will be conferred in June at AIA's annual convention in Orlando, Fla.

Lewis Davis, FAIA, of New York City, chaired the awards jury. Members of the jury included Reyner Banham, professor of architectural history, University of California, Santa Cruz; Donald Canty, Hon. AIA, editor in chief, ARCHITECTURE; Mark Simon, AIA, of Centerbrook Architects, Essex, Conn.; Adrienne Smith, FAIA, of Skidmore, Owings & Merrill/Chicago; Woodward Williams, Associate AIA, of Columbia, S.C.; and Jeffrey Owens, an architecture student at Auburn University.

The honors recipients are:

• James S. Ackerman, professor of fine arts, Harvard University, cited for expanding the public's appreciation of architecture. Ackerman has been writing about the parallels between modern and Renaissance architecture since 1950 as editor in chief of *The Art Bulletin* and author of several books, including *The Architecture of Michelangelo.* Also among his achievements are several films, including "Palladio the Architect and His Influence in America."

"Not only is he a scholar of the past but Ackerman is also a scholar of contemporary issues that plague modern architects," said his nominators. The jury called Ackerman's books "beautifully written studies of the architecture at that time, a happy combination of fresh vision and profound learning."

Ackerman has taught at Harvard for 25 years and has been named to the council of scholars of the Library of Congress. In 1986 he was a Mellon lecturer at the National Gallery of Art.

• Jennifer Bartlett, a New York City artist cited for her works that fuse art with architecture, particularly in five major commissions: "Swimmers Atlanta" for the Richard B. Russell Federal Building, Atlanta; "In the Garden" for the Institute for Scientific Research, Philadelphia; "The Garden" for the Saatchi home, London; "Pacific Ocean" and "Atlantic Ocean" for the AT&T Building, New York City; and several works at the Volvo Headquarters, Göteborg, Sweden. Her work is represented in museums across the U.S.

Bartlett also has published several books, and a major retrospective exhibition of her work opened at the Walker Art Center in 1985. "Bartlett's interest in different artistic media, modular and multiple images, environmental and landscape themes, and extensions of art beyond itself and its boundaries points to a direction where the relationship of architecture to its environment can be enhanced through works of art," said her nominators.

"Her ideas are relentlessly visual, artistic, and urban. Her spirit as well contributes to a standard of professionalism with which all architects can align," said the jury.

• Steven Brooke, architectural photographer, of Miami. Three times Brooke has been named photographer of the year by the Florida Association/AIA. Brooke also is involved in education and historic preservation, his most recent published work being *Vizcaya Museum and Gardens.*

Brooke has photographed architecture, historical and modern, all over the world—"all with the same mastery. His extraordinary eye and skill with photographic equipment have recorded all the elements of architecture, whether small or large, to make them noble for posterity," said the jury.

According to the jury, "His photographs have an extraordinary sense of composition, color, and texture; and though they are dedicated to architecture, they are more often than not works of art themselves."

"He knows that good architecture is a gift to us all, and by capturing it on film, he can ensure that we all can partake of it," said Beth Dunlop, architecture critic for the Miami *Herald.*

Detail photograph by Steven Brooke of the Miami Beach Community Center; restoration by Zyscovich-Grafton Architects.

• The Chicago Architecture Foundation, cited for "20 years of dedication to increasing the public awareness, understanding, and enjoyment of Chicago's architectural heritage."

The foundation was established in 1966 in an effort to save H. H. Richardson's Glessner house, which had been designated as Chicago's first national landmark. In 1971 the foundation initiated a crusade to enlighten the public about historical Chicago in order to protect the city's architectural heritage. A permanent result of this campaign is the Chicago ArchiCenter, an information center with exhibition galleries and lecture halls as well as a museum store devoted to the built environment. "The ArchiCenter makes the enjoyment of architecture accessible to everyone," said the jury.

The foundation operates two house/museums, the Glessner house and the Henry B. Clarke house, and is involved in other civic and cultural organizations and activities ranging from the development of the Prairie Avenue Historic District to the training of docents for the "150 Years of Chicago Architecture" exhibit at Chicago's Museum of Science and Industry. "The foundation has led the way for similar institutions with its wide variety of educational programs and dedication to the architectural heritage of Chicago," said the jury.

• The New York City architectural lighting design firm Jules Fisher & Paul Marantz Inc., cited for "their understanding of and sensitive approach to light as an architectural material and a surrogate of habitation that supports the idea of architectural space and the variety of human activities it contains, as well as for their ability to apply their skill in dealing with light in a practical and economical, yet creative and artistic manner."

Fisher is also active as a designer for many Broadway theaters. His designs have won numerous awards including a Tony for the production "Dancin'" and the design in steel award for his work on the California Institute of the Arts Modular Theater.

Marantz approaches his lighting designs with a multidisciplinary background in architecture, architectural history, and industrial designs. Marantz, like Fisher, has been recognized through a number of awards, among them Illuminating Engineering Society citations for both the Denver Symphony Hall and the Palladium Discoteque in New York City.

In 1978 the firm worked with Hardy Holtzman Pfeiffer & Associates on the

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Cliff Palace Ruin, Mesa Verde National Park, Colorado, 1942. Photograph by Ansel Adams. Courtesy of the Trustees of the Ansel Adams Publishing Rights Trust. All Rights Reserved.

The Anasazi ruins of the Mesa Verde National Park in southwestern Colorado.

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renovation of Cass Gilbert's St. Louis Museum of Art, which combines daylight and electric light to illuminate the galleries. Other buildings that incorporate the firm's lighting designs are the Boston Museum of Fine Arts, Procter and Gamble headquarters in Cincinnati, and the Dallas Museum of Fine Arts.

• Mesa Verde National Park, a cultural park established by President Theodore Roosevelt, cited for its outstanding effort in the preservation of the Anasazi ruins in southwestern Colorado. The award honors both the park organization and the Anasazi, the "Ancient Ones" in Navajo, who built the cliff dwellings.

In 1981 a symposium was held at the site, focusing on the Anasazi people, seeking an understanding and preservation of the Anasazi remains. The Anasazi ruins provide "a full picture of the development of an architectural form from its simplest beginnings to its most complex stages," said the nominators. "These Anasazi cliff dwellings, completed before 1300, are among the oldest and noblest monumental masonry structures in the U.S. and were described by Vincent Scully as America's only native school of urbanism," said the jury. The jury also honored "the National Park Service team, who, over a period of decades, have labored to preserve and maintain these ancient works and to make them available to the visiting public with dignity and respect to their spectacular landscape setting."

• Charles Guggenheim, president of Charles Guggenheim Productions, Washington, D.C., cited for "outstanding" film making in the area of public education. His films have been honored by the Academy Awards Association, among other groups; a number focus on architecture and its impact on the overall environment.

Two films in particular were noted for emphasis on technological accomplishments in design, engineering, and construction: "Monument to the Dream," reliving the building of Eero Saarinen's St. Louis Gateway Arch, and "A Place to Be," documenting the construction of the east building of the National Gallery of Art, designed by I.M. Pei & Partners.

Stated the jury, "It goes without saying that Charles Guggenheim is a master film maker—perhaps the contemporary master of the documentary. What we want to emphasize through this award is his continuing interest in architecture and design. Through his films he skillfully conveys the experience of architecture and the process by which it comes to be."

• Rizzoli International Publications Inc. in New York City, cited for its "outstanding" books, periodicals, and journals on architecture and related arts. Over the past decade Rizzoli has published almost 200 architectural books and more than 60 editions of architectural journals.

In 1974 Rizzoli International became financially independent of its parent company, which was located in Milan. Since 1980 Rizzoli has been publishing architecture- and art-related books independently of other European publishing houses.

"As critics have noted, in a very brief time Rizzoli has become a significant force in American architecture. With uncanny foresight, they select topics that inevitably become of special interest to architects just at the time of publication. In this way, they have led architects to educate themselves and have eased the way to architectural progress. Rizzoli selects

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The Institute *from page 24*

its subject matter without prejudice to any particular school of thought, and indeed has taken advantage of the wide range of current architectural theory. . . . The design of Rizzoli's architectural volumes is always exquisite. At the same time they allow the authors and architects they work with to influence everything from details of production to the look of a particular page," said the jury.

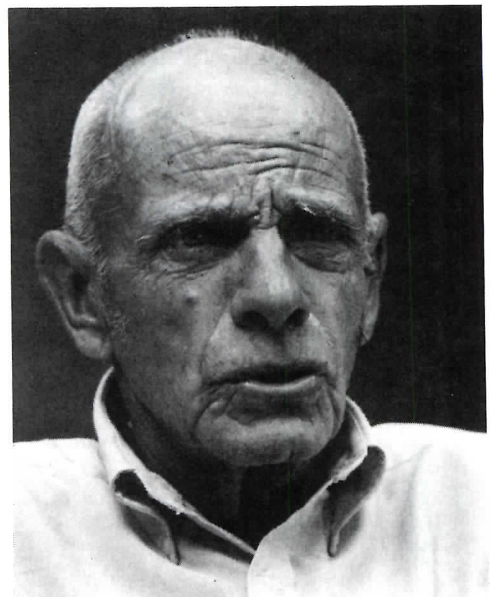
• Carter Wiseman, architecture critic for *New York* magazine, cited for his dedication to informing and educating the public on architecture and urban design."

In his column "Cityscapes" Wiseman has written about the architectural community. He has also published several books, including *Cities* and *Notable American Architects.*

According to the jury, Wiseman "has earned the respect of the architectural community for his willingness to knowledgeably discuss controversial issues even when presenting an unpopular point of view. Wiseman writes with clarity and verve about both architecture and urban affairs. He is not afraid to express an opinion but always backs it with facts. He is among the most reportorial of today's critics in his chosen fields."

• John Brinckerhoff Jackson (right), cultural geographer, author, and educator, cited for "his pre-eminent stature and unequalled influence as America's leading cultural geographer."

In 1951 Jackson founded *Landscape* magazine, where he remained for 17 years. Jackson's first book was published in 1970, and his best-known book, *Discovering the Vernacular Landscape,* was published in 1984. In it, Jackson stressed that "the



William Waldron

beauty we see in the vernacular landscape is the image of our common humanity," said the jury. In 1986 Jackson was a Cullinan visiting professor of fine arts, architecture, and urban planning at Rice University.

"His long and tireless campaign to direct sympathetic attention to the problems—and the often neglected virtues—of the common man-made environment has made him a great educator amd molder of public opinion. . . . As editor of *Landscape* magazine he made a transformation of attitude and modes of study. Into an area of design that had been dormant for decades he sent architects and scholars to look at 'dams and highways and trailer parks and even billboards' with renewed zest and understanding," said the jury.

—CATHERINE FULMER

Ms. Fulmer, a senior at Connecticut College, served as an intern in our editorial offices.

Seven Chosen to Receive AIA Honorary Membership

Six men and one woman have been selected to receive honorary AIA membership in recognition of their "outstanding service to the architectural profession and society as a whole." The seven honorary memberships will be presented in June during the Institute's annual convention in Orlando, Fla.

The honorees are:

• William A. Brown, supervisor of the United States Air Force architecture and engineering program worldwide, who implemented a new procurement system for A/E services for the Air Force and established a design awards program.

• Eric Englund, executive vice president of the Wisconsin Insurance Alliance and former executive director of the Wisconsin Society of Architects, who established a program to help government clients use a qualifications-based selection process for

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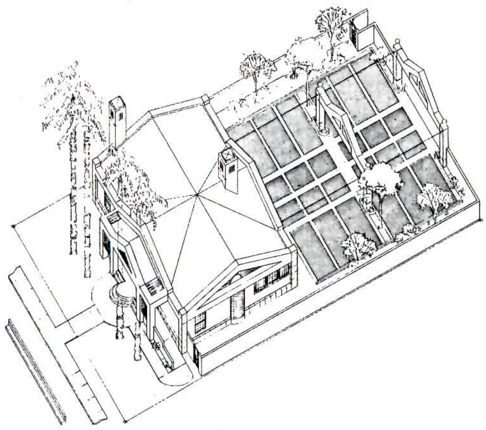
The Institute *from page 28*
A/E services and lobbied for state legislation regarding professional liability.
• Elizabeth Gordon, editor in chief of *House Beautiful* from 1941-65, a serious and literate advocate of quality in residential architecture.
• Frank Kacmarcik, urban designer, expert on ecclesiastical architecture, and former professor of art at St. John's University in Collegeville, Minn.
• Weiming Lu, executive director of the Lowertown Redevelopment Corporation in St. Paul (see July '86, page 56) and adjunct professor of urban design at the University of Minnesota.
• Joseph P. Riley Jr., mayor of Charleston, S.C., who has worked to preserve the city's architectural heritage while encouraging economic revitalization.
• Julius Shulman, pioneering architectural photographer, best known for his documentation of the development of contemporary architecture in southern California.

Jurors who selected the honorary members were Harry Harmon, FAIA (chair); James R. Nelson, FAIA; and Bernard B. Rothschild, FAIA.



Lawrence Enyart Architects of Phoenix was selected from among four finalists in a two-state design competition for a small office building in Phoenix to serve as the headquarters of the Central Arizona Chapter/AIA.

The competition, which drew a total of 31 entries, was sponsored by the local chapter and was open to local AIA-member architects and firms. The other finalists were Knoell Quidort Architecture & Planning Inc., Gary Nelson & Associates, and Douglas Frederickson of Cornoyer Hedrick.

Enyart's winning scheme (above) is a single-story building with a pitched shingled roof. A trussed gateway announces the main entrance, and the tiled central interior lobby running the length of the building has a gabled ceiling with a series of truss components incorporating neon lighting accents and hidden indirect lighting fixtures. Along the rear of the building, a covered porch with an outdoor fireplace faces a landscaped plaza—brick pavers used with exposed aggregate concrete detailing and truss gateways repeating the ceiling patterns.

Deaths

Arthur Drexler Remembered by Colleagues and Architects

The man most directly responsible for elevating architecture to a position of equality with the other visual arts, making its issues and controversies compelling points of intellectual inquiry, was Arthur Drexler. Until felled by illness and then death from pancreatic cancer Jan. 16, he had been curator and then director of architecture and design for 35 years at the Museum of Modern Art in New York City.

Drexler organized scores of "always controversial but always worthy exhibitions," in the words of former New York *Times* architecture columnist Ada Louise Huxtable, Hon. AIA. "The brilliant turns in architectural criticism were all led by the Modern," adds Philip Johnson, FAIA, who hired Drexler in 1951 as curator when Drexler was editor of *Interiors* (1948-50) after a short stint in George Nelson's office (1947-48). "I picked Arthur because of a brilliant piece he wrote on the Glass House," explains Johnson. "But he never liked my work, which helped him. Arthur was a free-thinking character, the opposite of academic, which was also very, very good. His interests were very idiosyncratic. He took an extraordinarily independent and perceptive line about which way the museum was to go."

Johnson goes on to praise Drexler for his "brilliant ability to pick new, important architects, though I often disagreed with his choices—he hated Gehry and Graves"; for his talent as an editor (of, for instance, Venturi's *Complexity and Contradiction in Architecture);* and for his originality as "a lapidary writer. Imagine," Johnson says, "starting the catalogue for the 'Eight Automobiles' show, Arthur's first at the Modern, with, 'Automobiles are hollow, rolling sculpture.'" Drexler was the recipient in 1977 of an AIA medal "for vast contributions in documenting the art of architecture."

Peter Blake, FAIA, who preceded Drexler as architecture curator at the Museum of Modern Art (1948-50), makes clear the magnitude of his successor's accomplishment of "making architecture lively, very visible, and talked about." You have to realize, Blake says, "that when Arthur took over immediately after World War II, people thought there was something odd about having architecture in a museum. One had to justify it. Now, that issue never comes up anymore, largely because of the tremendous job Arthur did." Some museums followed suit, and Drexler became a tastemaker as major patrons, including the Bronfmans (of Seagram fame) and the Pritzkers, sought his counsel.

"How did Arthur do it?" Blake muses. "Perhaps by his own persuasion, intelligence, diligence, and ability to sway trustees and directors. But, in fact, I don't know how he did it."

That remains something of a mystery. For the most part, Drexler's colleagues say they hardly knew him as a person. Johnson describes him as a difficult, distant person who had little converse with his peers. "He was not social-minded in any way," Johnson recalls, "though he gave brilliant talks. Arthur was best talking with theologians, was Talmudic in his rationalizations and his convoluted thinking that I was too dumb to understand."

Educated at New York City's High School of Music and Art and at the Cooper Union for one year before joining the Army, Drexler was largely self-educated. "Because he hadn't had much schooling, Arthur came at the subject with sheer brains, but felt inferior," says Johnson. "He was much better than he thought he was."

"Even in high school," recalls classmate Jack Macey, "Arthur was very aloof, very alone, very hard to get near." Macey was exhibitions director for the U.S. Information Agency for many years, and in the early '60s collaborated with Drexler on a traveling exhibition for the USSR on American architecture. "What was remarkable about Arthur in high school," Macey remembers, "was that he already had this consuming passion—at 13—for architecture." Another Music and Art classmate, Wallace Berger, AIA, credits Drexler for "introducing me to architecture"—also at 13—and having "an extraordinary understanding at such a young age." The source of Drexler's precocious passion is unknown to both Macey and Berger.

Berger further recalls being "flabbergasted when I heard Arthur was in a role that required such public exposure. He was exceptionally shy, which a lot of people interpreted as haughtiness and superiority."

There is evidence, however, of Arthur Drexler as a less armored, less isolated being. Asked whether he was shy and solitary, Drexler's longtime secretary answered that he was not, but didn't want to comment further. Huxtable speaks of Drexler as "having shared his search, his thoughts, in a very intimate intellectual way."

Other insights come from Emilio Ambasz, curator under Drexler from '69 to '76. Drexler hired Ambasz when he was only 25 and had never put a show together. "That required a lot of trust," Ambasz recalls. Why did Drexler bestow

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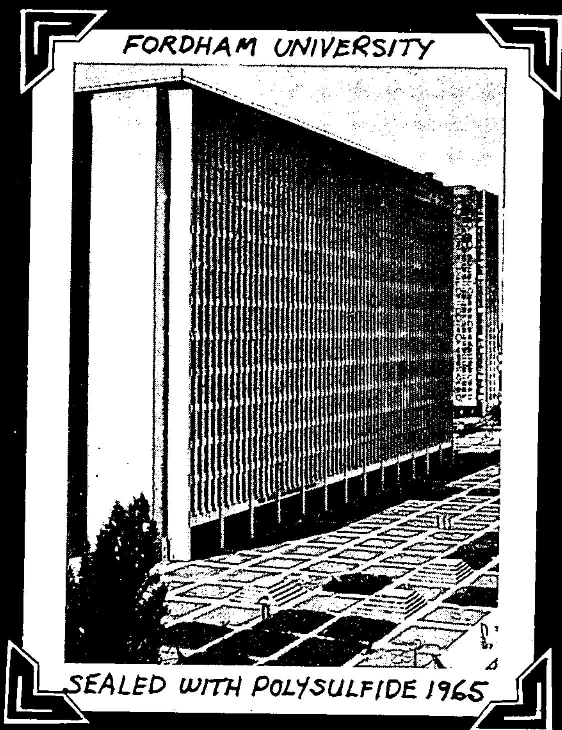
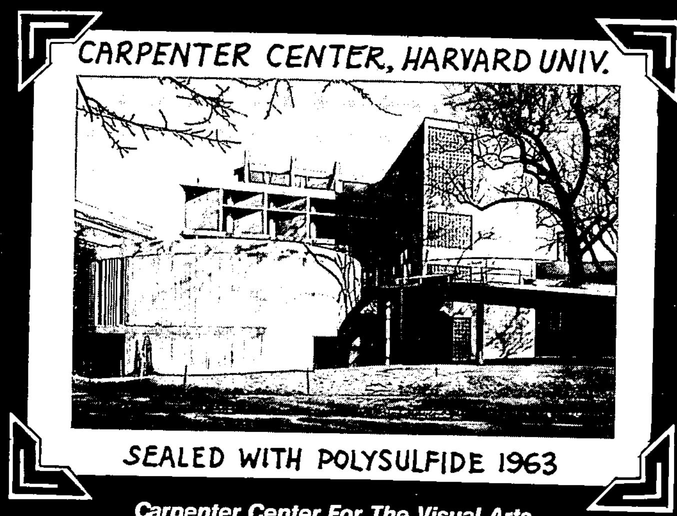
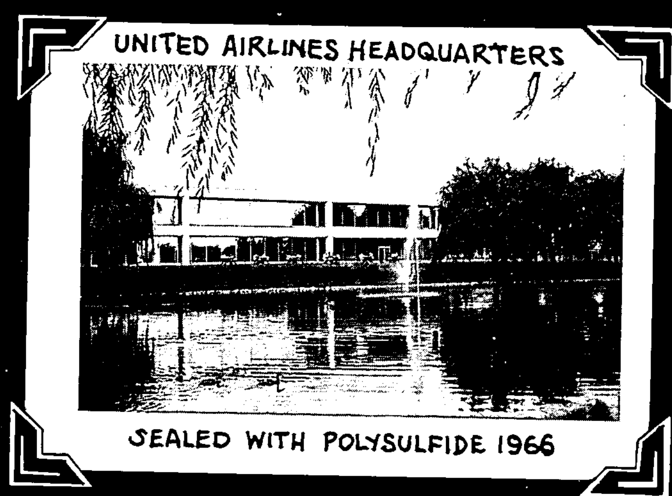
What Do These Prestigious Buildings Have In Common?



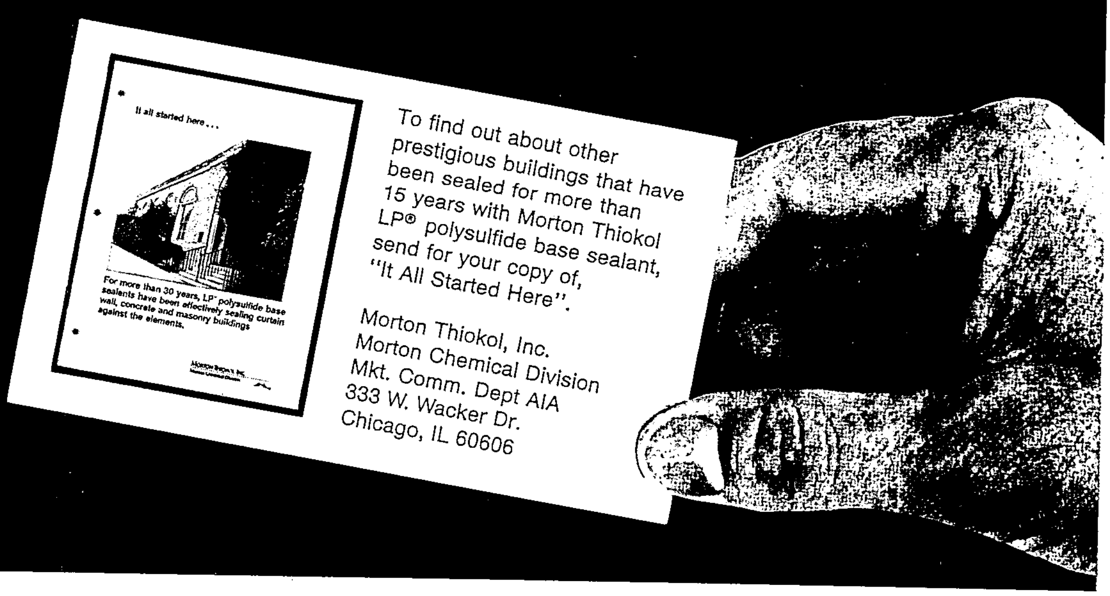
Lincoln Square of Fordham University
New York, NY
Architect: The Perkins & Will Partnership



Carpenter Center For The Visual Arts
Harvard University
Cambridge, Massachusetts
Architect: Le Corbusier



United Airlines Headquarters
Libertyville, Illinois



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Deaths *from page 32*

it? "I think," Ambasz ventures, "that Arthur understood and shared my passion for what I was doing. He was extraordinarily generous with me."

Ambasz goes on to say, "One reason Arthur kept a distance from most people—not from me—I think, was that he had an almost rabbinical idea of his position as someone called on to pass judgment. He therefore felt he had to be unbribable, so to speak, and tended to be suspicious of people who wanted to befriend him.

"Arthur had an immense love of learning and a non-Talmudic pleasure in images," Ambasz continues. "Like every self-taught man, he was extra-erudite. He had a remarkable mastery of English and could present complex ideas to a general public without talking down. But I don't think his pursuit was to bring architecture to the masses. He saw architecture as high art, as an act of imagination. His idea was that knowledge comes after images, and he therefore had a lingering distrust of ideology. For him the supreme misfortune occurred when the idea arrived before the image."

There is a lingering impression that Drexler's last exhibits—including "Transformations," one on Leon Krier's and Ricardo Bofill's work, and the Beaux-Arts exhibition—indicated a decline in Drexler's energies. Huxtable counters that "Arthur had this wonderful little germ of perversity that was never for its own sake. It was always to awaken visions of something." J. Carter Brown, Hon. AIA, director of the National Gallery of Art in Washington, D.C., believes Drexler was "intellectually mesmerized by post-modernism, had a love-hate relationship with it." Peter Blake, on the other hand, sees much of Drexler's late work as "necessary showmanship. One has to raise money to do exciting things in a museum," he explains, "so one has to put on blockbusters. If Arthur had done exhibits based solely on serious and valid commentary, they would have been boring. I don't think he believed his own statements about modern architecture being dead."

Ambasz views the Beaux-Arts exhibit as having been a magnificent but flawed idea. "Arthur had the nose," he explains, "to sense that architects were longing to recover a capacity to invent ornament. The show lost its edge in conveying the notion that there was a catalogue of images from which you could crib rather than inventing a new architecture that would generate its own ornament."

Ambasz sees Drexler in his last years as having been a beleaguered, deeply disillusioned man, "in despair in the Roman Catholic sense of the word. You could see how his intellectual capital had been used, stressed, bent, and exhausted," says Ambasz. "It was the same capital on which the modern movement had been created, and he was one of the most lucid observers of its erosion. He was cursed with lucidity. In the end, Arthur saw himself as a defender of a heritage of architecture as a high art and of an abandoned system of values.

"Where he was most moving at the last," Ambasz continues, "was in his brilliant presentations to high school kids. He put inordinate amounts of time, care, and tenderness into those talks." It was, perhaps, as though Drexler was ministering to the precocious, infinitely hopeful, and intellectually passionate youth of nearly half a century ago that he still cherished in himself.—Andrea Oppenheimer Dean

Jean Labatut: Professor emeritus of architecture at Princeton University, Jean Labatut died in late November at age 87 after a long illness.

A native of France, Labatut joined Princeton's faculty in 1928 as a resident critic in architectural design and was appointed professor in 1935. He also was a member of the architecture faculty of the American School of Fine Arts at the Palace of Fontainebleau in France and served as the director in 1947.

In 1951, France made Labatut a knight of the Legion of Honor. He was the first recipient of the award for excellence in architectural education, sponsored jointly by AIA and the Association of Collegiate Schools of Architecture.

Princeton University spokesman George Eager said that Labatut was chiefly responsible for developing Princeton's graduate school of architecture into one of the country's foremost schools.

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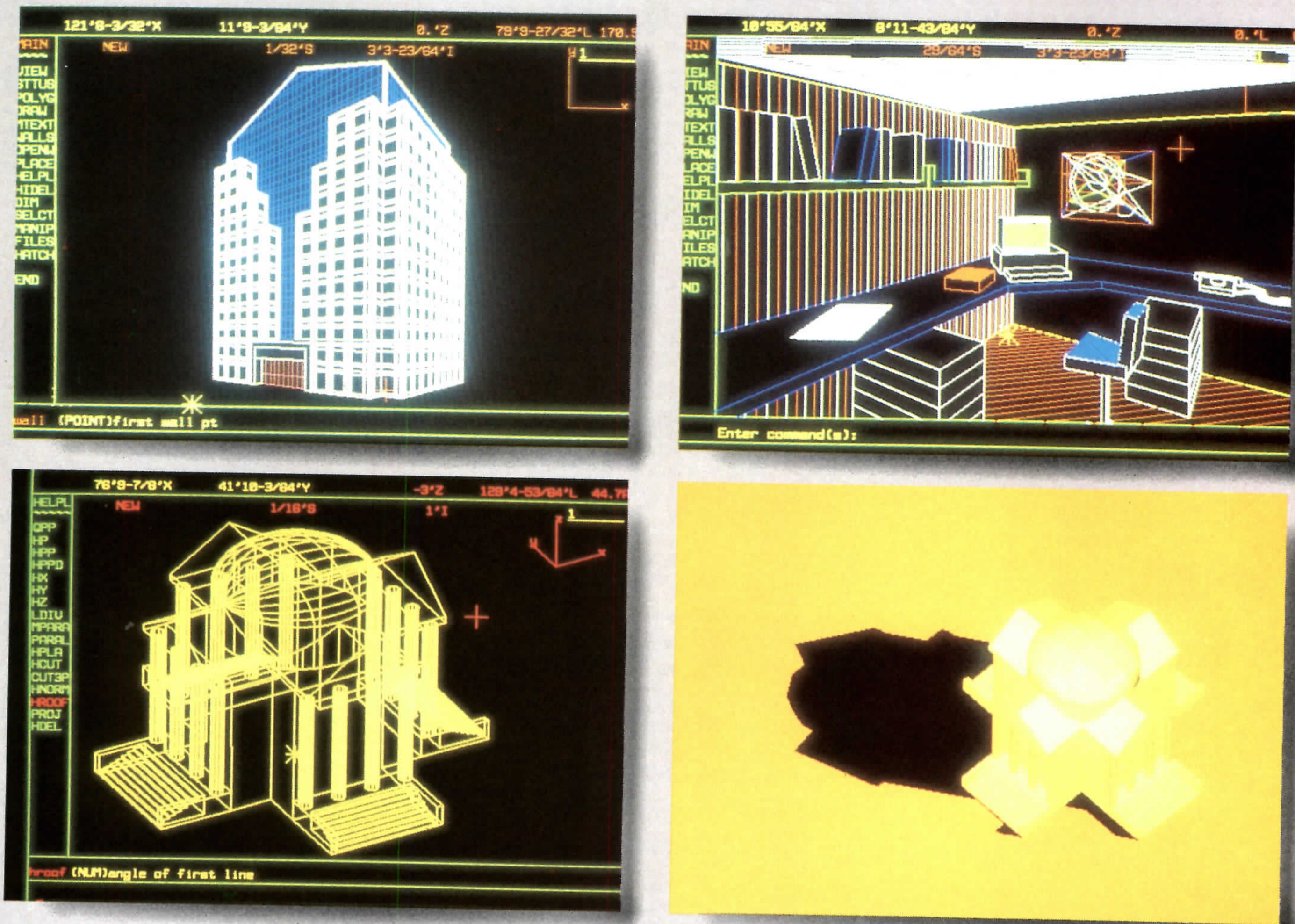

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Deaths *from page 36*

Paul Peng-Chen Sun, FAIA: Principal architect with Shepley Bulfinch Richardson & Abbot in Boston, Sun came to the U.S. from China at the age of 19. He earned a bachelor of arts degree at Tarkio College, Tarkio, Mo., and master of architecture degrees at Columbia and MIT.

His designs for the Humphrey Occupational Resource Center for the Boston School Department and the Portland Library, Portland, Me., earned him regional awards from AIA. His most recently completed work was the Annenberg Library at Pine Manor College in Brookline, Mass. He died in December at the age of 51.

Richard F. Hammel, FAIA: Founder of the Minneapolis firm Hammel, Green & Abrahamson, Hammel received his architecture degree from the University of Minnesota in 1944 and in 1947 obtained a master's degree in architecture from Harvard University. Hammel taught at the University of Minnesota's school of architecture from 1950-57. He also served as president of the Minnesota Society/AIA.

Hammel designed a number of educational facilities including the independent School District #196 in Apple Valley, Minn., and Hamline University Law School and Library in St. Paul. His firm won an AIA honor award in 1981 for the Colonial Church of Edina, Minn.

Design

Johnson's Boston Scheme Rejected; Developers Hire New Architect

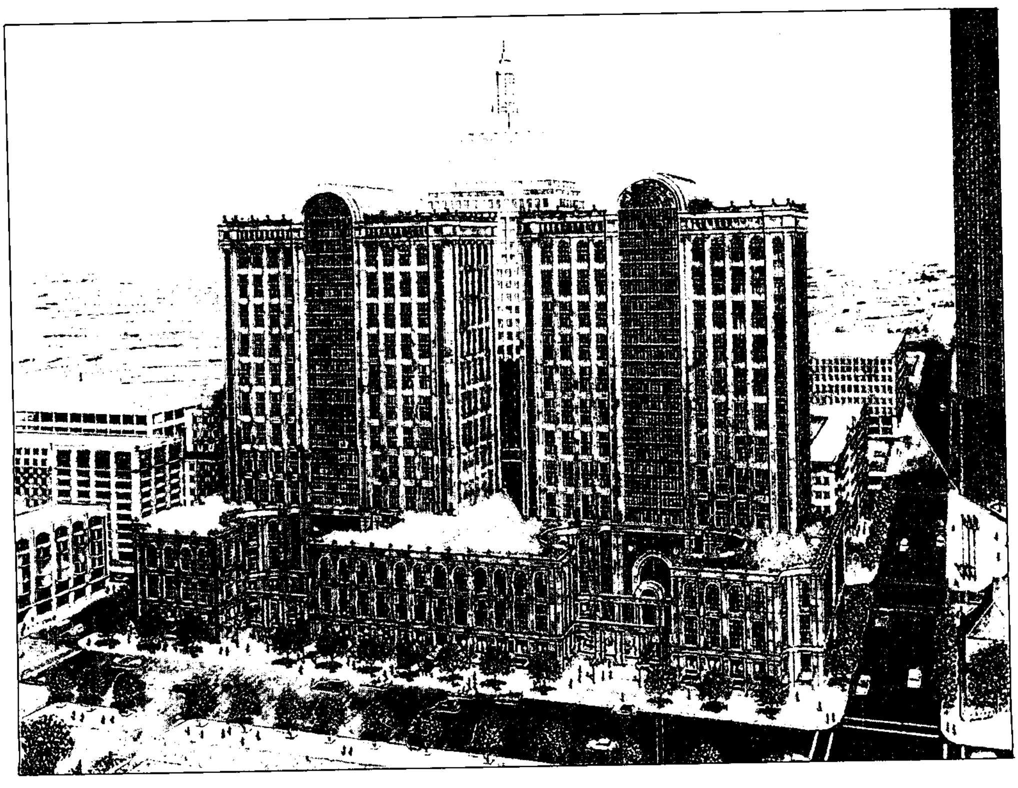
A long controversy in Boston over a proposed design for 500 Boylston Street, an insurance company building in the city's Back Bay neighborhood, entered a new stage in January when it was announced that the original architects, John Burgee Architects with Philip Johnson, were being replaced by the team of Robert A.M. Stern Architects and Jung/Brannen Associates.

The change in architects applies only to the second phase of the two-stage project. Phase one is currently under construction in accord with the Burgee-Johnson design; phase two, however, is being completely redesigned by Stern.

As originally conceived by Burgee-Johnson, the second phase would simply have mirrored the first, creating a twin-towered complex that would have filled two blocks of the Back Bay with 1.2 million square feet of office space rising to a height of 25 stories. From the beginning, this proposal—the chief sponsors of which are the New England Mutual Life Insurance Company and Gerald D. Hines Interests—stirred controversy.

Opponents charged that the project would overwhelm the scale of the Back Bay (and particularly that of H.H. Richardson's Trinity Church across the street) with its oversized double-story windows, its height and bulk, and its massive symmetry. Traffic and shadow impacts and the "canyonization" of St. James Avenue at the project's rear were also cited. Some thought the idiosyncratic Coulton Building on a corner of the site should be preserved, but failed to get it landmarked.

Below, Burgee-Johnson's scheme for the twin-towered, two-phase complex for 500 Boylston Street in Boston.



The architects and developers of 500 Boylston countered by noting that the towers were set far back from Boylston Street, leaving a continuous six-story street wall with retail frontage on that major shopping thoroughfare. They argued that the building's impact would be moderated by its neo-baroque detailing, its many-columned oval entrance courtyards, its high-quality materials (rose granite being the chief exterior finish), and its interior shopping arcades.

Both the Conservation Law Foundation and an ad hoc group called Citizens for a Better New England Life took the developers to court, where John Burgee, FAIA, testifed that the $289 million project would fit into the Back Bay "like an old shoe." (Some of the litigation is still in progress.) Negative pressure was also brought by the city of Boston through its redevelopment director, Stephen Coyle. A compromise was struck in December 1985 in which the developers were permitted to proceed with phase one on condition that they reconsider phase two. The replacement of Burgee-Johnson by Stern was the result of that reconsideration. The developers interviewed six architects and commissioned conceptual designs from three—Stern, The Architects Collaborative, and Graham Gund, FAIA. Stern's design was chosen last fall but has not yet been made public, pending review by the city and by neighborhood groups.

The Stern design (which has been seen by this writer) breaks completely from the Burgee-Johnson approach. It is 40 feet lower and 100,000 square feet smaller, and its tower is turned sideways to Boylston Street, fronting the side street, Berkeley Street, instead. The new design imitates none of the shapes, details, or materials of the Burgee-Johnson design; the effect of the project as a whole will now be that of two abutting dissimilar buildings rather than one grand corporate palace. Some continuity will be provided by the extension of the six-story Burgee-Johnson street wall, albeit with an entirely different architectural expression. A shopping arcade will also penetrate the block. Stern's materials are red brick with pale stone trim. His building sets back in both plan and profile by shallow steps, recalling such Georgian/Deco Boston landmarks as the nearby Ritz-Carlton Hotel. Bay windows at lower levels will also recall the Coulton Building, which is still slated for demolition.

Early reaction to the Stern design has been much warmer than that received by the original Burgee-Johnson proposal, although at this writing many issues remain to be resolved.—Robert Campbell

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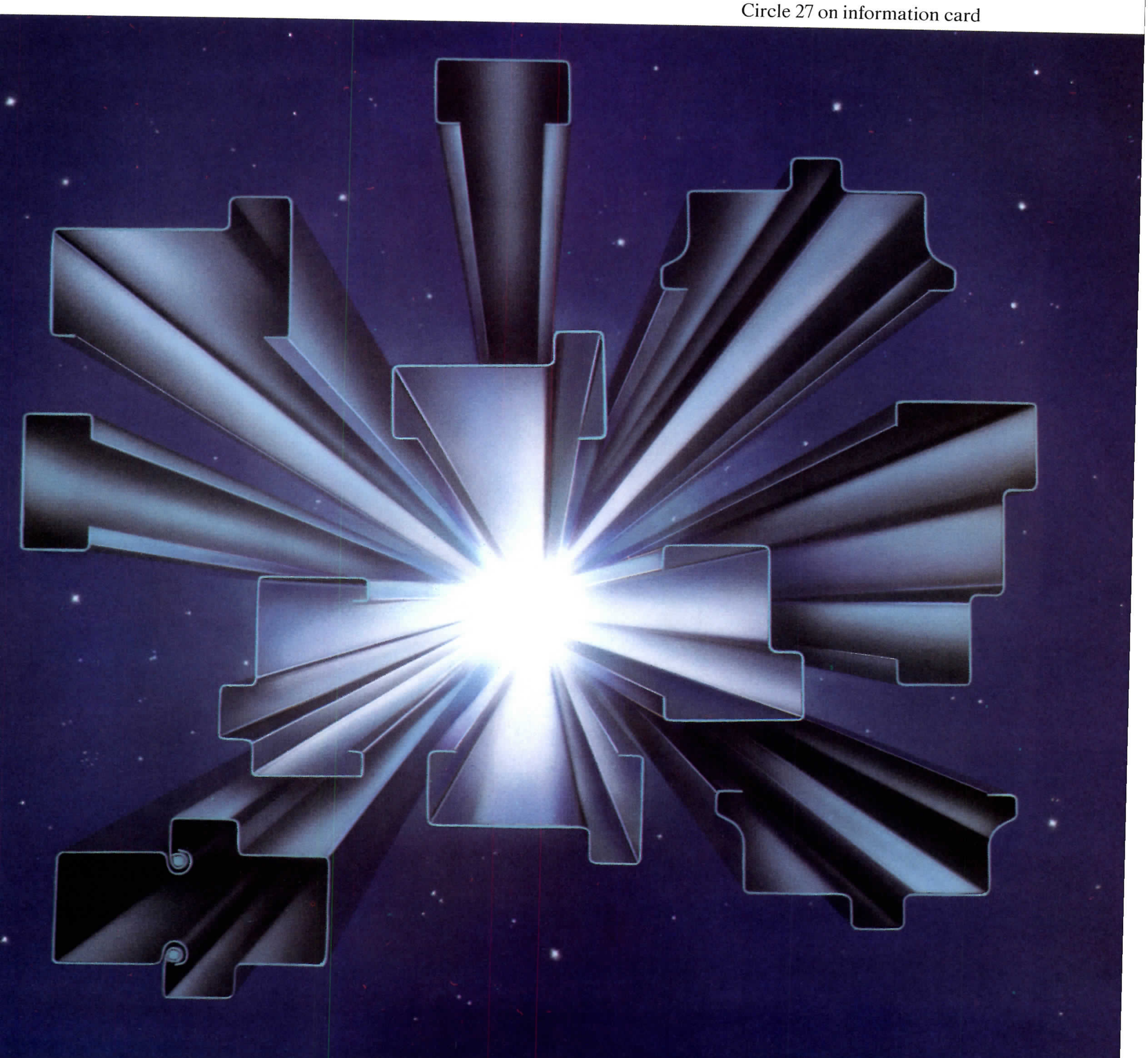
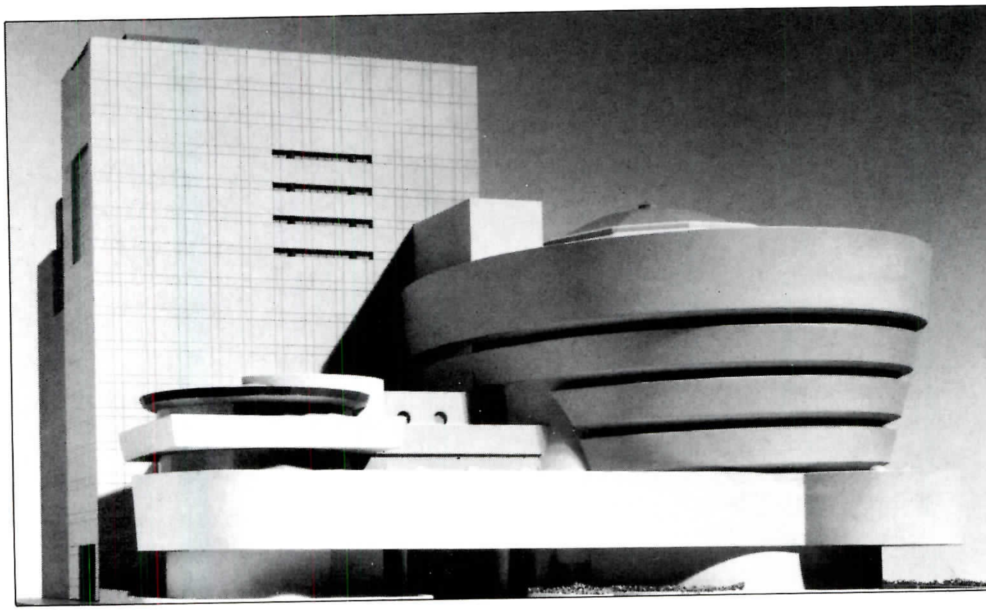


Guggenheim Unveils Modified Gwathmey Siegel Addition


© Dan Cornish/ESTO

The Guggenheim Museum has unveiled a significantly modified addition scheme by Gwathmey Siegel & Associates for Frank Lloyd Wright's museum on Fifth Avenue in New York City. Responding to critics who argued the original expansion plan overshadowed the Wright masterpiece, museum officials announced a new proposal that is smaller in both bulk and height and has a more subdued exterior surface treatment. They called the new scheme "a background building—similar in shape, mass, volume, and placement to the structure Frank Lloyd Wright contemplated for the site."

The original Gwathmey Siegel proposal, unveiled in October '85, was met immediately with strong criticism from preservationists, neighborhood groups, and Wright aficionados, although many New York architects and museum directors (several that are involved in their own expansion programs) actively supported the scheme. That proposal was withdrawn last fall, when Guggenheim officials determined that the New York City board of standards and appeals would not grant the necessary approvals and zoning variances. The proposal is not required to go through the rigorous review process of the New York Landmarks Preservation Commission because the 1959 Wright building is not an official landmark (city laws require any landmarks to be at least 30 years old) and it is not located within a historic district.

Guggenheim's revised expansion scheme calls for a 10-story tower with a height of 133 feet rather than the original 162-foot-high addition with 11 floors. The architect also eliminated one of the most controversial elements of the original scheme—the cantilevered tower—thereby reducing the width of the addition by almost 15 feet. The new wing is a simple rectangle measuring 35 feet wide and 99 feet long, and the gross floor space of the new proposal has been reduced by 20 percent.

Instead of incorporating a 1966 annex by William Wesley Peters, the revised design calls for the Gwathmey Siegel addition to be built on the base of the existing annex, which was designed with a structural foundation to support a 10-story building.

Gwathmey Siegel's new design replaces the greenish-gray enamel tiles of the first

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Design *from page 40*

scheme with a limestone facade detailed with a grid pattern of approximately eight-foot squares. The Fifth Avenue facade has four deeply set horizontal windows, creating an additional square pattern. The elevation facing 89th Street has more glazing and repeats the grid pattern with a series of horizontal bands of windows.

Under the new scheme, permanent collection exhibition space is double the present amount and is slightly greater than that in the withdrawn proposal. The space for temporary and changing exhibitions is consistent with the first expansion design, which provided an additional 3,200 square feet of space.

The first seven floors of the new wing will contain exhibition space with connections at each level to the spiral ramp of Wright's large rotunda. An outdoor sculpture terrace on the roof of the northern end of the Wright building, opening off the fifth floor of the addition, will provide views of Central Park and the exterior of the main rotunda.

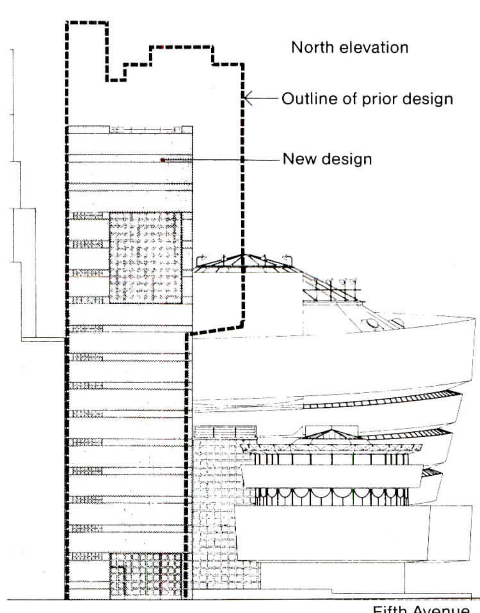
Museum officials agreed to forego plans to consolidate all functions on site and announced plans to house the art conservation department, art storage, library, and archives in a rented facility away from the main location.

Museum director Thomas M. Messer said, "The 10-story addition we now plan is lower in height and reduced in square feet. But it still allows for quantitative and qualitative enhancement of the collection on view. . . . In the process we have reached a solution that is sympathetic, responsive, and vital to the future of the museum."

The new design must be reviewed by the local community board and is scheduled to be considered by the city's board of standards and appeals this spring.

—Lynn Nesmith

North elevation of the Guggenheim addition, showing the new proposal and the outline of the original scheme.



Student Design Competition

Top honors in a national student competition sponsored by the McDonald's Corporation and the American Institute of Architecture Students went to Dagoberto Diaz and Orlando Perez of the University of Miami, Fla.

The winning scheme is a "neoclassical, Spanish mission-style" design with an ornate galleria and a spiral staircase leading to an elevated outdoor eating court. The first place team was awarded $4,000.

Second place honors went to Robert L. Burns of Montana State University. Stephan Evans of Auburn University placed third. Six other students were presented honorable mentions. Cash awards totaling more than $11,000 were presented to the creators of winning schemes.

The design competition drew more than 500 submissions from students attending 103 architecture schools in the U.S. and Canada. The jury included Philip Johnson, FAIA; Robert A.M. Stern, FAIA; John Morris Dixon, FAIA; Fred Matthias, McDonald's corporate architect; and Katherine Pedersen, architecture student at Miami University in Oxford, Ohio.

Indoor Air Pollution

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers has published a 622-page book of the proceedings of its conference, *IAQ '86: Managing Indoor Air for Health and Energy Conservation.* The book consists of 54 papers and the price is $74. Contact: ASHRAE Publication Sales, 1791 Tullie Circle N.E., Atlanta, Ga. 30329.

Air Force Design Award Winners

AIA, the Society of American Military Engineers, and the American Society of Civil Engineering have selected four projects to receive honor awards in the 1986 Air Force design awards competition. The winners are:

- Chapel at Travis Air Force Base, Calif., designed by the Western Division, Naval Facilities Engineering Command;
- Automotive Maintenance/Refueling Vehicle Shop, O'Hare Airport, Chicago, designed by Ware Associates Inc.;
- Visitors Center, Air Force Academy, Colo., designed by John James Wallace & Associates;
- Static Aircraft Display, designed by the Academy Base Civil Engineering office.

Call for Entries for Western Home Awards

AIA and *Sunset Magazine* are seeking entries for the Western home awards program. Entries must be the work of a registered architect in the 13 Western states, and only projects completed since January 1983 will be eligible. The application deadline is April 30, and the entry fee is $50. For more information, contact *Sunset Magazine,* Box 2345, Menlo Park, Calif. 94025.

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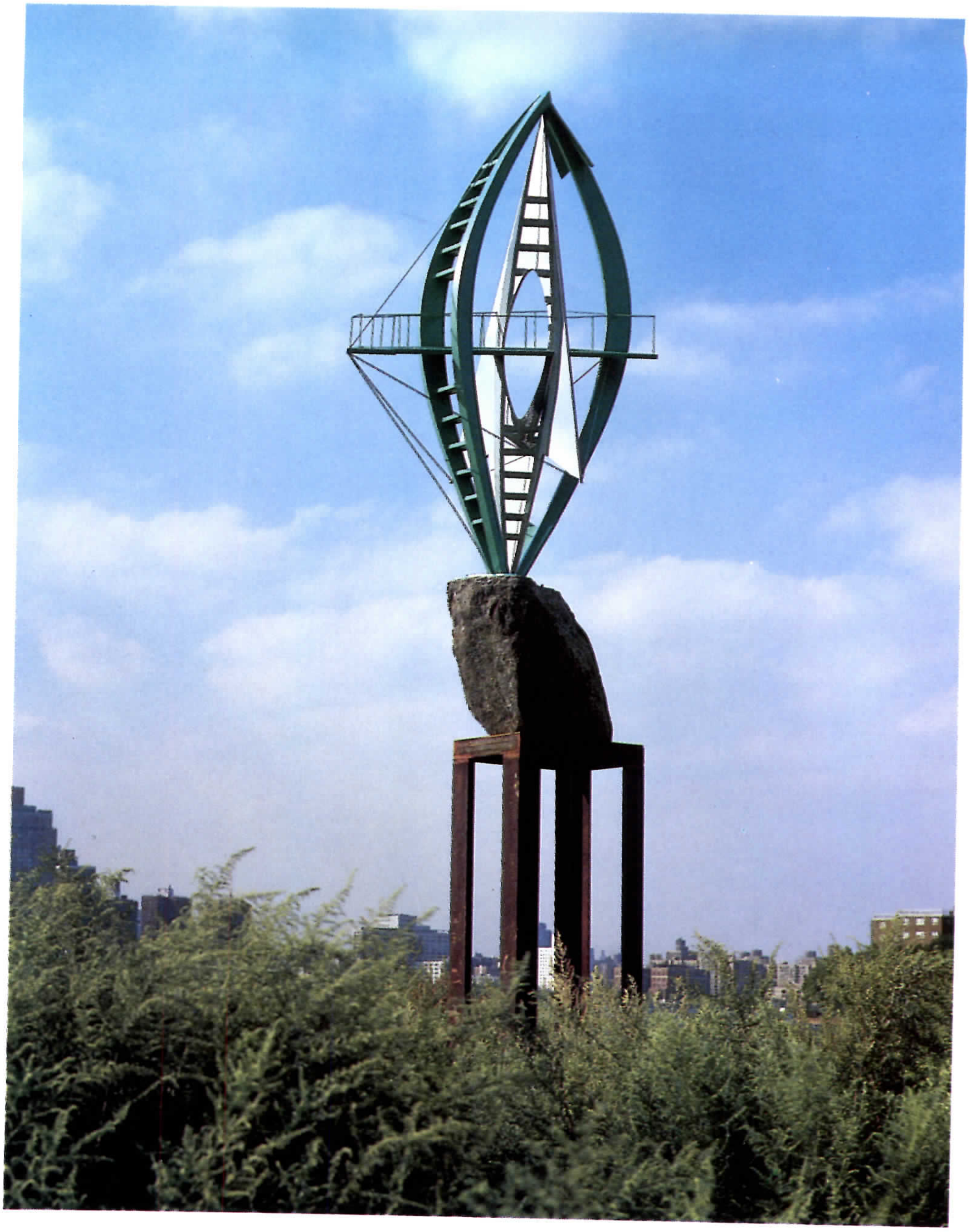
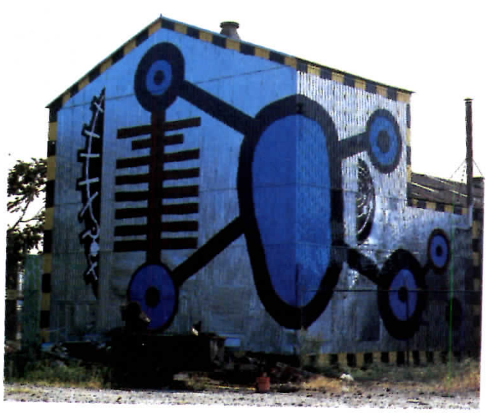
City Dump to Urban Park



In a park recovered from a dump on the East River, in Queens, New York, giant sculptures seem to have erupted from the scraped, still-raw ground. The Socrates Sculpture Space/Park, which opened in September, is the brainchild of sculptor Mark di Suvero, who for years had eyed the four-and-a-half-acre site with its spectacular backdrop, Manhattan's east side, from his studio on an adjacent pier.

The park's "esthetic" is funky, rough, and urban. There is no overriding theme to the first show, but all the pieces are large and make reference to the environment. Lauren Ewing's "Intruder" is a red tenement facade, torn by a giant V from which spurt colored and patterned shapes, like bits of the insides of homes. Owen Morrel's skeletal spheroid, "Ankor '85," located nearer the river, seems to lean into and expand with the wind. Other sculptures in this show are by di Suvero, Vito Acconci, Bill and Mary Buchen, Rosemarie Castoro, Mel Edwards, Linda Fleming, Florence Neal, Paul Pappas, Scott Pfaffman, Sal Romano, Richard Stankiewicz, and Bill Tucker. In addition, Richard Mock has painted a 30-foot-high mural entitled "Perceiving Space" on a corrugated metal shed facing one side of the park, with the help of teen-agers from a nearby housing project.

The current show will run through this month. The theme of the next one, scheduled for mid-May, will be "sculpture to walk on, sculpture to touch."



Above, Owen Morrel's 'Ankor '85'; left, Bill and Mary Buchen's 'Wind Antenna'; far left, Richard Mock's 'Perceiving Space.'

Currently, the sculptures sit amid rough rock gardens, winding gravel paths, and clumps of grasses and wildflowers created by the workers who helped clear the land. But recently, an urban landscape design class of the City College of New York architecture school has taken on the park as a project and competition. The winning design, says Sara Pasti, assistant director of the Athena Foundation, which runs the park, will be used as the basis for a permanent landscaping scheme.

Unfortunately, long-range plans are impossible. The park exists under a five-year, dollar-a-year lease from the New York Department of Ports and Terminals, and the city, which foresees either luxury housing or industrial development in that area, would not make a permanent commitment.

—Julia Lichtblau

Ms. Lichtblau is a freelance writer in New York City.

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ARCHITECTURE

With this issue technology moves front and center. Months ago the editors of ARCHITECTURAL TECHNOLOGY magazine set out on an ambitious task: to survey the field for the most innovative developments in technologies and materials in recent years. With the merger of ARCHITECTURE and ARCHITECTURAL TECHNOLOGY the survey became the basis of this special issue. What follows are 11 articles on major areas of innovation, interspersed with buildings that exemplify change. A similar survey was made of progress in development of building products, and this month's Products section groups them into six major areas.

Some personnel matters: Mitchell B. Rouda, former editor of ARCHITECTURAL TECHNOLOGY, who came to this magazine with the merger, has left to become editor of *Builder*, magazine of the National Association of Home Builders. It is a large magazine and he will be in charge editorially, so it was an irresistible offer. Rouda did much of the early conceptual planning of this issue, and Douglas E. Gordon and M. Stephanie Stubbs were editors in charge of its execution.

We are determined that Rouda's departure will not diminish the technology and practice content of the magazine. Toward that end Forrest Wilson, former chairman of the architecture department at Catholic University and former editor of *Progressive Architecture,* has gone from contributing editor to senior editor. His role in the magazine will be significantly increased. We have also added two new contributing editors: Bea Sennewald, AIA, for technology and Karen Haas Smith for practice (although both will write in both areas). Ms. Sennewald is a project architect with the Alexandria, Va., firm of Henningson, Durham & Richardson and has written for both ARCHITECTURAL TECHNOLOGY and ARCHITECTURE. Ms. Smith heads the Washington consulting firm Editors Inc. and has spent 10 years in construction journalism. She was managing editor and acting editor of ARCHITECTURAL TECHNOLOGY.—*D.C.*

'The Logic of Industrial Assembly'

It shaped this civic building in a tiny Canadian town. By Forrest Wilson

For years, the IKOY Partnership has pursued the dream of a truly industrialized architecture for an industrial age: an architectural expression that would flow rationally from the use of industrial materials, labor, and the design imperatives dictated by the logic of industrial assembly. The Provincial Center in Flin Flon, Manitoba, is among the most recent and most successful evidences of their search.

This is an industrial building in an industrial landscape. It is a bolted, red, corrugated box of the same material and gender as the automobiles that pass it on the street, park in orderly rows in an adjacent lot, cluster behind it, and stop at its front entrance. The traffic stanchions, dangling stop and go lanterns at the north and south corners of the building, are comfortable in its presence.

The facade is not an appliqué of architectural elements borrowed from the past. It is instead a kinetic industrial membrane, designed to change as the functions within the building change, yet to hold the building's unique architectural configuration.

Plainly a building assembled of industrial parts, the Provincial Center recognizes the disappearance of handcraft and celebrates the skill of building assemblers. It celebrates technical organization. Sophisticated technology in today's buildings is found not in their form but in their automobile-like assembly.

Automobiles, many would agree, are a bit obscene—they take up too much space, smell bad, wear out quickly, dent easily, and are incredibly dangerous. However, the skill and organization required to bring together thousands of parts from all over the world at the same instant to assemble an automobile in three minutes is an impressive accomplishment. The Provincial Center asserts the creative ability of assemblers and sits comfortably with automobiles, the primary contextual reality of our time.

Each piece of the building was designed and fabricated far away, brought to Flin Flon, and installed on the site. Each part could be fitted in no other way than as it now appears in the building.

No placement decisions were left to assemblers. Conventional practice is to supply semifinished parts to be put together as assemblers deem best. They invariably decide that easiest is best. This method can work, but it can also fail. Mistakes are made, money is spent, people are injured and killed.

The Provincial Center was designed to relieve assemblers and erectors of design decisions. Their task, their satisfaction, their skill, is putting things together as they were meant to be. Assemblers do not want to puzzle over how a building fits together. They cannot indulge in this luxury when their boss demands they assemble 17 buildings a day. But if the elements have a rational clarity and come together solidly, attractively, and precisely, the erector can work efficiently and take pride in his accomplishment.

In an industrial age buildings are industrial artifacts and designers are industrial designers. Buildings must be designed to reduce labor by simplifying connections. They must be designed in large pieces to minimize the number of connections, for much of the cost of building is in assembly. All materials must be dry, and as many as possible factory made. The symbol of industrial buildings is not hammer, nail, and saw but the assembler's wrench.

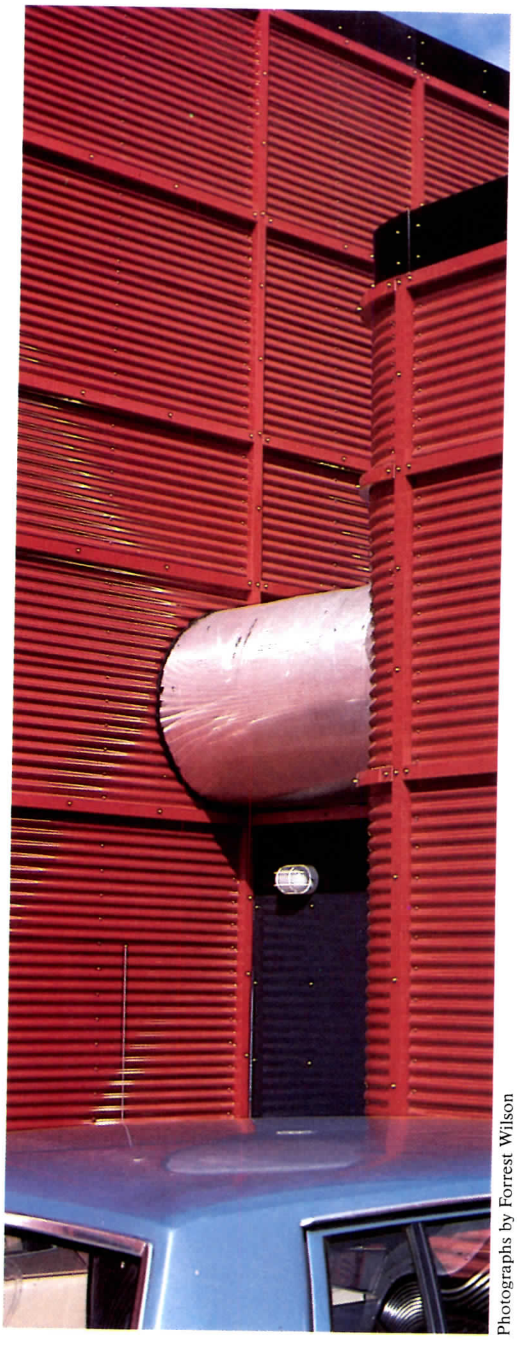
That part of the building that wears out in 15 years must be easily disconnected and separated from parts that will last 50 years and those that will last 500. The mechanical systems (HVAC) of the Provincial Center are in a separate building, umbilically connected to the working spaces. New systems can be installed in a day without disturbing the workings of the court or offices. The building says clearly that its value is that it can adjust over time and retain its worth.

The building makes no attempt to conform to the architectural context of surrounding structures by matching window heights, facade, and cornice lines. But it is contextual: a kinetic building amid kinetic artifacts.

Flin Flon is a frontier town on the northern edge of civilization. It lies 400 miles north of Winnipeg, the coldest major city in the world. Yet Flin Flon is in some ways cosmopolitan, with Scotch, Irish, English, German, Hungarian, Ukrainian, American and Asian Indian, and other groups composing a population of fewer than 5,000.

Born with the discovery of gold 50 years ago, the town grew from a helter-skelter collection of tents around an open pit mine into a linear town of "frontier vernacular" buildings along a "Main Street." The unifying design element throughout Flin Flon's history has been expediency. Most of the houses are built by owners with the help of friends. These are sturdy structures of found and "liberated" materials shaped in nostalgic remembrance of faraway homes in distant lands.

Many of Flin Flon's buildings proudly sport false fronts, the universal brag of the frontier boomer. The facades say that this is a city, not a town: "We have lots and subdivisions, choice sites, and land speculation. We are going someplace. We have Shriners, Lions, and Oddfellows. We are civitas."



Photographs by Forrest Wilson

Opposite, opaque and transparent panels on the Provincial Center's front. Left, mechanical and main buildings are umbilically linked.

Photographs by Gerry Kopelow

Transparent sections on facade reveal structural members.

Located near the end of Main Street, the new Provincial Center is the city's terminus. A bit farther, up and over a hill, the mine smelter sits in the middle of a wasteland of regurgitated earth from which the precious metals gold, copper, and zinc have been sucked. Next to the smelter, dominating a desolate landscape reminiscent of the mountains of the moon, is a great belching smelter stack. It can be seen for 50 miles, and it declares to the surrounding landscape of lakes, streams, and pools that God is a man.

The mine and red and white painted mine buildings share town space. Two gigantic red "head frames" and a great yawning open-pit mine are cut almost vertically into the hard granite and schist a few blocks from the town's main street. The buildings of the townspeople are of the same materials and painted the same colors, white and red, as the mine buildings.

Surrounding the town is a flat, lake-dotted land of birch and pine scrub forests that extends, unchanged, south to civilization and north to the frozen pole.

Flin Flon sits on some of the very few hills in the region. Sparse soil gathered into rock pockets supports lichen, grass, weeds, and flowers. House sewers are carried above ground and boxed in sinuous wooden colons. The stone earth is much too hard to dig for anything less precious than gold.

The new Provincial Center building, dedicated during last summer, centralizes the offices of government, formerly scattered throughout the town in rented spaces. The law court is the most significant addition to the community. During the early years, when Flin Flon was primarily a tent city, misbehavers were transported out to be tried in the courtrooms of larger towns. When civic pride had swelled sufficiently, judges were flown in and miscreants faced justice in the high school gymnasium. Today justice is served properly in a courtroom ringed with bands of zinc and copper and entered through bronze doors.

The offices of the highway department, social services, and natural resources surround the court. Here hunting, fishing, and driving licenses are issued. Social workers, foresters, and scientists protect the welfare of the people, the lakes, the scrub forests, and the bear and moose of the surrounding tundra.

The court, the jewel of justice, symbol of law, order, and civilization, is an architectural declaration that Flin Flon no longer will tolerate gunslinging miners beating each other over the head with crowbars on Friday nights. Mental cruelty can now be substituted. Differences are decided by lawyers, and judges dispense justice commensurate with their eloquence.

The concept was of a "transparent" shell sheltering a building within a building. The site's unique configuration, due primarily to the refusal of owners of an adjacent electrical shop to sell at a price the township could afford, ruled out two separate buildings.

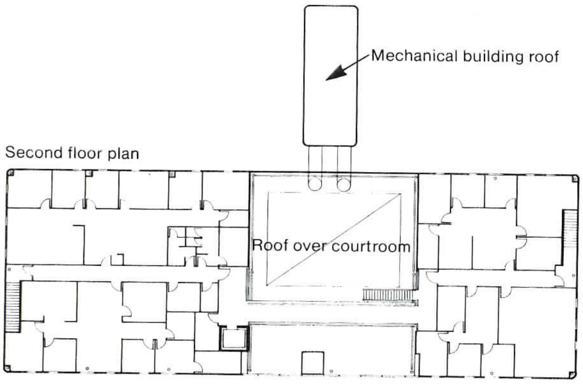
During the day, the low sun angles of the far north dramatically illuminate the court building behind its glass facade. Darkness comes to Flin Flon between 3:30 to 4:30 P.M. four months of the year; then lights are turned on and the court within is illuminated through the transparent facade.

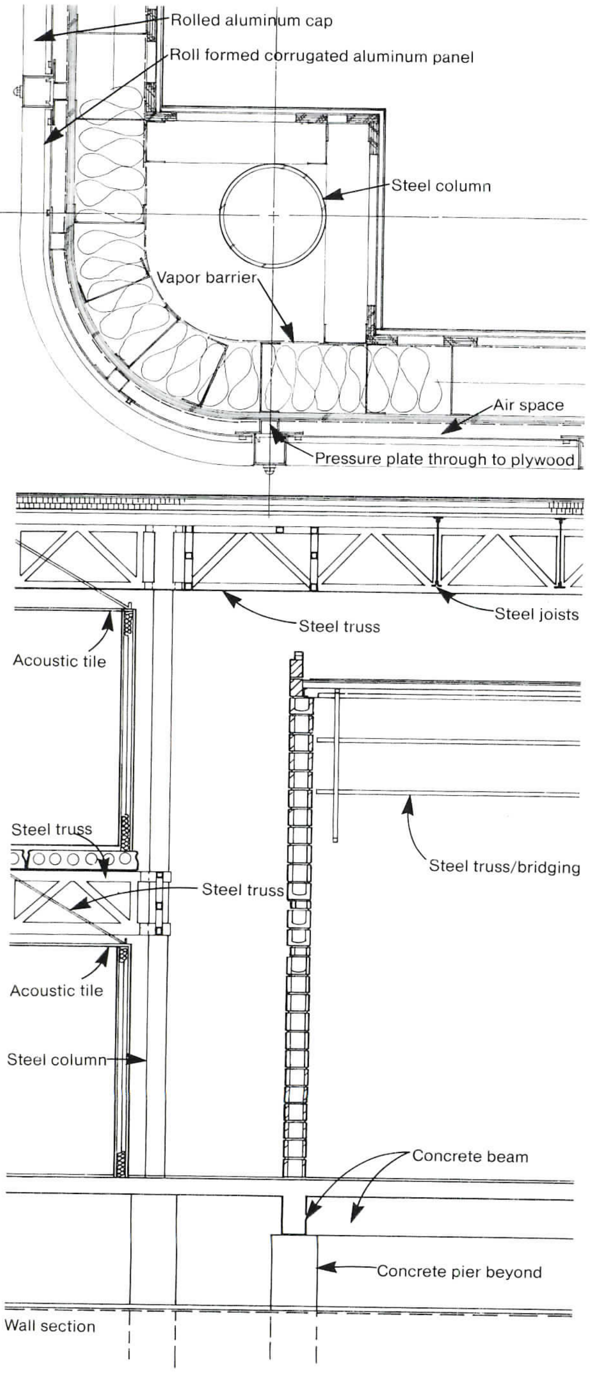
Citizens visiting government offices enter through a central atrium and face the metal-banded masonry walls of the court of justice—a proud symbol underscoring the importance of the administrative offices, otherwise not unlike those of any modern administrative center.

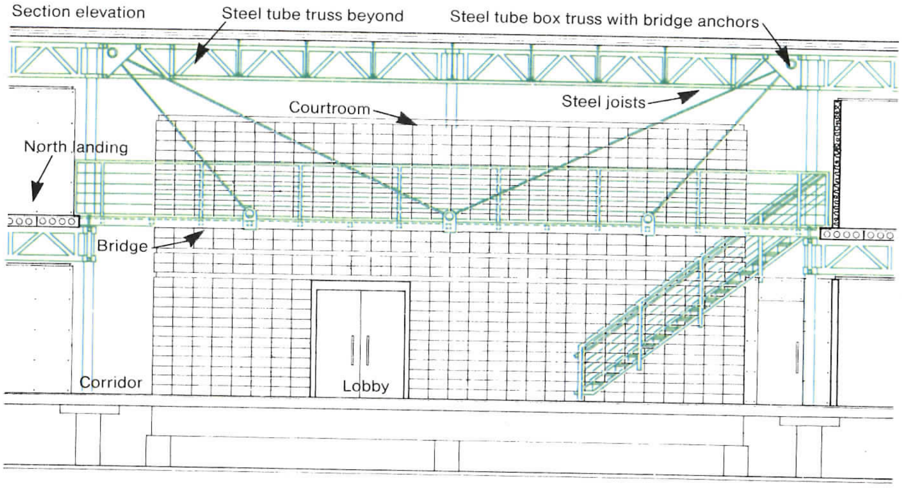
Three metal bands—a center zinc band between two of copper—encircle the court. Copper and zinc are mined in Flin Flon, the first link in the chain stretching from primitive copper to civilized bronze. The ore leaves the open-pit mine as raw copper and returns to Flin Flon as bronze.

Bronze doors are never found on common structures, but are reserved for entrances to churches, banks, state houses, courts, and sacred and authoritative buildings. The return of refined metal extracted from base copper dignifies the miners' labor and rewards their courage.

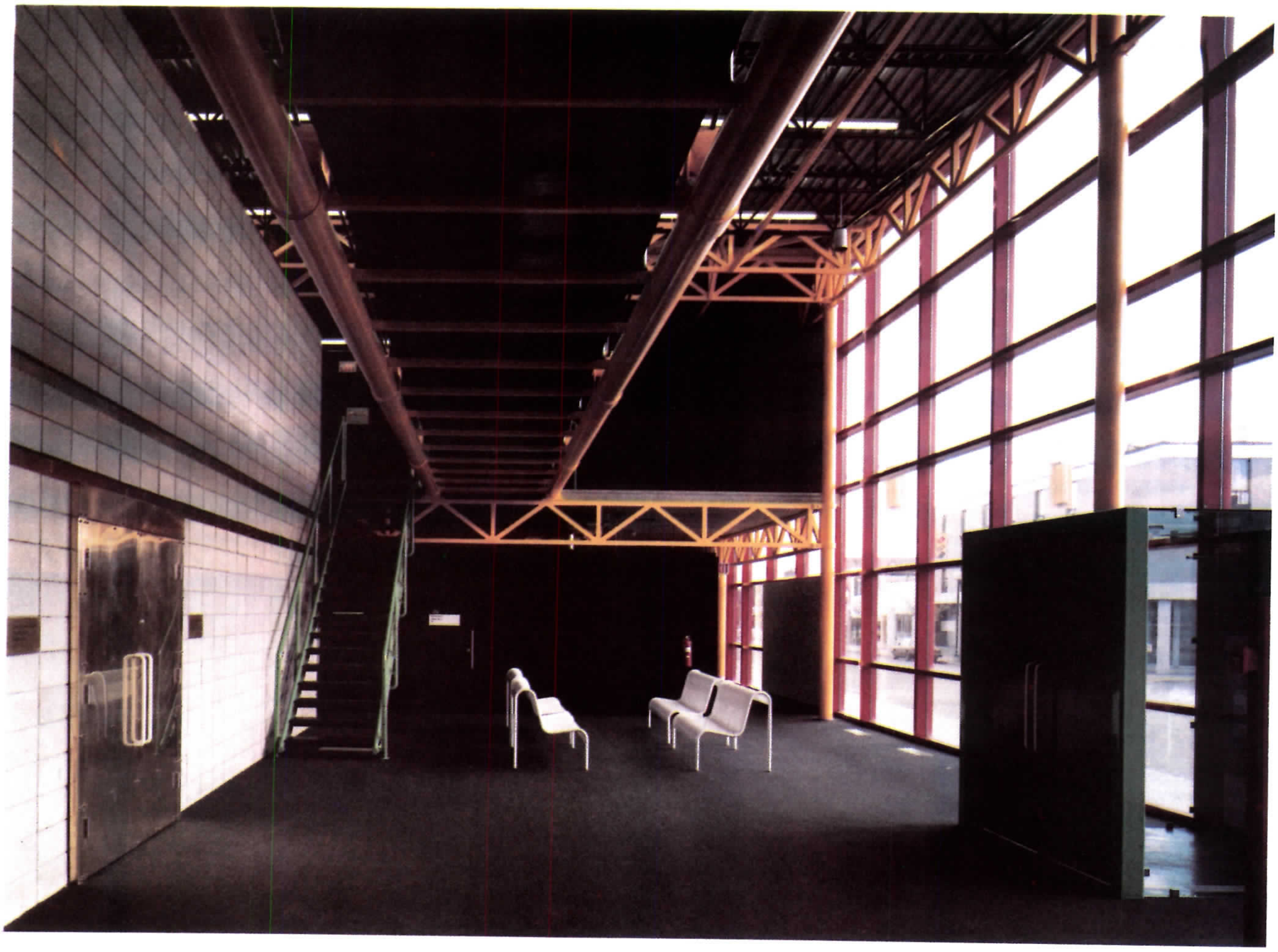
A bridge passes through the atrium above the bronze doors,



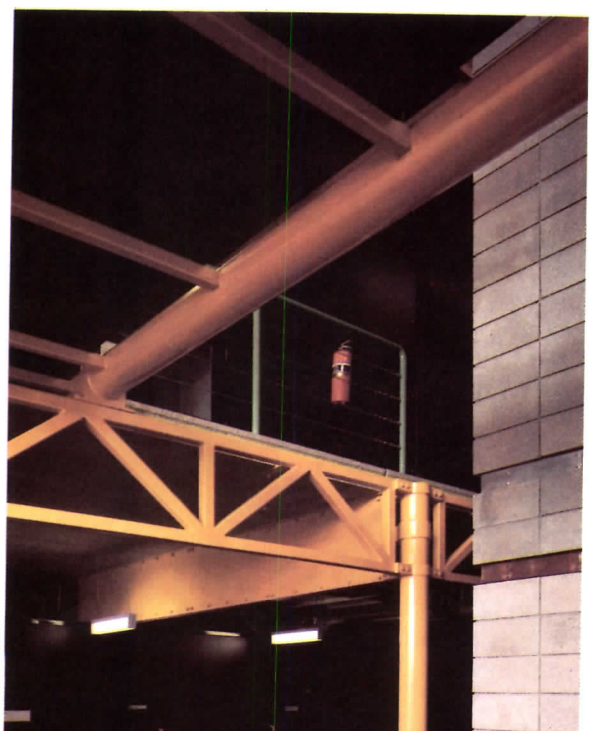




Top right, a nighttime view of the building within the building, housing court facilities. Right, swaying bridge passes through the atrium and over the court.



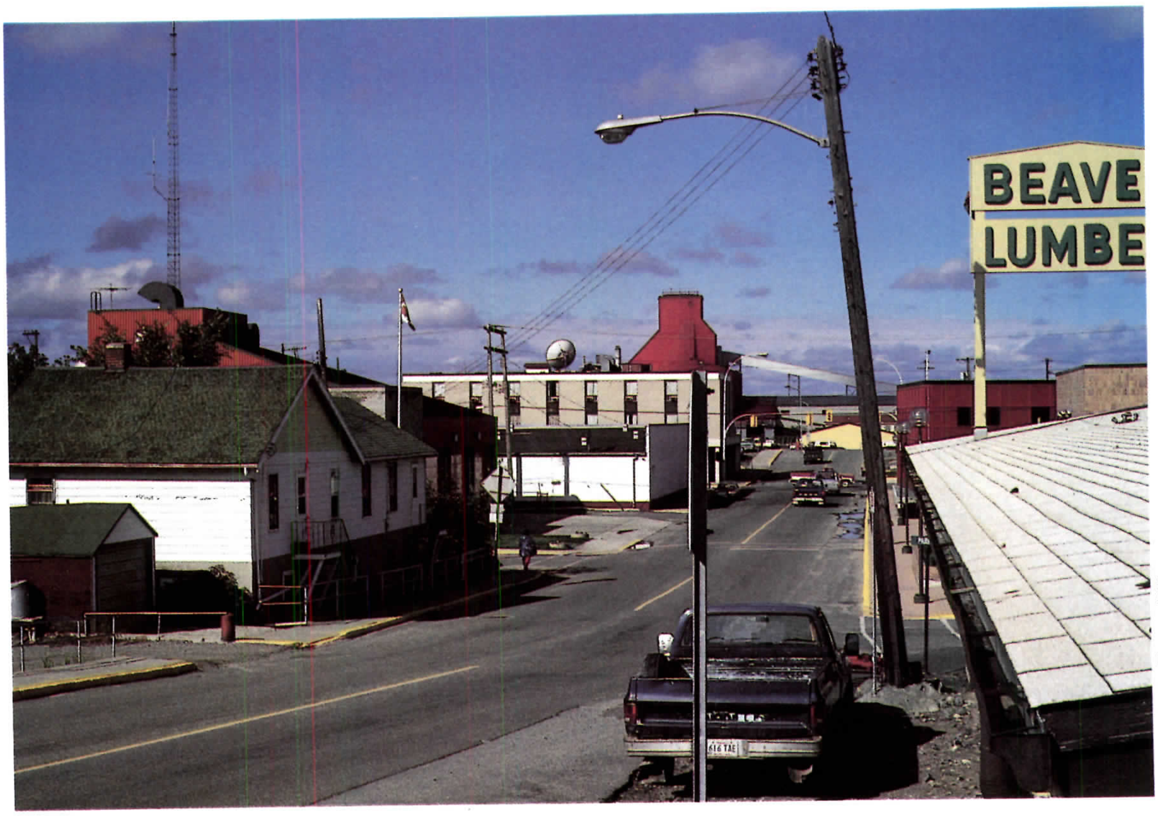
Gerry Kopelow



Gerry Kopelow

Forrest Wilson

Left, the summer sun draws cubist patterns on the atrium vestibule. This page, doors of bronze and horizontal bands of copper and zinc provide bright counterpoint to the building's industrial esthetic.



Photographs by Forrest Wilson

Top, mine head frames sprout on the flatlands of Manitoba near Flin Flon. Above and right, although the Provincial Center is not architectually contextual, it seems to sit among friends—the modest frame buildings and mine heads in downtown Flin Flon. The 50-year-old town is located 400 miles north of Winnipeg.

linking second floor office clusters. It says plainly, "The law is but our creation." The bridge is cable-suspended and has a slight sway reminiscent of suspended scaffolding in mine shafts. The stolid concrete blocks of the courtroom contrast with the steel's vitality. A young girl, perhaps 18, said, "I love the cable bridge. I wish it would swing."

This is a convivial structure. Its ends bear lightly on the hollow core plank at either end, rebounding like the human body when stressed. Threaded cables suspend it securely at quarter points. If stressed beyond endurance it would sag.

Ron Keenberg was no stranger to Flin Flon when he designed the Provincial Center. Ten years earlier, he had staked out a "bush camp" 70 miles to the east and made friends among the local hunters, trappers, and townspeople.

People in Flin Flon have seen more machinery than people in Winnipeg, he says, and people who work with machinery are interested in machinery. They like to look at it. Someone recently wanted to know if the Provincial Center was a heating plant. "I think it does look like a heating plant," Keenberg says. "It looks like industry, and Flin Flon should be proud of its industry. And proud that its industry is rooted in the mines."

The province of Manitoba has demanding energy standards. The center's windows face west to gain heat during the day, when the building has to be heated to its working temperature. During the summer the sun sets almost north at the end of its swing far down on the horizon. When offices close at 5, the sun is southwest. No work goes on in the atrium. If the temperature in the summer reaches 76 to 78 at 3:30, nobody is bothered. All the work spaces are set away from the windows, and air-conditioning is zoned into them. The building, its architects claim, is one of the most energy efficient in the province.

This is not the kind of building the good Flin Flonners expected. No genteel brick facade stretches over a concrete frame to satisfy a middle class longing for applied architectural art, so patently supplied by the neighboring city hall. There is no polite hint of gracious, tree-lined streets. The rippled bright red metal facade has nothing whatever to do with polite Palladio.

The Provincial Center building triggers a proud nostalgic memory of the mines. It stands as an assertion of the strength it takes to live, mine, and build in this place, and to love it. □

Pervasive Phenomenon Of Prefabrication

It has become virtually integral to building.
By Douglas E. Gordon and M. Stephanie Stubbs

The preceding story of the Provincial Center office building in Flin Flon illustrates one of the most common approaches to building industrialization and prefabrication: a "kit of building parts" assembled to tight specifications—a Tinkertoy methodology honed to an art. At the opposite end of the industrialized spectrum is another major approach, in which large chunks of a building are premanufactured and delivered to the site, needing only to be connected to form a building whole.

The permutations in between are so varied and all-pervasive in today's building industry that any discussion of prefabrication versus standard on-site construction is hampered by a difficulty of definition. Twenty years ago gang-nailed wood trusses would be included in a discussion of new prefabrication concepts; ten years ago movable full-height partitions might have been a topic of such discussion. Today both are elements of the standard design palette.

"There is no way to define a line between 'standard construction' and 'prefabricated construction,' because the line is blurred to begin with, and moving all the time," says Gunter Schmitz, professor of the advanced building technology program at the State University of New York at Buffalo school of architecture. He cites windows and office furniture systems as other examples of prefabricated components that have become standard building elements.

The primary impetus that seems to attract owners to pre-engineered and prefabricated buildings is financial, Schmitz says. Savings in cost over standard construction depend on the amount of finishing done in the factory and on the transportation costs. "One of the most economical forms of prefabrication in this country is semi-finishing components," Schmitz says.

The foremost financial benefit of prefabrication is not that it is necessarily less expensive per square foot than equivalent site construction, but that the amount of site work is lower and financially more predictable. Clients budgeting for new construction face fewer potential schedule delays with prefabricated buildings—the vagaries of weather have less of a chance of delaying construction, for example. The trade-off as one considers ever larger factory-built components, of course, is design flexibility.

Another attribute of prefabrication is the benefit of higher-quality workmanship derived from controlled factory conditions. "With prefabrication, there are fewer surprises on the construction site," Schmitz says. "For example, if one uses prefabricated walls, the major site concern becomes controlling the quality of the joints. The quality of the panels themselves is predetermined."

One element of prefabricated systems that cannot be underestimated is joint tolerance, says Bernard P. Spring, FAIA. In fact, improper fit has been a major inhibition to more widespread use of prefabricated building systems, he says. Even when tolerances seem acceptable, variances in fit can add up quickly. Schmitz warns that tight construction administration is imperative to proper assembly of prefabricated systems.

Factory prefabrication of building components, in lieu of on-site construction, has its roots in residential construction (see ARCHITECTURE, October 1986, p. 85).

More recently, prefabrication of major building chunks has spread to first industrial, then commercial structures of considerable size. For example, factory-built modular methods have been around for some time. What are fairly new and interesting are multistory modular buildings and pre-engineered commercial structures that can span 80 feet with heights of 100 feet or more.

PBS Building Systems Inc., of Anaheim, Calif., completed only its second multistory modular application in 1982, and its own multistory headquarters in Anaheim this past year.

The PBS Systems approach permits single-source control from building permits to interior finishes, resulting, the company claims, in buildings erected in less time, with greater cost efficiency. PBS claims that their approach requires less time than is traditional for all phases of design, construction, and finishing, cutting overall time in half.

PBS Systems' 24,000-square-foot, three-story headquarters was constructed in 120 days using a 12x13¾x60-foot module, a size governed by highway transportation regulations. The modules were

Uniformly sized modules are apparent during construction (below right). Glazing that breaks up the modular grid, a tile skin, and exterior trellises soften the modular appearance (below left).

Courtesy PBS Building Systems, Inc.

Courtesy PBS Building Systems, Inc.

delivered to the site, complete with insulation, plumbing, and electrical elements modified to suit each bay's particular needs. The module interiors were completed with a variety of standard finishes, and the exterior clad with 1x1-foot limestone tile veneer, tinted reflective glass, and a single-ply membrane roof.

PBS Systems' in-house architects, consulting with Gensler & Associates of Los Angeles, took advantage of the ease of creating setbacks with a modular system by having the building's ascending levels take three giant steps away from the sun for shading control.

When working with outside clients, PBS architects convert program needs into a floor plan that is divisible into a modular grid. PBS then fabricates modules with a varied percentage of factory-installed interior elements and finishes, depending on client demands and code restrictions. The modules are welded to base plates in a prepoured concrete foundation and spot welded together. Trusses are bolted or welded to the modules.

If the PBS Systems headquarters reflects the state of the art for commercial prefabricated construction, Ryland Modular Homes, of Columbia, Md., reflects services typical of today's more advanced U.S. residential prefabricators. Ryland, operating out of two plants in Maryland and one in Virginia, typically sells to independent builders from Connecticut to North Carolina. The company offers houses (of 50 different varieties, from townhomes to large single-family dwellings) that are 90 percent prefabricated and are erected by Ryland-trained crews on site-built foundations.

Factory workers assemble trusses, studs, and joists on pre-engineered forms to assure that prefabricated components are absolutely level and square. Modules are finished at the factory with wiring, plumbing, stairs, paint, and carpeting.

At the site, Ryland crews attach the first-floor sections to a poured-in-place foundation slab and stack second-story units directly on top of the first. The ceiling of the lower floor unit comes prefinished with the floor of the upper unit, eliminating the need for double floor joints. According to Catherine R. Barham, Ryland's marketing coordinator, the units typically require two weeks to install completely.

The speed with which prefabricated housing can be installed, and the minimum of disruption of surrounding activities compared with that of standard on-site construction also have attracted the attention of designers of correctional and detention facilities.

In many jurisdictions in the U.S., jails and prisons are crowded to the point that judges are demanding either increased housing or early release of inmates. With a typical lag of three years between preliminary planning and finished security housing, interest in a modular approach is increasing.

Istvan Lendvay, chief of facilities design planning for the Ontario, Canada, ministry of correctional services, describes how he was attracted to steel prefabricated housing, which the ministry first used in 1985 as infill emergency housing for five local jails, all in Ontario, Canada, that were severely overcrowded.

"In 1972, I saw concrete housing modules being made in San Antonio for shipment to Saudi Arabia, which piqued my curiosity. I learned later that similar housing units were being used in jail housing, and I took the idea with me to Canada.

"We have the same overcrowding pressures in Canada as you see in the U.S. In the metro facilities we were having to double bunk cells, but the real trouble was in the local jails," Lendvay says.

With the need to build housing quickly, the ministry's program required that a modular system fit within jail exercise yards, the individual components be small enough for four men to handle, the assembly sequence be straightforward so that housing could be built with inmate labor, and cost be comparable to standard construction.

With inmate labor, the cost per bed turned out to be $42,000—comparable to standard construction cost—taking about a third of the time to complete as standard construction.

"Though construction was straightforward, we found that components did not always fit together the way they were intended," Lendvay said. "Still, the system was basic enough that inmate labor proved suitable. Inmates even made the beds from steel tubing." □

One approach to prefabricated housing is construction of transportable modules (below). Another is production of components easily site-fitted, which can be configured in various ways (right).

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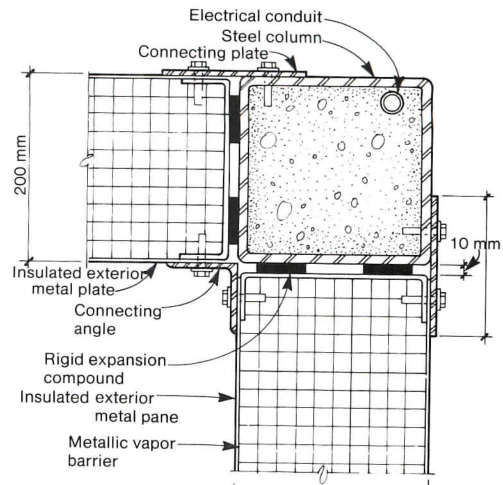
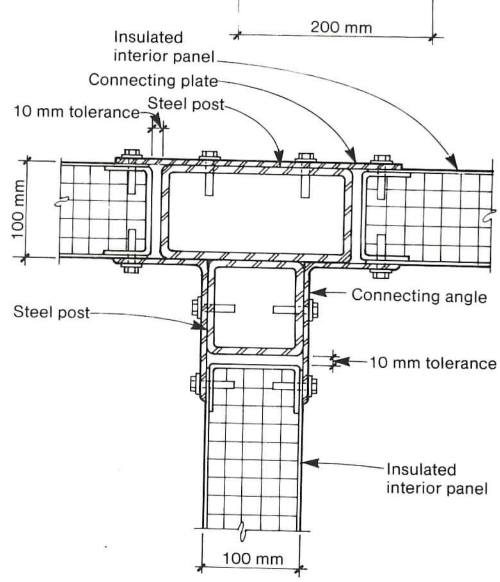
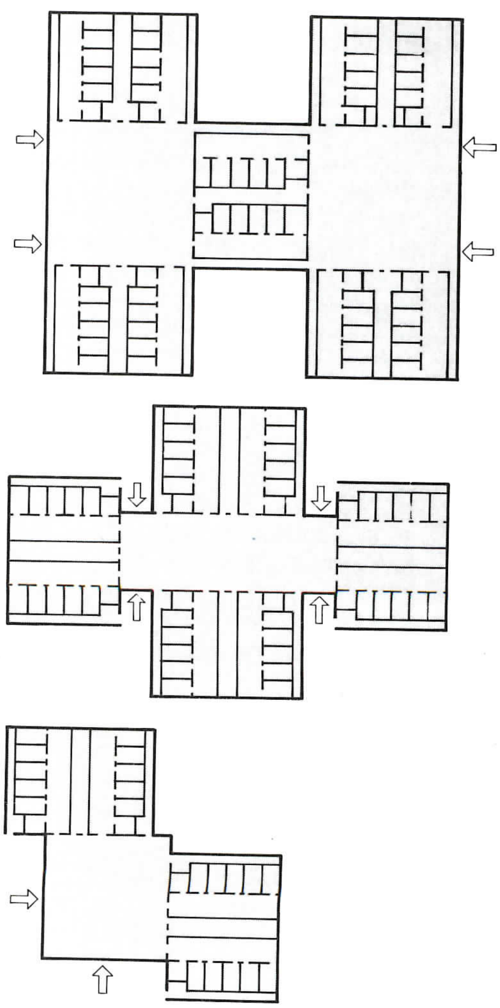






Windows Are Far From What They Used To Be

Glazing and film technology has virtually exploded.
By Nora Richter Greer

Glazing technology has so improved that windows can now be thought of as controllable membranes, letting in or reflecting out selected rays of the sun while also manipulating the transfer of heat from inside to out. Spurred on by the energy crisis of the 1970s, development of sophisticated window coatings has made it possible to significantly reduce a building's energy consumption and maintain thermal and visual comfort.

These selective windows foreshadow the more intelligent products of the future—glazing systems that will be electronically controlled to adapt to changing thermal or visual requirements. Some experts even believe these "smart" windows, with their ability to respond quickly to precise weather conditions, will have higher insulative values than wall and roofing systems.

The technological advances have resulted in an abundance of glazing products. "Surface low-e glass, as well as uncoated and coated acrylic and polycarbonate (PC) sheet, are now offered in a sometimes bewildering range of grades and performance characteristics," says Bradley J. Davids, director of marketing in the commercial division of Southwall Corporation. As a result, Davids adds, "it is becoming less necessary to begin the specification process with the choice of a glazing material and then force the overall design to conform to it. Rather, the challenge is now to find a material that best fits a design scheme."

The glazing area that has experienced the most phenomenal growth in recent years is that of solar control films that are applied directly to the surface of the glass. Metalized window films for solar control were first introduced in 1961 and were used mainly on the windows of retrofit projects. It was discovered that if an aluminized polyester film was placed on a plate of glass, that film would reflect solar rays away from the window, thus reducing the amount of solar heat entering the room. Where these sun-blocking qualities proved most effective was on large commercial buildings where internal heat gain from people and machines was high and in residences in warm climes. Early on, though, it was recognized that when glass was coated in such a way the optical properties were diminished.

As the coating substance on the glass became more reflective, the optical problems would increase, because the film would block more and more light as well as solar heat. (Generally speaking, the transmittance value of clear glass is 80 to 90 percent, of tinted glass 40 to 50 percent, and of highly reflective glass 8 percent.) To compensate for the absence of natural light in the interior, artificial illumination had to be significantly increased. In addition, adjacent buildings would receive the heat and glare reflected off the mirrored glass building. Overall, the energy savings of the films were significant: The 3M Corporation found their silver sun control film to admit 25 percent of the solar heat compared with tinted glass that in the same environment would admit 70 percent.

At the same time the demand rose for colored films. Bronze, smoke, gold, and amber, among other colors, were achieved by adding a second layer of tinted polyester to the glass surface that would ultimately face outward. But these films proved less effective in controlling solar gain than the noncolored films.

With the energy crisis in the early '70s came a strong interest in reducing heat loss from inside to outside. "Research showed polyester films have an irregular response to long-wave (infrared) heat, tending to absorb certain long-wave radiation rather than acting as a transparent medium," explains James Reynolds, marketing specialist for construction programs at General Electric's plastics group. So any long-wave (infrared) energy thus absorbed from the inside is eventually conducted outside. Introducing films more transparent to infrared frequencies would then allow the heat to reach the metalized film layer and then be reflected back into the room.

"These window insulation films," Reynolds adds, "improve heat retention by an amount equal, in some situations, to an additional pane of glass, while still providing the standard benefits of solar heat control and ultraviolet control. . . . Heat saved by this film, working 24 hours a day, often is significantly greater than the useful heat that would be gained from the sun during the heating season if the film were not in use." To tone down the shininess of these films, metals other than aluminum were used—copper, stainless steel, and titanium.

The newest films are able to react differently to the various wavelengths found in electromagnetic radiation. "With primary emphasis on radiant heat loss and secondary emphasis on solar heat gain, these fourth-generation films are best suited for using natural light, because they transmit more visible light though the window," Reynolds says. The films approach the optical characteristics of clear glass. In addition, only 2 percent of the sun's ultraviolet rays penetrate the films. They are also resistant to shattering and scratching.

In 1983 a new type of glass was introduced—low-e, or low emissivity, glass. Originally designed for insulative purposes, it consists of two panes of glass separated by an air gap, usually one-half inch. The inner surface of one of the two panes is coated through a pyrolytic or sputter vacuum process with a thin film consisting of multi-layers of metal or metal oxide. Only a few atoms thick, the coating is transparent to the sun's light and heat but does not transmit long-wave infrared radiation emitted by warm indoor objects. Low-e glass transmits 70 to 80 percent of the sun's light.

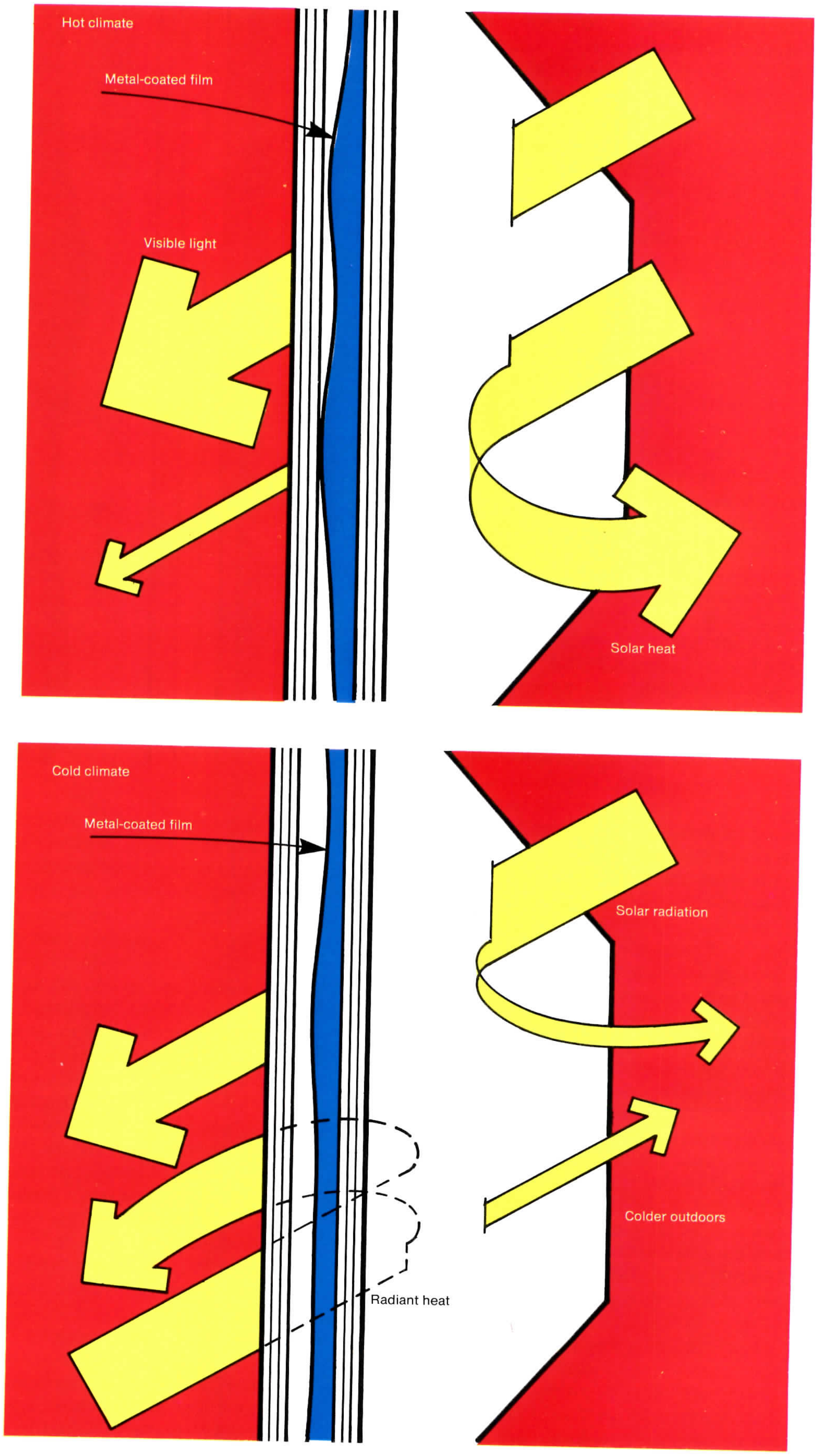
"In an ordinary window, this heat is radiated across the air gap to the outer pane, whence it is lost to the outdoors," writes Herb Brody in *High Technology.* "But a low-e coating applied to the air-gap surface of the inside pane stymies heat radiation across the gap. Unable to escape via its normal route, heat builds up in this glass pane, eventually being radiated back into the room. Low-e windows trap heat indoors, providing the same insulating value as a third pane of glass—triple glazed windows are available but seldom used, because of high cost and weight." Low-e boosts a double-pane window's insulating value by about 50 percent—from R-2 to R-3.

In this same way, a low-e window reflects long-wave infrared heat away from the building's exterior in the summer. In warm climates, glass makers often combine low-e coatings with reflective or tinted glass.

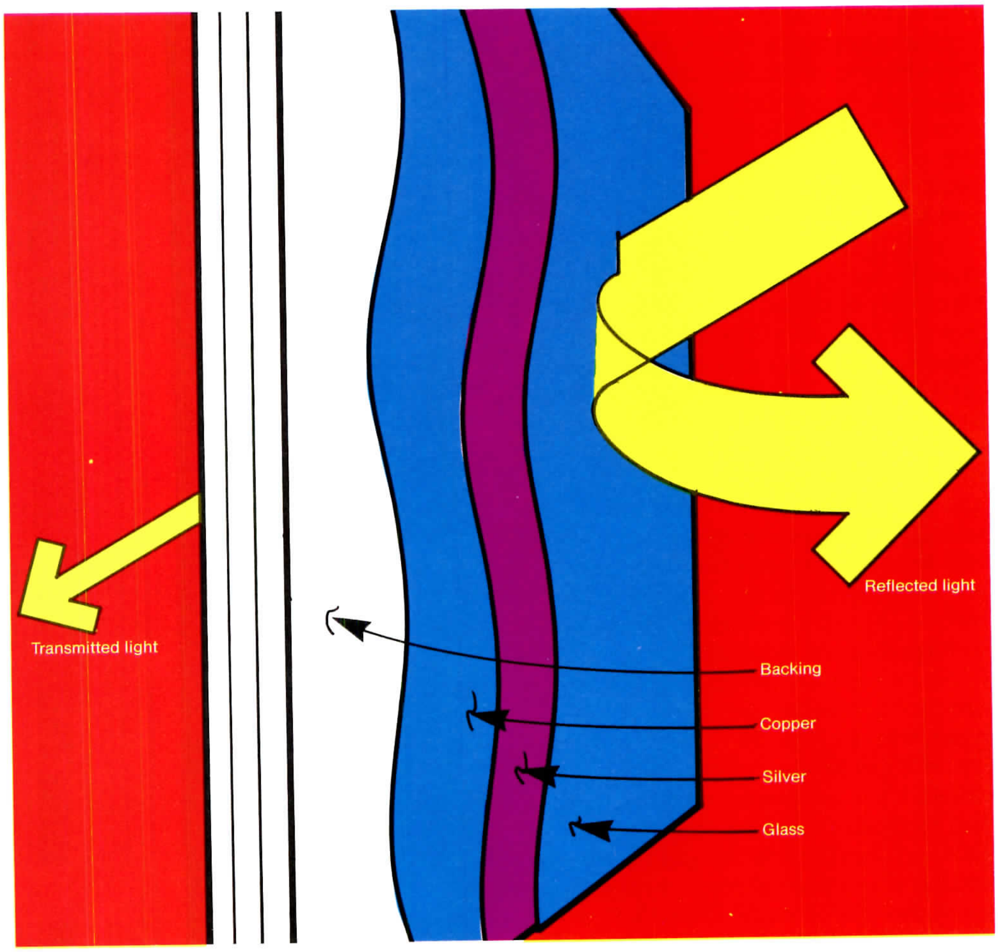
Low-e coatings are applied two ways—by pyrolytics and by a magnetic sputter deposition. Usually sputter-coated glass offers higher U values but can only be applied to the interior surfaces of insulating glass units. Pyrolytic-coated glass has lower U values but is more flexible in use.

In the sputter vacuum process, as explained by Reynolds, "metal oxide and silver are applied in a vacuum chamber off-line after glass has been produced. Ionized process gases are admitted into an evacuated chamber at very low pressure and high voltage. Metal targets on

Low-e glass uses a thin metal-coated film to admit light but reject heat.



Mirror glass layers silver over the glass, then copper, then a protective backing.



the coater are then bombarded with gaseous ions, dislodging individual molecules of metal from the target and gradually depositing them on the glass surface as a uniform, ultra-thin coating. The coating is applied in a triple layer: a heat-reflecting metal layer sandwiched between two anti-reflective coatings, which makes the glass nonreflective."

Sputter coated glass is considered "soft," in that it can be easily scratched or marred. It also tends to oxidize with exposure to air because of its silver content. Therefore, this type of coating can be used only on the interior sides of sealed insulating glass units.

Pyrolytic refers to a "molten glass that is sprayed with a thin oxide solution on line in the float process," Reynolds says. "A physiochemical reaction molecularly bonds the coating to the glass." Considered a "hard" material, pyrolytic coating is as abrasion-resistant as the glass it is on and can be tempered, heat-strengthened, or drilled after the coating has been applied. Such coatings will not oxidize.

In Southwall's Heat Mirror product the low-e coating is found not on the glass but on a thin polyester membrane spaced halfway between two panes of glass, thus creating a second air space for more insulation. "Compared to typical reflective glass," Davids says, "windows with Heat Mirror can block an equal amount of solar heat, but transmit two to three times the natural light, provide twice the thermal insulation, and maintain a nonreflective appearance."

Another type of insulating glass that has been used widely in Europe is gas-filled glass. Voids between panes are filled with nontoxic, inert gases that are heavier and less conductive than air. In the U.S., Marvin Windows manufactures such a unit using argon gas combined with sulfur hexafluoride. Krypton gas has been used by other manufacturers.

Says Jim Krahn, of Marvin Windows, "If you take a standard glass unit with one-half inch air space we would publish a U-value of .49. If you would change one side of the glass to a sputter coat low-e we would change that figure to a U-value of .31. Taking that same unit and adding argon gas, we will change the U-value to .25."

Krahn offers a few words of caution about gas-filled windows in general: "There are other gases that are better than argon as far as the conducting ratio, but those gases may have very low dew points, so if it got cold outside you would end up with a fog in your window. You also have to be sure that the gas you use and the sealants you use are compatible." There is also the question of permeability. Different gases have different permeability rates, as do different sealants. According to Davids, the units in Europe are considered long-life performers—losing perhaps 10 to 20 percent of the gas over a 20-year period.

It seems very likely that materials of higher insulative values will be developed that can be placed in the air space between two panes of glass. In fact, one is now being developed at the Lawrence Berkeley National Laboratory in Berkeley, Calif.: aerogel, a material that has an insulating value of R-20 per inch—or five times the efficiency of conventional double-pane windows and three times that of a low-e window.

As described by Brody in *High Technology:* "This performance arises from the material's structure; particles of pure silica hook together to form cavities only a few nanometers (billionths of a meter) in diameter. These tiny holes trap and isolate air molecules, preventing them from transferring thermal energy to other molecules. And because the pores are much smaller than visible light waves, aerogel is clear—one of the few known materials that are both transparent and porous." The material is expected to be commercially available by 1990.

Two other technologies that may ultimately create more solar responsive windows currently are being explored. One is photochromics where the coating on the glass darkens in response to bright light. While this technology has long been used in sunglasses, its use in buildings poses a major problem—that of blocking the sun on cold, bright days, when both solar heat gain and natural lighting are desired.

The other technology is electrochromics, whereby a window could be switched on and off like an appliance, or even connected with the building's thermostat so that when the building got warmer the windows would tune out more heat. Or, on a cold morning, the thermostat would automatically adjust to let heat in.

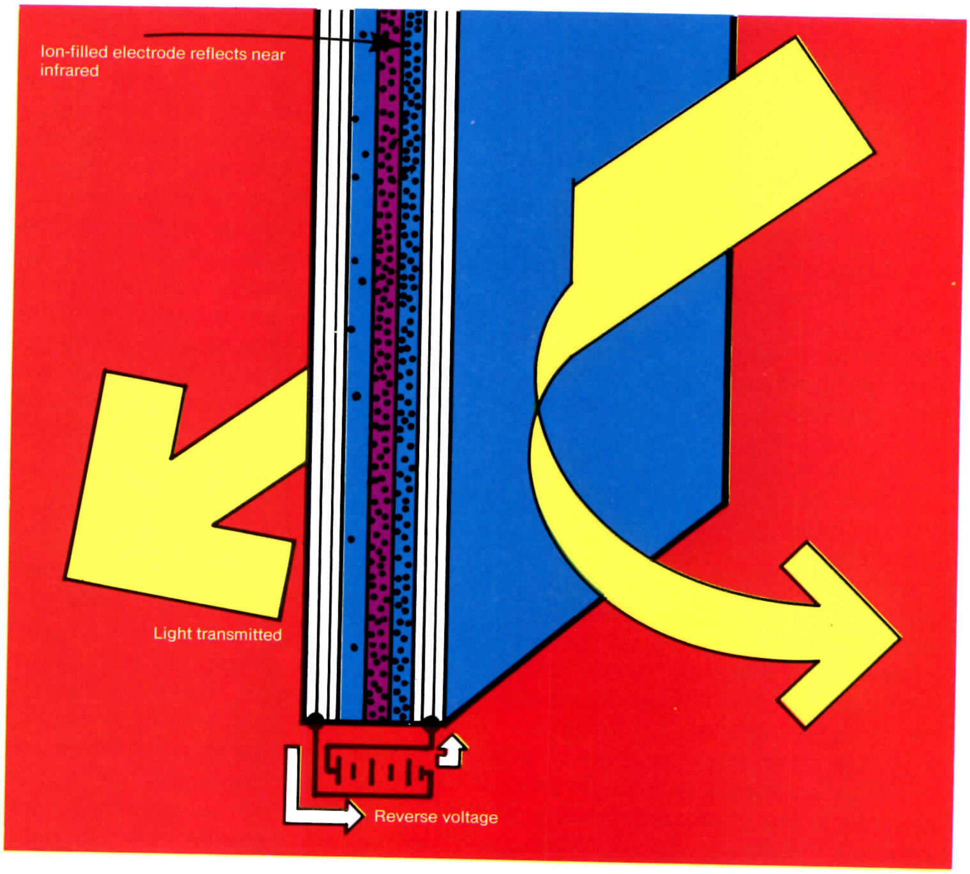
Brody gives this description of how the system would function: "An electrochromic window is coated with special materials in multiple layers to yield two electrodes sandwiching a conductive electrolyte. In the absence of electric current, both electrodes are transparent. But application of a voltage forces some of the electrolyte's ions into the crystal lattice of one of the electrodes; in this altered state, the material turns less transparent. Reversing the voltage extracts the ions from the electrode, leaving it clear again."

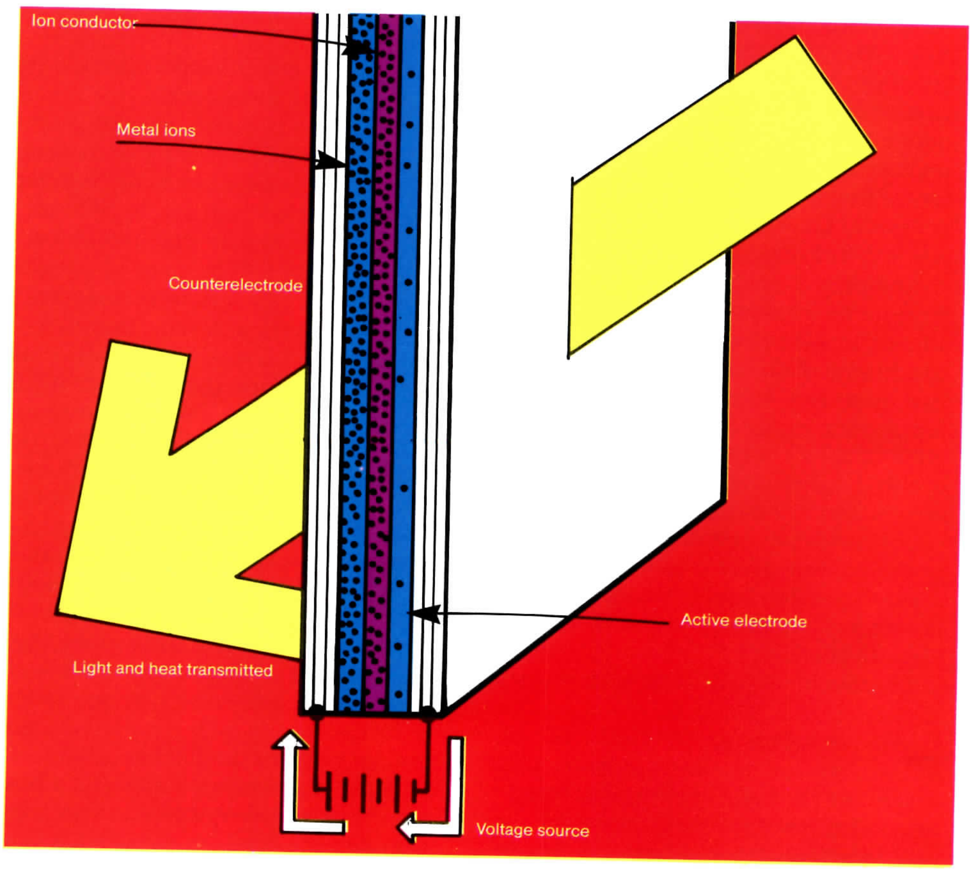
While this technology won't be commercially available for use in buildings until the early 1990s, it will likely debut earlier in automobiles. Already Nissan Motors has used an electrochromic sunroof in one of its prototype cars—the Cue-X. The amount of light admitted by the roof could be set anywhere between 5 and 30 percent.

"We think," says Steve Selkowitz, of Lawrence Berkeley Laboratory's windows and daylighting group, "that by 1989 you will see at least a number of Japanese cars and maybe American cars with some of these switchable glazings. When tens of thousands or hundreds of thousands of those are on the road, and an architect says to a building owner, 'We would like to propose the use of these switchable glazings—the same glazing that you have in your Chevrolet,' or something—then I think the market acceptance in the building sector will be somewhat better. . . .That of course assumes that the price is right."

Overall, what these new and developing glazing technologies mean for architects is more choice and more flexibility in window design. "You can look at coating with a new degree of freedom, in that, in the good old days, if you wanted to improve energy efficiency, then you had to get cumbersome, heavyweight, or complex windows with shades," says Selkowitz. "Now the coatings give both window designers and architects the ability to squeeze much greater performance out of what looks like the same old architectural package. . . . Now industry is beginning to think about other, more sophisticated coatings. So, the success of low-e sets the stage for coated glazings in windows doing a lot more in five to 10 years than people would have ever imagined possible." □

Reversing electrochromic window current switches it from clear to reflective.





Seismic Design: Now Comes Base Isolation

Devices for detaching buildings from the ground gain wider use. By Christopher Arnold, AIA

Because of today's concern for liability, engineering innovations must be exhaustively tested and analytically proven to a degree unknown in the past. Early engineers were respected for their ability to design from first principles and produce designs that were conceptually right even though analytical or laboratory methods did not exist that would remove all doubt. For the most part, the great early engineers removed doubt by force of their personality and confidence. They took risks that would be unthinkable today.

In seismic design, the great example of this was Frank Lloyd Wright and his seismic scheme for the Imperial Hotel in Tokyo. He conceived the entire structural and foundation concept, at considerable variance from accepted practice. At a late stage of design, he also arbitrarily halved the force values calculated by his Japanese engineering consultant. Although his hotel performed well in the 1923 Kwanto earthquake, this was due primarily to less publicized measures than his much-touted foundation system. Indeed, Wright's concepts were rejected by seismic engineers although they presaged in a surprising way the only really new concept in seismic design today, a concept that is only now entering significant application. In focusing on the building's attachment to the ground, Wright realized the importance of reducing the forces that were transmitted through the ground to the building, even if his method was not technically correct.

The field of seismic design is, as perhaps befits a subject directly concerned with both life safety and uncertainty, cautious and slow to innovate. In practice, improved seismic design does not represent a market opportunity because seismic safety is generally taken for granted. Like other code-dominated issues, and like airplane safety, seismic safety has never been much of a selling point. Money diverted to improved seismic resistance is often seen as a detraction from more visible and enjoyable attributes.

Improvement in seismic safety, since about the time of the San Francisco earthquake of 1976, has been due primarily to acceptance of ever increasing force levels to which buildings must be designed. Innovation has been confined to the development and acceptance of economical structural systems that perform reasonably well, accommodate architectural demands such as open exteriors and the absence of interior walls, and enable materials such as steel and reinforced concrete to compete in the marketplace on near equal terms.

Christopher Arnold, AIA, is the president of Building Systems Development Inc., a San Mateo, Calif., firm specializing in architectural planning, research, and analysis.

Flexibility finesses force

The vocabulary of seismic design is limited. The choices for lateral resistance lie among shear walls, braced frames, and moment-resistant frames. Over the years, these have been refined and their details developed, and methods of analysis and modeling have improved and reduced uncertainty. But the basic strategy has not changed: construct a very strong building and attach it securely to the ground. This approach of arm wrestling with nature is neither clever nor subtle, and it involves considerable compromise.

Although codes have mandated steadily increasing force levels, in a severe earthquake a building may still encounter forces several times above its designed capacity. This situation is quite different from that of vertical forces, in which safety factors ensure that actual forces will not exceed 50 percent of designed capacity unless a serious mistake has been made. For vertical forces, this is easy to do. But to achieve a similar performance for seismic forces, the structure would be unacceptably expensive and its architectural impact would be extreme. This discrepancy between seismic demand and capacity is traditionally accommodated by reserve capacity, which includes uncalculated additional strength in the structure and often the contribution of partitions and exterior cladding to the strength and stiffness of the building. In addition, the ability of materials such as steel to dissipate energy by permanent deformation—which is called ductility—greatly reduces the likelihood of total collapse. A great earthquake is a possible though unlikely event, so we take a gamble.

In the last few years, an alternative to the brute force response to nature has finally reached a stage, if not of fruition, at least of application. This approach is obvious and easily explainable at the cocktail party level: Why not detach the building from the ground in such a way that the earthquake motions are not transmitted up through the building, or are at least greatly reduced? This conceptually simple idea has required much research to make it feasible, and only with modern computerized analysis has it become possible. The first patent for such a system was recorded in England in 1909. Final application has depended on very sophisticated materials research into both natural and composite materials, mostly in Great Britain and New Zealand, that provide the necessary performance.

This new concept, now generally termed "base isolation," meets all the criteria for a classic modern technological innovation. Imaginative advances in conceptual thinking were necessary, as were materials new to the industry, and ideas have developed simultaneously on a worldwide basis. But the method threatens conventional and established design procedures, so the road to base isolation innovation is paved with argument, head shaking, and bureaucratic caution. All, to some extent, well-intentioned and necessary, given our litigious society.

It's all in the bearings

Beyond the general concept of detaching the building from the ground lie some more subtle concepts. Base isolation works primarily by two methods. One is designing for a single, large, controlled lateral movement (or drift) at the building base rather than allowing drift throughout the height of the building. The other method is to "detune" the building, making its natural period of vibration different from that of the ground beneath so that amplification will not occur. (If the periods of vibration of the ground motion and the building coincide, the building will resonate and its motion at its upper levels will greatly exceed that of the ground.) Base isolation achieves detuning by lengthening the natural period of the building so that it moves slowly while the ground beneath vibrates more rapidly. The building above the isolators is designed to be stiff so that, as it moves back and forth, the energy of the earthquake is dissipated in the bearings that attach the building to the ground rather than throughout the building itself.

For the bearings to achieve such performance, some unusual properties are necessary. The bearings must be strong in compression, for they must still support the weight of the building and yet be able to accommodate large lateral movements. Springs, for example, would allow large lateral deflections but would not simultaneously support the building. Ball bearings would support the building and allow sideways movement but would not automatically provide a returning force, so that once the building started to move laterally it would tend to continue.

Many concepts meant to achieve the desired performance have been researched. They include schemes incorporating torsion bars, similar to those used in automobile suspensions, to introduce energy dissipation and damping. A new system now under test uses ball-bearing-type supports in shaped housings that automatically introduce increased damping forces as the building moves. The most highly developed bearings so far are those that use natural rubber laminated with steel, sometimes with lead introduced as a damping agent. New Zealand, a leader in base isolation research, technology, and practice, has two base isolated buildings completed. One uses rubber/steel/lead bearings and the other uses a torsion bar system. Four nuclear power plants have been completed using a rubber and steel system developed in France.

In Japan, which has long embraced a "strong and stiff" design philosophy, base isolated buildings are now under construction, and research is under way. Base isolated buildings have also been constructed in Greece, Yugoslavia, Mexico, and China. Even more use of the technology has been applied to bridges. Some 30 bridges have been constructed in New Zealand using the rubber/steel/lead technology, and two freeway bridges in California recently have been retrofitted with the same system.

U.S. has largest application

The first base isolated building to be constructed in the United States, and the largest in the world, is the Foothills Communities Law and Justice Center in Rancho Cucamonga in southern California. The architects are HMC Architects of Ontario, Calif., with schematic design by architectural consultants HOK, of San Francisco. Taylor and Gaines, of Pasadena, Calif., are the structural engineers, with base isolation consulting by Reid and Tarics, San Francisco, and Leroy Crandall Associates, Los Angeles.

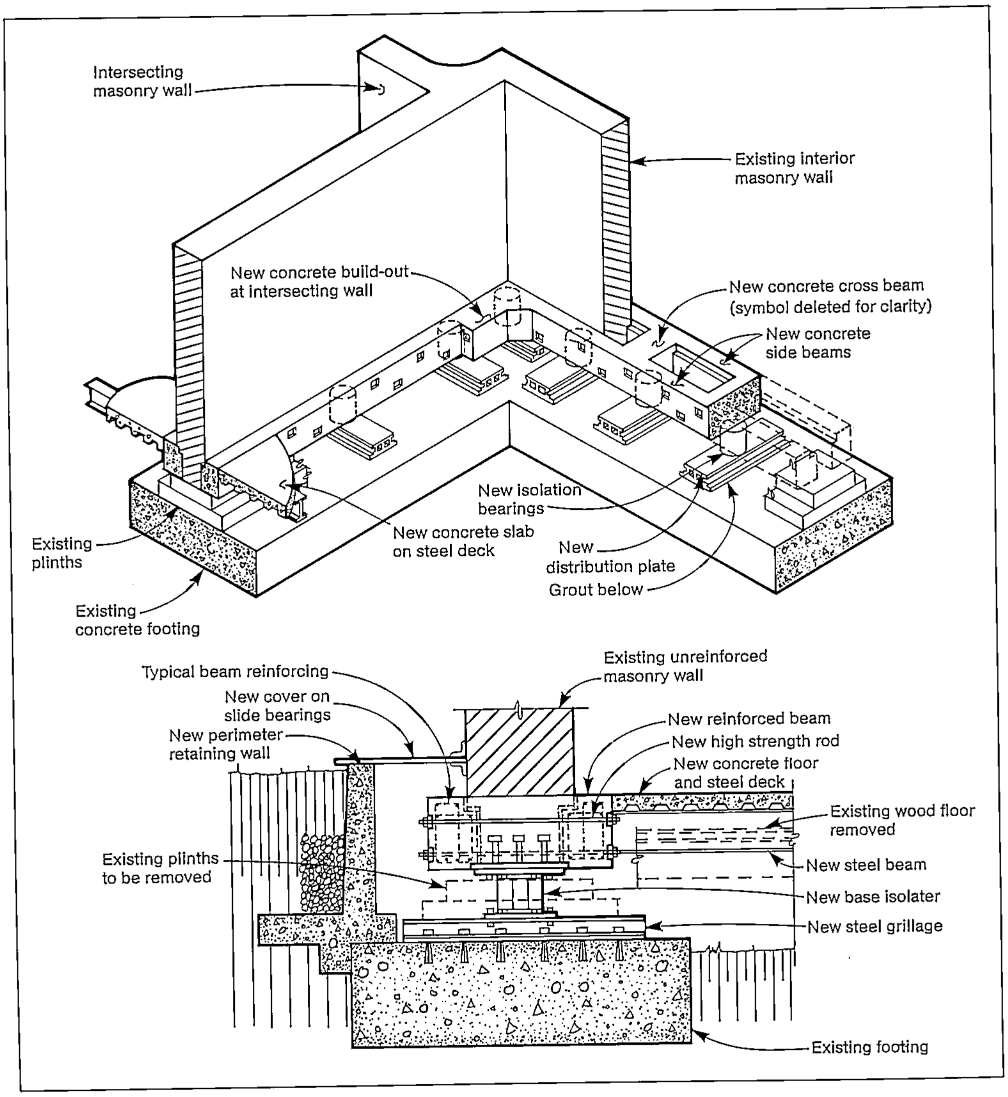
The four-story building is 414 feet long, 110 feet wide, and 76 feet high. It is supported by 98 isolators, each consisting of a sandwich of 23 layers of natural Malaysian rubber and 22 layers of 1/8-inch steel plate. The sandwich is retained between a 1½-inch-thick steel plate at top and bottom. This assembly can support up to 1.2 million pounds, yet stretch horizontally up to 15 inches in any direction. These isolators are 17 inches high and 30 inches in diameter, and are located under each column. A backup system consists of steel stub columns upon which the first floor could rest should one or more isolators fail.

The building, which houses courtrooms, holding cells, and associated facilities, is designed so that it will suffer only minor nonstructural damage in the "maximum credible event" of an 8.3 Richter magnitude earthquake with an epicenter 13.5 miles from the site. Seismologists give a 50-50 possibility of such an event occurring within 30 years, which is well within the building's lifetime.

The isolators shift the building fundamental period from one second into the two second range, well outside the danger frequency of anticipated earthquakes. The building superstructure is designed as a stiff braced-steel frame. Interstory drifts for the isolated structure are reduced to 0.4 inches, compared with an estimated three inches for the fixed-base structure—a deflection that would result in major permanent deformations. Displacement at the base is estimated at 15 inches with a maximum acceleration at the roof of 0.40g., compared with 1.60g. for the fixed-base condition (1.0g., or 100 percent gravity, is the acceleration of a free falling body under gravity). Thus the isolators act as a filter so that the first floor experiences one-half, and the roof one-quarter, the accelerations of the fixed-base design. The base isolation system adds approximately 3.5 percent to the building cost, a figure that should be recovered from reduced nonstructural damage in the first moderate earthquake.

Base isolators support each of 98 columns of the Rancho Cucamonga facility.

The cutaway at the interior wall section (below, top) illustrates placement of the base isolators in the Salt Lake City building retrofit. A typical isolator (below, bottom) attaches to existing footings. The overlay (right) indicates predicted motion of the unprotected 12-story tower during an earthquake.



In October 1985, the building experienced an earthquake with a Richter magnitude of 4.8 at the site. The earthquake was well below the design earthquake, but still the building, which is heavily instrumented, performed as predicted and no amplification of motion at the roof level occurred.

The origins of this project are interesting, for the drive to innovate came not from the design team but from the building owner, a county bureaucracy. Some years ago, the chief administrative officer of San Bernardino County, Robert Rigney, gave the opening speech at a conference on base isolation in Malaysia. To his surprise, representation from the United States was small. The application of the idea all seemed to be taking place abroad. But the idea seemed to make sense. So on his return, Rigney set about exploring the use of such concepts in his own earthquake-prone county. A suitable building was found—the Foothills Communities Law and Justice Center—but schematic design was already complete and the design team had been selected for its expertise in conceiving innovative courtrooms and jails, not for structural innovation.

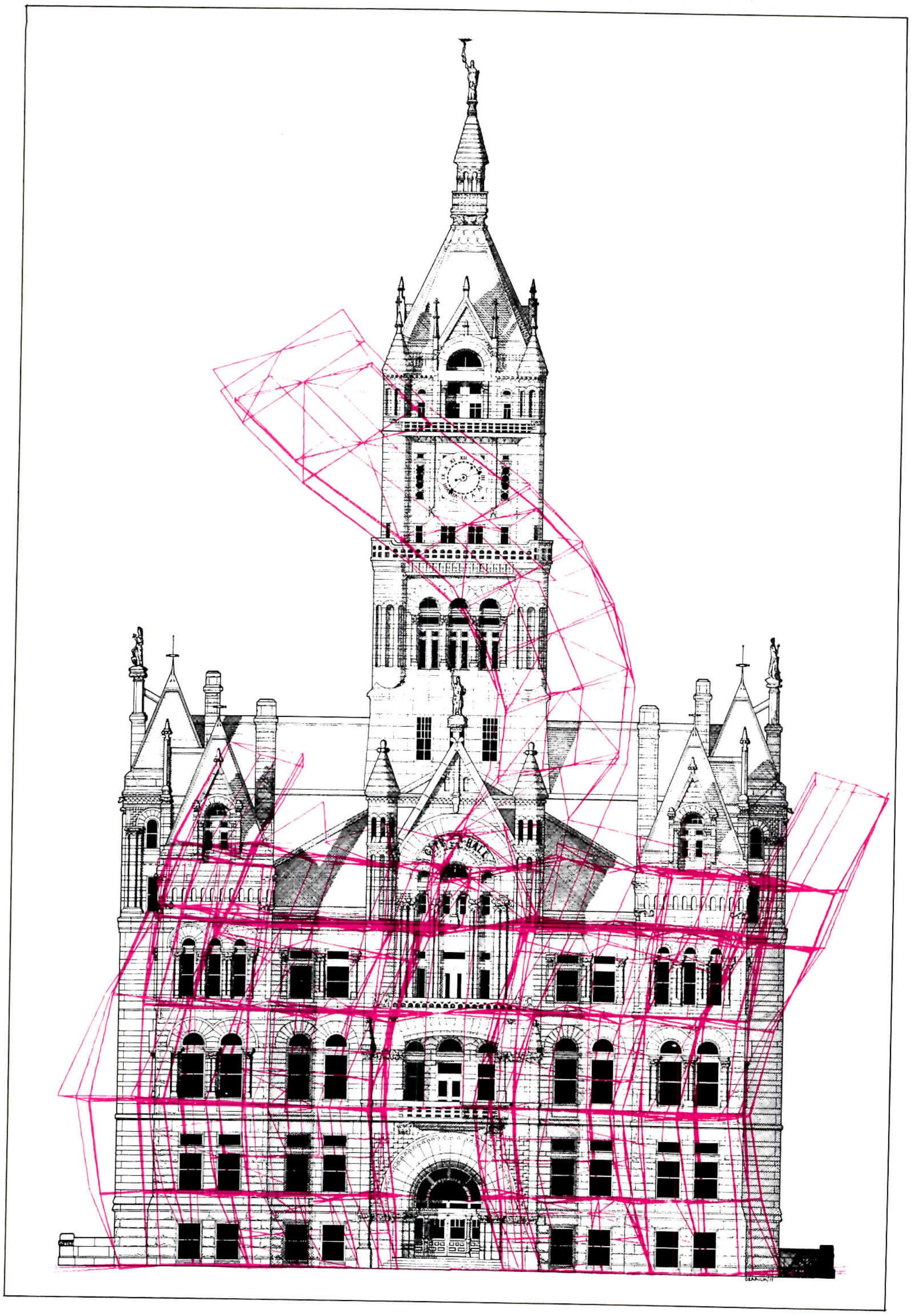
The county went ahead anyway. A research grant was obtained from the National Science Foundation to pursue the concept; base isolation consultants were added; trips were made to New Zealand, France, England, and Malaysia; review committees were formed; the building department was satisfied; budgets were set and met; and the job was done. As Rigney has said, local governments are meant to be administrators, not innovators. Yet this project shows that a conservative bureaucracy can break new ground and participate with the research community, if the grounds for such decision making are carefully prepared in advance.

Retrofit in Salt Lake City

The second base isolated system to be applied in the United States will be in the City and County Building in Salt Lake City, to be completed in 1989. This Richardsonian Romanesque revival building was constructed between 1891 and 1894 and is a National Register Historic Landmark. It is constructed of unreinforced brick load-bearing walls faced with sandstone. Seismological studies show that the building may expect to encounter ground motion up to 0.2g. during its lifetime, which is serious for a building of this mass and construction. In 1934, the tower suffered earthquake damage, and new cracks appeared following the distant Idaho earthquake of 1983.

This monumental building has five main floors and a 12-story clock tower. Highly ornamented, the building measures 130 x 270 feet in plan. The building is symmetrical in plan on both axes, and since its construction it has been occupied jointly by the city and county government offices of Salt Lake City. Each office occupies half of the building, divided along the east/west centerline. The central tower of unreinforced masonry is approximately 40 feet square in plan at its base and rests on four solid piers of sandstone that are L-shaped in plan and have a maximum dimension of 13 feet.

Unlike that of the Cucamonga building, the idea for this base isolation system came from the architects and engineers. The architects, the San Francisco office of the national firm of the Ehrenkrantz Group & Eckstut, also of New York City and Nashville, with engineers Forell/Elsesser of San Francisco, studied a number of seismic options before making a final recommendation of base isolation. Later, Burtch Beall, FAIA, of Salt Lake City, joined the team as associated architect, and E.W. Allen & Associates acted as civil and structural engineers for the entire work. Other engineering analyses were conducted by Reaveley Engi-



neers of Salt Lake City and Kariotis & Associates of Pasadena, Calif.

Beyond the obvious issue of seismic safety, the decision to use base isolation was primarily economic. Conventional strengthening approaches would require the insertion of large, internal, reinforced-concrete shear walls from foundation to roof with consequent total destruction of interior architectural components and finishes. With the use of base isolation, it is possible to reduce forces on the building superstructure to the point where concrete interior walls are unnecessary. Interior structural work is confined to new plywood diaphragms at the fifth-floor attic spaces to stabilize the top of the exterior bearing walls, and plywood shear walls are required within attic spaces to stabilize the existing roof structure. Anchorage of interior masonry walls to floor and attic diaphragms will provide a tension tie through the walls; a lightweight concrete topping will be poured around the perimeter of the floor diaphragms to increase their stiffness and strength. A strengthening system for the tower, which was begun some years ago and stopped for lack of funds, will be completed.

The isolation system shifts the building fundamental period from 0.5 seconds to 2.5 seconds. This has the effect of reducing horizontal force levels by a factor of about six—from .55g. to .089g. Damage under the design earthquake should be on the order of some cracking at interior corridor walls.

The isolation scheme uses 504 bearings that are 15 inches in height with diameters varying from 16 to 19 inches. These will be of the patented New Zealand type, which uses a rubber and steel lamination similar to that of the bearings at Cucamonga, but also incorporates a central cylindrical lead plug. The plug assists in damping action, which in the other type is accomplished by the properties of specially formulated rubber. The bearings are installed within the existing walls following removal of the wooden first floor to provide working space. Both sides of the walls will be notched between hole cuts every six feet for the isolators. Concrete tie beams will clasp the walls and be post tensioned and clamped through the walls. The isolators will then bear on the existing footings with loads spread by use of a new steel grillage over the footing.

Because of the lead time necessary to manufacture and test the bearings, they were bid in advance using a performance specification, and will be provided to the general contractor as an assigned item. The general contractor is currently being selected on the basis of a lump-sum bid from pre-qualified bidders.

The Salt Lake City job represents an important effort to reconcile the demands of seismic safety with those of economic restoration of a historic building. Similarly, the Cucamonga project is a carefully studied effort to deal with the seismic safety of an important building on a cost-beneficial basis. Quite different in their decision-making processes, both buildings have found the solution by applying the same technical concept.

What is the future of this innovation? Will seismic design in general be revolutionized and existing methods made obsolete? A fair assessment would be to say that, while base isolation is here to stay, its applications will remain relatively limited though important. Until some base isolated structures have come through some significant shaking, acceptance will be guarded. As a consequence, application will be slow and procedurally difficult. The system demands sophisticated and costly design, so its use will in any case be limited to important projects and knowledgeable owners. And the technical characteristics of the system limit its use to buildings of certain sizes and proportions—not small buildings and not tall, slender high rises, for instance—and to certain ground conditions. But the system does make it easier to design irregular building configurations, so architects should welcome it. □

Admixtures Give New Strength To Concrete

The superplasticizers.
By Barbara Heller, AIA

Concrete is one of the oldest and most constant of building materials. But that's not to say a good thing can't be improved, as two recently popularized admixtures have proven. Superplasticizers and silica fume (minute silica particles) are now available that create a concrete mix far more workable than ever before, which sets to form dense, impermeable concrete of unsurpassed strength.

"This is an order-of-magnitude change in concrete construction," says V.M. Malhotra, head of the construction materials section for the Canada Center for Mineral and Energy Technology, and an expert in the proper use of these additives. "These materials make excellent concrete that flows like water but still has strength and other important concrete properties."

Superplasticizers are liquid chemicals that interact with concrete paste to disperse cement particles and make the paste very fluid. As a result, less water is needed and more cement can be used without diminishing the workability of the concrete.

While typical ready-mix concrete has a compressive strength of 3,000 to 5,000 psi, the addition of a superplasticizer increases the strength to 7,000 to 10,000 psi. And whereas regular concrete typically has a slump of three to five inches, a slump of superplasticized concrete may be five to 10 inches and still produce high-strength, high-quality concrete. Superplasticized concrete is easier to pump and place than regular concrete, is more water resistant, and is less susceptible to long-term deflection.

Silica fume, a pozzolanic material, is a by-product of ferro-silica production that both strengthens and densifies concrete. When added to concrete in powder form, it requires a substantial increase in the amount of water in the mix. Therefore, silica fume is commonly used in conjunction with a superplasticizer to reduce the amount of additional water required in the mix. In the laboratory, concrete mixed with silica fume and superplasticizer has attained strengths as high as 25,000 psi, and it has been used in the field to produce concrete with strengths as high as 14,000 psi.

Superplasticizers currently are more available and are used more extensively than silica fume. Weston Hester, associate professor of civil engineering at the University of California at Berkeley, and a proponent of high-strength concrete, estimates that 10 to 15 percent of all ready-mix jobs and 50 percent of all precasters use superplasticizers.

Superplasticizers are more likely to be used when workability and high-strength concrete are desired. Silica fume, while providing even higher strengths than superplasticizers, is used primarily to give concrete greater durability and density and to reduce permeability.

High strength is sometimes not the major impetus for use of these additives. Precasters may use superplasticizers because of the high early strength they get on day one to resist the forces of prestressing. With parking garages, silica fume improves the durability of the concrete, reducing maintenance requirements. Designers of industrial facilities use it for chemical and abrasion resistance, and civil engineers use it on massive concrete structures because it has reduced permeability. In these cases, the high long-term strength is just a bonus.

Joe Colaco, president of CBM Engineers in Houston, provided the structural engineering for Texas Commerce Plaza in Houston, a 75-story office tower designed by I.M. Pei in association with 3-D International. It incorporated concrete with strengths up to 7,500 psi.

"We used a high-strength concrete because we wanted to minimize the column size at the lower levels of the building and because high-strength concrete has a better modulus of elasticity, which means less building movement under wind loads," says Colaco. "It is also the tallest pumped-concrete building in the world. The contractor pumped the concrete at Texas Plaza vertically up 1,000 feet." The use of plasticizers also allowed the contractor to strip forms quickly and improve construction speed, Colaco adds.

For special jobs only

High-strength concrete is not expected to replace regular-strength concrete, because of the expense, but it will be used increasingly to solve specific concrete problems. "Vanilla-flavored concrete is what you buy at the ordinary grocery store," says Hester. "High-strength concrete is a premium material that you buy at a gourmet deli. You need it for special situations, but it won't put the regular grocery out of business."

The addition of superplasticizers to a mix will cause a 5 to 25 percent increase in the cost of the mix, according to Hester. The addition of silica fume will

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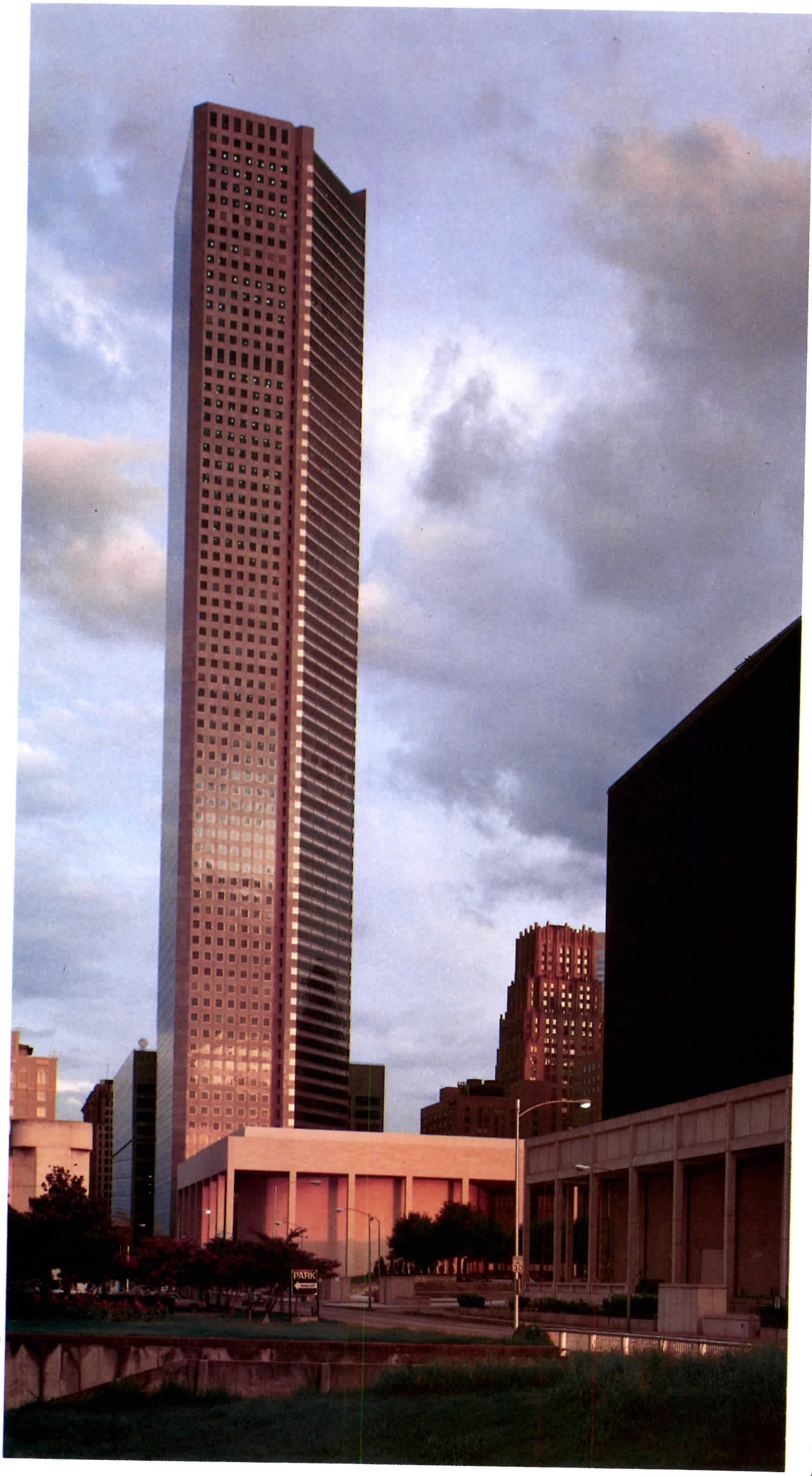
Ms. Heller is a principal of Heller and Associates, a specifications consulting firm in Washington, D.C.



increase mix cost by 30 to 50 percent. These costs are considered nominal in some cases where savings in long-term maintenance offset initial construction costs.

"Parking structure durability and concrete bridge repair are probably the biggest concrete construction problems in North America," says Hester. He expects that silica fume will improve the durability of these structures and will also be used extensively to repair existing deteriorated structures.

Howard Needles Tammen & Bergdoff, in Kansas City, elected to construct an eight-story parking facility for AT&T with silica fume concrete. Gary Busse, project architect for the job, said they "chose silica fume concrete because it was cost competitive with a surface sealer when subjected to a life cycle cost analysis." The structure, which was completed in October 1986, has performed well so far.

Questions remain

Ironically, superplasticizers are not really new materials. According to Hester, superplasticizers were first patented in the U.S. in 1932. He also cites studies in the U.S. of mix designs incorporating silica fume that date back to the 1950s. However, superplasticizers were used for oil drilling and not concrete construction, and silica fume was not developed at the time because of lack of awareness of superplasticizers. In the 1960s, the Germans and the Japanese applied superplasticizer technology to concrete construction and introduced it to the U.S.

While knowledge of superplasticizers and silica fume may not be new, their widespread integration into the U.S. construction market is relatively recent. Like other new products, lack of standards and experience with these additives presents certain problems. Most imposing is the need for the architect to develop quality-control standards for evaluating mix design and performance of high-strength concrete. Most superplasticizers have a pot life of only 40 minutes (the duration of time in which they achieve the desired chemical reaction in the mix). This necessitates adding the superplasticizer to the mix in the truck at the site for ready-mix concrete applications. Variations in loading, timing, and even weather influence the quality of the

The 75-story office tower of Texas Commerce Plaza is constructed of 7,500-psi pumped concrete.

resulting concrete from truck to truck. Newer plasticizers incorporate retarders to extend the pot life to 90 minutes and make it possible to add the superplasticizer at the plant in some situations, allowing for more consistency and better control of the mix.

High-strength concrete cylinders should be tested at 50 days and at 90 days, the times at which maximum strengths are achieved. To date, ACI does not offer guidance on special quality-control procedures to use for high-strength concrete jobs. Another problem is that the equipment in many testing laboratories is not sufficient for measuring the ultimate strength of high-strength concrete. Colaco considers the extensive quality-control program devised for testing concrete on the Texas Commerce Plaza to be largely responsible for the good results in the project.

Questions have also been raised about the fire resistance of concrete that is mixed with silica fume. Tests are currently being conducted at the University of California at Berkeley to see if this additive affects fire resistance.

Of great concern to the architect is the effect these additives have on the appearance of the concrete. According to Hester, "Half the time it looks worse, and half the time it looks better." Silica fume darkens the concrete, producing dark gray or black hues. Special finishes, particularly sandblasted finishes, can be very difficult to apply to high-strength concrete. However, high-strength concrete has fewer cracks and less bow and warp than regular concrete.

Given the growing acceptance of these concrete additives in the marketplace, architects should be hearing about and using more high-strength concrete in the future. □

Other types of admixtures

In addition to superplasticizers, concrete manufacturers offer a wide range of admixtures to enhance the characteristics of fresh or hardened concrete. Many types of admixtures have been in use for 25 years, but they are constantly expanding in effectiveness and the range of successful applications. Despite complicated chemical compositions, and new vocabularies developed by manufacturers to describe their own products, admixtures may be broken down into basic categories.

According to Harold J. Rosen, PE, FCSI, in his book *Construction Materials for Architecture* (John Wiley and Sons, 1985), there are eight major classifications of admixtures, in addition to superplasticizers:

Air entrainers with ominous monikers like "sulfonated hydrocarbon derivative" produce an air-void system, making concrete less susceptible to damage from freeze-thaw cycles. The cement placed in the concrete mix normally contains the air-entraining agent, which consists of chemically treated resins or fats. Alternatively, air-entraining agents can be added separately to the concrete just before or during mixing. ASTM standards currently specify from 4 to 7 percent entrained air.

Densifiers and retarders also reduce the quantity of water needed for a mix, yet work to retard the setting time for concrete, for example, to avoid cold joints between successive pours, or to provide time for finishing large areas. Retarders also slow the set of concrete poured during the summer.

Accelerators and hardeners work in the opposite way from retarders, producing a quick-set concrete with a high early strength. Some brands of accelerators are now reputed to develop "three day strength" in 24 hours. Accelerators are often added to concrete to be poured in cold weather, where reduction of setting time is critical. Some manufacturers, such as Euclid Chemical Company, recommend that accelerators be added to all concrete placed when the temperature is below 50 degrees Fahrenheit. Calcium chloride is often used but this requires special cautions: calcium chloride can cause discoloration and it corrodes steel. It also fosters electrolytic corrosion of aluminum and steel when applied in a humid environment.

Bonding agents contain acrylic polymers that bond new concrete, portland cement terrazzo, and cementitious mixes to existing concrete floors, walls, columns, and beams. Some manufacturers, such as Larsen Products Corporation, offer bonding agents that can be "painted on" to the substrate in a single coat one to 10 days prior to concrete topping or terrazzo placement. Other types of bonding agents are truly admixtures, added integrally to the concrete to improve adhesion and curing and reduce surface cracking. Check with the manufacturer if the bonding application is on the exterior—only certain types of bonding agents are waterproof.

Coloring agents, normally mineral oxides, can be added integrally to concrete. They now boast less tendency to streak, greater uniformity, and a much wider range of available colors.

Other types of admixtures that have played a significant role in extending the usability of concrete include:

Workability agents, which are often admixtures applied for another purpose doing double duty, such as air-entrainers or plasticizers;

Fungicidal, germicidal, and insecticidal admixtures, such as phenols, which usually are added to cements to be used in applications such as locker rooms and food-processing plants.

Dampproofing and permeability-reducing admixtures, purported to reduce the transmission of water through unsaturated concrete from the damp side to the dry side. Rosen discounts their use: "Experts put little credence in the effect of admixtures on the reduction of permeability. The watertightness of concrete depends primarily upon obtaining well-cured paste having a water/cement ratio not over .6 by weight (6¾ gallons of water per bag). Concrete made with less than 5½ gallons of water per bag and well cured produces a good, watertight concrete that is not improved with the use of dampproofing agents."

Manufacturers now often sell a "package deal" of two or more admixtures, designed for particular applications, which cuts down on one of the major problems still plaguing the field: compatibility. But regardless of the type of admixture employed, check with the manufacturer to ensure its compatibility with the type of cement employed, as well as with steel, the type of aggregate chosen, and any other admixtures placed in the mix.—STEPHANIE STUBBS

Suddenly Building Stone Is Everywhere

Its growth is spurred by thin-cutting techniques and economics. By Allen Freeman

© Steve Rosenthal

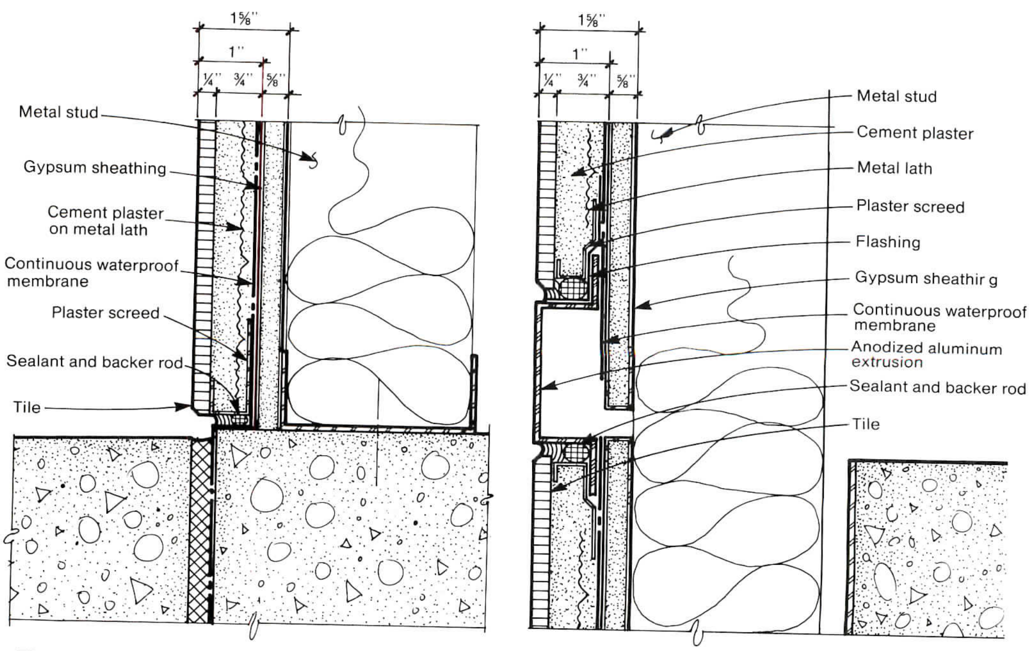
Building stone, something of a black sheep during the postwar reign of precast concrete, aluminum, and glass, is again becoming a cladding of choice. Between 1980 and 1985, the demand for travertine increased 600 percent, for finished marble 625 percent, and for granite an astonishing 1,735 percent. The rise in popularity can be attributed partially to style: Proliferating historicism has had an obvious impact. But more to the point, perhaps, have been the advances in technology that allow stone to be sliced thinner than ever before, producing more surface at less cost.

As Malcolm Holzman, FAIA, of Hardy Holzman Pfeiffer Associates, notes, the prices of other skins have risen as the price of stone has gone down, so that "today you can have a stone building for just a little more money."

The bottom dropped out of the stone business in the U.S. during the 1960s, says Robert Hund, managing director of the Marble Institute of America. "This country had the state-of-the-art machinery then, but in a depressed industry there was no money to finance new technology." Meanwhile, the Italians started developing machines for making 1x1-foot marble tiles ⅜ of an inch thick. This brought down the cost of marble, and granite tiles followed with similar economies. Today stones in a variety of thicknesses down to ultra-thin are available. Indeed, computer-controlled diamond blades or wires can now slice marble to a thinness of a quarter of an inch.

Appropriate thicknesses vary according to use and variety of stone. For exterior use, building codes generally require at least ¾-inch-thick stone for low-rise buildings and a minimum of 1¼ inches on high rises. Before deciding which stone to use, the architect should see as many installations as possible, do a full-sized panel mockup, and understand fully the properties of the stone, advises Carl Hensler, head of the technical group in the Washington, D.C., office of Skidmore, Owings & Merrill. Commodity stone—Spanish pink granite, for instance—is likely to have imperfections of color and require waste—25 percent or more—to obtain a uniform facade.

Anchorage systems include conventional attachment, in which the stone is fastened directly to the building structure or to a masonry backup, and steel truss systems on which the stone hangs



Top, thermal and polished versions of the same granite on the Registry of Motor Vehicles, Worcester, Mass., by Leers, Weinzapfel Associates. Stone panels, 1 1/2 inches thick, are anchored with stainless steel dowels to concrete block backup. Above, wall sections for Alpine Square, Walnut Creek, Calif., by Kaplan McLaughlin Diaz.

like a curtain wall. A third alternative is to attach veneer to a precast backup.

How does an architect determine which system to employ? Hensler says to start by evaluating the building's structure and then factor in economics. Precast panels, because of the dead load that shouldn't be carried at the slab edge, are appropriate for most concrete and steel structures with spans of no more than 25 to 35 feet. Steel truss systems, because of their economies of weight, are suited for longer span buildings. (Stone three centimeters thick weighs 23 to 25 pounds per square foot compared with 50 to 70 pounds per square foot for traditional panels.) There are methods to help architects determine the appropriate thickness of stone to select, but for the final design, experts recommend that designers obtain data from laboratory tests performed on specimens of the stone selected.

Because thin-stone cladding is a relatively recent development, no one knows for certain the severity of long-term effects of weather. As geologist Sidney Horenstein, of the American Museum of Natural History in Manhattan, explains, weathering is both the chemical decomposition and the physical disintegration of stone, and the thinner it is sliced, the more susceptible it is to weathering. Simply put, it is possible to diminish the interlocking process of coarse-grained rocks by slicing the minerals too thin.

The process used to obtain a thermal finish on granite reduces the thickness by one-eighth inch. Bush hammering also reduces thickness. As to polishing, there is disagreement over its effect on durability, with some experts saying it seals the pores of stone, and others, including Horenstein, saying it offers no additional protection against weathering.

All agree with Horenstein, however, that polished marble will not remain polished when exposed to the elements. (He uses technical terminology, which defines marble as recrystalized limestone. In more inclusive commercial usage, marble is any stone capable of taking a polish.) "Rainwater is a very weak carbonic acid that dissolves calcite, the basic constituent of limestone marble," Horenstein says. "In a very short time, the polish disappears because the surface is being dissolved."

Granite, on the other hand, is less susceptible to weathering, and architects such as Bill Webber of SOM/San Francisco think of it as permanent. "Typically, we polish the whole panel, mask portions, and then sandblast or flame-finish the rest. When you assemble them as groups, you create patterns," Webber says.

Architects are now mixing stone veneers with other cladding materials. Kaplan McLaughlin Diaz, for a newly completed downtown San Francisco skyscraper, Stevenson Place, employed precast panels on the shaft and crown, and on the six-floor base used standardized 2x4-foot, 1¼-inch polished granite panels attached to precast backing with metal ties. Rows of granite tiles alternate with courses of cream-colored precast panels to create a pleasing horizontal banding.

More intricate patterns are being employed on building interiors. Jung/Brannen Associates of Boston, for example, has been an innovator in designing ultra-thin interior decorative stonework. The economies of the ultra-thin stone system Jung/Brannen uses are such that speculative office building clients can afford marble lobbies. It began in 1978, says Robert Brannen, FAIA, when he was seeking "richness and exuberance" for the lobby of One Post Office Square in Boston. He encouraged a marble yard in Carrara, Italy, to develop a new technology for prefabricating marble slabs that are not prohibitively expensive—in the range of $22 per square foot, or about half the cost of setting marble in the field. Using state-of-the-art equipment, the supplier slices marble one centimeter (.39 inch) thick. The slivers then are joined to a backing of white Carrara or travertine by an epoxy process.

Stone backing is used because it is plentiful and inexpensive in Italy, where the panels are manufactured, and because it has the same coefficient of expansion as the veneer, thus eliminating warp. Finished panels range from 1¼ to 1½ inches thick and from 2x3 feet up to five feet square. Brannen says panels of larger dimensions tend to break if jarred during installation.

Typically, Brannen selects a dozen different stones from a palette of 50 from around the world—stones that he knows are in good supply and are strong enough and hard enough. He usually travels to Carrara to select among 6x6x12-foot marble blocks. A first cut exposes a face that is cut for inspection. "I point out some areas on the face that are either unacceptable or particularly desirable," he says.

There is an amount of waste in every block, he adds. After lamination, a special finishing system is employed that bypasses the need to polish pieces of varying degrees of hardness separately. The panels are shipped to the site and mounted conventionally with metal anchors. □

Below, elevator lobby of Jung/Brannen's One Post Office Square, Boston. Opposite, Innova in Houston (Cambridge Seven with Lloyd Jones Fillpot & Associates), clad in stone just three centimeters thick.

c Steve Rosenthal

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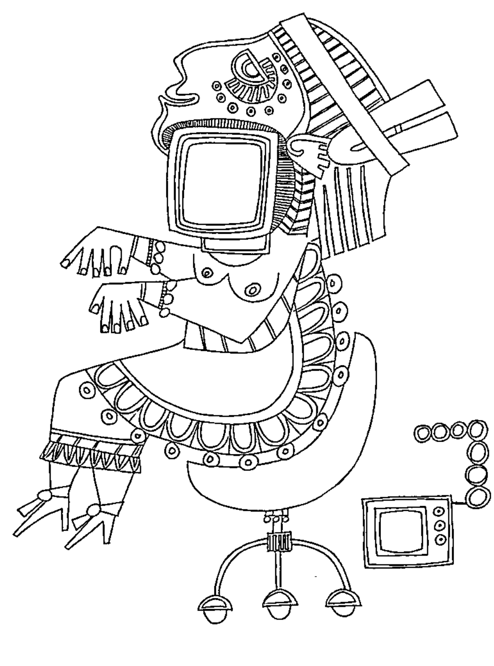
The State of The Art of Technological Space

The special demands of the 'intelligent building.'
By Forrest Wilson



Technological change alters our perception of the world. Air travel allowed time to take the place of distance: we are not 500 miles, but an hour, away from Chicago. When a million people looked down on Paris from the top of the Eiffel Tower, they saw the city in plan for the first time. When we saw the earth through the eye of a space capsule television monitor, the earth became a floating blue marble in infinite space.

We have accepted these perceptual changes as new insights and the positive contribution of technology. However, there are also negative aspects of technological progress that are usually not dwelt upon, though they constitute one of the major design challenges posed to today's architectural designers.

The "electronically enhanced" environments of "smart" and "intelligent" buildings are as jolting to the perceptions of their users as the view of Paris from the Eiffel Tower and the earth from the space capsule were to those who first saw them. Therefore, one of the great design challenges of the 1980s is reconciling the demands of technology with human needs—the creation of a humane technological space.—Ed.

New technologies invariably generate new building forms, but these seldom emerge as a new building type. The "smart" or "intelligent" building is growing within the shells of buildings designed to process paper for an industrial economy.

One indication of the newness of the idea is the lack of a generally accepted definition. Joseph Newman, vice president of Tishman Realty, says simply that smart buildings are those that are fully rented. The Harbinger Group describes the intelligent building as one designed to support the needs of "information intensive" tenants—designed to change as a tenant's organization changes.

Intelligent buildings may be described by the services they provide, including traditional heating, ventilating, and air-conditioning; electrical power; water; fire extinguishing and safety; lighting; elevators; security services; and backup power facilities. They offer in addition enhanced voice services via a private automated branch exchange, message services, voice mail, telex, and paging services.

Computer-based services include local area networks, office automation systems, electronic printing services, electronic mail, video conferencing, word processing, and network interfaces. The communications link to the outside world may be a satellite dish on the building roof. Encryption and archival storage also are included. Temporary personnel, delivery services, travel services, office supplies, computer-equipped conference rooms, training centers, health clubs, day care centers for working parents, and computer-aided design services for designing office space layouts also may be included.

A range of firms may provide these services. They may be individuals or joint ventures among telecommunications, office automation, and management firms. AT&T, IBM, General Electric, and United Technologies (since discontinued), have offered joint venture services. A growing number of consulting firms now specialize in the field.

Tenants of intelligent buildings depend on sophisticated information technology to conduct their businesses. Many are too small to buy the necessary equipment; others prefer to rent the services. A question is emerging as to whether intelligent buildings are actually information utilities and should be regulated as such.

Technological space

The most recent and comprehensive report on the state of the art of technological space comes from the Committee on High Technology Systems for Buildings of the Building Research Board of the National Academy of Sciences (to be released this spring). This committee confined their considerations to office buildings, in which the bulk of this technology is concentrated.

The new physical demands of the technological space include:

• *The physical space* must be adequate for necessary wires and cables, which must be readily accessible.

• *Electric power* must be adequate, readily accessible, reliable, and uninterrupted. There must be security for electric power and signal systems, involving backup batteries for emergency use, power filters, grounding and lightning protection systems, and adequate shielding to avoid contamination of signals by electromagnetic interference. An uninterrupted line of sight to satellites and microwave links may be necessary for some buildings.

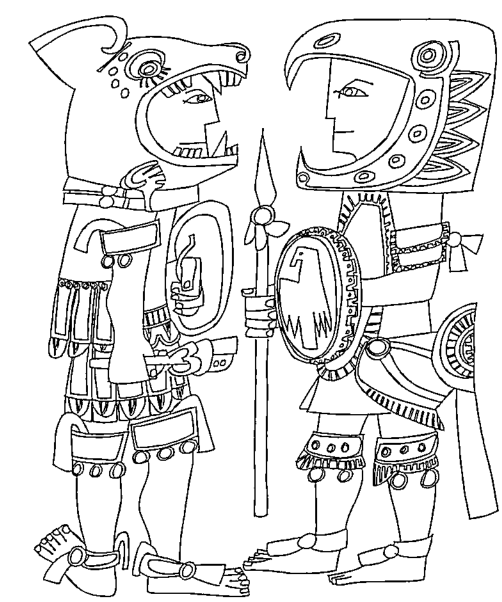
• *The building structure* must be capable of supporting the loads associated with a mainframe computer, a battery room, and a rooftop antenna.

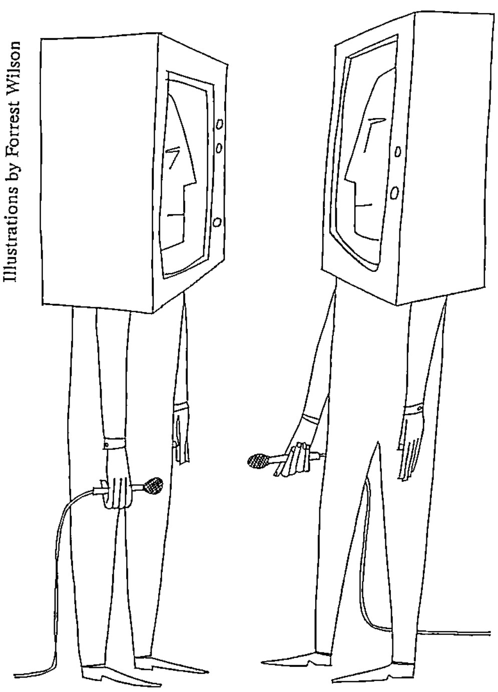
• *The heating and cooling system* must be capable of coping with the heat load generated by the electronic equipment and of providing the necessary climate conditioning in spaces occupied by sensitive equipment and in spaces occupied by people.

• *Interior systems* must include electric lighting and make possible the comfortable use of video display terminals, with carpeting and other interior furnishings that are static-free, and with wall and furniture surfaces that do not create problems in terms of glare or noise.

• Finally, *flexibility:* All of the above capabilities must be able to accommodate not only today's electronic systems but tomorrow's, and must permit their use by an increasing number of occupants in the years ahead.

The BRB committee noted that many





Illustrations by Forrest Wilson

buildings have been equipped to varying degrees with some or all of the capabilities listed above, either at the time of construction or by subsequent alteration. But few if any buildings exist today fully "electronically enhanced" to the extent possible with current technology. In such a building, the use of modern electronics would be all-pervasive and the driving consideration in building design. In the partially enhanced buildings of today, electronic technology is of secondary importance in the building design.

A fully electronically enhanced building provides sufficient flexibility to permit the use of a broad range of electronic facilities in a variety of ways that differ considerably among the building occupants and among the various parts of the building. Consequently, it changes the face of the design process.

More areas of expertise are needed in the early planning stages of an electronically enhanced building than are used for a traditional building. And the design activity takes place with all of the experts working simultaneously, instead of in the traditional linear arrangement of preliminary design, design development, and construction drawings, each specialist coming to the design sequentially as it is developed by the architect. A multidisciplinary approach is advocated from the beginning for assuring quality and providing diagnostic capabilities so that individual electronic components function as a system and significant deviations from performance are revealed early enough in the process of design and construction to allow correction with minimal disruption and cost.

The role of computers

Those kings of technological space domain, the computers, add their own spatial tenets to architectural design. There are three general categories: mainframes, minis, and micros, all of which have enhanced capacity or speed to become super mainframes, superminis, and supermicros. The differences among the three were once as pronounced as their physical and environmental requirements. Today boundaries are blurring.

Mainframes require specially designed rooms, or "data centers," and they must have additional power, uninterrupted power, and special grounding. Their weight is significant, and vibration must be controlled. Quantities of airconditioning for the space must be provided at five to 10 times the typical occupancy requirements. The equipment needs water cooling capabilities, humidity control, and thermal control. Condensation, security, and fire are serious concerns, often requiring separate systems for their control—room access must be controlled and halon fire systems with their own sensors and pumps installed. Massive and changing cabling also require attention.

Super mainframe and mainframe control rooms have critical specifications for power, airconditioning, humidity, security, fire, and stringent cable management. There are often additional access floors or trough walls for servicing systems. Superimposed on these equipment demands are the demands of the building occupancies within and outside these data centers. For example, the centers must be strategically placed for cabling and access, and also to minimize the effects of noise, traffic, heat, and cabling on the remaining office settings. This is not an easy task, and it is estimated that between $100 and $150 per square foot must be set aside for fit-up of these data centers.

For minicomputers, even though the equipment may not be enclosed within the office environment, significant power and extensive cable management are likewise required. Minis also generate heat and noise, are sensitive to dust, and need security and fire provisions.

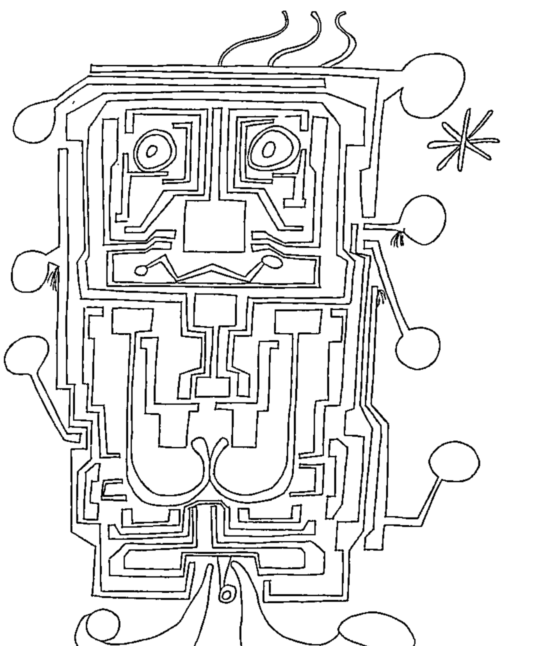
The active environment

In the evolution of mechanical and electrical design, the 1940s and 1950s are remembered for the advent of airconditioning as a norm, the late 1960s for quantum advances in life safety systems, and the 1970s for energy conservation. The 1980s will be remembered for the integration of these systems based on new information-processing technology.

Energy-related building systems, after 10 years of use, have forced changes in building configuration and systems—most importantly in building automation systems. These have demanded automatic, sensitive, quick, precise, and reliable controls.

Direct digital systems incorporate assorted pieces of information: weather conditions, time of day, weekend/holiday occupancy, prevailing rate structures, equipment performance, and the like. The systems automatically issue precisely calibrated commands to banks of controls and machinery. The building knows itself.

Today's technology and space are dominated by electricity, an energy that must be consumed at the moment of its production, adding an immediacy to our work and environment that is without precedent. The electronic equipment in today's buildings requires greater power supply capacity, higher quality power, and more flexibility and extensive power distribution. The growth in power demand is exponential, in part to run the equipment but also to remove the extra heat it generates. Power demand has increased by 100 percent or more in the past 20 years, with an average one-million-square-foot commercial building today requiring supply capacity of 9,000 kilowatts, as compared with 4,500 kilowatts in the late 1960s. (The total electrical load that goes to lighting decreased in the 1970s, but the reduction has been more



than made up for by the increase in demand for office machinery.)

Computer-based equipment creates the need for power of a higher quality as well. Higher quality power supply is characterized by reliability (the ability to guard against power failure from public utility outages) and uniformity (the ability to prevent inconsistencies in voltage and frequency). Power must be brought to many points within the building and, because of the frequency of moves and changes, must be extremely flexible. Proliferating cabling must be effectively managed.

Despite reductions in heat gain from light fixtures and external sources, and despite anticipated changes in computer technology that are expected to reduce the heat output of electronic devices during the 1990s, cooling capacity requirements have increased. Airconditioning systems now are being designed to a standard of 4.5 watts per square foot, as compared with 2.5 watts per square foot in the 1970s. And cooling loads are not just larger; they also vary widely from space to space and hour to hour. Distribution system design is therefore beginning to focus increasingly on control of microclimates. More planning is going into duct systems to eliminate possible hot spots and into systems designed to provide climate control only where it is needed.

Growing concern with air quality control has also affected HVAC system design. The production of toxicity from building materials, and the introduction of new electronic equipment coupled with the increased tightness of building shells, pose air quality problems not fully understood.

The influence on people

We know a tremendous amount about the active environment and how to measure its components inside buildings—ergonomics, air quality, light, heat, and noise control—but we know little about how designed environments influence worker well-being or productivity. This has not been the subject of systematic research.

Few would argue that the relationship of the worker to the office environment affects health, well-being, and productivity. Office automation changes the physical and psychosocial dimensions of the workplace and the work process. And although evidence concerning the risk of illness and disease in new office environments is said to be inconclusive, a major Office of Technology Assessment report recommends that the level of public concern and recent worker compensation awards for VDT-related illnesses justifies a comprehensive and systematic examination of all office environment exposures to determine actual exposure risk.

Is there something wrong with our technical space beyond glares, beeps, and whirrs that prompts this recommendation? Apparently, the confines being introduced to technological space are changing the office as a social arena and are beyond human endurance.

Electronic monitoring is a prevalent cause of stress, most commonly among support and supervisory staff. But as monitoring systems become larger, higher echelons also are under scrutiny. Management information systems watch each employee and check every conceivable item of work as well as the worker. This is common practice in the post office, airline ticketing desks, and telephone companies, and among the people expected to render pleasant civil service.

Time expectations are warped as speed leads to a distorted sense of time, and unrealistic behavior expectations result. Because the computer is fast, managers and clerical staff develop a new time reference. A down computer is a stressful event, as is observed quite frequently at airline ticket counters. Stress is communicated from agent to passenger. These new "hypertime" workers are much more upset by a systems breakdown and their loss of control than workers in traditional offices. They experience higher arousal states, which lead to high blood pressure, fatigue, and related illnesses.

Judgment is fundamental to work, but a fundamental goal of automated work is to reduce the need for human judgment. The goal of developing an expert system is to place in the computer the knowledge and decision-making process of the best workers on a particular job. This shift of control from the person to the system is the most common defense used against "data contamination" (human intervention). The elimination of human judgment or data contamination is the fundamental goal of automation.

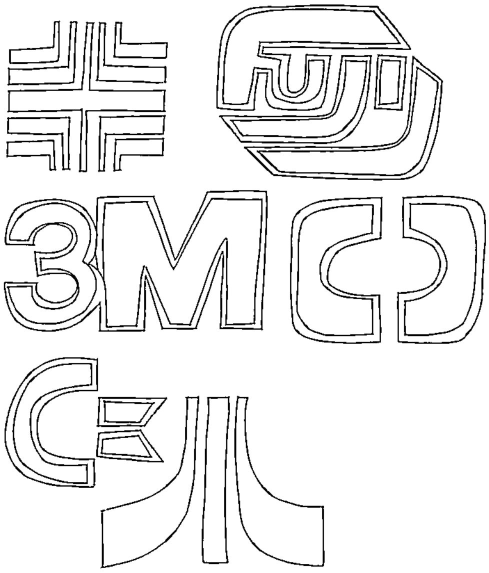
Risk taking and creativity, the specialties of professionals and managers, are constrained as decisions are embedded in the computer system. Meaning and challenge of work disappears, and boredom and dissatisfaction are the results. One key movement of the traditional office worker is the transferring from a physical to a mental activity, or the abstraction of work. Instead of manipulating physical objects—creating, storing, and distributing forms and documents—the operator moves symbols with the push of a button. This is an extreme abstraction of work. It demands more mental effort, but it is not mentally challenging. The operator must give undivided attention to the screen performing the same task repeatedly—a visual assembly line.

Social interaction is a major component of the traditional office. Social groups buffer the worker against unpleasant work conditions. Communication and social participation in the work process are central to the productivity of the work unit. When the computer becomes the primary source of interaction in the office, the coordination of the work process is transferred from the social to the technological milieu. Technological forms of communication develop, and both work and communication become formalized. The result has been increasing social isolation, depression, anxiety, job dissatisfaction, and even muscle fatigue. The computer operator may be electronically connected to the entire world, but he or she works alone. The social contacts of the office culture are eliminated and a terrible loneliness can result.

Do buildings make people sick as well as unhappy? The major obstruction to answering this question is the lack of long-term statistics on illness and disease of office workers. The most comprehensive and thoroughly analyzed national statistics are 25 years old, from the 1960 Health Examination Survey (National Center for Health Statistics, Office of Technology Assessment, Series 10, No. 21., Washington, D.C., U.S. Government Printing Office.) But there is undeniably an increase in four major categories of problems: visual systems, musculoskeletal, stress-related, and reproductive. As a commonly cited example, VDT work is the culprit associated most frequently with an increase in visual distress. Chronic arousal or overstimulation is held to be a plausible link to disease, and three working conditions associated with it are: (1) social isolation and lack of social support, (2) lack of control over timing, speed, and variety of work, and (3) heavy workload, and repetitive and machine-faced tasks. Each of these conditions is likely to occur with increased office automation. No evidence shows that all three must occur simultaneously to elicit a deleterious biological response. The fact is that in many jobs the three conditions are present as a package deal.

The number of worker compensation suits is an early warning of the effects of office automation on the mental health of workers. A comparison of claims indicates that mental stress is the leading

Illustrations by Forrest Wilson



occupational illness until age 50. From age 50 on, other diseases predominate. But, significantly, at the peak of working life, from 30–39 years of age, stress-related diseases almost double those of other occupational maladies.

The traditional subjects for collective bargaining have included wages, fringe benefits, and hours. Increasingly, unions deal with health and safety, electronic monitoring, and job security. Technological change is a major issue, but a difficult subject for collective bargaining.

The role of design

The design of the office greatly influences the success of the automation in increasing organizational effectiveness. Research findings suggest employees in automated offices place high priority on the quality of the workplace. Factors that support this are:

• The office work force is changing and is more engaged in automated activities. Expectations are different from and higher than those of clerical personnel generally.
• Work is demanding. Planning and creative thinking are typical activities that are susceptible to environmental intrusion.
• Occasional respite is needed from the technologically based environment of the automated office. Settings are needed for informal social interactions to offset the concentration and isolation required in information processing tasks.

More and more organizations consider the design of the office building and work station integral parts of the new technology. Design can contribute to the quality of work life directly and indirectly by ameliorating stressful working conditions.

Technology offers the opportunity to automate many functions, but this does not mean they should be automated. The worker's need for autonomy should be part of the design examination *before* decisions are made to automate environmental and operational systems. Often, in terms of effectiveness of technological space, a mixture of manual and automated systems proves to be the best solution.

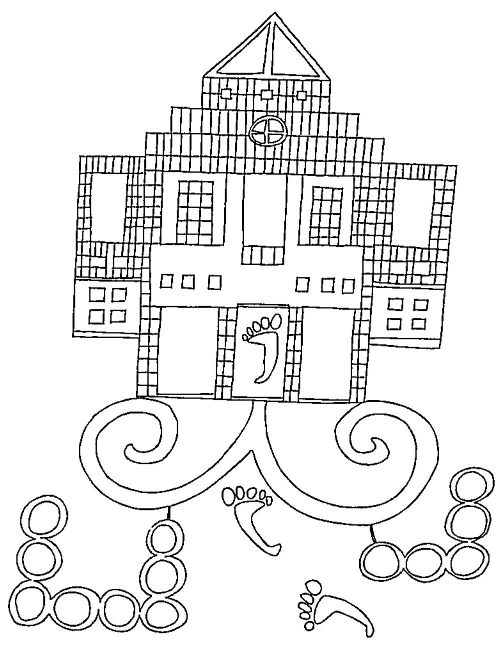
If I ask you how you ride a bicycle, you probably will not be able to explain it, and, if you try, you most likely will get it wrong. We obviously can do things we cannot adequately explain, and this, perhaps, is a strength of design. The history of architecture and technology is a history of doing things we can't explain. The first arches were used long before the birth of Christ, but we did not have an arch theory until the 16th or 17th century.

The history of technology is the same. Steam engines were invented and perfected by working craftsmen. The science of steam had nothing to do with their development. The science of aerodynamics followed the invention of the airplane. In fact, the Wright brothers flew during the very year that scientists had proven that nothing heavier than air could stay off the ground under its own power.

Can we, perhaps, design satisfying and productive human environments without the ability to fully explain what we are doing, as in riding a bicycle or inventing an airplane? The trick may be asking the right questions. These are questions designed to place the producer—the user of spaces—within the building, at the center of our concerns.

Dr. Arthur Rubin, a research psychologist at the National Bureau of Standards who has conducted a great deal of research on the implications of design and human behavior, proposed the following questions that designers might ask themselves regarding design for the active environment.

• Is the designed environment responsive—can workers see what the building is doing as they perform tasks that may be meaningless to them?
• Can the building be changed easily by those using it, yet retain its unique quality like a medieval cathedral or an Italian hill town that has changed and adapted yet kept its unique identity for centuries?
• Although technology is not the sole determinant of the environment, can it aid the producers in the painful task of making themselves comfortable in an automated environment?
• Is the environment supportive, open, and forthright to counter the feeling that the computer is "snitching" on the producer?
• Is the building environment in sync with our times? Does the producer working with the most advanced electronic technology of our times feel he or she is in the right place?
• Does the environment encourage judgment, reveal itself, and give the producers a sense that they are in control and that their decisions are significant?
• Does the environment encourage the exhilaration of risk taking and the challenge that makes work worth doing? □



Coatings, Sealers, Consolidants

They are subjects of increasing attention. By Timothy B. McDonald

A survey of new coatings, sealers, and consolidants—even as selective as this one—reveals a large number of new products, couched in chemical terminology and manufacturers' jargon. Many of these products have been on the market for a relatively short time, and their long-term effects on other materials, as well as their longevity, are uncertain.

The increasing popularity of restoration work finds many architects faced with the task of repairing exterior stonework, both visually and structurally. To that end, manufacturers have recently developed a wide variety of chemical consolidants, which repair crumbling stone by restoring the bond between the grains. A consolidant's ability to rebond stone grains depends on the penetrating character of the consolidant and the permeability of the stone. These consolidants penetrate the crumbling surface skin and re-establish the bond between the deteriorating surface and the healthy stone beneath.

Applied in liquid form, consolidants solidify and react with the stone grains in several ways. They cover the surface of each grain, bonding one to another at their contact points; accumulate in the contact areas of the grains, becoming a new intergranular adhesive; or fill the pores completely, allowing few if any voids. The last option, that of filling all the voids, can actually increase the damage because it restricts the passage of moisture through the stone. If moisture builds up behind the consolidated surface, it can deteriorate the healthy stone beneath and ultimately cause the consolidated surface to spall off.

There are three major types of consolidants on the market today: inorganic materials, alkoxysilanes, and synthetic organic polymers.

Inorganic materials should be used with caution, because they may form, as a byproduct, thin, impervious crusts of soluble salts that can lead to exfoliation (the separation of layers along the bedding planes). The inorganics most likely to cause problems are alkali silicates and silico fluorides. To deposit alkali silicates, one must use sodium hydroxide, which reacts with carbon dioxide and sulfur trioxide, forming salts that can damage the stone. When limestone or sandstones are treated with silico fluorides, they tend to discolor.

Barium hydroxide-urea, an inorganic consolidant, has been tested experimentally on limestone and marble with some success. Its major drawback for the building market is its caustic nature, attacking alumininum, zinc, and glass.

Alkoxysilanes can penetrate porous stone up to a depth of 20-25 millimeters, which makes them quite successful in consolidating sandstones in particular. Their drawbacks are cost (due to the number of coatings needed) and a tendency to change the color of the stone.

Synthetic organic polymers used for consolidation form thermoset resins. After penetrating the stone surface they chemically cure, and once set can't be remelted or reformed. Examples of thermoset synthetic organic polymers are epoxy, polyurethane, and polyester. Since these systems have been in use for a relatively short time, little is known of their long-term effects. However, stone treated with polyester has shown a decrease in porosity and tends to form an impervious layer, preventing the passage of moisture. Polyurethanes, on the other hand, are poor cementing agents and gradually become brittle after exposure to sunlight. There is a large number of epoxy formulations available with a variety of mechanical properties along with a range of gas and water transmission rates. The New York City Landmarks Conservancy manual, *Historic Building Facades,* recommends, however, "that epoxies not be used for stone surface consolidation. Since the epoxy tends to fill voids completely, differential thermal expansion will cause the epoxy to exert pressure against the remaining stone, eventually leading to its deterioration."

Acrylic polymers used to consolidate stone and concrete are methyl methacrylate, and to a lesser extent, butyl methacrylate. Both are applied solvent-free to the stone and consolidate in place. Methyl methacrylate hardens the stone surface and works well as long as deep penetration and complete consolidation take place. Concrete impregnated with acrylic-based polymers is considered a brittle material, and stone consolidated with it may exhibit similar brittle behavior. Stone treated with this consolidant also weathers differently from untreated stone.

Acrylic copolymers, such as ethyl methacrylate with methyl acrylate, acrylics with fluorocarbons, and acrylics with silicon esters, are all available commercially for stone consolidation. In specifying copolymer consolidant, the importance of the proper mixture of solvent to acrylic copolymer shouldn't be underestimated. Too much solvent, and evaporation can draw the acrylic copolymer back to the stone's surface; too little solvent, and the acrylic copolymer will not penetrate deeply into the stone.

Consolidation with deep-penetrating chemicals is admirably successful in stone objects of relatively small size, such as statues, but it is very different with buildings. Statues can be removed from their destructive environment, carefully and thoroughly cleaned, then treated with the consolidant in a controlled environment. That kind of careful attention isn't possible with stone buildings, and therefore the risks involved are greater. The long-term effects of some of these consolidants in everyday environments are unknown despite accelerated testing. A solution that proves effective in one case may not in another.

Concrete sealers

Coating concrete isn't a new idea; what is new is the concept of using a sealer or consolidant to alter the "climate" inside the material and extend its life. It should be noted that controlling the internal environment of concrete is best achieved through a combination of techniques rather than an attempt to control a single factor such as the sealers or consolidants.

Many of the chemical formulations used to consolidate stone are applicable to concrete, but the causes of deterioration and reactions to the consolidants can differ from those encountered when dealing with stone conservation.

The two major sources of deterioration associated with reinforced concrete are carbonation and chloride action. Carbonation occurs when atmospheric gases (mainly carbon dioxide in the presence of small amounts of moisture) react with some of the portland cement constituents (mainly calcium hydroxide) and produce calcium carbonate. Evidence suggests carbonation improves the compressive strength of the concrete. However, once concrete is carbonated it no longer has the high alkaline levels necessary to keep the reinforcing steel passive, and the steel begins to corrode. Chlorides may damage concrete through expansive subsurface crystallization of salts, although this reaction is confined for the most part to coastal areas.

For sealers or consolidants to function properly, careful surface cleaning and preparation is crucial. Evidence suggests that smooth concrete surfaces with a mininum of pitting accept sealers better than rough, uneven surfaces. A pitted, uneven surface that requires extensive filling may also require an opaque coating, if for no other than esthetic reasons.

Silanes are the best known of the penetrating chemicals that are drawn deeply into the concrete to consolidate and act as water repellents. Their water-repellent ability makes silanes perfect for immobilizing penetrating chlorides in concrete. Since these treatments often require an overcoating that will resist carbonation, the silane-treated surface needs to be modified with a binding layer before it will accept an overcoating. This makes the entire process quite costly. New vapor-permeable materials comprised of systems that combine silane primers and an acrylic topcoat or alkoxysilanes and moisture-cured urethanes offer an alternative. These coatings provide a hydrophobic barrier permeable to water vapor and are able to penetrate deep into the concrete to form a consolidated surface.

Sealers/consolidants for concrete should be evaluated on how well they penetrate concretes that vary in porosity and texture. No single treatment will solve all the problems one is likely to encounter when repairing or renovating concrete.

Intumescent coatings

The sudden interest in intumescents in the building industry may be attributed to a growing portion of the architectural market devoted to rehabilitation, along with the popularity of atriums and exposed structure in both new and existing buildings. Intumescents also offer a viable solution for architects to meet new fire code requirements in rehab work without altering the existing buildings. "Intumescent coatings have been around since the late '40s," Todd Metcalf, of ALBIclad, points out. "They were developed for the petrochemical industry. But the products we're using in buildings today were developed in the '60s."

Once applied and finished, intumescent mastics create a smooth surface that conforms to the contours of the objects to which they are applied. Exposed beams, columns, and space frames maintain the appearance of their desired forms. A 1 1/16-inch layer of this coating applied to a steel column achieves a three-hour fire rating. A 3/16-inch layer of the same coating is rated at one hour. When subjected to fire, the coating intumesces, forming a hard, ceramic-like char by transformation of the composition.

Some intumescent coatings are specially formulated to meet fire-resistance requirements. For instance, one intumescent epoxy coating provides up to three hours of protection for structural steel subjected to rapid temperature rises, such as those encountered in petrochemical fires. This coating withstands corrosive fumes and the weathering of marine environments. All these factors make it desirable in exterior applications, but few buildings are subjected to all these conditions, and its cost can be prohibitive. By carefully choosing the coating, or a number of different coatings (depending on location within the building), architects can economically meet the fire-resistance requirements.

Intumescent coatings are more expensive than fiber coatings, and architects are well advised to contact the manufacturer, who can recommend where best to apply intumescents and where a fiber coating makes more sense.

Like most coatings, intumescents require a clean, well-primed surface for proper adhesion. Some coatings demand that the steel be blasted clean and primed with an inorganic zinc primer. In existing structures where the steel has been painted, the paint should be checked for compatibility with the coating. If the existing paint is sensitive to the solvents in the intumescent coating, then the steel should be sandblasted and reprimed with a compatible primer. Almost every intumescent coating requires a compatible primer.

Manufacturers recommend close supervision during application. When applying intumescent coatings, the contractor should take random probes to measure coating thickness. Experienced contractors and applicators are necessary, since the coating shrinks due to evaporation of solvents and may not be as thick when dried as when it was applied.

When the intumescent coating has dried, an overcoating can be applied. Most manufacturers recommend overcoatings only where additional protection against spills is required or some type of color coding is needed while retaining a fire-inert surface. In most cases mastics can be painted over with any standard paint. Manufacturers can provide information on restrictions.

Manufacturers, in response to environmental restrictions concerning toxic solvents, have developed waterborne intumescent mastics. In the future, manufacturers plan to have on the market intumescents that more closely resemble paint than mastic. The new coatings will have a fire resistance rating of one to one-and-a-half hours and be much thinner than the existing mastics.

Aluminum powder coatings

Electrostatic powder coating is the most recent development in new coatings for aluminum. It involves the application of an electrostatically charged coating, in powder form, to the surface of a conductive, grounded piece of aluminum. The aluminum then is passed through an oven, and the separate powder particles are fused into a cohesive and continous coating. Powder coatings vary somewhat in durablity, weathering characteristics, and resistance to mechanical damage.

Of the two basic types of powder coatings, a thermosetting rather than thermoplastic coating is best for architectural applications. For the majority of architectural aluminum substrates, thermosetting systems currently in use are epoxies, acrylics, polyesters, and epoxy/poylester hybrids.

Powder-applied epoxy coatings display very good mechanical properties, including film flexibility, hardness, and resistance to chemical and corrosive environments. Epoxy resins can be formulated in a wide variety of textures, glosses, and colors. Their major deficiency is a tendency to discolor and chalk rapidly on exterior applications.

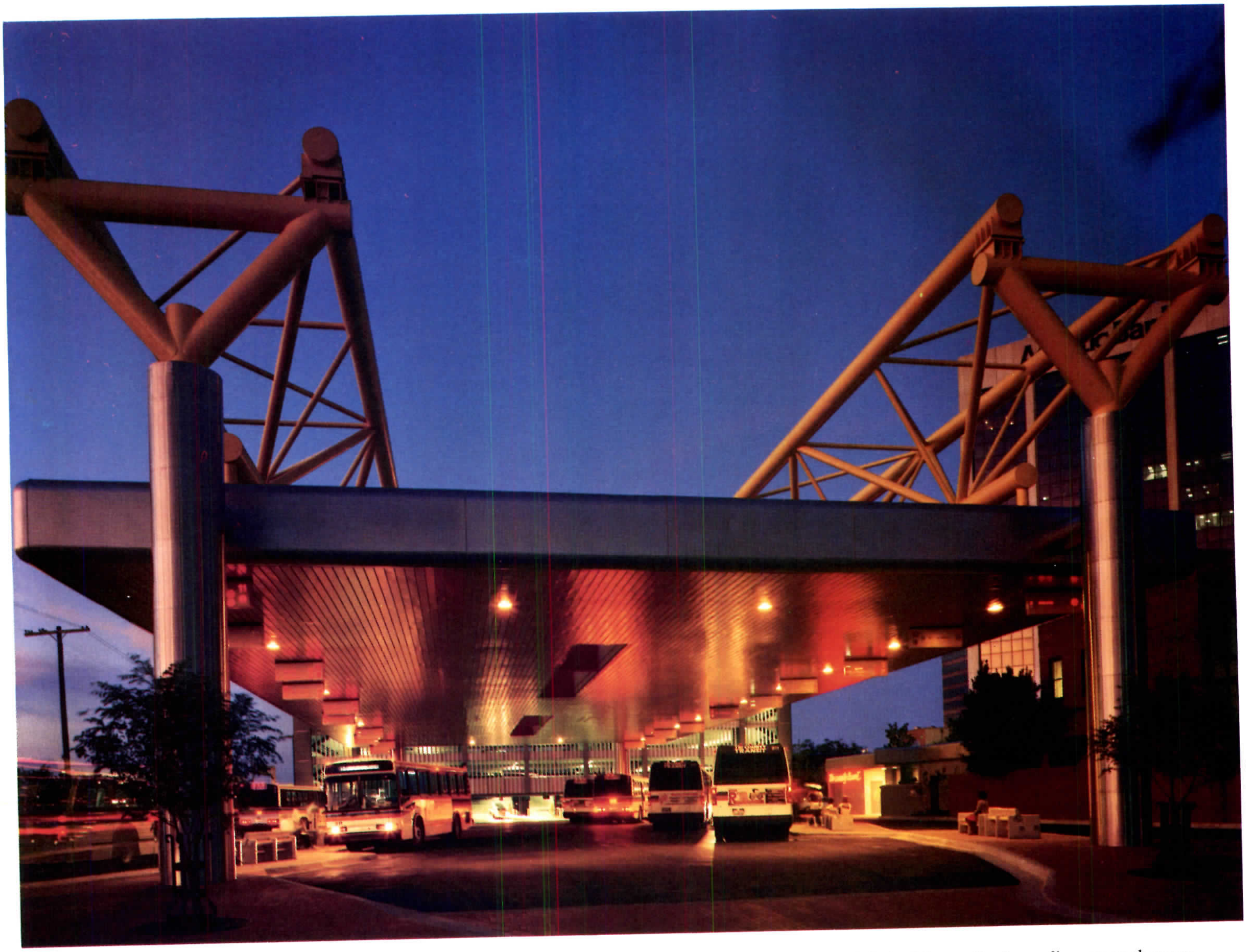
In an effort to improve the weathering properities of powder-applied epoxy coatings, manufacturers have developed epoxy/polyester hybrids. Slightly softer than epoxies but similar in flexibility, epoxy/polyester coatings chalk almost as quickly but after a point deteriorate more slowly. Their advantages over epoxies are improved weatherability and a resistance to overbake-yellowing during production.

Powder-applied polyester coatings divide into two groups: a urethane-cured polyester, and a European-developed polyester closely related to the epoxy/polyester coatings. The urethane-cured polyester coatings display excellent weathering properties, including resistance to humidity, salt spray, acid, and alcohols. They are also quite durable and not easily chipped, scuffed, or marred. The European-developed coatings are comparable to the urethane-cured polyesters in adhesion and corrosion resistance, but they are not as resistant to chemicals or solvents.

Powder-applied acrylics also provide good exterior durability. Like polyesters, acrylic coatings are urethane-cured and have many of the positive characteristics of polyesters. Acrylics combine hardness, alkali resistance, and weatherability with polyesters' mechanical properities, but are somewhat less flexible. □

Building Borrows from Oil Rig Technology

Structure becomes sculpture in a Florida bus terminal. By Andrea Oppenheimer Dean



The Architects Design Group Inc. and the client for Orlando's block-long bus terminal insisted on a column-free space suspended from trusses for at least three reasons: to improve security by eliminating places to hide; to provide uninterrupted sight lines for dispatchers working on the "pulse" system, whereby buses all arrive and then depart at the same time; and to protect against pigeons. Designer Keith Reeves, AIA, tells how during planning stages he visited at least one new bus facility in which pigeons had roosted in such numbers that the city found itself erecting a building within the building to house the birds and protect the public from them.

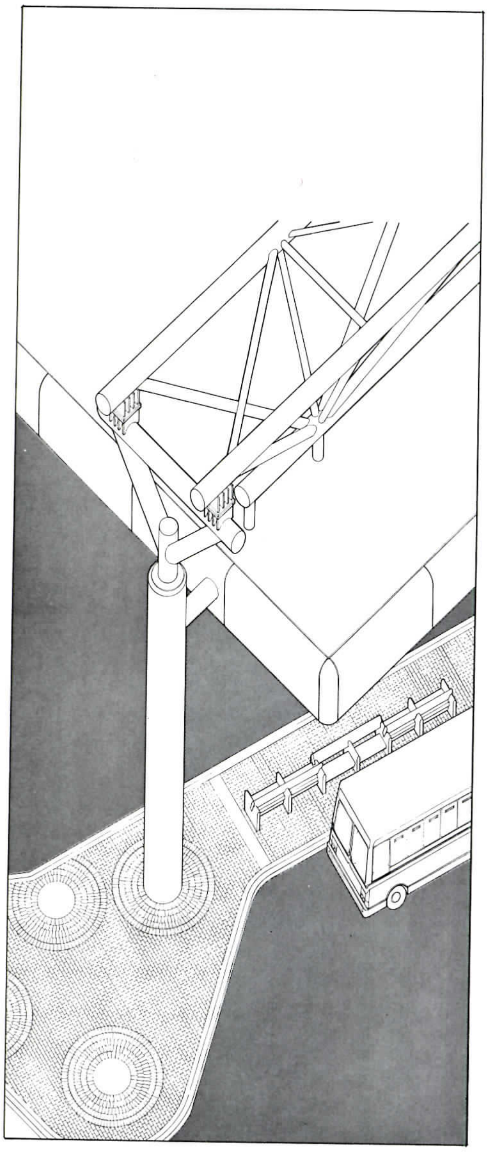
Because of the canopy's unusually long span (208 feet), Reeves (with Don Moe structural engineers) found no usable precedents in existing building technologies, and therefore turned to the stronger building component systems used in oil rig technologies. To protect against hurricane-force winds and estimate wind loads on the building's two pairs of 48-inch round structural columns—which are cantilevered from caisson foundations—the architects and engineers looked to principles of tower design.

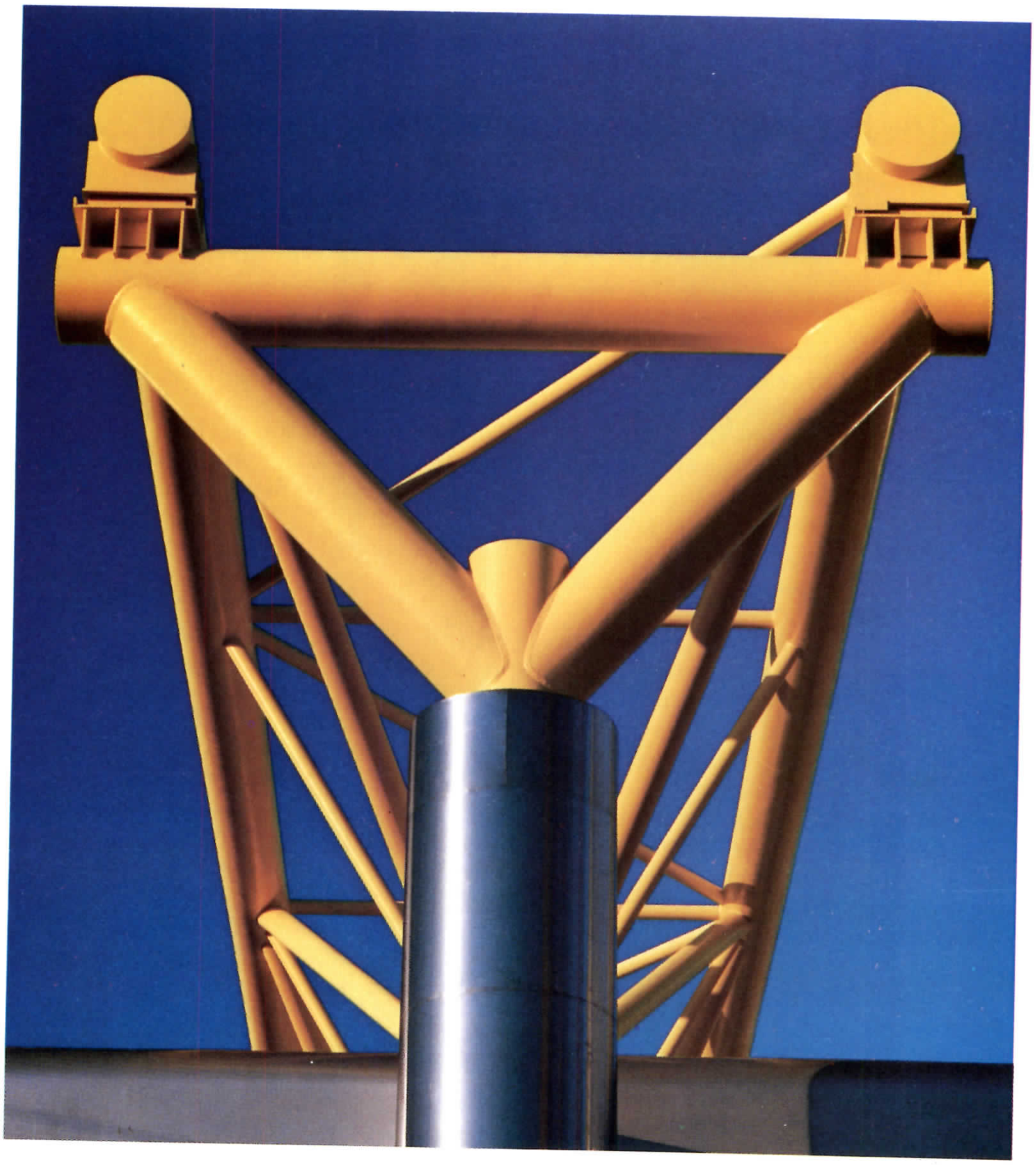
The result of their efforts is a roof-ceiling structure, 40 feet off the ground, supported by two welded 16-foot-high pipe trusses using 24-inch round steel pipes for the top and bottom chords. The canopy consists of steel joists, metal deck, foamed urethane insulation with fluid-applied roofing membrane, molded glass fiber fascia panels—which were cast by a boat manufacturer after default by the building contractor—and a linear aluminum ceiling. Two skylights running parallel to the trusses prevent dark spots and reduce the need for artificial light.

Constituting the terminal's only "building," a raised, enclosed administration/dispatch office stands just east of the long span canopy. It is equipped with electronics for monitoring the terminal and the flow of buses, some 20 of which simultaneously arrive, unload, reload, and depart twice an hour, in a system that eliminates waiting time for transfers. The building includes a lounge and restrooms for drivers and staff, as well as an information office, staff offices, storage spaces, and public restrooms, which are electronically monitored for safety.

In an effort to add softness to this building's high-tech appearance, the architects paved the portions for passenger use with brick and other natural materials, also used in the recent redevelopment and landscaping of the surrounding inner city neighborhood. Bus lanes are paved with concrete.

The heavy trusses were painted yellow, says Reeves, to make them look lighter and were intended as a huge sculpture and marker from the freeway, adding verve to an otherwise colorless downtown. □





Supporting this unusually long canopy (208 feet) are two welded 16-foot-high pipe trusses using 24-inch round steel pipes for top and bottom chords. To lighten their effect, the trusses were painted yellow. They serve as a huge downtown sculpture, as seen at right,

A Potpourri of Other Technological Advances

The 10 areas covered in accompanying articles may have been the hotbeds of technological change in recent years, but there have been advances across the entire spectrum of building. What follows is a brief summary of some of them. By Douglas E. Gordon and M. Stephanie Stubbs

Large fire disasters, most notably the 1980 MGM Grand Hotel fire in Las Vegas, and most recently the Dupont Plaza Hotel fire in Puerto Rico, where 96 lives were lost, prompt continuous reevaluation of design strategies to protect buildings from fire. Fire stops and barriers have recently become central to one of the current major strategies for fire-resistant design: to divide a building into zones separated by walls, ceilings, doors, and windows with code-specified fire ratings. This strategy, however, is only as effective as its weakest point of fire penetration, which is why fire-resistant sealants have received much attention lately.

To seal openings in fire barriers, as now required by the three U.S. model building codes and the NFPA life safety code, product manufacturers now provide a variety of caulks, putties, and foams that not only seal but also may expand and contract or intumesce. Specification of any of these sealants is dependent on performance requirements and site conditions.

Some fire-stop materials have the drawback of releasing toxic fumes when heated. Though most of the sealants offered today have overcome this deficiency, it's worthwhile to check before specifying. Another consideration is how well the sealant withstands the onslaught of water and fire-retardant chemicals during a firefighting operation.

Caulks are gunned into simple penetrations, and can now be used for fire-rated expansion joints. They may require backing and are temperature-sensitive, both for storage and application. The sealants adhere immediately, and some caulks have the added benefit of resisting dust and water penetration. However, because caulks cure and harden, they are not generally a good choice for penetrations that require frequent entry, such as wiring plenums.

In situations where frequent entry is expected, fire-stop putty is a good choice. It remains pliable after application and can be removed and replaced repeatedly. Further, because it does not emit fumes, putty may be applied in occupied buildings without causing inconvenience.

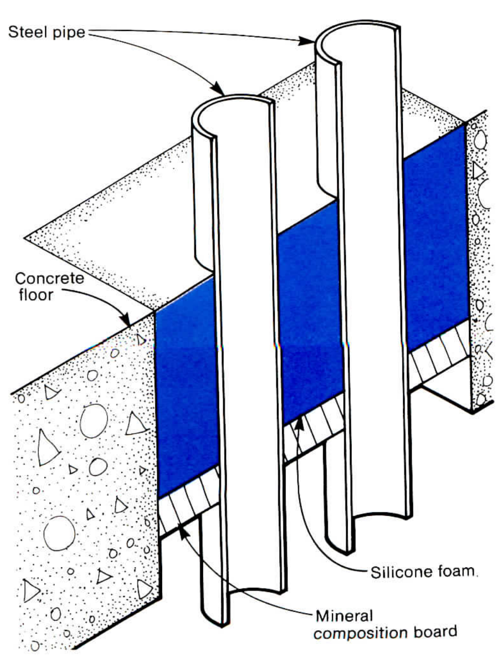
Two-part foam fire-stop sealants, also new to the marketplace, are good for large, irregular openings. In fact, because they require special machinery for mixing and pumping, they are cost effective only for large jobs. Once the foam mix is pumped into the penetration to be sealed, it sets within minutes, although full curing may take several weeks. The cured foam can be cut away and patched with hand-held cartridges if later access to the sealed penetration is required. Foam sealants are temperature sensitive during application and have limited shelf life.

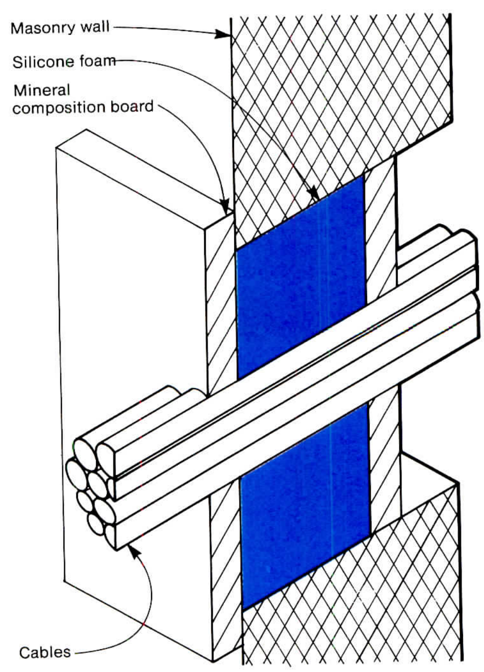
In some jurisdictions, PVC pipe may penetrate a fire barrier if it is sealed with an intumescent fire stop. Typically, intumescent materials expand eight to 10 times their original size when exposed to temperatures around 300 to 350 degrees Fahrenheit, forming a hard char that seals the gap left by melted plastic piping. Intumescent sealants are available in sheet form for lining penetrations, in easily removed and replaced bags for large openings that require frequent accessing, and in caulk form.

While fire rating for sealing penetrations currently is fairly well established by fire officials, smoke spread rating is not. In the wake of the MGM Grand Hotel fire, in which an estimated 70 of the 84 deaths were attributable to asphyxiation, smoke infiltration has gained considerable attention in fire safety design. In that fire, investigators determined that though the fire was contained in the kitchen and casino at the ground level, smoke spread freely to the upper floors through elevator shafts, air ducts, and mechanical plenums.

Smoke gaskets are currently available for sealing doors and elevators. Densely packed nylon filaments that resist air infiltration seal elevators and elevator shafts from smoke penetration. They are flexible and durable to withstand continuous use. Fire-resistant silicone rubber gaskets act to stop smoke penetration around doors.

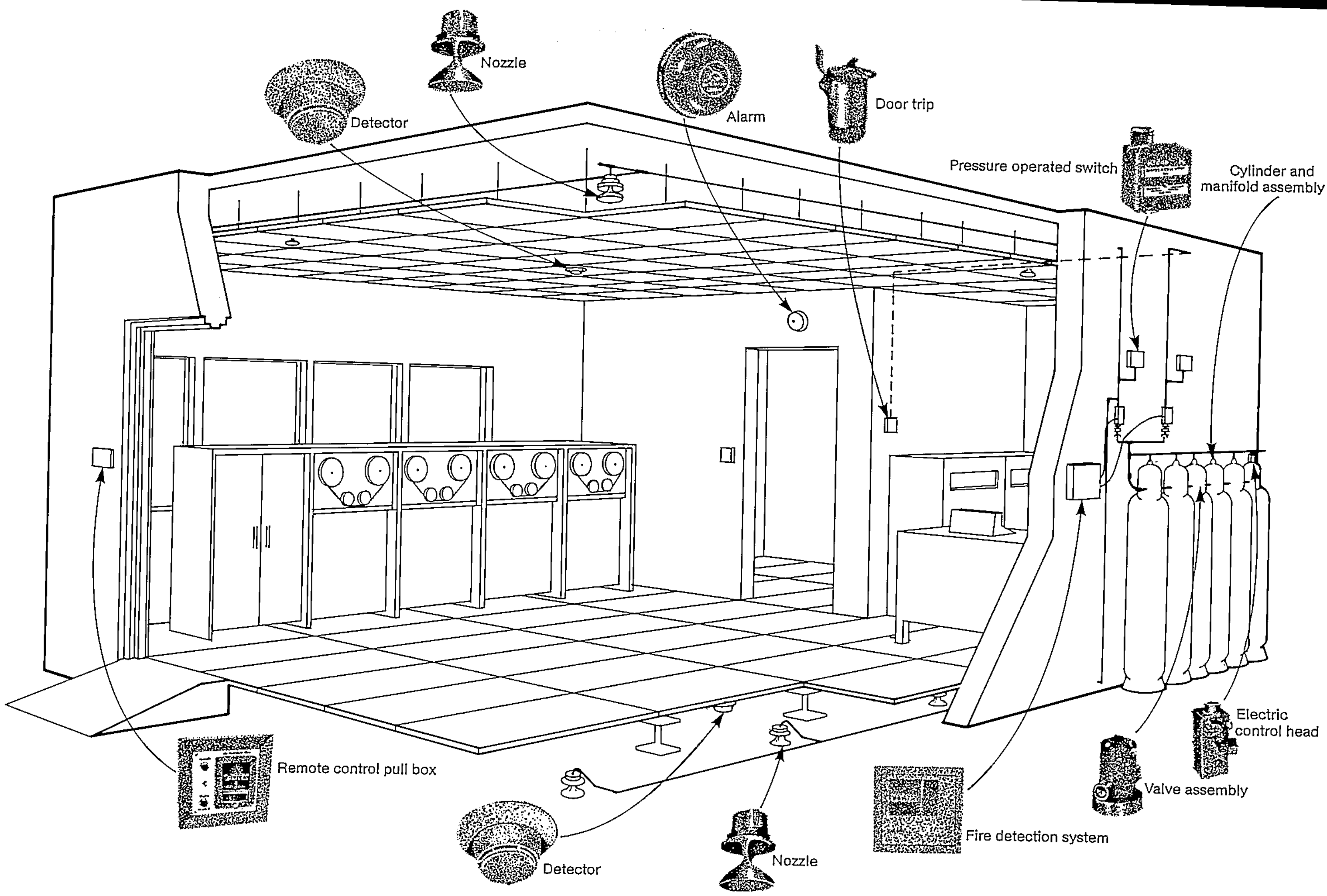
Typically, when applying two-part foam sealants, workers mechanically mix and pump the foam into penetration openings. Proper detailing of these penetrations includes mineral-board damming.





Fire suppression systems

Concurrent with the development of fire stops and barriers, which are part of any new building's fire safety system, has been the intensified development of fire suppression systems for special building situations. With industrial buildings—for example, those that store plastic materials—as well as structures housing rare and valuable artifacts, fire risks call for measures beyond the normal wet sprinkler systems. Two such specialized fire suppression systems, fast response sprinklers and halon suppression systems, deserve special recognition.



Kidde's Halon 1301 System for a computer room uses the equipment shown above.

Fast response sprinkler systems, called "ESFR" (early suppression, fast response) and "QRS" (quick response sprinklers), were developed in part to preserve structural integrity of buildings used to house increasingly combustible plastics and flammable liquids. The sensor of a conventional sprinkler, normally a soldered link, activates the sprinkler when its temperature reaches about 165 degrees Fahrenheit. In a fast-burning plastics fire, though, the ambient temperature could easily reach 1,000 degrees between the time the fire ignites and the sprinkler element begins to operate.

In the search for solutions to this problem, the United States Fire Administration contracted with the Factory Mutual Research Corporation of Norwood, Mass., to revise testing methods for sprinkler systems, originally for use in residential buildings. This research has been further supported by the National Fire Protection Research Association, an affiliate of the National Fire Protection Association.

The studies resulted in increased importance of three factors for sprinkler testing methods:
- Response Time Index (RTI), which takes into account, among other factors, the mass of the sensing element and its surface area (a lower RTI denotes a faster sprinkler response);
- Required Delivered Density (RDD), the minimum amount of water to suppress a fire in a specific stored commodity (the Factory Mutual test used a 25-foot-high, double-rack row of stored plastic products);
- Actual Delivery Density (ADD), the rate at which water is actually deposited from the sprinklers.

Of these three factors, the one that appears to have the most influence on sprinkler development is the Response Time Index. Manufacturers, by increasing the surface area of the sprinkler head and cutting down the mass of the sensor element, have developed what are now known as fast response sprinklers. Automatic Sprinkler Corporation of America is developing a final prototype based on the Factory Mutual tests, and they and other manufacturers currently offer fast response sprinklers for a variety of building types. The largest and fastest-growing market appears to be residential construction. In fact, several municipalities now require fast response sprinklers in all new buildings, including single-family homes.

Industrial markets are growing also. For example, the Viking Corporation, one of the five manufacturers to work with Factory Mutual in developing the first round of prototypes, offers a line of fast response sprinklers for high-challenge buildings, such as plastic storage facilities. The fusible links of these sprinklers now have an RTI of 50, as compared with standard RTIs of 225 to 500.

Halon suppression systems also are gaining in popularity. Water maintains its status as the firefighting medium of choice for most suppression systems. But in some instances, potential water damage from sprinklers is unthinkable. The most tenable solution used to be carbon dioxide systems, which create an atmosphere that won't support combustion. Unfortunately, carbon dioxide also won't support human life, making it unacceptable for use in areas through which people might leave a burning building. An alternative solution gaining greater acceptance in the past few years is pre-engineered halon systems, which will not support combustion at concentrations of five percent in the atmosphere, yet will allow people to breathe.

Halon 1301—clear, odorless, and electrically nonconductive—is stored as a liquid. When it is discharged from its tanks, it becomes a gas, five times heavier than air. Dry and noncorrosive, it leaves no residue after application.

Because of its expense, halon is normally employed to protect small, specialized areas of a building, such as rare-book rooms, computer facilities, and film storage rooms. One famous exception is Mount Vernon, national landmark and home of George Washington, which is protected with halon throughout.

Halon systems also offer the advantage of being easily retrofit into an existing building or room.

"Halon systems began gaining popularity in the mid-1970s" said John Trinajstich, marketing manager for

Walter Kidde, one of the largest manufacturers of halon suppression systems. "Because it is low in toxicity, it allows increasingly stringent life safety requirements to be met. Increasing use of computer rooms has also made halon more popular—it leaves no residue, reducing the down time needed if the halon system has to be used."

Solar technologies

Energy consciousness as a design strategy is alive and well, and, if we view solar energy technologies as a major subset of this consciousness, new developments are still occurring on drafting boards and in the marketplace. A few of the solar trends include motorized and automated controls for solar systems, superinsulation, innovative energy-storing systems, and developments in daylighting.

Motorized and automatic controls are now an active part of the solar vocabulary. Housing has long been the building type upon which most solar research shines, perhaps because heating and cooling account for a significant portion of residential energy use and a relatively small portion of commercial and industrial use.

Residential passive systems have moved from "hippie" to "yuppie" in the past 10 years as developers have incorporated them into the new-home market. We now see, as fairly standard selling points, south-facing glazing, thermal mass walls and floors, and more thought for insulation and infiltration.

The trend asserting itself on the solar development front forms part of the dissolution of "passive purism," the doctrine that states that a natural energy system must be able to run on nonmotorized, passive controls. One example for residential and commercial building alike is the addition of electric controls to allow push-button manipulation of solar shading components, such as blinds and awnings. (One company's product, the Somfy System, can control 2,000 awnings at once—individually, in groups, or all together.)

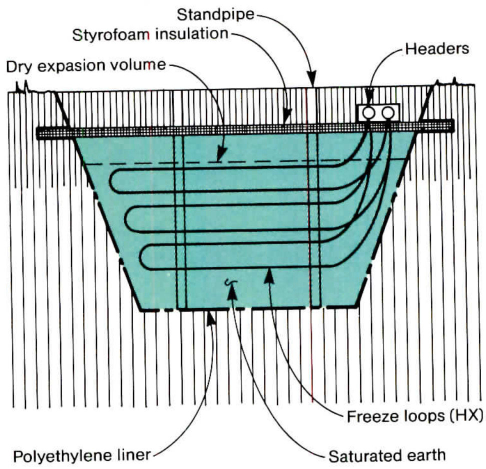
In a broader sense, controls of natural energy systems have been integrated into the "smart building" concept, typified by the National Association of Homebuilders Research Foundation's prototype house. As part of its control package, the prototype incorporates automatic sensors and controls to turn on electric lights when the daylighting level is too low, and to kick on the backup heating system when the passive solar feature can't provide enough heat (see ARCHITECTURE, October 1986, p. 102).

Superinsulation and unique storage methods are growing together. Tightly sealing and insulating a building envelope to avoid unwanted heat transfer has gone hand in hand with the development of solar technologies. Taken to its extreme, the concept has resulted in the "superinsulated" building, where designed R-values of walls commonly hit R-40, and roofs measure R-65 and higher.

Especially appropriate for building occupancies such as in housing, in which the main conservation concern is regulating heating and cooling, superinsulation is often paired with strategies to store solar energy for later use. The Illinois Department of Energy and Natural Resources recently funded the construction of a 2,200-square-foot superinsulated passive home in Springfield, Ill., designed to cut heating, cooling, electric, and water costs by one-third to one-half.

The demonstration home has many of the features now typical of the well-built energy-conscious home, including programmable lighting and heating controls, water-conserving plumbing and fixtures systems, and strategically placed thermal mass to passively collect and store heat. However, it also boasts superinsulation: R-15 rigid insulation on the basement walls, R-40 glass fiber insulation in the walls, and R-70 (23 inches) glass fiber insulation in the roof. The most unusual feature is a seasonal cooling system that stores the winter cold for airconditioning in summer.

Underground ice storage supplies all of a Midwest home's airconditioning needs.



The system, developed and constructed at Illinois State University under the direction of Dr. C.E. Francis, uses a 20x40x12-foot, foam-insulated, plastic-lined pit under the front lawn of the house. The pit is filled with dirt, gravel, and water. Antifreeze solution, chilled by the winter air, is pumped through 3,000 feet of plastic tubing buried in the dirt/gravel/water mixture. During winter the underground temperature becomes cold enough to freeze the earth in the pit. During summer the antifreeze recirculates through the frozen ground to the air-coil furnace, which releases air as cool as 40 degrees Fahrenheit into the house.

"The initial cost of the ice cooling system was $4,000 but it is expected to provide 100 percent of the airconditioning required, at only 10 to 20 percent of the cost of a conventional central airconditioning system, about $20 or $30 a year," said Don Etchison, the Department of Energy's director. "The home demonstrates to the public that energy costs can be substantially reduced by making the best use of natural heating, cooling, and lighting."

Solar lighting is forging a new frontier. Daylighting has once again come into focus as a tool for capturing the sun to save lighting energy (see ARCHITECTURE, February 1987, p. 78).

Manufacturers now offer a variety of off-the-shelf components beyond the myriad special glazings and traditional windows and skylights to help the architect capture daylight in a controlled fashion, not only to maximize its esthetic appeal but also to harness as much light as possible. One such roof-mounted system uses a sun-tracking mirror, which reflects light down through a pair of high-impact plastic diffusion lenses, one at the roof level and one at the ceiling level.

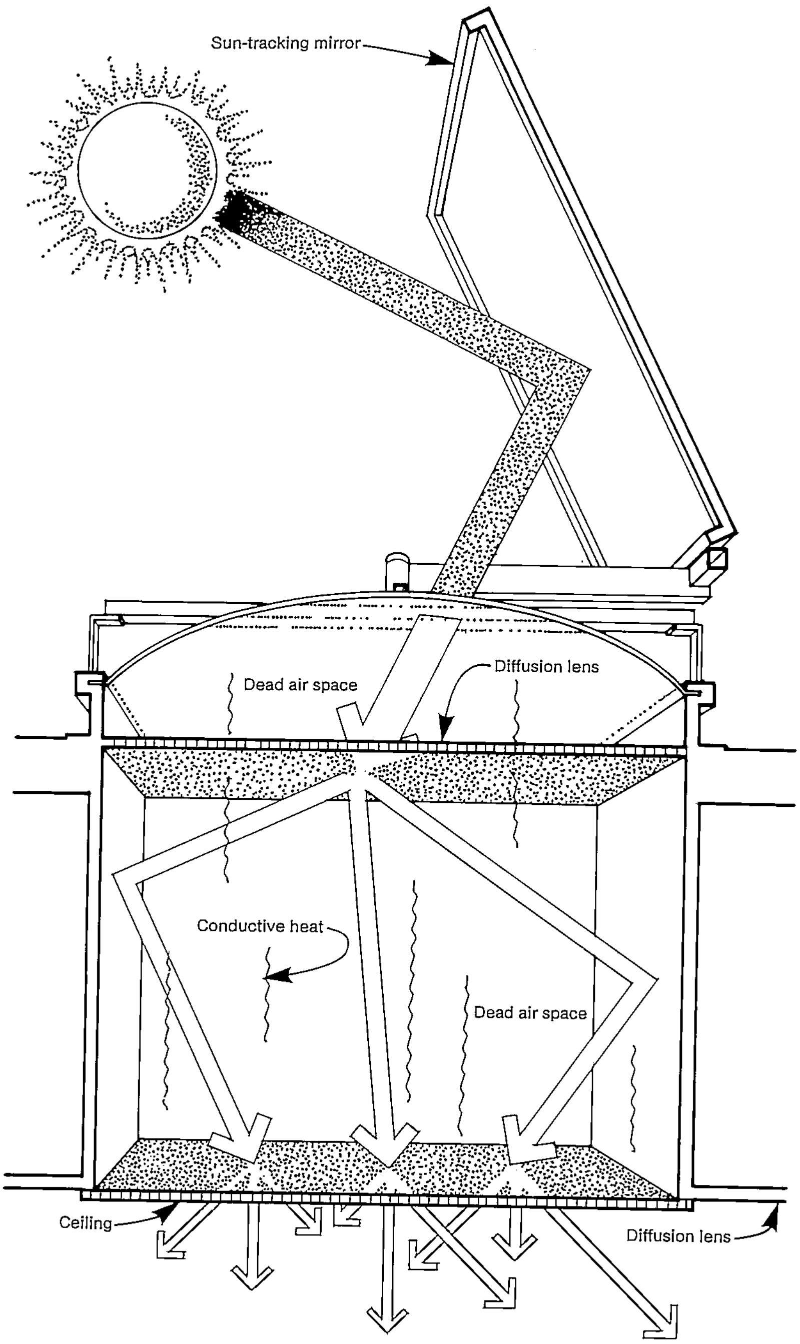
The mirror assembly, which is powered by two 12-V DC motors, automatically closes over the lens assemblies when there is insufficient daylight, preventing radiant heat loss by reflecting heat back into the space. One manufacturer of this type of system, So-Luminaire of San Diego, claims its system provides as much as three times the quantity of light of a conventional skylight.

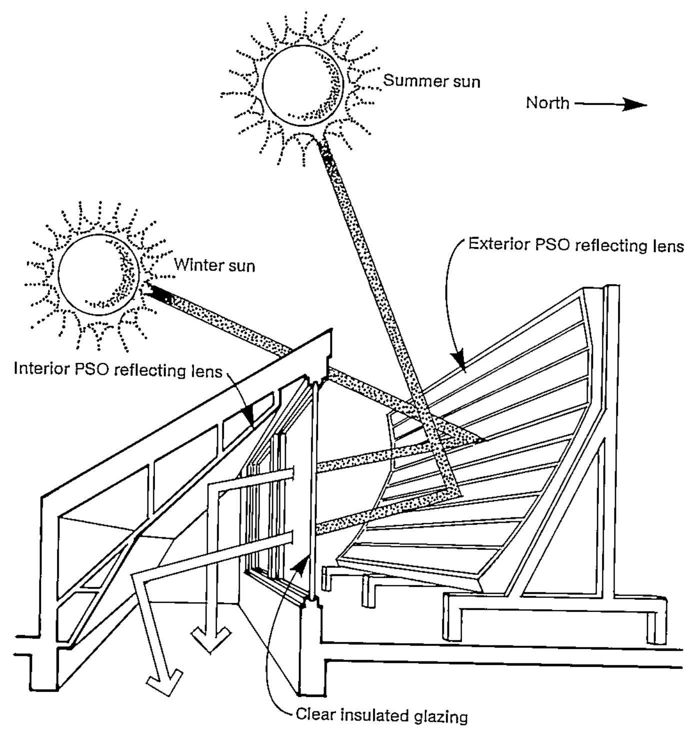
Other systems, such as Zomeworks' Skylids, have skylights above movable louvers that direct sunlight into the space. The louvers may be automatically tracked to follow the sun's path by use of a heliostat or by an electric motor.

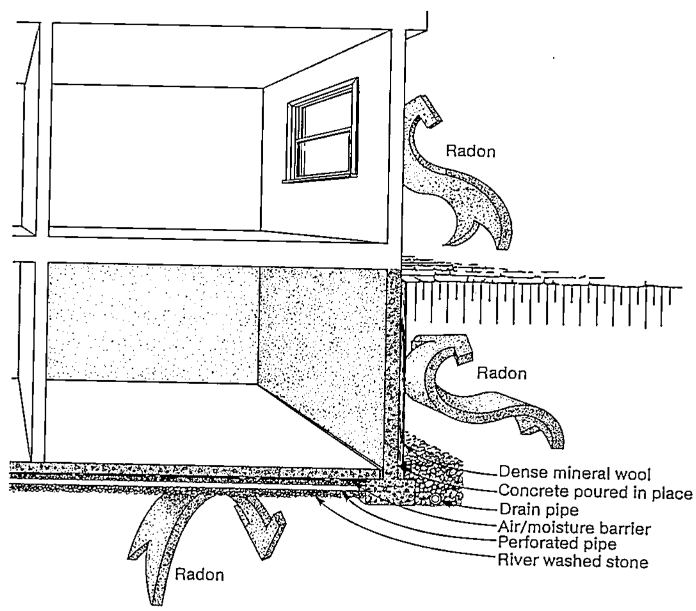
Another promising development in directing sunlight is the light pipe concept, in which a thin tube is configured so that an incoming beam of sunlight can travel through the tube, even around corners, with little absorption or loss of light.

David Eijadi and his associates at BRW Architects Inc., in Minneapolis, have been studying both active and passive solar optics systems and have incorporated them into several building designs, most notably in Minneapolis, at the new Civil/Minerals building on the University of Minnesota campus (see ARCHITECTURE, January 1983, p.64), at the renovated Langdon warehouse in Denver, and at the Thresher building in Minneapolis. Included in these projects has been a good deal of study and experimentation on optic systems, supported by the U.S. Department of Energy.

While the details of study and experimentation are a story in themselves, suffice it to say that Eijadi's work has pointed out how sunlight collecting and transporting work, and how they show promise for technical application in the future.







Soluminaire's sun-trackers, left, and Eijadi's solar optics, top, direct sunlight to the interior. "Radonproofing", above, prevents the gas from entering the building below ground.

Radonproofing

As a design strategy for foundations and basement walls "radonproofing" is a response to one of the major architectural concerns of the '80s—improving indoor air quality. Energy conservation and related standards for decreased air infiltration have resulted in "tight" buildings, which in turn have caused concern over the quality of the air that subsequently is turned over less frequently. Simultaneously, we have become conscious of dangerous effects of radon, found in high concentrations in the soil of many parts of the country, as well as in some building materials, including concrete and stone. Radon gas decays into radioactive progeny that have been linked to lung cancer.

However, David T. Harrje, senior research engineer at the Center for Energy and Environmental Studies at Princeton University, points out that it is a myth that tightening up a building to prevent infiltration automatically degrades air quality. On the contrary, he says, better insulation and building seals permit pressurization and air flow within the building to be optimized (see ARCHITECTURAL TECHNOLOGY, July/August 1986, p. 33).

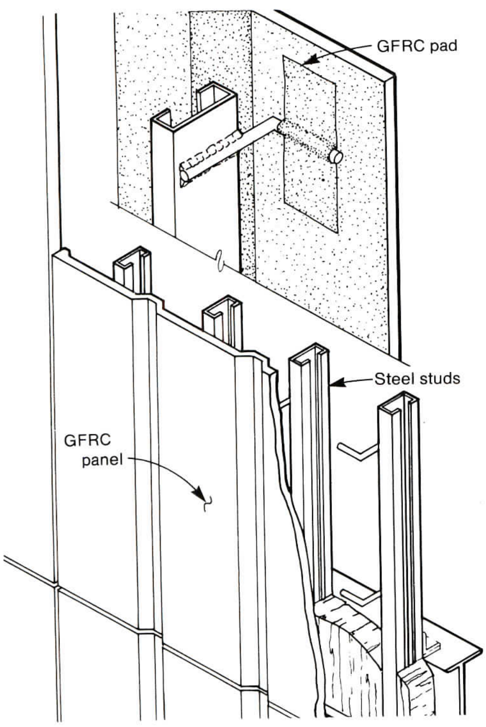
As far as radon is concerned, Harrje says that the best way to eliminate the hazard is not to let the radioactive gas into the structure in the first place. The major routes radon takes are through cracks in the foundation slab, and through subsurface walls, common in residential construction. Preventative measures can be taken.

• Insulating the *outside* of exterior walls of the below-ground space with dense mineral wool not only protects the building from heat loss but also relieves soil gas pressure so that the gas moves more freely to the outside atmosphere.
• Floors and foundation walls constructed of reinforced concrete composed of radon-free materials offer a less permeable barrier to radon migration from the soil than do standard slabs and masonry walls. Wire-mesh helps eliminate cracks in the slab, especially in corners.
• Placing a low-permeability membrane (tough enough to resist ripping while the foundation is being constructed) beneath the slab also discourages radon from permeating the slab. River-washed gravel, placed directly beneath the slab, will encourage the soil gas to move more freely to the perimeter of the building, where it can escape to the atmosphere instead of heading indoors. The gravel will also protect the membrane above it.
• Finally, installing perforated pipe within the gravel bed and extending beyond the perimeter of the building

further directs the soil gas away from the structure. In serious cases, blowers installed at the ends of the pipes can increase the flow rates. The blowers have the added advantage of keeping the subslab at a slightly negative pressure so that air moving through cracks in the slab would move from inside to outside, rather than vice versa. According to Harrje, this type of depressurization has proven successful in reducing radon concentrations in existing houses, where sumps or drains within the house are used for access to a gravel bed below.

Glass-fiber reinforcement

The development of alkali-resistant glass fibers has extended the use of glass fiber as a reinforcing material for concrete, gypsum, cement, and even roofing felts and architectural fabrics. In some building components, such as pipe insulation, glass fiber is replacing asbestos as a heat-insulating material. Glass fibers offer high tensile strength, light weight, and noncombustibility, making them the ideal reinforcement, especially for materials



GFRC panels require special detailing to accommodate higher contraction rates.

such as concrete, which by themselves offer good compressive strength but are weak in tension.

Glass-fiber-reinforced concrete (GFRC) panels are perhaps the most remarkable example of what glass-fiber reinforcement has to offer. GFRC panel weight typically is only one-third to one-tenth the weight of precast panels, offering the attractive advantages of:
• the possibility for a lighter-weight structure and foundation;
• reduced lateral loads, an important consideration in seismic zones;
• lower erection and transportation costs.

Manufacturers today offer panels spanning as long as 30 feet. GFRC panels require special detailing, different from that for precast concrete panels, to accommodate their higher contraction rates and their lower load-carrying ability for windows. For details, see ARCHITECTURAL TECHNOLOGY, Winter 1985, p. 70.

Glass-fiber-reinforced polyester is probably the ultimate in this technology. It takes the form of a polyester resin, which can be made corrosion-resistant or flame-retardant depending on the chemicals added to the mix. It can be molded into almost any desired shape, making it popular as a substitute for natural materials in ornate restoration projects. Less frequently, it is used for experimental roofs. Color is integral to the material, not just surface-applied, and manufacturers claim that gfr-polyester can mimic any finish, from metallics to masonries.

Glass-fiber insulation, though not strictly a reinforced product, deserves special note because of the way glass fiber is replacing asbestos in insulation products. For example, fire-resistant hydrous calcium silicate is now molded into rigid sectional pieces for use on heated piping, a job commonly done in the past with asbestos insulation. Available in thicknesses up to eight inches, this type of insulation can withstand temperatures up to 1,200 degrees Fahrenheit.

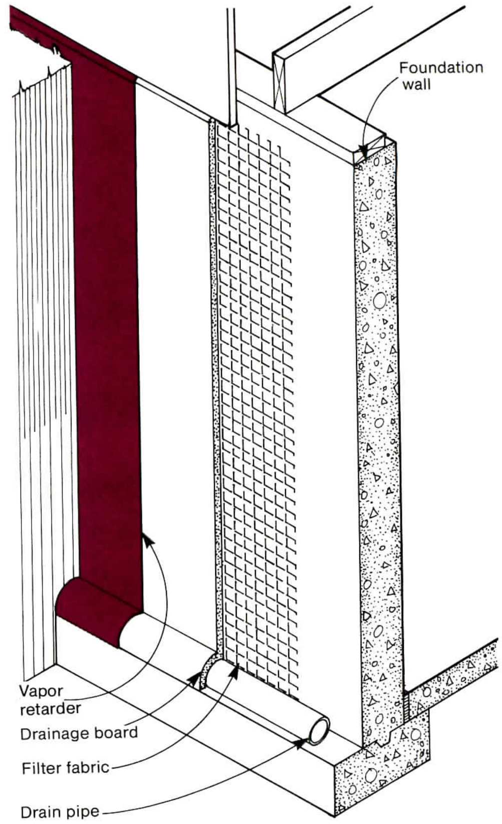
Glass fiber, when bonded with thermosetting resins, forms insulating wool "blankets" suitable for a variety of applications from panel insulation to boiler and vessel coverings.

Miracle mats

It's one of the most useless-looking objects you'd ever want to see—it resembles a pile of spaghetti-thin nylon knitting yarn after the cat has finished playing with it—but it has proven invaluable for applications that range from erosion control to cow bedding. It's nylon mesh tangled into a three-dimensional matrix that boasts high compression strength, light weight, and good lateral strength. Its major attribute, however, is the amount of open space provided within the matrix, making it a good medium to channel water, provide an air pocket, or be filled with other materials.

Erosion control was one of the first uses of the "miracle mat," which can serve as reinforcement for natural grass in athletic fields. The first product developed, called Enkamat by Geomatrix Systems, allows grass to develop a strong root system when the mat is placed one inch below the surface. Several other manufacturers in the United States now produce similar materials.

Building drainage became a later occupation for plastic mats, often referred to as "geomatrices." For instance, when



Plastic mats topped with a filter fabric facilitate drainage of subground walls.

topped with a filter fabric, they can serve as a drainage system for residential and commercial basements. The open mesh allows the water to travel straight down to the drain tile without hydrostatic pressure buildup, one of the primary causes of basement walls becoming wet. The filter fabric, placed on the side away from the wall, blocks sediment to allow the water to flow freely. Geomatrix reports that its product, Enkamat, developed in 1979 for commercial projects, has racked up millions of square feet in use in thousands of buildings across the country.

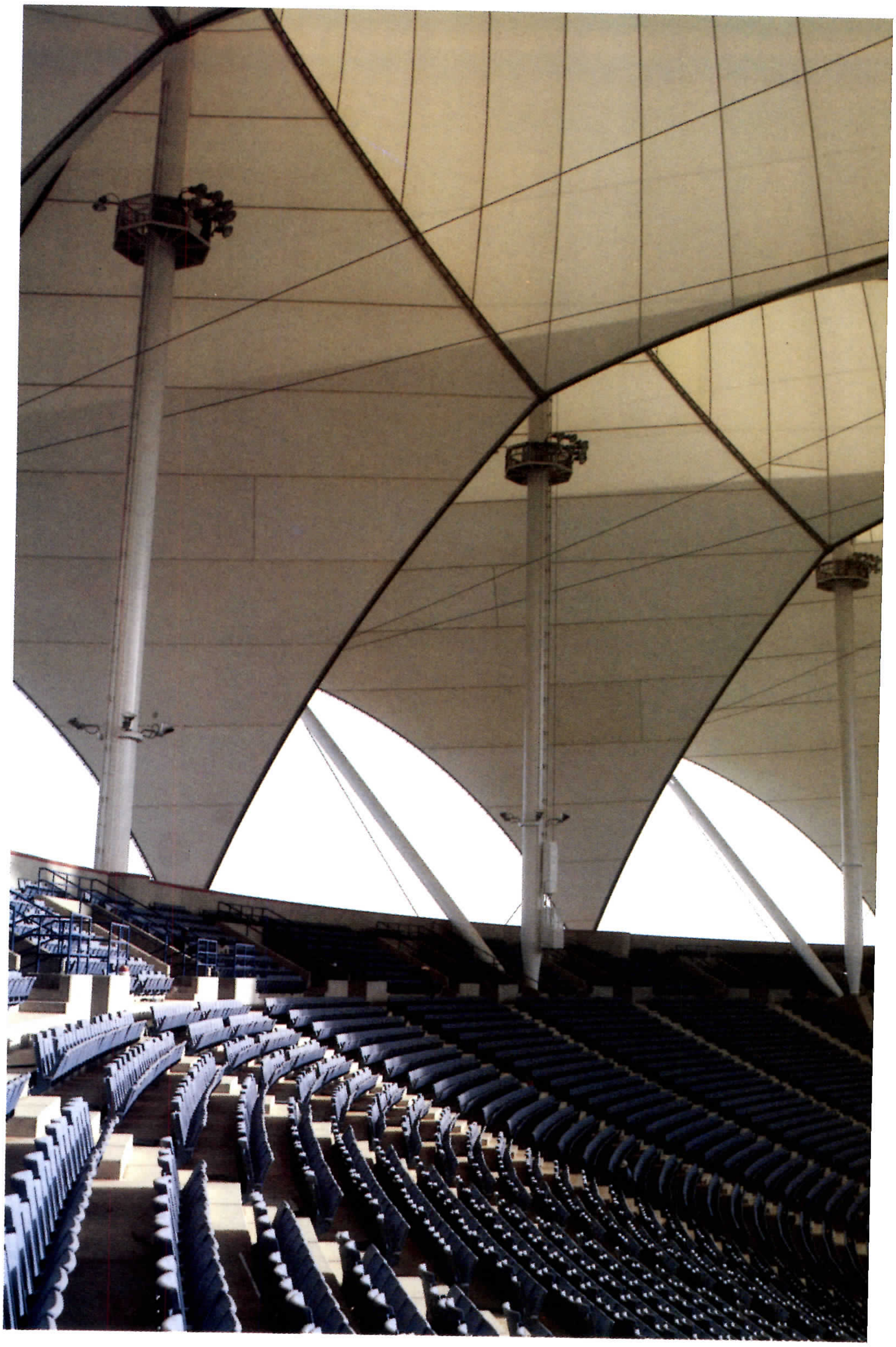
Sound transmission damping is the most recently discovered virtue of plastic matting. Used beneath a floor system, a third variation of the plastic mat creates an air barrier in its mesh, blocking both impact and airborne sound transmission. Another version of the product allows placement of a vibrating object to float on a cushion of air supported by the mat.

What's next for miracle mats? P.L. Skoglund, director of Geomatrix Systems, reports: "We are doing some development work in the area of mist eliminators, devices for recapturing particles from steam, either because they are valuable, or because they need to be removed from the atmosphere. We have used it in insulation systems for outdoor storage tanks, where you trowel mastic into it for the final outside coat of the tank. . . .

"When [the mats] are doing their job they are underground and invisible. Though they are out of sight, they are having a very visible impact in many different areas, and who knows what new challenges the future will bring?" □

Fabric Covers A Multitude Of Buildings

But technology still outstrips design prowess. By Andrea O. Dean



In no type of construction are esthetics and technology as tightly intertwined as in fabric structures, since the structure and materials are the major design tool, comprising envelope and architectural space as well as lighting and acoustical systems. "Here technology is the enabler of form, of our art," says Paul Kennon, FAIA, whose firm, CRS/Sirrine, has completed several fabric-covered recreational buildings for universities. Todd Dalland, of FTL in New York City, puts it this way: "With fabric structures, the form is the structure; the material is the structure; the material is the form."

FTL has completed some 50 fabric roofs in the last few years, whereas 10 years ago all existing U.S. buildings using tensioned fabric could be counted on the fingers of one hand, and all were either large sports facilities or performance facilities. Among FTL's completed projects are exhibition spaces, including the Bradford Exchange in Chicago (see April '86, page 82), shopping centers, restaurants, ballrooms, and convention centers. The firm's unfinished projects include three ferry pavilions for New York City, which Dalland describes as "prepossessing sculptural forms on the waterfront in the tradition of the Sydney opera house."

According to John Belniak, of OC-Birdair, "We're also seeing a lot of new activity in retail, food courts, and atriums," in part because of the lively, festive image conveyed. Other reasons mentioned by Belniak are that tensile roofs save money because they are pre-engineered and require no on-site construction; are leakproof; are usually self-cleaning; and bring in diffuse glare- and shadow-free natural light.

But despite the recent proliferation of fabric-roof buildings and advances in their technology, their primary use is still in large sports facilities—because the major cost advantage is long span construction—and in performance halls because fabric construction has superior acoustic properties.

Riyadh International Stadium, Saudi Arabia. Ian Fraser, John Roberts & Partners; Geiger Berger Associates, engineers.

Since they have continuous, nonporous and highly tensioned surfaces, fabric structures reflect all mid- and high-frequency sounds. In addition, their curved shapes disperse sound in all directions, producing blended acoustics throughout a building.

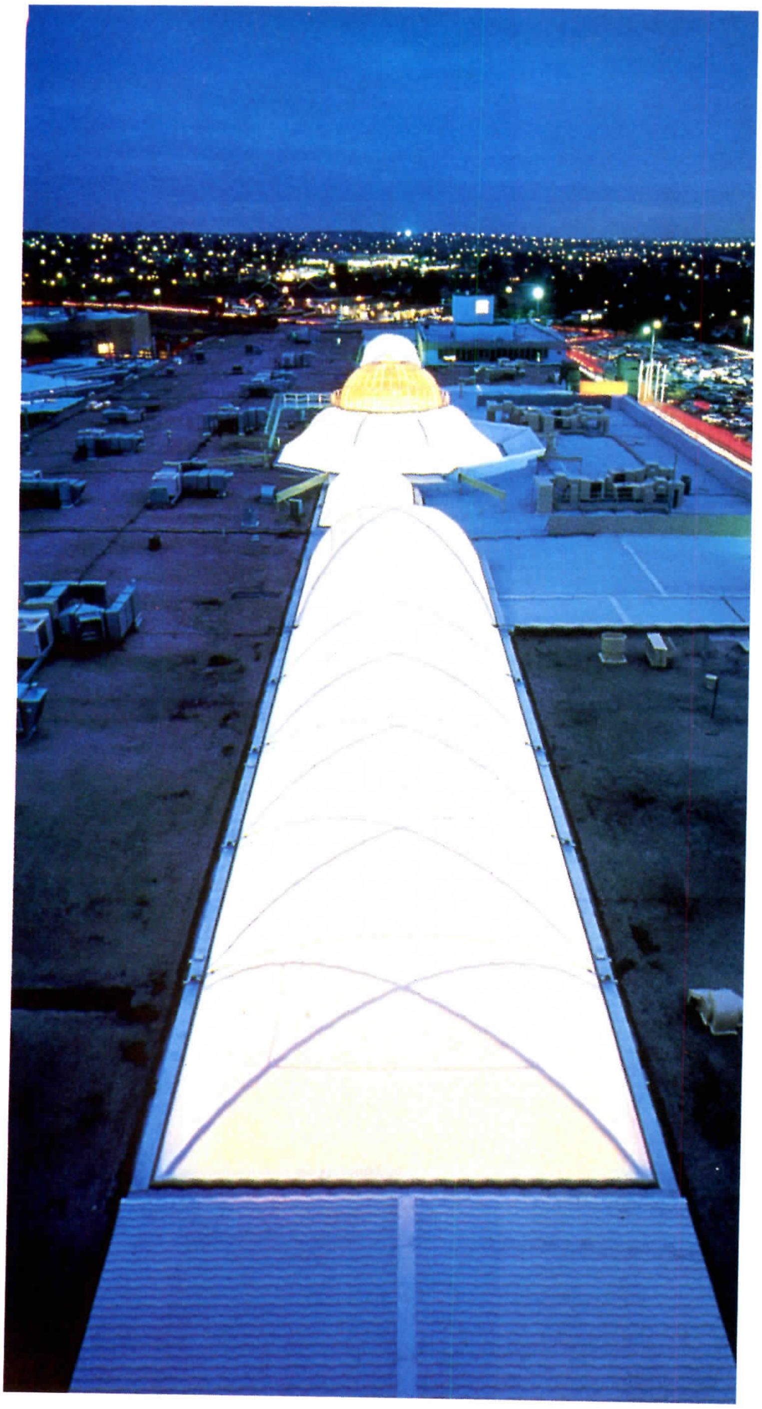
"After long span structures, the most cost effective use of fabric structures is for skylights, where a 20 to 30 percent cost savings can be achieved over conventional glazing," says David Geiger. Geiger Berger Associates (which was dissolved in 1983 to form Geiger Associates and Horst Berger Partners) engineered the fabric roofs of the Haj Terminal in Saudi Arabia, among others. Geiger Associates' most recent designs include the roofs of the Korean Olympic stadium—the world's first tensegrity dome—the Ontario pavilion for Expo in Vancouver, and the new aquatic center in Calgary.

Fabric skylights not only are cost effective but also constitute "the strongest market today for tensile construction," according to Steven Denbow, AIA. He was business development supervisor for ODC, a division of Dow Corning until ODC went out of business in January 1987, leaving OC-Birdair as the sole major U.S. corporation to distribute, engineer, fabricate, and install permanent glass fiber tensile structures. Birdair, a joint venture owned by Owens Corning Fiberglas and Chemical Fabrics Corporation, is now negotiating to obtain rights to ODC's materials, technical information, customer lists, and other assets.

"On average," says Belniak, of OC-Birdair, "Fabric is half the price of traditional skylighting materials—polycarbonate or glass." He adds that fabric can be customized to fit any opening. And, since it can be manufactured in very large continuous membranes, fabric is leakproof, unlike glass panes, which have a size restriction of about 40 square feet and need mullions. Furthermore, fabric skylights can carry heavy loads, since they are part of the structure. They are energy-efficient because of their reflectivity (which reduces airconditioning needs) and are getting more so because of new low-emissivity coatings that produce r-values approaching three or four. Fabric skylights are safer than glass since there are no panes to fall out or break.

The main disagreement about fabric

Top, Ontario Pavilion/Expo, '86, Zeidler Roberts Partnership. Above, Canada Harbor Place; Canada Place Architects; Geiger Berger Associates, engineers. Opposite left, Chadstone shopping center, Melbourne, Australia; Gandel Group Architects. Right, East Towne mall, Knoxville, Tenn.; Copeland, Bovak, Israel & Simmons, architects. All roof fabrication by OC-Birdair.



structure technology has to do with relative merits of different materials. Dalland favors tedlar-coated vinyl polyester. It is by far the least expensive material used in tensile roofs, though it has a life span of 15 years compared with 25 for glass film. Its more serious problem is in meeting fire codes for permanent buildings. However, Dalland says he has never had trouble from code inspectors and that, in his experience, polyester, which is "used 10 times more than other fabrics, is the workhorse of the industry and compares favorably in durability and quality with glass fiber materials."

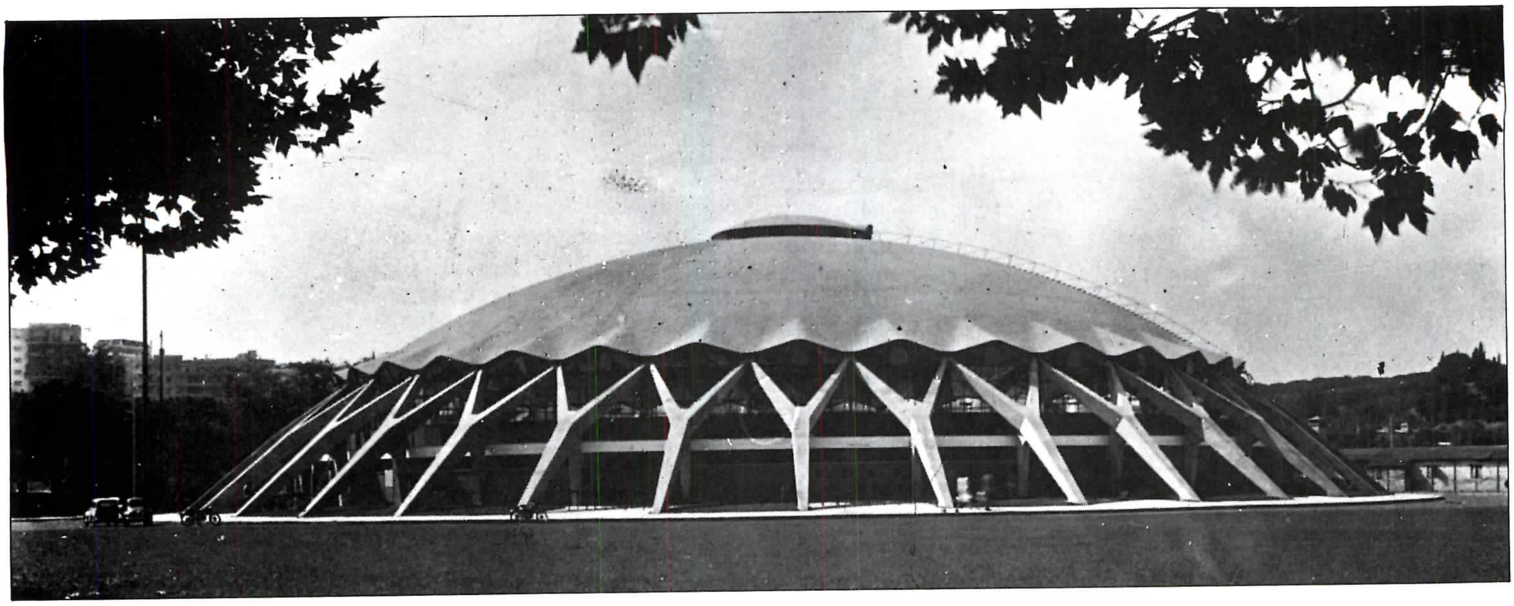
David Geiger counters that polyester is fine for temporary construction and low-occupancy buildings but is "prohibited by fire code in most situations for large seating facilities." He favors Teflon-coated glass fiber as a proven material, as does Belniak. It's Belniak's company's mainstay. While glass fiber coated with silicone has the advantage of higher light transmission, it doesn't wash as clean in the rain as Teflon-coated glass fiber.

Birdair's main research today emphasizes improving the self-cleaning properties of silicone-coated glass fiber and reducing the cost of all glass fiber materials through development of new yarns and weaving techniques. The company is also working on a modular skylight system capable of replacing traditional glazing techniques. Geiger believes that among the most important developments for the near future will be the replacement of air-inflated fabric roofs (some have had air leakages) with cable dome construction. He also thinks the cable dome's light, lacy framework will soon become a mainstay for long span conventional construction.

Dalland foresees a proliferation of large, interior fabric ceilings for ballrooms, convention centers, and the like. He just finished retrofitting the Roseland ballroom in New York City with a 12,000-square-foot fabric ceiling and is working on two tensile ceilings for the Cleveland convention center. Among fabric's advantages here, he says, are "greater architectural lighting opportunities" and the need for only minimal amounts of rigid structure and connections to the existing building. In addition, fabric ceilings are easy to install, and they accommodate sprinklers, air circulation, and lighting systems.

"But we don't look for breakthroughs in technology," Dalland says. "Available technical knowledge far outstrips design awareness and knowledge of fabric structure technologies."

There is, in fact, a consensus that broadening designers' familiarity and understanding is the most pressing task for everyone involved in the art and technology of fabric structures. □



New Approaches to Long-Span Structures

They have always opened new architectural possibilities as well. By Matt Levy

For the 1960 Olympics in Rome, Pier Luigi Nervi used prefabricated concrete elements to create two lacy, shell-like buildings. This supremely elegant pair was the culmination of Nervi's lifelong exploration of long span construction using the plastic properties of concrete. Felix Candela, in the same era, showed us the many faces of the geometrically defined hyperbolic paraboloid in a series of richly romantic concrete thin shells.

Once exposed to the work of Nervi and Candela, architects developed a love affair with concrete shells as a universal solution to long span structures, seduced by their apparent efficiency when measured against the criterion of economy of material. However, it soon became apparent that the high cost of the unique formwork was prohibitive in such structures even when the prefabricated ferrocement formworks championed by Nervi were used. It quickly became obvious that designs must be both labor- and material-efficient to produce economical structures that could compete with conventional steel structures for long span construction.

One such solution was the dish-shaped prestressed cable and precast roof structure developed by Leonel Viera for a stadium in Montevideo, Uruguay. However, since this idea is limited to circular buildings, and more important, since a dish is not perceived to be a proper shape for a roof (the drain ends up in the center), the Viera concept never made much of an impact after its use as the roof of New York's Madison Square Garden and the 420-foot-diameter arena in Oakland, Calif.

Mr. Levy is a principal of Weidlinger Associates, an international structural and civil engineering and research firm, headquartered in New York City.

Fabric structures appeared first in military applications—as dome roofs over radar antennas. World's Fairs in 1965 and 1970 demonstrated the potential of fabrics as long span roof structures. Although used timidly in New York in 1965, fabric structures dominated the 1970 Osaka fair with a number of innovative structural concepts. The U.S. Pavilion, with an air-supported membrane designed by David Geiger, was unique and spawned a large number of covered athletic facilities all over the world throughout the 1970s and into the early 1980s. It was the development of a high-tech material—Teflon-coated glass fiber, whose properties did not deteriorate over time—that permitted widespread use of this new concept for permanent rather than temporary fair structures. Gone was the image of the circus tent that disappeared after the last show on Sunday night. It was replaced by a perennial translucent sky floating over a football stadium. (For a discussion of fabric structures, see page 87).

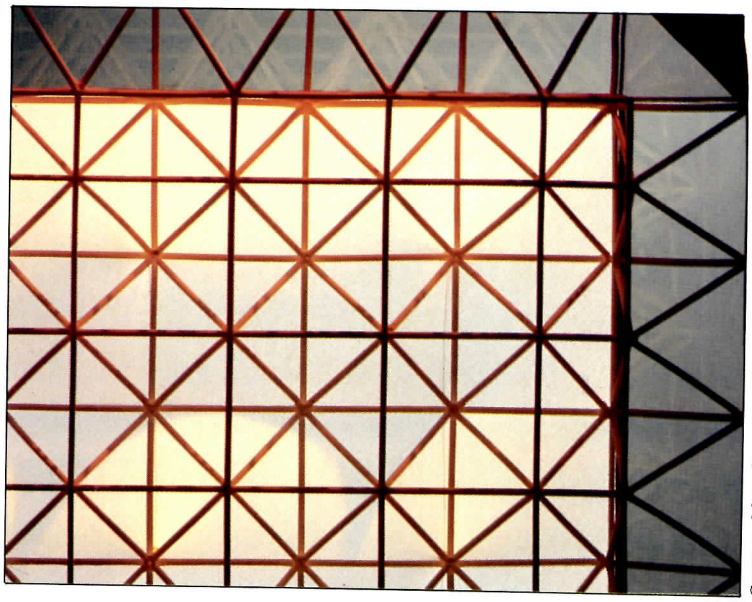
Air-supported roofs require a continuous input of air, and therefore a mechanical pump, for their very survival. Failure of the mechanical system results in a deflation of the roof, which, when coupled with a strong wind or heavy snow, can result in limp fabric tearing itself apart. Such failures include the stadium in Pontiac, Mich., which, with its span of 550 feet, raised the question of the permanence of such structures.

Tension structures, actually supertents, spectacularly used by Frei Otto in an 800,000-square-foot canopy for the 1972 Olympics at Munich, seemed to provide an alternative to the mechanical dependence of air-supported roofs. A network of cables supported by tall masts at the top and anchored at the bottom provide a matrix for a stretched membrane. R. Buckminster Fuller in 1961 proposed an "aspension integrity dome," with "islands of compression in a sea of tension."

For the 1988 Olympics in Seoul, Korea, David Geiger adapted this concept to real structure. Starting with a compression ring at the outer perimeter of the roof, an ever-decreasing series of trussed rings is held up by radial cables from the larger ring. This is conceptually akin to being boosted up by your own bootstraps. The principal difference between the Fuller and Geiger domes is in the cable configurations. Fuller proposed a triangular cable net, and Geiger used a radial and circumferential ("hoop") net. The judgment on how well this concept works awaits the completion of two arenas—one, 393 feet in diameter, and a smaller one, 295 feet across.

In 1986, the Javits Convention Center opened in New York City. Covered by a space frame roof with an area of over 700,000 square feet, this building demonstrates the practicality and elegance of a steel space frame as a long span roof structure (see page 92).

Alexander Graham Bell was one of the first to recognize the structural and material advantages of assembling standardized prefabricated elements into a three-dimensional space frame. Today there are a number of commercially available



Courtesy Mero Structures, Inc.

Architects' love affair with long span structures began with thin concrete shell buildings, such as Nervi's Palazzetto Dello Sport (left) and Candela's La Virgin Miagrosa church (above). This love extends to space frame systems, such as the Mero system for the Hyatt Regency Hotel atrium, Burlingame, Calif. (photo of model, right). Designed by architect Hornberger Worstell & Associates and structural engineer John Martin Associates, the steel space frame directly supports a tension fabric roof.

systems to satisfy different requirements of span and roof loading.

The Javits Center roof structure, with relatively short spans of 90 feet and high loading from roof-mounted airconditioning units weighing over 10 tons each, requires a structure that is both stiff and strong. This could have been provided with a grid of simple trusses. But with the interrelated imagery of the interior spaces, a more organic structural solution was desired. A space frame provides just such an isotropic structure at a reasonable cost. The small cost differential between space frame and trusses is justified by the reduced volume of space. Depth is less with three-dimensional space frames than with linear trusses; this is analogous to flatplate concrete being thinner than beam and slab.

Advances in electronic computation permit the solving of ever more complex problems with ever greater speed and accuracy. This has the advantage of optimizing structural solutions to their most economical state—at least theoretically. As applied to a space frame, optimization of the structure for all loading conditions results in a structure with a large variety of bar sizes and connectors. This entails a major record keeping program for the fabricator and the erector. The Javits Center roof, for instance, has more than 70,000 bars and 18,000 nodes. More than 55 different sizes of bars and six different nodes were actually used.

A "patterned" solution, with bars of a certain size used in a defined geometric region, would have resulted in two distinct benefits: increased capacity of the structure to resist undefined or accidental loads, and reduced cost of assembly and chance for error in bar placement. This approach is again analogous to flatplate concrete construction, where a generalized orthogonal pattern of reinforcing is used in practice against the more "correct" but complicated isostatic pattern (Nervi's Gatti Wool Mill).

The high-strength materials used in modern long span structure introduce new concerns and lead to the introduction of a new vocabulary to deal with high-tech problems, including stress corrosion and notch toughness. The failure of the roof of the Kemper Arena can be attributed to an unconventional use of a high-strength bolt; and well-publicized casting problems with the nodes of the Javits Center space frame resulted in construction delays there.

Not just confined to steel structures, problems have also surfaced with fabric structures. Fluttering can exist in a fabric roof unless the membrane is taut within narrowly defined limits of tension. For this reason a loss of pressure in an air-supported roof can result in self-destructive flapping of the fabric. Nevertheless, there is a clear trend in favor of the use of higher-strength materials. Fabrics used today have twice the strength of those of a generation ago. Steel with a 50 ksi yield is common today, where 36 ksi was normal 20 years ago. Very high-strength steel is also available, at 100 to 150 ksi, though it requires a degree of caution in application.

Fuller's prophetic image of a bubble covering central Manhattan Island may yet come to pass. The feasibility of spanning distances of more than a mile has been proven in a study by Paul Weidlinger for a roof over an oil refinery. Motivated by environmental concerns—to confine the toxic byproducts of the refinery and to visually camouflage the industrial facility in a rural setting—the study demonstrates that current materials and construction techniques can turn Fuller's dream to reality.

In general, fabric structures have proven to be economical for long span structures (200 to 1,000 feet) and, except for a few problems, have performed as anticipated. There is still a feeling that fabric represents "soft" and therefore temporary structure against the "hard" structure of steel and concrete. Such arguments will diminish with time as older soft structures demonstrate their durability. However, it is tension- rather than air-supported structures that undoubtedly will be proposed—a trend that is already in evidence today.

Space frames and space structures are ideally suited in the intermediate span ranges (80 to 220 feet) and should be economical in applications with multiple spans. Steel trusses will always be an economical choice in spans that result in transportable truss depths (spans under 120 feet, with truss depths under 12 feet).

Novel configurations using stacked trusses, reminiscent of the temporary, prefabricated-truss Bailey bridges of World War II, have been used for spans to 300 feet (such as at the Birmingham Coliseum). The advantage is transportability of segments, since it is always cheaper to assemble a truss in the shop than in the field.

What about concrete? Although not normally considered a material for long span construction, prestressed concrete has been used for bridges spanning many hundreds of feet. Segmental construction, using prefabricated elements, can be considered a viable alternative for long span roofs. Of particular interest is the recent development of concrete with strengths in the 10,000 to 20,000 psi range (see page 68). This may open the way to exploration of structural forms appropriate to concrete, and it brings us back to Nervi. He demonstrated one thing above all, and that is that structural form exists only in the context of an appropriate (economical) means of construction. □

Dazzling, Problem Plagued 'Crystal Palace'

Manhattan's Javits Center, I.M. Pei & Partners.
By Mitchell B. Rouda

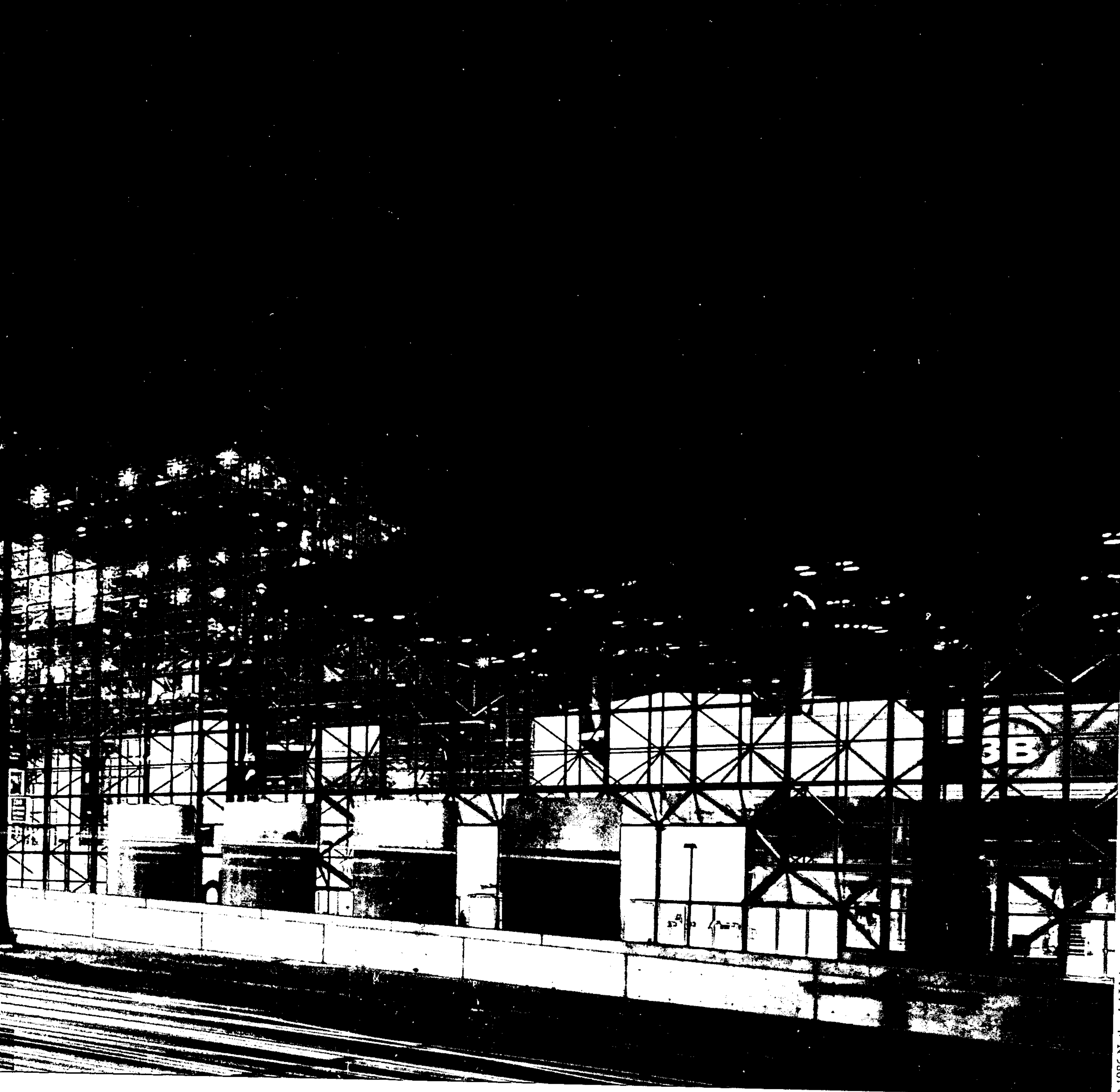
Whoever said architecture should reflect the culture that creates it never intended a building to carry the concept to such an extreme as the Jacob K. Javits Center, New York City's already famous and in some ways infamous exposition facility that opened last April. Here's a building that well displays the city's urban and populist ambitions. But mired as it has been with scandals and complaints, the Javits Center also reflects New York City's gritty physical environment, fickle economy, and politicized business practices.

The building symbolizes especially well the difficulties inherent in any large, public construction project: shifting clients who change ideas in midstream; budgets that run amok forcing indiscriminate cutbacks; convoluted contracting processes that make cost control and schedule adherence impossible; technical requirements that are difficult to identify, let alone fulfill; conflicting design agendas on the part of a multitude of users and project team members; and major construction foul-ups leading inevitably to legal warfare.

Given all this, the Javits Center—designed by I.M. Pei & Partners under the guidance of partner-in-charge of design James Ingo Freed, FAIA, and partner-in-charge of management Werner Wandelmaier, AIA—never had a chance to be anything but a mixed bag of a building, and that's what it is. Its spaces and structure are dazzling and its layout remarkably clear—both qualities that are especially surprising for a building type that has, in other places, produced some perfectly awful architecture. Yet the Javits Center is also full of problems. Not only has it suffered through years of construction delays and cost about $100 million more than budgeted, but all the two dozen-plus show managers and exhibitors questioned complain about such fundamental attributes of the building as its structural bay size, the placement and sizing of back-of-house facilities, the utility of its largest space, or, most of all, the decision to place it in an eerie area of Manhattan.

Like so many projects in New York, the Javits Center started with first-rate intentions. In the early '70s, when virtually every major city was entering a heightened round of competition for conferences and trade shows that pump billions of dollars into local economies, the city and state of New York began planning a new events facility that would replace the 30-year-old New York Coliseum at Columbus Circle and be the largest and highest quality exposition hall in the country.

Mr. Rouda is a former executive editor of this magazine.



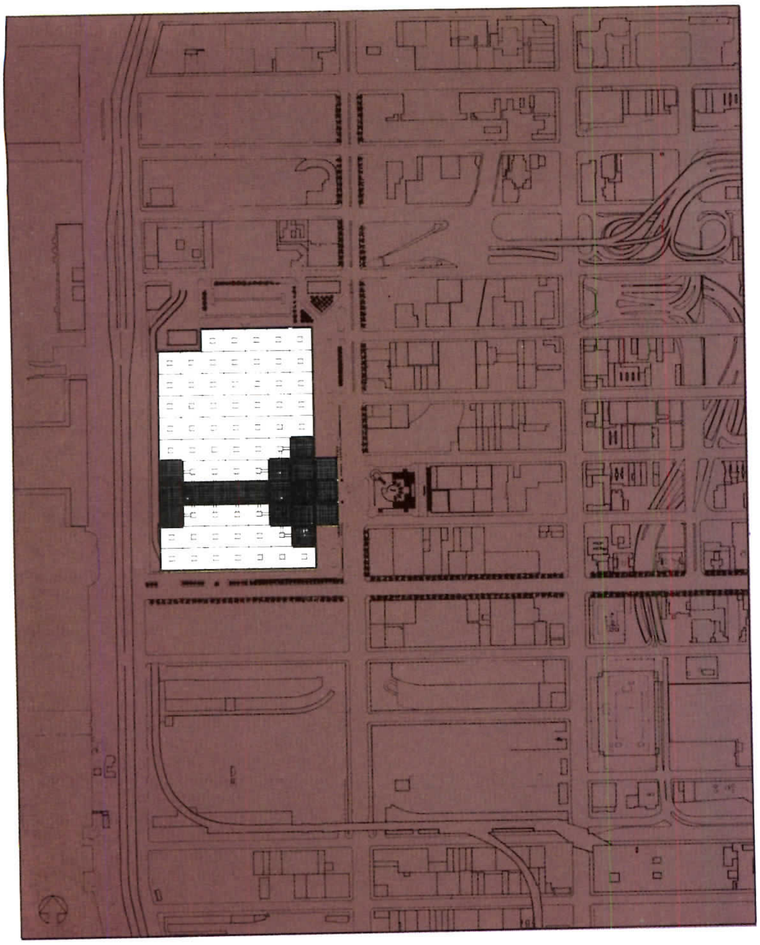
The all-glass facade can seem monotonous and opaque by day, but at night the building becomes a transparent lantern.

Since show halls work better on one, or at most two, levels, building a taller building on the site of the old coliseum was ruled out. So the first problem confronted by the state's Urban Development Corporation, which spearheaded the project, was where to locate the building. New York real estate is not only expensive but generally unavailable, especially in contiguous chunks of 20 acres. UDC quickly zeroed in on sections of Manhattan's deep west side, a miles-long strip of underutilized land on the Hudson River a few blocks from the urban core.

UDC talked up the potential of the project to switch off the growing decay and danger that had come to characterize that warehouse-ridden area. James Stewart Polshek, FAIA, prepared a feasibility study and, after soils problems were discovered at the first-choice site (near 44th Street), a determination was made to locate the project between 34th and 39th streets and 11th and 12th avenues. The project stalled for several years because of the city's fiscal crisis but was revived in 1978 when Albany legislators developed a bond issue plan and formed the Convention Center Development Corporation. They asked Polshek to develop an architectural and land-use program and, in 1979, commissioned the Pei office to design the facility.

So far, so good, save the curious and notable lack of a real user-client in all of this. It wasn't until a year later, after fast-tracked construction had already begun, that the Convention Center Operating Corporation—composed of administrators with experience running convention centers—was formed. The Pei office was therefore on its own when it came to finding out the specific demands of this building type except for the information contained in Polshek's program. That program was thorough and sound, Freed says, but the Polshek office had, at that time, never designed a convention center. Nor had Pei's.

The Pei design team started their work with a round-the-country tour of new convention centers. They conducted extensive interviews with managers of leading trade shows and national conferences. Then they began to address architectural concerns. Having noticed that most convention centers tend to be large, dark boxes that outscale and underclass any urban fabric, Freed considered ways to give the Javits more vibrant—and softer—qualities. The design team resolved to make the building less disorienting than the others inside and out, include a wide range of amenities for both show attendees and the gen-



Site plan shows location of Javits Center adjacent to Lincoln Tunnel entrances. The notched articulation of the bays, right, reflects the chamfered corners of the supporting space frame. Clear vision glass replaces tinted panes around entrances, below, providing clearer glimpses inside as visitors approach.

eral public, and provide a direct visual connection to the city.

Faced with a choice of orienting the building toward the water or the city, Freed gave up views of nature to capture views of the Empire State Building. This enabled truck docks to be placed along the 12th Avenue side, where the Westway highway was scheduled to be built, and allowed public entry at the highest part of the site. To further amplify convention-goers' awareness of the city outside, as well as to reduce the visual bulk of the building, the design team conceived an all-glass envelope with crystalline qualities, supported by the largest space frame ever built in America.

Freed also brought to the project a concern for what the building could offer to the city, above and beyond housing conventions. "Too much money was being spent for the building not to have a public use," he says. From this emerged his own addition to the program: the multimillion-cubic-foot "crystal palace," a massive space for indoor public gatherings that serves only in an auxiliary way as a lobby to the building. Freed also added to the program a large public plaza across 11th Avenue.

Operationally, Freed began to draw parallels between the design of the convention center and that of airports—both work as massive blocks of circulation space. The trick to making the convention center a special place to be, Freed reasoned, was to make those circulation spaces special, an idea that supported the creation of the crystal palace and led to its crystalline extensions—called concourses—on either side.

The result is exceptionally clear zoning. The front of the building is a 1,000-foot-long, 90-foot-deep circulation spine used for registration, special events, and conversation. As in an airport, entry is along the length of the pathway. Outside, electronic marquees lead attendees to the right door.

On the opposite side of the concourse, escalators lead up or down to the two show floors. Show managers appreciate the egalitarianism of this split-level arrangement. The architecture of most two-level centers encourages attendees to start on one floor, making it harder to rent space on the less trafficked level. The show floors are also very flexible, making it easy to orchestrate several concurrent events and subdivide some parts into meeting rooms to make a wide range of uses possible.

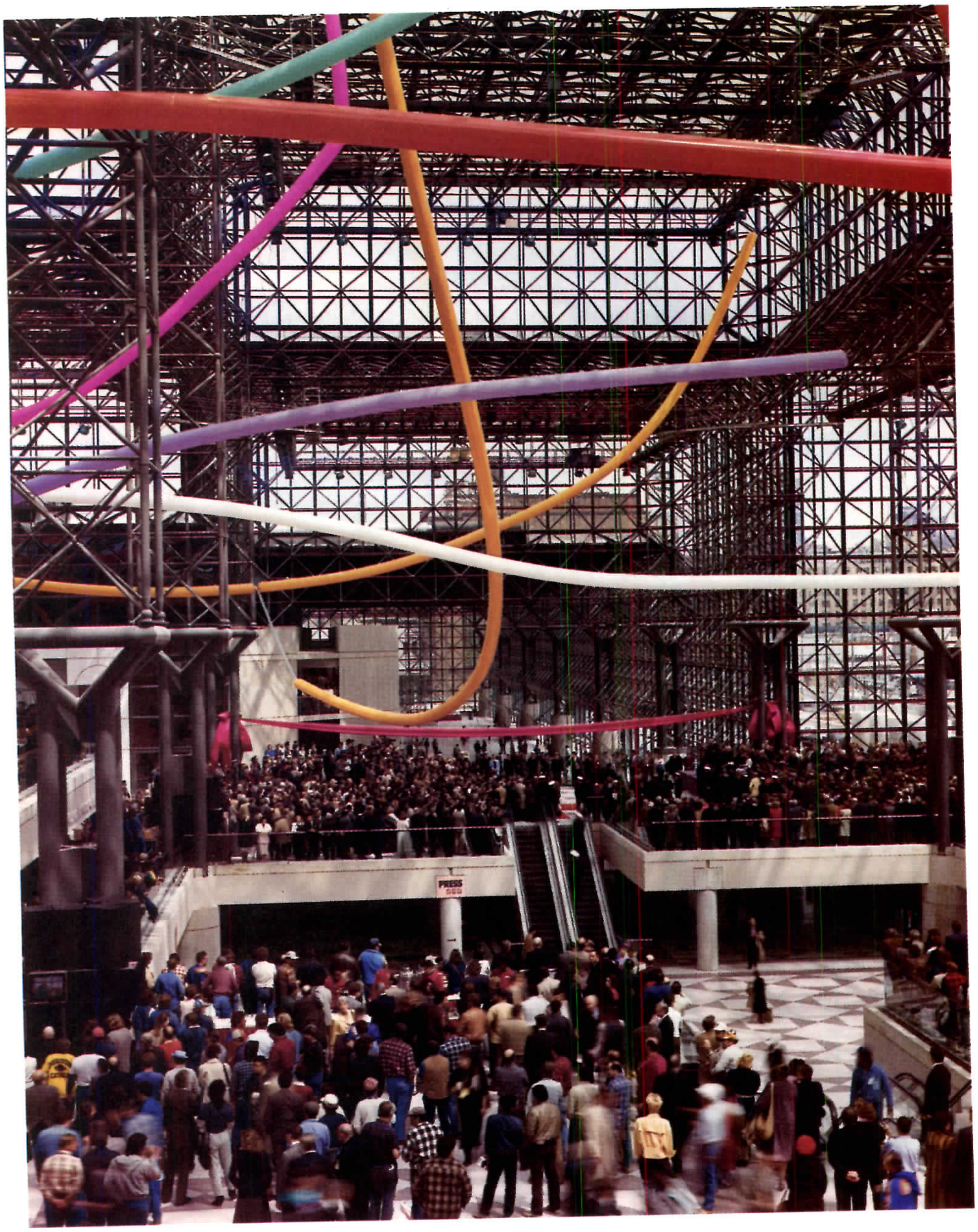
The show floors themselves, however, are quite dull. Except for the vaulting space frame above the upper level, the halls are typically dark caverns. "Show managers insist on this," laments Freed, who wanted to install skylights at the tops of each column. "They don't want people looking up at the architecture. They want them focused on the products displayed." Fortunately a few windows puncture the entry wall, letting some natural light filter in from the glass concourses.

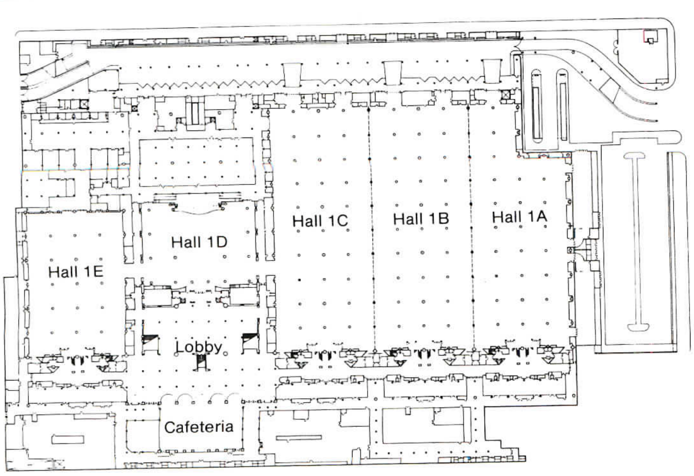
Between the concourses and the show floors is a concrete structure—a building within a building that houses elevators, lounges, and offices. The structure serves as both a symbolic gateway and security barrier for the exposition areas.

Bisecting the concourse about one third of the way along its length is an equally impressive circulation spine, called the galleria. The crystal palace occurs at the intersection of these two axes. This volume creates a focal point for the concourses and, outside, breaks the monotony of the facade.

The galleria is meant as a promenade of shops and services leading to a restaurant overlooking the river. Unfortunately both the galleria and the restaurant remain raw space in search of a developer. Alan Lew, chief executive officer of the CCOC, says a deal is imminent but not signed. Shops are badly needed since the neighborhood offers so little. The unfinished state of the galleria also makes it hard to judge the crystal palace as an architectural space. It's meant as a grand traffic junction but feels and operates instead like a mammoth interchange between a freeway and a road that goes nowhere.

The Javits Center's main hall, below and right, is called the Crystal Palace, a reference (amplified by black and white photography) to the famous exhibit hall constructed in London in 1851. The awesome scale of the space has made it a popular setting for fashion photographers, but at a benefit held there in November, guests noted that even with 3,000 people present the room felt too large.





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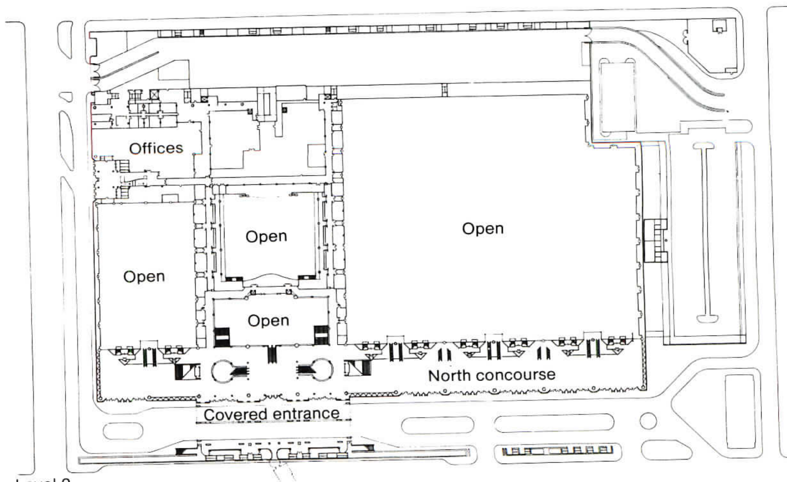

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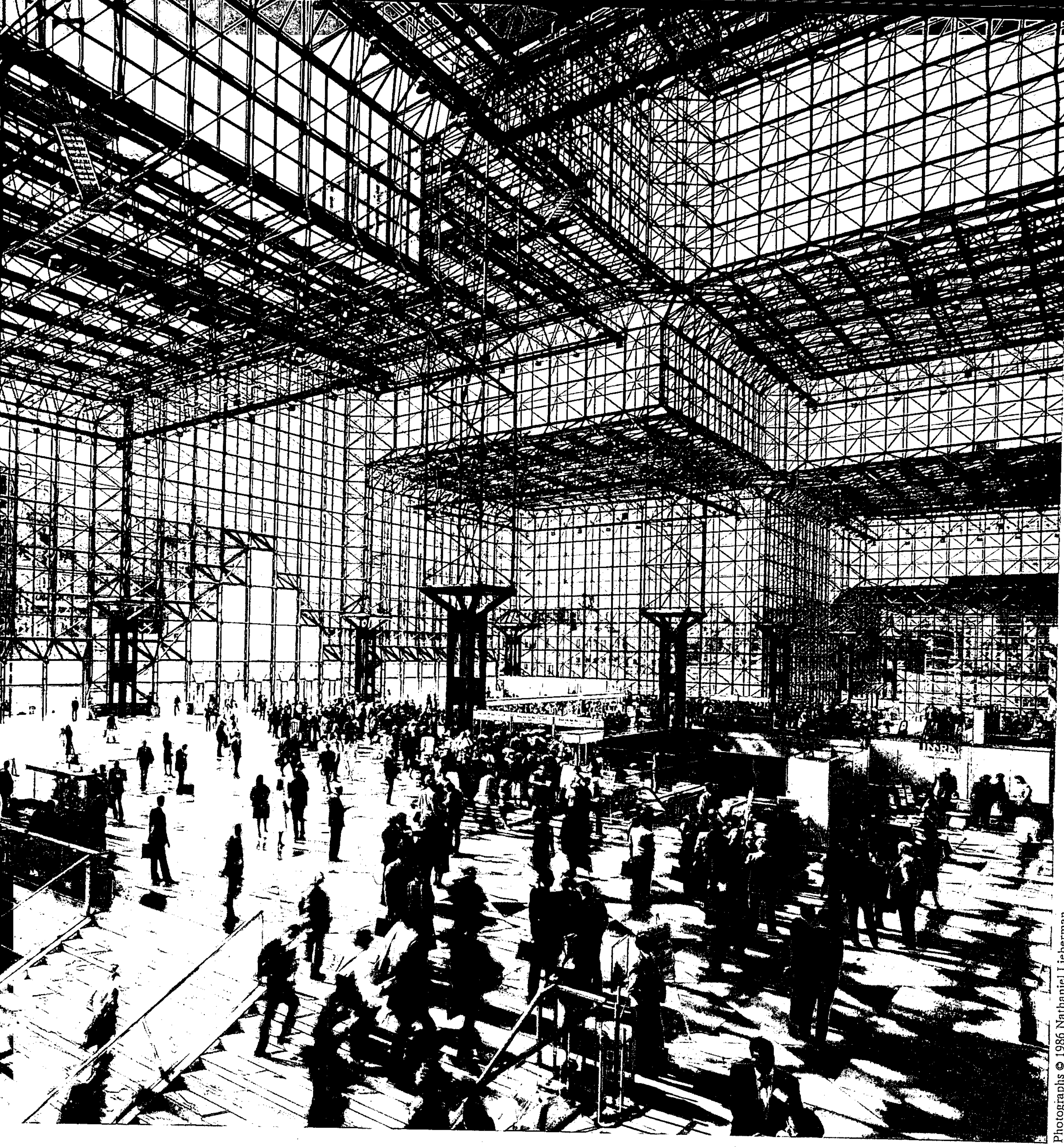
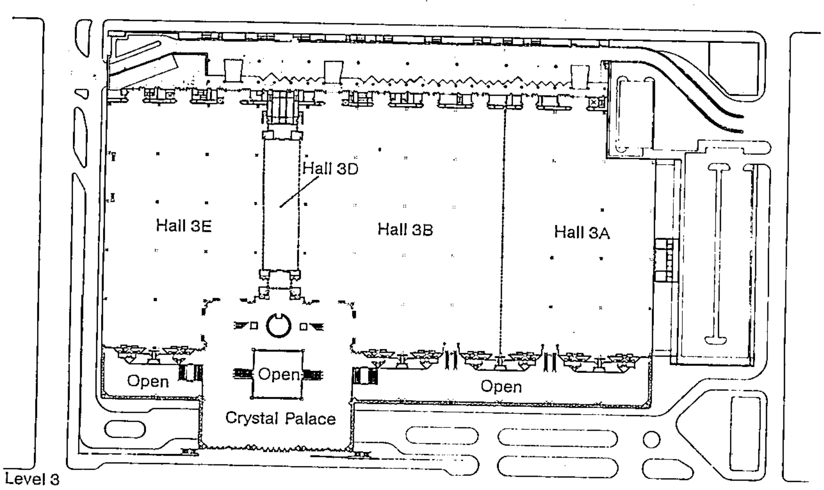


Photographs © 1986 Nathaniel Lieberman



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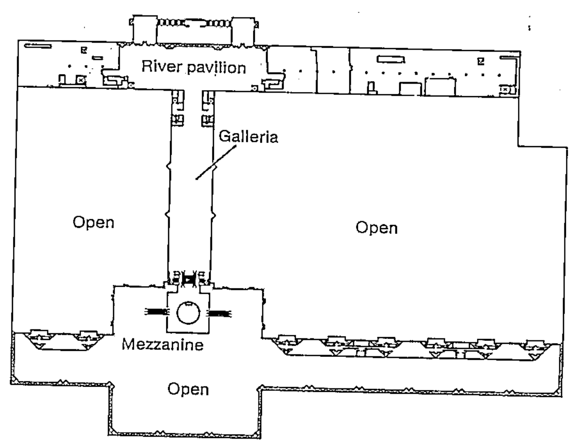

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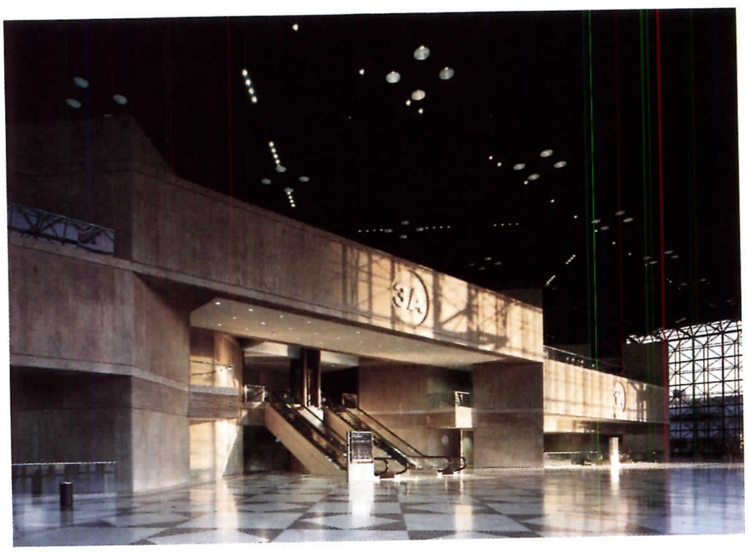


Photographs © 1986 Nathaniel Lieberman

There is perhaps no other building type that serves as many different users as an exposition facility. This is one of the reasons why so many conflicting opinions abound about the merits of the Javits Center.

For conference attendees, the pure architectural surprise and spatial generosity of the building's public areas must seem refreshing, and it is to the credit of the Pei office that this significant constituency, not directly represented by the clients, was so well served. On the other hand, those who don't use shuttle buses are likely to find the center's desolate and remote location more unnerving than the building is exciting, especially since cabs don't cruise 11th Avenue and parking is scarce and expensive. (Of course if the project achieves its most noble goal, reviving the west side, those problems will solve themselves.)

Show managers say the ambience of the Javits makes any event inside seem important. "Because the entry spaces are so large, even the longest queues can take place entirely inside," notes Howard Hamm, president of the National Association of Exposition Managers. "The excitement builds right away. When special activities are happening inside the crystal palace,

Aside from the drama of the space-frame structure, the environment of the exhibit floor reflects the snap-drape and canned graphics that are endemic to the trade-show industry. Meeting rooms and public areas are finished in gypsum-board, but a feeling of quality is achieved by a gridded acoustical tile.

attendees instantly feel glad they came—even though they may be coincidentally waiting in a very long registration line."

And for events such as the gift fair or the hotel/motel/restaurant show, the feel of the Javits parallels the sophistication of the products being traded. "The look of the building and the view of New York's skyline reinforced the style of our show," explains Susan Corwin, an executive with George D. Little, the show management firm that organized a recent gourmet foods exhibition.

The problem is that many of the biggest and most lucrative trade shows don't have that sophisticated look, and their managers and operators don't care how the architecture makes people feel.

What they care a lot about is how fast a show can set up and strike down, and how much of the gross show floor area can be rented to exhibitors. The first real test of both occurred in November at Pack Expo, a trade show of packaging machinery that completely filled the building. All concerned admit that many of the problems noted at Pack Expo stem from the variety of odds and ends not yet finished at the Javits and from a lack of experience on the part of the contractors who do the set up work. But even with more experience, and a fully operational HVAC system, several trouble spots remain.

A chief complaint is the 25-foot depth of the loading docks, which makes maneuvering long machinery off trucks time consuming. Many state-of-the-art convention halls allow 30-foot docks, says Tony Calanca, director of operations for the Cahners Exposition Group. Calanca questions why the architects weren't a bit less generous with the public areas on the other side. Even fans of the concourse and the crystal palace admit those spaces are not well used by convention-goers. And some object to the use they do get. "We don't get paid for people standing in a lobby," says Bill Pflaum, press manager for the Pack Expo show.

The columns on the show floor are another area of concern. Some are located opposite portals that permit loaded trucks to drive inside. And every show manager commented that the size of the columns on the lower level is exceedingly large and, because they are placed 45 feet on center, the columns are out of whack with the 10-foot module of the exposition industry's booth sizes. "It's hard to maneuver trucks in there and nearly impossible to get the gross-to-net usable space ratios you need," explains Joseph Cunningham, Pack Expo's show manager. Cunningham says he would have been much happier with more columns of smaller size placed 30 feet on center.

Other complaints frequently voiced regard the show managers' suites (too small), the restrooms (too few and too hard to find), the location of the press room (inside security checkpoints, even though this space should be used for press registration), the location of food vending stations on the show floor (near the freight docks where it's noisy and dirty), and the shape of the meeting rooms (too long and narrow).

Tom Baker, Pei's senior associate of design, notes that the design team responded to the original program's wish list in full. "The decision to make the docks 25 feet wide was a consensus decision. The program asked for 50 docks, and there are 50 there." Also: "We stressed during design that the 45-foot grid does not accord with industry standards. But the owner, and Polshek's program, insisted on it because they felt it would be more open for truck maneuvering than a 30-foot span, which incidentally also would have enabled cheaper waffle slabs above."

Freed admits that some decisions were not contemplated as long as they might have been, given the fast-track schedule. "The management of the convention center changed hands three times during the project," he says. "Each time there were requests for changes. These caused delays. Some of what was asked for, such as making more area on the show floor divisible into meeting rooms, hasn't yet proven necessary. In any case, there were two competing pressures at that time—the managers at the development agency saw prices rising and were rushing for completion, while the managers at the user/operating group wanted to amend the program."

For better or worse, questions related to the technical details of the Javits Center pale in comparison to questions regarding the building's extensive construction delays—and its still unfinished condition. When asked to explain the root cause of the problems encountered getting the Javits center built, all members of the project team point a finger at New York State's public construction processes.

For one thing, the state's Wickes Law, which insists that plumbing, electrical, structural, mechanical, and elevator work all be awarded as separate prime contracts, gives no one the power to ride herd during construction. Lew at CCOC, Freed at Pei's office, and Irving Fisher, project manager for the Javits Center's construction manager, HRH Corporation, all say that the Wickes Law makes timely completion of a building all but impossible. As if this weren't bad enough, the enabling legislation for the Javits Center amplified the Wickes provisions, resulting in 62 independent prime construction contracts. The zoo-like atmosphere inherent in this arrangement was made even worse by fast-tracking, a concept that, according to Freed, "is like cooking and eating at the same time."

One off-the-record comment explains what ensued: "If an electrical or a plumbing contractor was having trouble working around the duct work, he'd just take out a hammer and mash the HVAC system. Then the fan blades would start grinding and no one would tell the mechanical contractor. Nobody cared about any part of the job but their own."

"Because of the coordination problems inherent in a system of separate primes, the Wickes Law raises the price of projects," Wandelmaier notes. "The whole system is conducive to claims," adds Fisher. "No one has the responsibility necessary to get the job done, and everyone blames everyone else for delays," he says.

Design, construction, and project management team members also can't help but repeat the familiar gripes about public bidding. Though designed to ensure that competition keeps prices down, many suspect some bids were rigged.

Forced open bidding may also jeopardize quality, many team members contend. Implicit in this comment is the issue of cracks found in many of the steel nodes that hold the space frame together. Discovered before installation, these cracks were one of the most important causes of the center's delays.

To facilitate fast-track construction, and to enable open bidding, the space frame was issued as a performance spec. Freed and Matt Levy of Weidlinger Engineers, the structural consultant for the project, made no secret of their preference for a system designed and built by Mero, a European concern that had already constructed larger space frames in Germany. But Mero was edged out for the contract by about \$1.5 million on a \$20-million bid.

Without necessarily implying that the contractor who won the space-frame bid was responsible for the node problems, most team members are quick to point out that the company, and especially its subcontractors responsible for manufacturing components, lacked experience with space frames. "They have an extraordinary reputation as a steel erector, and their team included a recognized space-frame engineering expert," Freed grants. But, says Baker, "Private developers probably would have gone with the most experienced contractor when the bids were this close, just for insurance."

The issue of the nodes is now in litigation, so everyone is cautious about speculating what went wrong. What's clear is that, shortly after the steel contractor subbed out the manufacture of the nodes to a couple of New York casters, questions related to quality and production rates emerged. It took about a year before a Japanese steel company came along to bail out the lagging project, producing flawless nodes at six times the production rate of their American counterparts.

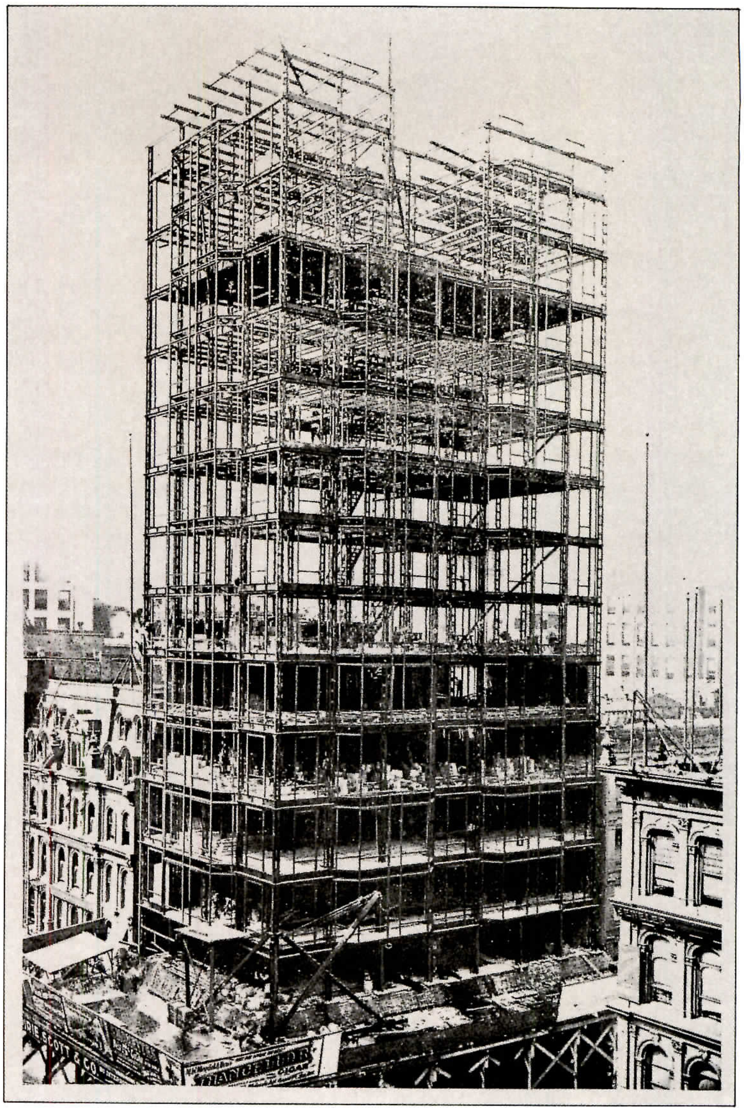
The delays led to a sharp rise in total project costs, given the inflation rates then prevalent. CCDC was forced to cut back the scope of the building commensurately, lopping off eight 90x90-foot bays at the northern end. The Javits is now merely the third largest exposition hall in the country, though expansion remains a possibility.

In the end, the troubled history of the Javits Center, and for that matter the design of the building itself, will have little impact on the convention center's most important goal: luring events, and the people that attend them, to New York. (Trade show attendees spend, according to Hamm, about \$615 each on the city's goods and services.) New York itself is the main selling point for Javits and, since the center is virtually booked solid for the next five years, that seems quite enough. As Lew points out, despite cost overruns the final construction tag on the building (about \$180 per square foot) seems in line with comparable construction, and the public's investment will be quickly paid off by revenues generated. □

Small cast nodes are the keystone of the space frame system, designed by engineer Paul Gugliata. There are 14,000 of these nodes throughout the Javits Center.

Architects as Technological Innovators

It's a role that they no longer play with the gusto of earlier eras. By Michael J. Crosbie



Architecture burst upon the 20th century with great faith in the power of industrial technology. Although technology had been changing the building trade since the early 1800s—with the introduction of iron, steel, machine-made materials and components, mechanized assembly techniques, and mechanical heating, ventilation, and illumination—architects had remained indifferent toward architecture's role in an industrialized society and their contribution to it. But in the early years of this century, with the rise of modernism, architects seized upon technology as the spirit that would animate the architecture of a new age. Science was reshaping the perceptions of the old world. The new age would be expressed in a new architecture planned with the coolly calculated measure of function, composed of the latest standardized materials, assembled with the ease of machine production, and reflective of the industrial society that made it possible.

At least that's how the architects saw it. Through manifestos more than through buildings, they expressed the contributions that technology could make to architecture. "The new age provides building materials for the new way of building," wrote Hannes Meyer. Mies saw industrialization as "the central problem of building in our time. If we succeed in carrying out this industrialization, the social, economic, technical, and also artistic problems will be readily solved."

More often than not, modern buildings fell short of technology's promise. The International Style was more concerned with the rhetoric and esthetic expression of technology than with legitimate experimentation and innovation.

A few architects, however, accepted the technical challenges that building in an industrialized society posed. Louis Sullivan and his fellow Chicago School architects molded emerging structural technologies of iron and steel into a new building type—the skyscraper. Sullivan was fully engaged in the material realities of his craft. The architect's mission, as he wrote in his *Kindergarten Chats,* was to "vitalize building materials, to animate them with subjective significance and value, to make them parts of the social fabric." Sullivan made architecture's media its message. He took brick, terra cotta, tile, carved stone, glass, steel, ornamental iron, and the elements of the pier and the lintel to new expressive heights.

Throughout his career, Frank Lloyd Wright experimented with materials and building techniques. His accomplishments in cantilevered structures and elegant structural members are well known. He was designing apartment buildings and single-family houses of pre-cut, standardized materials during the 1910s, and 20 years later employed brick wet cores and plywood sandwich panel walls in his Usonian houses. The Usonians were designed on a 2x4-foot module that accommodated window and door openings. The floors were thin concrete slabs heated with embedded hot water pipes, allowing the thermal system to be independent of the structure.

New technologies, materials, products—the entire scope of industrial society—implied a revision of architecture's professional structure. Walter Gropius seemed to best understand this. He believed that architects were in danger of losing control over the design of buildings to engineers and contractors, because architects were unaware of the impact of industrialization. "One component part of building after another is being taken out of the hands of the craftsman and being given to the machine," Gropius wrote. "The hand-building process of old is being transformed into an assembly process of ready-made industrial parts sent from the factory to the site."

Gropius saw a new role for the architect in becoming involved with the design of these components and in coordinating their assembly into complete buildings. The factory-made house was Gropius's passion, and he experimented with pre-

Left, steel frame of Burnham & Root's Reliance Building of 1894, one of Chicago's first skyscrapers; above, Eero Saarinen's General Motors Technical Center in Warren, Mich., was a testing ground for many building 'firsts.'

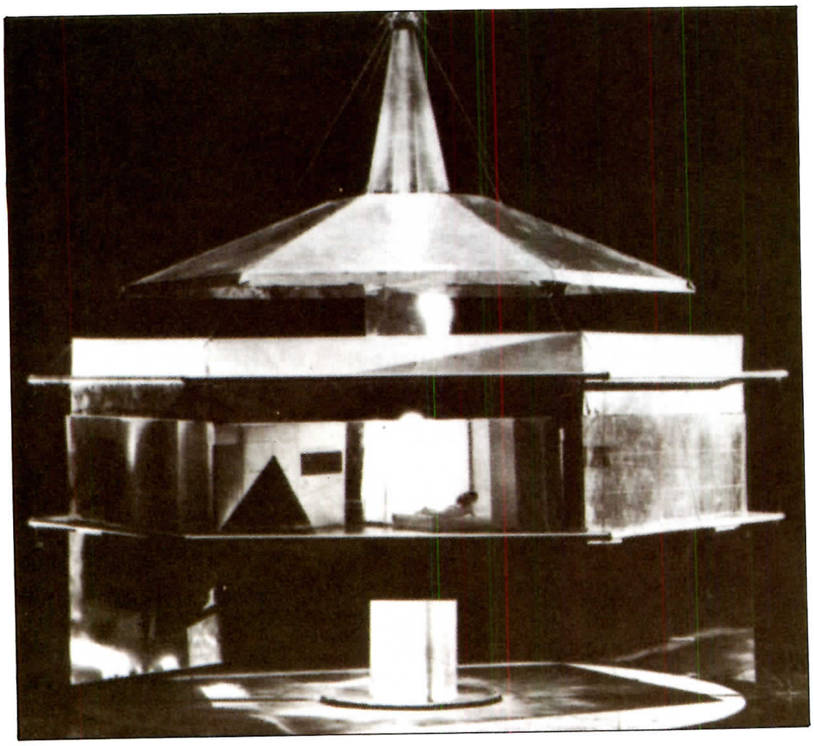
fabricated buildings as did many other architects in the pre- and post-World War II years. With Konrad Wachsmann, he collaborated on the "Packaged House," which was based on a complex panel system of Wachsmann's design. The architects secured financial backing for their project, formed the General Panel Corporation in 1942, acquired a large factory, and received a guarantee of a market from the U.S. government. The venture failed to produce more than a few dozen houses, however, and the company's collapse in 1952 was due more to financial and organizational than technical problems.

A decade later, the development of the SCSD system provided a sustaining example of how architects could work with the building industry to advance technology. Ezra Ehrenkrantz, FAIA, and his collaborators combined 13 California school districts as a single client, analyzed the needs of a new form of education (the open classroom), wrote performance specifications for building systems and components to satisfy those needs, and oversaw the development of systems that were designed to fit together. Using these integrated systems, architects for the individual schools could combine them in myriad ways.

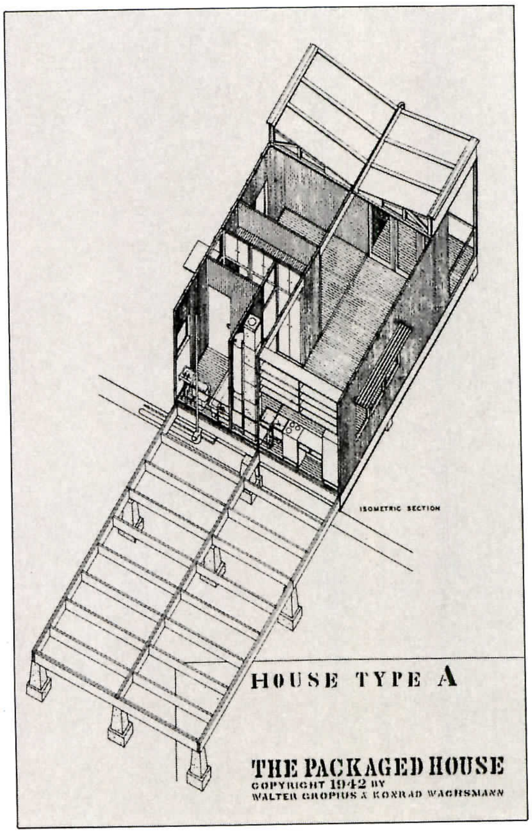
The exploration of new building techniques and materials was a hallmark of Eero Saarinen's work. Part of his practice was devoted to researching new building materials and techniques in their application to design problems. At the John Deere headquarters, Saarinen used Cor-Ten steel for the first time. The spanning abilities of thin-shell concrete were explored in the Kresge auditorium at MIT. In designing the dramatic, soaring space of the Ingalls Rink at Yale, Saarinen collaborated closely with his structural engineer. For the General Motors Technical Center, he developed the colorful glazed bricks and completely luminous ceilings, pioneered the use of laminated, porcelain-faced sandwich panels, and introduced neoprene gasket water seals that allowed the panels to be zipped out as the building's use changed. Of the technical center Saarinen wrote: ". . . working together with General Motors, we developed many 'firsts' in the building industry. I think that is part of the architect's responsibility." Saarinen used technology and experimental materials not as ends in themselves or as techno-exhibitionism, but in the service of design. He talked about his architecture in terms of its materiality: how things went together and why they went together in a certain way.

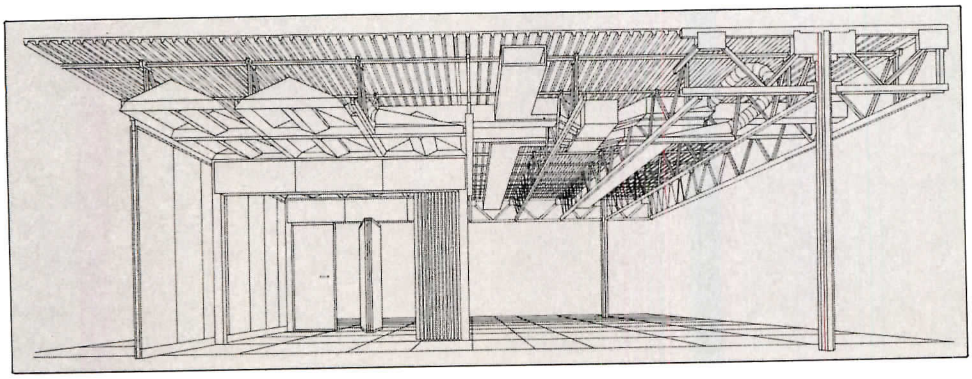
Today, much of this fascination with technology has been lost in architecture. New materials and methods of assembly are less and less the architect's concern as questions about structure, heating, cooling, cladding, and construction are handed over to engineers and technical consultants. As more and more complex environmental and communications technology is injected into our buildings, architects are left to design the shrouds. In architecture schools the role of technology is not the stuff of passionate debate in design studio. Critics and historians seldom appraise architecture in its technological dimension.

In an age when technology has never before so dominated architecture, why do architects appear to ignore its implications? Why has technology lost its inspirational power and architects their inventive, technical curiosity? Reyner Banham sees the matter as a change in attitude and style. "When modernism took a beating, i.e. Pruitt Igoe, etc., *then* most of the accompanying technology got beaten over the head at the same time," he says. "The mood, certainly in the latter 1960s with everybody quoting Heidegger and Ellul on the horrors of technology and so forth, prepared the ground for the postmodernist



Left above, Buckminster Fuller's 4-D House of the late 1920s was his first solution to the problem of low-cost housing, incorporating a mechanical mast that delivered heat, water, and electricity; left below, SCSD systems coordinated all the building's structural and mechanical aspects; below, Gropius's and Wachsmann's 'Packaged House' of the early 1940s was an answer to wartime housing.





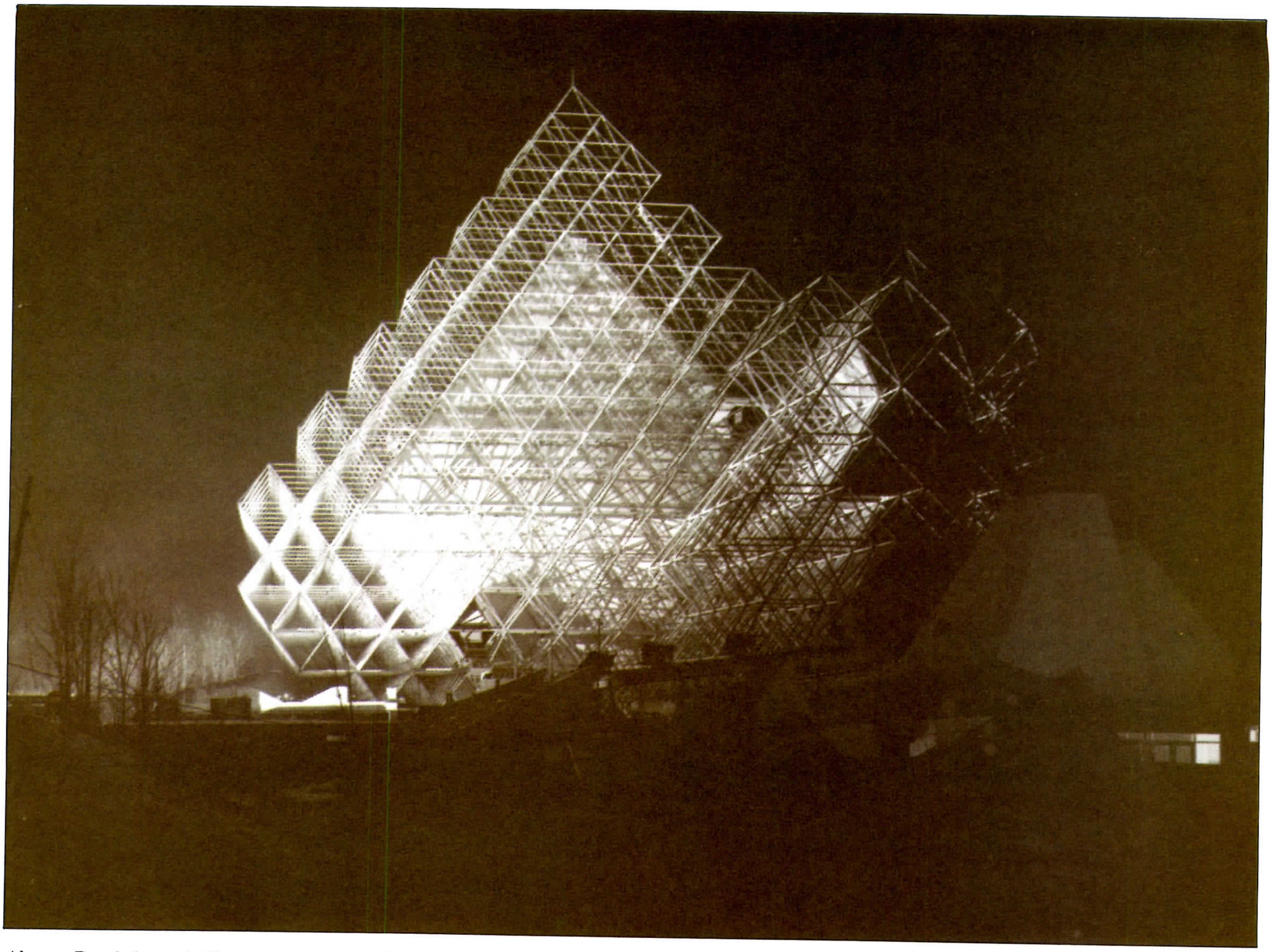
who pretended that technology didn't exist." Banham also observes that architects weren't at all comfortable with the new role, à la Ehrenkrantz, that advanced building technology suggested, "the idea that what you did instead of architecture was to coordinate products." He points out that in the CLASP building system in Great Britain, for example, it was possible for architects to design buildings by writing elaborate specifications without doing a single drawing. "That's a threat. When you deprive architects of drawing, you deprive them of the thing that proves they're architects."

The number of materials, components, products, and building techniques now available—tens of thousands of them—has had an intimidating effect on architects, believes Edward Allen, AIA, who has taught architecture at MIT and recently wrote a textbook on materials and construction methods. "With the industrial revolution and everything that followed, the material means that we have to realize a building has exploded into the vast array that architects years ago rhapsodized about. It was thought that this new rainbow of materials was going to be a tremendous release for architects—it would allow us to do anything we wanted. What has happened is that architects have found it impossible to confront this range of stuff, and they have reacted by simply not dealing with it. We haven't seen architecture brightened and enhanced by all these materials that are being used in a scattershot way. What seems to be missing is the romantic involvement with materials and techniques that we saw in Sullivan, Wright, and Saarinen."

Allen adds that keeping up on all the latest developments is in itself a full-time job that architects haven't time for. "It takes a tremendous amount of energy, time, and expense for an office to research out a whole new set of materials for a building and to do a lot of *simultaneous* innovations with materials and assemblies. Architects have to make a choice of what to pay attention to, and right now they're not paying much attention to what they're making their buildings out of or how they get put together." Even the high-tech buildings of architects such as Richard Rogers, Hon. FAIA, and Norman Foster, Hon. FAIA, which we associate with being technologically advanced, are better described as formal collages of one-of-a-kind pieces assembled in conventional, handcrafted ways than as breakthrough assemblies of standardized components.

Liability has thrown a wet blanket on experimentation with new materials and techniques. Allen contrasts what was going on in architecture firms and schools 20 years ago, when people were radical in exploring new ideas about how to make architecture, with the activity of today. "Everybody I know, myself included, is scared silly of professional liability. I've gotten to the point where I'm very conservative about specifying materials that I'm not absolutely certain are going to perform properly."

Witold Rybczynski at McGill University, who has written several books on the role of technology in architecture, believes that the profession is not structured in a way that encourages architects to think about technological innovation. "Even the largest firms are not in a position to undertake significant technical research; they don't have the resources," says Rybczynski, nor architects the proper training for such research. In European countries such as Switzerland, architects are expected to serve as general contractors. Many such countries also require architects to work in a building trade before they can be licensed. "This has many implications in terms of the amount of information an architect has to prepare and his control of technical innovation," Rybczynski explains. "Something similar happens in many Latin American countries where architects run large building concerns. An architect like Felix Candela couldn't function in our system, couldn't develop his thin concrete shells if he wasn't actually building them himself. These



Above, Boyd Auger's Gyrotron structure for Expo 67 in Montreal. When completed it was believed to have been the largest space frame every built and housed a ride at the exposition.

architects still can't innovate in terms of doing major research, but they can in construction techniques because the architect and the contractor are the same person, and they can undertake a greater degree of innovation than we can."

Opportunities for innovation and willingness to experiment aside, the apparent lack of keen interest among architects in technical issues (beyond what they need to know to avoid getting sued) threatens to impair their comprehensive understanding of the nature of building in our time. As architects remove themselves further from responsibility to limit their risk of liability, they become less willing and able to understand new technical developments. The avoidance of risk, of course, is antithetical to the notion of experimentation. "There is no creativity, no innovation, no discovery without risk," comments ARCHITECTURE senior editor Forrest Wilson, who has been following the impact of electronic technology on architecture. "Ignoring technology is like standing on the deck of the Titantic and refusing to launch the lifeboats for fear of catching cold."

One architecture firm that is not afraid to jump into the waters of building technology and innovation is IKOY, based in Canada. IKOY's Ron Keenberg is the type of new architect that Gropius might have had in mind. Keenberg sees the challenge of building technology and assembly as one that the architect meets through creative coordination, keeping attuned to available materials and their potential, using standardized, off-the-shelf components in ways that may have not been intended by the manufacturer, limiting the amount of on-site work by finishing most of the building in the factory where its parts are made, and joining entire assemblies at the site, reducing the total number of connections from 5 million to 100,000.

IKOY's approach to design is not divorced from the realities of structure and mechanical systems. Keenberg sees buildings as collections of components, not of functions. The architect's creativity is in getting the building's various systems to work together for flexibility, so that components (which wear out at different rates) can be replaced or new functions accommodated without tearing the building apart. And IKOY's buildings certainly celebrate the technology and materials they're made from.

"Today, architects view technology as something to be hidden," Keenberg says. "You can go through a building and have no idea why the thing even stands up. In our buildings, I want people to sense why the building is standing up and how it's made." In this way, IKOY's architecture is pedagogical, engaging the user by demonstrating the action of building.

As technology becomes more complex and as the range of possibilities through new materials and techniques widens, how are architects to respond? Last year, within the space of 12 months, our televisions flickered with clues, I think. In January the space shuttle Challenger, the very symbol of our culture's technological aspirations, exploded before our eyes. A few months later, we witnessed Robert A.M. Stern, FAIA, and Leon Krier riding in a horse-drawn carriage through the streets of Colonial Williamsburg, suggesting this Depression-era Disneyland as the city of the future. As the year closed, two people piloted a small plane made of lightweight, experimental materials around the world without refueling.

Perhaps our approach to technology should lie neither in the super-powered, complicated, expensive ventures whose failures can cripple our will to experiment nor in witless notions of architectural Ludditism. Perhaps instead we need to progress with one new idea at a time, with simple experiments, whose effects, like those of the machine-cut nail, may prove revolutionary. □

What's Likely to Come Along Next?

Building researchers offer some wide-ranging answers. By Karen Haas Smith

Asked what technologies are likely to influence the next generation of architects, John Eberhard, FAIA, director of the National Academy of Science's Building Research Board, responds with a definition of technology, a definition of architecture, and a reference to Lewis Mumford.

"Technology is a way of making or doing something," Eberhard says. "Computers aren't a technology. They are an application tool. Architecture is not what architects do, but the bringing together of scientific, artistic, and technological capabilities: science, in the sense of knowledge; art, bringing a sense of esthetics to what is made; and technology, meaning how to do it.

"Mumford argues that technological change is spurred by primary inventions," Eberhard continues. "An example is the electronics revolution, which is contributing a number of computer-based technologies. There are several primary inventions that will have an effect on the building industry in the foreseeable future."

Definitions and references established, Eberhard points to genetic engineering as a field to watch. Terming the restructuring of genetic material "still speculative, but almost inevitable," he notes that several committees at the National Academy of Science are busily at work investigating how genetic engineering might affect world food supply. The genetic engineering of organic material would make it possible to specify the properties desirable in construction materials such as fiber and wood products, or to develop totally new materials.

A second primary invention with important implications for the future is the capability to reconstitute the organic structure of molecules, a science known as photonics.

"A combination of products based on glass is coming out of Bell Labs that could improve the capacity of our present fiber optics by a factor of 100," Eberhard says. "The vice president of research at Bell Labs has said that by the end of the century the capacity of a single fiber could carry simultaneous voice transmissions from every person on earth.

"What do you do with that kind of capacity? The implication is that worldwide communications will be easier and cheaper, which will facilitate development of an international market for design services, rather than the domestic industry we have today."

Finally, Eberhard refers to the probability that further development of "robotics, artificial intelligence, and computer memory capacity will lead to a primary invention that's bound to change the technology of building.

"The technology of assembly is now largely determined by the strength of human workers," Eberhard says. "The prospect is that the whole technology of buildings will change as robotics permits us to exceed human limitations. Right now we are using robots for repetitive or dangerous tasks. For example, in Japan, robots are used to fireproof large buildings, or to paint where there are large numbers of spaces of the same dimensions. But we haven't begun to explore the real potential of robotics in the construction industry."

While robotics permits substitution of machine action for human action, artificial intelligence permits substitution of machine thinking processes for human thought.

"Schools that teach mechanical engineering are getting rarer, so HVAC engineers are getting rare. Expert systems could become a substitute for the routine skills of mechanical engineers. If that is so, ultimately, why couldn't clients have an expert system to do everything architects do?" Eberhard asks rhetorically.

"It's technologically conceivable that for routine buildings we could do so," he concedes. "But the architect brings social and behavioral expertise [that the computer does not have]; when the architect is skilled in these, design becomes an artistic activity." That said, the researcher hastens to add that "the architect *ought* to *also* bring a connection back to science."

Eberhard predicts that we will see the development of fifth-generation computers within five to 15 years. These computers would have sufficient memory capacity to access the world's data base; understand inputs and give outputs in any language; and understand visual as well as written output. (First-generation computers used vacuum tubes; second-generation, solid state; third-generation, solid state with integrated circuits; fourth-generation, microelectronics.)

The combination of advanced memory, artificial intelligence, and robotics represents an "exciting or threatening prospect to people presently studying architecture," Eberhard concludes. The message seems to be that computer science is an essential tool for architects who will be practicing beyond the turn of the century.

Like computer science, space exploration has spurred tremendous technological progress in the last 40 years. In meeting the extraordinary requirements for performance in space, we learn new techniques for doing things here on earth.

Building industrialization expert and senior editor Forrest Wilson, head of the doctoral program at the Catholic University's architecture department, explains how designing structures for outer space can have a radical effect on building economics.

"Labor, rather than materials, accounts for the greatest cost in constructing buildings," Wilson says. "In space, you need a structure that can be built with one hand, no tools, and no sharp edges." (Sharp edges can tear space suits.) "Labor in space costs $100,000 dollars an hour. If we design structures that are economical in space, the technology transfer will revolutionize what we can do here at home on earth."

Wilson points to the work of space structure designer Wendell R. Wendell as "among the most innovative" in building research today. Wendell's Star*Net Inc. firm is designing and manufacturing space stations for NASA. (His other business, Space Structures International, designs, engineers, and fabricates spaceframe structures for this planet.)

At a student-run workshop at MIT last fall, an interdisciplinary team refined a space station design that Star*Net had produced for NASA. Wendell started the workshop with a lecture on "astrotectonics," the term coined for architecture in space. He also donated materials and helped with the assembly of the models of the resulting designs.

The invention abstract published by the students describes the final design as follows:

"The workshop emphasis has been on the development of an innovative mainframe structural system comprised of three different deployment strategies: a spring loaded rectilinear platform truss system, a hydraulically deployed circular truss system, and a series of deployment by rotation mast systems. The main advantage of a series of deployable systems over an erectable system is the reduction of construction time in orbit. A large part of the cost of a space station is that associated with the supporting truss network. With a deployable system, this construction overhead is greatly reduced, thereby making it possible to implement stations at substantially lower cost."

"Later it was reported that NASA has indeed been interested in deployable structures after the shuttle disaster for the same reasons we singled out for emphasis," says building economics professor Ranko Bon, who coordinated the workshop. While the design description sounds very engineering-oriented, the architecture students who participated in the workshop made important contributions due to their integrated problem-solving abilities, Bon says. The next step is a design competition for the International Space University, a research campus to be constructed in space in 30 to 40 years. Bon is actively seeking funding from sponsors who will guarantee that the results will not be used for military purposes.

Meanwhile, a survey of architectural research centers shows that, even as they look toward future technological change, they are paying significant attention to ways of coping with technologies that have already emerged.

Lethal toxic fumes from burning building products, materials, and contents are a glaring example of how new technologies can kill. The National Institute of Building Sciences (NIBS), a quasi-government agency established by Congress to generate industry consensus on building science issues, has recently formed a working group to develop a new performance test method to measure the fire toxicity potential of building products and contents under simulated fire conditions. When developed, the test data may form the basis for improving fire-related product standards. In the meantime, designers are left with the responsibility for specifying fire-safe products, and they often lack the information necessary to do so.

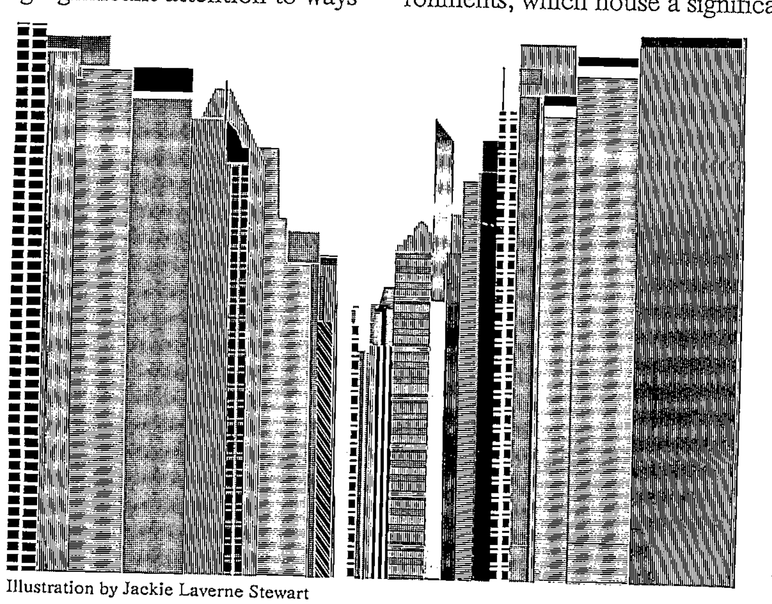


Illustration by Jackie Laverne Stewart

Indoor air pollution is another example of a problem resulting from failure to properly integrate new technologies. Energy conservation technology led to tighter building envelopes, but the resulting reduced ventilation rates led to a buildup of poisonous gases, such as radon, emitted from building materials, natural sources, and products used in buildings (see page 85).

"The Occupational Safety and Health Review Commission has reported a syndrome of constant respiratory infections among the occupants of sealed buildings," notes Frederick Krimgold, associate dean for research and extension at Virginia Polytechnic Institute and State University (VPI). "The whole issue of health in buildings is very important. We are realizing that visual design impact is not everything. What is less esthetic than sick people?"

In one of many indoor air pollution research efforts under way at building research laboratories around the nation, VPI's Environmental Science Laboratory is studying methods for radon detection and exposure control in housing. Another VPI project, funded by the Virginia Environmental Endowment, will provide guidance on hazardous waste disposal to small businesses such as gas stations and dry cleaners, which do not have the resources to consult professionals. An investigation of an extreme case is under way at the State University of New York at Buffalo, where Professor Edward Steinfeld is designing a house for a client suffering from "20th Century Syndrome," an acute environmental illness characterized by hypersensitivity and severe reactions to synthetic products, which currently necessitates isolation from community activities.

As with fire toxicity, the issue of indoor air quality involves untested properties of countless building products, materials, and contents, and is not likely to be easily understood and controlled. Publication of proceedings of a NIBS-sponsored workshop on radon in housing is expected this spring. NIBS also plans this year to update its 1985 compilation of standards, guidelines, statutes, regulations, and other criteria related to indoor air quality.

Productivity has become a major public issue, focusing attention on yet another problem of technological fit. In office environments, which house a significant portion of the nation's work force, it has been recognized that workers are prone to a range of occupationally related diseases resulting from a combination of visual, ergonometric, acoustical, respiratory, and social stress. Evidence suggests that many of those stresses can be alleviated through improved design. The Architectural Research Center Consortium (ARCC) has recently published proceedings of a 1985 workshop on *The Impact of the Work Environment on Productivity,* funded by the National Science Foundation, which includes 23 papers and presentations with discussions.

One of the leading researchers working to link design with productivity and the quality of work life is Michael Brill, president of the Buffalo Organization for Social and Technological Innovation (BOSTI). BOSTI currently has a grant from the National Endowment for the Arts to provide design guidelines for office design for small businesses.

Design for the handicapped, the elderly, children, single parents, and countless other special populations is another thriving area of architectural research. According to Peter Smith, who evaluates grant proposals for the National Endowment for the Arts Research Program, an especially innovative designer in the field is Wolfgang Prizer, a professor of architecture and environmental studies at the University of New Mexico at Santa Fe. Among the systems Prizer has designed is one for the blind using electrodes placed in the floor. Other architecture schools with major research programs in design for rehabilitation include Georgia Institute of Technology (which also launched a new Construction Research Center with $2 million in funds from alumni) and the State University of New York at Buffalo.

Daylighting continues to be a favorite subject of architectural researchers interested in energy conservation; and with well-known passive-energy researchers running the architecture departments at the University of Minnesota and the University of Washington, those schools are not surprisingly among the leaders in the field.

Doug Kelbaugh, AIA, chairman of the department of architecture at the University of Washington, confirms that daylighting continues to be a strong focus of research there. "The light in the Pacific Northwest is low-angled and diffuse; I think people here have more of an appreciation for light," he opines.

Harrison Fraker, AIA, the new head of the University of Minnesota's school of architecture, is using a $4.9 million grant from the state government to found a new Building Energy Research Center. The money came from funds the Exxon Corporation was required to give state governments for energy-related programs, as a result of a consumer lawsuit related to gasoline pricing. One of the major research programs to be funded is a daylighting technology transfer effort, to convince and enable building owners and managers to use the technology. Minnesota Governor Rudy Perpich is among the first governors to dispense Exxon funds, which could be a boon to energy research programs in other states as well. (In what seems to be a display of grantsmanship skill, the University of Minnesota's school of architecture also has recently received a $2.6 million endowment from the Dayton-Hudson Foundation to start a Center for Urban Studies.)

Another major project funded with Exxon money will be the planning of an implementation program to introduce an energy-efficient manufactured housing industry in Minnesota, based on Swedish building technology.

"The kinds of houses that are popular in Sweden may have difficulty selling in Minnesota; however, Swedish building technology could be applied and adapted to American-designed housing products," explains research coordinator Mary Vogel-Hefferman.

Improvement of heat pumps is the current product news in the building energy field. "The use of mixed refrigerants and better heat pump exchange design is going to be extremely important for the next energy crisis," says Richard Wright, a researcher at the National Bureau of Standards Center for Building Technology. "Fuel-fired systems (gas and oil furnaces) have been developed to over 90 percent efficiency. But the air-conditioner and heat pump are still operating at 20 percent efficiency." Wright notes that ground-coupled heat pumps are also "an important technology."

This brief and by no means comprehensive overview of future trends in architectural research has pointed to the stark contrast between the sophistication of the technologies used in the built environment and the construction industry's ability to integrate new technologies. The issue is not a new one, but now that productivity and international competitiveness are political buzzwords, the long-standing institutional problems of the U.S. construction industry are a popular topic for government-sponsored studies and reports. Whether that concern will translate into action in this budget-cutting era remains to be seen.

A recently released National Research Council report points out that the U.S. construction industry "probably invests proportionally less in R&D than any other U.S. industry, and also less than the construction industries of some foreign countries, notably Japan.

"For example . . . the Taisei Corporation (one of the largest construction firms in Japan) invests approximately $30 million/year (roughly .7 percent of sales) in R&D. It is doubtful that any U.S. construction firm invests even a fraction of that amount in R&D. . . . Taisei Corporation has a Technical Research Institute with a staff of 130 researchers; Takemaka Corporation has a technical research laboratory employing 256 people; Hazama Gumi Limited has a large research laboratory doing advanced research on tunneling and other subjects; Shimuzu Construction Limited supports a Research Institute employing 213 people, and Kumagi Gami Company, Limited, has an Institute of Construction Technology of undisclosed size doing research on various subjects," the report states.

Although productivity in construction trails that in virtually all other industries and has increased, at best, only slightly since the 1960s, the report concludes that the industry is not likely to increase research funding to the levels needed to improve productivity. Noting that the industry is a "decentralized group of about one million contractors, suppliers, and architectural and engineering firms," the report concludes that "if there is to be an increase in construction R&D, some direct action by the federal government will be required."

The study, undertaken at the request of 13 sponsoring government agencies, suggested that the federal government's self-interest alone may justify greater involvement in sponsoring construction-related research. In 1984, the latest year for which figures were available, federal expenditures totaling $43.5 billion accounted for 15 percent of all new construction and 65 percent of the public works construction in the U.S.

Dispensed by a variety of agencies, federal spending for R&D totaled $220 million, or about 18 percent of all funding for construction-related research, but most of that research was related to the design of federal buildings. Manufacturers of construction materials and machinery accounted for the bulk of research spending—$838 million, or 69 percent of the total.

To raise research funding to levels that will promote technological development, the committee recommended that Congress "formally acknowledge the need for federal leadership in conducting, funding, and coordinating general construction-related research." It compared the proposed program to federal initiatives in transportation, medicine, and agriculture.

The report puts the issue of "architectural technology" in perspective: architectural research remains a discipline struggling for recognition within the broader field of construction research, which, itself, is struggling for recognition in this country. □

'Where the Megatrends Collide'

A personal view of the technological future. By John F. Hartray, FAIA

This is supposed to be about the future of architecture and technology, but I'm not sure that I'm up to it.

To begin with, the future presents a gloomy perspective: a debris-strewn accident scene, where the megatrends collide. The picture is unrelieved by the flashes of intelligence and heroism that brightened up the past. A modern King Lear must worry about his social security benefits as well as his kids. We can see that the tools at our disposal are evolving, while our species remains stuck in a moral holding pattern.

Besides all that, I have been assured by a tenured professor from Princeton that architecture and technology are completely unrelated. This means that I have wasted my life, but I have to admit he is probably correct. It isn't that technology has no effect on architecture. Technology affects everything. And then, everything affects architecture.

Scenes from a misspent youth

Certainly the modern movement, in which I served as a foot soldier, was not the expression of technology that it was advertised to be. In retrospect it seems to have been a distortion of technology to conform to an artistic vision of the future.

Brick walls with reveals around their edges pretended to be the prefabricated panels the theorists had prophesied. Steel members, symbolizing future curtain wall mullions, were embedded in the masonry. There they transmitted heat and noise and slowly pried the walls apart as they rusted. For a decade it was impossible for some of us to turn a corner in a brick wall without two 8-inch-wide flanges and an angle, welded and ground to form a very expensive pilaster.

Modernist true believers used to laugh at the less sophisticated designers who attached their steel metaphors to the surface of the masonry, but the joke was really on us. Superficiality in philosophy and detailing did less damage to the walls.

In 1958, I saw a toll booth for the autostrada near Naples, where the smooth beige bricks, tooled mortar joints, and black steel mullions of the high, early modern style all were rendered in stucco over a tufa bearing wall, much as Palladio's Corinthian orders had been troweled over brick. My conclusion now is that construction technology has more to do with keeping the stucco attached to the substrate than with the expression of posts and beams.

Now, in a small Chicago office remodeling, a steel tee, painted pale blue, has been employed as a surface mounted horizontal belt course. This frank use of a rolled section as applied decoration probably represents the final stage in the evolution of the Miesian classic order.

Technical change in history

It is not surprising that attempts to express construction techniques in architecture have been historical rarities. Construction usually has been delegated to the working classes. Patrons of architecture normally have concerned themselves with loftier issues. The few examples that do exist are not very convincing.

The Doric order expressed wood joinery in carved stone, and while we think we see an expression of structure in 13th-

Jack Hartray is a partner at Nagle Hartray Associates, Chicago, and teaches at the Illinois Institute of Technology.

and 14th-century cathedrals, we aren't sure that this was intentional. These churches were certainly not sited to display their structural elements to good advantage, and it is possible that the flying buttresses were thought of as unesthetic necessities, like the rooftop mechanical equipment of our own time.

As far as I know, only Japanese traditional architecture, which successfully employed a modular system for both design and construction, fulfilled the technological promise of modern theorists. It remains, today, the one great example of craft raised to the level of art.

Most advances in construction technique have little or no effect on design. During the last two centuries, our traditional clapboard houses have been framed in heavy timber with mortise and tenon joints, with lightweight balloon frames, and with platform walls on floor diaphragms. Benjamin Franklin would not feel out of place in our present day suburbs until he went to the bathroom or began discussing politics.

I expect that the shutters and the window boxes of our space stations will look much the same when they are held in place by centripetal force.

Until mirrored curtain walls and Dryvit presented us with their licentious possibilities, proven construction details had set limits on the vocabulary of architecture. In some cases technology has provided expressive possibilities that had no immediate use, like noise waiting to be recognized as music.

Political technology

Lynn White, who used to teach history at UCLA, wrote a number of essays on medieval technology, in which he pointed out that seemingly small technical inventions often resulted in major social, economic, and political changes. It follows that the new institutions that are created to manage these changes demand their own new architectural expression.

One of White's most memorable examples concerned the introduction of stirrups into Europe. By giving a tactical advantage to horsemen, these gadgets allowed local communities to defend themselves from imperial tax gatherers. This defense required the construction of fortified city walls, which in turn provided the security for the new institutions and building types we associate with the Middle Ages.

In more recent times, the demands of publishing necessitated consistency in languages, which in turn created a sense of commonality within the groups who spoke them. This ethnic awareness, combined with new weapons and tactics that shifted the balance of power back to foot soldiers, led Europe into nationalism. The idea of national unity was symbolized, here and in Europe, by overscaled, classical structures intended to remind the taxpayers of the grandeur of Rome, prior to stirrups.

The First World War then demonstrated that nationalism was a mixed blessing. The modernists attempted to neutralize governments by taking away their colonnades and pediments, but the new revolutionary style was rejected by the war victims and adopted instead by multinational corporations, who enjoyed the anonymity and symbolic efficiency of an undecorated architecture with no visible connections to the past.

The part of the joke that Tom Wolfe failed to understand was that the postwar revolutionaries ended by providing an architectural style for the munitions makers.

If I had to invent an appropriate architecture for an imaginary nation that governed itself by television, I would start with a style composed of brightly colored, two-dimensional facades that would immediately call to mind simplified, low-resolution images of the past.

To keep it sufficiently impersonal and free of human scale I would design it on a TV screen. If major developers were involved, I would have my CADD system connected by modem to the real estate editors of important newspapers so that land values could be inflated without actually building anything.

The tools of our trade

Masters like Richardson and Mies could visualize a building before they drew it. (Mies drew his finely machined projects in charcoal and chalk.) But for most of us the medium and the message remain mixed. We visualize buildings by looking at drawings, and changes in our drawing instruments can radically alter our designs.

Tee squares and descriptive geometry allowed us to see our projects in perspective and aided our visualization of architecture. The moldings were mitered at the corners because we could show three walls, a ceiling, and a floor in one drawing.

The parallel straight edge, wired to the drafting table, restricted us to orthographic projections and to a decorative but incomprehensible abstraction, the axonometric. This artifact is so bewildering that it is confused with art and sold in galleries.

It is easier to imagine many current office buildings as rotating images on cathode ray tubes than to think of them as buildings on a real street. Their detailing has a very low resolution. Even 25,000 bytes of information are spread pretty thin when enlarged to fill a whole city block.

The architects who have solved this problem are those who have found media that are sympathetic to their design intent. Tony Predock's soft brushes and oil pastels seem to grow out of the New Mexico landscape. With adobe, he could even use them for working drawings.

We live in an age when despair is trendy. We are told that television is shortening our attention span while our problems grow ever more incomprehensible. Politically we have drifted from a liberal malaise to conservative amnesia, while the armaments industry siphons off our discretionary wealth and credit.

This cannot last. It is impossible to believe that our society will not discover a sense of purpose.

As a visionary profession we should be helping this to happen. At least, we should be preparing for a period of realistic optimism.

Our agenda might include the design of an affordable system of apprenticeship, interdisciplinary education, and professional exchange within the construction industry, recognizing that our competence as a profession depends on diversity, even though this may be inconvenient for the licensing bureaucracy.

We will also want to regain control of the methods of practice from our insurance companies and the attorneys who defend them.

The most interesting aspect of American history is that it is so short. We have only begun to settle into the continent. In doing so we may find that we need farmers more than commodities traders. I hope so, but that is an esthetic prejudice.

We may also find that the rational management of our land will point the way to a humane urbanism and a lasting architecture.

So far we have only made sketches. □

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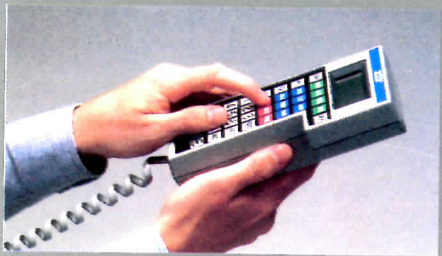

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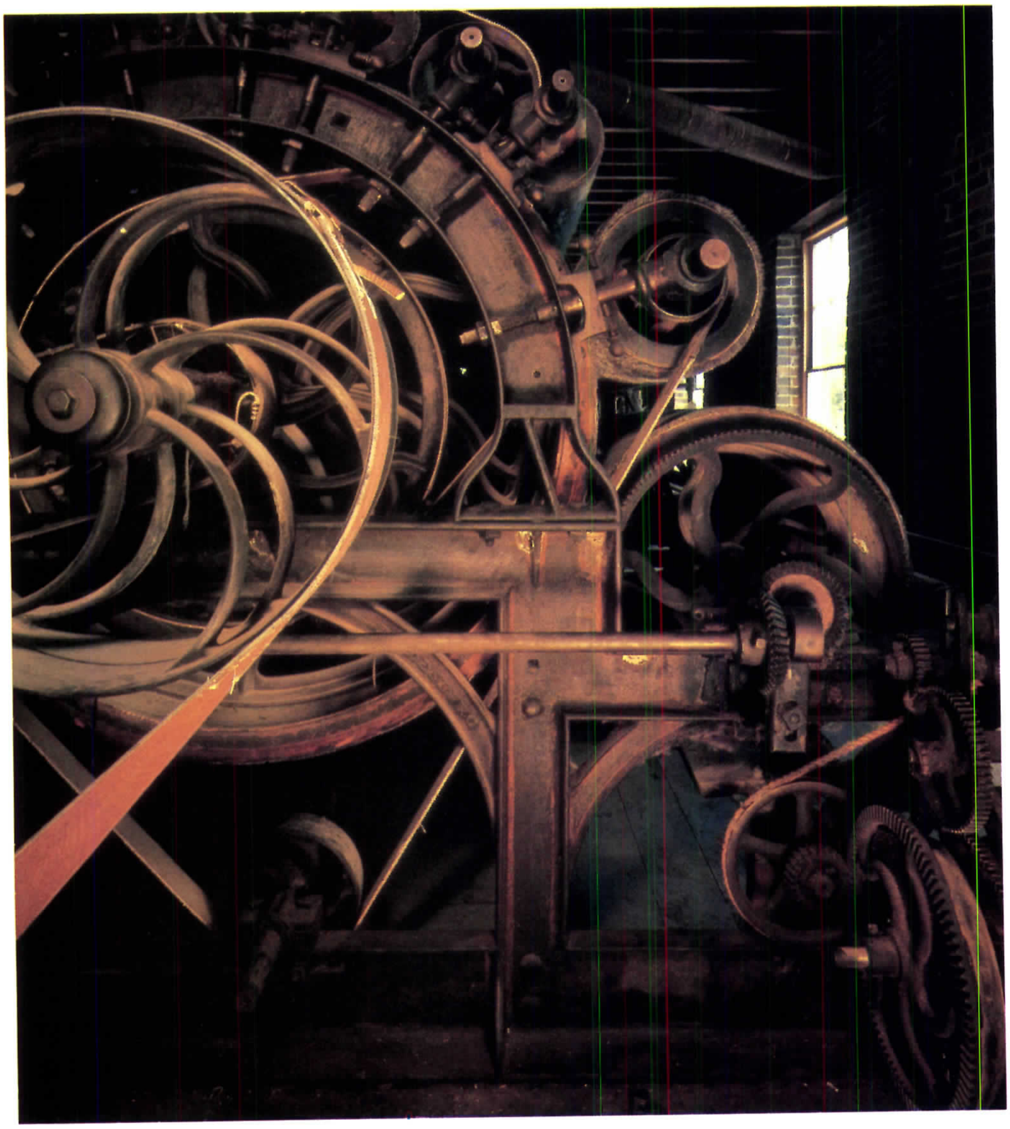
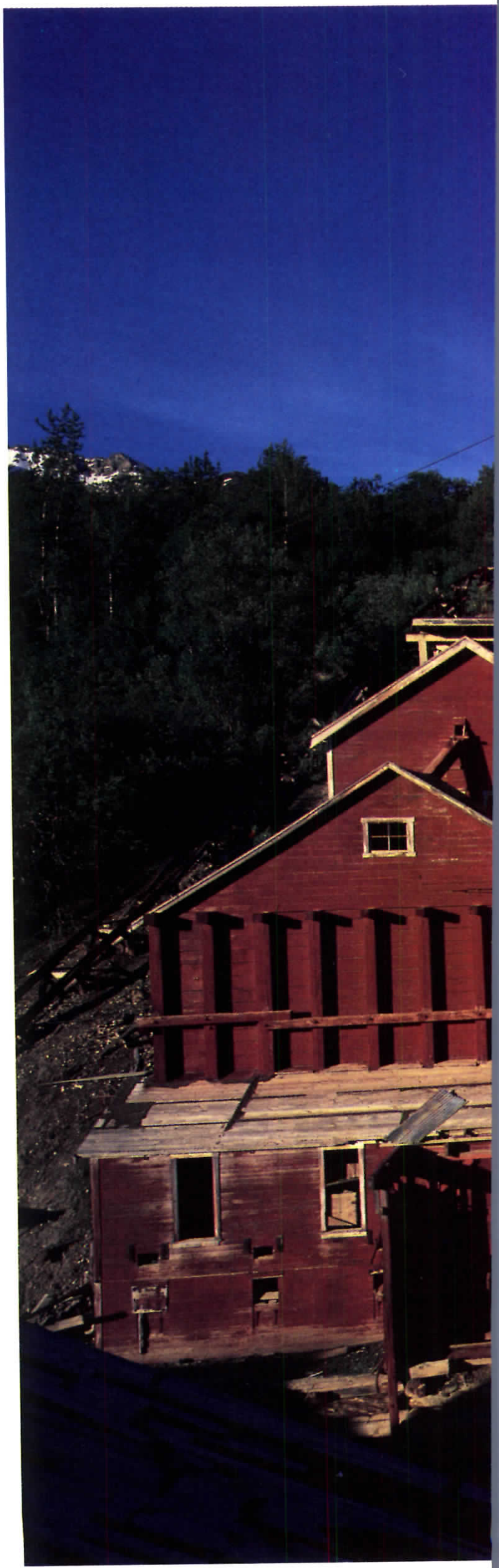




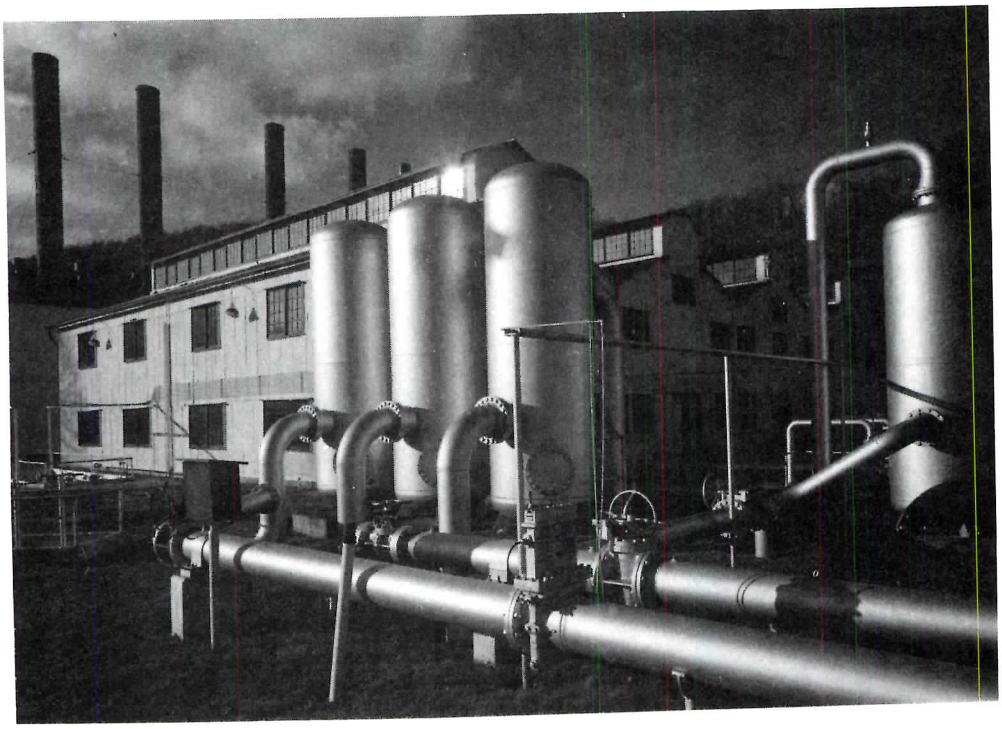
Industrial Eye. Photographs by Jet Lowe from the Historic American Engineering Record. (Preservation Press, $34.95.)

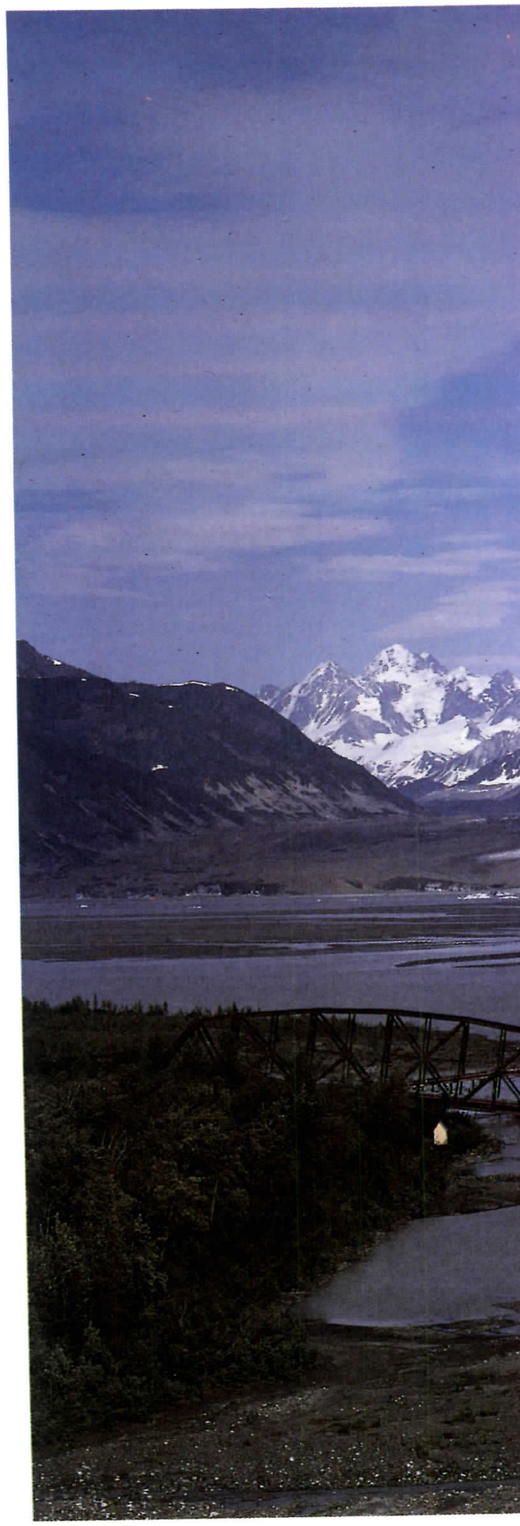
Jet Lowe's subjects are the surviving means and ends of our industrial life as a nation, mainly in the 19th and early 20th centuries: machines, mills, and factories; waterways, breakwaters, and bridges; harbors, dams, and generators. His photographs of the San Francisco-Oakland Bay and Golden Gate bridges and the Statue of Liberty restoration will be remembered by the readers of this magazine.

Many of the things Lowe shows us seem familiar yet remote. We have seen them—perhaps the giant ore unloaders on Cleveland's waterfront or the tobacco warehouses in Danville, Va.—but we haven't taken them in. Others, such as the remains of steam locomotives in Alaska (overleaf) or the primitive stage mechanisms in Louis Sullivan's Auditorium Building, are things most of us will never see. Lowe shows them to us and conveys through his craft why he thinks them worthy of our atten-

Above, carding machine at Watkins Mill, Lawson, Mo. The woolen mill was built in 1861. Right, Kennecott Mining Company, 1905-23, in Kennicott, Alaska.

BOOKS





tion. His images, straightforward or breathtaking, are invariably artful, seldom arty. Made on 5x7 or 4x5 sheets of film, they register subjects with minimum distortion and in minute detail.

The introduction, by California author David Weitzman, is for the most part eloquent and perceptive. But he edges toward a rhetorical abyss when quoting Le Corbusier's pompous 1923 declaration that American engineering and industries "make the work of man ring in unison with universal orders" to illustrate the period's presumably widespread perception that machinery would ease all suffering. Weitzman plunges when he adds: "Pollu-

Top left, locomotive remains near Nome, Alaska. Above left, steam powered gas pumping station, Burnsville, W.Va. Above, earthquake damaged bridge in Alaska.

tion, conflicts between labor and management, the cynicism of workers who have discovered that the 'leisure' promised by machines is actually unemployment have dulled the bright, heroic colors with which industry and workers were once painted."

Perhaps a more relevant view today is that the enterprising among those in the post-industrial generation are likely to turn the subjects of Lowe's camera into vehicles for marketing nostalgia—the proliferating theme restaurants and boutiques in the shells of our industrial past.

As for the book itself, it is a beauty. *Industrial Eye* reproduces on 128 9½x12-inch pages 33 color and 88 monochrome (duotone) photographs of the more than 10,000 that Lowe has taken since 1979 for the National Park Service's Historic American Engineering Record. The book is thoughtfully edited by Diane Maddex, handsomely designed by Marc Alain Meadows and Robert Wiser, and printed on thick, creamy stock that registers Lowe's details with precision.—Allen Freeman

Books continued on page 120

'A Proper, Old-Fashioned Biography' of Richard Rogers

Richard Rogers: A Biography. Brian Appleyard. (Faber and Faber, £9.95, paperback.)

No doubt because of the large sums of other people's money entrusted to them —£176 million in the case of Richard Rogers's Lloyd's insurance building—architects are expected to lead lives of such measured respectability that they provide little grist for the biographer's mill (Stanford White always excepted), and few architectural biographies make the best-seller lists or the canon of great literature. They may be of consuming interest to other architects, but the general public prefers *The Fountainhead.*

Yet architects are among the most conspicuous creative talents of the times (and the covers of *Time),* and surely *someone* can make a marketable, enjoyable, even truthful narrative of an architect's life. The last couple of years have seen a pair of brave tries: David Littlejohn's attempt on the life of Charles Moore *(Architect)* and now Brian Appleyard's *Richard Rogers: A Biography.* Both are works of *haute*-journalism, and both deal with obvious media-hero personalities, but there resemblance ends.

Littlejohn's book is built like a *New Yorker* profile, with set pieces and striking scenes in operatic rather than biographical order and the hell with logical development. Appleyard's, by contrast, is a "proper old-fashioned biography" that begins at the beginning, "Richard George Rogers was born on 23 July 1933 . . ." and goes right on to the end: ". . . tension and compression, steel and glass, kisses and smacks." That's right: *kisses and smacks,* for like most British biographies and autobiographies, this one sees prepubertal crises and disasters as of paramount importance, and its continuous harping on Rogers's early and persistent dyslexia is one of its less ingratiating features. Contrary to British tradition, however, it does not lose interest in its subject when he leaves high school, and we learn a lot about his many years of architectural education and sexual development.

This last aspect, together with the dyslexia, has made the book a godsend to Rogers's more vociferous enemies among the "young fogey" set, and its quasi-scandalous content has made it more of one kind of success than it really deserves and has diverted attention from some stunning failures of scholarship. For these, however, the publisher's readers must be blamed; it is scandalous to let pass, for instance, the statement that Adolf Loos said, "The evolution of structure marches with the elimination of decoration from useful objects," (he notoriously said "the evolution of *culture* . . .") or to allow Appleyard to move Schindler's Lovell house to La Jolla and have his widow live "at a neighboring house" (the Lovell house is still at Newport Beach, and Pauline Schindler was living in the original Schindler/Chase house in Los Angeles when Rogers met her).

Even more embarrassing than such schoolboy howlers, however, are Appleyard's attempts to summarize large but significant swathes of architectural history, particularly of the modern movement. These have caused widespread academic tittering, some in print, but have not evoked as much sympathy as they should for the boldness of Appleyard's attempt and the high biographical ambition that make these mind-boggling thumbnail summaries necessary. Rightly, Appleyard has recognized that Rogers is probably the most symptomatic figure to have emerged from the much-discussed "crisis of modernism" of the '70s, and he has therefore to give the common reader an account of the nature of the crisis, its causes, consequences, and leading actors.

Furthermore, he has to lay out somehow the idea that the kind of high-tech architecture favored by Brits like Rogers, Foster, Hopkins, and others is descended from the futurist/constructivist half of the modern movement's parentage, rather than the "large compact forms," "assembled in light" tradition of Gropius and Le Corbusier. This is a topic on which he had to do his own history, since the established literature is virtually dumb about it, and the massive catalogue of the Frankfurt Museum exhibition *Vision der Moderne: das Prinzip Konstruktion,* which tackles this very issue (contentiously), came out too late to be of any use to him.

Appleyard should therefore be congratulated on divining the true (though not the entire) origins of high-tech before the heavy academics got into print. And the congratulations must stand, even if the bold attempt is ultimately a failure—which, on re-reading and re-consideration, I still believe to be the case, in spite of the fact that I rather enjoyed the book. But it is far from a total failure, let me emphasize. Where it succeeds—so conspicuously that the relevant passages deserve to be excerpted and anthologized for the benefit of anyone who still believes that the "creative struggles" of *The Fountainhead* have anything to do with architecture—is in narrating the real creative struggles that go into the commissioning, designing, and constructing of even minor buildings, let alone monster monuments to cash and culture such as Lloyd's or Center Pompidou.

These narratives, as far as I can assess from my own viewpoint (which has sometimes been close to the action), are correct in all major particulars and in an astonishingly large number of smaller ones, down to and including throwaway remarks made in conversations of which I have heard other accounts. Appleyard's great strength, however, is in marshaling the "casts of thousands" that are involved in some of these sagas, introducing assistants and consultants, engineers, managers, wives, girlfriends, contractors, and amazed clients, on cue and in the right tone of voice, while still keeping Rogers and his "inner cabinet" of most valued associates at the center of the stage.

Inevitably, the high dramas of Pompidou and Lloyd's will command most attention, but more thoughtful readers will surely note how little drama surrounded the Inmos microchip factory in Wales, or the Cummins-Fleetguard warehouse in France, which are regarded as the very best designs to have come out of the Rogers office. Both have helped establish an industry standard that is almost embarrassingly high, and which Rogers himself failed to equal in his only work to date on U.S. soil—the PATechnologies facility outside Princeton, N.J. The differences between PAT and, say, Inmos seem to lie largely with the two structural engineers involved (Peter "Play It Long" Rice for PAT, Tony "Laughing Pragmatist" Hunt for Inmos) and the different modes in which they contributed to the design process, and thus we are brought back to the mysteries of the creative process in architecture and the persistence with which it eludes explication.

Indeed, toward the back of *Richard Rogers: A Biography,* Appleyard himself observes that " . . . the nets of words that are thrown over architecture repeatedly fail to trap their victim." If that is true of architecture in general, it seems even more true of this one architect in particular. In the end we still do not know how it comes about that this chronic dyslexic who has needed mothering all his life and was reckoned a totally useless draftsman at architecture school could emerge as one of the towering talents of his generation.

Along the way to almost predictable failure, however, Appleyard offers a vast amount that is not recorded elsewhere about the architectural profession over the last quarter century, its patrons and supporters, its schools and institutions, and its social subcultures. Scholars, even while they may sneer at its solecisms and errors, will be busily raiding this book for years to come, and ordinary regular architects will enjoy it for what it really is, a mine of gossip and what used to be called "a rattling good yarn."—Reyner Banham

Dr. Banham teaches architectural history at University of California, Santa Cruz.

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Image courtesy of Ragan Design Group

Books *from page 120*

A Concrete Atlantis: U.S. Industrial Building and European Modern Architecture 1900-1925. Reyner Banham. (MIT Press, $25.)

Reyner Banham, the Anglo-American architectural historian, here explores an oft-covered terrain—the impact of American grain elevators and industrial plants of the early years of this century upon European theoreticians of modern architecture. One might have thought this was a territory so often explored as to leave no room for further discovery. But Banham proves this is far from the case. Not only does he knowledgeably re-examine all the documents in the archives, beginning with Gropius's epochal article in the 1913 *Jahrbuch* of the German Werkbund, but he also revisits the sites of these buildings and—when they are still standing—photographs them. In the process, he brings new light to the fascinating web of interactions between the American engineers—pioneers with no intellectual pretensions—and such leading European theoreticians as Muthesius, Loos, Gropius, and Le Corbusier.

Banham's contribution is important for several reasons above and beyond his well-known intellectual equipment. For one, he offers native-born Americans a special European perspective of the trans-Atlantic temperament that played such an important role in modern architectural theory during the first quarter of this century. For another, he is well-educated in a special English fashion, not merely multilingual, but with a degree in civil engineering as underpinning to a doctorate in art history. This background produces a literate and perceptive analysis, without the semiotic bombast that characterizes so much contemporary American criticism, both artistic and architectural. It is not so much that Banham's style is dry—as a matter of fact, it is often laced with the barbed wit that characterizes much of the bearded Englishman's dialogue. It is rather that his esthetic judgment is disciplined by a comprehension of structural fact that few American critics can match.

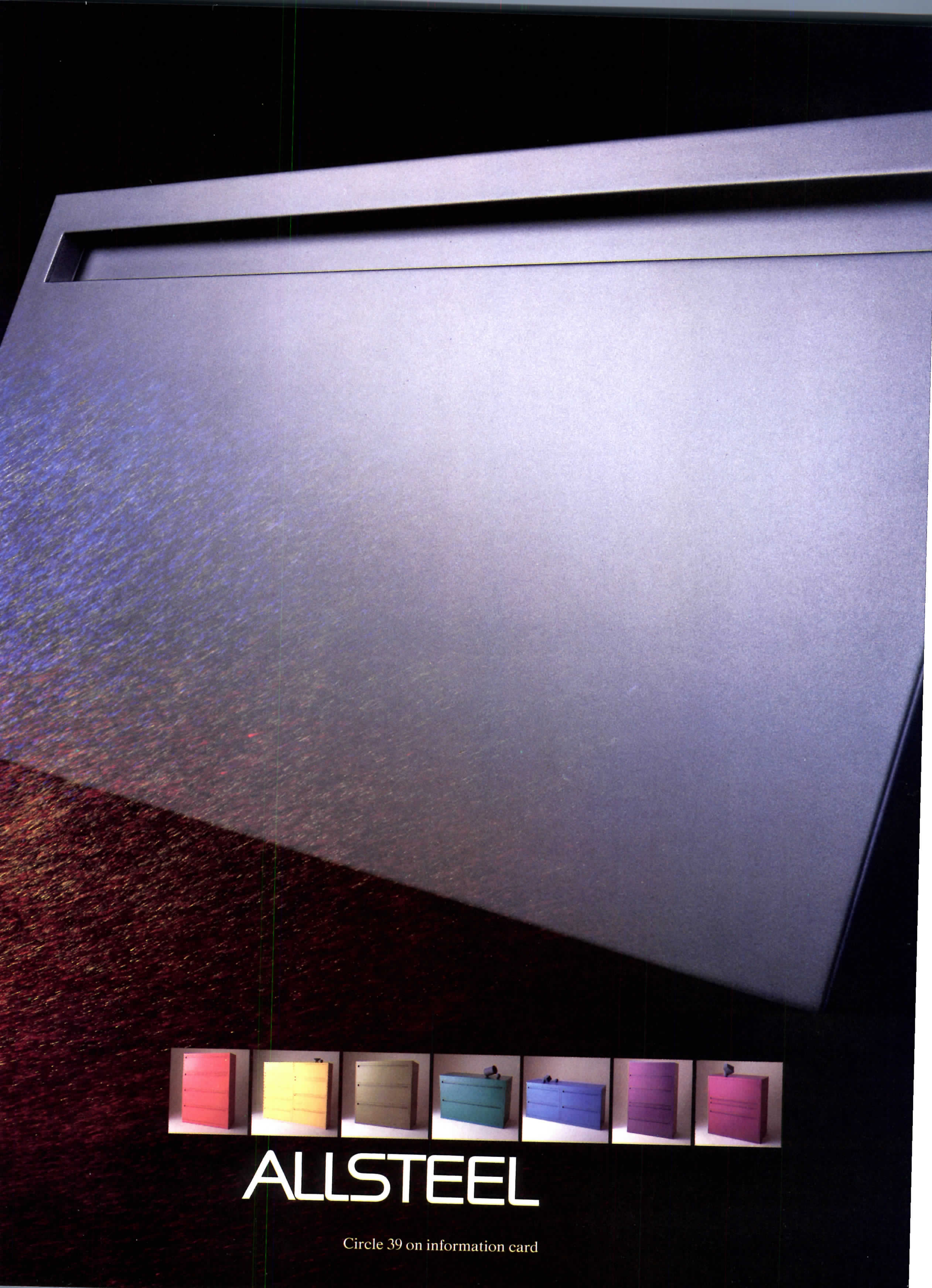
This is not to imply that Banham is—God help us!—a Marxian materialist, or even a simon-pure functionalist. Like most of his generation of scholars, he finds it necessary to make the *de rigueur* denigration of the Bauhaus as being just another of the stylistic movements of the early part of this century, no more significant than art nouveau, *floreale*, or *Jugendstil*. But he is too much the engineer to deny the causal links between the new structural forms of American factories and grain elevators and the new esthetic criteria being developed by European architects. And he is too sound a historian to deny the critical role played by Walter Gropius in this trans-Atlantic transmutation. Indeed, to my knowledge, Banham is the first critic, then or now, to go beyond praising the sober "Egyptoid" beauty of these silos and explain the machinery that moved the grain through them, from incoming trains into outgoing grain ships.

This is a small and unpretentious book; but for anyone seeking to establish new bearings in the history of modern architecture, after the wild metaphysical storms of postmodernist criticism, it will be valuable as both a compass and a navigational chart. Banham concludes that "the International Style . . . will remain, as far as any one can yet see, the dominant style of the high art of architecture of the 20th century." Architects of my generation have, of course, always maintained just that.

—James Marston Fitch, Hon. AIA

Dr. Fitch, founder of the first U.S. preservation program at Columbia University, is consultant to Beyer Blinder Belle.

Books continued on page 154


ALLSTEEL
Circle 39 on information card

Deep Roots Of Basque Architecture

It expresses some ancient traditions. By Sal A. Westrich

Fifteen thousand years ago man left the cave for the hillside and valley. The ice age was ending and the resulting rise in temperature and proliferation of wild plants made the move to open spaces advantageous. The house, which now became man's habitation, was itself not new. John E. Pfeiffer in *The Creative Explosion* refers to dwellings possibly 30,000 years old—no more than huts made of skins—uncovered at Solvieux in the Dordogne region of France. The newer structures were significantly different from these older ones. The hearth was dug out rather than built even with the floor surface; wood replaced animal skins; and the house was erected on piles—to obtain protection from predators and precipitation. In time stones were used to enclose the space below, which became a stable for the newly domesticated animals.

The prototypical Basque house had emerged. Modifications would follow cultural encounters—hinges and latches being introduced by the Celts, bricks and tiles by the Romans, the corbel by the Saracens—but the house's essential form remained unchanged. Repeatedly destroyed by invaders, the house was always rebuilt in traditional style, becoming thereby the carrier of Basque culture.

Dr. Westrich is a professor of history at the Pratt Institute in Brooklyn, N.Y.

In Basque architecture, cultural values are retrieved from the store of unconscious memory. In Basque life, the house is the focus not only of everyday life but also of ultimate concerns. For the house ensures eternal as well as earthly safekeeping, both the dead and the living being included in its protective embrace. The existence of special paths ("eliza-bide") linking dwelling, church, and tomb—a possible vestige of paleolithic burial practice, in which the dead were placed in a sacred area at the threshold of the cave—points to an indissoluble bond joining the three.

So great is the house's sway that its inhabitants frequently will add its name to theirs. By assuring each household member permanent living quarters, the house also will ensure the continuity and cohesion of the clan—a custom reinforced by common law that will not sanction the parceling out of the homestead, requiring instead that it be transmitted whole to the oldest surviving kin, whether male or female.

Faithful to traditional architectural values, the Basque house can serve as a reliable guide to past construction. Indeed, some have seen in the characteristically open ground floor traces of pile-supported neolithic dwellings. Continuity of design is evident in even the newest structures, which invariably adhere to a Basque prototype.

Photographs by Valerie Fernandez

The unity of things so central to Basque mythology and arts is particularly evident in Basque construction. Nature and habitation converge. Facades will be embellished with cosmic and vegetal symbols, while materials used are those found in the immediate environment—oak and other hardwoods being employed in the western region, stone and slate in the more mountainous northeast.

Geography will also determine the shape and orientation of the structures: in Soule, where winters are harsh, houses are squat and covered with steeply slanting slate roofs (in order to discourage the accumulation of snow); while in Labourd, houses face east to lessen the effects of the fierce Atlantic wind (and to obtain in full measure the morning sun).

The natural balance between house and environment extends to the house's interior, the form and disposition of spaces corresponding to their function. The typical country dwelling consists of a single unit housing humans and animals—the latter occupying the more exposed western side—and providing storage space for the harvest. The slanting roof may be extended to create additional space, breaking the original symmetry.

While certain characteristics of construction are common to the entire Basque region—for example the laying of a stone foundation, the use of brick or grit-stone,

Across page, top, Basque houses dot a dramatic landscape; bottom, houses of half-timber and masonry construction. Clockwise from above left, west facade of a country dwelling, where animals share quarters with their keepers; fortress-like Christian church; tombstone, or stele, displaying pre-Christian Basque iconography; street in the village of Soule compresses space.

the raised ground floor—significant stylistic differences separate one province from another. In Labourd, vertical joists are widely employed, as are corbels (which allow the fronts of houses to withdraw). In Navarre, lateral walls extend by as much as two meters, thereby permitting the insertion of a balcony. The influence of neighboring Béarn may be seen in Soule in the utilization of round stones and the establishment of a separate barn. Another spirit here prevails: the dark hues of the building materials, the lack of open spaces, the absence of wooden or lapidary ornamentation, impart to the Soulian house a somber, constricted appearance not characteristic of houses found in the other provinces.

The most appealing quality of the Basque house is its simplicity. The use of primary materials will invest the structure with a directness of expression altogether consistent with the simplicity and purity of the overall design. Spurning stylistic innovations that would damage the link with tradition, the Basque builder will introduce minor variations to avoid monotony. The number and disposition of joists, the color of beams and tiles (maroon and green—earth colors—being preferred), the size and placement of stones, will vary, as will the inscriptions and iconographic markings placed above windows and doorways. Here will be found the name of the house, the date and circumstances of construction, and a variety of emblems: the Basque cross, the five-pointed star, the six-lobed rosette.

The Basque house has been called "the essential achievement of Basque creativity" and "powerfully original." Yet its appeal cannot be said to derive from ornamentation, which tends to be spare, or from dramatic use of color. A factor infinitely more subtle is at work: the unique treatment of space—whether the two-dimensional space of a facade, the depth space created by juxtaposed structures, or the cosmic space enveloping each house in nature's totality. The presence of large doorways and symmetrically placed windows, the brightness of stark white walls, and a preference for unencumbered spaces—except in Soule, houses are generally disengaged and a central square will be found in even the smallest villages—all produce a sense of openness and fluidity: the blending of inner and outer worlds,

Photographs by Valerie Fernandez

the immediate merging with the timeless.

Village churches and their adjacent cemeteries are comparatively recent additions to Basque life, none seeming to predate the 16th century. The survival of traditional beliefs over Christianity is revealed in the use of sanctuaries. There are the proprietory church pews ("yar liku") reserved for each family and only changing hands when the domain is sold—a vestige of the practice of household deity worship. And there are funeral paths linking house, church, and cemetery that allow the departed soul to move freely from one site to another. The location of cemeteries is itself significant: rather than being placed on the outskirts of the agglomeration, as is typically the case in Catholic villages, they occupy the village center, presumably to enable the spectral forms to participate in the daily life of the community. And the tombs will face east, so that the dead also may receive the morning sun.

More than a place of worship, the Basque church is a village house where the community meets. The resemblance of church to family dwelling is indeed striking: joists, slanting tile roof, and eastern orientation are common to both. In contrast to the typical Catholic church, which strives to separate itself from human habitations, thereby conveying a sense of God's remoteness from man, Basque churches and houses draw together. The convergence of the sacred and profane can be plainly seen in the pelota court's proximity to the church and cemetery.

As with the house, the appeal of the Basque church lies in its unassuming appearance. Rectangular in shape to accommodate the long and narrow nave (transepts are rare), the steeple ending in a simple pyramid, the bleached outer walls devoid of statuary or other ornamentation, the Basque church presents a stark, restrained appearance reminiscent of the churches of New England. Inside, the occasional presence of a sumptuous altar wall (evidence of the Spanish influence) or, in larger churches, of stained glass windows, only accentuates the prevailing sense of austerity produced by white walls, exposed beams, and the absence of emotionally charged imagery. One might be in a place of meditation, where prayer is an interior dialogue rather than an appeal to authority. Rather than striving to foster a spirit of exalted devotion, Basque religiosity invokes a simple naturalism, the belief in the adequacy of faith in a familiar and responsive universe. □

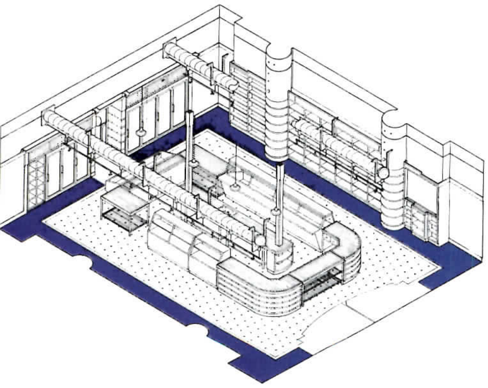
Top, church and cemetery share common ground with pelota court for playing traditional Basque racquetball game; middle, three-pointed Basque church in Soule; bottom, tiered balconies are reserved for men.

Interiors

Nowhere can there be found a more consistent and truly American style of architecture than in the turn-of-the-century commercial structures that lined the main streets of small towns across the country. Although there are regional differences, these buildings are all two-story, usually of wood frame construction, housing commercial uses on the ground floor with living quarters above, and, in spite of their utilitarian purposes, full of wonderful, eye-catching detail.

Such qualities were not always appreciated, and during the '50s and '60s many of these buildings were lost as bulldozers traumatized our cities and shopping malls destroyed downtowns. These structures now are being knit back into the fabric of their cities.

The three projects shown here exemplify what is happening all over. The results are a rich visual collage, a layering of styles that enhances the original building's qualities, preserving connections to its origins as well as making connections to its present day reincarnation.

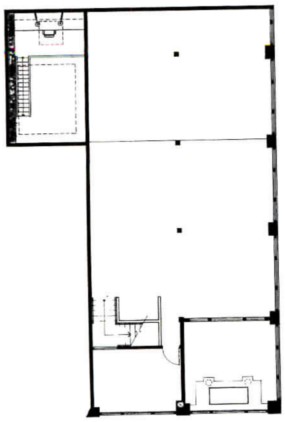


Located on Magazine Street in New Orleans, a newly fashionable area of restaurants catering to a predominantly young crowd, this shop features an array of packaged goods and cooking utensils along with its own take-out food prepared on the premises.

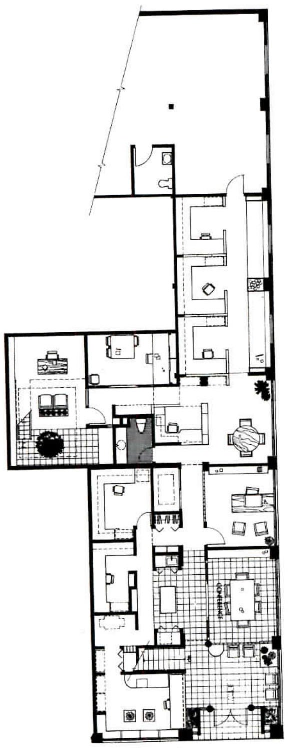
Originally built as the home of a shipping magnate, the building had fallen into disuse before the present owner purchased it. Architects Shelden Haizlip and Tom Howorth restored the exterior (below, left) based not on any existing plans but on a knowledge of what this building type was like and what was appropriate. The balcony was rebuilt on the second story, which now has two luxury apartments; the facade was painted in colors correct for its time; and new signage and lighting were installed for the ground floor shop.

On the interior (left) the architects added a structural beam down the middle of the space, opening up the interior to the full width. The original cypress tongue and groove ceiling was retained, the only visible element of the old interior.

The overall design strategy was to create a bright, clean, but "non-sanitized" interior, a backdrop for the display of all the foodstuffs. Shelving wraps two walls and is packed full of neatly arranged, colorful jars and tins; a food serving counter wraps around the columns in the center of the space incorporating food storage cases and maple countertops appropriated from an old bowling alley. Airconditioning ducts were hung from the ceiling and used as a mounting for display lighting for the wall units. But perhaps the most serendipitous design decision was the black and white tile floor pattern. While a traditional element in many turn-of-the-century commercial buildings, here it is laid in a very contemporary pattern, a result of the fact that thieves stole over half of the original tile order, and the replacements, at short notice, were a different color, necessitating an asymmetrical, atypical approach to the patterning.—Sharon Lee Ryder



Second floor plan



First floor plan

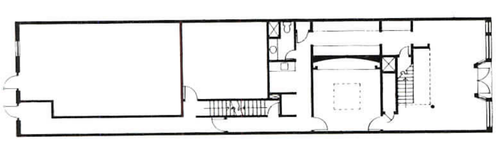
The offices of client and contractor Zcon Builders are a walk-in, three-dimensional advertisement for their company. Housed in two bays of a block-large building along the Oakland, Calif., waterfront in historic Jack London Square, the offices occupy some 3,000 square feet at one corner. Given that the space not only had been vacant but was in a state of semi-disrepair, the only aspect of the building worth restoring was the facade (left), whose terra cotta details and inlaid tile relieve the otherwise monolithic quality of the brick building. While keeping the window details at the entry, architects Sandy & Babcock recessed the entry doors and flanked them with two sonotube-formed concrete columns (below left), a deliberate juxtaposition of old and new. In the reception area, however, they enclosed the mezzanine level with a new window, replicating the old (opposite page). Off the conference room (below), a wall divides work areas from cooking/catering facilities.

The plan is a typical distribution of spaces off a center corridor organized around the 16-foot-sqare bays of the structure. It does, however, have one twist—an interior, two-story, skylit space, borrowed from an adjoining bay as an office for one of the partners.—Sharon Lee Ryder

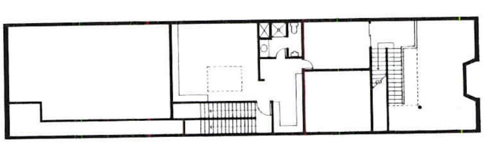
On South Street in Columbus, Miss., stands a modest two-story brick facade (right) with a cast-iron storefront on the ground floor, stamped metal window details on the second story, and a metal cornice at the roof. The only items that give a clue to what lies behind are the new awnings, installed by the architects whose offices now are housed there.

Formerly the home and studio of a sign painter, the 5,000-square-foot building was one of the first to be renovated along this stretch of commercial buildings. Architects Dean/Dale/Dean & Ivy took advantage of the overly generous ceiling heights and inserted a mezzanine level, creating three stories. Two skylights also were added, one over the mezzanine area. The other, over the stair at the entry, extends the overall height to a dizzying 35 feet. At the reception area (opposite page), typical tongue and groove wainscoat detailing was used on the stairs, and two old cast-iron columns found in the basement were reused, although no one knew quite where they had been originally.

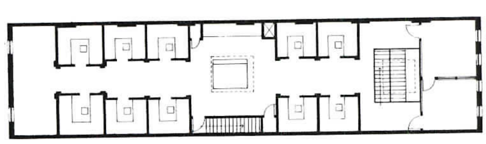
The top floor, a former men's club, houses the drafting stations as well as two private offices (above). Here, the glass partition details so typical of the period were redesigned in a more contemporary vein and painted in turquoise. The original stencil patterns were restored, although again in a different color, while the beaded board ceiling remains as it was when the building was built. The combination of old yet familiar images with the more modern detailing and colors creates a rich palette of images and a continuity between old and new.—Sharon Lee Ryder



First floor



Second floor



Third floor

Photographs by Binney Hiles

Solar and Security Properties Of Laminated Window Films

Window films offer solar and security properties for glass. The two-layer laminated films are applied to the inner windows and other smooth glass to strengthen and laminate the surface.

American Armatura recently introduced a double ply, transparent polyester film specifically for security and safety applications. Called Profilon Plus, the glass reputedly reduces the possibility of flying glass and window collapse from explosions such as bomb blasts, thrown objects, fires, hurricanes, and earthquakes. Profilon is also designed for fire resistance, melting on the glass at 480 degrees centigrade without producing any poisonous gas, says the manufacturer.

The laminate's strength is derived from two layers of laminated film that has continuous nylon filaments placed 1½ inches apart, forming a flexible armored shield. Profilon's adhesive is acrylic pressure sensitive, incorporating ultraviolet inhibitors and fungicidal agents. The adhesive impregnates the base film, thereby giving strength and energy dissipation to the glass. An adhesive coat weight of 25 gsm and 20 to 25 micron thickness helps achieve clarity.

Three types of window films by 3M help solve problems of unwanted solar heat gain, sun control, and shattered glass from high winds, accidents, or vandalism.

Scotchtint Sun Control film stops some of the sun's heat at the window before it enters a building. Scotchtint Plus All Season provides insulation for energy savings, and Scotchtint Shatter Resistant transparent polyester retrofit film offers safety and security, resisting 100 to 150 foot-pounds of impact.

All three films have a one-way mirror effect. For applications requiring two-way visibility, a nonreflective film is also available that allows insiders to see out but cuts heat gain and ultraviolet rays.

The films are code-approved according to ANSI standard Z97 and offer a limited five-year warranty.

American Armatura Company
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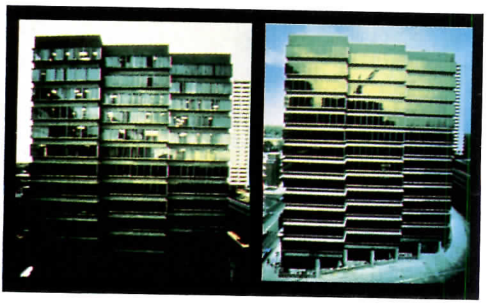
3M
Circle 244 on information card

Windows without and with 3M film.



Electronic Ballasts Designed to Provide Constant Light Output

Electronic ballasts operate fluorescent lamps at high frequencies and offer energy- and money-saving benefits compared to the standard core-coil ballasts.

A straight replacement for conventional ballasts with no effect on lighting design, electronic ballasts are designed to save enough electricity to pay for themselves within a few years (or even months, depending on the local cost of electricity, occupancy characteristics, and other factors), and have an estimated life of 10 years or more. Electronic ballasts average 20 to 40 percent more efficient than conventional ballasts, according to Rudy Verderber, a researcher at Lawrence Berkeley Laboratories (LBL).

The lighting design implications of electronic ballasts include increased controllability and dimming capability, less flicker, reduced noise, decreased lamp lumen depreciation, lighter weight, less fluctuation in lighting levels due to voltage variations (improved regulation), and a decrease in heat generation from the lamp.

Approximately 10 manufacturers offer electronic (sometimes called "solid-state") ballasts, at costs generally ranging from two to three times the price of standard core-coil ("magnetic") ballasts.

Ballasts have two functions: The ballast must generate a high voltage to start the lamp, and, once the lamp is on, the ballast limits the arc current to safe levels.

Core/coil ballasts use a magnetic iron core and copper or aluminum coil components to produce and control voltage and current and operate the fluorescent lamps at 60 Hz. The electronic ballast uses an electronic circuit to convert the 60 Hz imput power to high-frequency output power (usually 20,000-30,000 Hz).

The improvement in the efficiency of the fluorescent lamp system, which is operated at high frequency, is due to a decrease in the voltage drop at the positive electrode (anode fall). The current flows from the negative electrode (cathode) to the positive column—the gas-filled electron tube where the plasma produces ultraviolet radiation that is converted into visible light when it strikes the phosphor. Then the current is collected at the positive electrode (anode), where the power loss at higher frequency operation is decreased by about 10 to 15 percent because of the reduced anode fall (about 10 to 15 volts). Because the amount of power delivered to the positive column is the same in each case, fluorescent lamps operated with electronic ballasts produce the same amount of light as those operated with standard core/coil ballasts, using 10 to 15 percent less power (watts). Further, because electronic ballasts transform the input power into output power, the total efficiency of a high frequency system (ballast and lamp) is about 20 to 25 percent better than the standard ballasts. Additional energy savings—in the 40 to 50 percent range—can be achieved with dimmable electronically ballasted systems. These energy savings figures are taken from the results of Department of Energy-funded tests at LBL, and have been verified by the experience of users.

One of the major design benefits of electronic ballasts is their superior dimming and control capability. Standard core/coil ballasts require expensive control hardware for power switching, which is often not cost-effective, and produces additional flicker when lamps are dimmed to lower lighting levels. In electronic ballasts, the circuitry for dimming the lamps is internal. This permits manual dimming by occupants from a built-in control, or automatic lighting control by a centralized microprocessor that can monitor the amount of natural daylight (using photocells) and signal each ballast to produce the levels of light actually needed. A large group of ballast systems can be controlled as a single ballast system.

With the electronic ballasts, decreasing lighting levels from 100 percent to 75

continued on page 144

Products compiled and written by Amy Gray Light unless noted otherwise.

Products *from page 143*

percent results in a corresponding 25 percent decrease in the amount of power used. Lamps dimmed to less than 75 percent of their lighting capacity still use less power, but the decrease in power usage does not remain proportional to the decrease in light output.

—KAREN HAAS SMITH

Electronic Ballast Technology
Circle 256 on information card
Triad-Utrade
Circle 257 on information card
Advance Transformer
Circle 258 on information card
Universal Manufacturers
Circle 259 on information card
XO Industries
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General Electric
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Datapower
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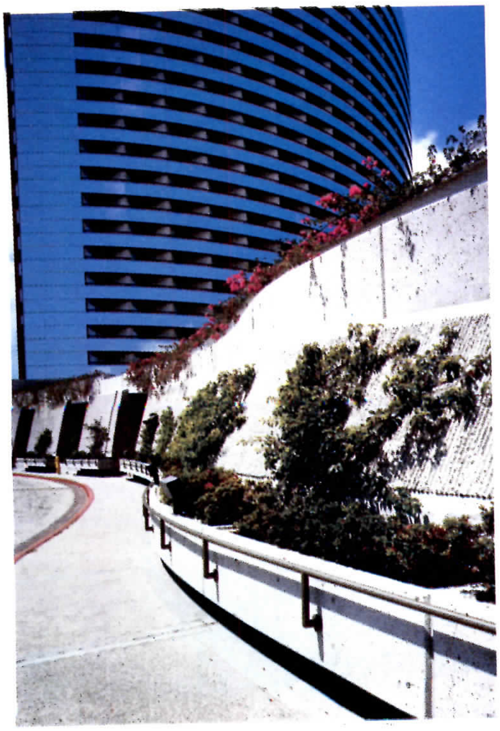
Fynertics
Circle 263 on information card
Luminoptics
Circle 264 on information card

Rigid Form Liners Give Texture to Structural Concrete

Plastic, glass fiber, and elastomeric form liners are designed to create a variety of patterns and textures in structural concrete.

Rigid plastic form liners for texturing tilt-up, cast-in-place, and precast architectural concrete are attached to the casting bed or formwork prior to placing the concrete. Greenstreak introduced such form liners in three different use ranges. Uni-Cast, a single-use form liner, is used for tilt-up or cast-in-place jobs. Multi-Cast is an intermediate-use form liner, suitable for two to 10 uses under normal site conditions; and Dura-Cast, a high-use form liner, is offered for use under normal site conditions.

Form liner for concrete shown on the Intercontinental Hotel, San Diego.



All liners come in nominal 4x10-foot sheets that are trimmed both straight and square. Custom patterns are available.

Elastomeric form liners, developed 10 to 15 years ago, were originally made from pure urethane materials. As experience with these materials increased, other ways to make form liners less expensive and more practical were sought. Five years ago Symons Corporation combined pure urethane materials with fillers to reduce overall costs. The resulting liners may not be as resilient as those made from pure urethane materials, but their job performance is deemed satisfactory for the jobs required of them.

Symons offers two types of liners, giving architects a wide range of patterns and textures to impart to concrete. Elasto-Tex is more of a pure urethane material than Dura-Tex, which is less expensive. Both products experience a high re-use rate, the manufacturer says.

Greenstreak
Circle 245 on information card
Symons
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Architectural Dimming Controls For Interior Lighting Systems

The past three to four years have seen several innovations of note in the architectural lighting field: miniaturization of equipment, new lamps, and new forms of control all have contributed to the lighting industry's continued sophistication. A new series of architectural lighting controls, or dimming systems, was developed by Lightolier.

While there are other forms of "control" in the lighting world—such as energy controls—dimming control has achieved enough sophistication in the past 12 to 18 months to make lighting designers, architects, and interior designers sit up and take notice. For the most part, architectural lighting controls combine function—getting the space lit at the proper level—and esthetics—choosing a pleasing light level. Because many rooms demand a changing level of light, such as a conference room or dining room, dimming has long been a part of most contract, and even many residential, projects. Previously, dimming systems were custom designed. Now, the new Lightolier control systems, called Scenist and Lytemode, provide user-friendly, off-the-shelf systems that accomplish the same end results with considerably less headache.

According to Gil Guttentag of Lightolier, the new systems—which were introduced in February 1987—offer consistency, ease of operation, and a net savings of up to 30 percent. By packaging the two systems in standard four (Scenist) and eight (Lytemode) channel controls, the manufacturer has simplified the specification process. Guttentag likens the systems to standard Japanese cars that come "complete with the works—you might not want it all, but it's all there for a standard price."

The system works, basically, like this: four independent dimmers, or channels, are combined (in the Scenist system) into one master unit that can be installed into a standard four-gang wallbox. This allows the unit to be retrofitted into existing installations, as well as specified directly for new construction. The control panel enables you to select and preset the dimmer intensities into four different scenes, each of which can then be activated by the touch of a button. For a restaurant interior, for instance, management could establish light levels for breakfast, lunch, cocktails, and dinner, preset these intensities, and shift from level to level at the appropriate time by touching only one button.

According to architectural lighting designer Craig Roberts, principal of his Dallas/Beverly Hills firm Architectural Lighting Design, the Scenist System "can be worked with easily and added to when necessary—it's all a matter of load." Roberts, who has specified the system for offices, restaurants, residences, and other commercial projects, reports that, while he does not feel the larger Lytemode System is unique, the Scenist System does offer special—and very welcome—dimming control. "The development of this system is going to open up a whole new area of dimming control," says Roberts.

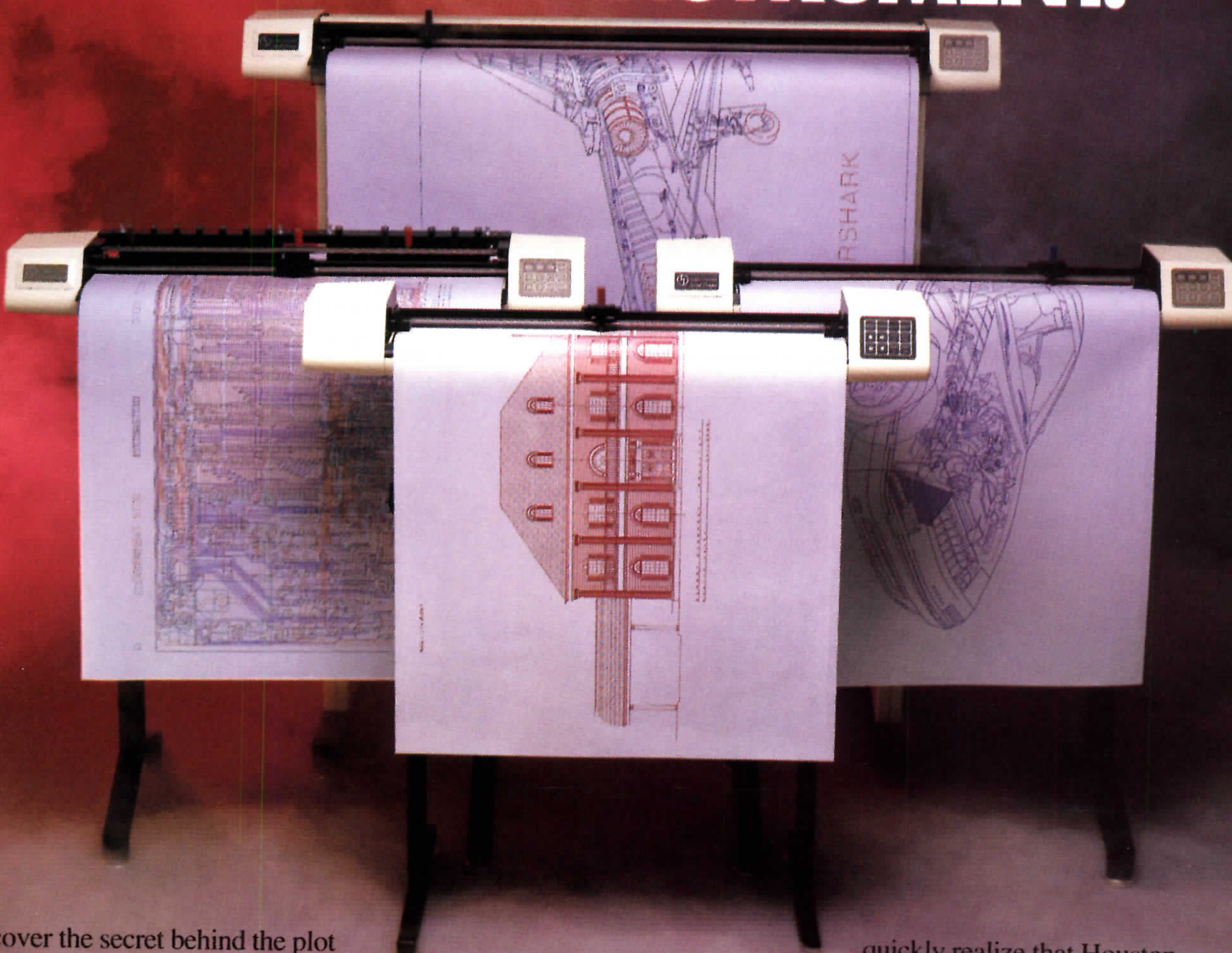
Because the system's memory controls are self-explanatory, inexperienced users can operate the control panel. Each individual scene can be overridden for particular functions yet still be held in memory. Three different models of the Scenist System meet wattage requirements from 2,400-watt total capacity to 1,600-watt total capacity, and all can control incandescent, low-voltage incandescent, neon cold cathode, fluorescent, or general inductive loads.

As Roberts says, "We've always had very expensive, custom dimming; now it's off-the-shelf and easy to use, and it's also cost-efficient." With all of that, experts in the field agree that the whole area of dimming control for architectural situations is only going to get more sophisticated and more cost-efficient as other companies join the manufacturing fray.—BARBARA KNOX

Lightolier
Circle 270 on information card

Ms. Knox is editor of Lighting Dimensions *magazine, based in New York City. She writes frequently on lighting design topics.* *Products continued on page 146*

THE SECRET BEHIND THE PLOT: HOUSTON INSTRUMENT.



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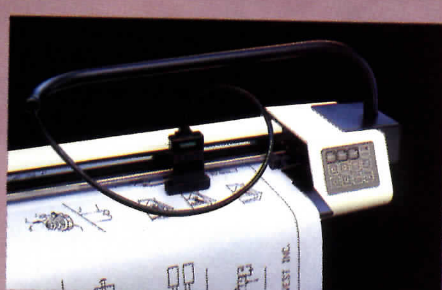

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Circle 46 on information card

Coated Low-Emissivity Glass Provides Thermal Insulation

Coated low-emissivity glass is formulated to reduce heat loss in winter and reduce relative and conductive heat gain in summer, while still transmitting visible light. In addition, the coated glass reflects outdoor long-wave infrared rays that re-radiate from driveways, rooftops, and other outdoor surfaces.

Glass coatings work by transmitting short-wave heat energy and light energy from the sun. Once the short-wave heat energy enters the house it is absorbed by objects and re-radiated as longer wave energy. The coating reflects heat energy and furnace-generated heat back into the house.

The transparent molecular coating is only a few hundred atoms thick, vacuum-deposited on clear polyester film, and mounted inside sealed insulating glass. This coating does not affect the appearance of the glass.

In the case of PPG Industries' Sungate glass coatings, the low-emissivity glass is transparent and not visibly reflective. Insulating windows with Sungate glasses are said to transmit almost 90 percent as much light as insulating windows with uncoated glass.

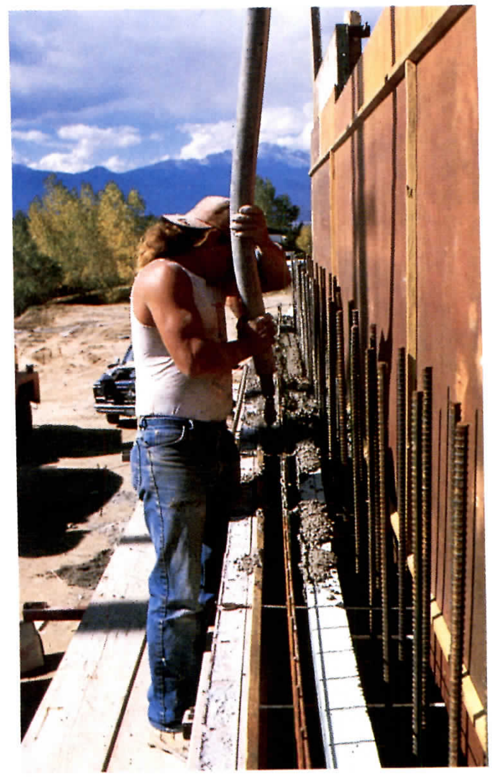
Heat Mirror low-emissivity glass from Southwall Technologies provides insulation and shading from direct solar heat gain without a dark or reflective appearance. Heat Mirror is a suspended film incorporated within sealed insulating glass by glass fabricators. This glass, particularly suited for cold-climate applications, is offered in four varieties, providing a range of solar control performance with high light transmission.

PPG Industries
Circle 241 on information card
Southwall Technologies
Circle 242 on information card

Insulated Composite Concrete Sandwich Wall System

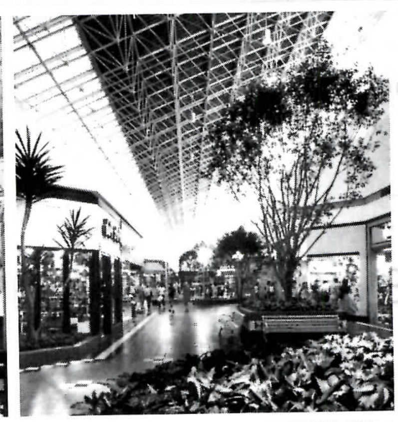
The Thermomass patented building system (right), constructs a composite insulated concrete sandwich wall in a single pouring operation. Low conductive pultruded glass fiber rods inserted in predetermined positions between layers of concrete and extruded polystyrene foam insulation board prevent heat loss, or "short circuits," through the sandwich wall because of the rod's low conductive composition and high-quality insulation. The rod ties the completed wall together and holds the insulation in place during the pouring operation.

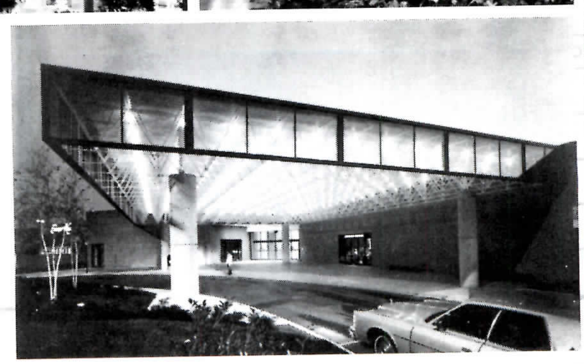
The flexible Thermomass system is designed for use in single-pour, pour-in-place, precast, and tilt-up applications.



No special tools are required to install the connecting rod and special molded snap-locks.

While most building methods construct walls in successive layers, this system enables a contractor to build a wall system complete with insulation and natural concrete finishes in one operation. This





system can be used with any type of forming system with or without form liners. Wall thicknesses are available in eight-inch, nine-inch, 10-inch, and 12-inch sizes. Insulation thickness is currently two inches. Three- and four-inch insulation thicknesses will be available this year. The insulation, which can be fixed at any location within the wall, uses a specially formulated and configured alkaline-resistant insulation board.

Finishes can include natural concrete, painting, skim coat plaster, or most other forms of concrete treatment. Other materials may be secured to the wall with concrete anchors.
Amoco Foam Products
Circle 269 on information card

Software for Graphics Display And Presentation Technology

Recent improvements in graphics displays and presentation technology are of interest to architects who employ computers in design and drafting. The advances have much in common.

The graphics display consists of a graphics controller board, which plugs inside the computer, and a monitor. They must be purchased as a set matched to the CADD program. Their capabilities have a significant effect on the productivity an architect can generate from a CADD program.

Presentation technology, the architectural application of desk-top publishing, is graphics-intensive because the users, mostly in the marketing department, must be able to merge CADD drawings, business graphs and charts, and typeset-quality text and headlines into documents including brochures, newsletters, and follow-up reports to presentation.

Here's what architects should consider in selecting graphics displays:

Compatibility with all current and anticipated applications.

Number of colors. Monochrome monitors have high resolution and low price, but most architects prefer to draw in color for both practical and esthetic reasons. The choice in color displays is between 16 and 256 colors. For drafting, 16 colors is satisfactory and less expensive. But for solids modeling and color rendering, a 256-color display will permit the monitor to display the drawing with acceptable speed.

Regeneration speed. Even within color categories, there are big differences in the speed at which the system will display the drawing. In making comparisons, the key test is to zoom in to see a portion of the drawing and then zoom out to display the entire drawing. With a big drawing, the difference between a fast and slow display may be measured in minutes.

Size of monitor. Architects, especially those responsible for reviewing drawings, often prefer 19-inch monitors so they can see large drawings in detail, without having to zoom in for close-ups.

Resolution. For 13-inch monitors, a resolution of 640x350 pixels is considered adequate. For 19-inch monitors, most architects prefer at least 1,024x768.

Price. Colors, speed, size, and resolution are expensive. Displays costing less than $1,000 are not likely to be good values. Having it all, though, may cost more than $6,000. An even tougher issue than cost may be compatibility. New generations of programs and controller cards are being issued so fast that it's becoming difficult to find a single display that will run everything.

The heart of a high technology presentation system is the computer program that integrates text and graphics on the screen and prints it out so that it looks as though it had been printed professionally. The key performance criterion has come to be known by the acronym WYSIWYG, pronounced "wizzy-wig." It means, "What You See (on the screen) Is What You Get (on paper)."

continued on page 148

Products *from page 147*

Apple dominates this market. The basic system consists of a Macintosh Plus computer, LaserWriter Plus printer, and a program called PageMaker by Aldus Corp., of Seattle. The hardware, with a 20-megabyte hard disk, costs $9,368 plus $495 for PageMaker.

Apple's weakness is CADD. Macintosh CADD programs are more than a year behind IBM-based programs. IBM's weakness is virtually everything else. But the gaps on both sides are closing.

On the Macintosh, CADD programs are improving rapidly.

On the IBM, Ventura Publisher by Xerox does a good job of merging text and graphics. And an IBM version of PageMaker that accepts Autocad drawings in ADI format was released Jan. 30. The problem is that PageMaker runs in the Microsoft Windows operating environment, and rather few graphics displays will work with both Windows and an IBM CADD program.

One of the newest high-resolution graphics displays is the Nth Engine by Nth Graphics, Austin, Tex. Its drawing speed is among the fastest and it permits the architect to move around the drawing and to zoom in and out as nimbly as if the drawing were on paper. The monitor also holds a bird's-eye view of the entire drawing in one corner of the screen, so the architect always has a sense of the relationship of the screen view to the whole drawing.

With a resolution of 1,024x768 pixels, Nth Engine is priced at $3,995 plus monitor. With a 640x480 resolution, the price is $2,995.

Its chief limitation is that it supports only 16 colors, making it much slower than 256-color boards for solids modeling. Further, Autocad and Versacad are virtually the only programs that support Nth Engine. It will not run PageMaker.

At the lower resolution, Nth Engine faces tough competition from another new graphics board, the Vega Deluxe by Video Seven, Milpitas, Calif. Its most important advantages are the speed at which it replaces the drawing on the screen and its broad compatibility. It works with most CADD programs and with Windows. List price of the board is $599 and it works with the Sony Multiscan and NEC Multisync monitors, which are priced at $895.

The Artist series by Control Systems of St. Paul, Minn., continue to be the most widely supported graphics cards with high resolutions of more than 640x480 pixels. Leading the line is the Artist 10, which runs with most CADD programs and Ventura Publisher, but it doesn't do Windows. It provides 256 colors at 1,024x768 pixels for $2,995 plus monitor or 16 colors for $2,495.

The Artist Transformer does Windows in 16 colors, but it will run only two CADD programs, Autocad and Cadvance.

Prices range from $1,095 to $1,695 depending on resolution and color configuration.

A new generation of 32-bit graphics controller chips will soon be introduced. Vermont Microsystems' Image Manager boards are among the first to use it. Model 640 is priced at $1,695. Model 1024, at $2,995, is still one of the few high resolution boards supported by Windows because it is designed for publishing and video compatible graphics.

The next generation of graphics boards will have the power of the new chips and the speed of the Vectrix PePe board.

Still more graphics power in the form of video imaging is being made available now. AT&T's new Targa 16 video board with True Vision software can capture images from a home video camera and permit the architect to superimpose a model of a building. A library of supplementary video symbols is available from ArchSoft, the San Francisco architectural firm that developed the first architectural template sold by Autocad. Prices are $2,995 for the board, $1,250 for the software and $895 for the symbols.

—Oliver Witte

Aldus Corp.
Circle 247 on information card
Apple Computer
Circle 248 on information card
ArchSoft
Circle 249 on information card
AT&T
Circle 250 on information card
Control Systems
Circle 251 on information card
Nth Graphics
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Vermont Microsystems
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Video Seven
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Xerox Corp.
Circle 255 on information card

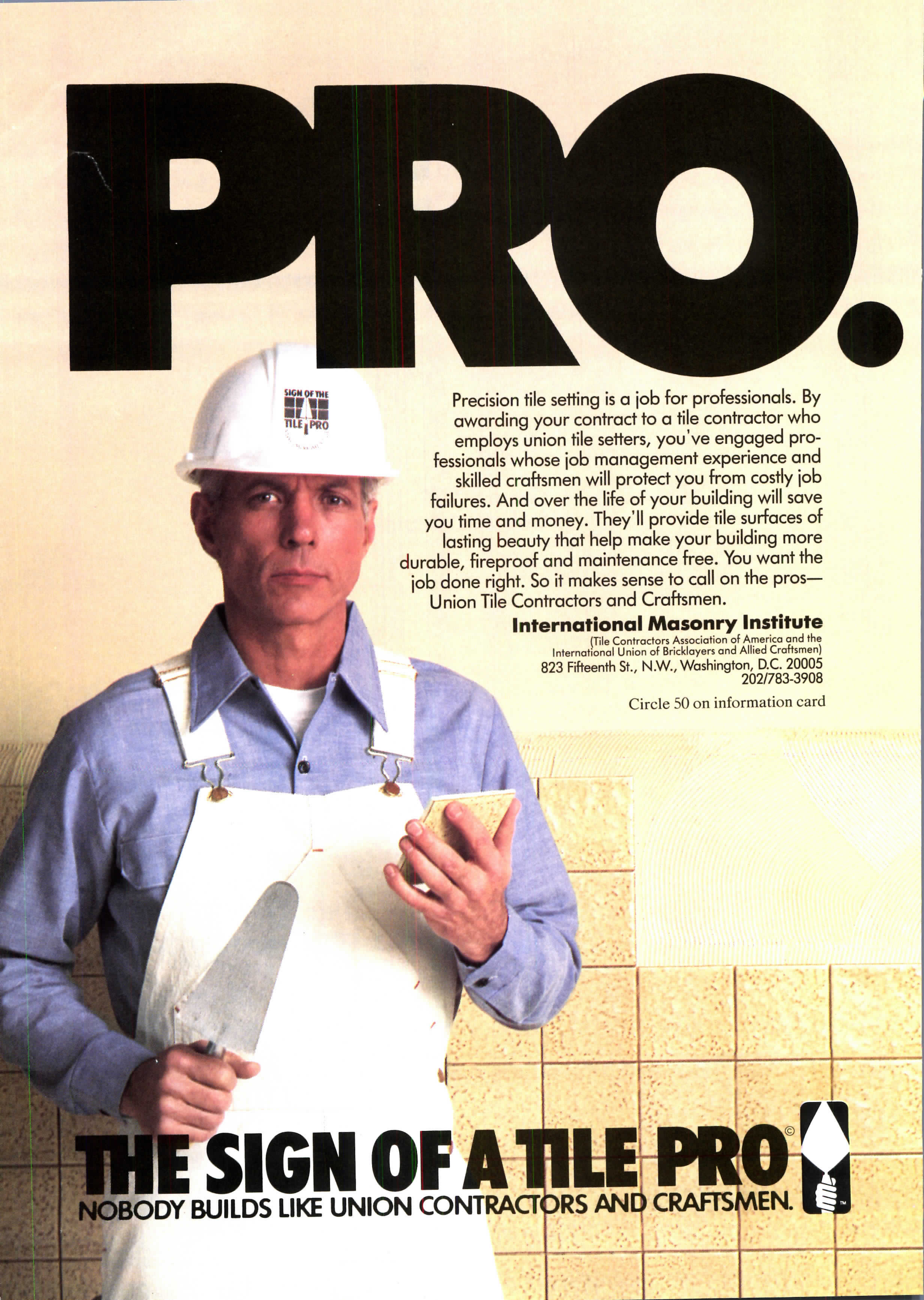
Potpourri of Other New and Innovative Products

• RADVA Thermastructure panels combine the strength of metal and the insulating properties of expanded polystyrene to create load-bearing, self-insulating panels that serve as exterior and interior wall, roof, and floor components. The building element accomplishes framing, insulation, and sheathing in a single step.

Thermastructure panels nominally weigh 45 pounds and are assembled with ship-lap joints and self-tapping metal screws. Panels are presized, square, straight, and stable to allow connection on site.

A typical 4x8-foot panel, 3½ inches thick, takes the place of a 2x4-inch stud wall system. In addition to standard sizes, panels can be customized in shapes and sizes to meet any requirement, and panel

continued on page 151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Products *from page 149*

properties can be adjusted for added load bearing strength and insulation levels. The panels are compatible with standard building materials, including wood or metal trusses.

Windows, door openings, and electrical conduits are premolded into the panels, so that an entire wall can be raised at once. When erected, the Thermastructure systems can be covered with almost any roofing, siding, or interior finish available.

RADVA
Circle 268 on information card

• Dur-Rex electrostatic powder coatings (below), provide a finish where long-range protection of material, construction, and functional parts is crucial, such as aluminum extrusions and claddings for outdoor architecture.

The coatings have no solvents or volatile components in their makeup. They are made by applying electrostatically charged polymeric powders to the surface of a conductive, grounded substrate, usually steel or aluminum, by means of a spray gun. When the coated substrate passes through a hot oven, it fuses to convert the separate powder particles into a cohesive, continuous coating. This fusion simultaneously causes the coating to harden by the chemical reaction between the binding agent and the hardener which are constituents of the powder particles.

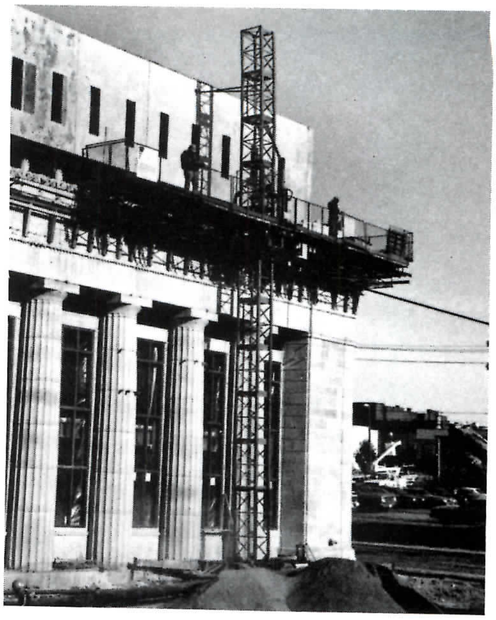
Revere Extruders
Circle 267 on information card

• Access Engineering, U.S.A. Inc.'s Satellite Elevating Work Platform (top right), uses twin electric motors to drive a platform up and down a single mast. Capable of carrying a four-ton payload of people and material, the platform has a free-standing height of 32 feet and is capable of attaining heights of over 350 feet with standard attachments. The mast of the system must be tied to the structure every successive 26 feet for optimum safety and stability.

The Satellite platform measures 40x40 feet and may be extended to 50 feet. Several systems may be combined at a single site without interfering with one another. Enclosed by a steel mesh fence, the platform can be lowered at the rate of 24 feet per minute for resupply.

A pull-wire safety switch is fitted under the platform for the protection of workers standing below the platform. Once the platform is in motion, an audible alarm and flashing beacon are engaged. The main connector cannot be energized unless the gate of the platform is closed and secured. For optimum security at night, once the day's work is complete the platform can be raised to an optimum position, limiting access only through the mast itself.

Access Engineering
Circle 266 on information card □



CREDITS

Tri County Transit Passenger Terminal, Orlando, Fla. (page 80). *Architect: Architects Design Group, Winter Park, Fla.* Structural engineer: Don Moe Engineering. Mechanical and electrical engineer: GRG Consulting Engineers. Landscape architect: Herbert Halback. General contractor: Gulf Seaboard General Contractors. Ceiling surfacing system: Armstrong, Atlas Aluminum. Doors: Architectural Openings. Environmental control systems: WeatherKing. Floor surfacing: U.S. Ceramic Tile, Armstrong, Stratton, Brick & Tile. Foundation: Florida Rock Corporation, Coastal Caisson, Drill Co. Lighting: Day Bright-Holophane, JM-NLCORP-KIRLIN, Polymer Plastic, GE Silicone. Caulking: Tremco. Flush valves: Sloan. Plumbing fittings and showerheads: American Standard. Toilet stalls: American Sanitary. Tubs and lavatories: American Standard. Water closets: American Standard. Water fountains: Elkay. Lockers: List Industries. Public address: Dukane-Soundolier. Signage: Colite Industries. Wall surfacing: Devoe-Reynolds, Mab Paints. Hardware: Yale, McKinney, Schlage.

Jacob K. Javits Convention Center, New York City (page 92). *Architect: I.M. Pei & Partners, New York City.* Partner in charge of design: James I. Freed, FAIA. Partner in charge of management: Werner Wandelmaier, AIA. Associate partner in charge of design: Charles Young, AIA. Associate partner in charge of technology: Michael Flynn. Senior associate/project architect for design: Thomas Baker, AIA. Senior associate/project architect for management: Robert Milburn. Senior associate/resident field architect: John Coburn. Project design team: Beatrice Lehman, AIA; Perry Chin; William Rowe, AIA; Andrej Morawski; Peter X. Ksiezopolski; Walter Patton, AIA; Raymond Searby; Kevin Montgomery; Kirk Conover; Philip Toussaint; Julie Salestrom; Robert Jefferson; Jeffery Rosenberg. Plaza design team: Vincent Polsinelli; Robert Hartwig; Richard Gorman; Michael Moore; Jennifer Sage; Steve Yablon. Associate architect: Lewis, Turner Partnership. Structural engineers: Weidlinger Associates and Salmon Associates. Mechanical and electrical engineers: Syska & Hennessy and Pierre A. Dillard. Additional Consultants: Rolf Jensen & Associates; Jules Fisher & Paul Marantz; Travers Associates; Robert Schwartz & Associates; Cerami & Associates. General contractor: HRH/West-King. Exterior walls: Cupples, Kenvil Newcrete. Roofing: American HydroTech. Performed flashings: American HydroTech. Skylights: Nab/Fisher. Doors: Flour City, Emco, McKeon, Crane. Glass: PPG. Ceilings: Armstrong. Partitions: U.S. Gypsum, Industrial Acoustics. Toilet partitions: Flush-metal. Paint and stain: Con-Lux Coatings, Tnemec, U.S. Paint, Surface Protection Industries. Wall coverings: Scalamandre. Plastic laminate surfacing: Wilsonart, Formica. Tile: Vanderlaan Tile, U.S. Ceramic, Hastings. Flooring: Endura. Floor treatment: AntiHydro. Carpet: Milliken, Magnan/Port Morris. Signage: Letterama. Bathroom and washroom accessories: A&J. Stage equipment: Hoffend, I. Weiss & Sons. Water chillers: Aerovent, Acme, N.Y. Brower, Peerless Electric. Refrigeration condensers: Carrier. Cooling systems: Baltimore Air Coil. Furnaces: Liebert. Pumps: Weinman. Air filters: Cambridge, American Air Filter. Air curtain systems: Berner-Miniveil. Insulation: Certain-Teed. Sound attenuators: Titus, Industrial Acoustics. Vibration control: Peabody, Vibration Mountings. Air grilles: Titus, Tuttle & Bailey. Wall and unit heaters: Berko. Roof ventilators: Loren-Cook. Control systems: MCC Powers. Mixing boxes: Titus, Tuttle & Bailey. Heat pumps: American Air Filter. Hot water heaters: Paterson-Kelley. Water closets: American Standard, Sloan. Drinking fountains: Filtrine. Tubs and lavatories: American Standard, Speakman. Plumbing: Victaulic, Allis/Chalmers, Sylvania, OS&Y Kennedy, Grinnell, Viking, Reliable, Central, and Crocker Standard. Electrical system: Westinghouse, Leviton, Midland Ross. Lighting fixtures: Omega, McPhilben, Lightolier, Kim. Communication/intercom: AT&T, MCC Powers. Reinforcement system: Altel. Elevator doors: Tyler. Moving stairways: Otis Elevator. Passenger elevator cabs: Parkline. ☐

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Books *from page 122*

Goodbye History, Hello Hamburger. Ada Louise Huxtable. (The Preservation Press, $14.95.)

Vintage Huxtable, this. And all the better for concentrating this selection of recycled pieces from the New York *Times* 1963-76 on the single theme of historic preservation. These are not "today's words for wrapping tomorrow's fish" but a reminder of Huxtable's strength deriving from her considerable background of graduate study at New York University, Fulbrights and Guggenheims to study in Italy, curatorial staff of the Museum of Modern Art, and much writing in architectural history. To these must be added direct efforts toward historic preservation long before her position at the *Times* amplified her influence, and honorary degrees and awards by the score affirmed her as the doyenne of architecture critics.

Increasingly it has been her larger concern with the city that has distinguished Huxtable's writing. Her earlier collection, *Will They Ever Finish Bruckner Boulevard?* subtitled "A Primer on Urbicide," commenced with a section "New York, The Death Wish City" and offered as its initial article "Death by Development." It proceeded to reflections under the heading "How to Kill a City" before the ultimate conclusion that historic preservation was a last best hope for the changing city. Five years later her second collection, *Kicked a Building Lately?*, came down with equal vigor on large, faceless commercial buildings and their displacement effects but emphasized the importance of well-designed new buildings and preservation as incentives to urban vitality.

The title of the present volume comes from an article in *Kicked a Building Lately?* that started the section titled "Failures."

All this is part of what Huxtable herself has called "a sustained wail" chiefly reflecting the degradation of Manhattan's quality of life, a view widely shared but also joined with many countervailing measures. If these more positive aspects seem to predominate in *Goodbye History, Hello Hamburger,* it may be due to the relaxation of the pressures of daily journalism that has accompanied her receiving the MacArthur prize, the initial five-year respite product of which would appear to be a book, *Architecture Anyone?* In these as in the work of no other contemporary critic, Huxtable has directed attention to the right questions (whatever one thinks of her answers) and has shown that they are durable themes of architectural concern. The skillful organization and editorial arrangement that allows them to be read as a continued narrative is no small part of their value, not to overlook some extraordinary photography.

From the wealth of subjects that invite comment I choose the essay on monuments, written originally as a review of an exhibition on the subject but used by the author as a vehicle to raise more fundamental questions of continuing interest. Acknowledging exceptions, such as the Fosse Ardeatine in Rome, Huxtable concludes, "The fact is that the emotional, intellectual, and spiritual climate of the 20th century has changed so much in response to a radically changing world that the familiar memorial is an anachronism. The great memorial era really ended with the Victorian Age." But these strictures do not exclude Maya Lin's Vietnam memorial, a photo of which illustrates the essay.

Huxtable's analysis of the 1970s effort to design the AIA headquarters building, flawed by minor errors of fact or misunderstanding, has nevertheless a sureness of direction and a rightness of conclusion that is typical of this critic. Her belief that AIA "should and could have stood firm, without compromising its belief in the review board function" and "could in fact have helped to clarify that function constructively" is an opinion of lasting significance.

These more immediate topics are less representative of the book as a whole than Huxtable's treatment of run-of-the-mill preservation issues such as the first commercial historic district in Salem, Mass., the destruction of Frank Lloyd Wright's Imperial Hotel, Philip Johnson's project for the extension of the Boston Public Library, or the remarkable creation of a building for the New York State Bar Association out of three row houses adjacent to the state capitol. As Huxtable tells it, the preservation of these architecturally middling but urbanistically significant row houses occasioned a marshalling of many preservation interests. A classic case for historic district preservation resulted, to which the Bar Association and its architect, James Stewart Polshek, FAIA, responded successfully. "The result is a demonstration project of how to use the past without turning it into a charade and how to extend its fabric functionally into the 20th century for the best kind of living environmental continuity." Like much else in this book, this account of what happened in 1968 is still an apposite lesson today.

Of the many issues to which she responds, that of architectural continuity is probably the most characteristic and valuable in Huxtable's writing. Now absorbed in the larger question of context, it serves to remind us that, as in so many cases, "Huxtable Was Here."

—Frederick Gutheim, Hon. AIA

Mr. Gutheim is a critic, author, and teacher in Washington, D.C.

Indoor Air Quality and Human Health. Isaac Turiel. (Stanford University Press, $24.95.)

This book is a primer of the problems of indoor air quality and human health. Its value is that it presents its case in simple, direct terms. It describes the hazards that could lead to litigation when air quality is ignored, which seems to be an embarrassing time and place for designers to discover that there is proof of the dangers of toxic indoor air and that this proof is in the hands of lawyers.

The concept that buildings, particularly sealed buildings, are no longer shelters but instead life support systems is not at present of great interest in the building design/delivery system. In contrast, developers, real estate investors, and building owners, who pay for air changes, are vitally interested and prefer as few of them as possible.

As yet there are no laws that say a person has a democratic right to breathe building air that has not been breathed several times by others. There are standards that set the amount of allowable pollutants in the air, but these are often contested and usually ignored. They are disregarded pending "more reliable data." We simply lack enough documented deaths to take air quality seriously.

But we do know that there are "air handicapped" people who can tolerate less pollution than others. Environmental Protection Agency studies have documented that there are people who have been forced from employment because they could not survive the pollution of their workplaces.

The causes of many building occupants' complaints have not been definitely established. Evidence suggests that the complaints are prompted by irritating and toxic gases released from modern building products, furnishings, and equipment, by microorganisms bred in or entering through the building ventilation system, by new lighting sources, by odors and gases that build up in indoor air because of inadequate ventilation. Then there are the everyday domestic problems of cooking with gas, wood and wood stoves, space heating, and kerosene heaters. These building sicknesses, residential and commercial, have many common features and have been reported in Scandinavia, Canada, Europe, and the U.S.

The world of chemicals and the dangers of hobbies, painting, pesticides, fabric cleaners, and air fresheners that either deaden the ability to smell or mask odors have off-gassed a carcinogenic ambience in which people are being internally rotted.

Major advances in building materials since World War II have been in the realm of plastics. The major concern of fire fight-

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Books *from page 155*

ers is not flames but toxic fumes that kill them and building occupants in strange and exotic ways. But no school of architecture, to my knowledge, requires a course in basic chemistry. The ghost of asbestos and its unpredictable dangers and present horrors hovers between the lines of this book.

We have become interested in daylighting, handicapped access, and solar energy ad nauseam and tend to dismiss Legionnaires' disease as a venereal infection. We know almost nothing of photochemical smog, carcinogens, particulates, radon, and all the other fanciful airborne killers.

There are draftsmen, architects, builders, engineers, ladies with funny hats, and men with colorful cummerbunds who specified asbestos for years, little dreaming of the havoc it would wreak in today's buildings. The same may turn out to be true of the host of airborne contaminants listed and described in this book.

—FORREST WILSON

Manual of Seismic Design. James L. Stratta. (Prentice Hall, $38.95.)

The need for architects to have an understanding of seismic design is assuming more importance. While events such as the 1985 Mexico City earthquake show the lethal characteristics of some modern buildings under severe earthquake forces, the increasing realization that seismic design starts with the architectural concept emphasizes that the architect must share responsibility with the engineer for seismic performance. In the U.S., earthquakes are now seen as a nationwide, rather than a West Coast, problem, and the rise of national and international design firms means that no firm can guarantee that its work will always be built in non-earthquake country. So knowledge of seismic design must be part of the knowledge of the fully professional architect.

For those who are uneducated or rusty, the *Manual of Seismic Design* would be a good place to start. The title is really a misnomer, suggesting a dry guide book filled with engineering formulas and details. The book is quite different: the author is the recently retired principal of a prolific California architectural and engineering firm, and the content of the book is very much geared to things that practitioners should know. The tone is that of the structural consultant talking to an architect or facilities manager: it is down-to-earth and interesting, and condenses a lifetime of professional experience. It is opinionated—as is any good consultant—but the opinions are always carefully backed by experience or a clearly expressed rational argument.

James L. Stratta has been a diligent earthquake chaser, and so the first chapter takes the reader to a number of earthquakes and demonstrates what has been learned from these events. From this, the author goes into how lateral forces are determined and how they are resisted. This is done with a small amount of elementary statistics that any architect should be able to handle. The author then goes into the seismic design of examples of simple one- and two-story structures. While there is some computation in these examples, it is used to clarify and quantify issues, and is really helpful.

The book focuses throughout on the design problems of one- to three-story structures, including residences. Simple details, mainly in wood and masonry, are developed and explained. The important topic of ductility in reinforced concrete frames rates an entire chapter, and the now important subject of the retrofit of existing buildings is well discussed. Building contents and nonstructural items are surveyed, with excellent damage photographs, and some specific issues of vertical acceleration, circulation dangers, bridges, landslides, and liquefaction are also reviewed.

Finally there are chapters on how to keep up with new research and how to organize the design team to ensure that

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Books *from page 156*

the full range of today's problems is dealt with. In this, the author draws on his considerable recent experience as witness and consultant on building failures.

The book is right up to date—lessons are learned from the 1985 Chilean and Mexico earthquakes. There are interesting discussions on traveling waves and their possible effects on buildings, and on some of the newer ideas on why certain sites, or even parts of sites, seem to be subject to unusually rigid forces, resulting in apparent anomalies in the building damage pattern.—CHRISTOPHER ARNOLD, AIA

Mr. Arnold is president of Building Systems Development Inc., San Mateo, Calif.

Drawings from the Le Corbusier Archive. Alexander Tzonis and H. Allen Brooks, eds. (*Architectural Design Profile 60*, Garland Publishing and Fondation Le Corbusier.)

This thoughtful sampling of the Le Corbusier Archive is a fascinating tip of a uniquely massive and dense iceberg. Thirty-two volumes were required to present more than 32,000 drawings in the full Le Corbusier Archive, making it the largest of the Garland architectural archives published to date.

The density of the totality of this icy mass is what is most striking, even as demonstrated by the random sampling selected by Alexander Tzonis. To initiate the analysis of Le Corbusier's thinking, creativity, and accomplishments, the full Garland Archive includes 17 essays by scholars who have begun the study of this many-faceted genius. Four of these are included in the volume under review.

As with any iceberg's tip, such a sampling is bound to be tantalizing, even frustrating. Some of the essays have number references to drawings in the archive not chosen as illustrations for this reprinting. For example, in Kenneth Frampton's carefully analytical study of "The League of Nations, the Centrosoyus, and the Palace of the Soviets, 1926-31," 24 drawings are reproduced but 113 more are referred to by their foundation archive number, to be seen there and in the full Garland publication. Even with this impediment, it is exciting to realize that the archive preserves a rich collection of drawings for many projects and the analysis of an extraordinary body of work. Clearly, Frampton has made excellent use of its availability.

Tzonis and Garland's general editor, H. Allen Brooks, have made a selection of essays that demonstrate a significant aspect of this form of archival presentation. They make manifest the dialogue taking place around the world between the observations and the theories developed by a surprisingly large number of Le Corbusier experts.

Bringing some of this dialogue together in this form stimulates the kind of understanding that Tzonis says is the phenomenon of "syncretism" in Le Corbusier's own work. His prominence in the development of architecture in this century is "due less to his adherence to a unique position than to his capacity to create an image of modern architecture through synthesizing the planning concepts and programmatic visions of many disparate groups and figures."

But Le Corbusier's was not, continues Tzonis, "a monistic and reductive tendency. On the contrary, like Stravinsky and Picasso in their respective fields, his approach was syncretic, that is to say uniquely polyphonic, universal, and inclusive, and, like the composer and the painter, he is both praised and condemned in the name of the modernity which he appears to represent."

—GEORGE A. DUDLEY, FAIA

Mr. Dudley is an architect, planner, and educator who now consults around the world. He is writing a book on the design of the United Nations Headquarters, for which he was secretary of the international board of design. □

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