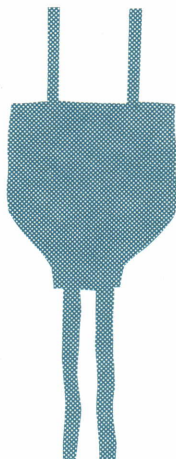
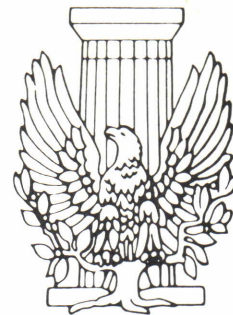


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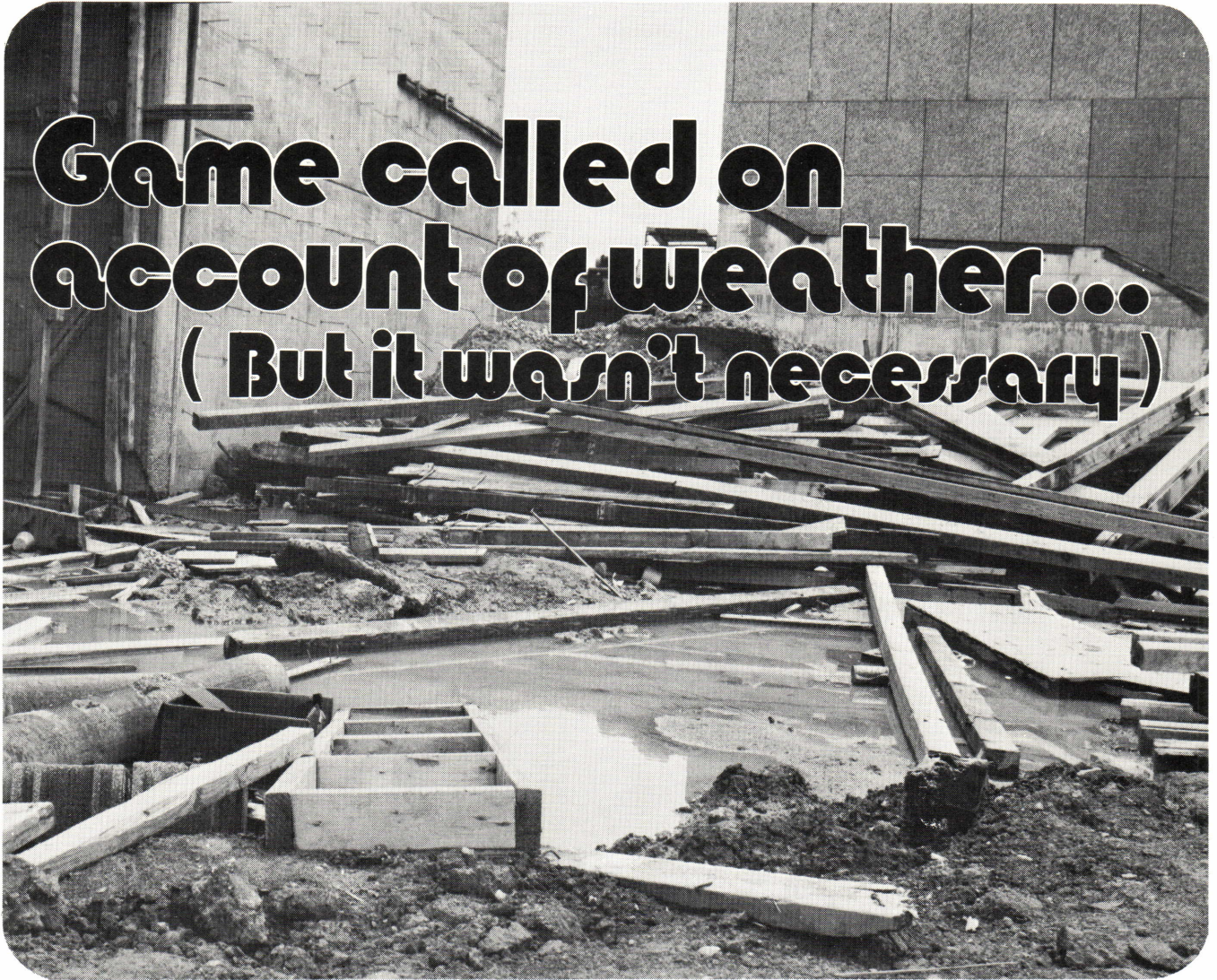
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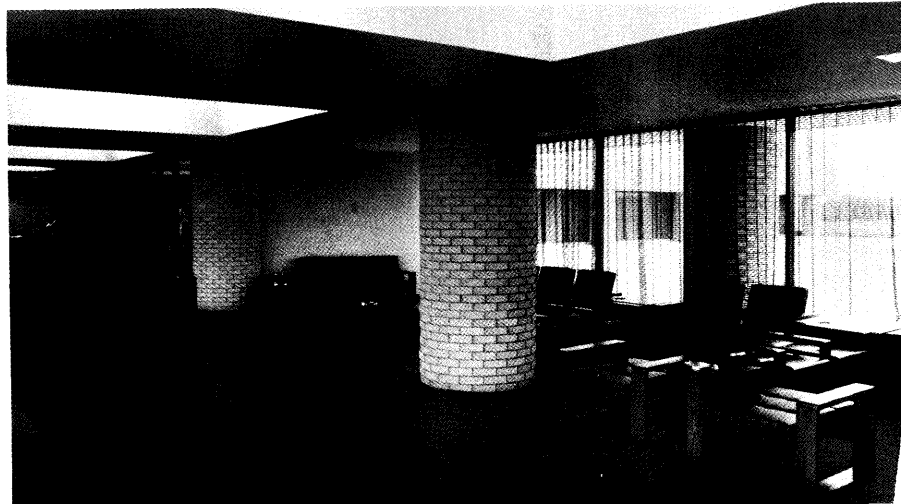
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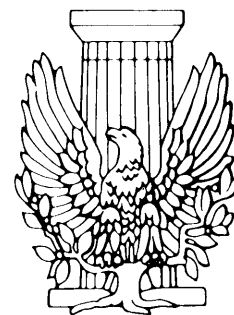
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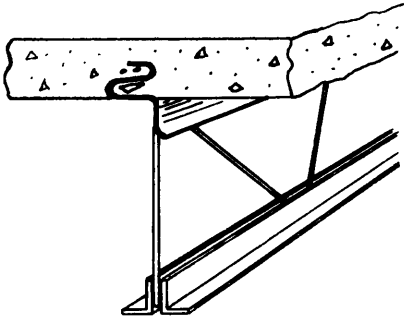
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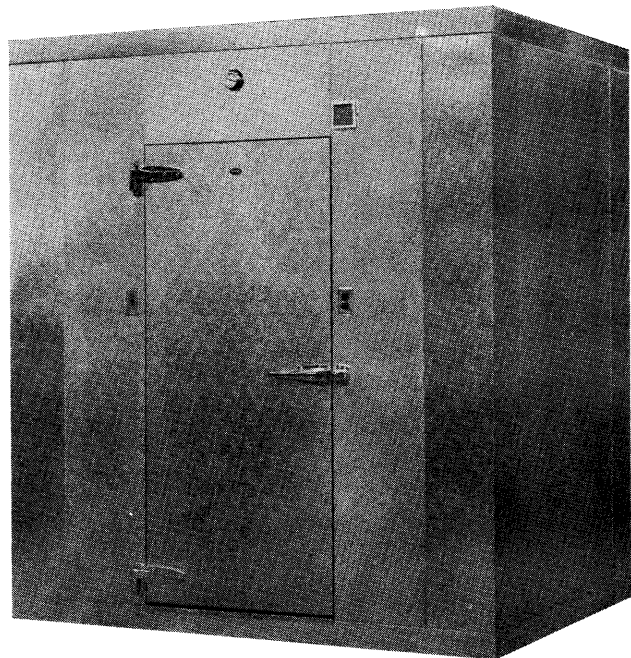
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## A STRATEGY FOR ENERGY CONSERVATION

### — NOW

By John K. Anderson, AIA

John K. Anderson AIA, is a principal of Anderson-Land AIA, AIP, Architects and Planners, Chapel Hill & High Point

The sudden disappearance of cheap energy sources has stimulated a wide range of research in alternate sources of energy. While progress is being made, we are told that it will be at least five years before the energies of wind, sun, water and earth can be effectively concentrated to supplement heat and power on a commercial basis. Meanwhile, prices of conventional fuels are increasing in large increments. Natural gas recently moved up; electricity, which in North Carolina currently averages a bargain rate of three cents per kilowatt hour, is expected to soon reach five cents per kilowatt hour. Since a major portion of all this energy is going to heat, cool, and light buildings, the architect must accept the responsibility — a major responsibility — of conserving energy through careful design.

A few architects are engaged in experimental work using alternate supplemental heating systems, such as solar collectors. Unfortunately, the opportunities for this work are still rare. The costs are high, and the present returns are marginal, at best. However, experience and improvements in the systems are increasing. Supplemental solar heating of domestic hot water is currently paying for itself over a three to five year period (Note that the demand for hot water is year round.).

The architect needs to consistently study the progress of this new energy technology, looking always for opportunities to apply it to his projects. While applications now seem to be expensive, they may prove to be as good an investment as all that "overpriced" real estate was ten years ago.

With this consideration in mind, the vast majority of architects are confronted with the problem of using commercially available technology to design buildings which must be significantly fuel efficient now. We

cannot wait for a technology breakthrough to save us in five years.

The fact is that a great deal of very old and very new technology exists which architects can bring immediately to bear on the problem. Using proper orientation to optimize the use of solar gain and prevailing wind is, of course, ancient technology. A great deal of unnecessarily large mechanical equipment has been installed in order that we could ignore these opportunities.

The emphasis here is on using solar gain positively. Architects are all familiar with the idea of letting light in during cold periods and screening it out during the warmer months. The current engineering buzzword for this age-old concept is "passive solar system". The building itself acts as a solar collector during cold weather. The walls, floors, furniture, etc. act as storage units — no bed of rocks or water tanks required. All that is necessary is either a small fan system or natural convection patterns to distribute warmed air throughout the enclosed space.

The author used this concept on his own home with impressive results: In winter, the furnaces did not operate during any but the most overcast day; the heating bill averaged 15% to 20% less than that of any of his neighbors with comparable square footage and heating systems (and uncomparable, small thermopane windows); house plants thrived all winter. During the summer, the house is air conditioned by running the forced air system fan and using a 20,000 btu condenser to cool and dehumidify the house. Overhangs shade so well that the house plants must be moved outside to receive direct light. Because the house has eleven sliding glass doors and an equal amount of fixed glass, one

consultant advised the installation of a 7½ ton air conditioning system. After seeing the proximity of the trees to the house and analyzing the overhangs, he revised this figure to 4½ tons. A 1 2/3 ton unit was actually installed, principally as a dehumidifier, after two summers during which the interior temperature rarely exceeded 76°. Ordinarily, the sliding glass doors are opened at night to fill the house with cool air, and closed throughout the hot portion of the day. A small attic vent helps keep the thermal buildup there to a minimum.

The James house, described elsewhere in this publication, is another example of a house utilizing a passive solar system for supplemental heat. But houses are not the only possibility for use of passive systems. The IBM building was included in a recent study of several Chicago buildings. It was found to be the most energy efficient of all the buildings studied despite the conventional wisdom saying that its expanses of glass were energy extravagant.

Because of its latitude, North Carolina is one of the better states for passive solar systems. While glass may be a poor insulator, it can be an asset here. Glass areas also provide supplemental lighting. Energy budget calculations must include a careful analysis of the added cost of cooling the heat generated by lighting required in the absence of windows.

Prevailing winds can be used to supplement ventilation. Orientation, operable sash, breezeways, etc. are required to take advantage of this resource. It might also be considered for venting solar screens and attic spaces during hot weather. Furthermore, the direction of winter winds needs to be acknowledged by extra insulation, wind screens, etc. to minimize heat loss.

Insulation has always been a good investment. Initial costs are usually retrieved in the first two years of use. Thicker, high performance insulation products are being introduced daily. These should be used. The obligation of the architect does not stop at specifying a higher R value or in putting insulation indicators all over his drawings, however. It requires a specification that demands very careful application of the product within the building.

The proper installation of insulation serves two purposes. From the mechanical point of view, it retards heat flow. As important, it affects the level of sensible heat, that is, how we sense temperature. And how we set the thermostat. For example, several recent studies show that people will consistently turn up their thermostat, regardless of the existing room temperature, if their feet are cold. Because of this finding, the Arkansas project designers used 6 inches of fiberglass under the floor or 2 inches of perimeter slab insulation. The resultant savings were not realized so much from actual reduced heat loss as by eliminated discomfort at the lower room temperatures. On this same principle, thermopane or storm sash reduces discomfort from drafts and the radiant effects of cold surfaces.

Use of new insulating materials, particularly in new combinations, can be problematic. Moisture characteristics, as well as heat flow, must be considered. The interior vapor barrier is absolutely essential, requiring extreme care during installation. Even a very small amount of moisture cuts back severely on the R value of the insulating material.

Exterior sheathing materials, including plywood and particularly various foam materials, can create an unwanted exterior vapor barrier in the wall panel causing water to

condense and collect quickly. Both water damage and insulation failure occur. The University of Illinois Small Homes Council recommends that above grade, the exterior skin have a vapor porosity four to five times greater than the interior skin. In addition, guarantees on combinations of insulating and finish materials should be checked and manufacturers' recommendations for installation carefully followed. It is already known that the life of a built up roof is affected by laying it on a higher R valued insulation. There are now rumors of problems with wood finishes applied directly to foam sheathing.

Insulation is a highly effective tool for conserving energy; however, its use, both from the standpoint of operation and liability, involves study and careful application. In other words, the architect must rely on his understanding of the insulation characteristics of building materials and not on PR puffery.

In addition, the architect must focus more strongly on field checking material and equipment installation. If ducts are not insulated and sealed, or insulation is not installed or torn out by a later subcontractor, the results will not be as projected. More care in workmanship must be demanded. Because much of this work will be atypical (i.e., not performed strictly by habit), drawings, specifications, and field inspections must be complete and concise.

Proper selection and sizing of mechanical equipment is another way of implementing energy savings. The significant economy achieved by heating a home with heat pumps is an example of this precept. This equipment works exceptionally well in North Carolina's mild winter climate. Its heating efficiency is, however, traded off for slightly higher operating costs incurred during summer cooling cycles.



Even so, the heat pump is the cheapest electrical system if it is properly sized. Much of the blame for high air conditioning costs is the result of *oversized* equipment. An oversized condenser will drop the air temperature and then cut off. The cycle is too short for proper dehumidification of the air. The result is that even with an acceptable interior temperature, occupants sense the latent heat of this humidity and reset the thermostat, much as they did when they had cold feet in winter. The effect of the humidity is accentuated during food preparation periods when heat and steam are added to the air. The longer operational cycle of a smaller unit depresses both humidity and temperature.

Operation of a large condenser unit for longer cycles to achieve dehumidification is significantly more expensive than running a smaller unit for even longer cycles. Comfort is achieved at higher temperatures with a small condenser, and the additional operational time required keeps the comfort level more constant.

The optimal sizing of equipment has proven to be a major energy saving factor in several studies. However, heat pumps much smaller than 1½ to 2 tons are not being manufactured. And believe it or not, these may be oversized for air conditioning. Until manufacturers produce smaller units, the architect will have to use a supplemental dehumidifier to maintain comfort and consequent efficiency levels.

Mechanical recycling of energy, while practiced, should be further exploited. Treated air can be recirculated and redistributed with only supplemental treatment. Even where treated air is being discarded, the btu content can be used to pretreat incoming fresh air. A variety of heat transfer equipment

is currently available: For example, one unit on the market taps heat exhaust from an air conditioner and transfers it to a hot water heater.

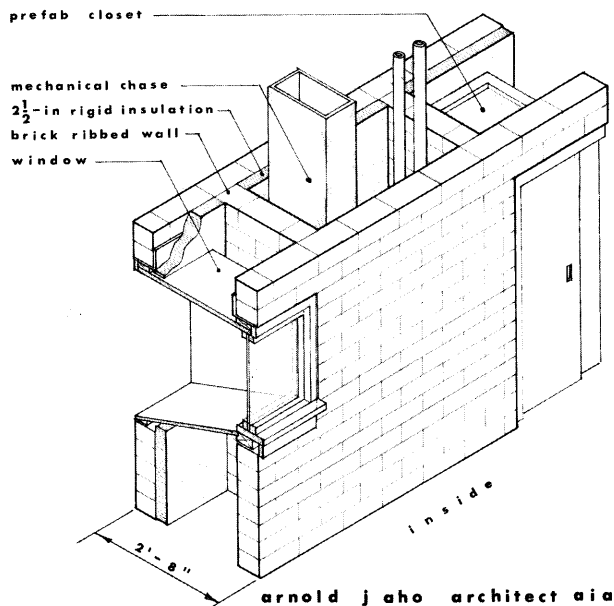
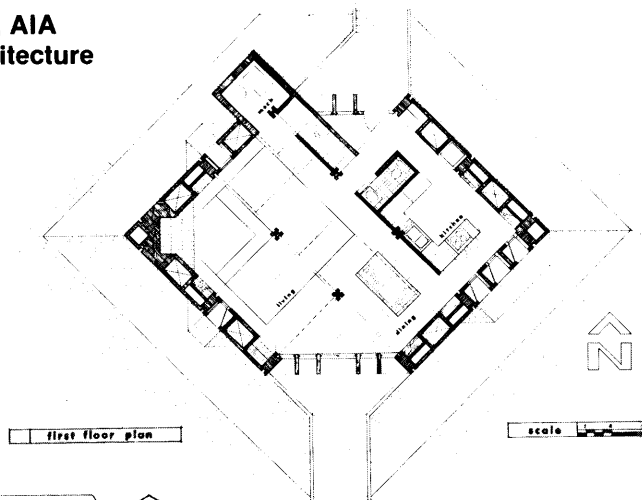
The concepts outlined here are not new, nor are they the only means currently and readily available for incorporation into energy efficient building design. And that is just the point. While we must constantly keep abreast of new systems, we must also use creatively the technology that is already available to us.

The architect must learn to put energy efficiency into his design in the same fashion that he includes his structural system. If he is to understand the problems and characteristics of energy, he must recognize both the energy opportunities and cost implications of all design features of his building. Understanding and experience can result in an intuitive ability to innovate. The architect has done this with structural systems. He has studied materials and mechanics to a degree sufficient to innovate and to stimulate innovation from engineering consultants. He has learned how to work closely with structural consultants throughout the design process. Now the architect must do the same with mechanical systems.

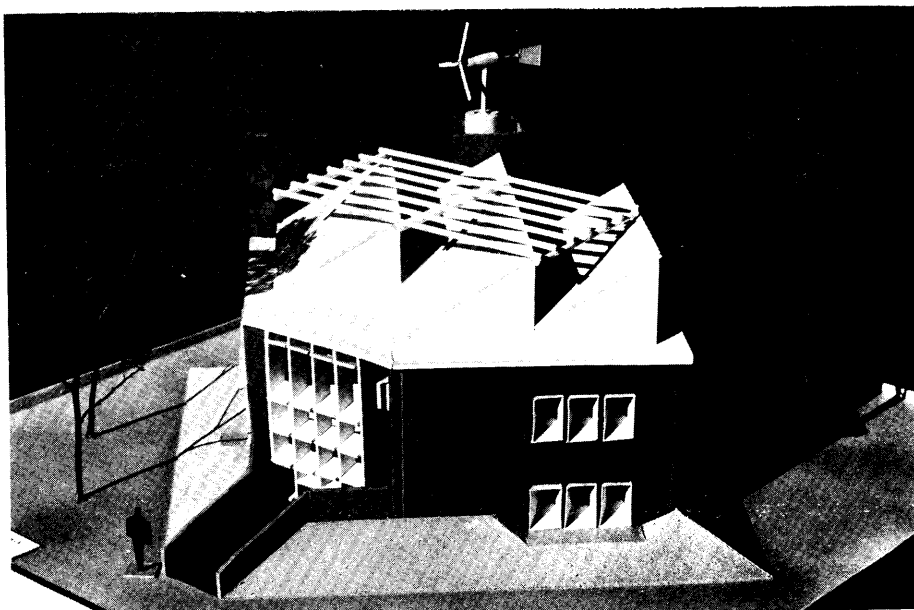
He must become more aware of the applications and limitations of available tools to provide treated air, light, etc. using less energy. He will seek to supplement heat and light with natural sources, and he will attempt to recycle discarded energy. He must develop sufficient insight to be able to make the most economical trade offs towards energy efficiency. Lastly, he must look for opportunities to innovate. Whether it is creative synthesis or discovery, it is a positive contribution to man's environment. This is the role of the architect. ■

# AN ENERGY CONSERVING DWELLING UNIT FOR THE BRICK ASSOCIATION OF NORTH CAROLINA

By Arnold J. Aho, Architect, AIA  
Associate Professor of Architecture  
Mississippi State University



**brick ribbed 'space' wall**



Recognizing the volumes of diverse technical energy data currently becoming available, the architect, must now be concerned with how this new technology can be integrated into the design process; how it might serve to INSPIRE architectural form.

In order to begin to answer this concern, and to discover how an energy-conserving design in North Carolina might be unique from those built in other geographic regions, our firm undertook a research grant awarded by the Brick Association of North Carolina. The program was left quite open. The energy-conserving design was to be a dwelling unit of approximately 1600-sF with 3 bedrooms. The building would have to be designed to be adaptable to varied sites within the Piedmont Region of North Carolina. The house must be capable of being built today using currently available systems and construction processes, or tomorrow using integrated alternative energy systems, such as solar or wind power.

The solution began with the view that building form must be a response to the natural energies ... light, climate (air temperature, radiation, humidity, and wind) and gravity ... and that the design decisions of building form, selection of materials and construction methods could draw inspiration from understanding the effects of these natural energies, as well as from resolving human needs and desires.

Based on our research it was determined that the building should be constructed using a 2'-8" thick brick-ribbed space-wall. Into this wall could go all the spaces not requiring energy-expensive conditioned air (such as closets, duct paces, and mechanical equipment) while also providing adequate space for insulation, shading for the windows, and



structural support. The walls were also bermed with well-draining, but cohesive, soil in order to take advantage of the moderating characteristics of masses of earth on daily and seasonal heat flow conditions. The energy advantages of soil are so significant that a trend towards soil-compatible materials and building techniques is virtually inevitable.

Since spaces are normally defined by walls and roofs, we began this design by investigating how wall orientations and building shape affect the flow of heat. Beginning by computing the sol-air temperatures for typical Piedmont winter and summer days, the hourly heat flow per square foot through various wall construction systems was calculated based on orientations. It was then possible to take a fixed square footage of floor area and compare the total winter and summer 24-hour heat flow as it related to various geometries, proportions and orientations. It was found that in the Piedmont greater compactness of the plan (area enclosed compared to its perimeter) reduced heat gain or loss for the building to a certain point. However, the optimum shape never was found to be a perfect euclidean figure (square, hexagon, octagon or circle); instead, at a certain point of compactness related to the geometric family, the sun would influence the shape and give it a slight east-west elongation. Interestingly, the optimum winter and summer shapes for our region possessed virtually the same proportions. As a result of these findings a hexoid shape was selected for the floor plan not only for its optimum heat flow performances but also, since it could be generated by a square grid, for its efficient subdivision of the interior space.

The designer must be acutely aware that whatever energy is conserved by optimizing building shape and

orientation could be quickly lost by the inappropriate location and size of windows. In response to this, a method was developed to determine the percentages of window area necessary for energy-conserving natural daylighting for various-proportioned rooms and orientations. When this information was compared with heat flow characteristics, window orientations, shapes, and sizes could be more sensitively determined. In the Piedmont for example windows on the south, southeast and southwest walls were up to 68% more efficient for daylighting, while also most optimum for heat load conditions, especially if shaded from the summer's direct sunlight.

The selection and detailing of building materials for energy conservation must be based on more than insulative value alone. Besides thermal conduction, the heat storage characteristics and radiation characteristics of materials significantly affect heat flow. Through extensive analysis of heat flow characteristics of various materials in the Piedmont Climate for S, SE, E, NE, N, NW, W, and SW orientations, on an hourly/sq. ft. basis, it was found that the total heat flow in BTU's/sf for the 24-hour period was controlled by the insulative value (U-value) of the construction. However, the maximum hourly heat flow ("peak load") was to the greatest extent controlled by the heat storage characteristics (amplitude decrement factor and time lag) of higher specific heat materials, such as brick. For example, the peak heat gain for the selected double-wythe brick construction is 42% of that for an equally insulated 2x4 wood frame construction. In winter, the peak heat loss is only 84% of that of the 2x4 wood frame construction. The significance of these reduced peak demands not only would reduce the necessary

size of the heating/cooling system, but due to the lower peak demand and more uniform 24-hour load demand, would make this construction more complementary to low intensity future energy sources such as solar or wind power.

Where the building walls were hexoid and oriented along the east-west axis for heat flow considerations mentioned earlier, the roof was oriented to optimize natural ventilation from the prevailing southwest winds.

Comparing the completed design to the typical wood frame house in the Piedmont Climate, the following results were found. For a typical 24-hour period total heat flow (in BTU's):

	<u>This Design/Typical House</u>	
In winter (21 Dec.)	38881	189873
In summer (21 July)	246733	306648

This represents 80% and 20% reductions in energy consumption respectively, (for winter and summer). This is particularly significant in the Piedmont area since the average family expends 47% of its total energy budget in heating and 14% of its budget in cooling.

In addition, a comparison of the peak cooling period, 4 p.m. 21 July:

<u>This Design/Typical House</u>	
18438	28479 (BTU's/hr)

This represents a 35% reduction in peak demand, indicating that a significantly smaller air conditioning system could be used.

In conclusion, our firm has also begun to recognize that after all the technology, the designer must still recognize that a building must ultimately be answerable to the immeasurable,

"FORMS arising not out of knowledge, but out of a sense of appropriateness"

—(L. Kahn) ■

# ENERGY CONSCIOUS DESIGN (COMMON SENSE)

By Donald W. Barnes, Jr., A.I.A.

Donald W. Barnes, Jr., A.I.A., is an Assistant Professor of Architecture in the School of Design at North Carolina State University. He is presently on leave at Texas A&M where he is completing the requirements for his Doctor of Environmental Design in Architecture degree.

A growing awareness that the world could run out of conventional sources of energy has re-kindled interest in solar energy. By now you should have had at least one client that seriously wanted "a solar building." Did you say "no" and force him to find another architect? Or did you say "maybe," and now you are looking for design help? I would like to suggest that you take a look at some alternatives.

Solar energy is not new. Solar collectors were used to heat domestic hot water in Florida and California before the depression. We have all designed solar buildings, for all buildings are really solar buildings. It is just that some buildings are more efficient solar collectors than others.

However, if your client wanted you to cover his roof with flat plate collectors, I hope that you explained one important fact. While solar collectors may work physically, they do not work economically. There is just no way that solar collectors are going to cut your client's umbilical cord with the utility companies. Solar hardware is in the experimental, not economical stage. Oh, if you are a tinkerer and don't mind babysitting a mechanical offspring, you might build a solar hot water heater for your own amusement. But, as a responsible architect, you cannot recommend solar space heating and cooling to a client. If he tries to give you that stuff about paying for the equipment with a grant from ERDA, get your entire fee in advance. It will still be the hardest money you ever earned.

There is, however, one breakthrough that should really interest your client. When the brownouts come, this breakthrough may keep his building alive while its neighbors become dead elephants. The breakthrough is called *Energy Conscious Design*. It might just as

well be called *Common Sense*. It has been market tested throughout the world and down through history. It works.

At present, over 20% of all the energy consumed in this country is used to heat and cool people. Energy Conscious Design can easily cut your client's portion of this bill by 50%. With a little effort, it can do even better. This is a real Break-through. This is the good news.

The bad news is that he may end up with a building that does not look exactly as he imagined it would. It may cost him more, too, in the short run. Over the long haul, however, he will be way ahead. Unfortunately, the IRS and his own investment strategy may not encourage a pay now, save later attitude.

We used to call it "Designing with Natural Energies," and we always tried to do it until about 1952. That was when air-conditioning-for-the-masses and cheap energy came along. Overnight, air conditioning freed the designer from the natural restrictions of climate and site. Every homeowner could now express his own personality, if only with a salt box in Tucson or an adobe on Cape Cod. For twenty-five years we have lived in the paradise of cheap energy with promises of more to come. The promises used to be cheap energy from nuclear reactors. Now they are promises of cheap energy from solar collectors.

Perhaps you feel that energy is not *your* problem. Energy is the problem of your mechanical consultants. True, engineers are working on solutions for some parts of the total energy problem, but they do not design the plan, site the building, determine the fenestration, or incorporate the other features that may waste energy. They take the building as a given, and you are the one who gives it.



You may also believe that there are computer programs that will help you design buildings that use a minimum of energy. True, there are energy programs, but they only predict how much energy your building will use. They cannot tell you if your building is a good or bad thermal machine. At best they can only compare two solutions and indicate the better of the two.

If Energy Conscious Design is so important, where can you find out more? You can start by laying-in a supply of books and articles on energy design. Some of these were written a quarter of a century ago and may be hard to find. Others were written about house design, and you will have to extrapolate for commercial applications. Some are merely a re-hash of the same information.

Must reading for every architect is *A Bucket of Oil* by Caudill, Lawyer, and Bullard.<sup>1</sup> Bill Caudill is the "C" in CRS. He has been a pioneer in energy conservation since he was a dean at Texas A&M. He applies energy conserving principles to the types of buildings that architects are likely to design. This is a how-to-do-it book by a successful doer that has done it.

Read *Energy, Environment and Buildings*<sup>2</sup> by Philip Steadman. Steadman gives an excellent overview of energy conservation measures that can be used in building with a checklist added. He includes a good bibliography and directory of existing solar buildings. For good measure he reviews some exotic energy proposals.

If you still have the July/August, 1973, issue of *Architectural Forum*,<sup>3</sup> re-read the twenty page article, "Architecture and Energy," by Richard G. Stein, FAIA. Mr. Stein outlines what he believes the architect's position should be in reducing energy consumption. He

also seriously challenges the recommended IES illumination levels. He is a good authority to quote if you agree with his position.

If you can find it, undoubtedly the best articles ever written anywhere about climate control in residences were published in the October 1949 issue of *House Beautiful*.<sup>4</sup> In succeeding months, climatic designs in 15 different areas of the country were featured. This work was done in cooperation with the AIA, and the technical portions were published concurrently in the *AIA Bulletin*. Unfortunately for us, North Carolina was not one of the areas in the climatic analysis. The D. H. Hill Library at N. C. State University has the *House Beautiful* series, and you can photocopy it.

For anyone who wants to get acquainted with solar hardware and other alternative energy sources, I suggest four paperbacks: *The Owner Built House*,<sup>5</sup> *The Energy Primer*,<sup>6</sup> *New Low-Cost Sources of Energy for the Home*,<sup>7</sup> and *Other Homes and Garbage*.<sup>8</sup> The last of these is a Sierra Club book.

Get your mechanical consultant a copy of the National Bureau of Standard's Special Publication, *Energy Conservation Through Effective Energy Utilization*.<sup>9</sup> The chapter on "Potential for Energy Conservation in Heating, Ventilation and Air Conditioning Equipment for Buildings" is the most sensible thing I have seen from the government in a long time.

If you really want to be sure that you have blocked the sun from your buildings, get a *Sun Angle Calculator*<sup>10</sup> from Libbey-Owens-Ford. They have just started putting them out again after a lapse of several years.

Don't forget your own experience. Go back and see how your own buildings work today. New equip-

ment and new processes may change lifestyles and the energy requirements of buildings. The computer is one example. Computers usually operate 24 hours a day, while the normal office may only be in use for ten hours. Yet in many buildings it is necessary to provide elevator and vending service and to light lobbies, stairwells, corridors, rest-rooms, and lounges for computer users. Computer rooms may occupy only 10% of the floor area but may use two-thirds of the electricity. Don't forget nature. Probably no problem will ever confront you as an architect that nature has not already met and solved.

Don't forget those that went before us. They had to design with natural energies because that was about all they had. Remember, our ancestors invented the window, the greatest climate control device yet. It incorporates its own lighting and ventilation system. It can let in the sunshine in winter and keep out the heat in summer. You can even turn it off when you don't need it. But, windows are like any energy saving device, you need to know how and when to use them. When they are used properly, they are very good, but when they are wrongly used, they are horrid. ■

## FOOTNOTES

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3. *Architecture Forum*, July/August 1973, pg 38-58
4. *House Beautiful*, October 1949 and the following 15 months.
5. Ken Kern, *The Owner Built Home* (Charles Scribner's Sons, New York, 1972)
6. The Portola Institute, *The Energy Primer* (Available from The Whole Earth Truck Store, 558 Santa Cruz Avenue, Menlo Park, CA 94025, \$5.50)
7. Peter Clegg, *New Low-Cost Sources of Energy for the Home* (Available from Garden Way Publishing, Charlotte, Vermont 05445, 1975, \$5.95)
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9. National Bureau of Standards, Special Publication No. 403, *Energy Conservation Through Effective Energy Utilization* (Available from Sup. of Doc., U. S. Government Printing Office, Washington, DC 20402, \$3.30) June 1976
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# R. J. REYNOLDS INDUSTRIES, INC. WORLD HEADQUARTERS BUILDING

**Architect: Odell Associates, Inc.**

When R. J. Reynolds Industries, Inc. announced to the press in December 1975 that it would move its international headquarters from Switzerland to Winston-Salem, North Carolina, they also unveiled the architectural design of Odell Associates Inc. which featured the latest developments in energy conservation for their new half-million square-foot building. The five story office is situated on 10 acres of land located on 33rd Street next to the Bowman Gray Development Center. The building is 790 feet long and contains over two acres of office space on each floor.

The first consideration for energy conservation by Odell Associates was the building's orientation on the site. Then, employing the latest advances in building technology, the World Headquarters was specified to be covered with reflective silver Thermopane glass that reflects 82 percent of the solar heat and light reaching it. In addition to the reflective and insulated glass, another energy conservation consideration was the environmental control system, which automatically adjusts the temperature and lighting according to a computerized program designed to achieve maximum results with minimum energy usage. The system automatically relays information from each part of the building on existing heat at that particular point. The control system then regulates the flow of heating or cooling air to that area. The efficiency calculations of this system for the 523,000 square-foot World Headquarters reveal only four percent more in energy usage than an existing office building in downtown Winston-Salem which contains slightly less than 300,000 square feet!

In addition to the centralized environmental control system, heating and air-conditioning in this building has the capacity to extract

internally generated heat from the lights and occupants and apply it to the exterior of the building, thus minimizing energy loss through heat transfer. The variable air volume system utilizes the following energy conserving characteristics: 1) perimeter heating for winter; 2) interior cooling year-round; 3) economizer cycle with an enthalphy control; 4) humidity control; 5) reclaiming light and people heat to the core area through a duct; 6) computer program monitoring lights and mechanical system.

By applying all these energy conserving features, the world headquarters building is within

the 4% national energy goal of 55,000 BTU's per gross square foot per year. R. J. Reynolds Industries' new building is 59,000 BTU's per gross square foot per year. Further reductions are possible based on operating efficiency and increases or decreases in operating temperatures from 75° year-round design.

In addition to total flexible office space, other features of the building include a large cafeteria seating 500 employees at one time with a full service kitchen and a branch office of the Reynolds Carolina Credit Union. It also contains a 340-seat amphitheater-style auditorium with a full range of audio-visual equipment. The art department will be able to handle publicity needs from magazine advertising to bill board publicity and darkroom and television studio facilities will be available. Extensive landscaping and site development work is planned.

The headquarters building, scheduled for completion in the autumn of 1977, will house the corporate staff of R. J. Reynolds Industries, Inc., and two of its subsidiaries, RJR Archer, Inc. and RJR Foods, Inc. The corporation's largest subsidiary, R. J. Reynolds Tobacco Company, will remain in its location in downtown Winston-Salem.

Parking facilities for employees and visitors will be plentiful at the rear of the building. R. J. Reynolds anticipates ultimately employing 2,000 people who will be located in the new headquarters building, and the parking area will accommodate them. In addition, there will be parking spaces for the handicapped employees on the underground level.

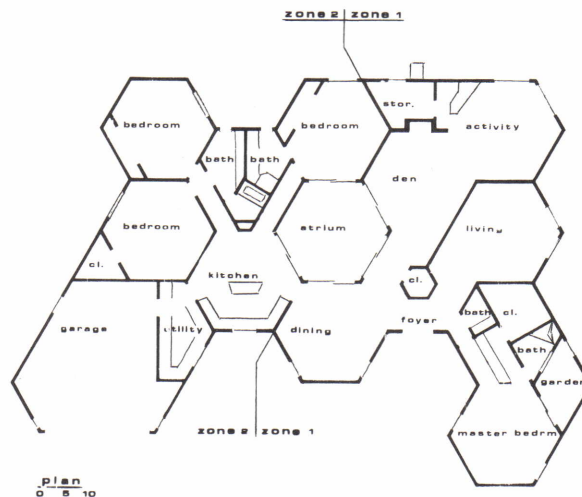
The headquarters building exceeds the North Carolina High-Rise Code requirements as well as the General Services Administration national goal for energy conservation. ■





# THE JAMES HOUSE

By John K. Anderson and Thomas J. Land, Jr.



The J. L. James, Jr. residence in Wake Forest, N. C. has received considerable attention for a variety of reasons, particularly for its low heating costs. In each of the last two years, the owner has heated his 3500 square feet for less than \$136.00. To achieve this efficiency, the owner-designer incorporated several well-known concepts.

The house is made up of several small hexagons linked together into a flowing floor plan. The most obvious feature is a centrally located atrium which is covered with corrugated fiberglass. Sliding glass doors open onto this atrium on five sides. In addition to its strong aesthetic appeal, the atrium acts as a passive solar collector. By day the

sliding glass doors are left open, and the solar heat energy collected through the atrium roof is distributed throughout the house. This will usually bring the inside temperature to 78°. At night, the sliding glass doors are closed to hold in the heat. In the summer, heat collection is minimized by installing shades. These reflect out considerable light before it is converted into heat energy. Heat that is captured is removed by a small fan.

The small garden outside the master bedroom is also used as a collector. During the winter, this space is covered to collect heat. In the summer, the cover is simply removed.

Another energy saving feature of the James house is the use made of an air plenum in the ceiling. In winter, the plenum is used as an air return, taking regular return air, as well as treated air from a circulating fireplace, heat from light fixtures, etc. Maximum advantage is taken of these supplemental heat sources by distributing it evenly throughout several rooms. The ceilings are framed with bar joists which allow air circulation between the insulated roof deck and the ceiling insulation. Three inch styrofoam insulation in the roof holds the heat in.

In the summer, the ceiling plenum is not used as a return air. Instead, it is sealed from the inside and vented directly outside. The roof deck serves as a sun screen; the six inches of insulation in the ceiling act as the exterior insulation. This system keeps the temperatures low.

With the small temperature differential between the plenum and the house interior, cooling needs are kept to a minimum.

The principal heat system is made up of heat pumps (2 HP and 3 HP) operating in two zones. Heat is applied directly to the bath rooms with heating cables cast into the floor. Heat loss from the hot water heater is used directly to heat the master bedroom closet.

In addition to three inches of styrofoam and 6 inches of blown ceiling insulation, the designer used two inch styrofoam perimeter insulation under his floor slab. The walls are 2" x 4" studs, with 3 1/2 inch blanket insulation and 1/2 inch insulating sheathing. Siding is redwood plywood, but with 1/2 inch of air space maintained between the siding and the sheathing.

The interior is also finished in redwood. This acts as an insulator, but perhaps more important, it is also a material which is warm to touch. Because one does not feel cold and uncomfortable when near it, he feels comfortable with a lower, more economical, thermostat setting.

There is really no new technology used in this house. Even the insulation is not out of the ordinary. However, maximum advantage was taken of the technology available. Rather than being strictly an engineering feat, the house is both an aesthetically and physically comfortable place to live. The fact that it is energy efficient is just one of its features. ■



# A/E DESIGN CONSIDERATIONS FOR ENERGY CONSERVATION

North Drive School • Goldsboro, N. C.

**OWNER:** Goldsboro City Board of Education

**ARCHITECTS:** Griffin-Flynn Architects Ltd., Goldsboro, N. C.

**MECHANICAL & ELECTRICAL ENGINEERS:** Fenner & Proffitt Inc., Wilson, N. C.

**STRUCTURAL ENGINEERS:** Progressive Design Collaborative, Raleigh, N. C.

**LANDSCAPE ARCHITECTS:** Bell Design Group, Raleigh, N. C.

The plan is a modified open plan of 30 Teaching Stations which surrounds a two level core of media center, activity areas, work rooms, toilets, and conference rooms. An additional 8 Teaching Stations are located in the Kindergarten Wing.

Following are design considerations and solutions for this 73,000 sq. ft. elementary school.

**1. Enclose the greatest amount of space with the least amount of exterior wall.**

The program did not allow a circular solution but the same result was obtained by splitting levels at the center of the school (2 story) and surrounding this area with teaching stations.

**2. Keep volume of building (and air to be conditioned) low.**

Precast prestressed double tees 24" deep were selected for:

- ability to bridge large spans with minimum depth (low roof deck 11 feet above floor).
- ability to carry mechanical and electrical components between the tees.

- ability to absorb and store heat in its mass providing a "flywheel effect" which helps keep temperature constant.

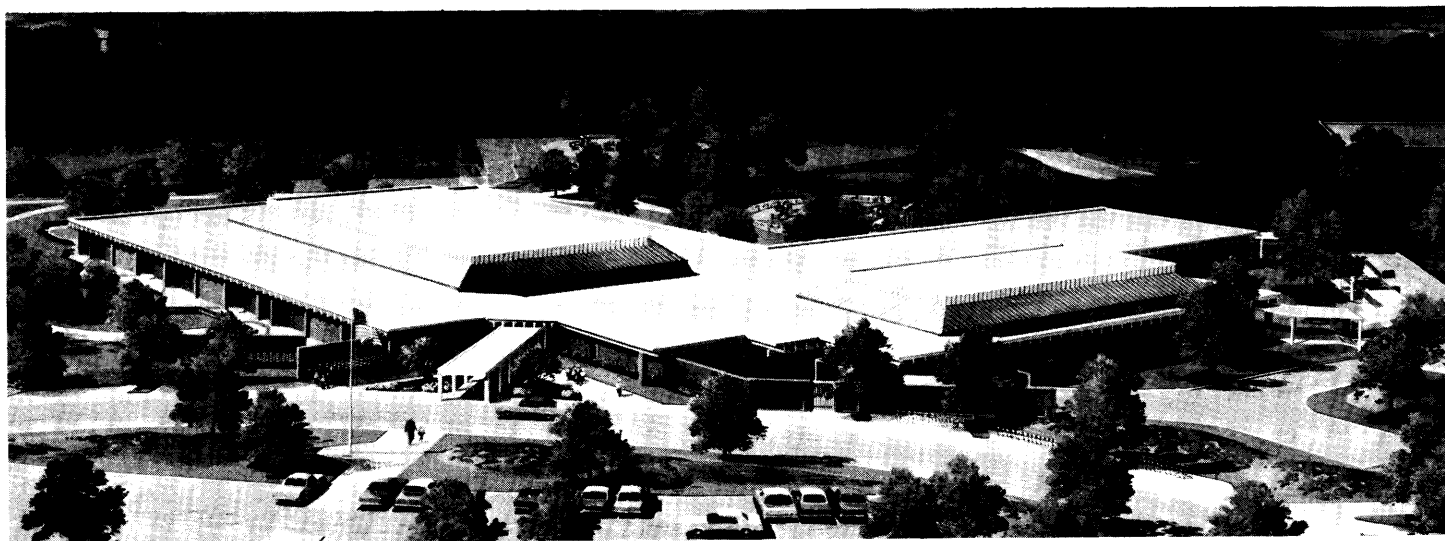
**3. Keep windows and openings to a minimum.**

**4. Insulate walls and roof to maximum extent feasible.**

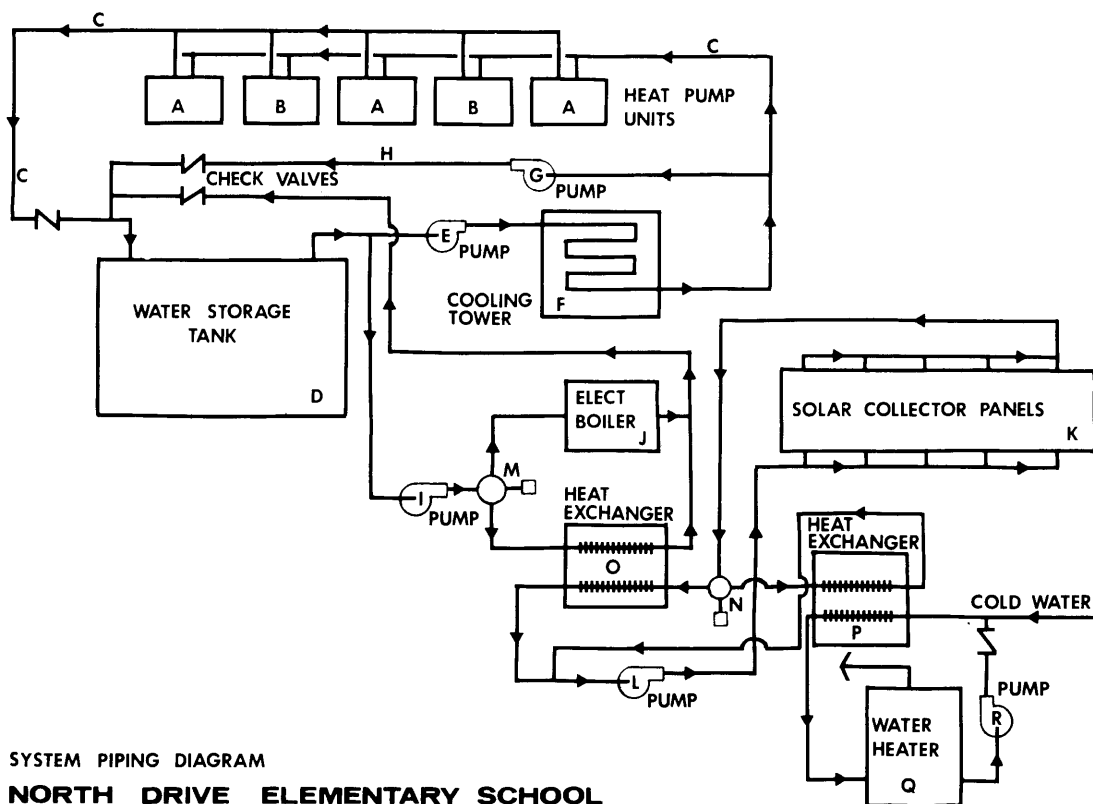
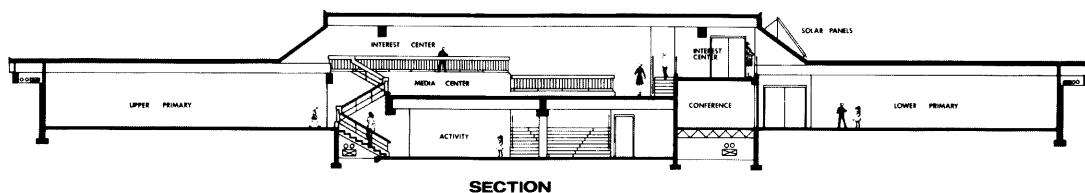
Sandwiching efficient polyurethane foam between the roof tees and lightweight cellular concrete topping provides maximum insulative value (less than .05 "U").

**5. Attempt to capture heat from lights and young bodies in building center to heat areas bordering exterior walls.**

This is done by a heat recovery system using some 40 water to water heat pumps located throughout the building. Heat is either absorbed (cooling) or dissipated (heating) on demand as the water makes its ways through the system. Saving here represent from 20 to 140% in KWH/sq. ft. per year over conventional systems.







SYSTEM PIPING DIAGRAM  
NORTH DRIVE ELEMENTARY SCHOOL

6. **Provide a “flywheel” which will allow heat energy to be stored and retrieved when needed.**

In the average afternoon heat removed from the building (cooling) is stored in a 20,000 gal. underground insulated storage tank to be fed back into the plant during the night.

7. **Using the principles of 5 and 6 above, strive for a balanced system of heating, cooling and storage of water such that a minimum of outside energy sources are required to maintain this balance.**

Dissipating or adding heat energy to the system costs money.

8. **Plan for peak-demand pricing of electrical power.**

This was done because it's considered inevitable. Thus, driving extreme spells of hot and cold weather when the system tends to be out of balance (required to provide more heat than is in storage or available for capture from lights and pupils) we turn again to the storage tanks for rescue. Its ability to store heat energy allows use of a smaller heater used only during the off peak night time to replace heat used during the previous day. Similarly, if heat absorbed during the previous day (during cooling) is to be ejected from the system,

it is stored and ejected at night when cooling tower runs most efficiently and electrical rates are lower.

9. **Use solar energy to assist the system during heating season; divert it for domestic hot water when not otherwise required.**

The addition of the solar receptors will keep the systems in balance for longer periods without outside assistance. (Energy consumption). The receptors efficiency at 60-90°F operating temperature is about 70% compared to 30% at 200°F, so maximum use is made of the solar produced heat by this system. ■

# AN ENERGY CONSCIOUS APPROACH

## MECKLENBURG COUNTY COURTHOUSE

Charlotte, North Carolina

Wolf Associates, Architects, Ltd.

### An Old Maxim

Absolute Capsulized environmental control continues to be expected of every building designed. We as architects do little to reverse this trend and are often indeed the cause of public expectancy and demand for the 72 degree, 50% humidity, 100 foot candle "maxim" for the designed environment.

This general expectation for absolute environmental control must be aborted.

### Design Attitude vs. Maxim

The Mecklenburg County Commissioners and Wolf Associates abandoned the 72 degree, 50% humidity, 100 foot candle maxim as a first step towards making their new 102,000 square foot Courthouse an energy pincher. Mechanical and lighting design criteria was established for each space based on user need rather than an abstract maxim.

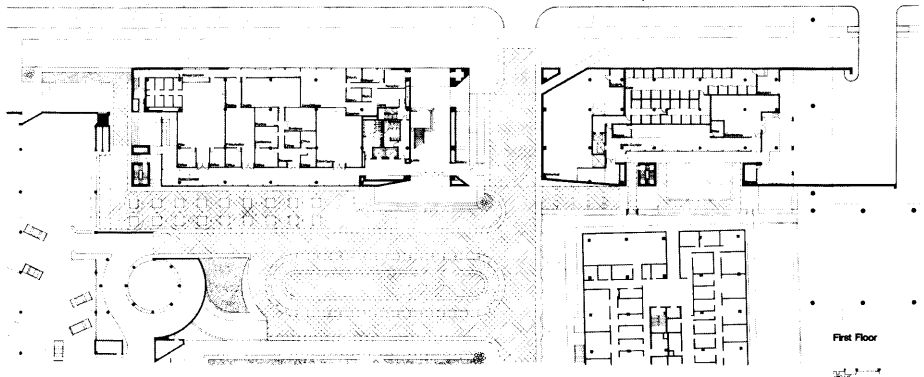
For example, broad variances are allowed for space conditioning

### The System

Analysis showed that an all electric heating and air conditioning system was most energy and life-cycle cost effective.

### Heat Reclaim

A heat reclaim system was incorporated so that energy expended for the cooling cycle of the interior courtrooms is recycled through the reclaim chiller to heat the exterior corridors. The heat reclaim system



New sources of unlimited energy will never be an answer to wasteful energy consumption. Our expectations of the designed environment must be tempered with a sincere desire to make buildings climatically responsive energy pinchers.

### The Approach

This can be achieved through an energy conscious design approach.

1. Establish mechanical and lighting design criteria based on room by room user need.
2. Develop the building plan and envelope to minimize energy waste.
3. Maximize the efficiency of the energy using systems.
4. Maintain a program of operational standards for all energy using systems.

in the public and private dual corridor system of the Courthouse, thus realizing a real savings in the energy consumption of the building.

### Corridors Insulate Courtrooms

Further, the plan was developed to save energy by the placement of the corridors on the building exterior to insulate courtrooms and offices.

### Glass Used Sparingly

The noted variance in the usage of glass in the north and south exposures is a direct response to orientation to reduce the solar heat gain of the building.

### Computer Analyzed

Both the building envelope and the mechanical system were computer analyzed for their impact on energy savings and life cycle cost.

will save enough energy to pay for itself in ten years.

### Future Solar Energy

Though solar energy heating was considered, it was not found to be economically justified. The heat reclaim system used incorporates water as the heat transfer media and is designed at a low temperature datum in order to be adaptable to the low heat available through solar energy technology.

### An Energy Pincher

The Mecklenburg County Courthouse will be an energy pincher because careful attention was given to the building envelope, the energy using systems, the program of mechanical system operation, and in establishing mechanical and lighting design criteria, rather than building accepting the 72 degree, 50% humidity, 100% foot candle maxim. ■

# BLADENBORO COMMUNITY MEDICAL CENTER

## Bladenboro, N. C.

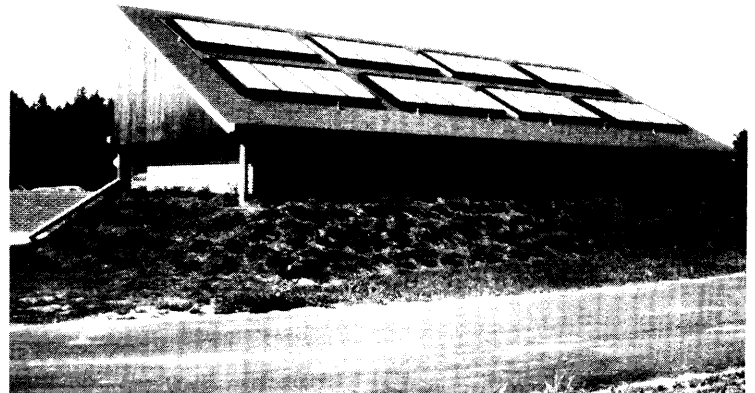
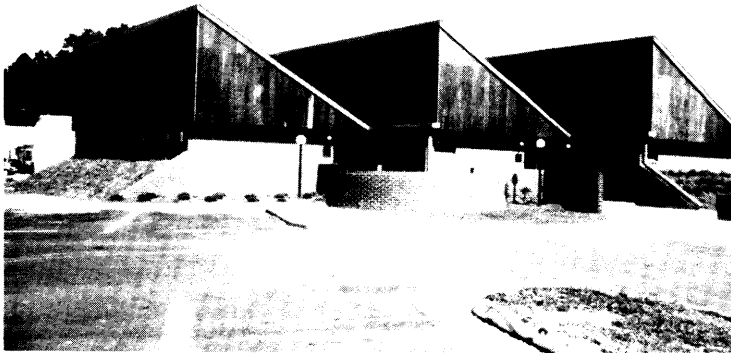
By Arnold J. Aho, Architect, AIA

The small rural community of Bladenboro in the southeastern part of North Carolina has been in need of continuous, locally-available medical services ever since the last local physician relocated elsewhere. The town is approximately 15 miles from the nearest doctors and hospital. A group of aggressive citizens organized through the Bladen Development Corporation to fulfill the need for basic or routine health care, treat-

energy system for heating and hot water.

The final design is a one-story building with an area of 2364-square feet, to which a dental annex of 1004-square feet was added approximately halfway through the design phase. The building is built on reinforced concrete footings and a reinforced concrete slab-on-grade. The exterior walls are 12-inch insulated brick cavity walls, portions of which are bermed with well-

Barnes, Jr., AIA, formerly of the School of Design at NCSU. This system features one of the first field applications of freon as a medium. Freon not only solves some of the freezing and corrosion problems inherent in hot-water systems, but also since it undergoes a change-of-state, it is capable of conducting far more BTU's more efficiently. Three zoned heat pumps provide 100% back-up for the solar heating system.



ment of minor illnesses and emergency services within their own town using the family nurse practitioner/physician's assistant model, with physician backup from a nearby town. Instrumental in getting this program off the ground was the North Carolina Office of Rural Health Services who responded to the community's requests for technical, financial, and organizational assistance. With ORHS help the community developed a comprehensive program for these medical services and facilities to house them.

Being concerned with their future operating expenses, the members of the Bladenboro Medical Center Committee required that their new facility be energy-conservative and asked that the architect explore the feasibility of employing a solar

draining cohesive soil to take advantage of both the insulative and heat storage characteristics of earth. The soil is stabilized using low-growing juniper shrubs which also deter individuals from climbing the mounds. Windows were sized and located based not only on interior functions, but also on heat flow characteristics. They feature double panes of glass, with an internal slim-shade blind to further control radiant heat gain. The larger glass entrances are so located to remain predominantly in the shade throughout the cooling season.

The principle visual features of the design are the solar flat-plate collectors which are mounted on the south-sloping wood truss roof. These are part of a unique solar energy system designed by Donald W.

This building is one of the first medical centers in the country to be solar powered. Partially for this reason, it has been selected by the AIA Research Corporation as an extended case study building in conjunction with their research grant into the early use of solar energy in buildings.

Construction was completed on all systems in August of this year.

Currently, the N. C. Office of Rural Health Services is in the process of preparing for an evaluation of the energy conservative facility. It is anticipated that this evaluation will be conducted in the spring of 1977, at which time the maximum peak use period for the solar energy system for heating and hot water shall be over. ■

# ENERGY AND THE ARCHITECT

By Herbert W. Stanford III, PE

Mr. Herbert W. Stanford, P.E., is with the firm of J. N. Pease Associates, Charlotte, North Carolina and he is the Chairman of the Professional Engineers of North Carolina (P.E.N.C.) Energy Conservation Committee.

The design of an energy-conserving building is no accident; it is a result of the efforts of a knowledgeable and motivated design team — Architect and Engineer. And, in these days of rising fuel and construction costs, the people who build buildings, our clients, know it. They are aware of at least some of the energy aspects in design and are looking for the design team that can do the best job for them in this area. A church building committee recently interviewed our firm and one of their primary selection criteria was our knowledge of solar energy. Our last planning commission was awarded because, among other things, we demonstrated the ability to analyze alternative energy system approaches. Chapter 434 of the North Carolina General Statutes requires that life-cycle costing be applied to State buildings.

All of the factors add up to the fact that our prospective clients are developing a new attitude about what they are looking for in the design team. More and more, the client wants to know, from ground zero, what the design team is going to do for him in terms of providing a functional, energy-conserving building. This new attitude on the part of our clients requires a new approach by the Architect and Engineer in the selling of design services.

One by-product of this changing market is that the relationship between Architect and Engineer is changing; now the Engineer must be included as part of the team from the very beginning — even to the selling of the job initially. For sophisticated clients, this can even extend into the types of projects that have long been the sole realm of the Architect — land planning and space programming because, now, such things as district energy systems and the effects of space

arrangements on energy consumption are factors to be considered.

Because of the impact of energy considerations on the design process, many architects and engineers find that, suddenly, they are at the bottom of the learning curve. There is a new rule to the ballgame and there is a certain amount of natural resentment. But, if the design professional is to provide the service that is required, he must develop in terms of the new requirements — not fight it.

Another aspect is that the need to involve the design engineer at very early stages in the project's life has upset the traditional balance in the work performed by the Architect, versus the work performed by the Engineer. Many architects find that the engineers with whom they have worked for years satisfactorily, perform less satisfactorily when placed in a selling environment where the topic is as broad as energy.

Let's look for a moment at the avenues open to the Architect in operating in this new environment. The number one priority is for every design professional to get "energy conscious". The architectural aspects of designing for energy conservation can be extremely exciting and will require, on the part of the design professional, considerably more imagination than many other aspects of the profession. Part of the energy-consciousness program must include staying abreast of what is going on in the world around him:

- Federal legislation, typically Public Laws 94-163 and 94-385, is forthcoming that will have significant impact on the design process.
- ASHRAE Standard 90 is being presented as a "consensus energy design standard".



—A new chapter defining energy conservation requirements is being developed by the North Carolina State Building Code Council.

These are but a few examples of new developments. These, and a plethora of discoveries on the part of the other design professionals constitute a large and continuously changing body of information with which the Architect must be familiar.

Over the years there has been an increasing tendency on the part of engineers to specialize in relatively limited fields — there is the Mechanical Engineer who is limited to the design of HVAC and plumbing systems, the Electrical Engineer who does power and lighting, and the Civil Engineer who develops our transportation arteries and provides many of the utility services to our buildings. The new energy consciousness is changing this. While there is a continuing need for these specialized services, there is a new need for a “generalist” who can look at the many, many different aspects of engineering and architecture as related to energy impact in building design and construction. This new individual we will label, for the lack of a better name, “the energy utilization consultant”.

The energy utilization consultant can serve the design team, in the initial stages, in the selling of the project and in providing guidance to the specialized members of the design team during the design and document preparation phases. The energy utilization consultant has the tools with which to evaluate the energy and economic impact of various design alternatives — mechanical systems, construction materials, glass types, building orientations, or even different design concepts.

Let's examine for a moment the

criteria for an energy utilization consultant: Normally, he is a registered professional and usually an engineer. He must have a demonstrable background in the evaluation of energy systems and have a broad knowledge of both architecture and engineering. He must be informed — aware of past and expected future trends in energy availability, cost, and utilization. And, he must be a “salesman”, capable of discussing energy considerations with a broad range of potential clients, from the amateur church building committee to the sophisticated industrial client.

Some larger A-E firms will be able to afford to maintain such an individual on their staff. Some can afford to acquire and maintain the computer-based analysis tools required for meaningful energy and economic analysis. But, the vast majority of architectural firms will find it necessary to retain an outside consultant. There will be many representing themselves as energy utilization consultants and, consequently, some criteria for selection must be developed. The criteria outlined above should enable the Architect to retain a qualified energy utilization consultant.

There are a number of benefits that accrue to the Architect through the use of an energy utilization consultant. First, he has an individual on his team who can aid the Architect in coordination of the sometimes conflicting goals of the traditional members of the design team. Last, the energy utilization consultant can make available to the Architect information and ideas that help him develop an exciting solution to a design problem.

Bill Caudill defined the architectural process as a blending of form, function, and economy. Today there is perhaps a fourth leg to the architectural animal — energy. ■

# CONSERVATION AND ARCHITECTURAL EDUCATION AT UNCC

By: Charles C. Hight, AIA, PE  
Dean, College of Architecture

As UNCC's College of Architecture program develops during the next few years, one of its basic tenets will be the integration of conservation considerations into the environmental planning and design processes. We believe it quite important for students to develop the skills and obtain the knowledge of environmental conservation to such an in-depth degree that it becomes a natural part of their problem identification-solving processes.

Consequently, conservation is not treated as a separate subject but rather it is integrated into all studio years. Equally important, conservation is thought of in terms of land, capital and resources as well as in terms of energy. The students are constantly made aware of the inter-relationships between land, capital, resource and energy considerations, for example, the influence of land use policies upon energy consumption.

It is believed that while new systems of energy supply and distribution must be developed and the architects should play a role in these efforts; we must not make the mistake of the past, i.e., examining items out of context or in a too limited scale. All too often what is considered to be ancillary turns out to be the most influential factor. A prime example is while it is certainly worthwhile to improve solar energy techniques so that it is economical, continued use of the land-use policies that we have utilized since 1945, will be counter productive to energy conservation. Likewise, solar energy

application must be set in within a context of providing a quality environment. Thus efforts will include in-depth examination of building performance criteria, that is, in terms of energy use as well as human behavior. Also included will be an examination of those factors which significantly affect each other; one example being how federal tax laws encourage energy waste and misuse to a much higher degree than all the highly publicized energy conservation and alternative developments of the past few years.

Likewise, while the College of Architecture fully recognizes its need to provide students with the basic body of knowledge and to develop the fundamental skills required of any practitioner; it also sees unprecedented opportunity for architectural graduates to enter into a series of non-traditional architectural activities because of the energy dilemma. Therefore, the program will provide opportunity for students to explore various energy sources, conservation and delivery systems. This will allow those interested students to enter into research (private and government) and delivery systems development activities in addition to the more traditional activities of building and land planning/design.

Furthermore, the program wishes to avoid the pitfalls architectural schools fell into during the zenith of the housing prefabrication interest, i.e., a romantic attachment in which they assumed it was "the way of the future," rather than performing a rigorous analysis and

requiring first hand information. Certainly our past and future efforts aren't limited to only new construction. All indications are that building recycling in all its many facets, i.e., renovation, preservation, adaption, restoration, etc. will continue to be a major activity of architects. Quite obviously, use of new energy sources and energy conservation in existing building poses even greater problems than with new construction. It must be clearly understood that in our rush to save and re-use old buildings, we may, in fact, increase energy consumption and that the two popular movements are not necessarily supportive of each other. Thus, the architectural education program must be prepared to comprehensively and in-depth include examination of building recycling in terms of new energy sources and energy conservation.

The Metropolitan location of UNCC means that the College of Architecture should be involved in not only performing its role of educating collegiate architecture students, but also including the following:

- 1.0 Provide Continuing Education for the practicing architects so that they are able to make proper use of the newly emerging bodies of knowledge regarding new energy systems and conservation techniques.
- 2.0 Informing the public that new energy sources and their impact upon environmental quality as well as impact of present land use, movement systems, tax

laws, etc. upon new energy source development, application and energy conservation.

- 3.0 Development of research and community assistance projects which emphasize use of energy conservation and new systems.
- 4.0 Educating non-architectural students so that they become better prepared citizens and sensitive clients.

Fortunately, UNCC has a relatively large number of faculty who share in the desire to accomplish the aforementioned activities. In fact, during the past several years, a number of the faculty have been involved in energy related activities either at UNCC or prior to their appointment. Some examples of faculty involvement are as follows:

During the 1974/75, academic year, Assistant Professor Linda Searl received a grant for the study of the relationship between urban growth patterns and energy use. The object was to examine the effects of land use density upon energy use and how various urban growth patterns can increase or decrease energy consumption as well as relationship between urban growth patterns and type(s) of energy consumed.

Prior to coming to UNCC, Assistant Professor Carl Hauser participated in the schematic and design development phases of the University of Nevada System's Desert Research Institute. The solar heated-cooled building for Boulder City, Nevada was the first of its kind. The building design incorporated various energy conservation techniques in addition

to the installation of a solar collector which worked in concert with heat actuated cooling-heating injection system. In 1974, Owens-Corning Fiberglas Corporation gave an award for its energy conservation.

Professor Michele Melaragno has had several articles published in British and Italian professional magazines regarding:

- 1.0 Use of wind as an alternate energy source and its relation with urban development.
- 2.0 Use of alternate transportation modes as a method of saving energy, such as use of cycling in an urban setting.
- 3.0 Examining the feasibility of utilizing thermal energy from power plants and thermal differences between bodies of water and the atmosphere.

Last year the third and 4th year design studio students explored urban development in a way of taking advantage of the large amount of thermal energy through use of heat discharged by power plants. The Charlotte Observer printed an article about the students' work of developing a prototype urban settlement including new urban forms and new life styles.

During the last academic year, a number of our fifth (5th) year students selected projects which dealt with energy concerns. Briefly, the key issues which were addressed were:

- 1.0 Investigation into grouping units and solar collectors in order to

conserve energy and capital.

- 2.0 Planning and designing housing units in such a manner as to avoid unnecessary duplication of spaces and facilities.
- 3.0 Explore site orientation in order to obtain maximum utilization of climatic elements, especially sun and wind.
- 4.0 Examine site development of alternatives and the required relationship between solar collectors and vegetation — buildings.

During this year, Tom Moore will be developing a program in the second year studio which primarily addresses energy issues. Thus, the efforts initiated several years ago regarding conservation in all its ramifications and complexity will be continued and expanded. As stated at the beginning of the article, the College of Architecture believes that our efforts must include developing and teaching hard type conservation information, and making the subject an integral part of an architect's, indeed the public's thinking process. We strongly believe that until conservation i.e., in terms of material, capital, land, resources and energy becomes a habit and we learn to establish priorities habits, the tendency will be to regard conservation as an after thought or as something you add on if you can afford it. The fact is we cannot afford to ignore it. The fact is we must learn to integrate conservation into our everyday lives, i.e., if we are to have an opportunity for a quality life. ■

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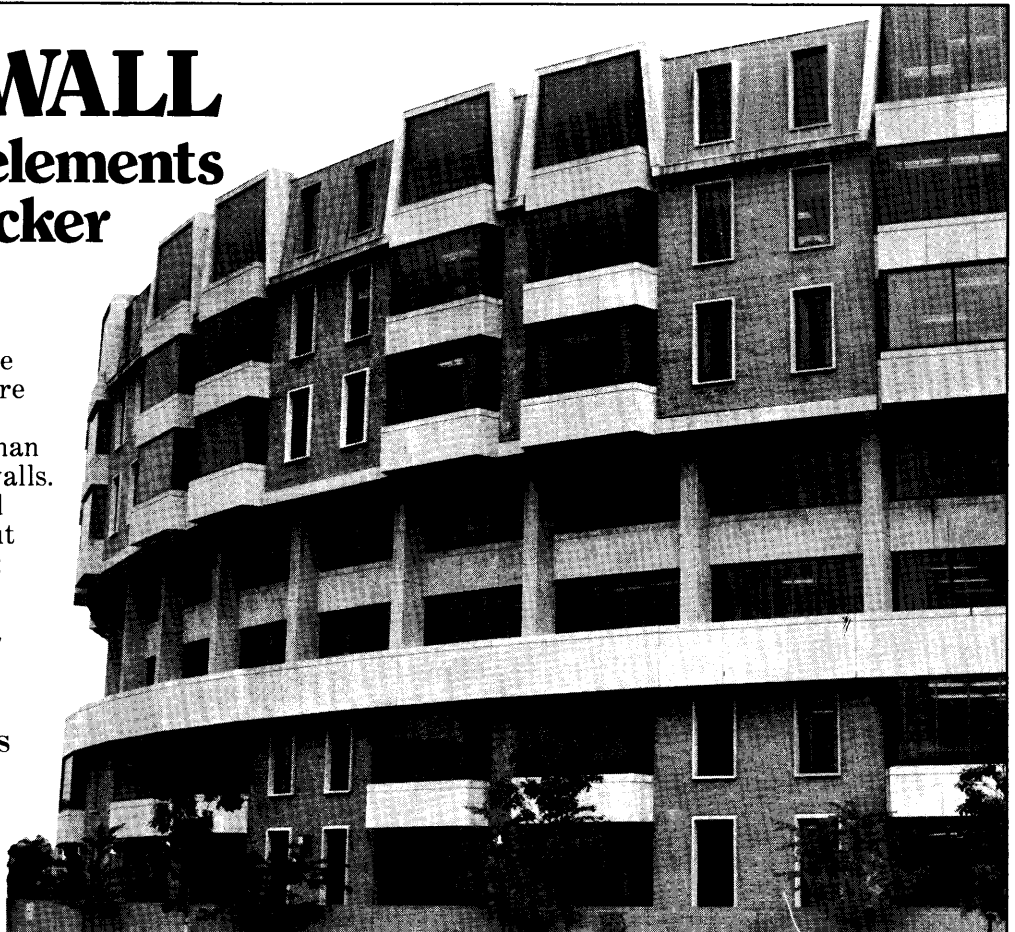
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## 1977 Honor Awards Jury

Each year the NC Chapter AIA sponsors an Honor Awards Program. Submissions of completed projects designed by members are invited. Entries are submitted in see-through folders containing 8" x 10" photographs, floor plans, sections and a written description of the project. A minimum of five slides accompany the submittal.

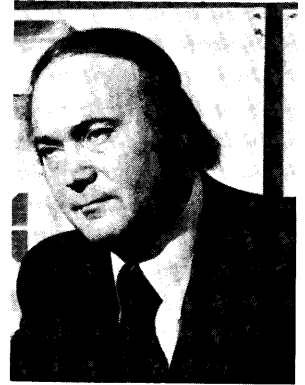
The slides and folders are keyed by number so the jury cannot know the designer. Jurying for the 1977 Awards takes place in Houston, Texas on December 4. Announcement of Awards will be made at the annual Awards Banquet, Pinehurst, N. C. on February 11.

Charles McMurray, AIA, of Charlotte is Chairman of the NCAIA Awards Committee and will take the entries to Houston. Committee member Eugene W. Brown, AIA, of Raleigh will accompany him.

### Jury Members

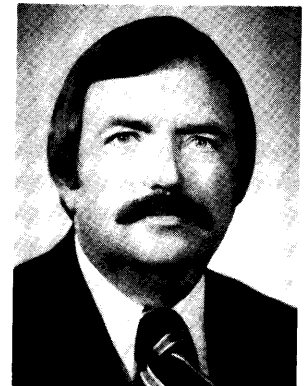
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President and Chief Executive Officer of CRS — Bachelor of Architecture from Texas A & M University — Masters in Architecture from Cranbrook Academy of Art — Former Associate Director of the School of Architecture at Rice University — Served as guest lecturer at universities throughout the United States — Ford Foundation advisor for the Chilean Regional and Community Facilities Program jointly sponsored by the Ford Foundation, Rice University, Harvard University and CRS — Senior designer with Eero Saarinen and Associates for seven years.



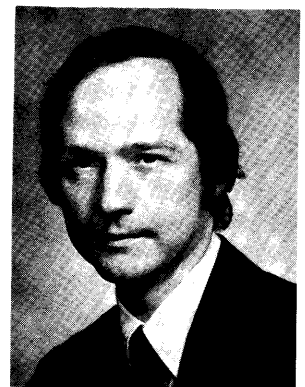
#### O. JACK MITCHELL, AIA, AIP

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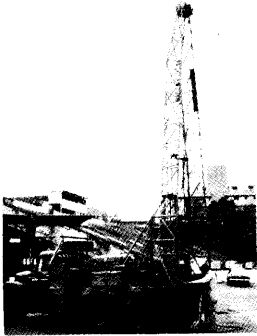
#### THOMAS P. HUGHES

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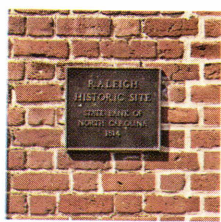
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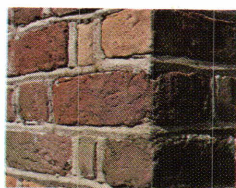
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