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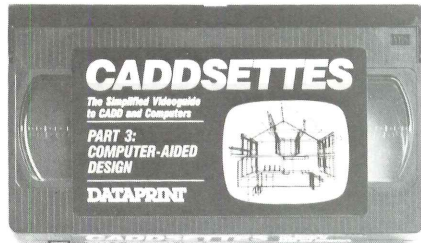
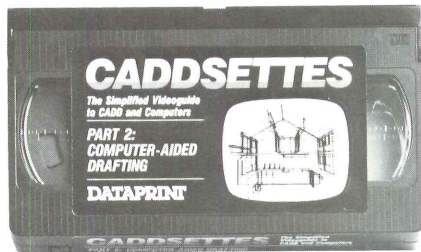
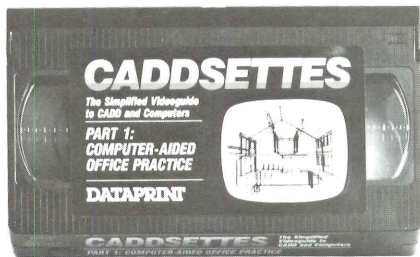
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Cover: With a burst of light, a welder connects wall panel to slab at 2000 K St., N.W., in Washington, D.C., an office building designed by Skidmore, Owings & Merrill, Washington, D.C.; developed by Farragut Development Company, Washington, D.C.; and contracted by Omni Construction Inc., Washington, D.C. Photograph by Stephen R. Brown.

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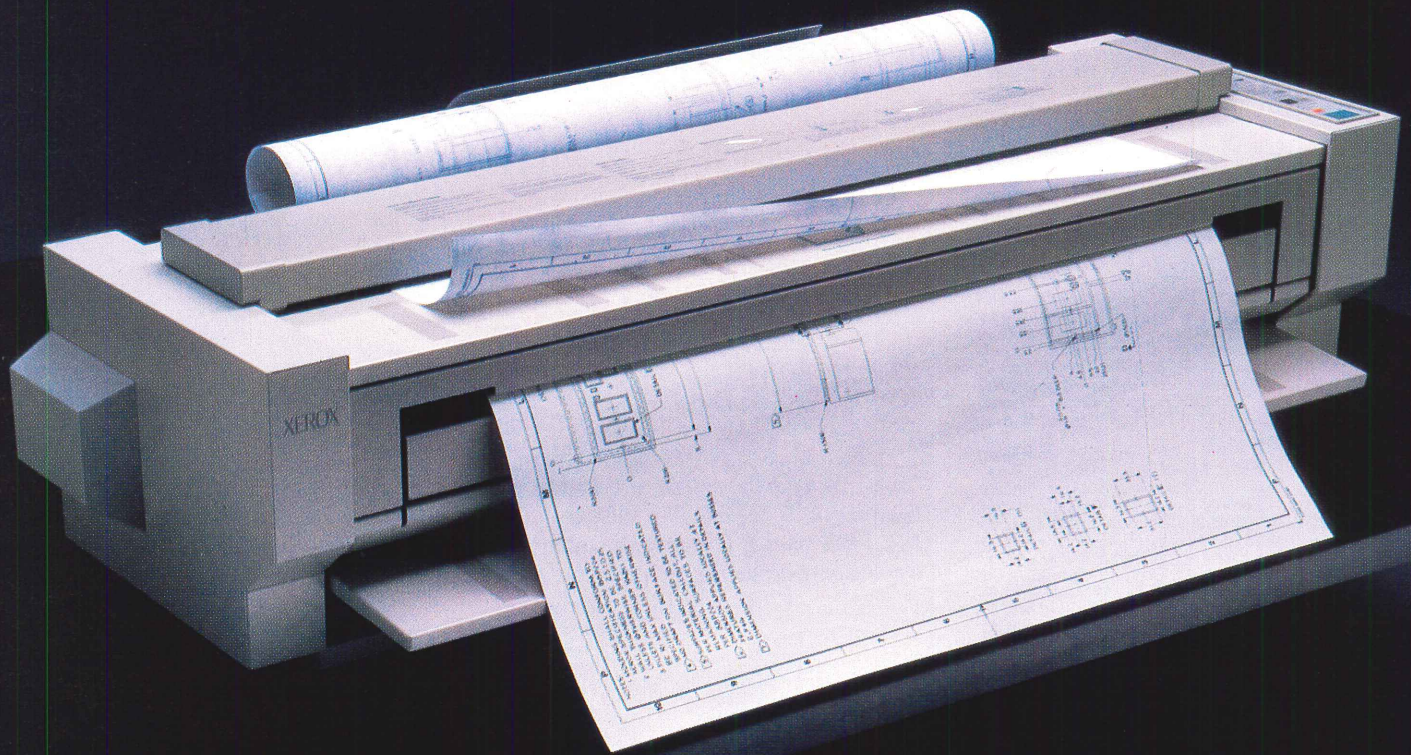
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MOST OF US, WHILE we were still in school, developed strong preconceptions about architectural practice. We learned to expect that every project would be an opportunity for us to create forms and spaces of lasting significance.

Real life isn't that way at all, of course, nor should it be. Every building program asks something different of its architect, and sometimes skills quite apart from design determine how well we do.

That being the case, it's not surprising that a form of specialization is emerging among architects that focuses not on building types or sizes, but rather on fulfilling programs containing certain priorities. For instance, many architects are particularly good at project management, and therefore excel at working with programs that pose complex construction or organizational challenges. Others can crank out routinized "plain Jane" structures with great efficiency—and given the fact that many clients want nothing more or less than that, there is a strong market for this service.

In light of these different approaches, "Charting Your Course," a feature story on page 52, is one of the most important articles on architecture firm management we've published. The story begins with the

assumption that no single organizational and managerial strategy can guide all firms, because "making architecture" can mean many different things. But once a firm decides to specialize in a certain "type" of practice, it can follow more or less prescriptive courses for delivering services in the best possible way.

Between the lines is an essential message: There is nothing more or less noble about any one approach. If our goal as a profession is to improve the whole of our built environment, some of us must be prepared to apply our skills to building assignments that focus on issues other than design. These assignments require another kind of architectural expertise, and the owners of these buildings would pay well for skills that are tailored to their specific needs, not to some vision of what their needs *ought* to be.

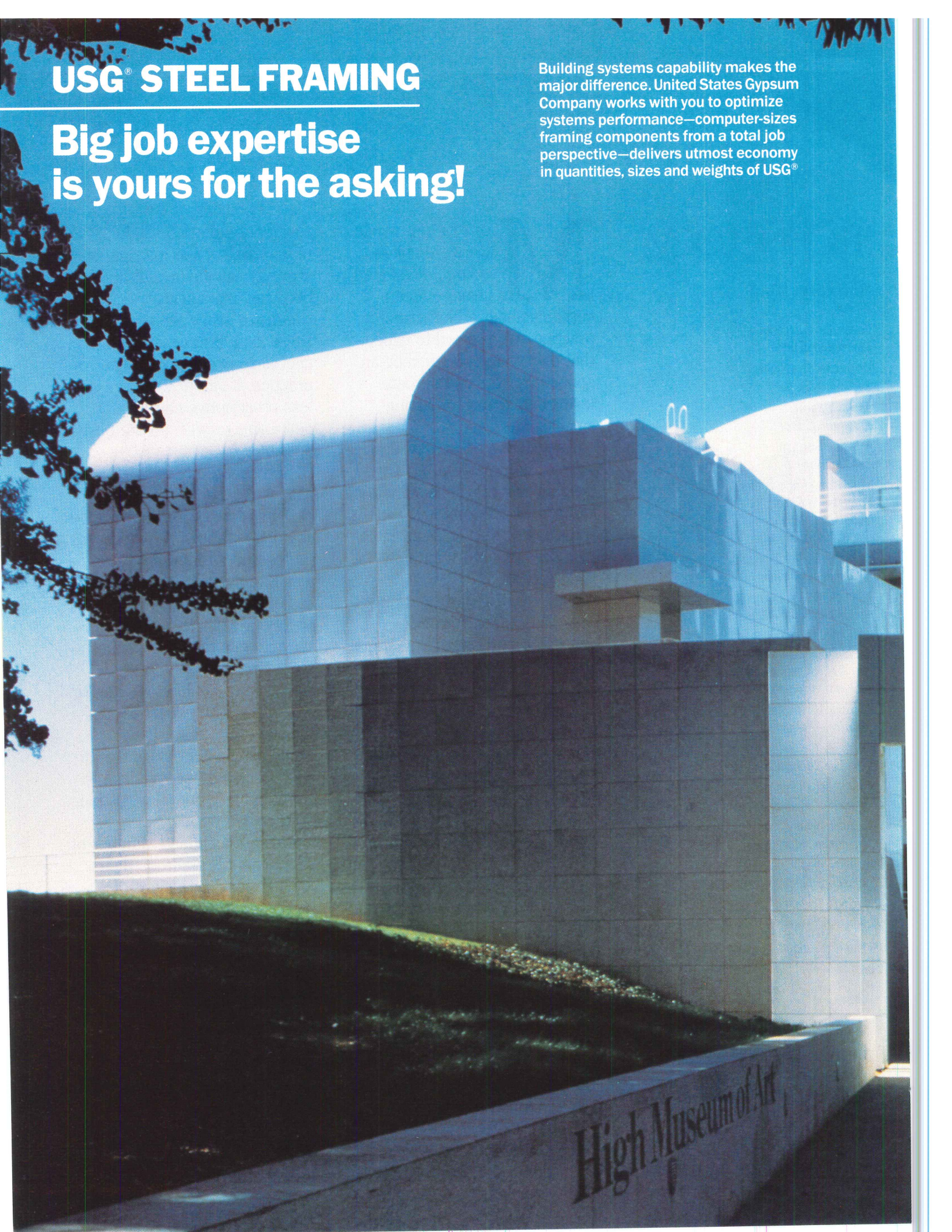
A disproportionate number of architects still embrace their original, singular visions of architecture. As a result, clients with altogether different visions look to other professionals to lead their construction projects. That's one reason architectural fees are declining. Worse, it's why too few architects participate in the design of many structures that, in the end, heavily influence the character of our environment.

—*Mitchell B. Rouda*

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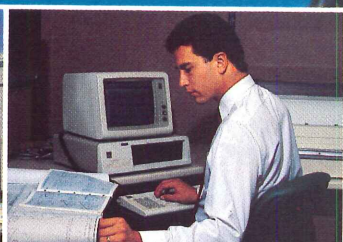
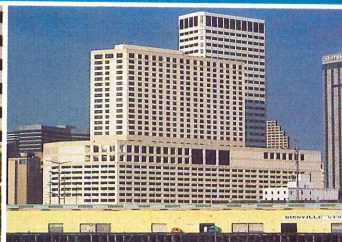
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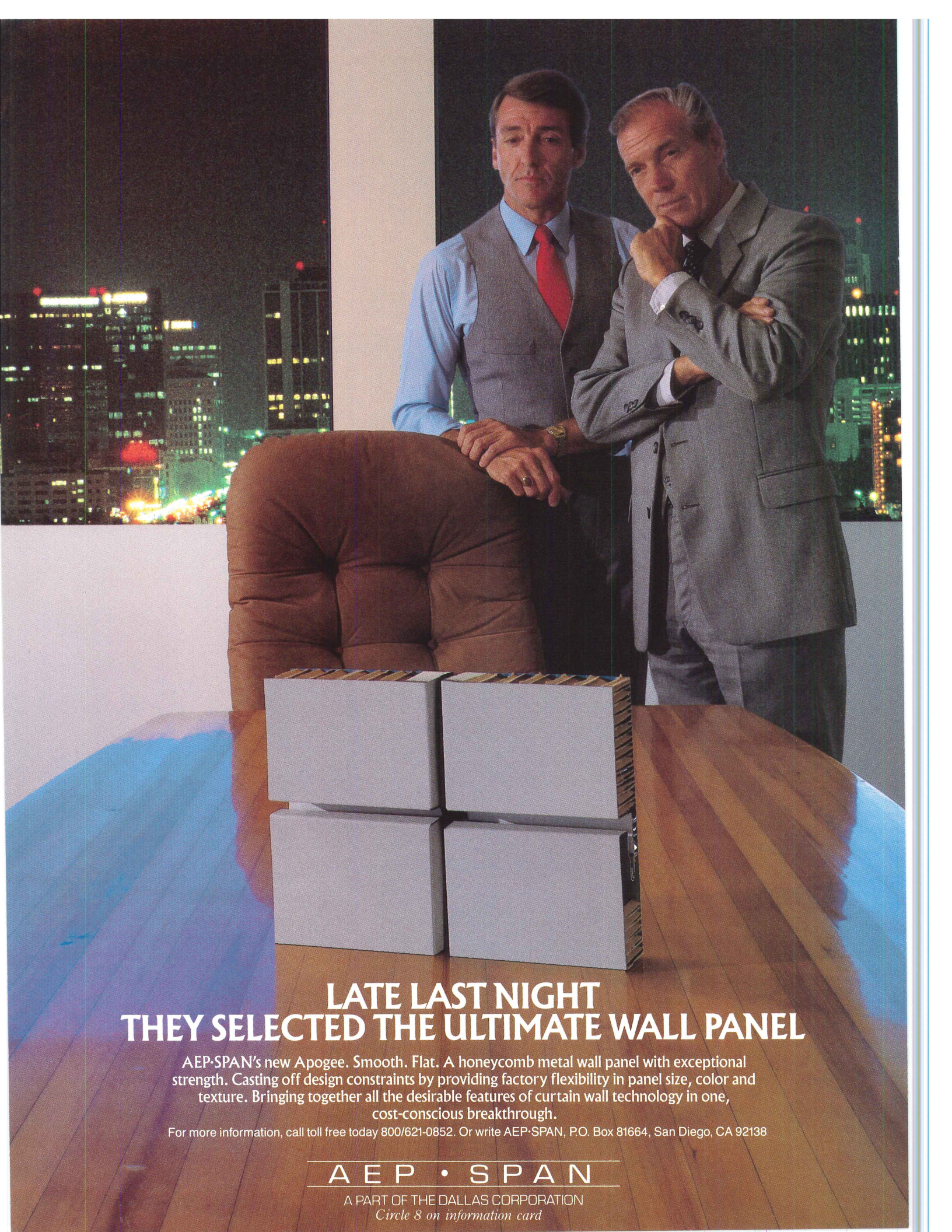


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WHAT IS THE CUTTING EDGE?

Last year, in an effort to develop a consensus among AIA Board members about important professional trends, Billy Herrin asked his fellow Board members to comment on "the cutting edge of architectural practice."

"The results were startling. It became obvious that the single greatest concern was making a living in the architectural profession," Herrin wrote in a Commentary published in the Fall 1985 issue of ARCHITECTURAL TECHNOLOGY.

Board members commented specifically about poor relationships with clients, cut-throat competition among firms, and fundamental problems with fees, bidding practices and the issue of liability.

In writing his article for ARCHITECTURAL TECHNOLOGY, Herrin extended his questioning to rank-and-file practitioners. About 130 readers responded. A sampling of readers' cutting-edge concerns, many that reinforce the Board's observations, and some that raise other issues, appears here.

Giving the profession away . . .

■ The cutting edge is the giving away of the profession to P.E.s, entrepreneurs, developers, spec writers, consultants, brokers, materials people, insurers, planners, environmental "designers" and anybody who wants a piece of the design effort.

Competition is not our enemy, it is our friend. We must keep united and look out for nonprofessionals using our talents, taking credit and giving us the shaft. Insurance is the tip of the iceberg! Code consultants are next!

It takes competence to get the leadership role back

■ The cutting edge in the practice of architecture is to recapture the leadership role architects traditionally had and then slowly abdicated over a period of 25 years. When we regain the "captain-of-the-team" position—through competence—our problems of fees, jobs, salaries, litigation, prestige and respect will automatically return along with the "fun."

■ The firm on the cutting edge is the one that can produce an award winner that is also energy-efficient and functions well. Many

COMMENTARY

IN SEARCH OF THE CUTTING EDGE

By WILLIAM W. HERRIN JR., AIA

What is the "cutting edge" of architectural practice? Just as in an interesting exercise to find out.

Since joining the Board of Directors of the AIA in 1984, I've been concerned about what issues are really important to architects. For without a clear consensus about trends, how are we to shape the organization's programs realistically?

Last spring, I asked other board members to share their own conclusions about the cutting edge of architecture. About a month before the AIA convention, I sent a note to each member. A few weeks above the bottom of the letter I typed a dotted line, that the one on this page. I asked the members to record their thoughts in the blank space and mail the comments back immediately.

The results were startling. As I wrote in a cover letter accompanying the report I later mailed to the Board, "It became obvious that the single greatest concern was making a living in the architectural profession.

Even more surprising, I felt, was what wasn't mentioned. Noticeably absent were comments pertaining to social responsibility, research, materials technology, production techniques and even the issue of post-construction design.

Clearly, as far as the AIA Board members, the cutting edge seemed to be the survival of the fittest. This issue included more than fees. The search for talented engineers, the liability situation, marketing and client relations also were mentioned.

The architects' survival of the fittest, as we mean that the Board isn't thinking about design. Rather, it means that our contention is that one—what saves them are all the obstacles in the way.

Terry Stankovic from New England writes: "Architects seem to be affected most by

badly-defined relationships with their clients. Instead of being respected team leaders, responsible for all aspects of a project's success, more and more we are being asked simply to supply the cosmetics."

And David Lawson, North Central region, wrote, "Architects are willing to cut themselves for a job."

Ray Francis from New England noted three trends: "A steep increase in bidding, an increase in clients holding design competitions for selecting architects, and a trend towards clients selecting architects, negotiating fees, and then, as a pressure strategy, for shopping for other architects not previously considered."

Don Heick, AIA vice president, school Florida, "We've turned down clients seeking fee discounts, but many others have not!"

From Ohio, A. Hedy Alford writes: "Selecting AEs via an unpaid competition is really a ruse for fee bidding with the added benefit to the potential client of getting sev-

eral size plus smaller fee of charge."

From St. Kenneth Bussard, Central States: "We need a value-based pricing system."

From Kenneth Wheeler, New Jersey: "A big concern here is the lack of competent manpower. Wages are going up and there's a lot of standing from other firms."

And Ray Crowder from the Northwest Region summed it up this way: "Architects of all ages and in all economic conditions tell me the fun has gone out of architecture. There's a sense of being worn down by new priorities, responsibilities and concerns."

Robert Okernast, California, wrote: "My liability insurance just rose by more than 100 percent. How can we get the word out that these increases force us to raise fees?"

Terry Stankovic added: "No single measure would save us if we were within five miles of a building site within five years either side of completion, whether we were the designers for the project or not."

There were additional comments on other issues, such as the increasing popularity of low-cost CAD systems, unusual CAD capabilities, smart bidding and environmental conservation strategies.

At the 1985 convention in San Francisco, we received to continue to discuss the "cutting edge" in every meeting.

One which came from a question by Ray Stankovic: "Is the AIA Board required?" He suggested that we include the rest of the members in our search.

Hence this article. Exploring the cutting edge in architecture is vital, if we are to understand ourselves as architects and be able to collectively defend our professional future. Break your chance to participate in the process! □

schools are producing "architectural artists" who have poor technical skills. We should teach design thoroughly. Lack of technical training is a major contributor to the decline of our profession.

■ How can an architect design a building if he or she can't conceive of the beam depths or doesn't understand the effect of orientation on the HVAC system? How can an architect be team leader without understanding the language the team is speaking? If society is asking us only to supply cosmetics, we are beginning to accede by learning cosmetics only.

Competition, fees and ethics

■ Admittedly, we all must compete for the finite number of clients available. How is it possible to confine that competition to quality and "value" architecture when the word "ethics" appears to stand only for an out-moded impediment to "good old American aggressive marketing"? I am in competition with firms a hundred times my size that are currently taking projects for 80 cents per square foot.

■ The main issue for our small firm of three architects is having to cut fees to a minimum to get the job and then having to provide more services than agreed to, in order to satisfy the client or to comply with the multi-

tude of complex, ever-changing codes. Combine this with rising expenses and professional liability insurance and the bottom line is long hours and hard work just to meet costs. Yes, the professionalism and fun are definitely gone from architecture for me. At age 44, I'm ready to switch professions.

■ How can small- and medium-size firms survive the high pressure "marketing" encroachments of the big "in house" offices?

■ Bidding for design services is a real problem that won't go away unless the AIA takes some serious action to stop it! Competition [shouldn't be] a kill-or-be-killed exercise.

Another problem has to do with getting more black minority design firms into the mainstream of the profession.

■ The cutting edge is when a recent Harvard architecture graduate designs a \$500,000 home for \$8,000. The fee should be .15 × \$500,000, or \$75,000. Doesn't Harvard have a program in business administration?

■ The architect's fee seems to be the most hated and despised expense of the project. The owners will do *anything* not to pay [it]. Without a firm hand by *everyone* attempting to make a living at architecture, the fee will continue to be thought of as incidental to the project, with payment considered an option.

■ I feel that all architects should be forced to charge the same fee for professional services. This would be to the architect's advantage because clients could not shop around for lower prices. (Realtors are united.)

Managing, to turn fees into profits

■ The cutting-edge issue seems to be rigorous management in order to have "profitable" projects. The time spent on all facets of each project *has* to balance the fee (or beat it) or we go out of business. Clients want (demand) to cut every corner, shave every line item and proceed with increasingly shorter schedules; and we are stretched farther than ever for fewer fee dollars.

■ Please refer to the *Commentary* in your Summer 1985 issue (page 11), "Why Architects Earn So Little," second column, second paragraph: "Most clients seek a professional *service* that manages the entire

process of creating a building." That is what I am offering clients—with great success, no competition and no fee cutting.

Costs of cutting corners

■ We continue to disappoint our clients by promising more than we can competently deliver in a given time frame. The intermediate result is obvious—what we deliver in haste, we repent of and pay for in many ways. The ultimate result is a diminishing number of "repeat clients," who are, after all, the hallmark of a successful practice.

■ Here in Austin, Tex., there is no question about the most serious issue confronting our local professional colleagues and their firms: SURVIVAL! Profitability is not even in question. Pricing has become a deterrent to quality control and increases the potential for liability suits, compounding the liability problem further.

■ The "cutting edge" starts with the highly competitive marketing of A/E services and the willingness to market fees. Having [cut] fees to perhaps a dangerously low point, we face the next question: How do we produce contract documents at a profit? Does time for coordination and checking suffer? Do shop drawings get a cursory look? Do we leave it to the fabricator to design the con-

nections? Do we look for shortcuts where none should exist or be invented? Finally, do we do all this knowing full well that today our society is a litigious one?

Those who berate the client for taking advantage of us miss the point. We are our own worst enemy. Until the profession learns to demand appropriate fees commensurate with the effort required, we will continue to suffer the "slings and arrows of outrageous fortune" hurled at us not only by our clients, but by our competitors as well.

Firm management

■ [Two concerns are cutting-edge:] Managing growth while maintaining quality control, and making a successful transition from a small- to medium-size office.

■ We want to bring in talent as partners to share risks, stay with the firm and work harder for the future of the firm. Our problem is how many chiefs can a firm have?

A multifaceted cutting edge

■ For our firm, which has five people and two principals, the main concerns are 1) dilution of control because of construction managers, 2) making CAD pay for itself, 3) finding *responsible, competent* help to get up

on CAD, 4) obtaining fees adequate to produce jobs responsibly and pay proper salaries and 5) SURVIVAL!

■ The key issues are (as usual!) 1) fair professional fees, 2) competition *without* throat-cutting, 3) *affordable* liability insurance and 4) higher awareness of what an architect is.

Insurance stranglehold

■ [The cutting-edge is] the cost of liability insurance! Do we tell clients our fees are going up because our insurance costs have doubled? Isn't that only going to encourage them to include us in a lawsuit at the first sign of trouble?

Professional esteem

■ The profession seems to be suffering from a well-deserved case of low self-esteem. When we act with competence and professionalism, the system will welcome us and treat us with the respect we so desperately seek. (Don't they train architects in school?)

Communicating what we do

■ We as a profession are not [telling] the general public, first, what we do, and second, what our problems are. Most members of the AIA are employed in small firms that lack the time and/or resources to launch a publicity campaign to explain what we do. I believe most AIA members would welcome support from the Institute in this area.

The second point is reflected in the fact that six out of 10 architects are being sued. I don't believe this is due to incompetence (in most cases) so much as to our clients misunderstanding our problems: 1) there is no perfect building, 2) there is no perfect set of drawings, 3) there is no perfect contractor and 4) the client needs to participate in the design process. The AIA should lobby for more legal protection for Institute members.

Professional values

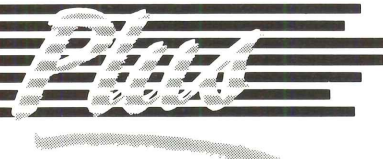
■ Traditional architecture is dead. I'm restructuring (designing) myself into a niche in the construction industry where I can use my very-hard-earned skills and talents to make money so I can have a respected business and a decent life-style.

■ What has become of the ethics of our once-respected profession? I'm almost ashamed to admit I am an architect who has practiced nationally! All architects talk about is computers and money.

I have retired as an "Emeritus" and dropped out of the AIA national committees

continued on page 12

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Probably no other installation could demonstrate the merits of this lighting system so dramatically.

Think a moment about every indoor swimming pool you've ever seen. The overhead downlights reflect on the surface, shimmering white spots that interrupt your look into the depths of the pool.

This pool has no bright spots of light. Look at the ceiling. No hot spots, shadows, or fixtures. It's as clean and even as the open sky.

Light comes from the two unassuming linear fixtures mounted along either side. They turn the whole ceiling into a single soft overhead light source.

A design plus: the unobtrusive fixture

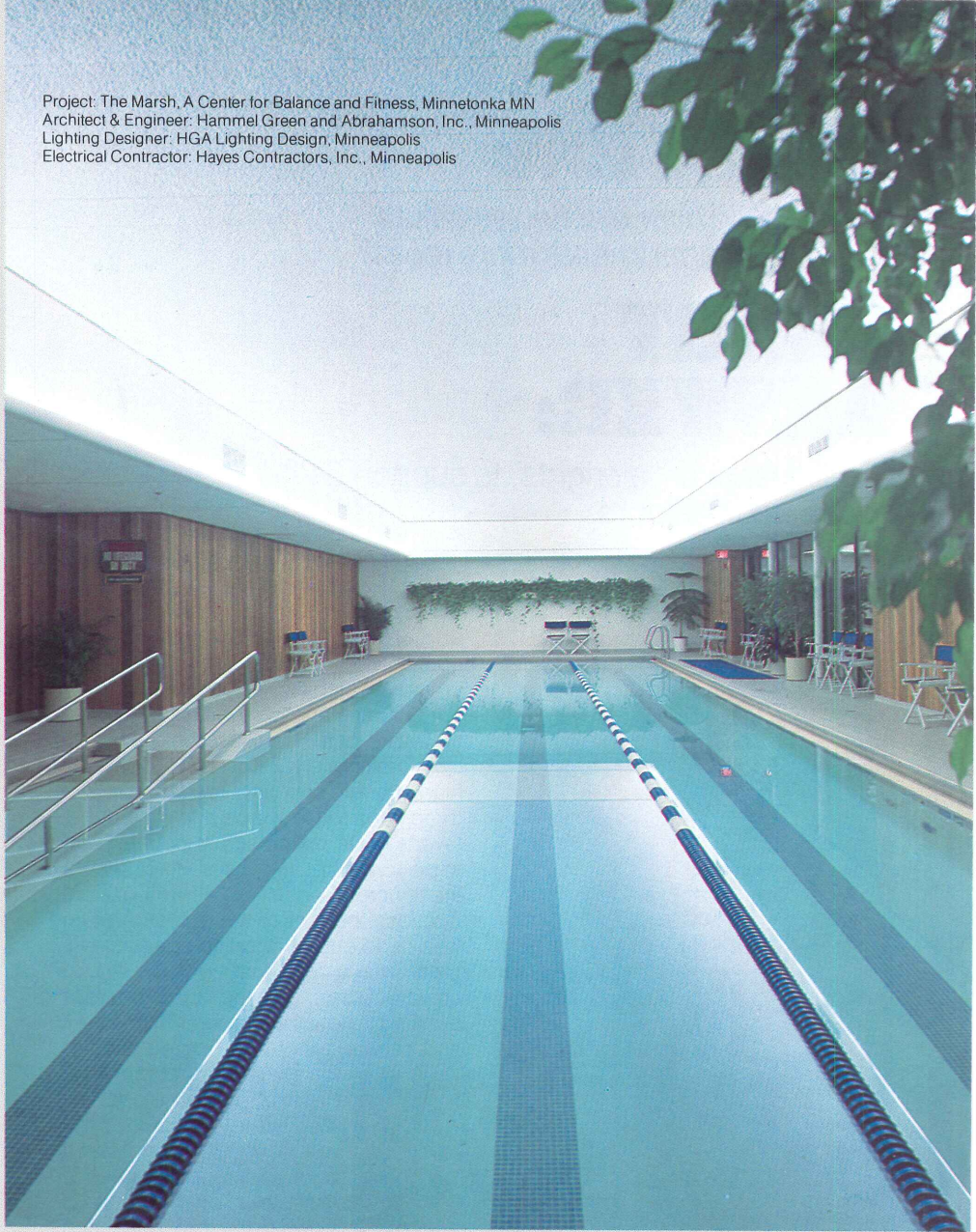
Designers have always liked cove lighting because it takes the emphasis away from the fixture. But it's usually "mood light," relegated to department stores, restaurants and lobbies. Until now, indirect wall-mounted fixtures have been too inefficient for serious lighting tasks.

The fixtures over the pool are 6" x 6" Rounded Very Wide Spread Softshine Indirect by Peerless Lighting. Softshine Indirect fixtures give more good light per watt under ceilings 8'6" or higher than any other fixtures made. Furthermore, they incorporate a strip of visible lens that increases their perceived illumination by 10% to 25%. Both these claims are substantiated by Peerless research data, including independent studies by major universities. All data is available from Peerless on request.

An obvious use: the featured space

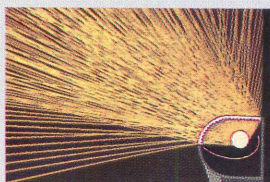
These fixtures belong in important places: reception areas, corridors, dining facilities, examination rooms, conference rooms.

Project: The Marsh, A Center for Balance and Fitness, Minnetonka MN
Architect & Engineer: Hammel Green and Abrahamson, Inc., Minneapolis
Lighting Designer: HGA Lighting Design, Minneapolis
Electrical Contractor: Hayes Contractors, Inc., Minneapolis



Nothing else gives the smooth illumination of a good ceiling wash. It's the best of all techniques when a room has reflective surfaces like polished tabletops or glass-covered artwork—or a swimming pool.

They offer cove lighting's chief virtue (they don't impose their personality on the space) and they give good light—enough for visually demanding tasks like research work on a lab bench or picking just the right piece of cake in the cafeteria.



The new cove light: great amounts of even, glare-free light, enhanced by the sparkle of a visible lens.

Research computers at Peerless generated this diagram to show how these Softshine Indirect fixtures work.

The fixture's lensed optics distribute the light facet by facet into precisely the right viewing areas. These remarkable fixtures can wash an entire ceiling when they're mounted only 30" below and as much as

24' apart, as the swimming pool picture proves.

A ceiling like this reflects as a soft, barely noticeable veil, as on the pool's surface. The same holds true for any other surface that reflects, such as the waxed floor in a hospital corridor or a glass-topped sales counter.

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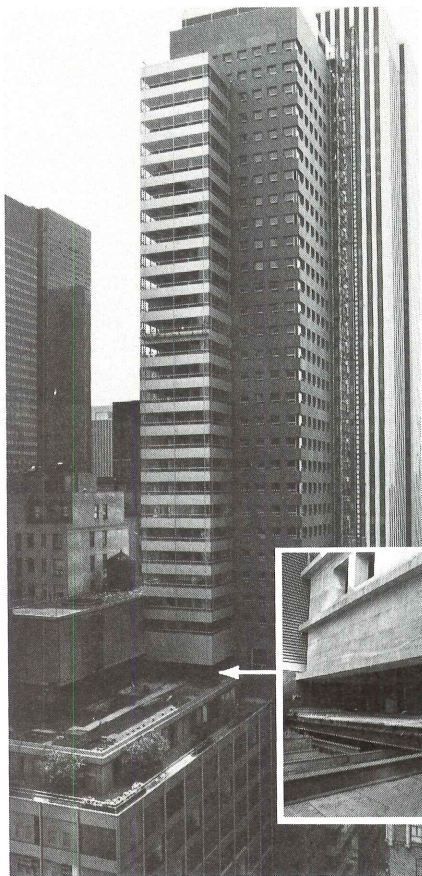
Circle 10 on information card

SPACE QUESTION:

How to build over existing structure to give new apartments more room?

SMART ANSWER:

Cantilever over "air rights" to support 31 space-adding floors.



How could the developers of the deluxe new 40 story Park Tower, New York condominium expand beyond the confines of a limited site to gain apartment size?

The ingenious solution: construct two huge concrete beams to project over "air rights" of an adjoining landmark structure and build up from there. Result: 31 floors were placed over the older building—and the new apartments got an additional 21,700 sq. ft. of space.

The cantilever actually consists of three reinforced concrete beams. Two beams extend out 25 ft. from the new structure and are connected by a beam 28 ft. across which carries two building columns with loads of 1000 kips each. Interior columns and core walls function as tie-backs for the cantilevered beams.

Approximately 260 yds. of 7,000 psi high-strength concrete were poured into three huge forms. Because of the cantilever's great mass, actual pouring had to be completed in stages. Placing all of the concrete at one time was impossible because the roof of the older structure was unable to support the cantilever's great weight. The smart answer was to construct shoring on the roof of the older building to act as a support for the forms and concrete that was poured into the

forms at the first stage. After the first pour, the shoring was removed so that the weight of the second-stage pour was supported by the first pour, and not transferred to the roof. Then each subsequent pour was supported by the cantilever already in place. Grade 60 reinforcing steel was used throughout for maximum economy.

Another clever design concept made possible by versatile reinforced concrete. Ask for Case History No. 27.

Architects: **James Stewart Polshek and Partners, New York, NY; Schuman, Lichtenstein, Claman & Efron, New York, NY**

Structural Engineer: **The Office of Irwin G. Cantor, P.C., New York, NY**

Construction Management: **Lehrer/McGovern, Inc., New York, NY**

Contractor: **Turner Construction Company, New York, NY**

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Circle 12 for Professional Membership details.

THE ANSWER'S IN REINFORCED CONCRETE.

continued from page 10

because of what has happened, but I am working voluntarily on the housing scarcity for the multitude of homeless on the streets—not the wealthy. No more country clubs for me!

Billy Herrin replies:

One of the clearest messages I perceived from reading and rereading the comments on the cutting edge of architectural practice is that many architects are frustrated by their lack of "business skills." We are all taught wonderfully in school to be excellent designers, to think we will have complete control of a single project and to absorb the accolades of happy clients graciously. But it doesn't happen that way. Within five years of graduation, most of us spend the majority of our time managing people and managing businesses.

The issues that confront us indeed loom large: liability, quality control, firm management, fair compensation, lack of technical knowledge, communications, political action, dilution of leadership and responsibility, marketing, fee cutting, bidding for services, etc. Are these the issues we studied in order to become architects? No, and the Board realizes this clearly.

The AIA is now preparing to focus energies on ways that architects can acquire or supplement necessary skills and aptitudes. At each Board of Directors meeting, we're devoting three to four hours to determine just how we can help.

Changes are in store. Some are already apparent. Since last Summer, there have been big changes in the focus of the AIA MEMO (the April issue is on CAL—the compensation, accountability and liability committee). ARCHITECTURAL TECHNOLOGY is now running case studies on successful firms in addition to an already-full schedule of articles that embody the good results of AIA programs and activities. Articles such as regaining control of the construction process, university curricula, fee methodologies and alternative role-models for professional practice are all planned for publication within a year.

I'm sure that the almost 50,000 AIA architects are united in a desire to produce better architecture. Your Board of Directors is committed to providing you with the tools to do the job and to keep listening carefully to your concerns.

Thanks for writing in. The feedback we get directly from members helps us tremendously. Count on us to focus these concerns into broad-based programs that can really help you in return.



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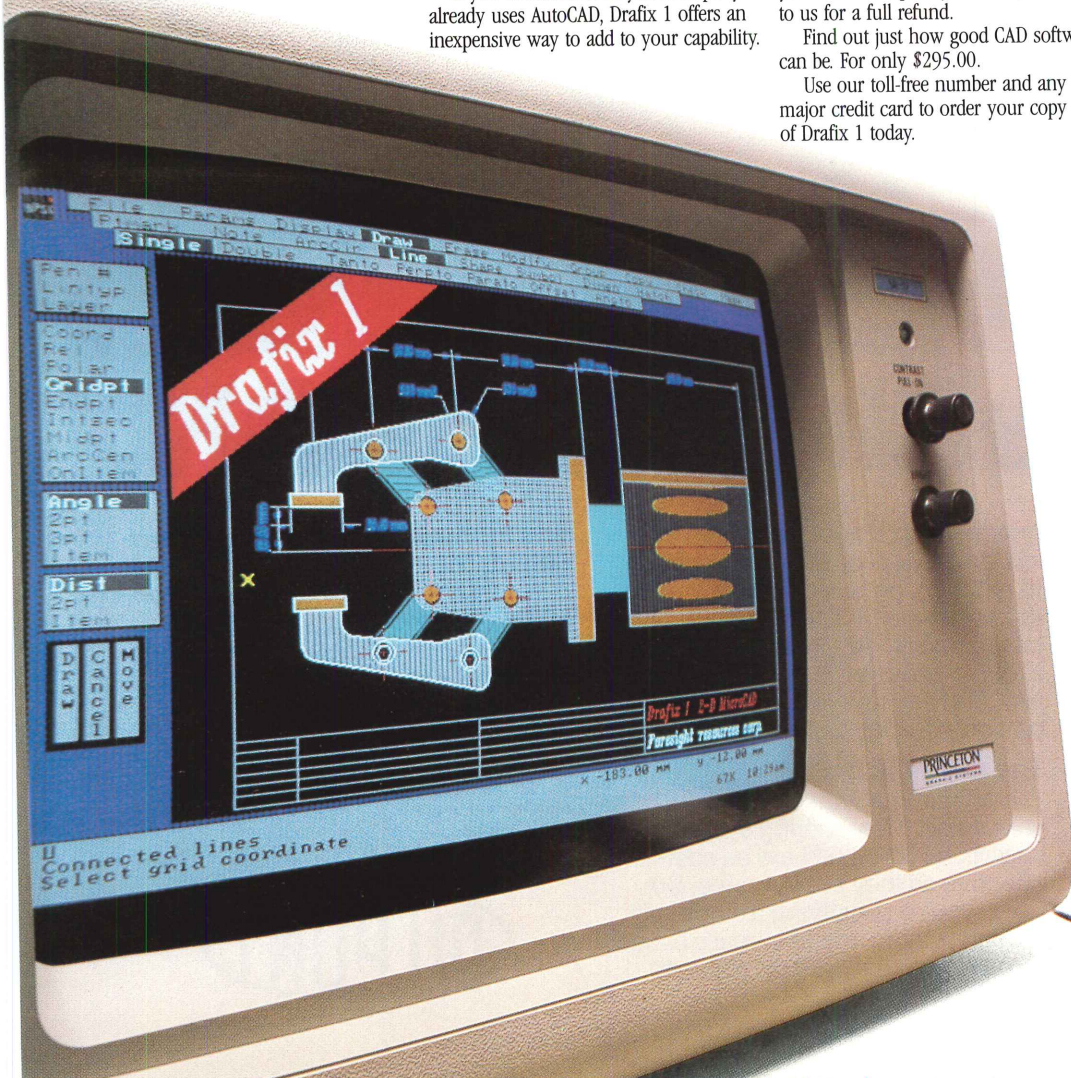
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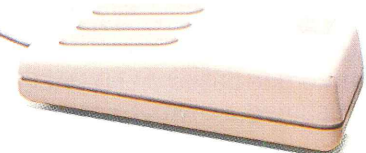
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Circle 15 on information card



TEACHING DESIGN ETHICS

BY ARTHUR E. STAMPS III, AIA

ABOUT 15 YEARS AGO, A FELLOW PH.D. student and I were walking to our office at school, carrying Plato's *Republic*, Aristotle's *Nicomachean Ethics* and Kant's *Critique of Practical Reason*. A world-famous architect joined us, looked quizzically at the books and inquired, "What's ethics got to do with architecture?"

The question surprised us because we understood ethics and architecture to be intimately connected. The basic ethical questions are: What is worth doing? and How important is one action compared with other actions? Since architecture is loaded with complex decisions and conflicting priorities, we found it inconceivable that people could practice architecture without *first* exploring what was worth doing. Only later does it seem appropriate for us to explore more directly architectural questions like, How can we create the things we think are important?

Architecture students are free from the twin masters money and time, and so are well suited to explore open-ended issues like ethics. Time is necessary partly because ethical questions are hard and partly because ethical questions are likely to be new. For instance, it is reasonable to suppose that if you want to have a satisfied life, you will pursue the things that give you the most satisfaction. But when I asked students to make up lists of a) what gave them the most satisfaction and b) what they were doing, there were no matches between the two lists! Teaching ethics would resolve this misfit by pointing out the relationship of means and ends. This simple thought is often new to a lot of designers.

Ethics can solve many "new" problems. For instance, many young professionals I know are suffering "burnout," "alienation" and "getting in a rut with no new ideas." Aristotle outlines the solution to these problems in his *Ethics*.

Arthur E. Stamps III, Ph.D., AIA, practices architecture in San Francisco and teaches architecture at the California College of Arts and Crafts. Stamps, who is currently writing a book on design judgment, particularly recommends C. West Churchman's The Systems Approach and Its Enemies as "the most gentle guide to applying ethics to design."

One ethical exercise is to postulate what is most worth doing and then try to achieve it. One might try designing for the health of the personality, sympathy, happiness, self-realization or peace.

He states that people need six activities in their daily lives: maintaining health (eating, sleeping, exercise, etc.); working to earn a livelihood; working for a purpose higher than mere subsistence (self-improvement, enriching the community, etc.); play; time away from conscious, purposeful activities; and contemplation about what is important. (The six parts of a full life are explained more completely in Mortimer Adler's *A Vision of the Future: Twelve Ideas for a Better Life and a Better Society*.)

Many modern problems are caused by neglecting one or more of these six activities. Burnout is solved by leaving time for nurturing and play, alienation, by improving one's self and society, getting in a rut, by blocking off conscious thought, and so on. Contemporary solutions can be found in the "ancient" field of ethics.

Usually, ethical decisions are more difficult. For example, in my "Design for Values" studio, each student designs to fit the needs of a particular life-style, as identified by Arnold Mitchell in *The Nine American Lifestyles*. The ethical principle is that architects should satisfy the needs of a building's users. But what if someone asks you to do something "wrong," like retrofit an urban slum with 8-inch steel walls or build a factory in South Africa? When should you *not* satisfy a client? This is not an easy question, but the answers can be found under the ethical topic "natural law."

Another ethical exercise is to postulate what is most worth doing and then try to

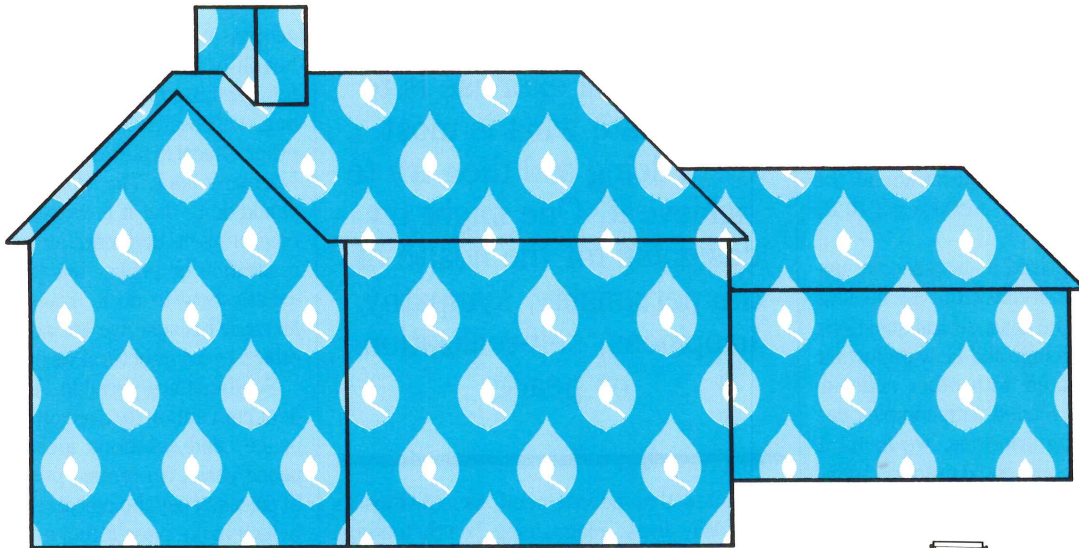
achieve it. One might try designing for the health of the personality, sympathy, respect for persons, happiness of the greatest number, self-realization or peace. (These and other ethical systems are discussed in Richard Norman's book *The Moral Philosophers*. Few would deny that it is worthwhile to design an environment that creates sympathy or self-realization or peace, but it is difficult to see exactly how to do it. I suggest it is difficult *precisely* because we are not used to applying ethics to architectural design.

Solutions are possible. The 1985 AIA student convention focused on the architecture of peace, and solutions included designing a) peace parks (to remind people about peace), b) places of psychological refuge from daily life (which make people feel more secure) and c) resource-conserving cities (which reduce the effects of one of war's major causes: scarcity).

Programs to teach design ethics are easy to implement. Instead of beginning a design studio with a list of spaces and areas, ask the students what is worth doing. The first "presentation" is not a drawing at all, but a line of thought stating what is important and why. Chances are this approach will shock the students; they will need hints to help them explore the relative importance of various design goals. These "hints" come from the great theories of ethics. What is critical is to bring the ethical decisions out in the open and to spend time creating ethical bases for design decisions. What is dangerous—to the designer as well as to society—is to forge ahead at full speed with a project that is merely technically feasible.

Who could teach design ethics? The answer is surprisingly broad: anyone who is concerned and can think and read and write. If you want to do advanced work in high-energy physics, you will need a hundred million dollars worth of hardware; but if you want to be an ethical scholar you need only a conscience, a library card, subscriptions to a few journals like *Ethics* and *Issues in Science and Technology* and some time away from daily pressures in which to reflect. David Hume called this institution the "Republic of Letters" and, like any decent republic, it is open to all who care. ■

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RELATING RISK TO COMPENSATION

BY JOSEPH DUNDIN

THE PRESENT, ACUTE PHASE OF THE LIABILITY insurance problem is only one part of a complex set of issues affecting the practice of architecture today. One cause of the liability crisis that will remain even after the problem subsides from acute to chronic (as some experts predict will happen within a year), is the expanded concept of liability that developed over the last several decades.

Judges have grown more creative and plaintiffs' attorneys have become less discriminating in their search for the "deep pocket." In addition, high defense costs virtually guarantee that the innocent suffer with the guilty. These developments have made it much more difficult for insurance companies to quantify risks, driving up the cost of premiums and deductibles and making insurance unavailable for activities such as asbestos removal.

In this respect, the architect's situation does not differ greatly from that of other professionals. It certainly justifies architects' support of tort reform—that is, of efforts to change the rules under which the litigation game is played. A particularly worthwhile goal is modification of the *doctrine of joint and several liability*, whereby a single party—the "deep pocket"—can be made to bear costs out of all proportion to its actual share of responsibility for a loss. Alternative forms of dispute resolution also offer some promise of relief. So do proposals to immunize design professionals under state worker's compensation laws.

Nevertheless, the complexity of the construction process and the architect's pivotal position in it have given the profession unique problems in the area of liability, with ramifications affecting every aspect of architectural practice. According to a study by Victor O. Schinnerer and Company, well over two-thirds of the suits involving architects are initiated by other parties involved in the project.

What is strikingly clear from the proliferation of disputes is that owners, contractors, subcontractors, materials suppliers, sureties, workers and other members of the construction team want something from the architect that they are not getting.

Joseph Dundin is an editor in the AIA's Documents Program.

Insulating oneself from liability exposure may be thought of as a kind of ransom: One gives up a part of the job and a proportional amount of compensation in order to stay out of court.

Historically, the architect assumed conceptual direction of the project, and the need for that kind of guidance has, if anything, increased. Many architects recognize this need for clear direction, as well as the problems that arise when the architect declines to provide it. But they also see that more control means more exposure to liability, and the trend in recent years has been to back away from control as a means of limiting this exposure.

John Webb, FAIA, of Bodman, Webb, Noland & Guidroz in Baton Rouge, imagines a frightened architect addressing a prospective client in the following terms:

"I want to be your architect—let me tell you what I am *not* going to do. I'm not going to program your building. I'll give you an idea of what it's going to cost, but I won't stand behind the cost figure. I won't tell you how long it will take to get the documents out. I'll observe what the contractor does, but if it's a bad job, it's not my problem. And as soon as the job is accepted, I'm gone."

Architects don't need to say these things out loud—owners read them in the contract documents. They look at the stamps on the shop drawings, which no longer express approval of those drawings. And they decide, not without reason, that a professional who backs away from exposure to liability is worth less money than a construction manager or package builder—regardless of qualifications—who will take overall responsibility for the project, liability included.

Insulating oneself from liability exposure

may be thought of as a kind of ransom: One gives up part of the job and a proportional amount of compensation in order to stay out of court.

If this passive strategy worked, it might be worth the cost. But it doesn't seem to be working. Architects are getting hauled into court anyway. It is time for architects to trade the passive strategy for an active one—to take greater control of the project and make sure that a loss, if one occurs, is mitigated and minimized by measures they themselves have taken.

Architects need to recognize, too, that not all of their colleagues are competent to play this more active role. "Although most of the claims filed against architects are unfounded," says George White, FAIA, the Architect of the Capitol, "when you look at some of the errors that have been made, you can't help but wonder how much quality control there is in some architects' offices."

A choice becomes evident here: The profession can police itself with the aid of the marketplace, or it can leave the policing, more or less by default, to the courts.

Clearly, the courts have not been the most discriminating police force. As for the marketplace, owners may not be motivated by any deep and abiding concern for the profession of architecture. At base, all an owner wants is a building that works well for a reasonable price. If someone other than an architect can provide this, while the architect is retained in the capacity of exterior decorator, that someone may get hired. The architect will get hired too, but in a reduced capacity and for a reduced fee.

Architects have to look at their own practices, at what they do and don't do, and consider how well they are meeting their own needs and the needs of the owners they serve. They should look at the fees they charge, and ask themselves whether owners might pay them more for a broader range of services.

Above all, architects must remember these things after the crisis in liability insurance has passed. The near total eclipse of energy issues in the last several years tells us what can happen when a perceived crisis is over: We forget about what caused it, including the things we can do something about. ■



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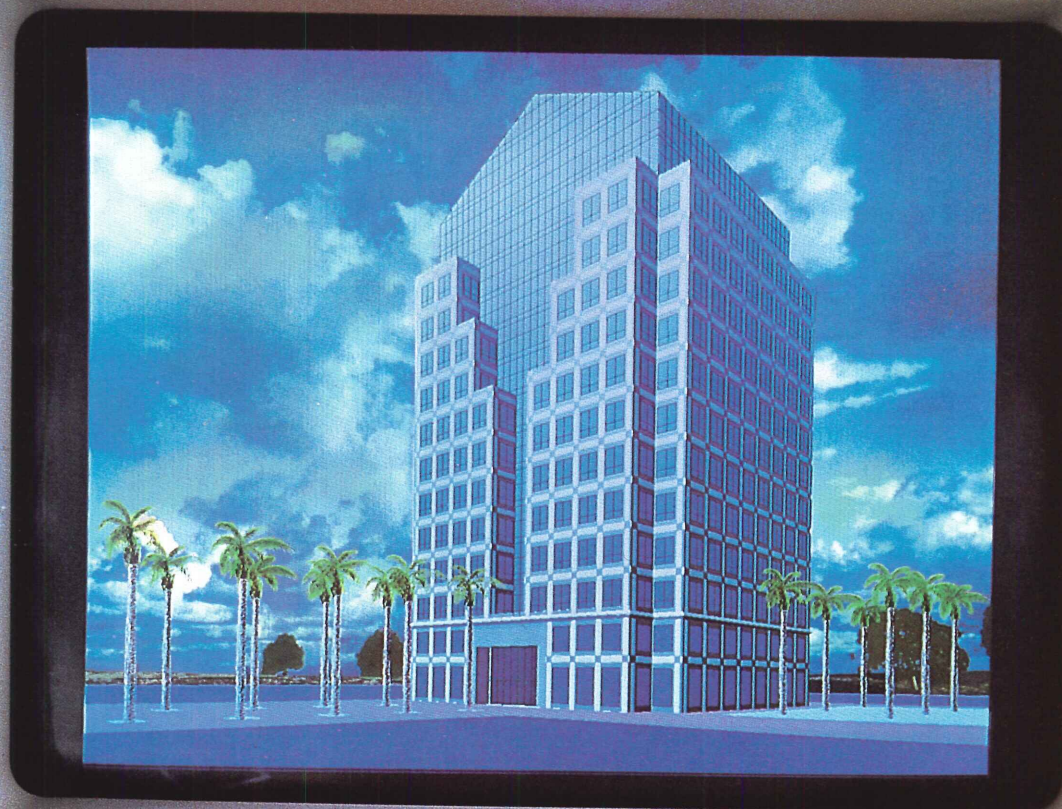
But what about quality? An Atlanta CalComp user answers:


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Actual images displayed on a CalComp System 25, showing rendered perspective composites onto a photographic background.

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BUILDING PERFORMANCE AND REGULATIONS COMMITTEE AGAIN OPEN

The AIA's Building Performance and Regulations (BP&R) Committee, closed to general AIA membership in 1985 for reorganization, returned to its former status as an open committee this year, and held its first meeting April 24-25 in Washington, D.C.

Activities of the BP&R Committee, chaired by Alan Sclater, AIA, of Seattle, include testimony before the three model building code groups and service as a technical liaison to national standards-setting organizations, such as the American National Standards Institute (ANSI) and the American Society of Testing and Materials (ASTM). Committee liaison activities include recent contributions to the newly revised ANSI A117.1-1986 (see below), taking part in a controversial debate over the proposed changes to ASHRAE 90A-1980 in the energy requirements for performance of the building shell, and reviewing the proposed major format reorganization of the BOCA model building code.

At the April meeting, the BP&R Committee hosted 50 members of the building regulatory community. Representatives from a number of federal programs linked to building regulations, including the National Bureau of Standards' Center for Building Technology, the National Fire Academy and the National Institute of Building Sciences, presented updates of ongoing work in their agencies and suggested methods by which interested architects could become involved.

Future BP&R Committee events include the educational conference "Architecture 2000—A Look at the Future," to be held this October in Los Angeles.

Those wishing more information about BP&R activities should call: Tick Vicars, director, Building Performance and Regulations Committee, (202) 626-7456.

REVISED ANSI HANDICAPPED STANDARD NOW AVAILABLE

The American National Standards Institute (ANSI) Standard A117.1-1986, Specifications for Making Buildings and Facilities Accessible to, and Usable by, Physically Handicapped People, is now available, replacing its 1980 predecessor. The standard has been used for the last 25 years to help eliminate architectural barriers and make facilities accessible to and usable by people with physical disabilities.

ANSI A117.1-1986 considers the needs of

people with disabilities such as walking difficulties; sight and hearing impairments; coordination, reaching and manipulation difficulties; trouble interpreting and reacting to sensory information; a lack of stamina; and extremes of physical size.

The latest revision of the standard incorporates changes to ensure uniformity and to facilitate referencing the standard in building codes and in federal and other regulations. The revised standard more directly parallels the Uniform Federal Accessibility Standards, used extensively by the federal government.

Other major changes include new requirements for tactile signage, more stringent definitions of reasonable numbers for provisions such as parking spaces, and alterations that reflect technological advances for alarm and communication systems used by people with visual or hearing impairments. All previous illustrations have been redrawn, and several new ones added.

Copies of ANSI A117.1-1986 are available from ANSI, 1430 Broadway, New York, N.Y. 10018, or from the AIA Bookstore, order #M531 (\$8 for members, \$8.50 for nonmembers plus 5 percent shipping). Call (202) 626-7474.

JOURNAL OF BUILDING PERFORMANCE PLANNED BY ASCE

A quarterly journal focusing on building failures from the catastrophic to the mundane is being planned by the American Society of Civil Engineers (ASCE) under the direction of the Architecture and Engineering Performance Information Center (AEPIC), the National Society of Professional Engineers (NSPE) and the Technical Council on Forensic Engineering. The new publication hopes to improve the general quality of all constructed products by providing interdisciplinary communication between practicing professionals in the construction industry.

Architects, engineers, contractors and professionals in the legal and insurance professions are encouraged to submit papers to the publications committee.

Papers that discuss problems with leaking roofs and facades, excessive deformations and premature deterioration of materials are desired. Other suggested topics include forensic investigations; case studies; construction litigation; insurance implications and quality-control strategies. How various professionals in the industry relate to one another is also of special interest to the publications committee.

The first issue of the journal is scheduled to be published in February 1987. Interested authors should contact ASCE for an author's guide. The address is Publications Department, American Society of Civil Engineers, 345 East 47th St., New York, N.Y. 10017-2398.

RUB ELBOWS WITH CLIENTS AT INDUSTRY COMMITTEE CONVENTION

Top-level executives from Allied Bancshares, Amtrak, AT&T, IBM, Lockheed, Marriott, McDonald's, Mercedes-Benz and Westinghouse, among others, will speak at the 10th annual conference of the AIA Corporate Architects Committee (formerly the Architects in Industry Committee). The conference, titled "A/E and the Corporation; is it Good Business?" will be held November 13-14, 1986, in Annapolis, Md.

The conference will address such topics as "Corporate Procedures for A/E Selection," "Corporate Facilities' Working Philosophies," "Corporate Image Through Design" and "The Impact of the Corporate World on the Architectural Profession." AIA President John Busby Jr., FAIA, and dean of humanities and social sciences at Rensselaer Polytechnic Institute, Thomas Phelan, will also speak.

For more information, call Charlotte Yowell, AIA professional services, (202) 626-7410.

MANY NEW JAILS EXHIBIT SAME OLD PROBLEMS

A recent survey sponsored by the AIA's Committee on Architecture for Justice reveals that although jails constructed during the last 10 years exhibit many marked improvements over older facilities, they still often exhibit the same operational and facility problems. The reason, the survey suggests, is that many recently-constructed jails have not adopted some of the changes recommended by the '60s and '70s prison reform movement.

According to the survey, much of the problem stems from a lack of awareness of helpful resources.

Case studies of older jails, together with information from the survey (which analyzed 255 newer county jails), indicate facilities that feature single-occupancy cells, a division of prisoner types, some form of an exercise program and a well-staffed and trained group of support personnel are the ones that most successfully eliminate common operational and facility problems.

Four points of planning and design advice derive from the survey responses: Visit other jails for advice and suggestions; consult the staff of your own facility; don't skimp on space and building materials; and plan for the future.

The 1985 survey on new small jails was conducted by Kimme Planning and Architecture, prison design consultants in Champaign, Ill. Funding was provided by the National Institute of Corrections (NIC). For more information, call (303) 444-1101.

THIRD ANNUAL ACSA CONSTRUCTION MATERIALS AND TECHNOLOGY INSTITUTE

The Association of Collegiate Schools of Architecture (ACSA) is offering 40 full fellowships to their third annual ACSA Construction Materials and Technology Institute, to be held at the University of Pennsylvania August 10-15, 1986. Schools that sent faculty to last year's Technology Institute are eligible for partial fellowships.

The program is designed to introduce the architectural educator to new and improved building products, services and applications. The week-long series of workshops will con-

centrate on such subjects as structural systems, exterior envelope materials, roofing systems, prefabricated building systems, landscape architectural systems and computer-assisted design.

The Institute is sponsored by ACSA and six other organizations. For an application form and further information, write to Richard McCommons, ACSA, 1735 New York Ave., N.W., Washington, D.C. 20006.

SEALANT SPECIFICATIONS

"Voluntary Specifications and Test Methods for Sealants" is a 16-page compilation of standards and test methods for determining the performance of compounds and tapes used to manufacture and install windows, sliding glass doors and curtain walls.

Sealant specifications in this publication include back bedding compounds, back bedding mastic tapes, glazing tapes, narrow joint-seam sealers and nondrying sealants.

The booklet is published by the American Architectural Manufacturers' Association (AAMA). Copies of AAMA 800-86 are available for \$16 by writing to AAMA, 2700 River Rd., Des Plaines, Ill. 60018.

LATEST WORD ON LIABILITY

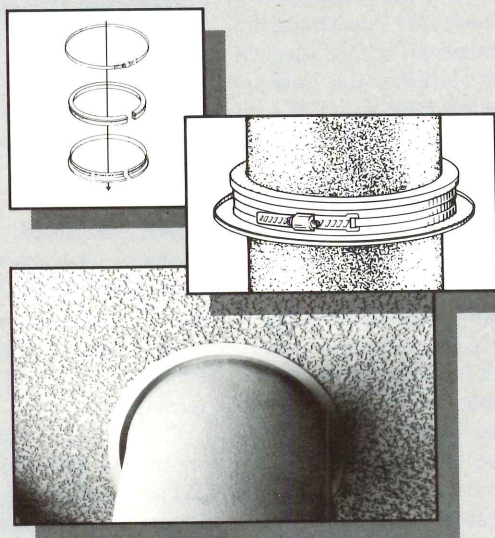
The insurance crisis will soon show signs of receding, according to Paul Genecki, senior vice president of Victor O. Schinnerer & Company (managers of CNA's liability insurance program for architects and engineers). "At the end of July, the first six months' financial reports should come out," says Genecki. "Insurance companies will be healthier at that point, and you'll start seeing the first signs of companies asking themselves, How can we improve our share of the market? What other lines can we now take on?"

New carriers will not begin to enter (or re-enter) the market before year's end, Genecki says. But when they do, they will compete in price. "The only way a new carrier can bring in business is to have more attractive coverage or a lower price or both."

Asbestos and pollutant coverage is a separate issue, however. "It will be a lot longer before coverage comes back for those," Genecki admits. "What needs to happen is for the companies that insure contractors and owners to start loosening up on coverage for asbestos and pollutants. If they do, CNA will follow the next day. Right now, our concern is that design

continued on page 26

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professionals would be the only ones with insurance, and that they would become the target for all claims."

"A caution may attach to cheaper policies when these are offered," says Jim Franklin, AIA group executive of the AIA Professional Services Center. "Some of the companies that offered such attractive premiums in the past have either canceled their policies or gone out of business. Given the cyclical nature of the insurance industry, this could happen again."

Architects, meanwhile, are finding their own ways to deal with rising insurance costs. "We have got to preserve the ability to make choices in controlling our business," says Chris Smith, AIA, Northwest regional director for the Institute and president of CJS Group Architects, Ltd., a 15-person office in Hawaii. "Firms of 10 people and under represent 95 percent of AIA membership, and escalating premiums are keeping them from moving into CADD and other positive management areas."

Speaking of his own firm, Smith says, "It is our policy to charge clients for their proportional share of the premium expense. We haven't had any trouble doing this, because clients understand our dilemma. The problem

has gotten national exposure, and it isn't limited to architects."

Quality control and contract negotiation are other areas receiving more attention from architects. "As 'unarchitectural' as it may seem," says Rocky Rothschild, author of the AIA's *Bonds and Insurance Guide*, "architects are going to have to read and understand contracts, especially the terms of the Owner-Architect Agreement and the General Conditions. They are going to have to allocate adequate time to check the drawings thoroughly, and cross-check against the engineering documents. The product and contract aspects of practice are prime sources of our problems. If we can short-circuit the problems at the source, we will go a long way toward making the insurance costs manageable. We can't depend on the insurance industry to do everything for us."—*Joseph Dundin*

CSI ISSUES MONOGRAPHS ON WOOD, SCHEDULING TECHNIQUES AND HARDWARE

Three new monographs published by the Construction Specifications Institute (CSI) provide information to architects on wood, network analysis and finish hardware.

Pressure Treated Wood explains how treating wood under pressure can offset deterioration by fire, insects and decay. The volume discusses available pressure treatments for wood as well as design considerations.

Network Analysis Schedules creates a mathematical model for a project by plotting the relationship between projected construction activities and the sequences in which they should be performed. The booklet discusses basic techniques for compiling data and developing a network diagram.

Finish Hardware is intended to help architects, engineers, designers and others select finished hardware. The monograph discusses codes and requirements, installation, and inspection procedures.

To order, write to Construction Specifications Institute, Order Department, 601 Madison St., Alexandria, Va. 22314-1791.

BROCHURE HELPS CHURCH GROUPS WORK WITH ARCHITECTS

The Interfaith Forum on Religion, Art and Architecture (IFRAA) has reissued "The Architect and the Congregation." The pam-

continued on page 28

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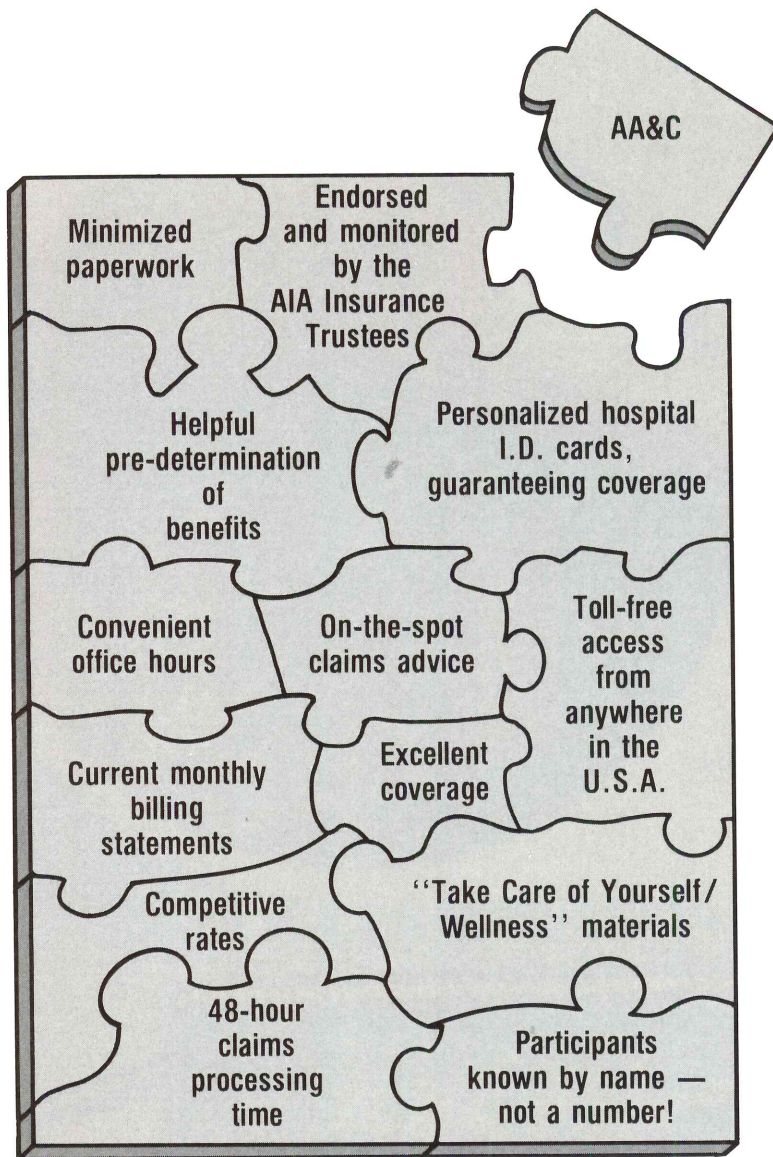
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phlet, written for church groups, details the services architects provide in church design and explains how to secure these services. The updated black-and-white brochure, which many architects will want to give church clients, is illustrated with line drawings and photographs of IFRAA Architectural Award-winning religious facilities. Copies are available for 50 cents each. Contact IFRAA's national office, 1777 Church St., N.W., Washington, D.C. 20036.

TILE HANDBOOK AVAILABLE

“The Designer's Guide to Italian Ceramic Tiles and Their Installation” is a full-color, 64-page publication that details the varieties of tile available and their many uses. The booklet also discusses methods of tile installation, cleaning and maintenance. For a free copy, write to the Italian Tile Center, Division of the Italian Trade Commission, 499 Park Ave., New York, N.Y. 10022.

SWEET'S TO BE RELEASED AS COMPUTERIZED DATABASE

Electronic Sweet's, a computer-driven database of construction product information, will be introduced in prototype form in June at the AIA convention, the Electric '86 exposition, the Construction Specifications Institute convention and the A/E Systems show.

The retrieval system utilizes a personal computer to allow architects and engineers to locate particular manufacturers' building products that “fit” their design requirements on construction products by keying in descriptive data on the products they are seeking. Electronic Sweet's will then scan its database on disk, matching these specific criteria with manufacturers' products that meet them. The database will display a detailed information profile on those products and direct the user to specific manufacturers' brochures in conventional Sweet's catalog files.

Sweet's, a division of McGraw-Hill Information Systems Company, publishes a 50-volume Sweet's catalog file of construction product information.

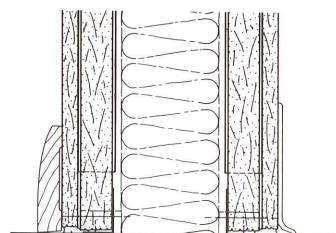
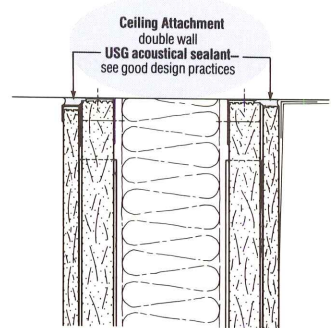
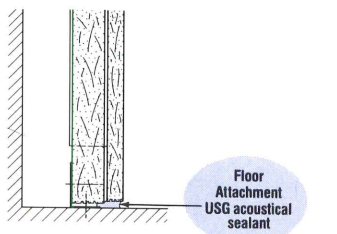
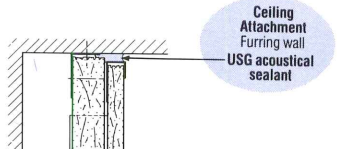
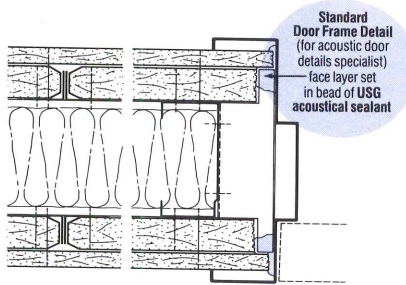
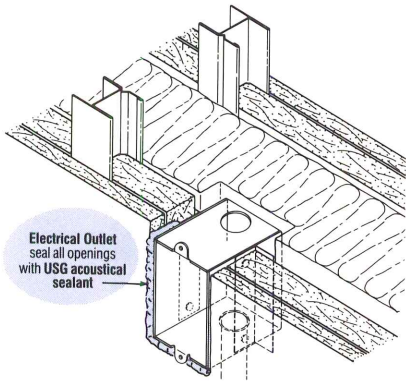
For more information, call Larry Mathews, Sweet's marketing vice president, (212) 512-3953.

CORRECTION

Forrest Wilson, Ph.D., is director of the doctoral program at the Catholic University of America in Washington, D.C., not chairman of the graduate program, as indicated in our March/April 1986 issue.

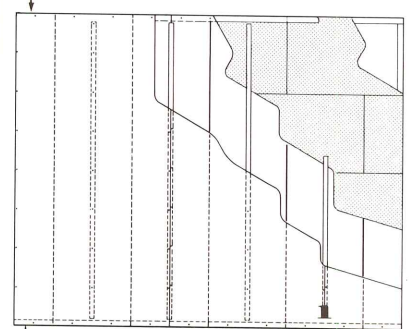
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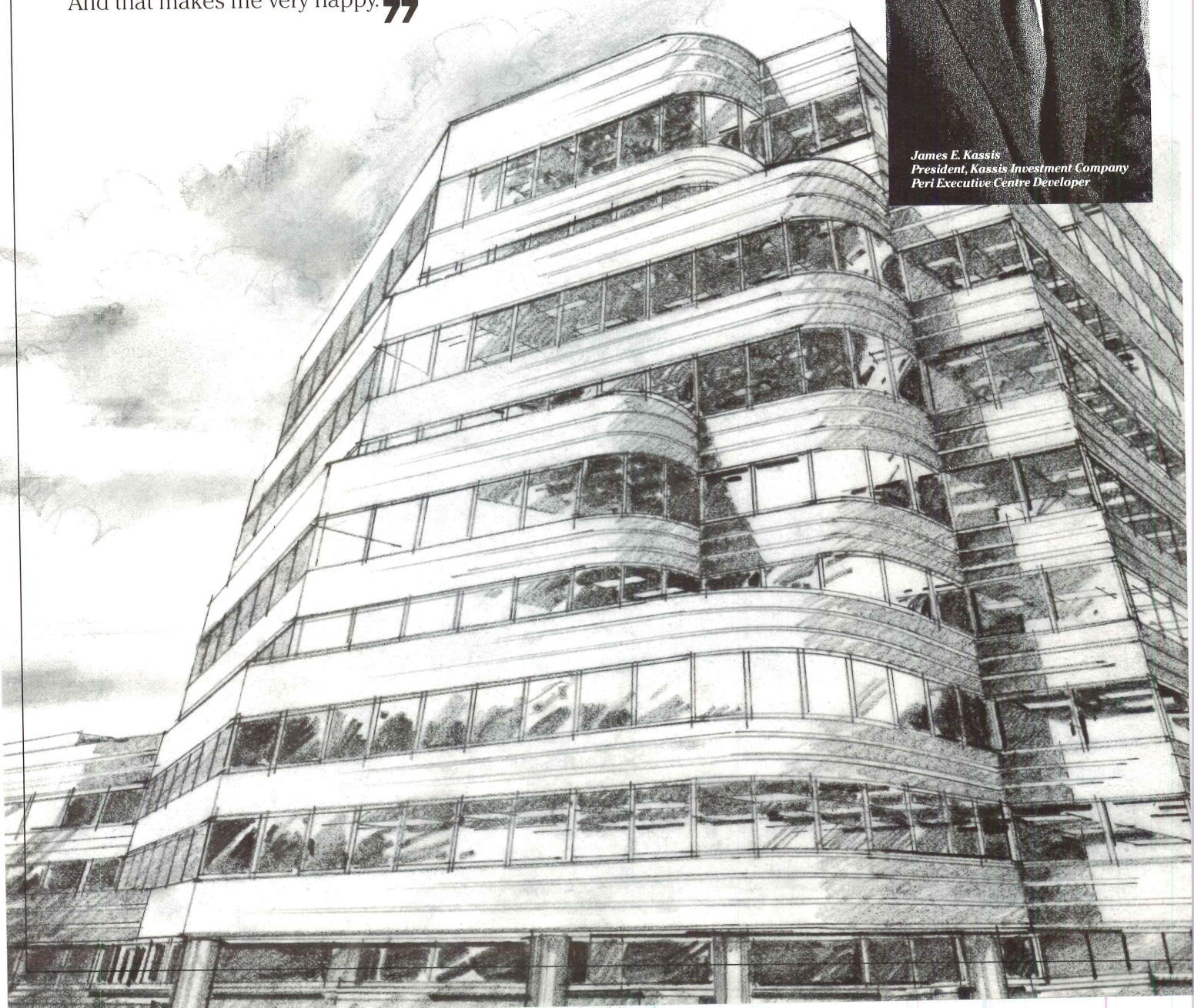
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Curtain-Wall Connections

The search for strength, flexibility and watertightness

BY DOUGLAS E. GORDON



Stephen R. Brown

Whether designing a custom cladding of multi-ton precast column covers and spandrels for a corporate headquarters or a standard, straight-out-of-the-catalog, aluminum-panel-clad warehouse, the typical architect relies heavily on others to detail the connections for curtain walls. Yet those connections are a principal cause of failure in walls—the building system that is second only to roofs as a source of lawsuits brought by building owners.

Curtain-wall connections are generally detailed by a curtain-wall contractor. Yet architects usually set the initial design, assemble the bid package and approve design changes. The potential for error inherent in this transfer of design control is strong incentive for architects to understand how contractors typically detail curtain-wall connections, and why.

THE IDEAL EXTERIOR WALL IS VISUALLY pleasing and structurally sound; provides daylighting; and controls exterior heat, cold, rain, wind, sound and intrusion. If budget allows, an architect designing a curtain wall has almost total flexibility with regard to visual appearance, fenestration, thermal and acoustic properties and strength of the wall panels or sections, thanks to the almost limitless array of today's manufactured wall systems.

The primary design concern is anchoring the wall system securely to the structure with enough strength and flexibility to withstand wind and other live loading and at the same time allow thermal and

Connections should allow for three-dimensional adjustment

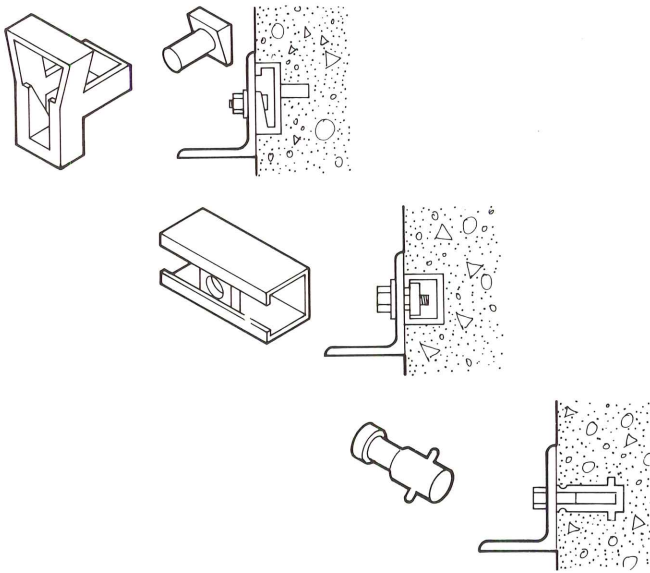


FIGURE 1
For adjustable support during assembly, malleable embedded anchors (top and bottom) allow minor vertical adjustment and a continuous channel insert (middle) allows attachment at any point along its length.

ground movement—all the while resisting water penetration and providing adequate fire stops. Architects should also select and position connection components so that they are protected from weather deterioration, are easily assembled on-site and are simple to maintain or replace. Initial and life-cycle costs are other guiding concerns (see page 44).

TYPES OF CURTAIN WALLS

Curtain-wall systems can be classified according to method of construction: stick (or grid), built-up, unit, panel, unit-and-mullion and spandrel-and-column-cover. With the stick system, individual wall pieces—mullions, horizontal framing, panels and glazing—are field-assembled, which allows some flexibility to adjust on-site to the configuration of the building frame. The chief advantage of the stick system over most other systems is the reduced shipping costs—since the components are small and easy to crate.

Built-up systems include single- and double-wythe, field-assembled masonry panels and metal stud walls with a variety of built-up claddings. These systems are similar to stick systems in that they allow a great deal of on-site flexibility and the convenience of easily shipped components. A disadvantage of both stick and built-up systems is that they require a greater amount of field labor, which adds time and expense to construction and makes quality control more difficult than with more completely prefabricated systems.

Unit systems are, in effect, factory-assembled stick systems. They are available, preglazed or not, in one-story or multistory units. Installers can fit the prefabricated units quickly. But because assembly involves a sequential interlocking of push-in units, installa-

tion of the final unit on each level typically requires a special joint.

Panel systems are similar to unit systems. The difference is that units consist of prefabricated assemblies of individual pieces. Panels are homogeneous stamped- or cast-metal, masonry or concrete monoliths. Panels, which also may be preglazed, often incorporate a surface pattern. Custom-designed patterns are possible, but are usually economically feasible only when a considerable number of identical panels are used in a wall design.

The unit-and-mullion system is a cross between the stick system and the unit system. Mullions are attached to the building frame, and prefabricated units are installed within the mullion framing.

Spandrel-and-column-cover systems consist of column-cover panels attached directly to the structural columns and spandrel panels connected to the floor slab, which span the distance between columns. These systems are always custom-designed, and often include framed glazing, either mullioned or butt-joined. An example of a precast system of this type is provided on pages 40 and 41.

ASSEMBLY SYSTEMS

With many wall systems—especially unit and panel systems—the curtain-wall contractor selects a manufacturer and details the wall anchorage based on standardized hardware that the manufacturer provides. With more complex systems, such as spandrel-and-column-cover, many architects and contractors secure an exterior-wall consultant for custom engineering and connection detailing.

Usually, with steel structures, either the on-site steel worker or the on-site panel assembler (depending on contract agreements) bolts or welds metal braces and angles to the structure. The panel assembler in turn connects these braces or angles to clips attached to or embedded in the cladding material.

With concrete structures, the concrete worker embeds steel anchors in concrete columns and slabs, and bolts steel angles to them (Figure 1). The panel assembler hangs wall sections from the anchors with at least four clips—usually more—attaching both the top and bottom of each panel.

When the panel system is precast concrete, embedded steel dowels often serve alone or in conjunction with angles to hold the panels in place. Haunches on the back of the precast panels rest on the floor slab and are keyed into the dowels, which provide lateral support for the panel. The panel assembler connects the top of the panel to the floor slab above with a dowel or an angle (Figure 2).

With either steel or concrete structural framing, panel assembly is more efficient when the architect or contractor designs panels to attach at the top of floor slabs rather than at the vertical face or underside of the floor slab. This design makes the attachment more accessible to the assembler, explains John Gurniak, technical director with the American Architectural Manufacturers Association (AAMA). With either type of system, the successful interweaving of the work of the structural and cladding contractors is key to minimizing problems in fitting the wall to the frame.

No matter what anchorage assembly is chosen for a wall, the connections should allow three-dimensional adjustment to accommodate structural deflection, inaccuracies in alignment, and thermal expansion and contraction. Shims provide lateral and vertical adjustability

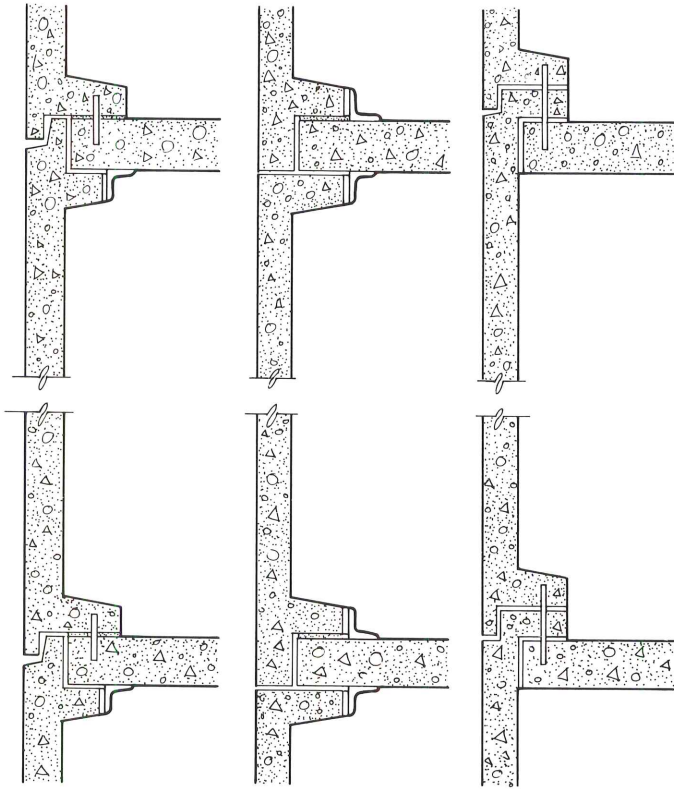


FIGURE 2
 Steel dowels and angles in conjunction (left) provide lateral panel support. Angles or dowels alone are also common (middle and right).

during field assembly. Slotted bolt openings, dovetail anchor joints and bolts with flexible sleeves allow horizontal and vertical adjustability and movement (Figure 3). Common impediments to free joint movement are overtightened bolts, foreign material wedging the joint apart or gluing it together, and corrosion.

Another problem with movement joints, though relatively minor, is noise. Clicks and clacks result from thermal movement and from wind rattling insufficiently tightened panel connections. Applying permanent lubricant at movable connections helps eliminate noise from thermal joint movement, but this practice is not common.

ENVELOPE STRENGTH

The three major forces that affect the structural integrity of curtain walls are gravity, wind and seismic movement. Architects and engineers calculate what stiffness values enable connectors to transfer loads from the envelope to the frame. They also make sure that the designed structure is stiff enough to withstand transferred load without deflecting so much that the cladding is damaged.

Gravity is a constant force. Barring unforeseen deflection of the structural support, the design engineer is able to calculate with certainty the amount of anchorage required to hold the static weight of

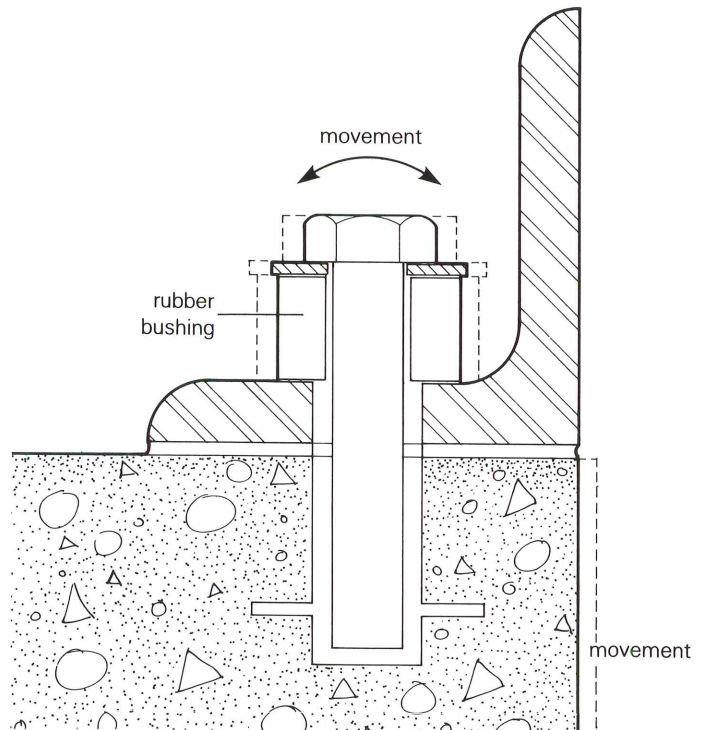
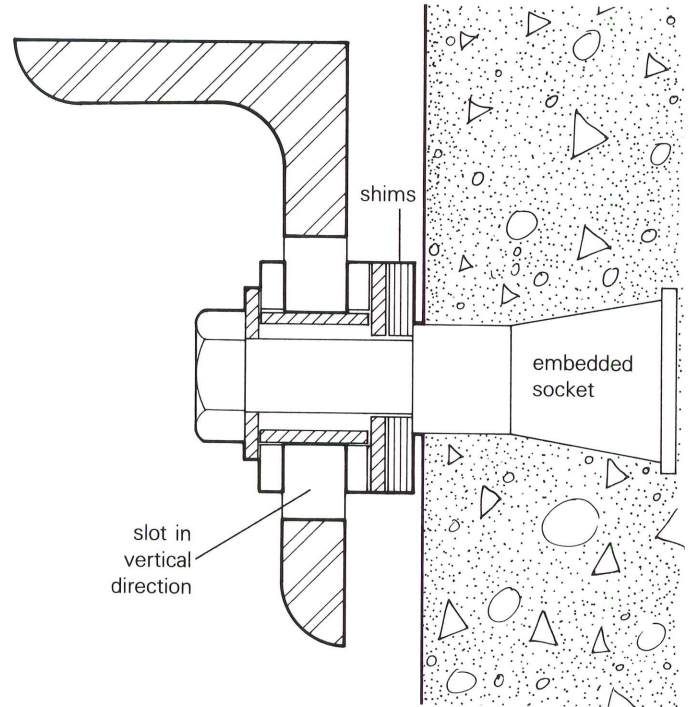
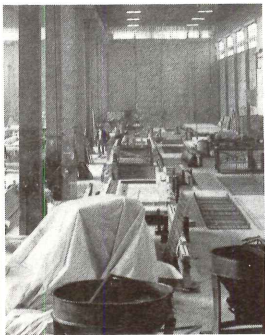


FIGURE 3
 In the top diagram, shims provide lateral adjustment during assembly, and a slotted bolt hole with nylon washers allows vertical panel movement. Horizontal movement in the assembly at bottom is accommodated by the rubber bushing.

A Precaster at Work



The outside is not particularly impressive: piles of aggregate behind a chain link fence and, across the street, a long, low concrete-clad building. Inside it's noisy—and busy—with the ear-molesting drone of concrete vibrators punctuated by bright-white flashes of welding. This seeming inferno is actually Arban & Carosi Precasters Inc., the precast panel contractor for such

notable structures as the Forrestal Building and 1201 Pennsylvania Ave. in Washington, D.C., and Memorial Stadium in Baltimore.

The plant, which Robert Walton, executive director of the Architectural Precast Association calls “pretty representative of precast manufacturers in the United States,” employs about 130 persons, including an engineering staff that produces working drawings for about 80 percent of the company's work. “We typically have five jobs going at any one time,” says Nicholas Carosi III, the third-generation owner of a firm that evolved in the 1940s from casting ornamental plaster to casting concrete.

Because of this background, Arban & Carosi forms reinforced plaster for its positive molds, from which it makes concrete and wood negative molds. Positives are typically made of fiberglass or wood, which take less time to form and require less craftsmanship than plaster, but don't produce the same smooth curves, Walton says of the process, adding that plaster casting is a dying art.

Once negative molds are assembled and lubricated to ease panel extraction, workers position steel reinforcement frames and any embedded hardware, measuring to make sure location and depth of concrete coverage meet the required specifications. Metalworkers shape and weld the frames on-site.

An overhead conveyance system machine-measures each batch of concrete for mixing and pouring. As the concrete is pumped into the molds, samples are taken regularly for testing. Workers slosh through the concrete-filled molds, pushing large surface vibrators that jiggle out air pockets.

After the panels set, the aggregate—which Arban & Carosi grades themselves to achieve a level of consistency some aggregate suppliers don't provide—may be brought to the surface with high-pressure water spray, sandblasting or chemical corrosion of the outer veneer of cement, depending on the desired appearance. The panels are then ready for shipment to the site, the process from contract negotiation to shipment taking an average six to nine months.

the wall system plus the weight of anticipated additional loads, such as snow and occupancy.

Wind loading is altogether another matter. Although local codes typically spell out wind pressures based on building height, wind loading is also affected by building shape, topographic surroundings, and the density and configuration of surrounding buildings. Moreover, the effects of wind on discrete portions of a curtain wall are not the same as on the building structure. Whirling eddies and gushing currents of wind press and pull simultaneously at small sections across the face of a wall. The wall anchors transfer those forces more homogeneously to the structure.

Unlike gravity, wind force is multidirectional, imposing positive pressure, negative pressure and shear forces on a wall. Wind suction is as critical a design consideration as positive wind pressure, a point that is not generally appreciated. In fact, at the tops and corners of tall buildings, suction is often the dominant wind force.

Building codes set the method for calculating wind load. For example, the International Conference of Building Officials' Uniform Building Code-1985 (UBC) establishes procedures and standard values for determining wind load on small- to medium-sized buildings. UBC then requires that any structure that is over 400 feet high, has a height-to-width ratio of 5 to 1 or more, or is sensitive to wind-induced oscillation, be designed in accordance with approved national standards.

The most widely accepted national standard for wind loading is the American National Standards Institute (ANSI) A58.1-1982, Minimum Design Loads for Buildings and Other Structures. The ANSI standard defines wind load as windward design pressure plus leeward or sidewall design pressure.

The numerous values that play a role in determining wind load for a building include:

- Basic wind speed, in miles per hour
- Exposure classification, which determines the effective velocity pressure (urban, suburban, wooded area or open terrain)
- Special wind conditions (increased pressure in flat coastal areas where the wind blows over a large body of water, and decreased pressures in centers of large cities where at least 50 percent of the surrounding buildings have a height of 70 feet or more)
- Slenderness ratio (an architect designing a building five times as tall as its smallest horizontal dimension must include a “gust response” factor)
- Wall openings (if the area of wall openings in any one wall exceeds the area of all other walls by 10 percent or more, the architect must consider internal pressure control)
- Importance factor of the buildings (determined by occupancy and building use—for instance, hospital patients are less able to react to an emergency than able-bodied factory workers).

ANSI A58.1-1982 applies to typical rectangular buildings with vertical walls. “Buildings of other configurations are prospects for Boundary Layer Wind Tunnel (BLWT) testing,” advises Gurniak. Such testing requires a wind tunnel with a long working section capable of subjecting full-scale wall mock-ups to full-strength winds like those found naturally in the boundary layer (the atmospheric layer from the ground surface up to a height where ground-based obsta-

	Aluminum	Stainless Steel	Galvanized Steel	Zinc	Lead	Brass	Bronze	Monel	Uncured Mortar or Cement	Woods With Acid (Redwood and Red Cedar)	Iron/Steel
Copper	●	●	◐	●	◐	◐	◐	◐	○	○	●
Aluminum		○	○	○	◐	●	●	○	●	●	◐
Stainless Steel			◐	●	◐	●	●	●	○	○	◐
Galvanized Steel				○	○	◐	◐	◐	○	◐	◐
Zinc Alloy					○	●	●	●	○	●	●
Lead						◐	◐	◐	●	○	○

● Galvanic action will occur
 ◐ Galvanic action may occur under certain circumstances and/or over a period of time
 ○ Galvanic action is insignificant under normal circumstances

FIGURE 4

This chart compares galvanic compatibility of metals commonly used for flashing with some of the more common building materials. Galvanic reactions occur

most readily when materials touch, but may also occur when water runs from one material onto another.

cles no longer affect wind speed, turbulence intensity and gustiness). Guidelines for BLWT testing can be found in the AAMA Aluminum Curtain Wall Series number 11. "Acute wall angles, unusual projections or setbacks, sloped walls, curved walls, open arcades, bundled tubular construction or other unusual construction should be tested unless there is substantial data available from previous work on similar structures," Gurniak says. The box on page 43 describes wall testing methods in more detail.

With respect to seismic movement, cladding units must withstand earthquake forces individually and as a system, with the cladding connections doing much of the work. Although the effects of earthquake forces on nonstructural cladding systems are only beginning to be studied in depth, research has shown that the spacing of panel attachments with respect to structural elements is particularly important to earthquake resistance, according to Peter D. Stone, associate professor at Florida A&M University's School of Architecture. Cladding connections usually dissipate earthquake energy by their ability to move in several directions, Stone says. Because the panel connections take the majority of the earthquake load on a wall, panels with vertical connections at columns and horizontal connections at each floor are less likely to permanently deform during an earthquake than panels that span across these critical building planes, where earthquake movement is concentrated.

PROTECTING TIES AND ANCHORS

To ensure that the strength and working integrity of connection hardware will last, working drawings must include provisions for protecting it from water and other foreign matter. With masonry or concrete, which tend to absorb water, this means embedding anchors or bolts under at least three inches of material to prevent

water penetration and corrosion. With less than three inches of coverage, stainless-steel or galvanized anchorage is necessary to avoid corrosion. Another approach to keeping hardware dry and clean is to use flashing or covers. When non-water-absorbent panels are used, connection hardware covered by the panel material is safe from water-induced corrosion as long as the panel joints are kept watertight.

Protecting against galvanic corrosion is just as important as shielding metal connection elements from water. For example, when specifying aluminum, which has a high degree of galvanic activity compared with most other metals used in construction, the architect must always consider possible galvanic reactions with components of dissimilar metals that might be in contact with the aluminum (including fasteners). When fitting steel elements close to aluminum, the designer can protect against corrosion with sealants or coatings, such as paint. When paint is used, however, it is important that both the steel and aluminum are coated. If the fabricator coats only the aluminum (the anode—from which electrons flow), subsequent chipping of the paint will expose small areas to large areas of open steel (the cathode—to which electrons flow). The consequent electron flow will severely pit the exposed aluminum, possibly resulting in perforation. See Figure 4 for a chart of galvanic compatibilities.

COMPATIBILITY OF TOLERANCES

Because curtain-wall connections typically involve the attachment of prefabricated sections to a field-constructed frame, the architect should take care to specify construction tolerances that will ensure proper fit and sufficient clearance for assembly. Specifying that a concrete frame and its cladding be "plumb and true" will not guarantee that construction tolerances will be compatible. If tolerances are

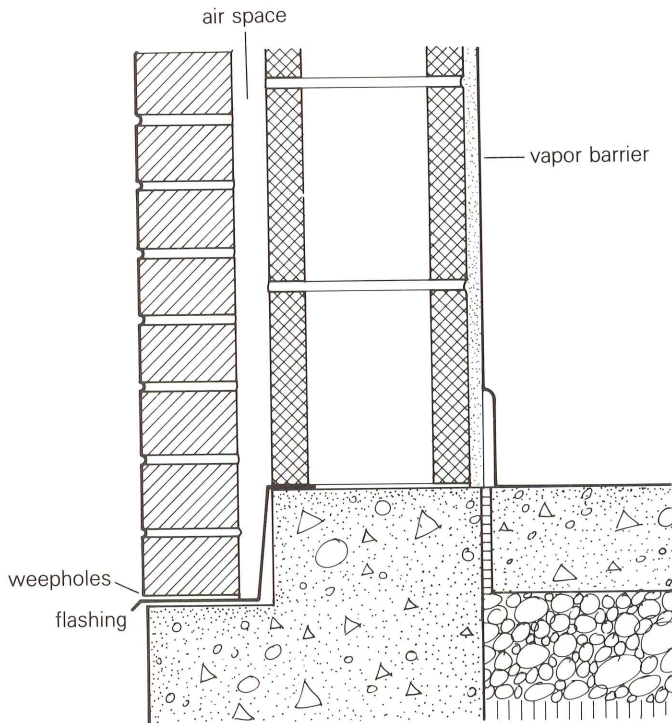


FIGURE 5
An insulated brick-and-block cavity wall illustrates the two-stage sealant system. Water that penetrates the outer wythe is redirected back out through weep holes. The inner wythe is the secondary seal.

not specified, and the cladding cannot be installed, the allocation of responsibility (and determination of who will be liable for delays and extra costs) may become a concern that overrides and impedes the construction schedule.

Section 3.3 of the American Concrete Institute Standard Recommended Practice for Concrete Formwork sets the standard tolerances for poured concrete structural framing, and Section 7, Paragraph 7.11, of the American Institute of Steel Construction Code of Standard Practice sets the standard tolerances for steel structural framing. When possible, the architect should obtain the limits of deviation from the prospective cladding-system manufacturers before the bidding package is prepared. If either the structure or wall-system tolerances are insufficiently stringent for project engineering requirements, the architect must then weigh the value of decreasing allowable variances against the increased cost of achieving more precise on-site construction or cladding prefabrication.

When specifying clearances, the wise architect heeds Murphy's Law and allows enough room for maximum construction deviation for both the structure and the cladding system, including maximum deflection values. The architect should make it clear to the owner that even with set maximum deviations, the cladding system may not fit; it is the owner's obligation to contract for regular on-site inspection to ensure that the fabricator adheres to tolerances.

JOINT DESIGN

The design of a joint depends first on its purpose. Some joints are designed for only slight or no movement. Others must accommodate continuous thermal- or moisture-induced movement. Unfortunately, a standard nomenclature has not been established for classifying joints. There are many names used to classify building joints—*working/nonworking* and *control/expansion*, for instance. But members of the various trades who will work together on a single building use these terms differently. Architects should take care, when referring to a particular kind of joint in the specifications, to describe it in a way that will prevent misinterpretation.

Joints designed for slight or no movement provide lateral stability. They include glazing joints, isolation joints and construction joints separating large monolithic concrete pours. Large concrete monoliths that are expected to crack may also be half-sawn to control where the cracks form. Joints designed for no movement typically employ welded, embedded or tightly bolted connections.

Location and sizing of joints are based on engineering calculations specific to project conditions. Generally, slight- or no-movement joints are located in long, straight walls; at major changes in wall heights; at changes in wall thickness; above joints in foundations; at columns and pilasters; at one or both sides of wall openings; near wall intersections; and near junctions of walls in L-, T- or U-shaped buildings. Wall joints should also be carried through adjoining roof parapets.

Joints that accommodate thermal- and moisture-induced movement allow movement in all directions along the plane of a wall while resisting positive and negative forces perpendicular to the wall. Besides accommodating structural deflections, movement joints absorb the differential expansion and contraction that results from thermal and moisture gain/loss and, in some cases, resist earthquake forces. Thermal/moisture-movement joints include flexible ties to the structure, horizontal joints below shelf angles or frames supporting wall sections, and horizontal joints between wall panels and overhanging floor or roof structures. To seal such joints, the architect designs a joint cover or specifies a flexible sealant.

WATER AND THERMAL CONTROL

In curtain walls, exterior joints provide a primary path for water penetration, especially when wall materials are nonabsorbent. Masonry and concrete absorb and hold some of the water coming in contact with them, but with materials such as metal and glass, all water is free to migrate to wall joints.

For water to penetrate through a wall, three conditions must exist: 1) the presence of water, 2) an opening through which the water can flow and 3) force to drive the water through the opening (gravity, air pressure, surface tension or capillary action). Eliminating any of these three factors will result in a watertight wall.

Except in a few very arid regions, water—usually in the form of rain—is an ever-present factor. So eliminating that part of the water-penetration triad is not possible (although for lowrise buildings, overhangs can reduce the amount of rainwater that reaches a wall). The traditional approach to sealing out rain water involves eliminating the sec-

ond factor—openings to the interior—with either one- or two-stage sealant configurations. Unfortunately, with large wall faces, sealing and maintaining all openings can become impractical. The alternative is to negate the forces that would drive water through openings to the interior. This alternative strategy, commonly called the rainscreen principle, directs gravity-driven water away from the vapor-sealed exterior wall, provides capillary and surface-tension breaks, and protects the wall from air-pressure-driven water with pressure-equalization pockets.

The one-stage water-repellent system is typically a field-applied sealant connected to the two opposing joint faces, and separated from the back of the joint with coated paper, tape or a plastic rod. The joint-backing material keeps the sealant from adhering to the back of shallow joints (the added stress of which would tear the sealant) and decreases the amount of sealant necessary for deep joints (narrow beads also perform better under most conditions).

Two-stage sealant configurations are more effective than one-stage configurations in keeping water out of a building interior, but rely on the same basic principle. A two-stage sealant system can be as simple as two beads of sealant—one on the exterior wall surface and one on the interior surface of the same wall. More typically, a two-stage system incorporates a drained interior air space as well. The exterior seal blocks the bulk of outside water from entering the wall. Gravity and flashing redirect the water that breaches this primary seal to weep holes at the bottom of the wall section. The sec-

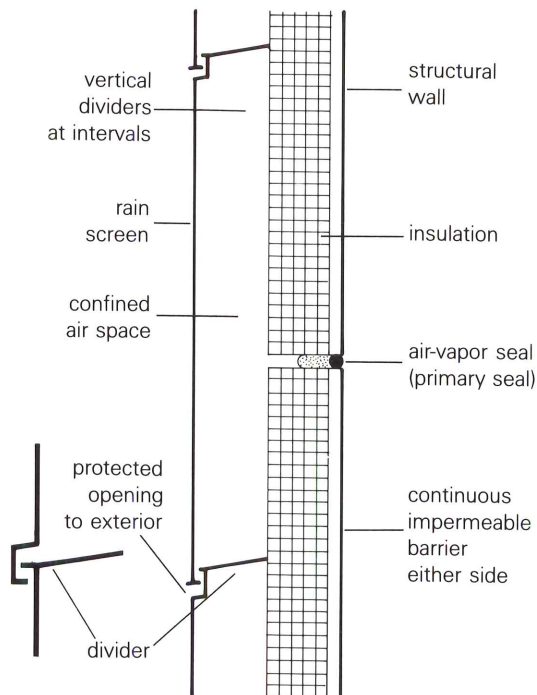


FIGURE 6
A rainscreen wall excludes water at the exterior face but allows air penetration, segments the interior air space into exterior-pressure-equalized pockets and vapor-seals the interior face of the wall.

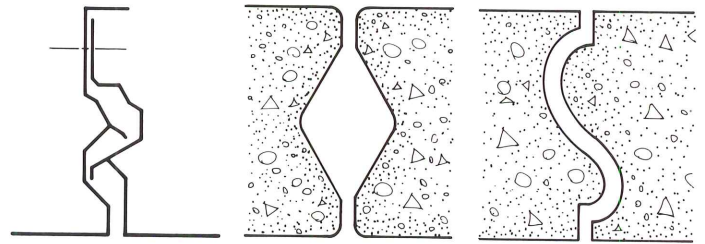


FIGURE 7
Water-baffles negate gravity, surface tension and capillary action.

ond water seal, on the inside surface of the exterior wall, stops any remaining water from penetrating to the building interior. A classic example of such a two-stage sealant system is a brick cavity wall (Figure 5).

Although two-stage sealant systems are very effective against water penetration, their performance still hinges on the sealant installer eliminating all paths for water flow. Furthermore, the exterior-exposed sealants require periodic replacement.

A detailed discussion of sealants will appear in the September/October 1986 issue of ARCHITECTURAL TECHNOLOGY.

THE RAINSCREEN PRINCIPLE

Rainscreens—wall-waterproofing systems that work by negating water-driving forces—have existed for thousands of years. An example is shingle siding. But it is only recently that researchers have recognized the physical principles behind rainscreening and have advanced their application. Rainscreening is particularly applicable to the design of curtain-wall systems for tall buildings, which are exposed to strong, multidirectional winds and intense solar radiation (which can deteriorate exposed sealants).

Though a rainscreen is similar to a two-stage sealant system, there are two significant differences (Figure 6). One is that the vapor seal is on the interior surface of the wall system, not the exterior surface. The exterior-wall-surface joints are baffled to exclude water driven by gravity, surface tension and capillary action, but are left open to air penetration (Figure 7). The second significant difference is that the air space inside the wall is separated horizontally and vertically into autonomous pockets of air. By allowing air to flow freely between the exterior and an air pocket within the wall, pressure is equalized on either side of the baffled joint opening. Consequently, all of the forces that might drive water through the wall are equalized, and only water vapor is able to penetrate to the air pocket within the wall. The vapor seal on the interior joint of the exterior wall keeps water vapor from penetrating to the building interior, and weep holes drain condensation from the air pocket.

Although the rainscreen principle is gaining favor with designers and manufacturers—witness the increasing use of the term in wall-system ads—it does have its drawbacks. Three major complications in designing an effective rainscreen are continuity of insulation, integrity of the interior vapor barrier and creation of small-enough air pockets to accommodate the rapid pressure changes that occur across the face of an exterior wall. Despite these difficulties, the

16 TONS AND WHADDYA GET?

The transition from architect's concept to the final working drawings of a cladding system is a balancing act that weighs structural integrity, ease of construction, local codes and cost. In the example presented here, the architect's initial design for a curtain wall of 5-foot-long natural-stone panels with 20-foot exterior column spacing evolved into a precast-concrete spandrel-and-column-cover system with 40-foot spandrels weighing as much as 16½ tons.

The architect, Hellmuth, Obata & Kassabaum, of New York City and Washington, D.C., designed and specified the cladding system. Contractor George Hyman Construction Company, Washington, D.C., awarded the precast contract to Arban & Carosi, Woodbridge, Va., which subcontracted production of working drawings to CHD Consultants Ltd. in association with William D. Houston Inc. and R. Sneddon & Associates Inc., all of Toronto.

HOK delineated at the outset individual responsibilities for the job. The specifica-

tions stipulated that the structural design of reinforcing and cast-in elements was the responsibility of the manufacturer, with engineering data to be submitted to the architect for approval.

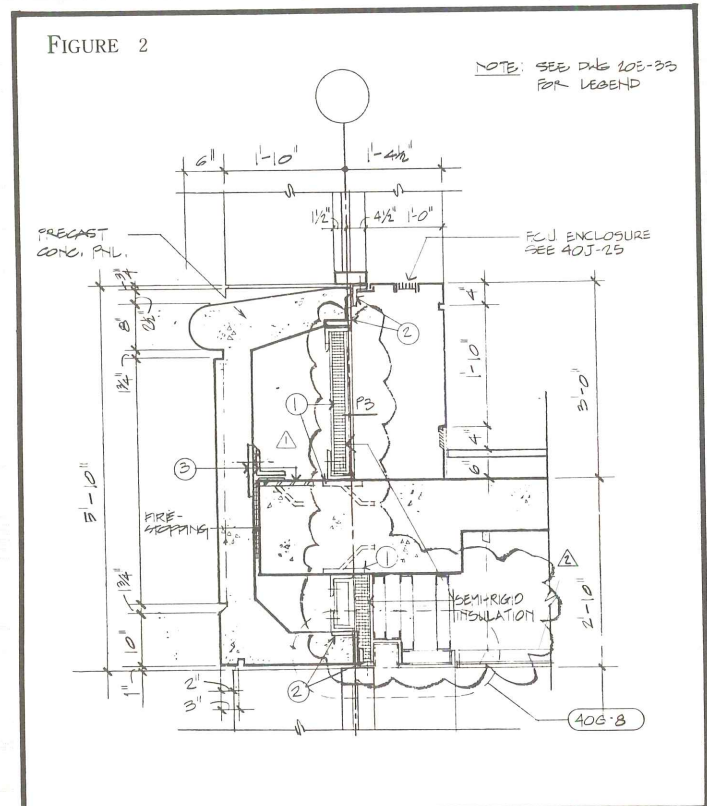
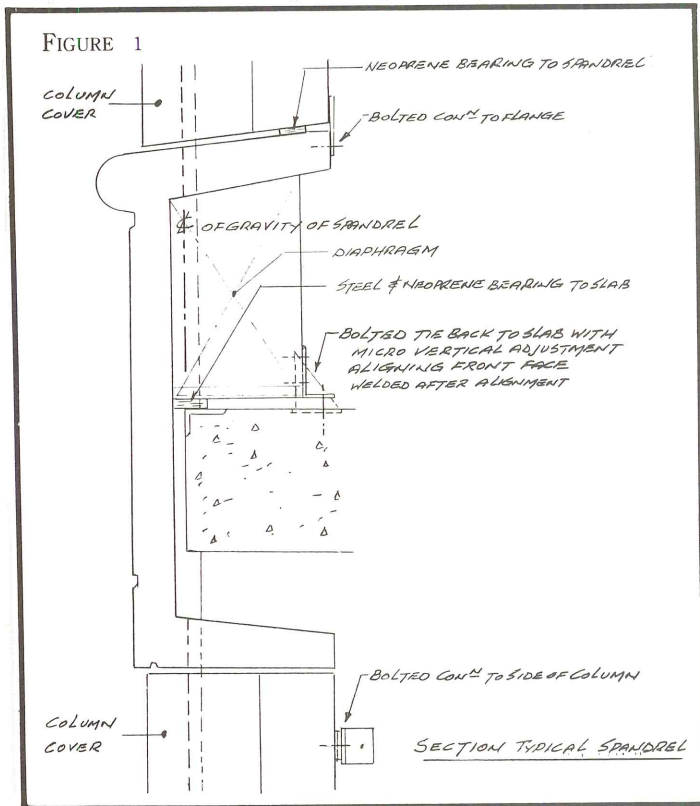
The architect designed the concrete panels to be 40-foot long and attached at points of minimum slab deflection with angles welded to the back of the panels and to the top of the floor slabs (Figure 1). At the building corners, the architect narrowed the panel height (to allow for larger windows), attaching the upper lip of corner panels to the floor slabs (Figure 2). "But we expected the precast subcontractor to make changes in the connection detailing," said HOK project manager Sam Spata, AIA. "Our drawings were diagrammatic and meant to convey design intent, they were not shop drawings," he said, citing the wording of HOK's specifications:

"Methods of fabrication and assembly . . . shall be at the discretion of the contractor (subject to approval of the architect) provided that the . . . architectural effect is not

changed, the work of other contractors is not affected, and the weathertightness and strength qualities . . . are not reduced."

At that point, wall connection design was the responsibility of the precast-subcontractor (and its consultants). "When considering design changes, we looked at several factors: ease and accuracy of construction, minimizing danger to workers and pedestrians, economy and structural integrity," said John Robson of CHD Consultants Ltd.

Cost, space-planning and engineering considerations precipitated the change from natural-stone panels to 40-foot-long precast-concrete spandrels. The cost to clad the entire building in natural stone was prohibitive, so the architect substituted precast concrete on upper floors. To meet interior space requirements, complicated by local building height limitations, the architect increased the length of structural bays from 20 feet to 40 feet. Consequently, engineering calculations indicated that even with post-tensioning of the floor slabs, the



increased spans would result in 3/4-inch sustained live-load deflections of the slabs at the center of each bay. To handle the additional deflection, HOK considered large movement joints, but found them esthetically unacceptable. The solution they reached was to attach the spandrels to the slab at points of least deflection, which are five feet from column centerlines.

The unusually large spandrels are each supported by the floor slab at two points: near the column on either end. The spandrels are also connected to the column covers, which in turn are bolted directly to the column. At corner wall sections, five one-story panels, curved in plan, were separately cast and welded together at the plant, then set on-site as a single section. Each section is connected at three points to the floor slab (Figure 3).

To ease assembly, the precast-manufacturer also changed the panels to adjust their

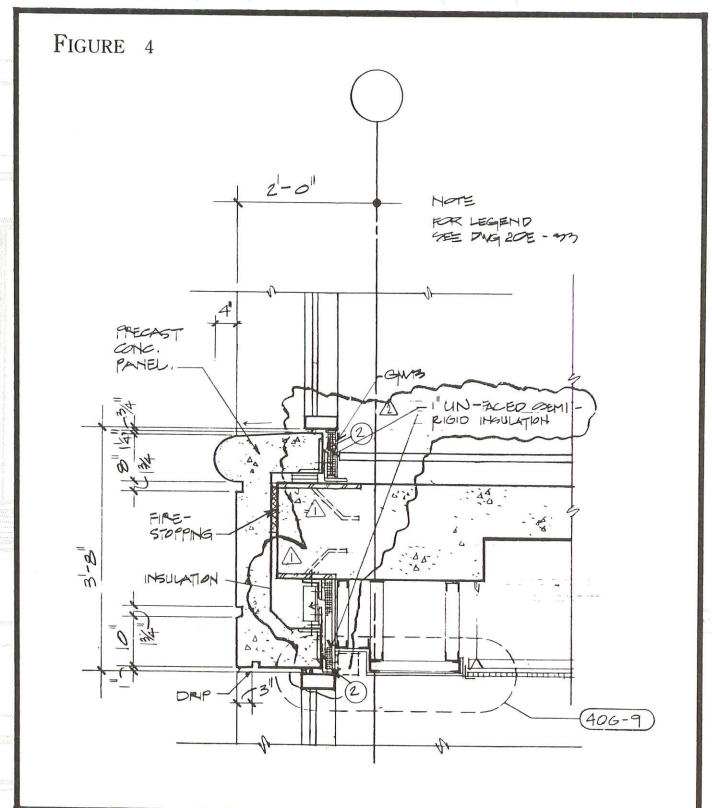
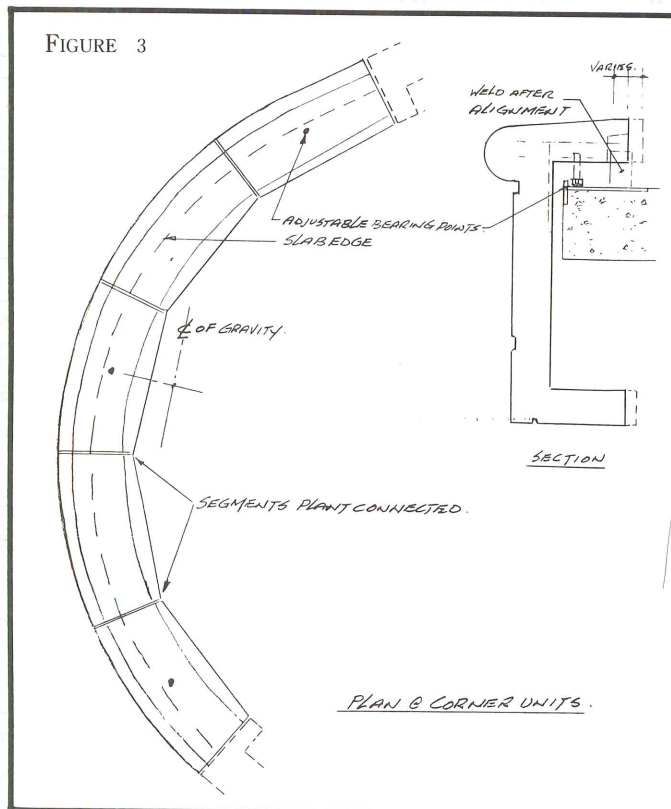
center of gravity (Figure 4). Two haunches on the back of each panel act to move the center of gravity inward to the edge of the floor slab, at the same time providing a more secure connection to the slab than the steel angles proposed in the architect's contract documents.

By placing the center of gravity at the floor-slab edge, the manufacturer was also able to design an elegantly simple means of microadjusting the position of the huge panels within the installation tolerances set by the architect.

The installation began with assemblers bolting angles to the panel haunches. A crane operator hoisted the panel into place while workers on the ground and inside the building guided the panel with ropes. Once the panel haunches were set in place on top of the floor slab (balanced on neoprene bearings at the edge of the slab), assemblers inside the building bolted the angle to steel embedded in the floor slab.

Tightening the bolts accomplished two tasks: it connected the spandrel to the slab and adjusted the angle at which the spandrel hung. As the bolt tightens, the lower horizontal edge of the panel swings outward, and the upper edge moves in. Assemblers hung all the panels on one floor of a facade, aligned the panels using the adjustment bolts, then, with sideplates, welded the angles to the embedded steel.

The cladding assembly system worked very well, and went on schedule, according to project manager, Kay Lantrip. In fact, the only major problem the assemblers faced was a side-effect of the large panel sizes. While the crane hoisted panels into place, it was necessary to block the street and divert traffic. As evidence of the success of the design/fabrication/assembly team effort, minimal design changes were required after contract documents were issued.



Rainscreens allow outside air into the wall

AAMA reports in the *Aluminum Curtain-Wall Design Guide Manual* on many successful water-resistant wall systems that have been constructed using the rainscreen principle.

Continuity of insulation is a problem because rainscreens allow outside air into the wall, and therefore the air space within the wall does not itself act as an insulator. The insulating material within the wall must alone create a thermal break. Furthermore, if the wall system is attached to metal studs, the studs may act as a direct thermal link between the exterior and interior, entirely negating the effect of applied insulation within the wall.

A second drawback stems from the fact that the barrier between the interior and the air pocket must be airtight. Otherwise, air leaking into a building during a rainstorm creates lower pressure in the air pocket than at the exterior wall surface, and outside air pressure pushes water into the outside wall joints. Making the interior wall joint airtight incurs an extra expense during on-site assembly. Neoprene flanges in interlocking wall panels are not sufficient vapor barriers, so the architect designing a rainscreen must design for and specify either airtight gaskets or field application of sealant on inside wall joints.

The fact that wind pressure is not equal across the face of a wall means that the designer must segment air spaces within the wall (Figure 8). If a one-story-high air space the full width of a building is opened at intervals along the bottom edge—as is the case with a brick panel wall with weep holes—the difference in air pressure

between the center of the wall (low relative pressure) and the edges of the wall (high relative pressure) can be significant. The net effect on the pressure in the air space, which is fairly uniform relative to the exterior air pressures, is that water may be forced into wall openings near the corners of the building.

As yet, there are no standards for the most effective sizing of air pocket segments in a rainscreen system. However, the AAMA advises that vertical closures within the wall air space be placed at building corners and at 4-foot intervals for the first 20 feet on either side of building corners. Across the rest of the face of the wall, the designer should place both vertical and horizontal closures at 30-foot intervals, and place a horizontal closure near the top of the wall, according to the AAMA. Closures should also be placed around projections and recesses where the architect expects abrupt air-pressure changes.

A specific application of the rainscreen principle is the two-stage joint used frequently in precast concrete and metal cladding systems, Stone points out. The two-stage joint is not the same as the two-stage sealant system mentioned earlier. A distinguishing feature is that the protected openings, the pressure-equalization air space and the air-and-vapor seal occur within the thickness of the cladding. Such cladding systems often incorporate rigid insulation completely sealed by the metal or concrete.

The rainscreen principle may also be used, in a rudimentary form, to increase the effectiveness of single-stage joints in thin-metal-panel

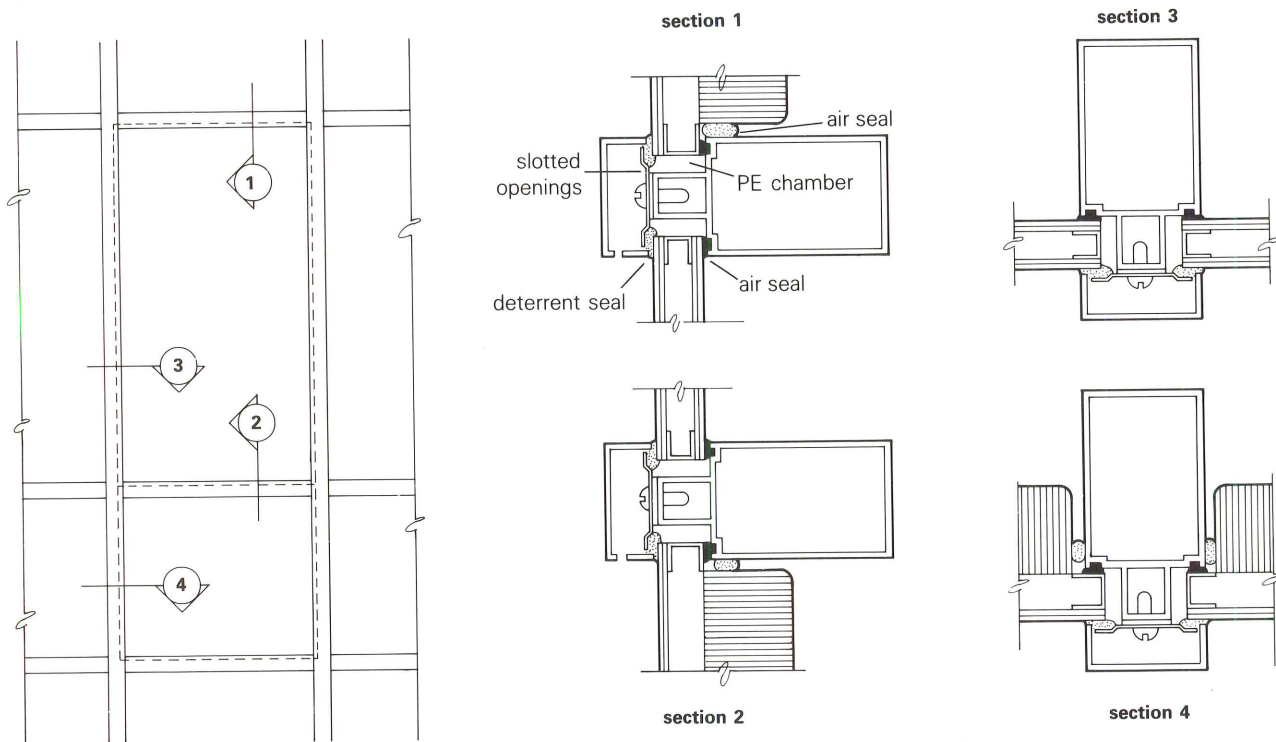


FIGURE 8

A rainscreen design divides the air space within a wall into small, discreet pockets with condensation drainage openings at the bottom of each air pocket.

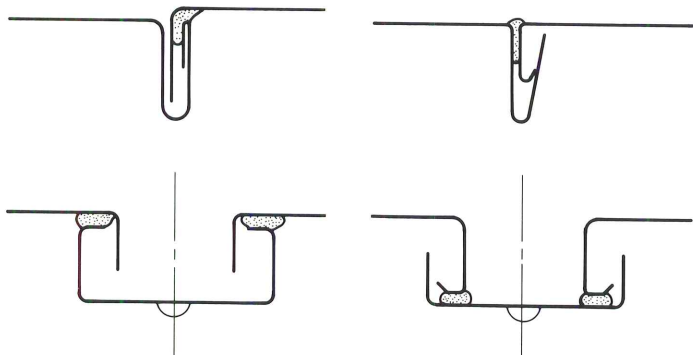


FIGURE 9

The rainscreen principle explains why sealant beads in thin-metal panels work better when placed on the inside bend of the metal joint (diagrams on the right) rather than exposed to the exterior, as is the common practice (diagrams on the left).

connections. By sealing the inside bend of the metal joint rather than the exterior edges, the sealant is protected from rain by a narrow pressure-equalized air space (Figure 9).

FIRE IN THE WALL

A penetration problem that is often overlooked in designing joints and curtain-wall connections, and one that can be concealed and overlooked during building inspections, is the existence of fire paths. Joints that are not fireproofed provide a path through the wall along which fire can jump from one floor to the next.

Smoke containment is equally important, because it is the smoke rather than fire itself that causes most fire-related deaths. All wall joints and wall penetrations should be detailed for both fire and smoke containment (Figure 10).

Codes set the legal minimums for detailing fire and smoke control devices in buildings. And many manufactured wall systems are tested and fire-rated as assemblies. However the gaps where the wall panels are joined create a prime path for fire penetration.

Typically, an inside curtain-wall surface is made of fire-resistant material, such as metal or concrete. Curtain wall joints are often baffled to eliminate paths between floors or bays. And through-wall penetrations are sealed with fire-resistant materials.

Other materials included in a wall system during assembly but not included in the fire-rated assembly may reduce the wall's fire rating, and should be monitored as well.

POINTERS ON SPECIFICATION

It is important that curtain wall documents lead to single-subcontractor responsibility on all major curtain walls, states the MASTERSPEC® section on glazed curtain walls. MASTERSPEC®, the AIA-developed specification system, offers the following comments on specifying for curtain walls:

- Currently, aluminum curtain walls are the only wall systems available that are standardized, engineered and tested enough for the architect to specify them without special testing and warranting. There are almost no competitive producers of stock-steel, cast-iron,

Test That Wall

Generally, architects should subject all custom walls to mock-up testing. Some stock systems may be excepted however. Testing is expensive and time-consuming, usually requiring six to eight weeks to perform, and may not be worthwhile under normal conditions for curtain-wall systems that have been independently tested and warranted by the manufacturer, and have a good track record.

The architect does not usually specify the testing procedure, deferring instead to the industry-standard ASTM procedures. The architect *does* specify the criteria a wall mock-up must meet to pass the tests. These criteria are established by the client program, the architect or by industry representatives, such as the American Architectural Manufacturers Association.

It is important that the same labor force build both the mock-up wall and the actual wall. This doesn't mean that every laborer be at the mock-up site, since union labor is fairly uniform across the country. But certainly the foremen for the project should be present, says Carl Hensler of Skidmore, Owings & Merrill, Washington, D.C.

Also critical is the choice of the test specimen, which should be made in consultation with the wall manufacturer and testing facility. The architect must specify testing of horizontal and vertical joints, and should include all other vulnerable elements (for instance coping or corner connections). The architect is well advised to provide the testing facility with detailed drawings of the specimen being tested and to have a responsible representative witness the test. Typically, the architect's specification directs laboratory personnel to change the design of a specimen that fails a performance test and then retest the component.

Architects usually request static-wind testing, static- and dynamic-water testing, structural-performance testing and thermal-cycle testing, says Scott Warner of Architectural Testing Inc., York, Pa., which has been conducting full-scale mock-up testing for over 15 years.

The static-air test measures air leakage under pressures of 1.57 to 6.24 pounds, which simulates the pressure generated by 25- to 50-mile-per-hour winds.

Static-water tests subject a wall to high static-air pressure and a continuous spray of water. A wind generator creates air pressure for dynamic-water testing, blowing water at a wall at the same rate as in the static-water test. Structural-performance tests measure stiffness by subjecting a wall to very high air pressures, and will often be carried to the point of wall failure to determine where the weaknesses in a system are located. Structural-performance tests incorporate both negative and positive pressure to simulate actual field conditions. Thermal cycling measures condensation properties and indicates a wall's U-value.

A Case Study in Costing

Comparing equivalent costs of different cladding assemblies is difficult because of variations in the available unit cost data. In an effort to overcome this obstacle, the Masonry Institute in Bethesda, Md., commissioned the construction consulting firm Monk Dunstone Associates, Alexandria, Va., to prepare a comparative cost study of several typical exterior wall types (with labor and materials) from the exterior wall surface to the interior finish.

Using costs current for the first quarter of 1985 in suburban Washington, D.C., the study compared common construction assemblies for commercial-office, institutional/high-quality-office, residential, and industrial building types. Summarized here are some of the unit prices quoted in the study for three commercial-office-building types, and total-cost comparisons for other types.

The itemized charts indicate the material and labor for low- to midrise commercial-office construction. Costs are based on construction of an exterior wall 16 feet wide and 11 feet high from floor to floor, incorporating a strip window 12 feet wide and five feet high. Costs included in the "Unit Cost per Square Foot of Panel" column, but not broken out in the itemized chart, are gypsum wall board (including insulation and sheathing), interior paint and aluminum strip windows plus caulking.

The Masonry Institute will be issuing its 1986 Washington Area Construction Cost Survey on July 1, 1986. Copies are free to architects. Write to the Masonry Institute, Penthouse 1, 4853 Cordell Ave., Bethesda, Md. 20814.

COMMERCIAL-OFFICE CONSTRUCTION TYPE 2*

Oversized facing brick (\$200 per 1,000).

6-inch Galvanized steel studs with exterior sheathing, 4-inch batt insulation, 5/8-inch gypboard wall lining

	Qty	Unit	\$ Rate	\$ Cost	\$ Unit Cost per Sq. Ft. of Panel
Masonry					
4-inch Brick veneer	116	sf	4.89	567.24	16.78
4-inch CMU back-up	105	sf	2.74	287.70	
Brick sill	12	lf	7.00	84.00	
Thru-wall flashing	40	sf	0.50	20.00	
Clean brick face	116	sf	0.40	46.40	
Scaffolding	176	sf	0.70	123.20	
Material hoist	176	sf	0.20	35.20	
Metals					
Metal supports and bracing	600	lbs	1.12	672.00	
Wedge inserts	5	ea	5.60	28.00	

COMMERCIAL-OFFICE CONSTRUCTION TYPE 3

Precast concrete spandrel and column-cover panels with plain finish.

4-inch Galvanized steel studs with exterior sheathing, 4-inch batt insulation, 5/8-inch gypboard wall lining

	Qty	Unit	\$ Rate	\$ Cost	\$ Unit Cost per Sq. Ft. of Panel
Concrete Work					
Precast panels, including anchors	116	sf	11.25	1,305.00	19.05
Erection	116	sf	3.75	435.00	
Caulking	16	lf	1.80	28.80	
Safing insulation	16	lf	0.80	12.80	
Metals					
Angle bracing	160	lbs	1.12	179.20	

COMMERCIAL-OFFICE CONSTRUCTION TYPE 4

Insulated metal panel

4-inch Metal stud with exterior sheathing, 4-inch batt insulation, 5/8-inch gypboard wall lining

	Qty	Unit	\$ Rate	\$ Cost	\$ Unit Cost per Sq. Ft. of Panel
Metal Panels					
Insulated metal wall panel, including supports and erection	116	sf	18.50	2,146.000	20.17
Safing insulation	16	lf	0.80	12.80	

OTHER BUILDING TYPES

Institutional/High-Quality-Office Exterior Wall Construction

	\$ Unit Cost per Sq. Ft. of Panel
1. Cavity wall with brick outer skin and CMU inner skin	20.30
2. Reflective-glass curtain-walling	30.60
3. Curtain walling with spandrelite panels	25.50
4. High-quality precast concrete panels with CMU inner skin	26.25

Residential Exterior Wall Construction

1. Brick veneer to timber-framed wall	10.00
2. Painted aluminum siding to timber-framed wall	7.45
3. Textured plywood siding to timber-framed wall	7.73

Industrial Exterior Wall Construction

1. Jumbo brick veneer with CMU wall back-up	8.53
2. Preformed metal siding with CMU wall back-up	9.20
3. Precast concrete double Tee panel	10.53

* Commercial Office Construction Type 1 is facing brick with back parging on 4-inch concrete-masonry units. Its unit cost per square foot of panel is \$17.58.

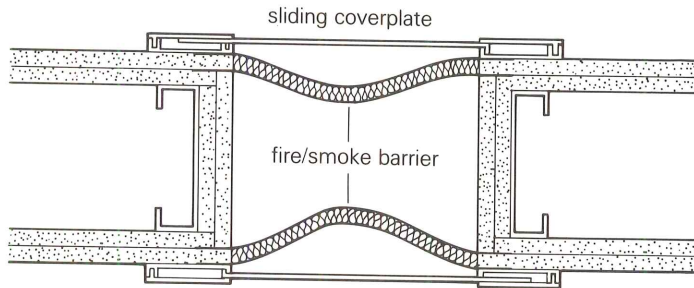


FIGURE 10

An expansion joint alone creates a concealed path for fire and smoke migration from one floor to the next. This movement joint is sealed with a flexible, fire-resistant smoke barrier.

hollow-metal, bronze, stainless-steel, plastic or wood curtain-wall systems, so the architect must custom design them.

- A custom-fabricated wall system should be carefully designed, thoroughly documented, specially tested and covered by a specific warranty.
- When architects select standard manufactured competitive curtain-wall systems, they should avoid extensive detailing on their drawings. Strict adherence to over-detailed drawings tends to reduce the number of manufacturers who can compete for the job, and usually does not result in better performance or appearance. On the other hand, too little specification of finishes, fasteners, gaskets, etc., may lead the manufacturer to use the cheapest materials able to last through the warranty period.
- Architects should use performance requirements when specifying qualitative minimums for a curtain-wall system.
- One area to be avoided in detailing stock systems on the drawings is the exact size and shape of sealants, gaskets and glazing arrangements. The architect should give the manufacturer freedom to use details that the manufacturer has tried, tested and proved workable.
- It is important when specifying stock curtain-wall systems that the architect identify several prospective and acceptable manufacturers.
- The framing system is the key element in curtain-wall work. Of secondary importance are the various materials that might be used to fill the space between the framing members, such as glass, louvers or solid panels.
- The single-subcontractor responsibility provisions work out best on stock curtain walls if the scope of that responsibility is not loaded with an excessive amount of other work, such as integral HVAC-unit enclosures or louvers, solar shades, window blinds and masonry infill. Architects should clarify in every way possible the scope of the curtain-wall contract.

"A successful building is a great achievement," concludes Robert T. Packard, AIA, Architectural Graphic Standards editor. "But even though the technology to produce a successful building is known, we find too many buildings with leaky walls, failed connections and pieces falling off. Learning the principles behind curtain-wall design is beneficial for architects, of course. But above all else, a project benefits most from quality control, practiced from start to finish." ■

References and further reading

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- Cladding of Buildings*. Alan Brookes. 1983. Longman Inc., 500 N. Dearborn St., Chicago, Ill. 60610. (312) 836-0466. A primer on nonstructural wall systems, the book's 207 pages cover precast concrete, fiberglass, glass-fiber-reinforced concrete, insulated panel, sheet metal and glass walls.
- Design Wind Loads for Buildings and Boundary Layer Wind Tunnel Testing, Aluminum Curtain Wall Series, Volume 11*. 1984. The American Architectural Manufacturers Association, 2700 River Rd., Suite 118, Des Plaines, Ill. 60018. (312) 699-7310. This pamphlet explains the AAMA's recommended procedures for determining limits of wind load in the boundary layer—the atmospheric layer from the ground up to the point where ground-based obstacles no longer affect wind characteristics.
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- Wall Systems: Analysis by Detail*. Herman Sands. 1986. McGraw-Hill Inc., 1221 Avenue of the Americas, New York, N.Y. 60018. (212) 512-2000. *Wall Systems* is informative and fun. Sands gives a cutaway perspective on the wall systems of 10 case-study buildings.

Technical Adviser: Robert T. Packard, AIA, architectural books editor, The American Institute of Architects Service Corporation.

Technical Reviewers: John Gurniak, technical director, American Architectural Manufacturers Association; Herman Sands, professor of architectural technology, New York City Technical College of the City University of New York; Peter D. Stone, associate professor, Florida A&M University.

Glued-on Glass

Examining structural silicone sealant glazing

BY M. STEPHANIE STUBBS

IT FLOATS THROUGH THE AIR WITH THE GREATEST OF EASE—WELL, it looks like it does. Structural silicone glazing, which is approaching its 20th birthday in field applications, has been primarily responsible for the large expanses of mullionless glass that appear to float on our buildings with no visible means of support. Architects have exercised this esthetic option, available in all shades, levels of reflectivity and emissivities, for a wide variety of building types all over the country.

The element that gives each individual structural glazing system its identity is the kind of glass it employs, and the kinds vary. But the common bond of all structural glazing systems is silicone sealant, the small miracle of weatherability, bonding strength and flexibility that holds glass panels together.

A silicone glazing system is considered structural if the sealant transfers the load from the glass to the back-up frame (usually aluminum), most or all of which lies behind the expanse of glass facade. Concerns that traditionally affect the design of any curtain-wall system apply for structural glazing systems as well. The glass manufacturer sets the maximum usable panel size; the silicone support system accommodates the panel size by design. Wind loading—and the internal (suction) pressure it precipitates—causes major structural concerns, particularly in highrise applications. Edge conditions deserve special attention, from visual and structural viewpoints.

THREE BASIC SYSTEMS

There are three basic silicone glazing systems:

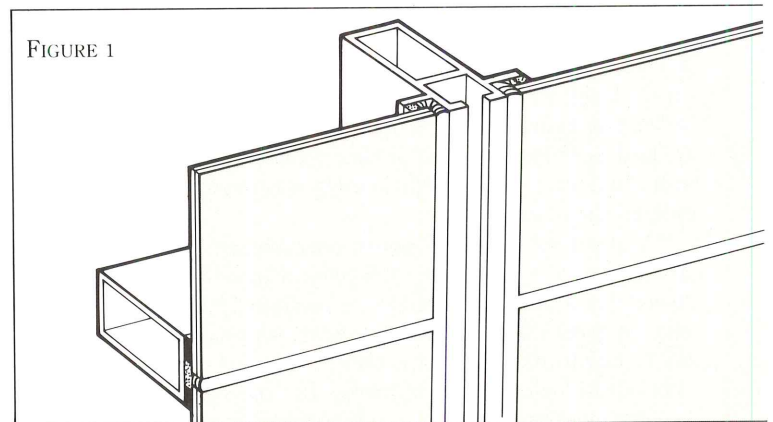
■ *Systems with silicone attachments on two sides.* These systems have glass panels attached on two opposite edges to metal pockets in the back-up frame. The other two edges of the glass are attached to other pieces of glass with structural silicone. The frame appears on the facade as either horizontal or vertical bands. This system is also called “strip window” silicone glazing (Figure 1).

■ *Systems with silicone attachments on four sides.* These systems appear as a frameless curtain wall from the outside. Each glass panel is attached with structural silicone on four edges to an interior support frame. This type of system represents the visual Cadillac of the structural glass genre, and is known as “total wall” glazing or “stopless” glazing (Figure 2).

■ *Systems with fins.* These systems use perpendicular glass mullions to stabilize glass facades, but do not use silicone sealants to attach to a structural frame; no metal subframe is used. There is some question about whether this kind of system should be called structural silicone glazing. When finned systems use panels of glass stacked more than one panel tall, the panels of glass are clipped together with metal clips, rather than fastened to each other with silicone. The glass supports its own weight (often for several stories); the silicone sealant does not help carry the load. Because of improvements in the other two types of systems, fin-type glazing is losing some of the popularity it once had (Figure 3).

According to Bill Schoenherr, construction-sealant and technical supervisor for Dow-Corning (the world's largest manufacturer of silicone sealants), approximately two-thirds of the structural glazing systems under construction today are the two-sided type. However, the four-sided type is gaining in popularity as more and more designers become convinced these systems do indeed work, and as improvements in silicone sealants make fabrication and application easier.

In silicone glazing, just as in so many other areas of construction,



M. Stephanie Stubbs, a regular contributor to this magazine, is an architectural researcher in Arlington, Va. An associate member of the AIA, Stubbs received her M. Arch. from SUNY/Bufalo.

The drawings for this article were prepared by Timothy B. McDonald, a Washington, D.C., architect, based on sketches prepared by the Spector Group, North Hills, N.Y., for inclusion in the eighth edition of Architectural Graphic Standards (to be published in 1989 by John Wiley & Sons).

the use of larger and more complicated system types has resulted in a growing number of specialized consultants. These consultants not only offer design help, but also perform field inspections, write specifications and establish testing standards—often for some of the most prominent architecture firms in the country. Architectural engineer Jack Heitmann, P.E., says there were three firms specializing in curtain-wall construction when he founded his consulting practice in 1968; now there are more than 60.

Heitmann thinks highly of structural silicone glazing systems. “The silicones are good systems,” he says. “Their potential is great, not only esthetically, but for energy efficiency. There simply is no exposed metal to transfer heat into and out of the building.”

According to Ralph Ottaiano, AIA, of the Spector Group in North Hills, N.Y., his firm will hire a curtain-wall consultant “depending on the size and complexity of the job. We definitely will work with a curtain-wall consultant if the project is a midrise or a highrise. We rely on them especially for their expertise in designing for additional loading, drainage and the removal of condensation. We also work closely with curtain-wall contractors, sometimes requiring them to make full-scale mock-ups.” Ottaiano reports that approximately half of the glass curtain-wall work that the Spector Group designs uses structural silicone glazing. The firm also often combines structural glazing with spandrel panels.

CHOOSING A TYPE OF GLASS

To design a structural silicone glazing system, most architects begin by selecting the glass. Almost any type of glass, properly applied, can work in a structural silicone glazing system. Certain types of coated or filmed glass work well only in some applications, however. In any case, each type of glass poses its own challenges. Monolithic glass in its many forms (tinted, coated, tempered, heat-strengthened or annealed) is commonly used for structural applications. Laminated and insulating glass are also candidates. For all applications, edge conditions and surface conditions help determine the suitability of a particular glass. Here are some of the special concerns that must be considered for each glass type:

■ *Tinted glass* requires calculation of potentially higher thermal stresses. It is also important that the glass be sufficiently thick to

meet design load requirements.

■ *Coated glass* may cause compatibility problems. The architect must check with the sealant manufacturer to be certain that the coating on the glass will not interfere with the adhesion of the sealant to the glass. The sealant manufacturer may also supply special guidelines for treating and cleaning the coated glass surface before the sealant is applied. Checking with the glass and sealant manufacturers can confirm that the coating on the glass specified is suitable for structural applications.

■ *Tempered glass* must be checked for bow, warp and kink characteristics to make sure they will not cause a violation of minimum *or* maximum joint requirements as specified by the sealant manufacturer or the glass manufacturer.

■ *Heat-strengthened glass* should also be analyzed for bow, warp and kink characteristics. Because of its manufacturing process, heat strengthened (and tempered) glass may be produced with visual distortions, such as oil-canning. When used in a monolithic application, the glass is not broken visually by a frame, and distortions may appear compounded. The American Architectural Manufacturers Association (AAMA) recommends construction of a full-scale mock-up to evaluate how the wall will look.

■ *Annealed glass* is suitable for structural glazing applications as long as the glass clearance and size limitations can be met.

■ *Laminated glass* requires special consideration and consultation between the architect, the glazing contractor, the sealant manufacturer and the glass manufacturer. Certain sealants can cause minor amounts of edge delamination when they come in contact with some laminates. The designer also has to consider the long-term weatherability and the adhesion of the sealant to the glass edge.

■ *Insulating-glass* applications must be viewed with a cautious eye—sealants and all materials in contact with the edge of the insulating

Figure 1: Two-sided silicone glazing, the most widely-used structural glazing system, has two opposite sides supported by a frame visible on the facade. Figure 2: Four-sided silicone glazing, with all four edges of each glass panel attached to an interior frame, appears as a mullionless facade. Figure 3: Systems with fins do not rely on silicone for structural support. Glass panels in multistory systems are attached with metal clips.

FIGURE 2

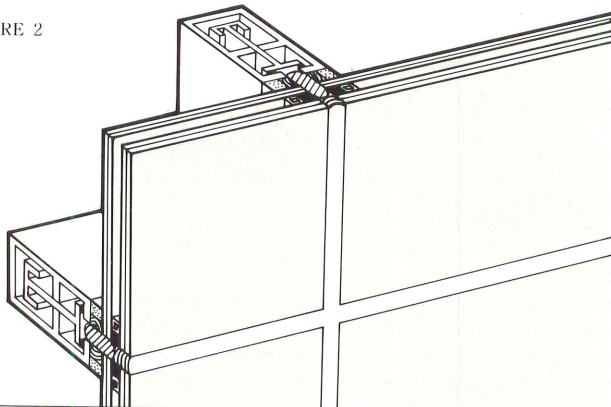
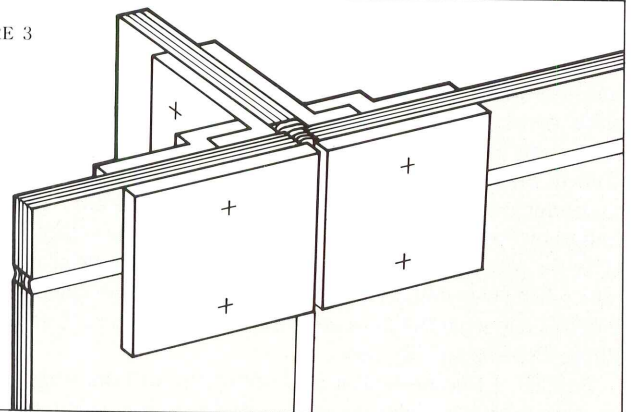


FIGURE 3



Silicone sealants are easy to appreciate

units must be compatible. Carefully checking the edge support and setting conditions for insulating units is mandatory. Permanent cushioning must be provided, as per ASTM Standard C24.32. Wind-loading criteria require that the contractor carefully check the depth of the sealant specified and installed. Drainage must be provided to avoid failure of the glass unit. And most important, because the glass transfers the load from the outer panel of the glass to the inner panel and then to the frame, it is imperative that the secondary sealant in the glass unit be structural silicone as well.

Ottiano states that the Spector Group uses insulating glass almost exclusively in its structural silicone glazing applications from Connecticut to Florida. "We do both two-sided and four-sided applications; the color and kind of glass we use develop as we refine the esthetic of the design. But because of their energy efficiency, we invariably use insulating units, and we've had great success with them." A typical section of a structural silicone glazing system, taken from a project designed by the Spector Group, is shown in Figure 4. Details for that section are shown in Figures 5–8.

WATCH THAT EDGE

Ground, polished or clean-cut edges generally fit the bill for structural silicone glazing, although clean-cut edges are the strongest and most often preferred. The sealant manufacturer will normally specify the degree of cutting imperfection permitted along the edge; often this degree depends upon the joint configuration. The architect should discuss—with both the glazing contractor and the glass manufacturer—the permissible level of common flaws caused by factory cutting, such as shark's teeth, score marks and flake chips.

Edge conditions also affect the esthetics of the wall system. Special edgework for appearance' sake may be costly and also may compromise the strength of the edge or its ability to hold the seal. A check with the sealant manufacturer will clear up any doubt.

Glass handling and installation generally follow the glass manufacturer's specifications. One cautionary note: Any oil or fluid used to cut or prepare the glass edges must be thoroughly removed during the glass-cleaning process to avoid compromising the bond between the glass surface and the sealant.

SELECTING A SEALANT

Choice of sealant is easier than choice of glass—it has to be silicone. The sealant in a structural glazing system performs three major jobs: It acts as a weather seal, it supports the dead load of the glass and it transfers wind load. When the structural silicone glazing system is in place, its large expanses of glass act like a plate system, and the silicone must be able to carry the highly variable wind load from the glass to the frame behind the facade. The sealant must also be able to accommodate movement of the glass and the back-up frame caused by thermal expansion/contraction or possibly seismic forces. Over the past two decades, only silicone joints have been able to offer strong performance in all these categories. The major structural silicone manufacturers are Dow-Corning, General Electric, Rhone-Poulenc and Tremco.

Typically, a silicone sealant for a structural application has a medium-to-high modulus of elasticity and an expected lifetime of 30

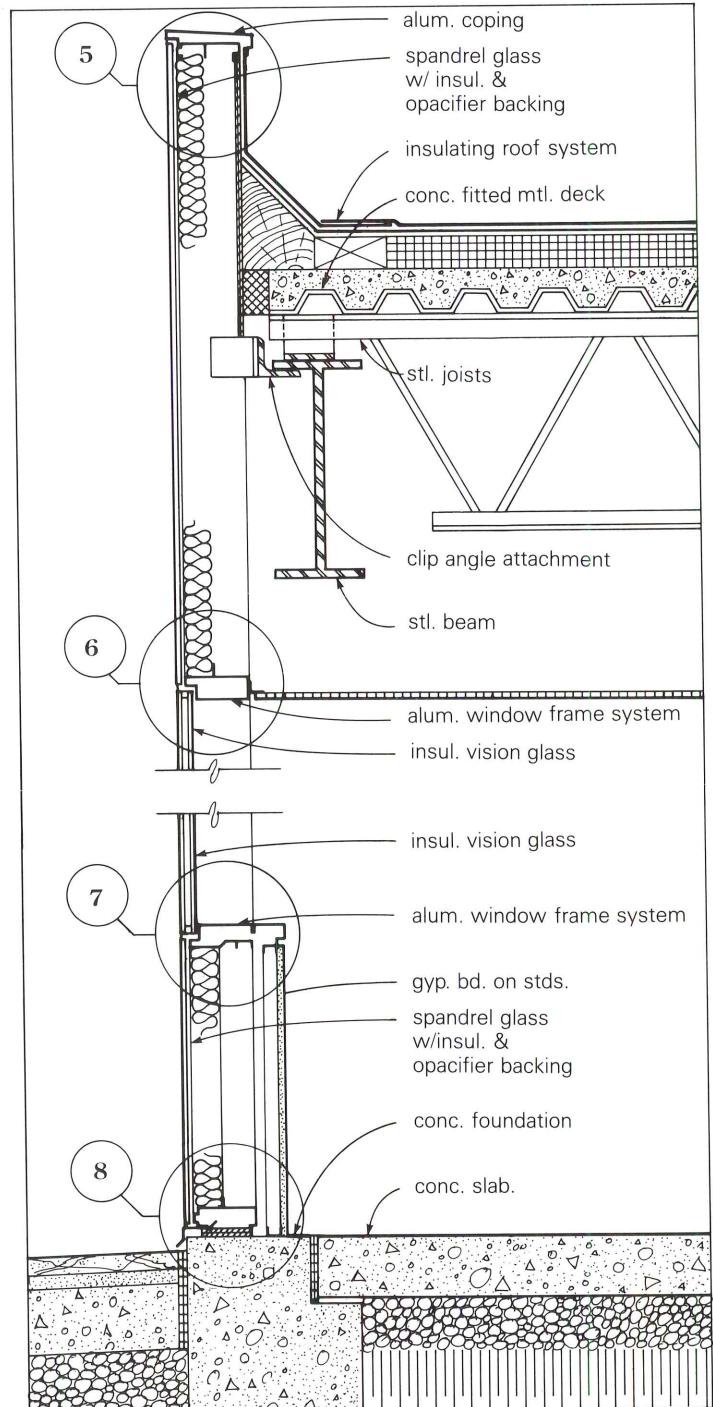


FIGURE 4 This wall section, developed from details provided by the Spector Group, shows a typical structural silicone glazing application that would be developed by this firm. This two-sided system uses an aluminum frame to hold both spandrel glass and insulating glass units that are silicone-sealed. Weather seal and structural silicone joints are separate.

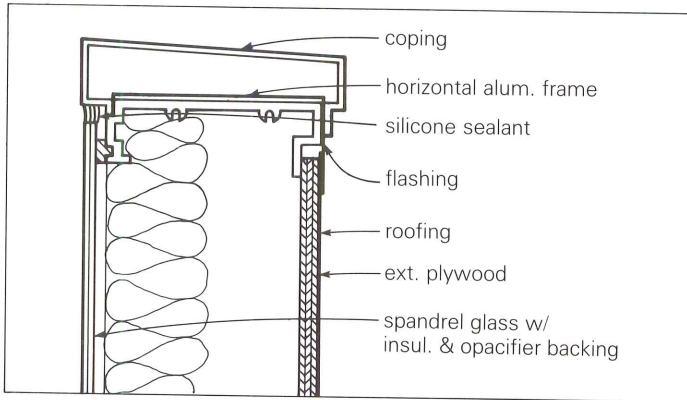


FIGURE 5
Roof Parapet Spandrel—Note clip angle attachment. Insulation at glass must be shop-applied or set back a minimum of two inches.

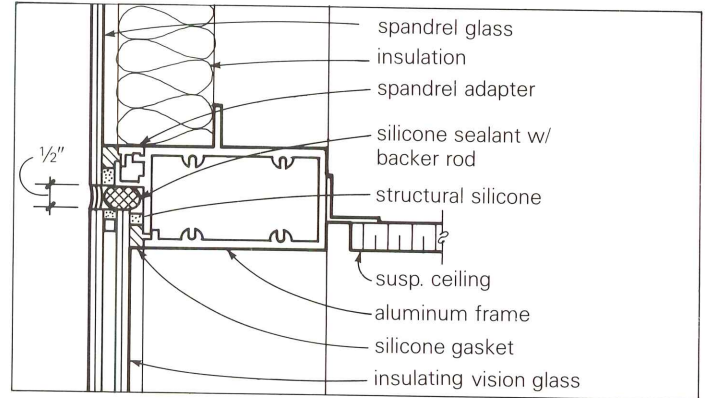


FIGURE 6
Vision Glass to Spandrel Head—Note that if insulating glass is used, setting-block clips and setting pads are required at the joint.

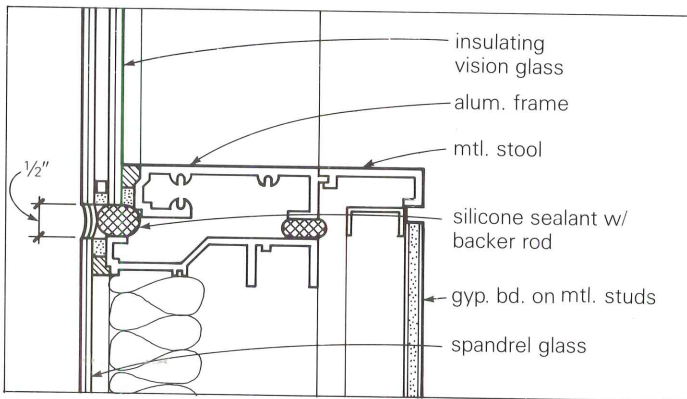


FIGURE 7
Vision Glass to Spandrel Sill—As with glass-to-head details, setting blocks and clips are required for insulating glass units.

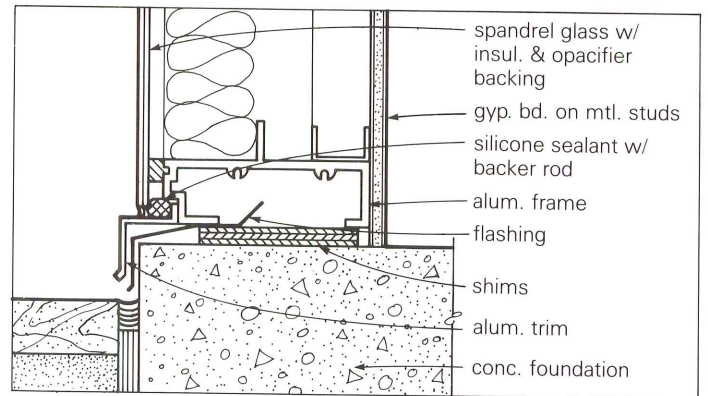


FIGURE 8
Spandrel Detail at Grade—At the foundation as well as at the wall connections, the silicone sealant is supplemented with a backer rod.

to 50 years as a weather seal. Silicone used in structural glazing applications must be of the neutral-cure type to avoid the outgassing problems of common silicone caulk, which gives off acetic acid during its curing process.

The first commandment of structural glazing design is, Contact your sealant manufacturer for advice before designing any structural glazing application. This rule makes more than good sense. Before offering warranties for structural adhesion, many sealant manufacturers require designers to consult with their technical departments. Most glass manufacturers also require the sealant manufacturer's OK, particularly for reflective-glass products. If the designer follows the project-specific written specifications, the sealant manufacturer will warrant the sealant against adhesive or cohesive failure; Dow Corning offers a 20-year warranty.

One of the newest innovations in silicones is a two-part, neutral-cure sealant (Dow-Corning 983 Silicone Glazing and Curtain Wall Adhesive/Sealant), which cuts cure time down from a typical span of 14 to 30 days to a span of 3 to 72 hours. This shortened cure time allows units that normally had to be manufactured in the field (and

temporarily braced while they cured) to now be made in the factory. The advantages are lower costs for warehousing materials and higher quality control. Schoenherr reports that currently, one year after "983" appeared on the market, 20 percent of all units for structural applications have silicone applied in the factory.

DESIGNING AND DETAILING JOINTS

Designing structural sealant joints can be difficult for reasons both apparent and not so apparent. The behavior of silicone sealants is tricky to calculate and to model because, as incompressible elastomers, they tend to defy Hooke's Law (unit stress of a material is directly proportional to the unit strain placed on a material). Each sealant joint takes force in tension, bending and shear. For example, consider the silicone bead on the back of the glass (Figure 9). Obviously, it acts in tension. However, it also acts in bending because of the tendency of the glass edge to rotate from the wind load, and in shear because of thermal, building and/or potential seismic movement. The amount of each type of stress put on the sealant joint depends on the configuration of the joint, the thickness and size of

Success depends on design-team togetherness

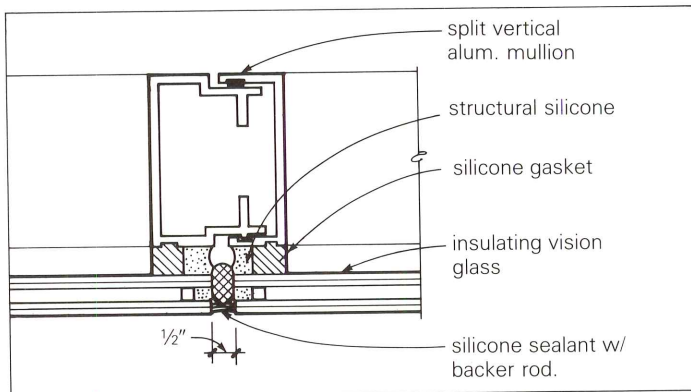


FIGURE 9
The structural silicone beads located on the back face of this application of insulating glass carry the load in tension, bending and shear.

the glass, and the connections to the framing.

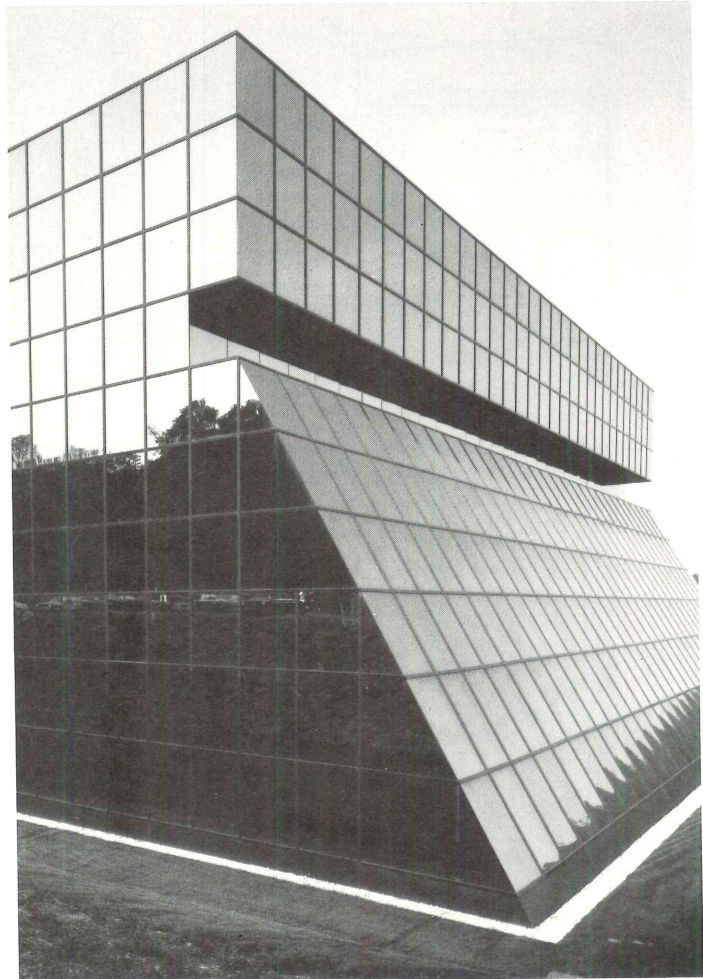
To date, there are two general types of joint configurations in which silicone has been used successfully. The first (Figure 10) uses a separate configuration for the weather-seal joint and for the actual load-carrying joints, which are located behind the glass. The second configuration (Figure 11) allows the dual-purpose weather seal/structural silicone joint to wrap around the corner of the glass. Some curtain-wall consultants only recommend this application if a bond-breaker is included.

In an attempt to preserve the “all-glass” appearance of a structural silicone system, designers are often tempted to reduce the size of the frame mullions behind the glass to a minimum. In doing so, it’s natural to expect the face bead of silicone to share a large structural load. However, the designer may overestimate the shear strength of the face bead. According to a report issued in 1984 by the Dow Corning Corporation and Michigan Technical University, the combined strength of the face beads and the back beads is not significantly greater than that of the back beads alone. This is because the back beads, being of higher modulus than the face bead, will take most of the load before the face bead will act in shear. Dow Corning therefore recommends that the designer assume that all of the shear strength comes from the back beads and that in essence the face bead be considered only as a weather seal. If the face joint is used to take the shear load, it should be designed to carry the *entire* structural load. Structural silicone joints in skylights commonly use this design.

ALUMINUM FRAMING SYSTEMS

While the glass is giving the building a distinctive and pretty front and the silicone joints are performing structural gymnastics, the aluminum frame remains in the background—strong, silent and essential. In the case of fin-type systems (with or without clips), the frame may be a suspension system with support on the ceiling and floor. With a two-sided or four-sided support system, the frame is a grid behind the facade.

Almost all structural glazing systems rely on extruded aluminum



Structural silicone glazing forms the entire enclosure for the IBM Research Group building, located in Eastview, New York. When closed, the inset operable windows yield no noticeable space or separation. Architects: The Spector Group, North Hills, New York. Photograph: George Erml.

alloy frames because they are lightweight, strong and readily available. Special care must be taken to ascertain that organic coatings and anodic finishes are compatible with the silicone adhesives. Both sealant and frame manufacturers are able to supply advice on compatibility between coatings and adhesives.

Structurally, the frame must conform to local building codes and referenced national standards, such as the Aluminum Association’s *Manual of Specification for Aluminum Structures*. The type of glass specified may factor into the calculations. As a rule of thumb, deflection perpendicular to the wall plane of any unsupported span should not exceed $L/175$ or $3/4$ inch, whichever is less.

Other considerations for framing design include appropriate edge and face clearance, provision for expansion and contraction, adequate drainage, and a means to provide spacers to hold the glass if the silicone is field-applied.

TYING THE SYSTEM TOGETHER

Although the three major components of the structural silicone glazing system all play distinct roles, the system, like most architecture, must in essence be designed as a whole. Architect Jesse Horvath, AIA, another curtain-wall consultant, explains why a team approach is important: "The architect must create a three-way concurrence among the designer, the glazing (installing) contractor and the component manufacturers. The final selection of all materials, including the sealant, gaskets, spacers and accessories, should be as recommended by the glazing contractor. It is also a good idea to get a letter from the manufacturer(s) saying that the materials and applications specified are proper for the particular project design. We must work directly with the manufacturers. With new technologies such as the silicone systems, the architect should not be placed in the position of functioning as a chemist or engineer."

It is becoming more and more common for one type of manufacturer to supply all the components necessary for the structural glazing system. Other manufacturers require that only certain components be combined with theirs to form a system. Still others offer services such as software to calculate structural loads for

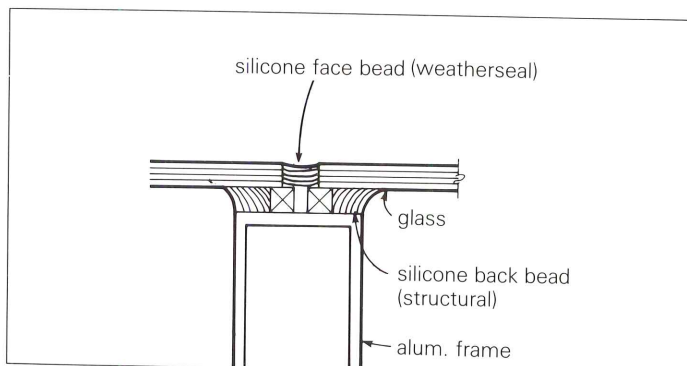


FIGURE 10
The weather seal joint (at the front face of the glass) carries no load; the structural joints are located in back of the glass.

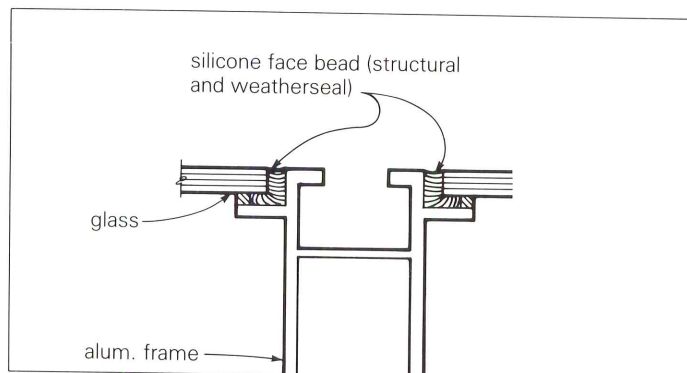


FIGURE 11
One joint serves as both a dual-purpose weather seal and a structural joint. Many manufacturers require a bond-breaker with these systems.

designs incorporating their products.

This togetherness goes beyond product warranty. In addition to stringent component testing, most structural glazing systems are required by code to be tested in accordance with AAMA/ASTM curtain-wall test procedures for water penetration, air infiltration and structural performance. Joint designs, structural integrity for insulating glass units and any out-of-the-ordinary conditions may also require testing.

Systematically speaking, on the top of the list of things architects should know about structural silicone glazing systems are material-selection and workmanship, Heitmann says. "Compatibility and application make up the Achilles' heel of structural silicone glazing systems. The silicone and the substrates—glass, frame, connections, everything down to the gaskets—must be compatible." Heitmann contends that the engineering for these systems is fairly simple and straightforward. However, the systems are "frail" in that they are dependent on workmanship for their success. Insulating glass systems rank high in vulnerability. For this reason, Heitmann & Associates insists on shop-fabricated, preglazed units to implement quality control under factory conditions. "You just can't do it in the field," Heitmann insists.

To further insure a successful job, Heitmann's firm uses some of the ASTM tests to determine the acceptability of components for a particular design application. But because the ASTM tests are for individual product performance, the firm will also write its own test standards for any particular application. Heitmann feels it is essential to test the behavior of specific material assemblies *before* the mock-up stage is reached.

Testing goes beyond the design stage. The AAMA recommends a field test for adhesion after the silicone is fully cured. Specifications for this "hand-pull" test are contained in the AAMA publication "Structural Sealant Glazing Systems" (AAMA-1985). Maintenance could also be considered part of an ongoing testing process. AAMA recommends, "Structural silicone glazing systems, like any glass installation, should be inspected on a regular basis to substantiate that damage has not occurred that would affect its structural integrity." Though the maintenance schedule should be developed in accordance with "a responsible structural engineer's recommendations," AAMA's rule of thumb is an inspection every six months for the first year, and once a year thereafter.

Architect Horvath agrees that the concept of maintenance is paramount. "Structural glazing systems are just reaching the age when we have to start worrying about long-term performance. In fact, all kinds of panel systems, including brick veneer and granite, now need close scrutiny. We should start examining the first systems that were put up just after World War II. Careful vigilance is needed, that is, periodic inspection of the connections and facade. To see that this is done is the responsibility of the owner."

In the end, no one can ignore the dollar sign attached to structural silicone systems—Heitmann puts it in the ballpark of 10 percent over the cost of traditional stick curtain wall. But when you consider the number of silicone glazing applications appearing all over the country, it seems apparent that to architects and owners, "floating through the air" is an option more than competitively priced. ■

Charting Your Course

Master strategies for organizing and managing architecture firms

BY WELD COXE, HON. AIA; NINA F. HARTUNG; HUGH H. HOCHBERG;
BRIAN J. LEWIS; DAVID H. MAISTER; ROBERT F. MATTOX, FAIA; AND PETER A. PIVEN, FAIA

*"Things are so variable you can't just sit down and write a formula."
—Overheard at the AIA Practice Management Conference in
New York City, October 1985.*

THE SEARCH FOR THE BEST WAYS TO ORGANIZE AND MANAGE architecture firms has occupied more and more attention over the past generation. The goal is always simple: Find the format that will enable the architecture firm to provide excellent service to the client, do outstanding work recognized by peers, and receive commensurate rewards in professional satisfaction and material returns. The answers, as the observation quoted above reflects, have not been so simple to find.

As management consultants with the opportunity to analyze literally hundreds of architecture firms, we have found the search for ideal management methods challenging. Each time we've observed a format that appears to work well for some or many firms, an exception has soon appeared, contradicting what looked like a good rule to follow. For example, some firms do outstanding work organized as project teams, others are very successful with a studio organization and still others get good results from a departmentalized project structure. One of the major puzzles for observers has been finding a relationship between the project delivery system used by firms (that is, "how we do our work") and how the organization itself is operated (that is, "how we structure and run the firm").

After years of study, and trial and error, a model has begun to emerge that holds promise for making some order out of these issues. At the heart of this new model is the recognition that although no one strategy fits all firms, there is a group of understandable principles with which almost any firm of architects can devise its own best strategy.

The model derives from observing that two key driving forces shape the operation, management and organization of every architecture firm: first, its choice of *technology*, and second, the collective *values* of the principals of the firm.

Technology, in this sense, refers to the particular project operating

system or process employed by the firm to do its work. The choice of technology resolves such questions as: Are we going to work in teams or departments? Will we have one design director or do we all design our own work? *Values* refers to the personal goals and motivation of the principals in charge of the firm. The choice of values answers these questions: Why do we do what we do? What do we want to receive for our efforts?

TECHNOLOGY SHAPES THE DELIVERY PROCESS

Recognition of the importance of technology in shaping architecture firms is particularly derived from work conducted by David Maister during his years as professor at the Harvard Business School. In studying other professional firms generally—especially law and accounting firms—Maister recognized a pattern in the key technologies they all use. He defines these technologies as:

- *Brains (expertise) firms*, which provide service to clients who wish to retain "the smartest kid on the block"—at almost any cost. These firms give their clients new ideas.
- *Gray-hair (experience) firms*, which customize ideas, but rarely are positioned at the cutting edge. Clients of these firms recognize that the problems they themselves face have probably been dealt with by other companies; the client therefore seeks an organization that can offer know-how based on past experience.
- *Procedure (execution) firms*, which serve clients who know that their problems can be handled by a broad range of firms and who are seeking a professional firm that can give them a prompt start, quick disposition and low cost.

Figure 1 is an illustration of Maister's model for positioning professional service firms. The diagram illustrates the relationship of these technologies and the best markets for firms that specialize in each.

The impact of different technologies on the shape of an architecture firm is profound. For example, a firm where the partner-in-charge directly executes the project uses a technology different from that of a firm where the partners hand the execution of projects over to project managers. Similarly, a firm that organizes projects around a single design director has a technology different from one that allows each project team to make its own design decisions.

Applying Maister's work specifically to architecture-firm technology, three categories—similar to the generic categories above—emerge:

- *Strong-idea (brains) firms*, which are organized to deliver singular

Ms. Hartung and the Messrs. Coxe, Hochberg, Lewis, Mattox and Piven are principal partners of the Coxe Group, Management Consultants (Philadelphia). Mr. Maister, a former professor at the Harvard Business School, is now head of Maister Associates, Management Consultants (Cambridge, Mass.).

expertise or innovation on unique projects. The project technology of strong-idea firms flexibly accommodates the nature of any assignment, and often depends on one or a few outstanding experts or "stars" to provide the last word.

■ *Strong-service (gray hair) firms*, which are organized to deliver experience and reliability, especially on complex assignments. Their project technology is frequently designed to provide comprehensive services to clients who want to be closely involved in the process.

■ *Strong-delivery (procedure) firms*, which are organized to provide highly efficient service on similar or more-routine assignments, often to clients who seek more of a product than a service. The project technology of a delivery firm is designed to repeat previous solutions over and over again with highly reliable technical, cost and schedule compliance.

It is important to recognize that there is nothing judgmental being implied about the architectural quality of any of these technologies. At their most successful, firms specializing in each technology still exhibit strength in all areas of design, service and delivery. It is the emphasis that makes the difference. This emphasis may be shifted by the preference (strengths) of the architects in the firm, or by the marketplace.

Take the hospital market, for example. The modern hospital was first the province of hospital specialists (strong-idea firms). As the ideas these specialists developed were understood across the hospital industry and the architectural profession, the center of the hospital market shifted to strong-service firms, whose strength was the ability to offer close, experienced attention throughout the very complicated process of building or rebuilding the modern hospital. After proprietary health-care clients entered the market in recent years, a share of hospital work has gone to strong-delivery firms, which specialize in adapting the standard specifications of the proprietary owners to different situations.

Obviously, these technologies often overlap. Clients frequently

want a kind of service that incorporates some aspects of more than one technology, and some architecture firms, similarly, deliver services that do not clearly fall within just one of these groups. Nevertheless, it is worth noting that there is a general progression in the way technologies evolve in every firm and every market. New ideas originate in strong-idea firms. As the ideas become understood and accepted in the marketplace, they are then widely applied by strong-service firms. Eventually, when the ideas can be routinized and are in demand by client after client, some or all of the work will move on to strong-delivery firms, where repetitive projects are turned out and efficiency is the key. Thus, it is important for firms to pay attention to how their technology matches the evolving market.

The different technologies, when they are working best, require notably different project-operating organizations, staffing patterns, decision structures, etc. Technologies in architecture firms influence:

- Choice of project process
- Project decision-making
- Staffing at the middle of the firm and below
- Identification of the firm's best markets
- What the firm sells
- What the firm can charge
- Best management style

Technology is the fundamental driving force that shapes the professional design process of the firm, and it is becoming recognized that all really successful firms have a clear and consistent project process. Those firms that try to be all things to all types of clients tend to have the most difficulty optimizing their work and/or their organization.

One immediate example is in staffing. Strong-idea firms will hire the best and the brightest right out of school and expect turnover after a few years. Strong-service firms seek career-oriented professionals and try to retain them so their experience is available to future clients. Strong-delivery firms, on the other hand, will hire

FIGURE 1

David Maister developed this "Model for Positioning the Professional Service Firm," based on analyses of all types of professional services. Within each field, Maister found that firms could be categorized by the skills they offered, and observed that the kind of work each performed reflected this. The model shown

here uses various kinds of health care as an analogy to clarify these distinctions. Consider how firms specializing in each type of service would differ in: billing practices, staffing, marketing, use of systems, management style, training and recruiting, firm size, etc.

	BACK ROOM ADDED VALUE	FRONT ROOM ADDED VALUE	
Execution-Intensive Programmatic Low Client Risk	"Pharmacy" (Familiar, Routinizable Work: Consultation Not Required)	"Nursing Ward" (Familiar, Routine Work: Consultation Service Sought)	Procedure = Execution
Diagnosis-Intensive Nonprogrammatic High Client Risk	"Surgery" (Complex, High Risk: Client Does Not Seek Involvement)	"Psychotherapy" (Complex Problem: Client Wishes to Be Involved, Advised)	Gray Hair = Experience
	Consulting Technical Skill Content of Work	Consultation Interactive Skill Process	Brains = Expertise

A way of life or a means of livelihood?

paraprofessionals and use computers to apply standard details and procedures over and over again at the most efficient cost. The senior partner in charge/project manager of a strong-service firm, who is accustomed to giving individual attention to each aspect of complex projects, is rarely geared to provide the fast, efficient, routinized service desired by the strong-delivery client. Thus, the difference in staffing models makes each technology so distinct that it would be difficult to have all three models operating in top form in the same firm. The tables that accompany this article illustrate similar contrasts in strategies for all the different areas of the firm influenced by its choice of technology.

VALUES SHAPE MANAGEMENT STYLES

The second driving force that shapes architecture organizations is the values of the professionals leading the firm. The fundamental differences in values become evident if one examines the word “practice,” which is so often used by professionals to describe their organizations, in contrast to the word “business.”

Practice, as defined by Webster, is “the carrying on or exercise of a profession or occupation . . . as a way of life.” *Business*, on the other hand, is defined as “a commercial or mercantile activity customarily engaged in as a means of livelihood.”

When the two definitions are compared from a management perspective, what stands out is the contrast between “a way of life” and “a means of livelihood.” What is becoming evident is that many architecture firms are practices first and businesses second, while others are businesses first and practices second. Therein lies a whole new perspective about what goes on in such organizations. The basic difference is their bottom line:

■ *Practice-centered* professionals, who see their calling as “a way of life,” typically have as their major goal the opportunity to serve others and produce examples of the discipline they represent. Their bottom line is *qualitative*: How do we feel about what we are doing? How did the job come out?

■ *Business-centered* professionals, who practice their calling as “a means of livelihood,” more likely have as their personal objective a *quantitative* bottom line, which is more focused on the tangible

TECHNOLOGIES	Strong Delivery	A	B
	Strong Service	C	D
	Strong Idea	E	F
VALUES	Practice-Centered Business	Business-Centered Practice	

FIGURE 2
The best organizational and management strategies for architecture firms depend on the kinds of technologies it uses and the values subscribed to by firm principals. This matrix divides firms into six categories, based on these distinctions. Each category has its own “master strategy.”

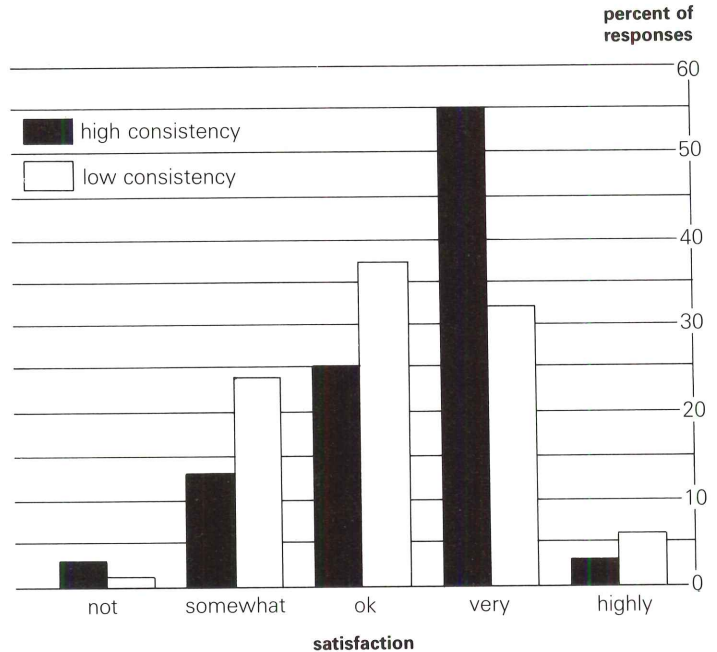


FIGURE 3

Principals of firms that fall most completely into a single category (as shown in Figure 2) report a far greater degree of satisfaction with the way their firms operate than respondents from firms that exhibit less consistency.

rewards of their efforts: How did we do?

As with technologies, it must be emphasized that there is nothing more noble about either choice of values. The choice is an entirely personal, largely self-serving one, derived from how individual architects view their missions in life and what they hope to get out of their lives in return for working.

What is important about this distinction is the recognition that although all successful architects clearly strike a balance between practice values and business values, it makes a significant difference which of the two is primary. The choice can be expressed as a spectrum with practice-centered architecture firms at one end and business-centered firms at the other.

The different positions—practice-centered versus business-centered—will lead to very different choices in significant areas of organization and management. Practice-centered firms, for example, tend to prefer partnership structures, where the leadership is collegial and decision making is often by consensus. Business-centered firms, in contrast, work well in corporate models, where there is a clear hierarchy of roles and decision making is by chain of command. The practice-centered model is frequently preferred by principals who like to work as closer/doers—getting and carrying out their own work. The business-centered model is frequently preferred by principals who see marketing as a departmentalized function, with the work handed to operating departments to carry out.

Both values can produce equally successful results in client service, design quality and even profitability. The choice of values, how-

ever, can make significant differences in the best way to structure the firm. Values in architecture firms influence:

- Organizational structure
- Organizational decision-making
- Staffing at the top
- How the firm markets
- Identification of the firm's best clients
- Marketing organization
- Profit strategy
- Rewards
- Management style

What is most valuable about recognizing values as a key force shaping architecture firms is seeing how important it is that all the leading professionals in the firm share similar goals. Depending on these values, different organizational patterns will work best. Any effort to compromise values will inevitably weaken some of the choices of organizations, and consequently weaken the firm.

MATRIX INTEGRATES TECHNOLOGY AND VALUES

When the two key driving forces described above—technology and values—are looked at in combination, they form a matrix within which the differences between firms, and the best strategies for different firms, become clear. The matrix (Figure 2) produces six basic types of firms, each of which will have a distinctive “best strategy” for each consideration described above. Examples of each of these best strategies are given in the accompanying tables (Figures 4–10).

The model gives, for the first time, a clear picture of why some

firms succeed doing things one way, while others can be equally successful doing things quite differently. Also clear is that it will be very difficult to optimize any firm that mingles too many of the different strategies. And when this recognition is combined with the understanding that the best clients and best markets for each different technology are quite distinct, it is possible to take a whole new view of how firms can best position their strengths to serve their clients.

In a recent test of the implications of this new model, the Coxe Group surveyed by questionnaire a sample of about 100 firms of different sizes, different markets and different organizational formats. After answering a series of questions to define its position on the matrix, each firm was asked to rate its level of satisfaction with the way the firm was currently operating. The results are illustrated in Figure 3. Those firms that showed the highest level of consistency in conforming to the best strategies for their position also reported the highest level of satisfaction with the way their organizations were working. The Coxe Group plans additional research to further validate the implications of the model, but this initial sample confirms the essential hypothesis. Those firms that have a clear notion of what they do best (their technology) and a common set of goals (their values) have always succeeded the best—for themselves and for their clients.

The chart below, and those on the following pages, reveal rudimentary “master strategies” for each category of architecture firm. Once a firm decides which type of practice it is (e.g. an “A,” “B,” “C,” “D,” “E” or “F” firm), it can follow the suggestions in the appropriate box to gain insight into the best ways to organize and manage the firm.

FIGURE 4 **Best Strategies for PROJECT PROCESS AND DECISION MAKING**

Strong Delivery	Projects are processed through departments or teams, headed by a principal in charge, in accordance with standard details and specifications developed through experience. The PIC makes the decisions. Success is achieved by delivering a good product over and over.	Projects follow an assembly-line process in which established standards are critically important. Since the product is standard, the client may deal with several job captains over the course of the project. Quality control is the key to client satisfaction.
Strong Service	Projects are delivered through project teams or studios whose principal in charge (the closer/doer) has a high degree of project decision-making authority. Strong, technically oriented people provide quality-control input, but project success relies on the authority of the closer/ doer.	Projects are headed by project managers and delivered by departments whose department heads have quality control and project decision-making authority.
Strong Idea	Projects are delivered via highly flexible teams, organized around each job, which take their creative direction from the idea (design) principal.	Projects are delivered via stable teams or studios, often organized around different client or project types. Design principal(s) maintains project authority.
Practice-Centered Business		Business-Centered Practice

In “strong-idea” firms, staff turnover is encouraged

FIGURE 5

Best Strategies for ORGANIZATIONAL STRUCTURE AND DECISION MAKING

Strong Delivery	Closely held as a proprietorship or corporation by one or a few design professionals who manage a vertical organization. Decision making tends to be autocratic. Thrives as long the principals stay closely involved.	“Investor”-owned by insiders or outsiders who delegate much of the operations and management. Decisions are largely based on a standardized process or SOP. Works well as long as the firm’s process/product does not become obsolete.
Strong Service	Broadly owned by professionals structured as a partnership or as a corporation functioning as a partnership. Organizational decision making is by consensus. Functions best when owners share similar professional capability and goals.	Closely held proprietorship, partnership or corporation with owners making decisions by majority rule. Decisions are clearly oriented toward meeting the goals of major owners.
Strong Idea	Owned by a sole proprietor or a few equal owners who function as partners. Their ideas and creativity in projects drive the firm, and few organizational decisions are made.	A proprietorship or small partnership (or closely held corporation functioning as a partnership). Organizational decisions are tailored to maximize the application of one or a few original ideas.
	Practice-Centered Business	Business-Centered Practice

FIGURE 6

Best Strategies for STAFF RECRUITMENT AND DEVELOPMENT

Strong Delivery	Recruit experienced professionals who are committed to getting the job done efficiently. Financial compensation—base and bonus—tend to be higher than industry norm. Limited job security, except at top.	Hire and train paraprofessionals to do maximum amount of the work via standardized procedures. Invest in training, not salary and benefits, to keep costs low, efficiency high. Factory-like culture with compensation by job classification, publishable benefit package.
Strong Service	Recruit career-oriented professionals with strong sense of commitment to client. Reward via stability of practice, good benefits, pensions—average or below-average salary. Goal is to retain experience via low turnover.	Hire experienced professionals comfortable in corporate-like structure, as workload requires. Higher pay, limited benefits. People at top are entrenched; less loyalty to staff in event workload declines.
Strong Idea	Young bright professionals are attracted to the firm to be associated with one of the leaders (“gurus”) of the profession. Typically receive below-market salary, minimal benefits and move on after a few years unless tapped to an inner circle.	Recruit young bright professionals interested in learning from the firm. Compensation often below industry norm—attraction is working on interesting projects. Turnover is encouraged as staff develop experience, want higher rewards.
	Practice-Centered Business	Business-Centered Practice

FIGURE 7

Best Strategies for SALES MESSAGE AND TYPE OF CLIENTS

Strong Delivery	Best clients are volume developers and organizations interested in reliable, proven, repeat-type solutions. Sell the firm's proven track record and knowledge and understanding of principal(s) about how to get through the system and agencies. Past clients return because of proven track record and rapport with the principal(s).	Best market is one-time or repeat client unconcerned with originality and/or clients looking only at bottom line. Sell proven product, standardized design, assembly-line ("it will only take a minute and we'll have it all done") package deal.
Strong Service	Best markets are institutions and agencies with complex projects that seek reliable solutions and expect to be involved in their project's evolution. High repeat business from well-satisfied past clients. Sell closer/doer experience, technical skills and commitment to remain on top of the job with personalized approach tailored to the client.	Best markets are major corporations and agencies with large, mainstream projects where the client expects to delegate execution of the project after making the selection. Sell proven track record, known or demonstrably competent project manager and organization's strength.
Strong Idea	Best clients are those with unique, one-of-a-kind problems, or "patrons" with individual or corporate egos to be satisfied. Clients are always the top decision makers, who may bypass input from their organization. The sales message is the reputation of the "guru" leader, and a track record of successful innovation, both design and technical, and/or solutions to uncommon problems.	Best markets are usually clients seeking leading-edge solutions that have been successfully tested by others, e.g., developers or lower-risk corporations and institutions. Clients respond to "sizzle" and messages like "innovation that is cost effective."
Practice-Centered Business		Business-Centered Practice

FIGURE 8

Best Strategies for MARKETING APPROACH AND MARKETING ORGANIZATION

Strong Delivery	Principal(s) sells one-on-one; may frequently proactively take opportunities to past clients. Effective advertising and public relations campaigns keep the principal's and firm's name in front of the market. Marketing staff supports these efforts.	Marketing is carefully planned and managed. Sales representatives find and sometimes close leads. Bidding opportunities are welcomed. Advertising promotes a standard product/service. Often rely on heavy entertainment of prospects. Blanket coverage of conventions.
Strong Service	Marketing relies on closer/doer principals strong at finding and courting clients. Facilitative marketing manager (who may be a principal) encourages broad staff participation in marketing, produces high-quality brochures, publishes a client newsletter, seeks regular publications in both professional and user-oriented publications. Good record of design awards, particularly by trade or user groups.	Centralized marketing and sales department, under a strong marketing director, is responsible for preparing the marketing plan. Frequent use of "bird dogs" to find leads, publication of articles oriented to meeting client needs, targeted direct mail, client seminars, some advertising. Sales are closed by one or a few principals who delegate work to project managers.
Strong Idea	Marketing is generally unplanned, relies almost entirely on reputation developed via books and/or articles, professional society awards, entry in premier design competitions, frequent speeches and often a faculty appointment. Marketing staff, if any, responds only to inquiries.	Marketing is actively planned, particularly efforts to get to know specific clients, seek publicity, publish articles in leading magazines and produce effective brochures. A marketing coordinator will keep the program moving.
Practice-Centered Business		Business-Centered Practice

“Strong-delivery” firms compete on the basis of price

FIGURE 9 **Best Strategies for PRICING AND REWARDS**

Strong Delivery	This firm specializes in producing a relatively standard product over and over again. It will do best charging lump-sum fees—its profits come from efficiency. Maximizing efficiency—reducing the costs of production—produces high monetary rewards for the principals.	This firm also seeks high monetary rewards, but achieves them by maximizing volume. Its standardized product and assembly-line process for delivering it thrive on volume. Thus, the firm can often bid low to keep volume up. Lump-sum fees are essential.
Strong Service	Given the choice, this firm will price all its work hourly, producing steady cash flow with moderate profits. Rewards here relate to security for many in the firm— increase in salaries, increase in benefits, share in profits, and growth to ownership.	For this firm to maximize return, the task is to focus on profitable activities, minimizing nonbillable time, carefully controlling overhead. This firm can do well on lump-sum fees, hourly rates without an upset or cost plus fixed fee. Rewards are high monetary returns for the few at the top.
Strong Idea	The essential reward for this firm is, simply put, fame. What is most important is wide recognition of the importance of the ideas because fame will bring new opportunities to develop new ideas. Economically, this firm will do best if it charges high rates based on the value—not the cost—of what it delivers.	This firm, having business values, will seek monetary rewards as well as fame. It will strive to capitalize monetarily on the innovative ideas it develops via value-added premiums, royalties and the like. It will not consider itself successful unless it makes money, as well as builds a reputation.
Practice-Centered Business		Business-Centered Practice

FIGURE 10 **Best Strategies for LEADERSHIP AND MANAGEMENT**

Strong Delivery	Authoritative owner leads firm and establishes a working environment that attracts professionals willing to subordinate themselves to, and implement, the defined management policies.	Owners delegate operations authority to managers who structure rigid processes to keep the “assembly line” working.
Strong Service	Broadly-based ownership with many equals. Can thrive on weak leadership as long as all are committed to the goals. Consistent organizational management provided by a facilitative general manager.	Owner(s) establishes leadership direction and assigns strong management authority to a CEO, who is likely to be the most influential (or majority owner) among them.
Strong Idea	Strong leadership based on ideas/values and projects precludes the need for structured management, relying rather on administrative support.	Strong leadership based on ability to draw ideas/creativity from others. Management is a coordinating and administrative function.
Practice-Centered Business		Business-Centered Practice

Warranties Defined

Owners' rights and remedies under A201

BY DALE ELLICKSON, AIA

By understanding the warranties contained in AIA Document A201, as well as general principles regarding warranties that manufacturers issue, architects can better advise their clients on the specific rights they do have and the ones they may think they have but actually don't. For example, some architects believe that the warranty in A201 protects the owner for one year only—and this may be the case. In many jurisdictions, however, protection can extend for up to 20 years—that is if the language of A201 is left intact, and is not changed to a specific, shorter time limit. This article examines the rights and remedies provided by a variety of warranties in everyday commerce and culminates in an exploration of the legal nuances of A201.

BEFORE SPECIFYING PRODUCTS, ARCHITECTS ROUTINELY EXAMINE them for function, appearance, durability and often, when other factors are similar, the warranty. Not infrequently, a superior warranty becomes the basis for a product's selection.

Most architects are acquainted with the general warranty on workmanship and materials an owner is given by a contractor under most construction contracts. We are also familiar with specific warranties that manufacturers supply with their products, either as a standard published warranty or as a special warranty that is issued to fulfill the requirements of a particular project specification. Many of us have come to believe that these documents give us and our clients added rights and remedies. Often, though, the actual remedies do not meet expectations.

Many architects assume that the *warrantee* (the party that receives the warranty) has the right to have a court enforce a specific obligation of the *warrantor* (the party that issues the warranty) to fix, replace or repair the warranted item. Another common assumption is that the duration of the contractor's warranty on workmanship and materials, under AIA Document A201 (General Conditions of the Contract for Construction), is one year after the completion of the building. Both assumptions are wrong.

A MONETARY REMEDY

Most nonlawyers think that a warranty is a promise given by a seller to a buyer to fix the article sold in the event that it breaks. This is

Dale Ellickson, AIA, senior director of the AIA's documents program, is both an architect and an attorney. Since coming to the Institute eight years ago, he has directed the Institute's work on such issues as professional liability, codes and standards and contract documents.

not so. A warranty is a *representation* given by one party to another that certain facts are correct. The representation may be 1) verbal, or expressed in writing, 2) a sample or model or 3) implied by law according to the type of transaction. The party giving the warranty is held to strict liability to the other party should the representations not coincide with facts. In addition to the warranty language, promise may also be given to repair, replace or return payment on the product or services in question if the representation is inaccurate.

In the above definition, the focus is on the *representation* of facts, not on a specific obligation to repair a product or replace it. Architects tend to miss this point and assume that a warrantor of a product is obliged to fix it if anything goes wrong. This assumption is not completely correct. Suppose, for example, a heat pump's compressor fails because its owner did not perform proper maintenance or because of metal fatigue resulting from normal wear and tear. Most product warranties specifically exclude responsibility for failures that stem from abuse or normal wear and tear. Even if the exclusion is not explicit, a court will consider these factors when asked to enforce a warranty.

A warranty is not an absolute promise to repair a defect but simply a representation as to the correctness of a fact or facts.

On the other hand, suppose the owner has maintained the heat pump correctly and it still breaks down before the end of its expected life. And suppose that the owner calls the contractor that installed it (and, often, the architect as well) and demands that the contractor live up to the warranty and fix the heat pump. Now suppose that the contractor refuses to fix it or pay to have it fixed. What remedy can the owner expect from a court? If a court orders the contractor to fix the heat pump, the remedy is known as *specific performance*. This remedy is rarely granted. A major reason is because of the difficulty a court could have in supervising the contractor's specific and exact performance over the time period needed to make the repair. Instead, the court often will render a monetary judgment sufficient to cover the expense of repair. In this case, the owner, as warrantee, will have the burden of establishing the cost of repair.

In short, a warranty is not a promise to repair a defect, but simply

A warranty is not a guaranty

a representation that certain facts are correct. An owner can obtain only monetary payment for a contractor's breach of the warranty. Usually, this payment will not cover all the owner's costs. The owner is put to the trouble of hiring another contractor to perform the repair, overseeing that contractor's work and paying legal expenses.

TYPES OF WARRANTIES—LEGAL CLASSIFICATIONS

Under the law, warranties may be classified as 1) *implied* or *expressed* or 2) *limited* or *full*.

The broad category of expressed warranties includes the written warranty card most people think of when they hear the word *warranty*. Expressed warranties may be written or verbal and may also

be indicated by a sample or model of the product. The warranties we normally find in the contract documents for construction are all expressed warranties.

Implied warranties are created as a matter of law either through common-law equity or through the Uniform Commercial Code (UCC). For example, under common law, the owner of a project warrants to the contractor, by implication, that the plans and specifications are sufficiently detailed to enable the contractor to build the project from them.

Under the UCC, which has been adopted in one form or another in every state except Louisiana, other implied warranties exist. The UCC regulates the sale of goods other than those involving real property (such as construction contracts). Even though construction contracts are not generally covered by the UCC, many secondary transactions between contractors and their suppliers involve goods covered by the UCC.

Two important implied warranties are in effect under transactions governed by the UCC: the *implied warranty of merchantability* and the *implied warranty of fitness* for a particular purpose.

A warranty of merchantability is an implication that a product will perform as a reasonable person would expect it to perform. For example, someone who buys a furnace expects that it will provide heat to their house. The warranty of merchantability mandates that the furnace work as reasonably expected, regardless of whether the buyer ever mentioned an intention to use it to heat a house.



The warranty of fitness does not apply to every transaction. When a buyer clearly tells the supplier's salesperson how he or she intends to use the product, and the product is sold based on that purpose, then a warranty of fitness for that purpose attaches to the transaction. For example, in selecting a product, an architect tells a manufacturer's representative the purpose for which the product will be used. The representative confirms that the product will work and the architect specifies it. If the owner purchases the product directly, it is very likely that a warranty of fitness attaches to that purchase.

In most cases however, an intermediate party, the contractor, does the purchasing. If the specification says that there is only one proprietary product that the contractor may purchase, then, clearly, a warranty of fitness has a good possibility of being proven in the owner's behalf. If, however, the contractor has discretion of choice, especially when an "or equal" clause is added to the specifications, substantial doubt may arise about the existence of a warranty of fitness.

When reviewing a proposed product, architects may wish to make a practice of discussing the specific application with the manufacturer's representative and taking notes that outline the substance of the discussion.

Warranties may also be classified as limited or full warranties—but these categories apply only to written warranties provided by manufacturers of consumer products. These warranties are fairly recent classifications, enacted into law under the Magnuson-Moss Warranty

Act of 1975. For a product to fit this system of classification, it must cost more than \$15. It must also be intended for the personal use and consumption of the purchaser rather than for resale in the normal course of business. These categories of warranties have very little, if any, impact upon the commercial construction project. Occasionally, however, they are encountered during a project since manufactured products may be purchased in both consumer- and business-use contexts.

The Magnuson-Moss Act requires manufacturers to make the warranty available for review by the consumer at the time of sale and to label the warranty as either a full or limited warranty. A full warranty states the duration of the warranty and notes that the product will be repaired "within a reasonable time and without charge" (costs of removing and reinstalling the product are paid for as well). Furthermore, the warranty states that there is no limitation on any implied warranties. A limited warranty imposes certain costs and risks on the consumer. Perhaps it will pay only for parts and require the consumer to pay for labor, or it may limit rights otherwise available under implied warranties.

Adding to the confusion of the definition of *warranty* is the tendency to use it interchangeably with *guaranty*. Those who have sought precision in the language have often claimed that there is some real difference between the two words. Etymologically, however, they are derived from the same root, *guaranty* coming to use through the French and *warranty* through the Anglo-Saxon.

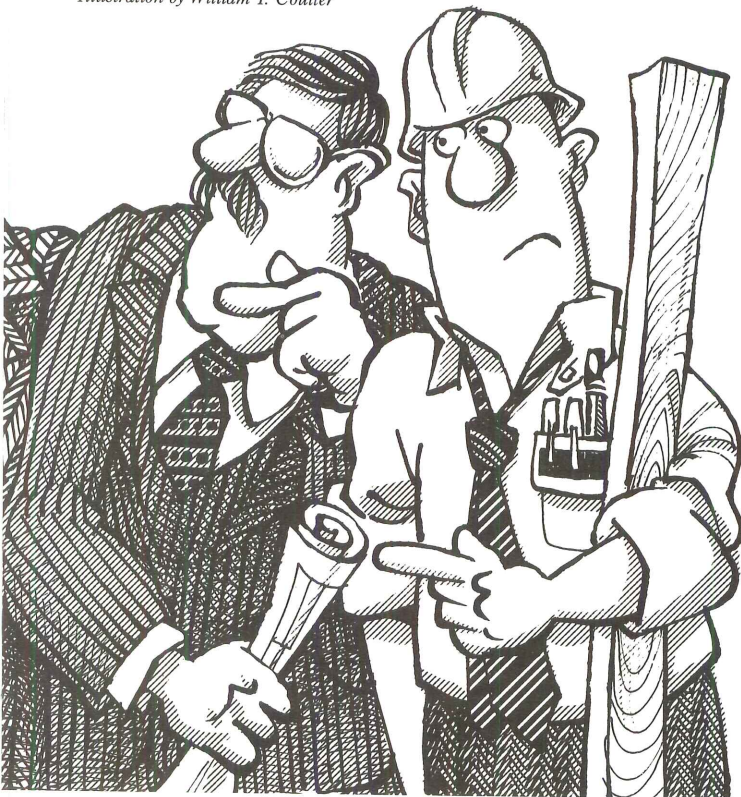
In law there is indeed a subtle difference. A guaranty is a third-party contract wherein the performance of a second party is guaranteed to a first party. If the second party fails to meet the obligation, the third party will. This contract is similar to a surety's obligation—for instance, on a construction performance bond. A surety, however, adopts the contract of the first and second parties (for example, owner-contractor contract) into the surety's contract (for example, performance bond) and becomes jointly bound in all the terms of the prime contract (for example, owner-contractor contract). The contract of a guarantor is a stand-alone contract (similar to a warranty). The guarantor agrees by that contract to provide, to the second party, substitute performance should the first party default.

To end the confusion between the words *warranty* and *guaranty*, the AIA adopted a rule that the preferred term is *warranty*. The AIA has not always abided by this rule. The term *guaranty* has appeared in AIA documents, including a document entitled Guarantee of Bituminous Roofing (AIA Document 331—now discontinued).

CONSTRUCTION INDUSTRY CLASSIFICATIONS

Expressed or implied warranties and limited or full warranties are terms and classifications not customarily used by architects, owners and contractors. Instead, we are familiar with three kinds of warranties: 1) the *general warranty of workmanship and materials* given by the contractor under AIA Document A201 (specifically in Paragraph 4.5); 2) the *standard warranties* published by manufacturers for their particular products (they are standard only for that individual manufacturer and not for the industry) and 3) *special warranties* required for certain critical components, such as roofing.

Illustration by William T. Coulter



A201, Paragraph 4.5 is the important one to study

In common parlance, we might call these *general, standard* and *special* warranties—although these terms have no particular legal meaning. (These classifications overlay with the legal terms discussed earlier.)

General, standard and special warranties are all expressed warranties. Many manufacturers' standard warranties, because of the Magnuson-Moss Act, also carry the title *Limited Warranty* or *Full Warranty*.

The 1976 edition of AIA Document A201, General Conditions of the Contract for Construction, contains two expressed warranties made by a contractor to an owner. In Paragraph 4.5, the contractor warrants workmanship and materials to be free from defects and in conformance with the contract documents. In Subparagraph 9.3.3, the contractor warrants the *passage of title* for all work to the owner. Because product failures are more frequent than breaches of warranty for lack of clear title, Paragraph 4.5 is an important one to study. There are substantial misunderstandings about the remedies an owner has under this warranty of workmanship and materials. Also, there is confusion about the duration of this warranty.

Most manufacturers publish preprinted warranties for their products as standard practice. These warranties are often given to the owner at the end of the project by the contractor. In addition to such *standard warranties*, the owner may, through the architect's specification, require the contractor to furnish a *special warranty* signed by the contractor, the manufacturer's representative or both.

Special warranties are usually intended to extend the terms of standard warranties to encompass more rights for the owner, or to entail longer time limits. For example, a specification may require a five-year warranty instead of the manufacturer's standard one-year warranty.

Two problems may arise from the use of special warranties. First, the special warranty may state a time limit that is longer than the standard warranty but less than the general warranty of A201 (the latter is determined by the applicable statute of limitations). Although this time-limit expansion may extend the liability of the manufacturer, such a warranty would be interpreted to supersede the contractor's general warranty and thus reduce the contractor's liability. Second, the time limits of the special warranty may be so excessive as to render it difficult, if not impossible, to find a manufacturer willing to commit to such a broad warranty.

Thus, in changing from the manufacturer's standard warranty to a special warranty, care must be taken to consider the effect on the contractor's general warranty, and especially the impact on the statutory limits of that warranty.

CONTRACTOR'S OBLIGATION TO CORRECT WORK

An owner's remedy for breach of warranty is money damages. Most owners, however, expect that they should have the right to demand that the contractor *fix* a problem rather than merely pay money for the owner to have it fixed by someone else. So strong is this expectation that general contractors complain about building owners who assume that the contractor is obliged to maintain building components through the duration of the warranty. A general warranty of workmanship and materials, such as that contained in Paragraph 4.5 of AIA Document A201, is not a maintenance agreement *or* a form of

insurance. The owner still must act prudently to maintain the property and protect it from loss through proper care and attention.

Nevertheless, the writers of AIA Document A201, from 1911 to this day, have attempted to address the reasonable expectations of the owner through another provision of the document. Under Paragraph 13.2, "Correction of the Work," the contractor is given the specific obligation to "promptly correct all work rejected by the Architect as defective or as failing to conform to the Contract Documents, whether observed before or after Substantial Completion. . ." This provision is intended to set the stage for a request from the owner for the additional remedy of "specific performance," which is normally denied under the warranty provisions. *Specific performance* is an equitable remedy granting the exact performance of the contractual provisions. This provision does not, however, assure that specific performance will be granted in every instance. The owner must show that 1) money damages would be difficult to prove, 2) substitute performance by means of a money award would be inadequate or 3) damages would probably not be collectable. Because of the unique nature of most construction sites, the second factor is the one usually referred to in requesting specific performance under construction contracts. For example, the contractor may be the only party who knows the exact location of buried utility lines, or may have the only granite quarry that can supply granite of matching color and grain to repair a granite facade.

DURATION OF WARRANTY

Many people read the warranty and correction-of-work provisions of A201 as being two parts of the same remedy, and believe that the warranty is limited in duration to one year. Many federal and state construction contracts contain warranties of workmanship and materials that are limited to one year, so A201 does the same thing, right? Wrong! The general warranty contained in Paragraph 4.5 has no stated time limit. The duration of the warranty is determined by the relevant state or federal statutory limits. In some states, this period is two or three years. In others, it may be as long as 20 years if the contract is made under seal. On the other hand, the correction of work provision contained in Paragraph 13.2 (sometimes erroneously referred to as a "guaranty") is limited to one year "after the Date of Substantial Completion . . ." (Subparagraph 13.2.2). As further stated in Subparagraph 13.2.7, "Nothing contained in this Paragraph 13.2 shall be construed to establish a period of limitation with respect to any other obligation which the contractor might have under the Contract Documents, including Paragraph 4.5 hereof."

In sum, the general warranty and correction-of-work provisions have been written as separate remedies and with different durations. For breach of warranty, the owner may receive money damages up to the time limits specified in the statute of limitations. For breach of the correction provisions, the owner may receive "specific performance" if certain preconditions are met, but the time for correcting the work is generally limited to a year after substantial completion.

Warranties are a good device for assuring a remedy to the owner for the failure of a product. They are not insurance, and they will not give the owner exact performance of a contract. Other provisions of the A201 Document related to correction of work give the owner nearly what is expected—but not always. ■



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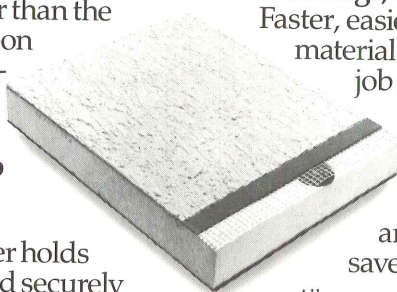
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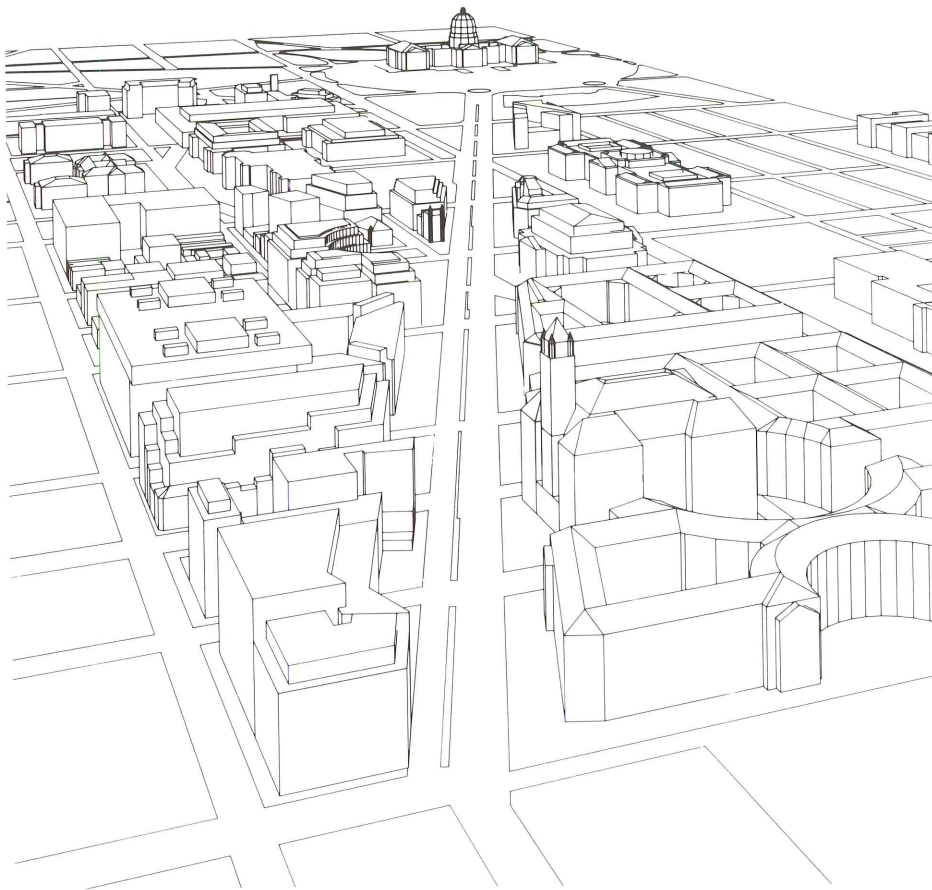
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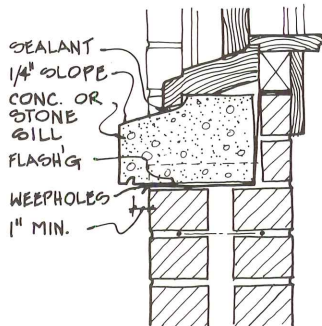
HISTORY LESSONS

THESE TIPS ON RENOVATING and restoring buildings come to us courtesy of the AIA's Committee on Historic Resources. The committee regularly collects practical hints from its membership and publishes them in its newsletter, *Preservation Feedback*.

PAINT AND LIGHTNING DON'T MIX

Keep the cables that ground lightning rods free of paint. Paint impairs the ability of the cable to dissipate lightning energy, making it possible for the cable to explode. Mount the cable 1 inch from wall surfaces to allow the wall to be painted without endangering the cable's effectiveness.

—Dennis Brown, AIA
Washington, D.C.



SLOPE THE SILLS

When renovating existing buildings or historic structures, do not take for granted the ability of door and window sills or cornices to shed water. Tooling an imperceptible 1/4-inch slope into stone sills can correct a common and continuing moisture problem. Stone coping or stucco caps on parapets often require a new cant or crown to correct a poor detail or construction practice.

—M. Allen McCree, AIA
Austin, Tex.

TENSION BARS SAVE MASONRY

Preservationists working on the penitentiary in Port Arthur, Tanzania, have discovered a simple yet effective method for repairing tension cracks in masonry walls. The masons restored brick structures that suffered

structural damage from fire and resulting thermal expansion and contraction.

The repair process the preservationists used involves inserting a flat bar into the horizontal joints. Anchors on the bar lock into the perpendicular joints. The system therefore acts like reinforcement in concrete beams by providing horizontal and ver-

tical strength, and by equally distributing the load along the weight of the wall. Its ability to carry loads is independent of the wall's mortar strength. The system offers the additional advantage of being unobtrusive.

To install the remedial support system, workers cut slots into the brick wall with an abrasive wheel and rake out vertical



The fine detailing of the Landmark Center in St. Paul, Minn., by the two firms Winsor/Faricy Architects and Perry, Dean, Stahl and Rogers, offers many history lessons of its own. Built in 1892, this AIA Honor Award winner now houses commercial activities.

joints. They then slide in a tension bar equipped with riveted, T-shaped stops that fit into each vertical rake (see right).

The stops act as a positive locking mechanism against the headers in the wall. Corners receive special connection pieces. Masons then grout-fill and point up the joints to match the original brickwork.

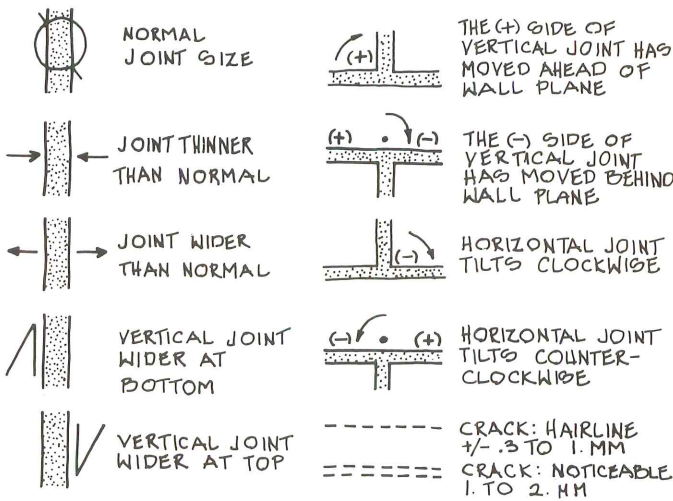
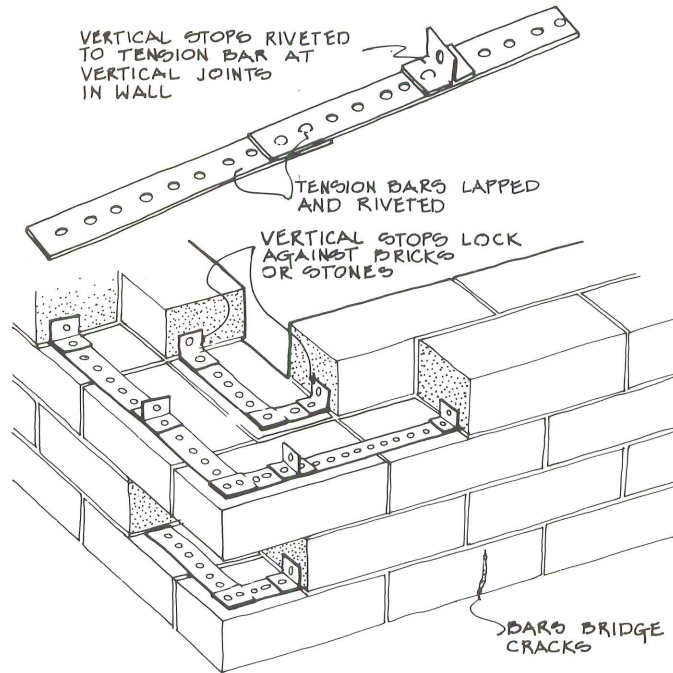
—Brian J. Egloff
Port Arthur Historical Site

PHOTOGRAMMETRY HELPS MEASURE CONDITIONS

Inspect and monitor hard-to-reach building features with close-range photogrammetry. Photogrammetry means measuring by photography, and techniques vary from the simple (using inexpensive hand-held optical squares containing prisms and standard camera equipment) to the sophisticated (involving special cameras). Viewing paired negatives through a stereo plotter makes three-dimensional distortions or defects readily apparent. The architect can print condition notations right on the drawing or photo. The notes can indicate where repairs are needed and can serve as a base record for monitoring change. Henry Chambers, at the National Park Service, recently developed a notation system for these observations that may become the universal standard (see right).

A good way to learn more about photogrammetry is to order *Using Photogrammetry to Monitor Materials Deterioration and Structural Problems on Historic Buildings*. It's available from the Government Printing Office for \$1.75 prepaid. (#024-055-00969-8).

—Lee H. Nelson, FAIA
Washington, D.C.

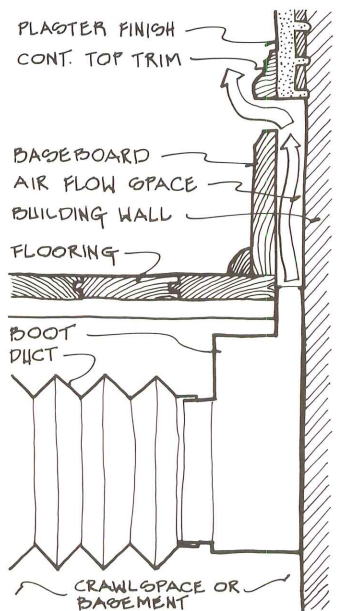


- A - ANCHOR STAR
- C - CHIPPED EDGE
- D - SCUPPER
- E - CHIPPED CORNER
- F - CRACKED FACE
- G - GRAIN OF STONE
- H - HAIRLINE CRACK, PATCHED
- I - HAIRLINE CRACK, OPEN
- K - METAL CLAMPS
- M - MORTAR
- N - NEGATIVE BLENDISH
- P - PATCH
- Q - WARPED SURFACE
- R - COPPER STAIN
- S - STAIN
- T - TARGET, PHOTOGRAMMETRIC
- U - UNKNOWN CHECK
- V - VANDALIZED
- W - LIGHTING CONDUCTOR HOLE
- X - MORTAR JOINT UNSYMPATHETIC
- Y - MORTAR JOINT WORN

GIVE REGISTERS THE BOOT

The architect may find that the right place to "hide" a mechanical air register is in a baseboard along the wall. On the average, a 2-inch-wide boot with a depth of 18 to 24 inches should effectively distribute or return the air. A 1/4- to 1/2-inch-wide slot between the baseboard and top trim mold works with this size boot.

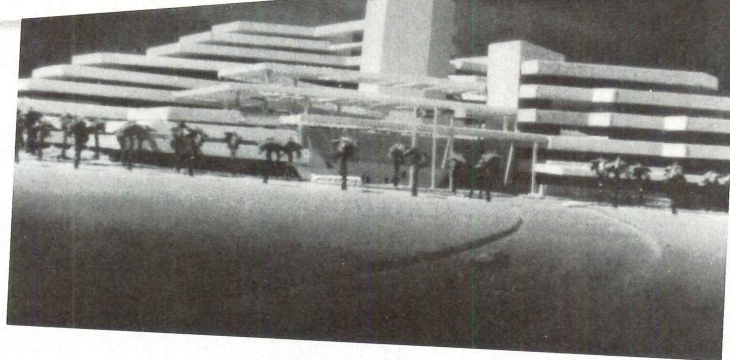
—Paul D. Marshall, AIA
Charleston, W. Va.



This issue's Technical Tips was edited by M. Stephanie Stubbs.

Special thanks to Hugh Miller for his help. Miller asks architects to send them to him at the National Park Service, P.O. Box 37127, Washington, D.C. Miller's telephone number is (202) 343-8146. AIA committees (and readers) who wish to contribute technical tips regarding other areas of professional practice should contact their committee's AIA staff liaison or call associate editor Doug Gordon at (202) 626-7482.

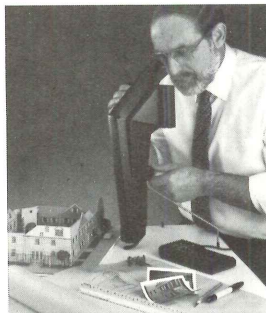
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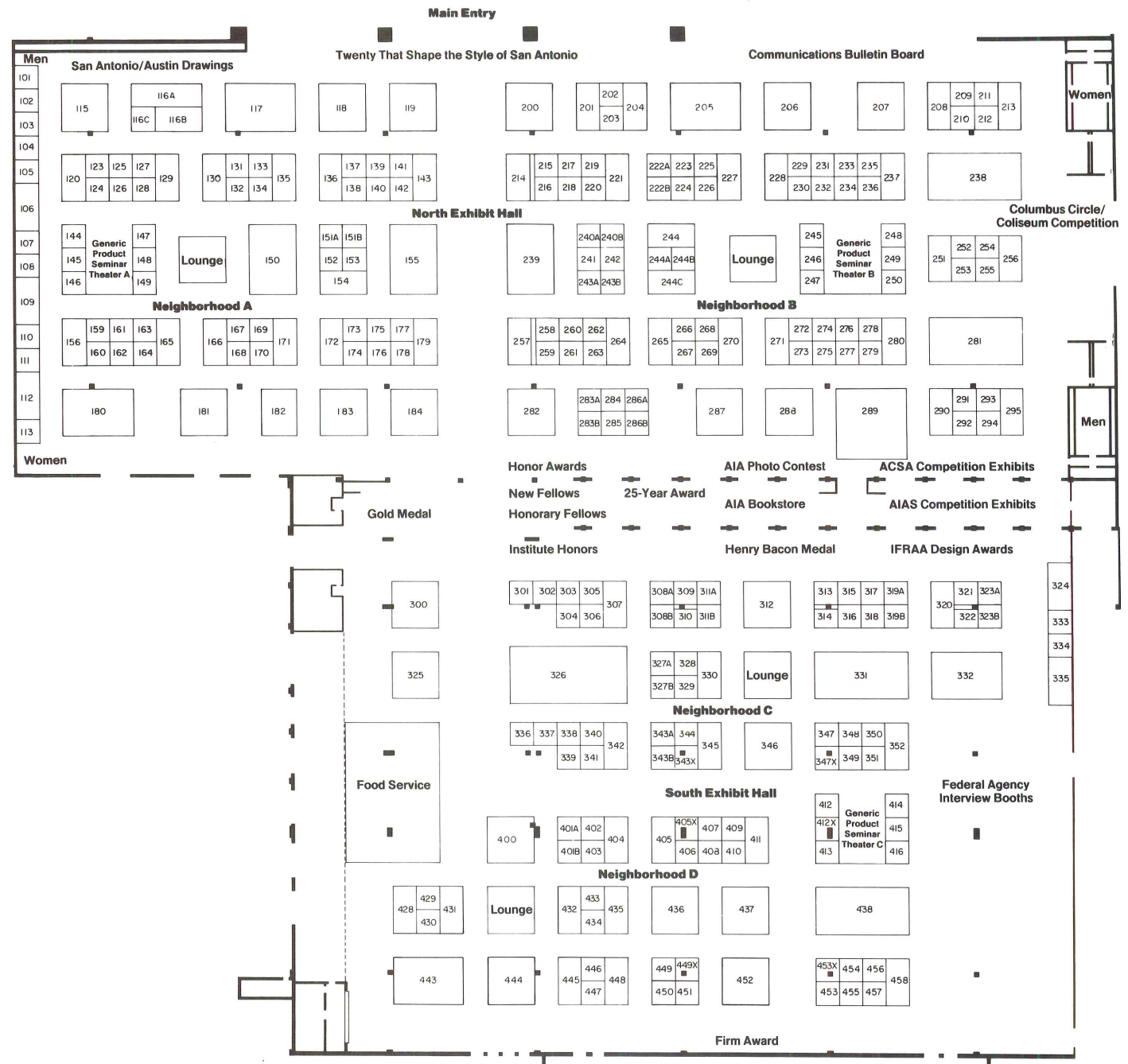
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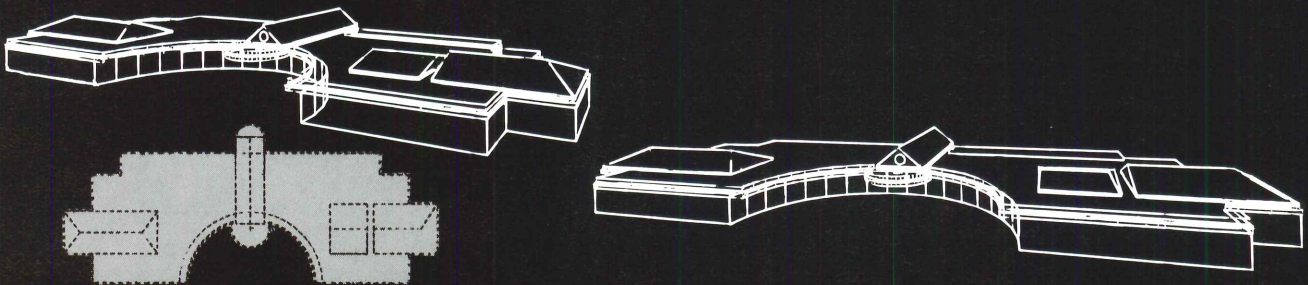
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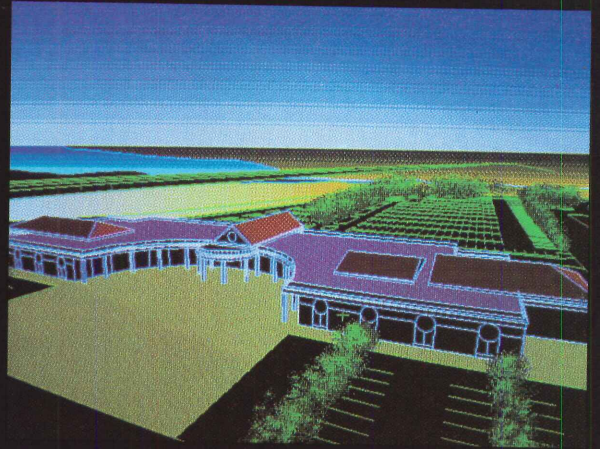


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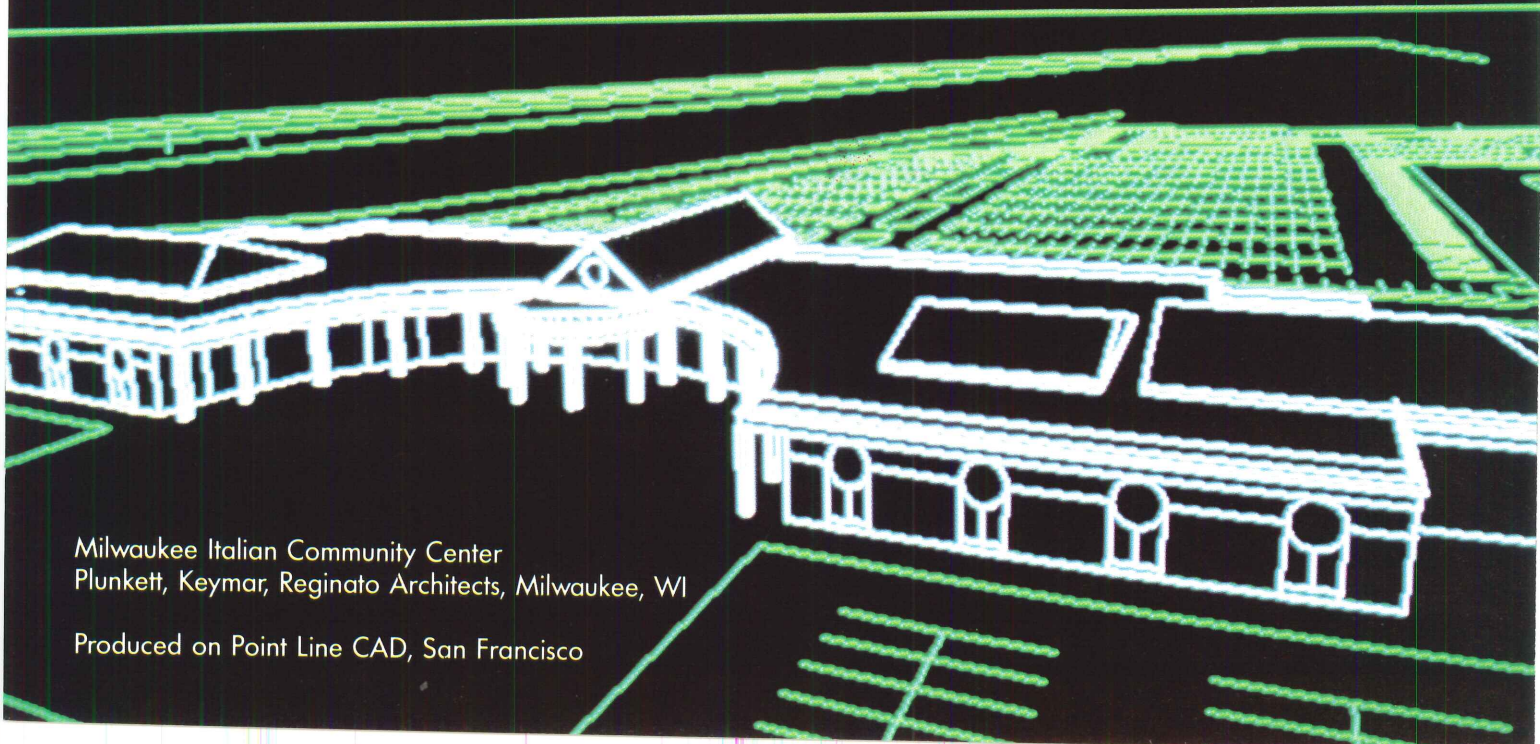
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COMPUTERS IN ARCHITECTURE



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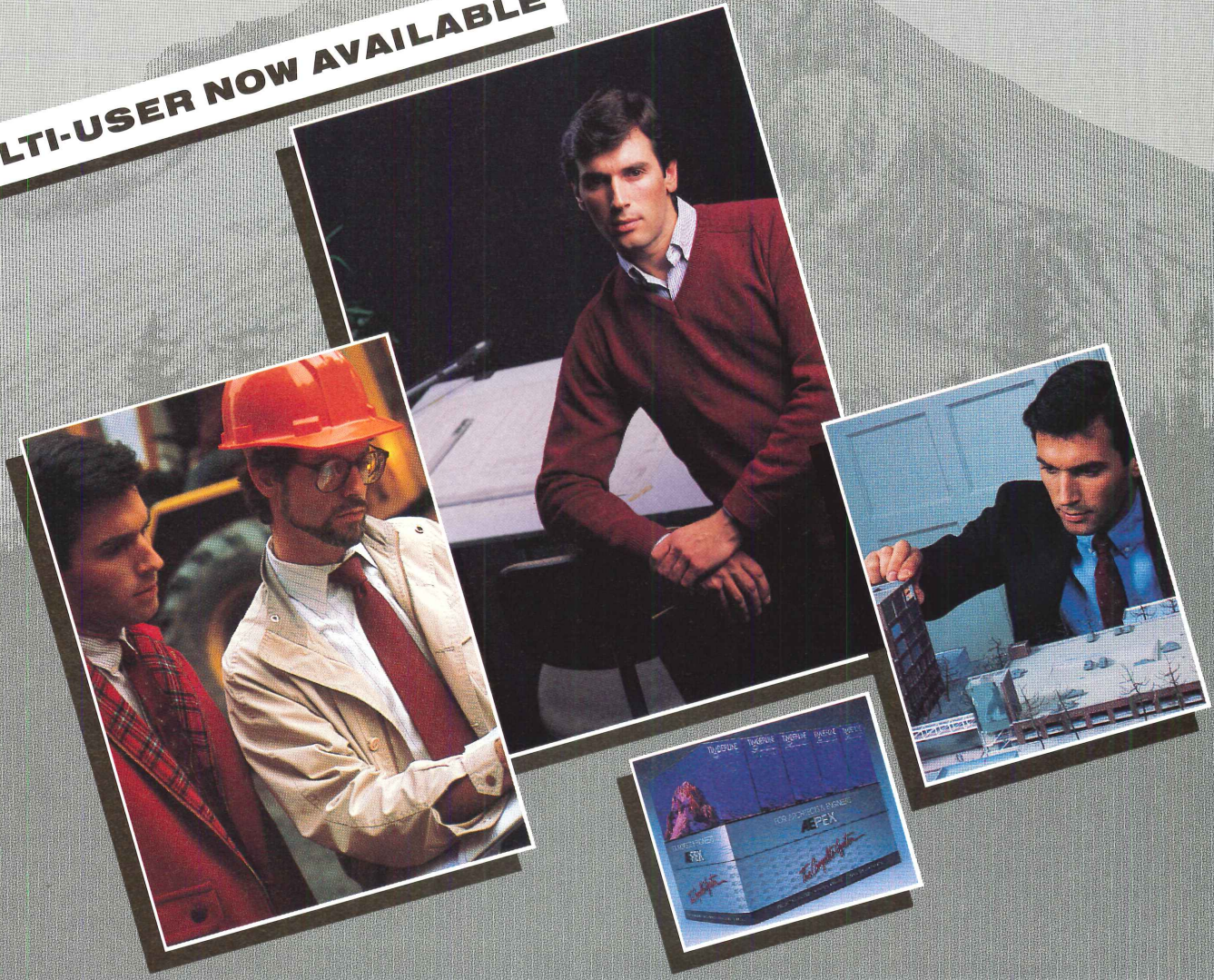


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CHOOSING A SOLUTION

BY ROLAND LOUIS

Who's buying computers? Your competitors, that's who. And they're using their computers to work faster and smarter, offering clients better service as well as lower fees. That's the positive side.

Here's the negative: By 1990, practicing architecture without a computer is

group. Conclusions are based on a 40% response to a survey of the 4,500 firms using the Sweet's catalog. Mileaf said follow-up studies to validate the results of the research shows that non-respondents show about the same pattern as respondents.

Mileaf predicts that 94% of all architectural firms will be using computers by 1989.



CAD systems by McDonnell Douglas (foreground) and Autodesk (rear) work well together in the office of Jones Mah Gaskill Rhodes, Memphis.

likely to become difficult, if not impossible, because vendors and clients will start to assume that the architect not only has a computer but knows how to use it effectively.

This supplement will explore applications by beginners and experienced computer users to improve their service, productivity and profitability, and will offer a glimpse of what the future may hold during the next 12 to 18 months.

Although architects as a group have been slow to automate, there is no longer any question that the so-called "critical mass" has been reached. Computers have crossed the boundary between fad and necessity in the architectural office.

McGraw Hill, which has been surveying computer penetration in construction so it can plan its delivery of product information, reports that the number of architectural firms using computers has grown from 28% in 1981 to 60% last year.

The research was conducted by Harry Mileaf, vice president of planning for the firm's construction information

currently has 87 members.

The surveys show that computerization of member firms has grown to 53% from 33%. And the number of applications used by the firms has grown from three—word processing, accounting and engineering—to nine. Of the firms not now using computers, 21% say they plan to buy.

The most popular computer applications that northeastern Illinois architects say they are planning to buy are, in order: spreadsheet, graphics, CAD and database management.

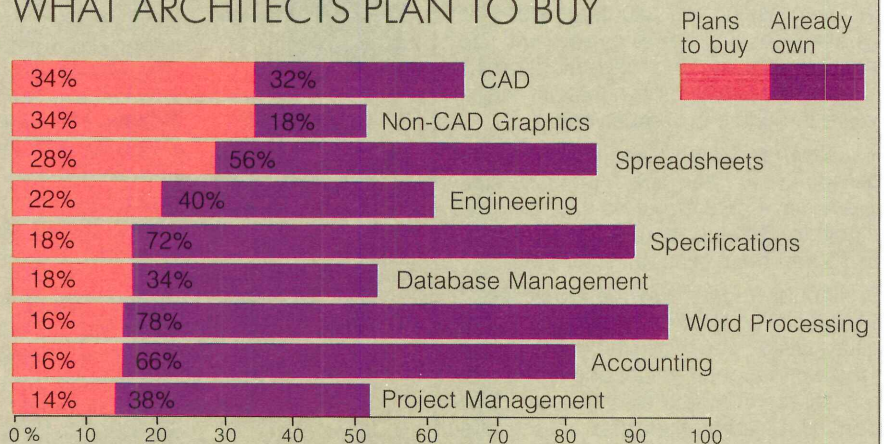
For a copy of the survey report, write the chapter's president-elect, Charles Grant Pedersen, AIA, Suite 322, 4515 Harrison St., Hillside, Ill. 60162.

Regardless of which survey is used, it is clear that (1) architects have been slow to automate and (2) they are starting to catch up. Vendors now recognize that architects represent a tremendous marketing opportunity, not only for their sheer numbers but also for their leadership.

The latest surveys show 55,000 to 60,000 practicing architects and about 14,500 architecture or A/E firms. Although large, sophisticated owners often dictate the choice of computer and program, most other owners and a host of specialists take their cue from the architect who retains them or directs their work. Equipment choices made by an architect are likely to influence the buying decisions of 10 to 15 other design consultants.

All this spells good news for the architect because it signals the emergence of a significant market for software applications specifically designed for use in architecture.

WHAT ARCHITECTS PLAN TO BUY



WHICH SYSTEM IS BEST?

Some questions generate more opinion than fact, in part because definitive answers cannot be found. Although firms might come to different conclusions, experienced managers agree that it is important to consider these issues carefully before taking the plunge into computers. Here is a selection of 10 great issues in computerization:

1. Which system is best? That's like asking which restaurant is best. There's no substitute for reaching your own conclusions for your own reasons.
2. Should we proceed on our own or get a consultant? Again, the decision is yours, but don't get a consultant to avoid becoming involved in planning.
3. Is it better to buy from a discounter or a local dealer? This one comes down to the question of which is more important: your money or your time. The discounter probably has the better price and the dealer probably offers better service.
4. How much should we spend? The price of a professional level system starts at \$5,000 for the most basic applications, everything included. You ought to spend more. For CAD, equipment that can do serious work starts at \$13,000 (list price) plus plotter. Spending more would be worthwhile.
5. Is it better to buy more but less powerful computers or fewer but more powerful computers? The experts disagree.
6. How should computers be introduced into our office? There is no formula. Even asking for volunteers does not guarantee that employees will not change their minds. The best advice is simply to consider the question and involve the office in discussions.
7. On what basis should we charge for computer time and how much? No standards have settled out so you're free to innovate. Rates generally range from \$5 to \$50 an hour, plus operator time.
8. Should we buy only the top sellers in each field or should we consider other alternatives? The top seller got to be No. 1 by being a good value, and it probably has set the standard for third-party support. But newer products might offer lower cost or higher performance or both. If you had bought the industry

standards four years ago you might still be running VisiCalc on an Apple II.

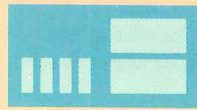
options are your dealer, the manufacturer, a consultant, a user group and your colleagues.

10. Is it better to lease or buy? Bigger systems are more likely to be leased, but firms make different decisions at both extremes. Leases usually run from three to five years. Leases are hard to arrange for the purchase of small, single-computer systems.

9. Where can we turn for help? The

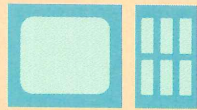
THE ARCHITECT'S COMPUTER: POSITIONED FOR GROWTH

A productive computer for an architect assumes a graphic capability. The equipment shown here is the minimum generally recommended, with prices quoted at list. Upgrades in each area should be considered. Budget also for software, cables, installation, training and furniture with storage for manuals.



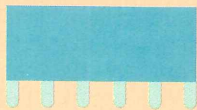
\$6,200

Computer. The magic words in micros are "IBM or compatible" and technology based on the 80286 processing chip. Include at least 640K RAM and a 20 megabyte fixed disk, a floppy disk drive, two serial ports (for input device and plotter) and a parallel port (for printer). If you're planning to run CAD, consider whether a microcomputer will suffice for you.



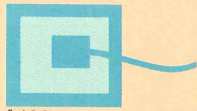
\$1,600

Graphics card and monitor. Buy them only as a matched set to avoid flicker. Get at least 16 colors and a resolution of 640 by 350 pixels. The Hercules card is a best buy if you can manage without color. For renderings, 256 colors is the minimum.



\$375

Math coprocessor. This chip sits inside the computer and improves the speed of the computer. It handles the mathematics necessary to display geometric figures on the screen. It also improves the performance of some spreadsheets and other programs.



\$600

Input device. Your choices are a digitizer and a mouse. The latter is less expensive (\$175) and satisfactory for many CAD programs, but it can't make use of the templates some programs require. Digitizers come with a puck or a stylus. The choice is a matter of personal preference.



\$800

Printer. Most architects will prefer a printer with a 24-pin printhead and the capability for Near Letter-Quality output and graphics. A wide carriage is handy for some financial reports but not necessary. A laser printer offers greater speed, higher quality output and quiet operation at two to four times the price.



\$3,300
and up

Plotter. Most CAD programs require a device that draws rather than prints for output. Sheet size options for CAD are 24 by 36 and 36 by 48 inches. Most architects will prefer more pens, more speed and greater resolution than \$3,000 will buy. The best pen plotters cost up to \$15,000. Architects with heavy production needs are starting to look at electrostatic plotters. They start at \$30,000.

Accuracy

in every detail

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in every background

Accurate in automatic generation of reflected ceilings, electrical, mechanical and other backgrounds from the same base drawing.

in every revision

Consistently accurate as revisions to the base plan create new backgrounds. Later, you can visually check the impact of your revisions on each drawing.

in every schedule

Accurate for schedules since each schedule is generated directly from specifications embedded within the drawings themselves.

in every choice

Accurate in the representation of line
Circle 36 on information card

weights, tick marks, text styles, doors, windows and other shapes. Choose from those supplied or create your own, and generate prints at different scales automatically.

in one place!

Accurate because all information about a drawing is stored on that drawing. Just zoom in to the drawing to see more details, imbedded specifications and even notes for revisions.

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TIPS FROM THE TOP

JUST GETTING STARTED IN COMPUTERS? INTERESTED IN GETTING MORE FROM YOUR SYSTEM? HERE'S THE LOW-DOWN FROM 12 TOP EXECUTIVES



CHUCK NEWMAN, AIA, AND JOHN VOOSSEN, AIA

Newman and Voosen seem to generate more controversy than usual between architects. Voosen practices in downtown Chicago; Newman prefers the suburbs. Voosen likes Compaq computers; Newman sticks with IBM. Voosen picked Autocad; Newman's choice is Versacad. They meet, but so far neither has gotten the upper hand.

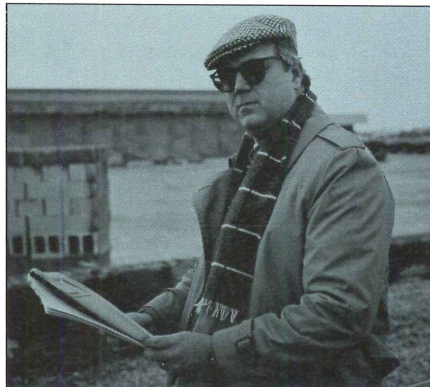
Like the other people quoted in the interviews that follow, they disagree on details but see eye-to-eye on one basic principle: The computer can help make an architect's practice more successful. Naturally, they define successful in different ways. Newman is adding volume, whereas Voosen is getting pickier about the jobs he takes.

Both suggest that their fellow chief executives analyze the purchase of a computer and its applications on the basis of profitability. This comes primarily, they say, from the reuse of data, faster completion times and the higher quality of documentation.

Newman, who has analyzed his applications, says the most profitable are, in order, word processing (including specifications), spreadsheet, accounting and CAD.

In selecting hardware, they urge buyers to stay with equipment that can be updated as technology changes. Neither considers it a good idea for a small firm to dedicate any computer to a single function.

Newman currently has eight well-digested programs in his office. Voosen has 11 programs and utilities.



INTERGRAPH MANAGER TOM FEAZEL, AIA

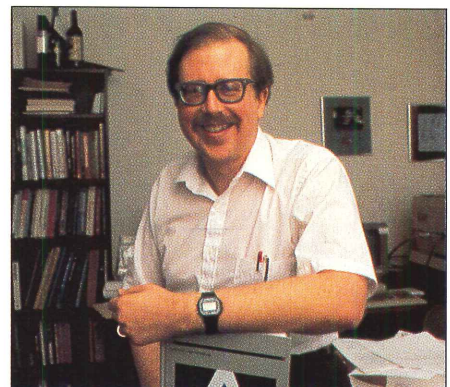
The wave of the future is full integration of CAD, specifications and cost estimating.

Architects are finding themselves the owners of vast amount of information, permitting them to expand their services and to develop continuing relationships with clients.

Systems that don't create a readily accessible database from this information will become less useful and thus less competitive. If the computer can handle the volume of data necessary to develop good planning models and to play "what if" games, the architect will have available to him a degree of analysis unheard of in the past.

Small firms should start to think of big systems, now that the total price has dropped below \$100,000. A sole practitioner with an intergraph is a money-making machine. The major bottleneck in CAD speed is the decision-making capability of the operator. If the architect-in-charge is operating the system, his productivity would boggle the mind.

One week of training will make an operator as productive on an Intergraph



AUTOCAD PRESIDENT JOHN WALKER

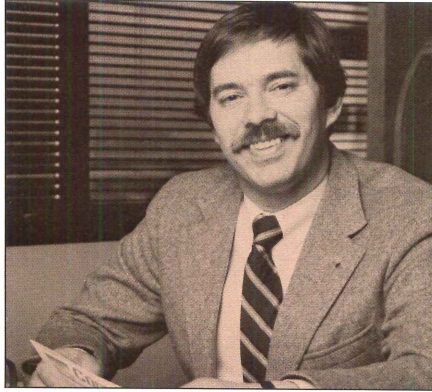
The competition in CAD is between general purpose design tools, like Autocad, and packages addressed to a specific market, like architecture. I believe the first will succeed because it's easier to address the whole building process than to build specific tools for each profession and have them work well together. A specific program may be 5% or 10% more efficient, but does it make sense if a contractor or facilities planner down the line must re-draw or re-enter information? You're going to see a major effort to provide CAD that thinks the way a designer works.

The era of CAD being synonymous with lines and arcs has ended. The central issue in CAD currently is the capture of information into a database. Today you can pull a door schedule off a drawing, but you can't change all 6 foot doors to 7 foot doors by another manufacturer, highlight recent changes and find conflicts.

Designers work on projects, not drawings. The drawing is just one part of a database that represents a project. The next leap will be to the project level. Buyers should give some thought to how they will interface drafting, database, scheduling and estimating.

A major effort is going into making CAD easier for the first-time user. "Powerful" and "easy" need not be mutually exclusive.

Within 12 months, Autocad will make use of RAM above one megabyte in machine addressable space for program memory.



**MICRORIM CHAIRMAN
WAYNE ERICKSON**

The cry of beginners and experienced computer-users alike is the same with database programs: Help me get started! Of all the common computer applications, database management has been the slowest to catch on because you had to be a programmer to use the early versions.

Then came the second generation, easy enough to use but not good for much more than maintaining a mail list—a function now being taken over by the new word processing programs.

Current database managers, like R:Base 5000, offer ease of use, power, speed and the ability to make changes. Finally, it's OK to start looking at their ability to maintain and analyze some of the vast amount of extremely valuable information that an architectural office assembles.

Start by asking yourself what information you want to track, what information worth keeping and how you want to retrieve it. Utilities in the new programs will help you organize the data and enable you to type questions in English to get at it. If the program doesn't recognize a word, it will ask you to explain and then remember the next time you ask.



**TIMBERLINE PRESIDENT
JOHN GORMAN**

Computerized bookkeeping is essential to be competitive in business today. But don't let anyone tell you it's going to be easy or fast. Once your files and procedures are set up, though, the pay-off will be dramatic.

My advice to chief executives of architectural firms is to manage the system. If you don't, it will fall apart like any other aspect of a business that isn't actively managed.

Accounting should be your first computer application because everything else flows to it. And, because bookkeeping is no labor intensive, no other application will pay for itself so quickly.

Good accounting software should include an architect-specific module as good as our AEPEX for project management and for time and billing. The rest of the modules can be generic, but they should be integrated so data must be entered only once and all modules that use that information, such as payroll, will be updated automatically. The software also should be simple to use and provide management with accessible, timely and pertinent summaries.

Install the General Ledger module first. It will give you a financial picture of where you are.

If your present system is pinching you, don't delay conversion.

Perhaps the most important consideration in choosing software is support. Good support can cover up a bad package but even a good package needs some support.



**SYSTEMS INTEGRATOR
BRUCE FORBES**

The architect of the future is going to be a data merchant . . . the keeper of the system . . . the one with access to the marketplace. Computers offer a way for the architect to rebuild his role. It's a mistake to assume that contractors know the market better; they go to manufacturers they're familiar with.

But the trouble with computer technology is that it's hard to assimilate right away. Even those who know the computer and the programs still must learn how to apply them to the architect's special needs.

The best solution may be Archibus, a drop-in crib course in computers for architects. It offers (1) tutorials in word processing, database, CAD, spreadsheet and the transfer of files between those applications, and (2) help in integrating them into an architect's office. The three volume set costs \$2,000, including nine diskettes with architect-specific examples.

TIPS FROM THE TOP



**ENTREPRENEUR PRESIDENT
BERT HELFIN**

The difference between success and failure in computers often is the dealer.

My advice to first time computer users is to find a store you trust to help you identify the right hardware and software, to install the system smoothly, to help in training and finally to provide after-sale support.

Prioritize your needs. Set realistic goals. Make sure your own employees are receptive. Early productivity requires an investment in planning time and learning time.

Pick a dealer that is dedicated to CAD and authorized by manufacturers to inventory and support the necessary equipment.

Afraid you're too small for a computer? Challenge a dealer to show you if the computer will pay for itself.

Worried by the rapid pace of change? Challenge the dealer to show you a respectable return on your investment.

My advice to experienced computer users is not to look at features—only at a straight forward capital equipment investment analysis on improved productivity. Consider networks and a better plotter.

For the future, I see a personal computer in every workstation. The power already available for only a few thousand dollars is mind-boggling.

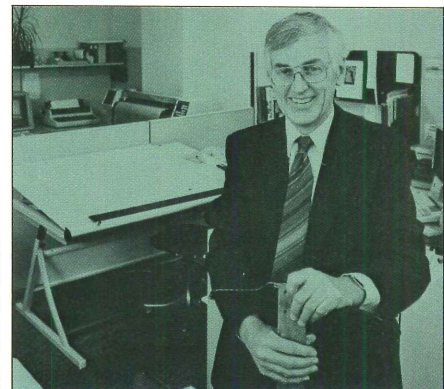


**TEXAS INSTRUMENTS'
JOHN MANDELL**

A beginning computer user today can't go too far wrong by buying a quality product with a reputation for good support.

Once you've gotten familiar with word processing and accounting, it's time to step into CAD. New technology is having a greater impact on CAD than on business functions.

Since TI makes both micro and mini computers, people often ask us what we recommend. For business applications, the decision can be based on the number of users. With fewer than 15 users, a micro is sufficient. With CAD, it's more a function of the applications a firm needs and its growth plans. If the firm needs that last 5% of possible features and full 3-D, a mini computer is worth the cost. Otherwise, we suggest starting with micros and after 8 or 10 link them to a compatible mini.



**ARCHITECT
BRYCE HASTINGS, AIA**

Hastings & Chivetta, a 35 person architectural firm in St. Louis, started with word processing on a Wang in 1982, moved into CAD with Cadplan on two IBM XTs in 1984 and moved up to HOK Draw on two DEC Microvax II workstations last November.

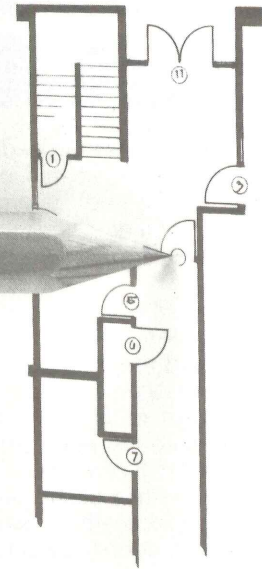
When our clients started getting CAD and more design capability than we had—and we were professing to be the experts—we decided it was time to launch. We're still using our microcomputer but it lacks a 3-D capability and we found that it doesn't take a very large building to reach its capacity.

We wanted to get our designers working earlier on the computer. We were attracted initially to HOK Draw by the price, but we were hooked by its performance. We have been able to manipulate shapes, play with things and look at options—all in 3-D. Drawings for a gym, for example, always show a basketball court and track; there's no point sketching them every time.

Two workstations, including software and training, cost us \$82,000 plus plotter. A third terminal is on order. Although we'd like to put a computer on everyone's desk, we must be careful not to go overboard. Any equipment we buy must be used 100%.

We're still using our three XTs for Cadplan, Harper and Shuman's financial management program, the Society for Marketing Professional Services' AMS-1 for lead tracking and F. W. Dodge's Design Estimator. The Wang runs word processing and MasterSpec.

DOOR SCHEDULE							
DOOR NO.	TYPE	MATERIAL	DOOR SIZE			DOOR FINISH	REMARKS
			W	H	T		
1	A	H.M.	36"	80"	1 1/2"	PAINT	'B' LABEL
2	A	H.M.	36"	80"	1 1/2"	PAINT	'B' LABEL
3	B	WOOD H.C.	36"	80"	1 1/2"	PAINT	'B' LABEL
4	C	WOOD H.C.	36"	80"	1 1/2"	PAINT	EX-HELD
5	B	WOOD H.C.	36"	80"	1 1/2"	PAINT	
6	B	WOOD H.C.	36"	80"	1 1/2"	PAINT	
7	B	WOOD H.C.	36"	80"	1 1/2"	PAINT	
8	CLD	ALUM.	48"	80"			
9	B	H.M.	36"				
10	B						
11	O.H.						
12	O.H.						



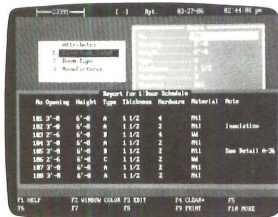
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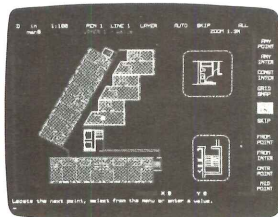
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PC-based system to integrate advanced color graphics and powerful data management into one

interacting system. So changes you make graphically are automatically reflected in the data base, and vice versa. You get better information, so drawings and reports are more complete. All at a cost that will keep your business manager smiling.



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MOVING UP IN APPLICATIONS

Computers once were criticized for being a solution in search of a problem. Remember when it seemed that their primary application was sorting punched cards for television game shows?

Perhaps all the whizzing and whirling captured the popular imagination because the blinking machine with the room full of tubes was then embraced as the solution to all our problems. "Hal," who was smarter than we were, would lead us to the new Promised Land.

Today, both extremes seem naive, although some people seem to remain fixed at one or the other of those stages of development. Young architects now accept the computer as simply a helpful tool.

The available help is becoming progressively better, as represented in both the number of applications and the number of competing software products for each application.

WORD PROCESSING

Of all applications, word processing is the cheapest, quickest and easiest to computerize. Another friendly aspect is that it enables the small office to produce professional-looking correspondence, proposals and specifications without a secretary.

Typical architectural applications are correspondence, proposals and specifications. MasterSpec, for exam-

ple, has 4,000 subscribers; about 40% also receive the text on disk and the percentage is growing.

A word processor drastically reduces the volume of typing. All programs have a "boilerplate" function so that an architect preparing a proposal, for example, can use stock paragraphs and formats, adding only that text that applies to the current prospect.

The program everyone knows is WordStar (\$495) by MicroPro. It is widely supported by related programs and can do almost anything anyone can ask of a word processor. It is criticized for being difficult to learn and use.

Lately it has been replaced on the Best Seller lists by Word Perfect (equal or greater power), pfs:File (simpler) and Microsoft Word (adapted to the new laser printers). Dozens of other programs have their champions.

ACCOUNTING

Computers have revolutionized bookkeeping. The process now can be totally integrated, automatic, simple, accessible, accurate, fast and current. Timely access to information enables a manager to act while it's still possible to influence the outcome.

Automated bookkeeping offers architects the fastest return on their computer investment. Maintaining ledgers is labor-intensive and prone to expensive errors. Perhaps most important, the

computer will help get out the bills on time.

The functions architects need most are job costing, time management and accounts receivable. All three should be integrated (so re-entry of data is not necessary) and should follow the AIA accounting guide. They, in turn, should feed a general ledger program.

All but the smallest firms should consider buying payroll and accounts payable modules.

Five firms dominate the architectural market. They are Timberline, Portland, Oregon; Data Basics, Cleveland; Harper & Shuman, Cambridge, Mass.; and ACCI, Houston, and Micro-Mode, San Antonio, which offer the same program. With all modules, their software costs between \$5,300 and \$6,300.

ELECTRONIC SPREADSHEET

Number-crunching operations are what spreadsheets do best. Once a series of assumptions are entered, including formulas for how some result should be calculated, the architect can sit back and play "what if" games and the program will make the calculations.

Architects use spreadsheets to budget, to analyze the probable profitability of a project, to schedule staff needs, for basic engineering calculations.

Spreadsheet templates, or overlays, usually are exchanged between friends like freeware at a computer club, but occasionally the templates are good enough to acquire commercial value. An example is Enercalc Engineering Software by Michael Brooks. Enercalc, priced at \$795, is a library of structural design and analysis routines for timber, steel, concrete and masonry. It comes with detailed, well written instructions.

For years, the best selling computer program of any kind has been a spreadsheet—currently Lotus 1-2-3, at \$495. Whether it is the best is another subject. Various shoot-outs have rated Framework II and SuperCalc 3 higher. Multiplan, another winner, is priced at only \$195. The Smart spreadsheet is faster and has better graphics. All perform essentially the same functions.

COMPUTER-AIDED DESIGN

Affordable systems now are available to draw plans, elevations, renderings and models faster and, some say, better than by hand. The drawings generate a database that can



This 3-D model is one of several studies for a hospital renovation in Memphis by Jones Mah Gaskill Rhodes on a McDonnell Douglas CAD system.

How does the Hartsfield Atlanta International Airport manage 45 football fields of facilities? With CADVANCE. The PC-based professional architectural Computer-Aided Design system.

DMA Architects Inc. maintains the entire airport design on CADVANCE—including more than 130 gates at 5 concourses, 4 runways, and an underground transit system. And that lets DMA's 5-person firm operate at a 25-person level.

DMA uses each of CADVANCE's 127 layers to define one aspect of the drawing. From walls to plumbing. From landscaping to aircraft configurations. So it's easy to consider proposed modifications. Recently, for example, four alternative International Concourse gate

configurations were developed in 20 minutes.

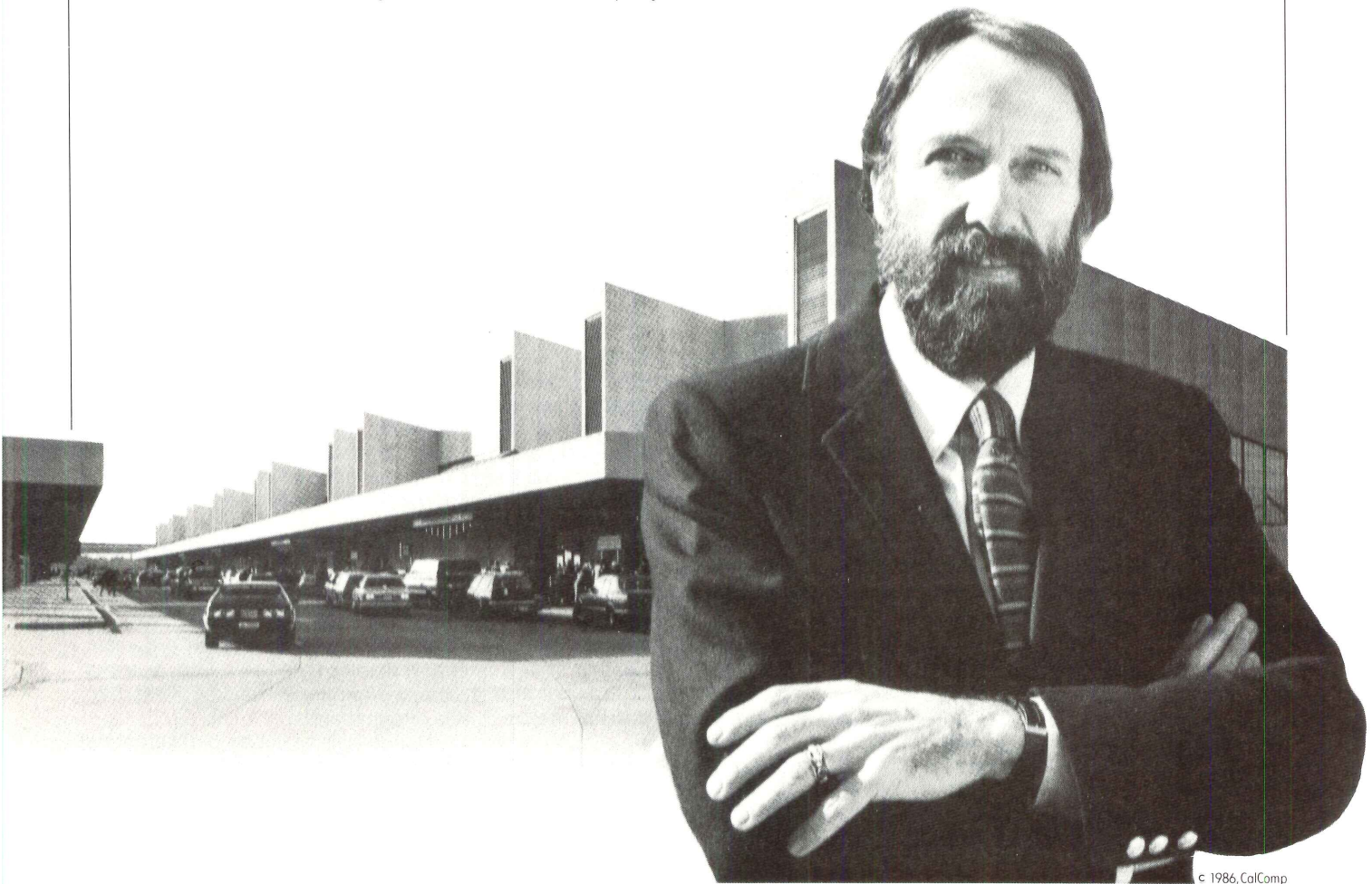
Hartsfield has been called the airport of the future. And CADVANCE helped make it happen. CADVANCE is the latest in a continuum of CalComp design products from PC-based software to large systems. No wonder CalComp has the most CAD products installed among architects and facilities planners. Call (800) CALCOMP for the name of your nearest CADVANCE dealer. Or write: CalComp, 200 Hacienda Drive, Campbell, CA 95008 (TELEX 188746).

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C A D V A N C E

THE ARCHITECTURAL CAD SYSTEM.

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MOVING UP IN APPLICATIONS



Corporate logos are easy to integrate into presentations with Diagraph, a business graphics program by Computer Support Corp., Carrollton, Texas. Samples shown here were drawn with a Hewlett Packard 7550 plotter.

be used repeatedly and in new ways to achieve impressive gains in productivity and accuracy.

The last of the fears that CAD might prove to be an unsuitable tool for serious architects faded last year when CAD systems were purchased by two of the world's best known design firms, I.M. Pei & Partners and John Burgee Architects With Philip Johnson. They chose the Graphics Design System by McDonnell Douglas.

The run-away best seller is Autocad, a 2-D program by Autodesk. It costs \$3,500. But a panel of 24 architects preferred Datacad by Microecture. They also gave high marks to Cadvance by Calcomp and Versacad by T & W Systems. An impressive bargain, they said, was Drafix by Foresight Resources. It costs \$300. For a 3-D program, the panel favored Mega Cadd and Point Line.

Leaders among the more powerful systems include Intergraph, Sigma Design, Calcomp, Skok, Prime, Computer- vision, HOK/CSC, Holguin and Arrigoni Technology. They sell turnkey CAD at prices that start above \$25,000.

NON-CAD GRAPHICS

The two main divisions of this application are analytical graphics and presentation graphics. Analytical graphics are for internal study; presentation graphics are intended to persuade.

Presentation graphics include still applications (for slides, transparencies, charts) and motion (for display on computer or television screens). The best program aimed at still presentations generally cost \$400 to \$500; those intended for motion start at that level.

Top-rated presentation graphics programs include ChartStar by Micro-Pro, Overhead and 35mm Express by Business & Professional Software, Energraphics by Enertronics, Graphwriter by Graphic Communications, Sound Presentations by Communication Dynamics and Diagraph/Picture Perfect by Computer Support Corp.

Most of them have drivers for the Polaroid Palette, which makes prints or slides directly from the computer.

Although programs that include motion tend to be expensive, IBM makes one of the best and most affordable: PC Storyboard.

DATABASE

Two capabilities are expected of a good database program: information management and information analysis. The less expensive programs are easy-to-use list managers. More money buys the opportunity to analyze the information, change the data base and generate specialized reports.

Architectural uses include change orders, certificates for payment, transmittals and the like. The architect enters the project number and the computer pulls the rest of the information from a file and fills out the form. Specialized databases can produce a bill of materials from a CAD drawing.

The most popular database program is dBase III, which lists at \$695. R:Base 5000 by Microrim is at least as powerful as dBase but faster and easier to use. It costs the same.

Other well regarded database programs include Power Base and Cornerstone. Paradox, Q&A, Nutshell, Reflex and V-P Planner are good new pro-

grams unencumbered by the programming complexities of dBase.

INTEGRATED COMBINATIONS

This category normally combines spreadsheet, word processor, database and communication applications in a single, integrated family of programs designed to exchange data easily. For example, part of a spreadsheet could be inserted in a letter without jumping through the hoops necessary with unrelated programs.

Early combinations sold poorly, three of the programs or even all four often were mediocre or worse.

The survivors are starting to do well. Most are marketing their modules separately to gain recognition for them. And ability to exchange data files readily is important in networks.

The leader is Lotus's Symphony at \$695, but reviewers generally credit its sales to a strong spreadsheet. The PFS family might be generating more sales, but Software Publishing, the vendor, reports each module separately.

The Smart series by Innovative Software is more powerful than PFS and better balanced than Symphony. It costs \$895.

Other contenders are Enable and Framework II.

SOFTWARE UTILITIES

Utilities include keyboard macros, desk organizers, DOS file managers, report generators, multi-tasking environments, copy protection breakers, spelling checkers, thesaurus programs, text enhancers and many more. Several handy programs will take a spreadsheet that is too wide to fit on an 8½ by 11 sheet and rotate it 90 degrees.

The best selling utility vendor is Borland. Its products include Sidekick and Superkey. They become instant staples on the best-seller lists when they were introduced. Sidekick, a desk organizer, is a veritable magician's bag of tricks. Superkey generates macros (linked series of commands).

Norton Utilities is bag of different but equally indispensable tricks. The most useful will help recover a file inadvertently deleted.

1Dir(pronouncedWonder)byBourbaki permits DOS commands to be executed simply by pointing to function names. It's salvation for all those users with less than perfect mastery of MS-DOS.

Most utilities are priced under \$100.

CHECK LIST.



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EQUIPPING THE HIGH-TECH OFFICE

Decisions about hardware purchases are relatively easy, once the software has been selected and a budget established. The manual for most programs has an appendix that lists the equipment it supports. Trying to work the other way—finding out what software will run a specific piece of equipment—is more difficult.

Nevertheless, if you are aware of a superior new printer, for example, and your software does not support it, you might want to reconsider your choice. The program might lag in other respects, too.

COMPUTER

Equipping the high tech office starts with the computer.

The powerful CAD systems run on relatively few brands. One of the most prominent is Digital Equipment Corp. Its VAX line, including the popular MicroVAX II, is widely used.

McDonnell Douglas, for example, runs on Digital and Prime computers. Intergraph also uses Digital equipment but modifies it to the firm's own specifications. Sigma Design and Computervision support the Sun computer. Both Prime and Computervision also have versions that run on their own computers.

In the microcomputer arena, IBM has one-third of the market, the IBM

compatibles have a third and all others have a third.

The best of the IBM compatibles are made by such highly regarded companies as Compaq, Texas Instruments, Radio Shack, Hewlett Packard, Zenith, Wang and AT&T. There are many more. They compete by offering superior performance or lower price or both. One way the compatibles achieve superior performance is to run the computer faster—at 8 megahertz (mHz) compared to 6 mHz for the standard IBM AT.

Among the non-compatibles, Apple Macintosh cannot be overlooked, especially if the applications will include presentations or business graphics.

More speed is the major demand by architects who are upgrading or expanding their computers. They are tired of waiting while the computer redraws the CAD screen or recalculates a big spreadsheet.

How fast the machine runs depends primarily on seven parts that can be replaced or bypassed simply, either by pulling out the original part and plugging in a new part, or by installing a switch.

The IBM AT is blissfully open to such tinkering. In other IBM micros, resoldering would be necessary instead of just re-plugging.

Alterations described here will not cause the AT to blow up, although they could cause a program to crash and

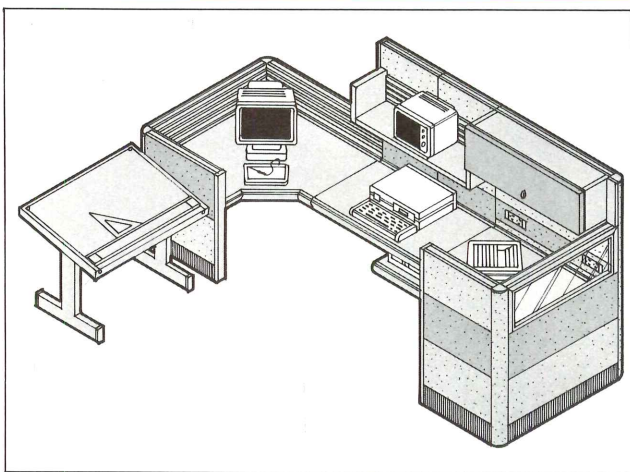
they could raise eyebrows in the service department if the AT needs repairs in the future. No guarantees can be made. Keep anything you remove. Save your data files frequently. If the tinkering works, great; if not, most firms supplying the replacement parts offer a money-back guarantee.

1. Replace the original 16 mHz timing crystal with a faster crystal built to military specifications. (The computer operates at one-half the rated crystal speed. This means that a 12 mHz crystal will run the computer at 6 mHz.) Ariel Corp., Flemington, N.J., studied how 500 otherwise unmodified IBM ATs reacted to a faster crystal and found that 99% accepted a 16 mHz crystal, 95% accepted 17 mHz, 87% accepted 18 mHz, 84% accepted 19 mHz and 68% accepted 20 mHz. Ariel sells the crystals for \$25.95, guaranteed to work. Brian Roemmele, the president, recommends buying 16 and 18 mHz crystals and returning one. If 18 mHz works, try a higher speed. If this sounds risky, Megahertz Corp., Salt Lake City, sells a device with 12 and 16 mHz crystals and a switch to choose between them. The price is \$69.95.

2. IBM, evidently distressed at the growing use of speed-up crystals, last October altered the AT's BIOS chip. If it finds a crystal operating faster than 6 mHz, the current version of the AT will not work. The peripheral industry took just four months to overcome this hurdle. Ariel and Megahertz now offer crystal devices that run initially at 6 mHz to satisfy the BIOS chip and then shift into overdrive—user-selectable up to 12.5 mHz. The price is \$89.95 from Ariel and \$99.95 from Megahertz. They also work on pre-October ATs.

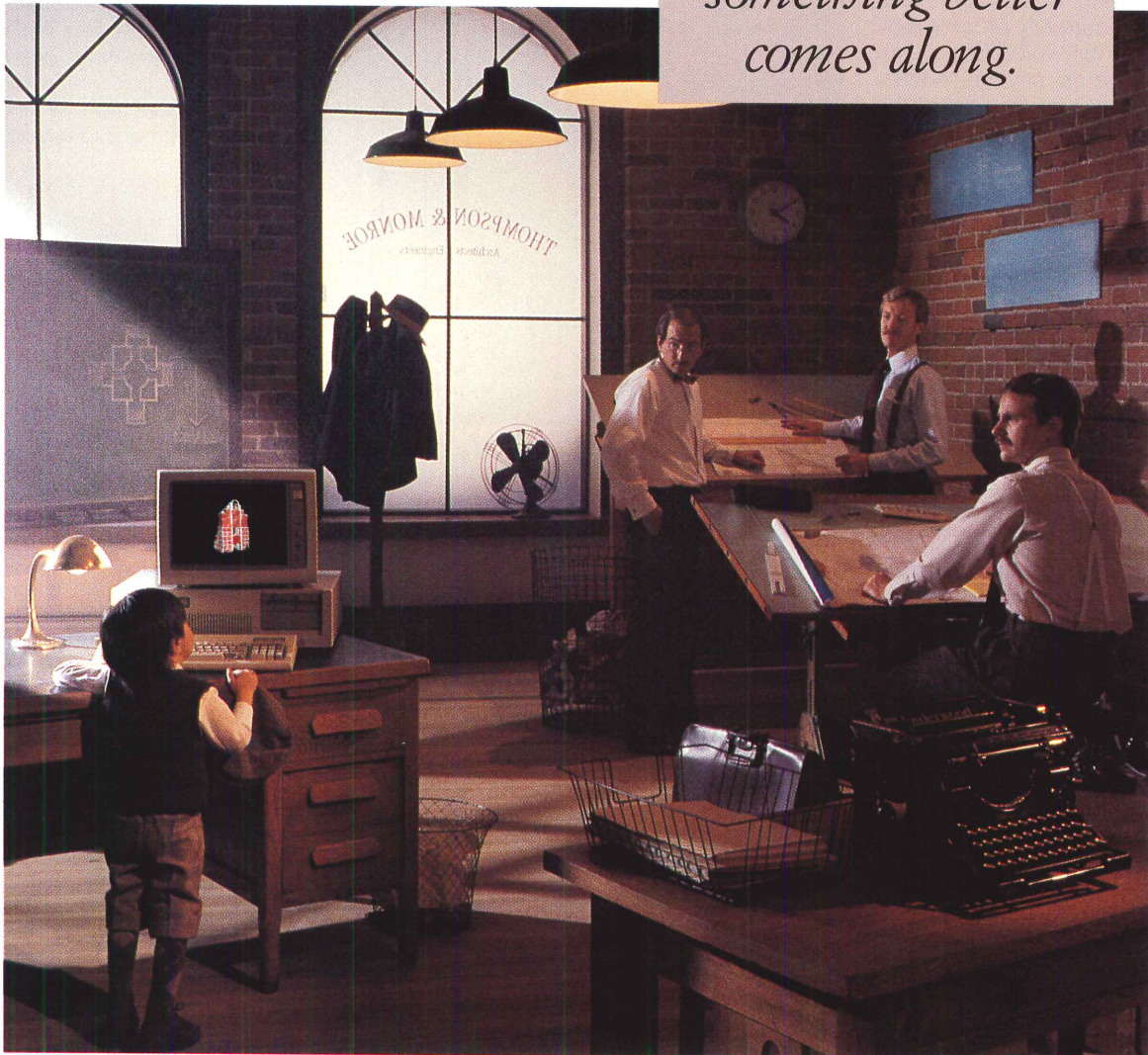
3. If the computer won't run faster than 8 mHz, consider replacing the Intel 80286 microprocessor chip. At least two firms now build a faster version. The price from Ariel is \$299.95. With an improved 80286, the success rate of a 20 mHz crystal climbs to about 90%, Roemmele said, and he would recommend trying a 22 mHz crystal. Processor chips should be handled carefully according to directions to avoid damage from static electricity.

4. If a faster processor doesn't solve the problem, try replacing the RAM chips. Standard chips are rated at 150 or 200 nanoseconds. A better bet would be 120 or even 100 nanosecond chips. The price of 512K of memory in 120 nanosecond chips is \$153 from Ariel. The 100s cost \$250. RAM chips should be



An ideal computer workstation for an architect might look something like this, suggests office systems manufacturer Herman Miller, Zeeland, Mich. The product line shown here is Ethospace. Power is available at beltline or baseline. Key components are a 19-inch monitor with digitizer and, to the right, a data monitor and keyboard. On a shelf below the keyboard is a Bernoulli Box for data storage.

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handled carefully to avoid damaging their legs or driving them into an unwary thumb.

5. Memory boosting boards that take RAM above 512K currently present a bit of a speed limit. AST, a leading manufacturer of the boards, says its Advantage board is more likely to accept the higher speeds than the Rampage, forcing buyers to choose between expanded and extended memory.

6. The graphics card also must be capable of handling a higher speed. Vermont Micro Systems, for example, guarantees its card for 10 mHz.

7. Replace the original 80287 co-processor chip, which runs at an effective speed of 4 mHz, with one that runs at 8 mHz. Microway Corp., Kingston, Mass., sells an assembly that plugs into the original socket for \$395. The 80287 chip performs the mathematics required to display geometric figures on the monitor.

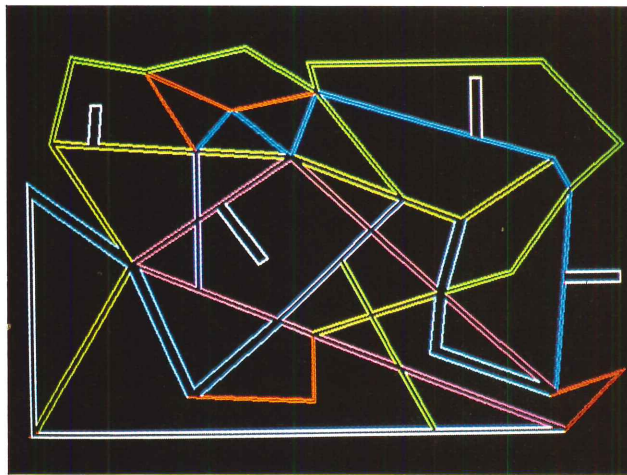
We tried running Datacad on a pre-October AT at the higher speeds. The Megahertz and Microway devices running at 8 mHz presented no problem. A 20 mHz crystal from Ariel caused Datacad to throw out stray vectors and eventually crash. We then replaced the 80286 processor and substituted 120 nonosecond RAM chips from Ariel. This enabled us to draw satisfactorily. A 22 mHz crystal would not run the IBM diagnostics program properly and the computer would not work at all with a 24 mHz chip.

But the speed of the AT operating at 10 mHz and refreshing the screen at 8 mHz was breathtaking. Crowds gathered to ooh and aah. Reporting the price to the kibitzers sent them scurrying for pencil and paper to write down phone numbers of the vendors.

PERMANENT STORAGE

The architect needs a hard disk. Relying solely on floppy disks is not recommended, even for the sole practitioner, in part because it is too slow. Hard disks of 10 megabyte and up are widely available, but they should be purchased with a back-up system, often tape.

Another option is a Bernoulli Box by Iomega Corp., Roy, Utah. It provides dual removable cartridges with 10 or 20 megabytes each and combines the advantage of floppy and the hard disk. The dual 10 megabyte system lists at \$3,700, or the dual 20 at \$4,700.



Smart Walls is one of the hottest architectural applications being developed at Sigma Design, Engelwood, Colo. Intersections of walls of different widths are trimmed and cleaned up automatically.

GRAPHICS DISPLAY

The monitor and its controller card should be purchased as a matched set to avoid flicker.

The IBM enhanced graphics display (EGA) with 16 colors and a resolution of 640 by 350 pixels lists at \$1,600 and is adequate for today's needs. The next step up, which offers 256 colors and slightly better resolution, positions the architect for the advent of solids modeling and rendering routines. The list price is about \$3,500. Don't buy a color screen without comparing the Autocad "Chroma" file in 16 and 256 colors.

Leading in professional-grade displays include Vermont Micro Systems, Winooski, Vt., and Verticom of Sunnyvale, Calif. CAD software programs like Personal Architect by Computervision also are starting to take advantage of VMI's build-in routines for 3-D modeling.

PLOTTER

Plotters also are a necessity for architects. Plotters have two uses: production drawings and presentation graphics. Printers are starting to erode the presentation graphics market and electrostatics are attracting interest on the upper end.

The market leaders in pen plotters are Hewlett Packard, Houston instruments and CalComp. IBM Instruments makes splendid small plotters for presentation graphics. Prices range start at several hundred dollars for small plotters to \$13,000 for a 36 by 48 inch model.

One of the newest entries in the field is a 36 by 48 inch plotter from Houston

Instrument for \$5,995. This single-pen plotter is called the DMP-56.

PRINTER

Every computer needs a printer. Early printers produced only text, much like the output of a typewriter. New printers do graphics or color or both.

Options today are laser, ink jet and dot matrix. Daisy wheel printers are becoming obsolete and thermal printers aren't far enough advanced to recommend.

For black and white output, the lasers may make everything else obsolete. The Hewlett Packard laser has about 70% of the laser market. Its Plus model lists at \$3,900. The Apple laser is superior in most respects but it also is more expensive.

The run-away best selling dot matrix printers are made by Epson. Other well regarded dot matrix printers are made by IBM, NEC, Brother and Toshiba. Leaders in ink jet technology are Diablo, Quadram, Xerox and IBM.

INPUT DEVICE

An additional input device is required for CAD. Architects must choose between a mouse and a digitizer.

Those who choose a mouse next must decide on the number of buttons and whether they want an optical or mechanical mouse. Two or three buttons are the usual options. In digitizers, the choice is between a stylus and a puck as pointing devices. And pucks come with 1 to 16 buttons.

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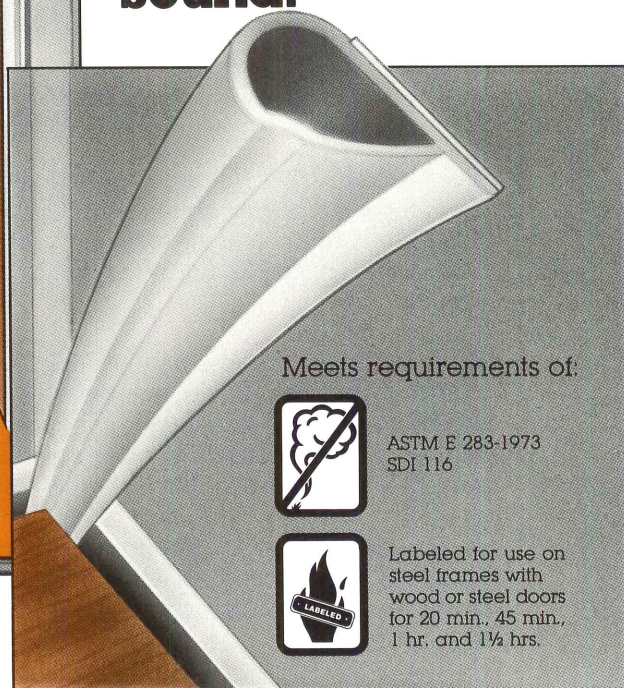
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GLAZED FRAMING SYSTEM

Amarlite Thermafront is an insulated framing system that can be glazed from the inside or the outside of low- to midrise storefronts. A polyurethane bridge provides a positively bonded thermal break between the exterior and interior sections of the framing members.

The Thermafront system features a 2½-inch by 4½-inch frame member size that can accommodate 1-inch, ⅝-inch and ¼-inch insulated glass. A continuous gutter subsill provides a base for weepage. The system's two-piece mullion design allows screw splining of all joints with only two screws, rather than four screws as required for traditional shear-block or clip systems.

ARCO Building Products, Atlanta, Ga.
Circle 55 on information card

STRUCTURAL GLAZING

Planar tempered 10mm or 12mm glass panels are bolted to vertical mullions with counter-sunk bolts. The exterior surface of the wall is thus perfectly flush. The glass can be clear, tinted bronze or gray, or reflective. Finishes for the mullions can be glass, steel or aluminum. Planar is also offered as an insulated unit.

Pilkington, (North America) Limited, Ontario, Canada
Circle 56 on information card

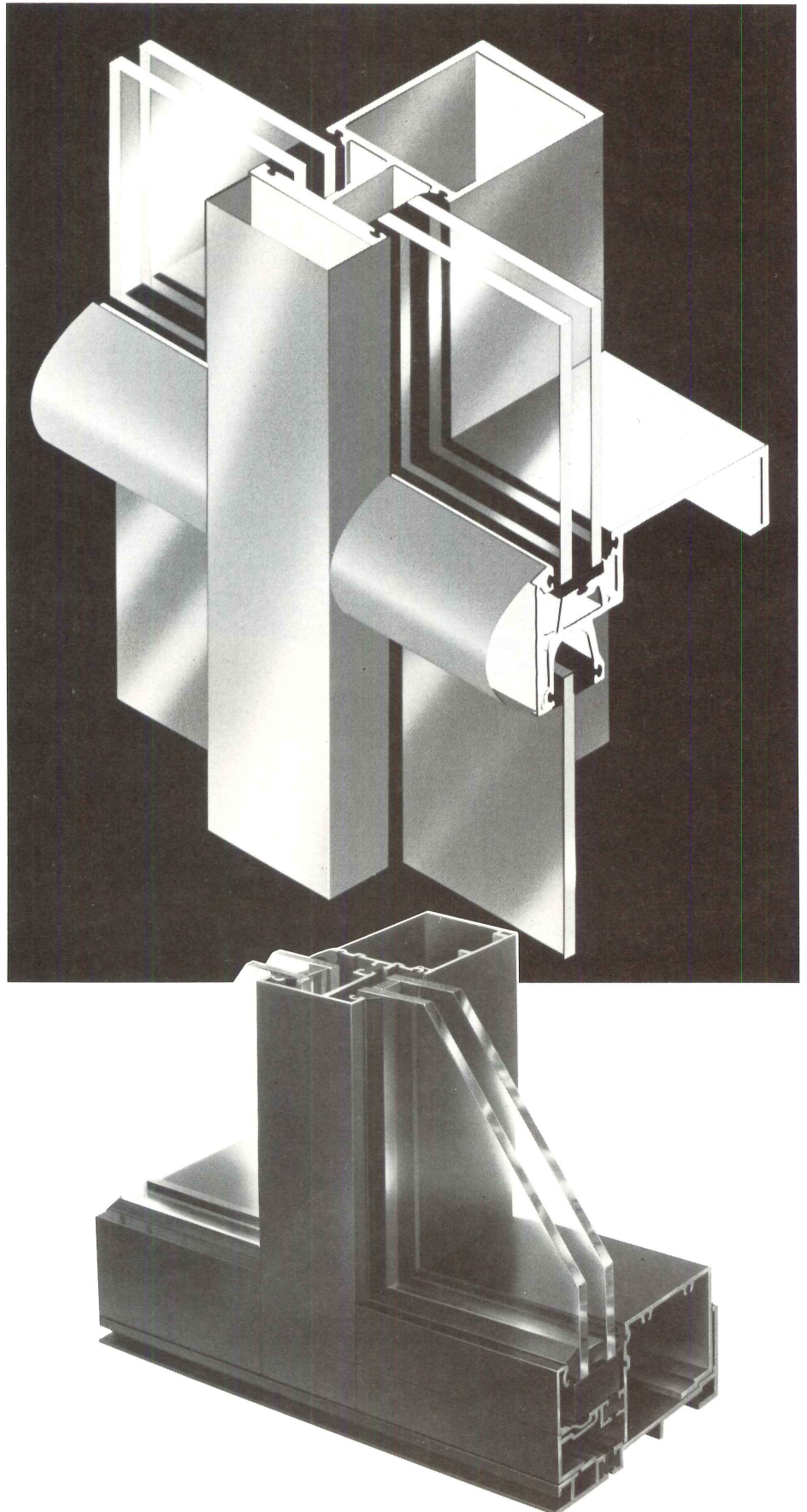
CURTAINWALL SYSTEM

"Horizon," a curtainwall system composed of prefabricated vertical mullions, panels and horizontal members, is engineered, tested and packaged for simple on-location assembly.

"Horizon" offers excellent thermal performance and rain-resistant pressure equalization, according to the manufacturer. The appearance of the basic wall system can be upgraded with panels of aluminum, stainless steel, glass or stone. Special features include nine standard metallic fluoropolymer colors and dimensional covers for vertical and horizontal members. A compatible strip window system is offered to give designers further flexibility.

Cupples Products Division, H.H. Robertson, St. Louis, Mo.
Circle 57 on information card

Product information compiled and written by assistant editor Amy Light.



LOW- AND MEDIUM-MODULUS SEALANTS

Spectrum 1 low-modulus and Spectrum 2 medium-modulus silicone sealants are one-part moisture-curing sealants formulated to have the physical properties and adhesion traits of a standard silicone sealant.

Spectrum 1 is designed for use in joints where high movement is expected. It features movement capabilities of +100 percent and -50 percent, making it effective for expansion, control and lap joints.

Spectrum 2 is a neutral-cure silicone formulated for general-purpose caulking and glazing

applications, including cap beads, toe beads and heel beads/air seals. The sealant is said to be well suited as a weather bead in butt (two-sided) and stopless (four-sided) glazing systems and for sealing joints within the curtain/window wall systems. Its movement capability is +50 percent in extension and -50 percent in compression.

Both sealants are designed to exhibit excellent tear resistance throughout a wide temperature range and a life expectancy of more than 30 years.

Tremco, Cleveland, Ohio
Circle 64 on information card

COMPOSITE WALL PANEL

Composite wall panels by AEP are constructed of an aluminum paper honeycomb core bonded to metal skins. Panels can be used for both exterior and interior building applications.

The metal skins are bonded to the core with a special adhesive so that both sides of the panel maintain the same surface temperature—precluding differential expansion/contraction. The panel is classified as a noncombustible because it is an all-metal composite.

The wall panel is also designed with male/female joints, which allow joint edges to float as the building moves because of high winds, seismic sway or thermal load. A water bar formed by the male edge of the joint creates a barrier that makes it difficult for wind-driven water to reach the sealant.

Panels are available in lengths up to 30 feet and widths to 60 inches, and are offered in a variety of finishes, textures and colors.

Architectural Engineering Products, Dallas Corporation, Dallas, Tex.
Circle 63 on information card

ARCHITECTURAL PANEL BROCHURE

A new line of nonasbestos architectural panels said to possess the same performance characteristics and appearance as their asbestos-cement counterparts is described in a 24-page, color brochure from Manville. The panels are used for fasciae, soffits, spandrels, interiors and entire dry-built walls in commercial, multiunit residential, institutional and industrial buildings.

In addition to describing physical properties and design characteristics of each panel type, the brochure provides installation details and illustrations.

Manville, Denver, Colo.
Circle 65 on information card

LOW-REFLECTANCE SPANDREL GLASS

Spectraclad architectural panels consist of 1/4-inch heat-strengthened glass with a ceramic enamel coating fired to its exterior surface. A protective overcoat creates a matte, opaque surface that looks like metal.

The proprietary overcoat is designed to resist scratching, fading, chemical attack and environmental degradation, and is a nonwetting agent that resists staining.

Eight standard colors and a range of custom-specified hues are offered.

PPG, Pittsburgh, Pa.
Circle 66 on information card

continued on page 96

GEOCAD

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subsidary of GEOCAD, a low cost drafting system for architects, is gaining wide acceptance among architects and other design professionals. It is structured around AutoCAD™ the most popular CAD program in the world.

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Job # 300

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January 9, 1986

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As you know, we were extremely nervous about basing our architectural production on such an inexpensive system. Our first four months have reassured us, and we believe our productivity and the reliability of our production were both significantly increased within a month of purchasing the first station. We are presently training all our staff in the use of GEOCAD, and we expect additional gains in productivity in the future.

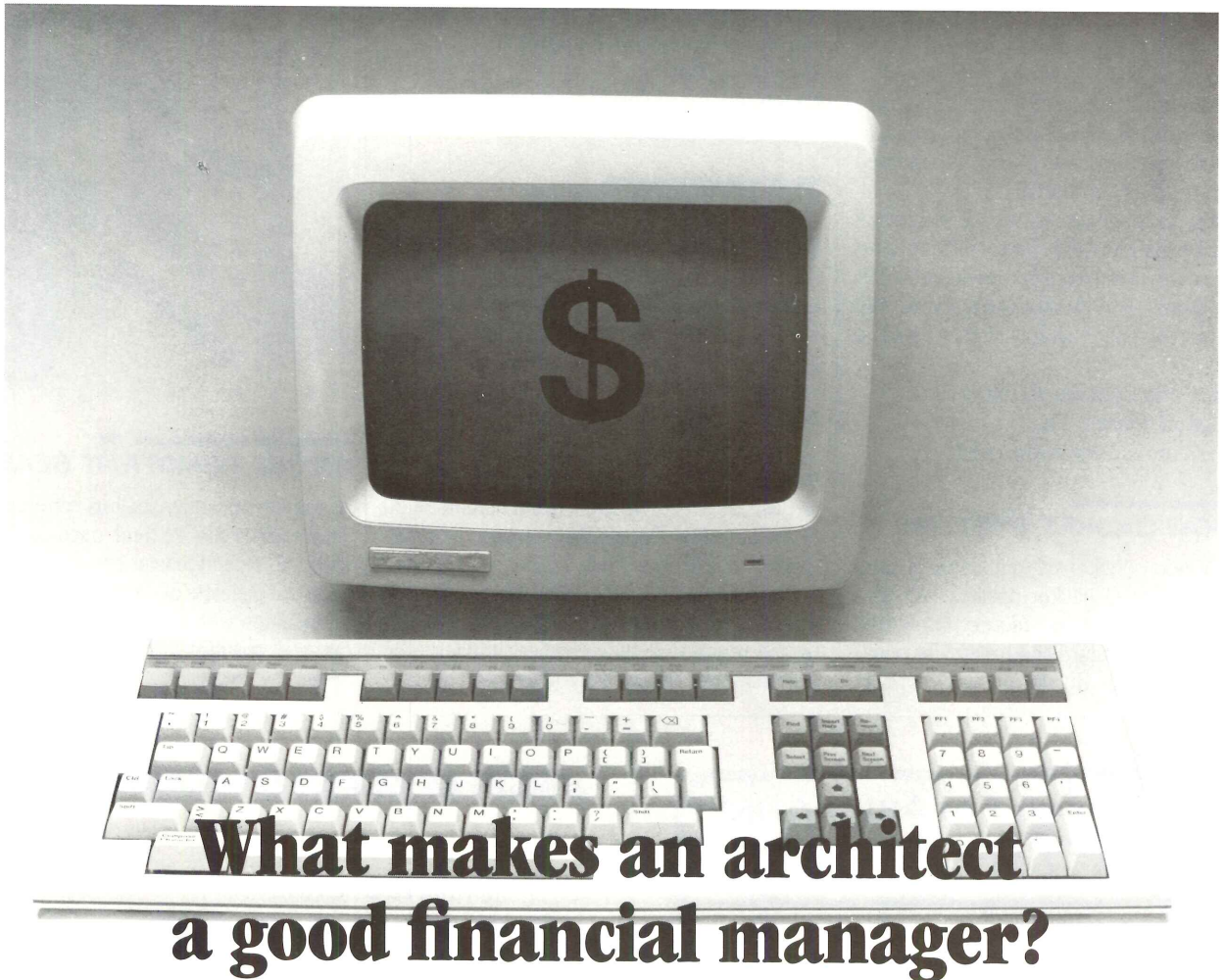
We are looking forward to Version 3.0, which will incorporate several new routines which should save us a lot of time. The layer management system alone has justified the cost of the software, and we feel strongly that we made a good decision in going with your system.

Please let me know if there is anything we can do for you.

Sincerely,

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LOW-MODULUS SILICONE SEALANT

Chem-Calk 1000 is a neutral-cure, low-modulus silicone sealant specifically formulated to compensate for dynamic movement in porous substrate materials. The sealant, according to the manufacturer, exhibits excellent unprimed adhesion to glass and metal.

Suggested applications are metal curtain walls, and expansion and control joints in pre-cast or prestressed concrete, brick and architectural stone. For glazing applications, the sealant can be applied with or without glazing tape.

Bostick Construction Products
Huntingdon Valley, Pa.
Circle 67 on information card

WINDOW GASKET SYSTEMS

Dry Set window-gasket systems come in more than 30 Lock-Strip gasket designs. All window-gasket systems are factory-fabricated and sized to fit standard and hard-to-fit openings. The systems are designed to support

differently expanding materials without leakage. Gasket components flex and withstand continuous exposure to the elements without deterioration.

Maloney Precision Products,
Houston, Tex.
Circle 68 on information card

SEISMIC GAP FILLER

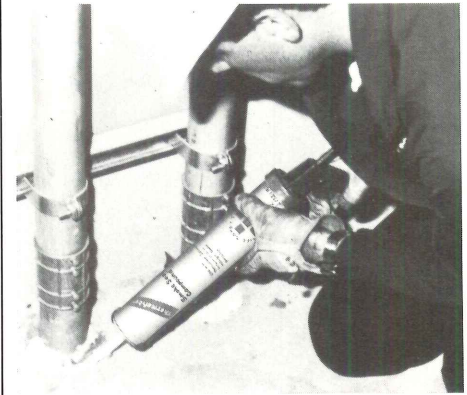
Zipout collapsible seismic gap filler is made of layers of compressible foam "slats" held together by a reinforced plastic tape. The joint filler material is the same as the manufacturer's seismic Gap Filler II, which is used in various nuclear power plants and projects subjected to seismic movement.

Zipout removable seismic gap filler can be supplied to fit joint widths from 1 inch to 9 inches, lengths of 48 inches and heights of 20 to 25 feet. The Zipout filler is made of "slats" 1/2-inch or 2-inches thick.

A fire-resistant joint filler offered by the manufacturer can be used to close the void left by the removal of the seismic gap filler. The filler also prevents water and debris from get-

ting into the gap or joint.

Progress Unlimited, New York, N.Y.
Circle 69 on information card



SMOKE-RESISTANT SEALANT

A smoke-resistant sealing compound called Thermafiber Smoke Seal, used in combination with foil-backed insulation, is designed to impede the passage of smoke and noxious gases in openings where floor-slab edges meet curtain-wall spandrels. The sealant can also pro-

continued on page 98

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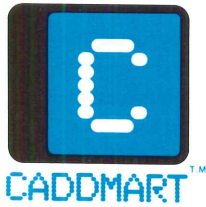
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continued from page 96

vide a smoke barrier at "poke-through" openings in walls and floors.

**USG Acoustical Products,
Chicago, Ill.**

Circle 58 on information card.

PREFORMED EXPANDING- FOAM SEALANT

Emseal and Emseal Greyflex are two impregnated preformed compressible sealants that provide permanently elastic weathertight seals for all prescribed conditions of joint movement, according to the manufacturer.

Both sealants are produced by combining elastic, high-density, open-cell polyurethane foam with either polymer-modified asphalt (Emseal) or stabilized acrylics (Emseal Greyflex). The sealants are factory pre-compressed to less than joint size; the material expands to fill and seal after the joint is placed.

Emseal is designed for high-performance expansion and control joints in high-traffic areas, such as parking garages, concrete roadways, bridges and plaza-decks. Emseal

Greyflex is intended for vertical and horizontal joints in building facades. The Greyflex is said to be particularly suited to metal cladding systems, curtain-walls and skylights.

Emseal, Stamford, Conn.

Circle 59 on information card.

HIGH-PERFORMANCE SEALANTS

LP polysulfide liquid polymer sealants for curtain walls and highrise structures adhere to almost any surface to provide a weatherproof seal, according to the manufacturer. With a high resistance to UV, the compound has applications in insulated glass units, patio doors and windows for environmental chambers.

Morton Thiokol, Chicago, Ill.

Circle 62 on information card.

FOAM SEALANT TAPES ↓

Will-Seal precompressed expanding foam sealant tapes are designed to provide watertight, weathertight or draft seals, depending on the need and the size of the joint to be sealed. The foam tapes are made of specially impregnated

polyester/polyurethane and are guaranteed by the manufacturer never to shrink or become brittle. To simplify installation in any weather without special joint preparation, the tapes are compressed smaller than the joint opening and are equipped with a self-adhesive strip; once in place, they expand on their own.

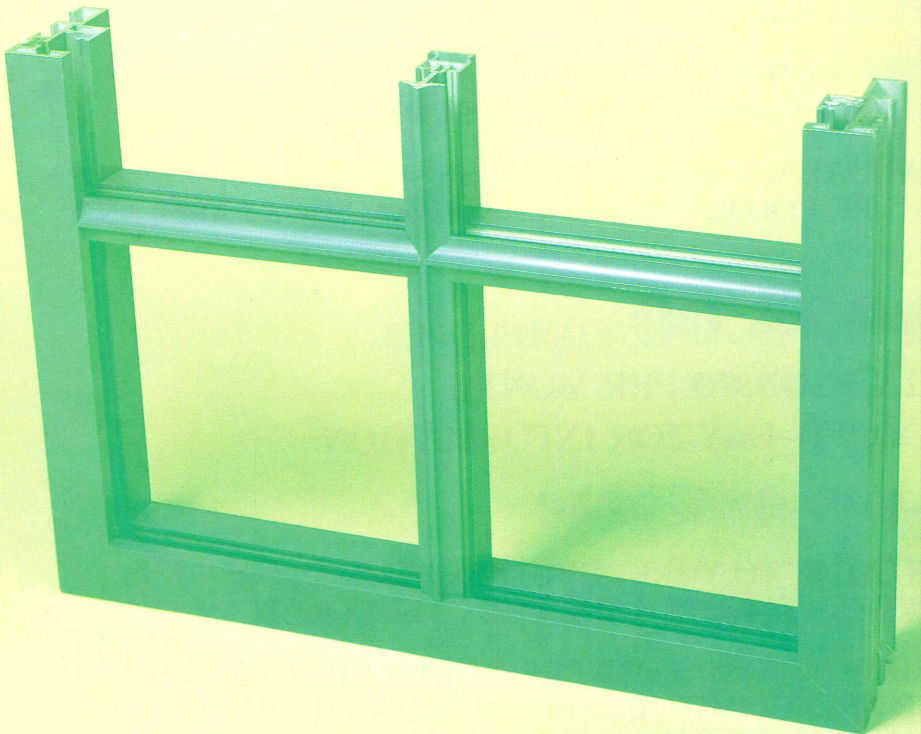
The tapes are available for vertical and horizontal joints, and joints at or below grade. They are supplied in both self-adhesive rolls and sticks. Colors are standard black or neutral gray.

**Will-Seal Construction Foams,
a division of illbruck, Troy, Mich.**

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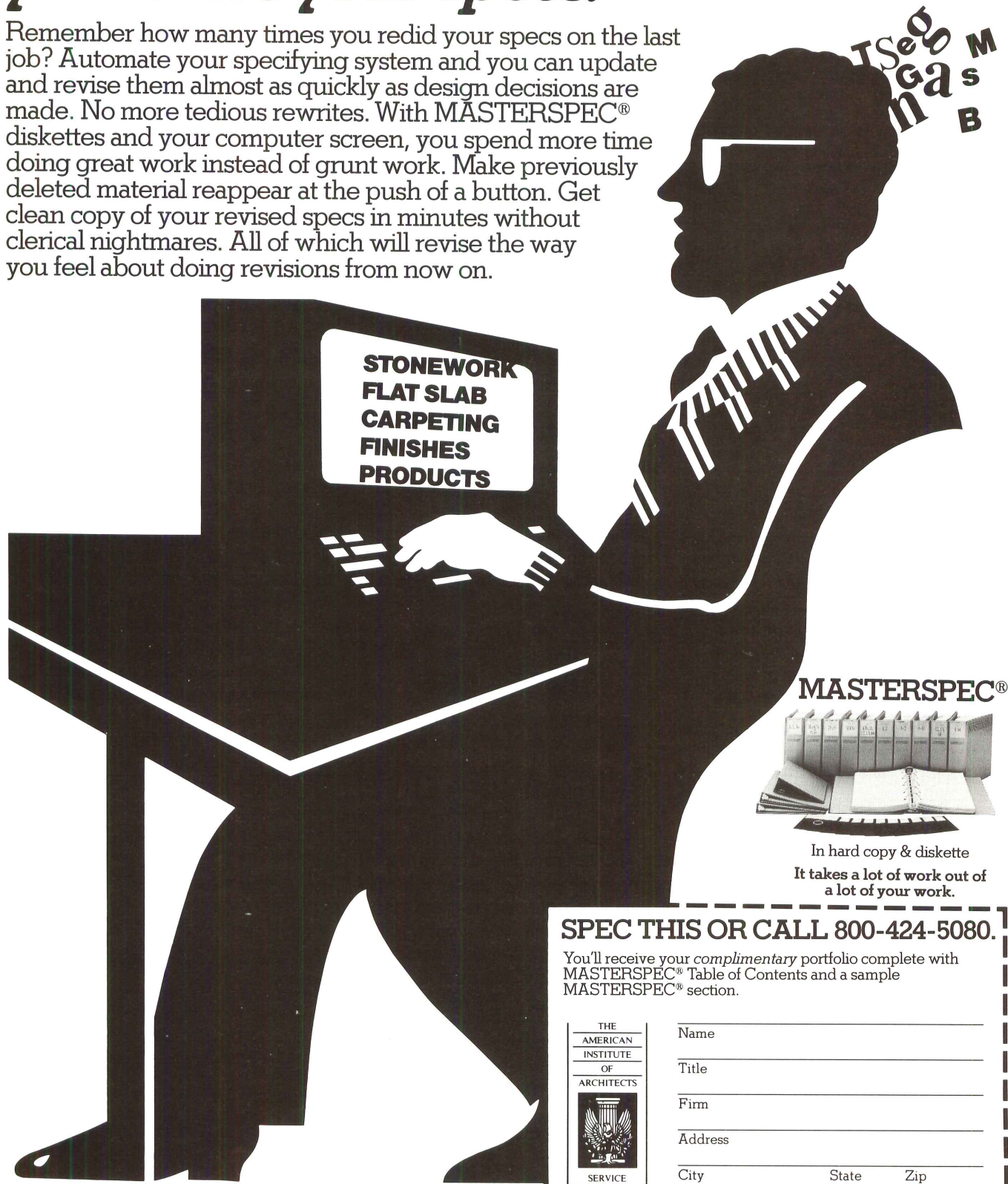


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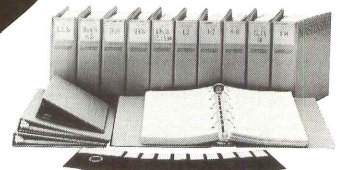
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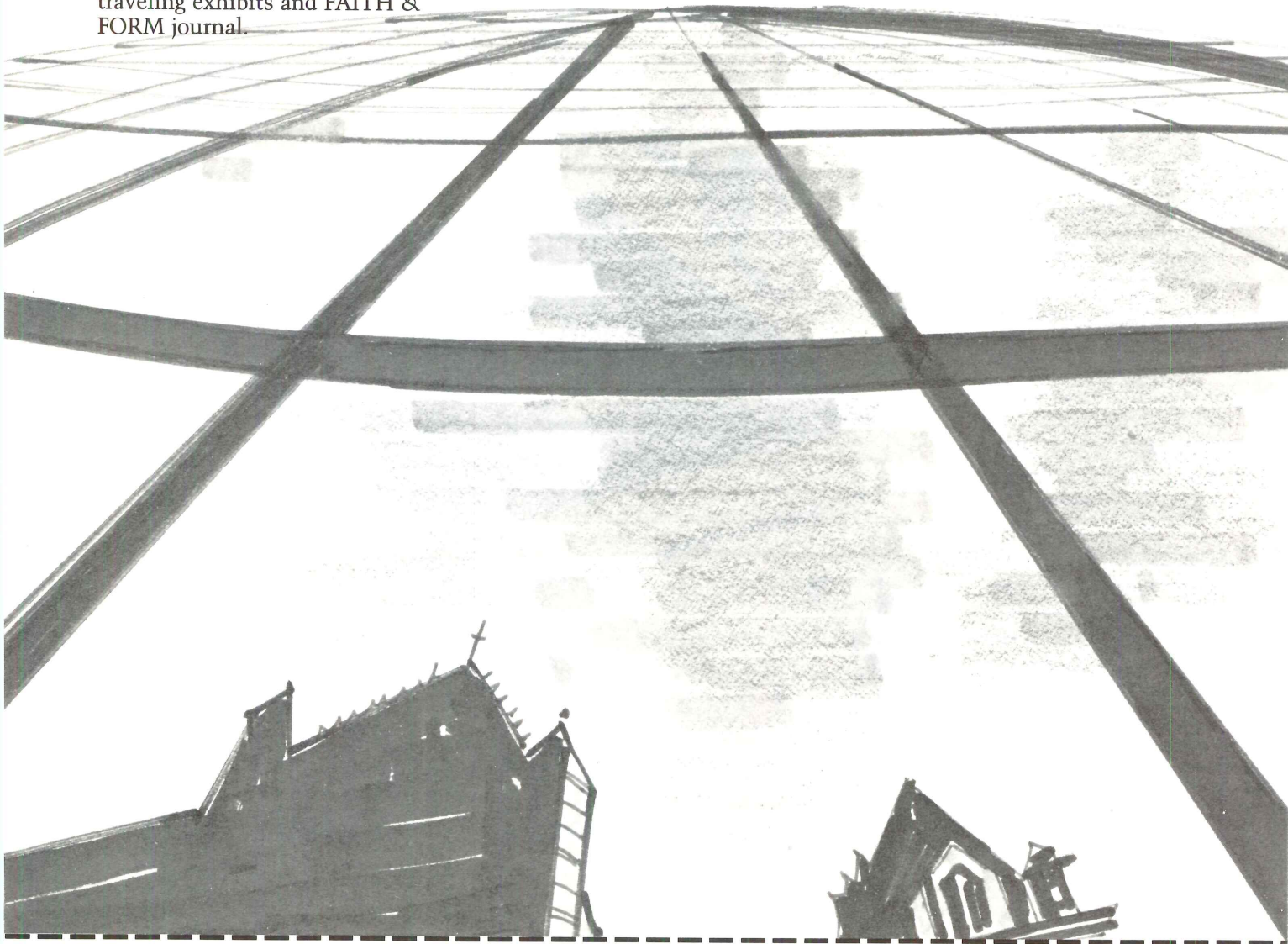
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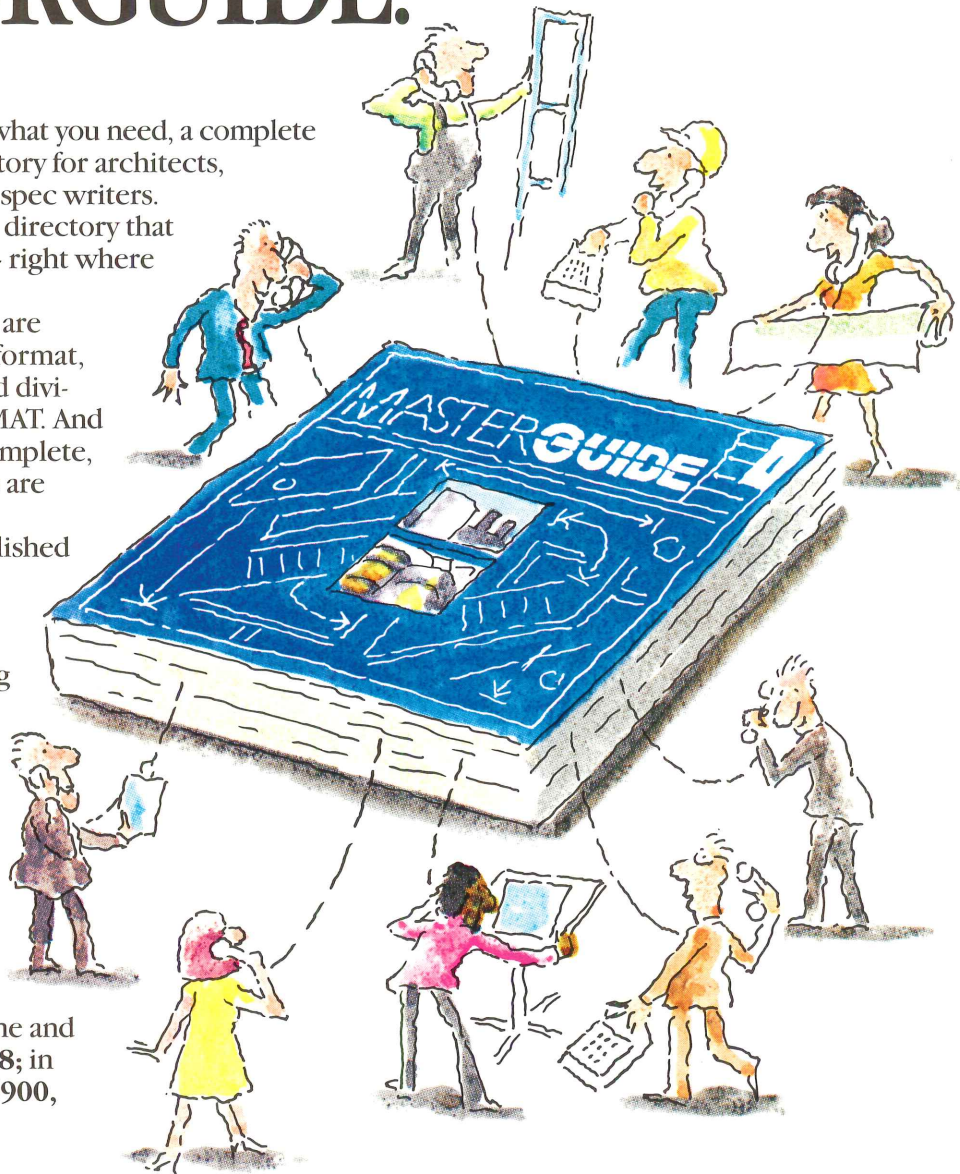
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ONCE MORE INTO THE BREACH

BY JOHN F. HARTRAY JR., FAIA

NEAR THE WEST ENTRANCE TO the Cathedral of Florence there is an equestrian portrait of Giovanni Acuto (1320–1394), one of Italy's foremost military heroes.

As the leader of a highly disciplined mercenary army, Acuto fought in the service of Pisa, the Papacy and Florence. His tactical ingenuity transformed warfare on the peninsula and, judging from the length of his life, he gave a fair value for the money to his diverse clients.

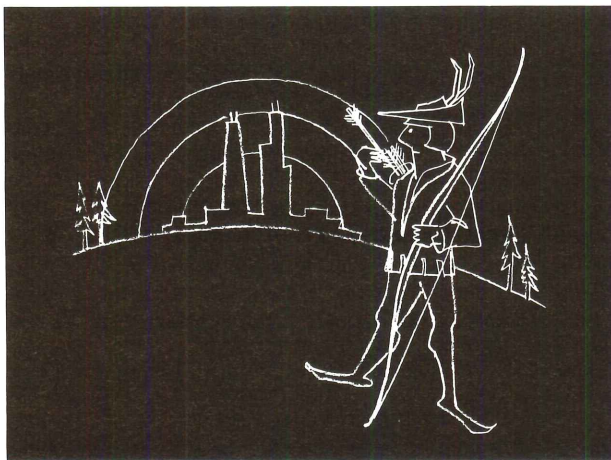
Acuto entered Italian history suddenly, as a fully developed participant. His military apprenticeship had been served in his native England, where he was called John Hawkwood. There, he was one of the English commanders who invaded France in 1337 in the Hundred Years' War.

Medieval war was relatively inexpensive, but still, 100 years was a long time for sustained conflict. By 1360, the English had captured the French king, both armies were out of money and the Black Death had increased the body count. A treaty, which resolved nothing but which temporarily ended the hostilities, was therefore signed.

Peace left Hawkwood with a choice between returning to unemployment in England or finding another war. In this respect, northern Italy appeared to offer rich opportunities.

When Hawkwood crossed the Alps, he moved from the Middle Ages into the Renaissance. The urban republics had already begun an economic and political challenge to the old order. The Welsh longbow, which Hawkwood and his armies brought with them, was all that was needed to end the age of chivalry. With it, a common soldier was able to kill a horseman of good family quickly. It was a very democratic gadget once adopted by the Italians.

Immigrants invariably carry their skills with them. It is not surprising that colonial agriculture and arts and crafts tend to replicate the techniques of the mother country. But the Hawkwood-Acuto case is unusual in that Italy seemed to be poised, waiting for English infan-



try tactics, so that with one new piece of technology (the bow), history could proceed.

During the last 15 years, the construction industry in the U.S. has benefited from a less violent, but similar transfer of technology. Once again, technically proficient Englishmen found a receptive environment for their skills.

Now that we have the 12-part Uniformat as a tool for organizing preliminary estimates and outline specifications, it is difficult to remember life without it. But, in the '60s, there was no uniform way of producing these documents. Architects had a choice between estimates based on the floor area or cubic content of a proposed design, or on a sketchy quantity take-off based on incomplete drawings. Dodge and Means published detailed unit prices that were organized by trade jurisdictions but were too fragmented to use as a design tool. Larger offices employed old-timers who would squint at details and grunt, "\$25 a lineal foot." As I recall, the price never changed no matter what you did to the detail.

A few general contractors provided conceptual estimates on negotiated projects, but what was learned on one job could not be transferred to another. Every estimator had a personal system.

Then, gradually, it all seemed to clear up. Estimating-information became available in a form that assigned a unit cost to major building assemblies, such as complete exterior walls. The cost of generic structural systems could be compared without designing and detailing them. Better yet, the foundations, wall systems and roof assemblies all began to show up

in the same order in a lot of different publications. We were all using the 12-part systems-format, or Uniformat. We had apparently reached a consensus without having had a meeting.

Like the longbow, Uniformat arrived fully developed as the result of the migration of a small band of Englishmen.

As far as I can tell, their journey began with Expo '67, the Montreal World's Fair, which attracted construction talent from all over the world. When construction of the fair was completed, many of its English builders moved south. Those who were members of the Royal Institute of Chartered Quantity

Surveyors (RICQS) brought with them estimating techniques. They also brought the ability to explain those techniques in clear English. They added a touch of class to the planning and design process as well as a ruthlessly logical approach to cost control.

Like Giovanni Acuto, they arrived at an opportune time. Interest rates and the cost of options on land did not leave time for exhaustive design studies. Economic decisions were being based on vague cost projections. By the time a complete estimate could be made, it was often too late to backtrack.

The uniform cost-reporting format established by various committees of RICQS cut through these problems.

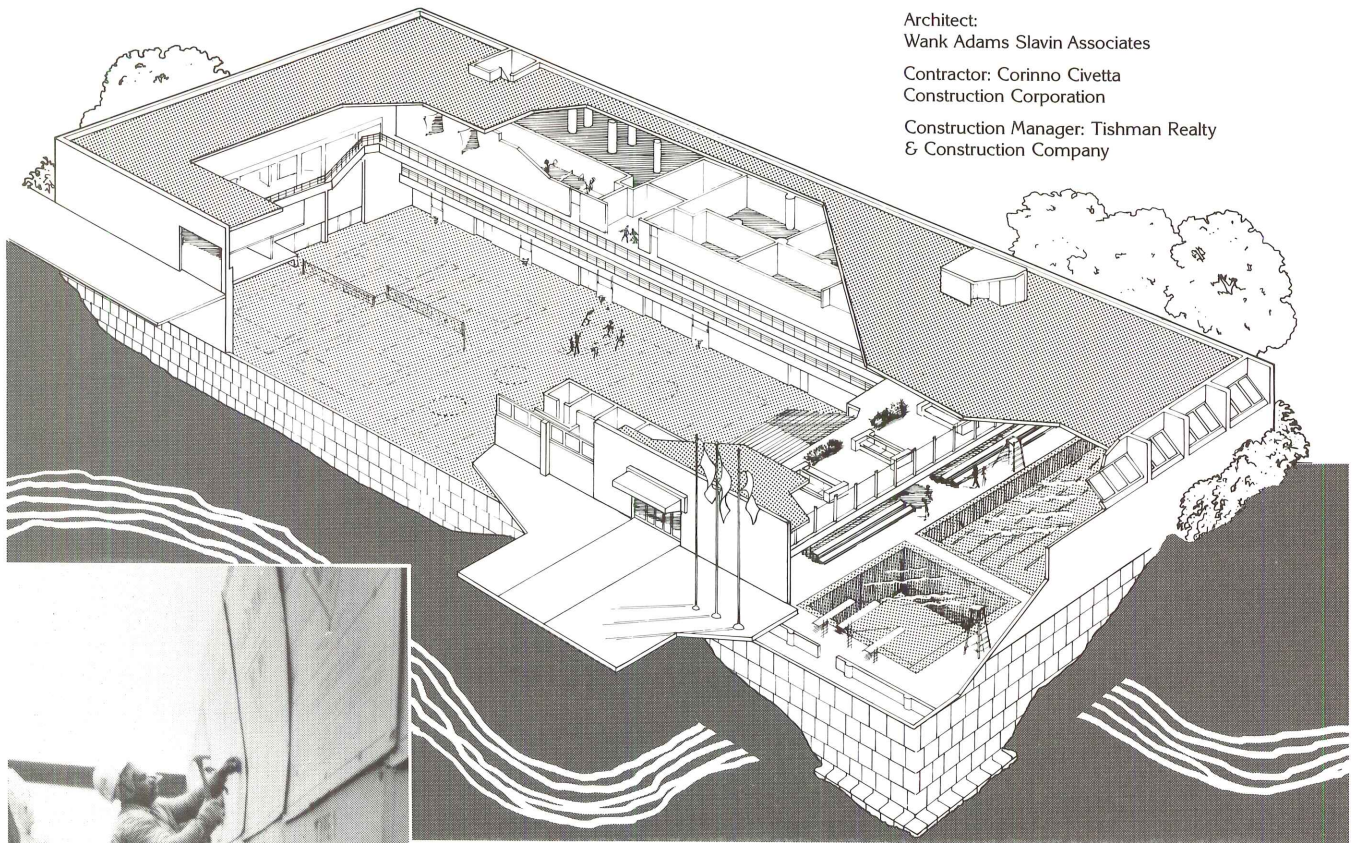
In the mid-'70s, Hanscomb Associates, one of the early settlers among the quantity surveyors, was commissioned by the GSA to draft a U.S. adaptation of the RICQS system.

The rest, as they say, is history. But history is delicate; a lot depends on luck. A few years later, French separatist sentiment might have prevented a high level of British participation in the fair. Later still, the Gramm-Rudman approach to federal finance might have prevented the GSA from investing in an easily-installed national standard.

Uniformat's British origin is hinted at by some of its terminology: "superstructure" for "frame," "exterior closure" for "skin." Site-work and general conditions follow rather than precede the building system, which seems a bit like driving on the left side of the road. But the format is useful, and I am grateful to the chaps that brought it to us. ■

John F. Hartray Jr., FAIA, is a partner at Nagle Hartray Associates, Chicago. Hartray also teaches at the Illinois Institute of Technology.

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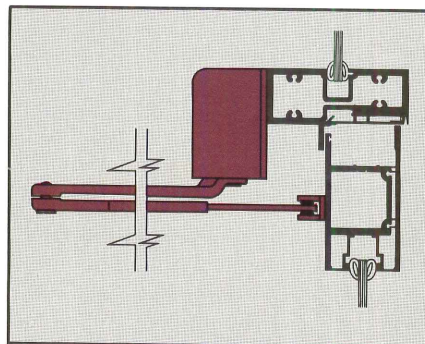
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