NEW DESIGN CONCEPTS FOR ENERGY- CONSERVING BUILDINGS

MASTER

RESULTS OF A NATIONAL COMPETITION AMONG
STUDENTS IN SCHOOLS OF ARCHITECTURE

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New Design Concepts for Energy Conserving Buildings

Results of a
National Competition
Among Students in
Schools of Architecture

1735 NEW YORK AVENUE NORTHWEST
WASHINGTON, D.C. 20006

This book documents the National Student Competition in Energy Conscious Design held among professional schools of architecture in the spring of 1976. The competition was part of a larger project sponsored by the Federal Energy Administration, to bring energy conscious design into the mainstream of architectural practice and education.

Energy conscious design is the profession's response to the national issues surrounding the changing energy situation. It is a major challenge to architectural creativity and provides an opportunity for architects to use their skills to design buildings that are responsive to human comfort and environmental conditions within an ethic of energy economy.

Energy conscious design implies that energy become a criterion for each step of the design process, complementing other criteria. Among the competition's objectives were to:

- Lend recognition and support to efforts by architectural students and faculty to incorporate energy concerns in their work;
- Bring energy consciousness into the design process as it is taught, learned and practiced in architectural curricula;
- Serve as a vehicle for introducing energy-related resource material to architectural design courses;
- Provide a means and a focus for an exchange of information and a sharing of knowledge among participants, both students and teachers, primarily through publication of all competition entries;

- Serve as an assessment of the range and depth of endeavors related to energy conscious design in schools of architecture.

Fifty-five schools participated, submitting one hundred and fifteen entries, which were reviewed by the competition's National Review Board on June 23, 1976. Twelve entries were selected as Entries of Distinction and are featured in this book.

The competition was intended to stimulate new ideas and to document the process by which new design concepts were formed; hence, the rules were flexible. Students and faculty were encouraged to adopt their own studio strategies.

Only three final submissions were allowed from each school; the schools determined their own procedures for internal evaluation of the entries. In some cases schools had to select from among hundreds of entries. It was suggested that the student summary statement (a required part of the entry) be considered as a criterion for selection.

The National Review Board met on June 23, 1976 to select the most outstanding entries based on the conditions under which the project was conducted at each school. The board's purpose was to amplify and augment internal evaluations done by the schools. In its deliberations, the board considered the program options chosen, the length of time spent on the project, the level of study, the school's internal criteria for judgment and the quality of the student summary statement.

ABOVE/National Review Board members Fred Dubin and Sally Harkness examine entries. Review Board members were: Jean J. Boulton, Federal Energy Administration, Washington, D.C.; Fred S. Dubin, Dubin-Bloome Associates, New York, New York; Sarah P. Harkness, AIA, The Architects Collaborative, Cambridge, Massachusetts; Philip J. Meathe, FAIA, Smith, Hinchman & Grylls Associates, Inc., Detroit, Michigan; Bradford Perkins, Llewellyn-Davies Associates, New York, New York; Anita Picozzi, Graduate Student, University of Virginia, Charlottesville, Virginia; Lynda Simmons, Phipps Houses, New York, New York; Thomas Vreeland, Jr., AIA, Kamnitzer, Marks, Lappin, Los Angeles, California; and Henry Wright, AIA, Editor, Author, New York, New York. Quotes and photographs of jury members appear throughout the text.

ABOUT THIS BOOK

There are four major sections in the book. The twelve Entries of Distinction appear in the first seventy-nine pages. This section contains drawings, illustrations and diagrams with excerpts from student statements accompanying the entries and from interviews conducted after the entries were selected. Where possible, we have included jurors' comments on the entries.

The remaining one-hundred and three entries are located in the second section and are representative of students' work. We have attempted in this section to select the aspect of each entry which shows its most noteworthy energy conscious design features.

An annotated bibliography makes up the third section. It is drawn from works listed in the bibliographies of some entries and from AIA/RC sources. Although not inclusive, this annotated bibliography contains those works which could provide a basic guide to the reader interested in energy conscious design.

An index comprises the last section. Complete information about each entry is given, keyed to the number which appears for each entry. A subject index keys energy conscious design concepts with the entry number and page.

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The competition program, criteria and guidelines were inspired by Bernard P. Spring, Dean of the School of Architecture and Environmental Design at the City College of City University of New York. Dean Spring, who served as our consultant, strived to make the competition as open as possible, stressing the process of energy conscious design as well as the products and anticipating the needs and interests of schools. He made the competition difficult to resist and few did.

The Energy Conscious Design Student Competition was open to all students enrolled in a design, workshop or studio course within a professional school of architecture. The competition offered a list of energy conscious design criteria which could be applied to either an existing studio problem or to a specific problem developed by the AIA/RC to design a Community Resource Center. The energy criteria were subject to modifications by students and/or faculty.

The suggested energy criteria included the following:

1. Space planning should be reasonably related to client needs. Try designing indoor activity programs to use less floor area than is now considered standard.
2. Where possible, use natural daylight for activities requiring light.
3. Concentrate activities that have similar temperature, humidity, air circulation and light requirements and consider separate zones for their control.
4. Take advantage of site conditions, such as variations in grade, landscaping, surfaces and adjacent structures in locating your building.
5. Try to protect openings and glazed areas from unwanted exposure to sun in the summer, but still provide for solar gain in the winter by locating them differently on different sides of the building and by shading or sheltering them architecturally.
6. Use natural ventilation for cooling where possible and consider ways to store cool night air in the building during summer days, or hot air during winter nights.

ABOVE/Location of schools participating in Energy Conscious Design Competition. Through provision of a wide range of problem options and a set of energy related design criteria, this competition engendered participation and response from more schools of architecture than any recent national student design competition. One hundred and fifteen final submissions arrived from 55 schools, representing the efforts of nearly 1700 students and 100 faculty members. In one school, the entire student body adapted the energy conscious design criteria to their existing studio problems.

Participating schools were distributed evenly throughout the United States. The dots correspond to the location of each school. The map on page 80 shows the locations of project sites.

- COMMUNITY RESOURCE CENTER

A CRC is a multi-use learning center. It should be planned as a marketplace for community information. Community activities and services are provided, materials are lent, information and referrals are sought and given, and people gather to spend leisure time.

Physical facilities include an administrative area for offices, a multi-purpose function room, a preschool learners center, a library center (stacks for 50,000 volumes), a sales and exchange area, and a public exhibition space.

1 UNIV. OF WISCONSIN, MILWAUKEE

2 KANSAS STATE UNIVERSITY

3 UNIVERSITY OF MICHIGAN

7 HARVARD/MIT

8 IOWA STATE UNIVERSITY

9 LAWRENCE INST. OF TECHNOLOGY

4 UNIV. OF WISCONSIN, MILWAUKEE

5 RENSSELAER POLYTECHNIC INST.

6 NEW-YORK INST. OF TECHNOLOGY

10 UNIVERSITY OF COLORADO

11 OHIO STATE UNIVERSITY

12 UNIV. OF CALIFORNIA, BERKELEY

Students: Bill Drewek, John Strege
 School: University of Wisconsin-Milwaukee
 Faculty sponsors: John Schade,
 Frederick Jules
 Site: Mequon, Wisconsin

Four entries of distinction were designs for a community resource center; this is one. The programmatic requirements for the hypothetical CRC are set forth in the introductory pages of this book.

Students and faculty were encouraged to amend and adapt the CRC program as they saw fit. Drewek and Strege have done so, especially with respect to particular climatic factors near Lake Michigan:

"In adapting the problem to our area, we assumed that the site was located in Mequon, Wisconsin. Mequon is a fairly rural portion of the Metropolitan area with light to moderate development. Located north of Milwaukee and near Lake Michigan, its climate is typically Midwestern, with all seasons somewhat moderated by Lake Michigan. The design took this challenging climate and its effects under consideration throughout its development."

TOP RIGHT/Perspective showing entrance to Community Resource Center. The entry area is oriented due south and is glazed to gain maximum advantage from winter sun. Folding insulating shutters cover the glass at night. Along the lobby back wall is a waterfall. Its water is heated by the sun, stored, and released at night.

BOTTOM LEFT/Diagram illustrating life-cycle cost analysis. Assuming an energy cost inflation rate of 12 percent per year, the students conclude it would take 2.7 years to achieve payback on required initial investments in insulation, earth berms and other features. Vertical axis represents dollars and horizontal axis years; white area of bars represents period required to achieve payback. Shaded areas show magnitude of savings.

BOTTOM RIGHT/Diagram illustrating overhang lengths at various elevations during summer and winter. This analysis contributed to design solution.

The form and schematic arrangement of their design stems from the combination of climatic factors and human requirements. "By zoning areas according to the heating needs of specific functions, considerable energy savings may be made. Zoning also insures a comfortable environment for the user. On the floor plan drawings, three different zones are indicated through shading. The clear area is the warmest, largely due to solar heat gains, and has an average daytime temperature of about 70° F. The light shading indicates the intermediate zone which has an average temperature of about 68° F. The dark shading shows areas which require less heat by nature or duration of use. This 'buffer' zone, generally located along the north and west walls of the building, protects more heat-dependent rooms from heavy heat losses."

TOP/The students attempted to preserve existing site vegetation and to add trees. They state: "Deciduous trees are the ultimate adaptors to the seasons. They provide shade in summer and allow winter light. Coniferous trees are a source of food and shelter for wildlife, all year long. They also serve as windbreaks and provide visual screening."

BOTTOM LEFT/Illustrations of design concepts contributing to solution: "On the lower level, the book stacks, the mechanical room and loading dock have all been buried beneath a 3- ft. covering of soil. The temperature of the earth is more moderate than the outside air temperature. When winter average temperatures range in the low 20's, ground temperatures are in the 40's. In summer when temperatures are often well into the 80's and 90's, average ground temperatures are in the 50's and 60's. These moderate temperatures reduce heat losses during winter and provide cooling during the hot summer months."

"In order to bring some natural lighting into the stack areas, a number of skylights project up through the soil covering. Surfaces are on angles to allow easy shedding of rain and snow. Demountable insulating shutters can close skylights at night and during periods of very cold weather."

BOTTOM RIGHT/Diagram illustrating the generation of building's form. "The geometric shape which contains the greatest area within the least amount of 'wall' is the circle. Taper the circle to draw northwest winds away from the building. Allow for ventilation and cooling from southwest summer breezes. Finally, increase the southern surface area to increase winter solar gains."

In addition to the criteria set by the competition's sponsors, the following objectives were set by the students for their project:

DESIGN/The building must function well as a community resource center as well as demonstrate energy-conserving materials and devices.

RESOURCE AND ENERGY USE/We hope to make building as energy self-sufficient as possible within design and monetary constraints. Life-cycle cost analysis will be used to compare relative effectiveness of the materials and devices to be used. Most items should fall within a ten-year recovery period, or slightly longer in cases of exceptional merit.

USER COMFORT/The center should provide an environment which is both comfortable

BILL DREWEK (student): "The availability and cost of energy will probably become the most crucial factor in future architectural design. Clients will no longer be willing or able to support carelessly designed 'energy hogs.' Balancing a tight energy budget will become an additional responsibility for designers, and users will be asked to play a more participatory role in their environment."

and conducive to the activity at hand. Through zoning, spaces are heated or cooled according to their use. Proper humidity should be provided in order to avoid the withering plants, static shocks and chapped skin so often found within our "indoor deserts." Natural light should be provided wherever its inclusion will not incur excessive heat losses. Artificial lighting should be kept minimal to conserve energy.

LOW MAINTENANCE/Materials and systems should be durable, easily repaired and simple in operation. Passive systems requiring little or no attention are best solutions.

USER INVOLVEMENT/The people using the center should be made aware how they can best use their community resource center, energywise and otherwise. By using the center as an example of the options available in energy conserving devices, others, too, could use these ideas in their own homes and businesses.

JOHN STURGE (student): "I think that energy consciousness will lend impetus to development of new design concepts, different from the low-initial-cost, single-family-detached and/or high-rise syndrome."

ECONOMIC FEASIBILITY (LIFE-CYCLE COSTING)/Any material, device or system to be used should be proven to be economically feasible over a reasonable period of time, prior to installation. Owning (financing), operating and energy costs will be included in the feasibility evaluation.

INDOOR/OUTDOOR RELATIONSHIPS/The building should become an integral part of the site and create relationships with the kind of activities going on outside. The site and its elements should be recognized for their great potential as a part of energy conscious design. A new concern for the native landscape should be developed.

Juror Sarah Harkness observed that "the entry addresses problems of cost in a way that no other solution does." Juror Anita Picozzi wrote: "The number of criteria considered and brought together in a rather simple solution is interesting. The cost analysis is notable."

Brad Perkins, also a juror, considered the entry "a very credible analysis which was not matched in the aesthetic quality of the design — this was one of the more 'real' presentations."

Section A-A

Section B-B

SECTIONS

0 8 16

TOP/Perspective view of sunken garden: "Located directly to the south of the building, the sunken garden is sheltered from cold northwest winds. This makes it more useful as an activity space during cold weather months or when changing weather may force a sudden move indoors. White gravel increases solar gains in winter."

BOTTOM/Outdoor trellised spaces: "Located to the north of the building near large existing trees and views of the lake, this area is primarily for use in warmer months, though wind-breaks could extend use into cooler months. Rough wood posts and beams provide a grid on which deciduous vines can provide cooling summer shade. Recycled bricks from local sources will be used for paving. Bazaars and larger activities can use open areas on each side for expansion."

Student: Paul Bilski
School: Kansas State University
Faculty sponsor: Edward De Vilbiss
Site: Lakewood, Missouri

PAUL BILSKI (student): "I was intrigued by the fact that the earth and underground water could satisfy most of the heating and cooling needs. As such, my design focused on ways of nestling the CRC into the site and working environmental systems in conjunction with the constant ground and water table temperatures.

"Energy conscious design is getting maximum benefit for a minimum sacrifice - like going to the candy store with a big appetite and the week's allowance and wanting to get the best deal possible (i.e. lollipops last longer, but you get more if you buy jelly beans, however, candy bars taste better), keeping in mind that if you spend it all in one day there will be no money for other things and other days."

RIGHT/Model of CRC submitted by Kansas State University. Large skylights allow natural light into a central court. Although the building is underground, the spaces within are open, airy and pleasant.

After analyzing the Lakewood, Missouri site, Bilski chose to bury the CRC building in order to maximize insulation and to reduce the mechanical system's load by using the 54° F. water table to pre-temper air. Solar collectors and wind generators were ruled out because of high cost. In his project statement Bilski writes:

"I began by looking at alternative energy sources (sun and wind). At first they seemed the perfect solutions — all the energy one needs and free of charge. Upon further investigation it became clear that energy from the sun and the wind is not at all free. It takes energy to harness both sources.

"In order to obtain energy from the wind one must pay the cost of expensive windmills and storage batteries. In the case of solar energy one must continually use energy to run pumps and fans in order to store and distribute the sun's power."

Instead, Bilski chose an energy strategy which adapted the building architecturally to natural energy sources. Air is moved through underground tunnels by convection currents, which are caused by temperature differentials. However, a number of problems arose:

"Space planning was very difficult because I had to be careful not to locate walls where they would impede natural air movement. The underground tunnels through which the system would move and temper air could best be applied to a building that was below grade. Putting the building underground

LEFT/Photograph of site model. Site for the project is in Lakewood, Missouri, a suburb of Kansas City. Climatological data used are for the Kansas City area. Ground temperature is 54° F. throughout the year below frostline (frostline 24 in. below grade).

intrigued me. It made good sense from an environmental systems point of view because heat gains and losses could be minimized; and the underground building seemed a good opportunity to provide open space and a park-like atmosphere. However, the unfavorable psychological and physiological impact on the users of an underground building proved a very difficult problem.

"I looked for ways to overcome the effects that an underground building might convey to its users. Starting with the entry, I sought to design a way of descending that would be pleasant and exciting for the users. A winding ramp between plantings of trees eliminated the need for an elevator. Stairways on both sides of the ramp allow users to select a direct descent.

"Once below grade, the user walks into a large, glass-roofed court, planted with trees, ferns and flowers. The natural lighting from above provides a pleasant atmosphere for activities within the court and those on its perimeter, as well as lowering the need for artificial lighting in these areas. Some of the glass sections are operable, providing natural ventilation."

RIGHT/Floor plan conveys Bilski's concern for unfavorable physiological and psychological effects that an underground building may have on the user. The entry consists of a winding ramp between trees for a gradual descent and stairways on both sides of the ramp for a direct descent. The entry leads to a large court covered by a skylight, providing a pleasant atmosphere for activities within the court and on the perimeter.

12

SCALE 1/2"=1'-0"

Bilski believes that underground buildings may help to conserve energy in a number of ways:

- Insulative quality of the earth reduces heat gains and losses.
- Constant 54° F. ground water temperature pre-temper air.
- Air conditioning system uses underground water to cool water supplied to unit ventilators.
- Skylights can provide natural lighting.
- Operable glazing can allow natural ventilation.
- Vertical glazing can be architecturally screened to prevent unwanted solar gains.
- Entries can be well-sheltered to minimize infiltration.

The project fulfilled the goals Bilski set for it: "In seeking to retain the positive aspects of an underground building and to eliminate its negative effects, I achieved a building that is both energy conscious and user responsive." Juror Phil Meathe agreed, rating the project, "a 100 percent execution."

LEFT/Mechanical system diagram. Bilski states: "Heating and cooling are accomplished by a number of unit ventilators that supply tempered air to various building zones. Unit ventilators are supplied with chilled or hot water as required by a central air conditioner or boiler. The boiler also supplies radiators below windows to prevent downdraft. The air conditioner uses underground water to cool the water it supplies to unit ventilators. Each unit ventilator takes its supply air from the mechanical tunnel. The tunnel is supplied by both return air through dampers and by fresh air that is pre-tempered as it passes through underground ducts."

TOP/Winter operation of ventilation system. Fresh air moves through duct and into tunnel to replace the air drawn from tunnel by the unit ventilators. Water in coil is at 54° F. As cooler air passes over the coil, heat is released to the air and the water becomes cooler. The cooler, heavier water falls, forcing 54° F. water up to replace it. Thus, the fresh air warming process is continued.

BOTTOM/Summer operation of ventilation system. As in winter, fresh air moves through duct and into tunnel to replace the air drawn from tunnel by the unit ventilators. As the warmer air passes over the coil, heat from the air is absorbed by the water which becomes warmer. The warmer, lighter water rises, forcing 54° F. water up to replace it, continuing the fresh air cooling process.

ANITA PICOZZI (juror): "This entry utilizes the advantages of ground insulation and natural sunlight. Good analysis of seasonal variations and incorporating these into the design."

TOP LEFT/Diagram showing flow of natural ventilation. Sun's rays pass through glass roof, warming inside air. Warm air rises and escapes through opened glass sections. Fresh air entering through open windows and underground ducts replaces escaping air.

TOP RIGHT/Diagram of air conditioning system. A pump supplies chilled water to unit ventilators where the chilled water absorbs heat from the air passing over it. The air is cooled and the water warmed. The warm water returns to the underground well where its heat is absorbed by underground water. The water is then rechilled and recirculated.

BOTTOM/Photograph of model. Juror Lynda Simmons noted that the project, "hardly interfered with the landscape and used very little energy, but still maintained pleasant spaces... a well integrated design using sophisticated technology."

Students: Mark M. Mardirosian,
Jay C. Van Duren
School: University of Michigan
Faculty sponsor: A. Peters Oppermann
Site: Columbus, Ohio

This CRC is designed by first-year graduate students as a compromise between the need for a strong visual statement to focus community attention, and energy conscious design criteria suggesting a modest building form with a low-profile, minimum heat loss, and compact spaces. The resulting task lighting in combination with heat-of-light systems, selective fenestration, a sod roof and berms for insulation, zoned mechanical systems, a southeastern orientation and solar collectors, positioned so that they help block a view of an adjacent parking lot.

JAY VAN DUREN (student): "I see energy conscious design developing into an all-encompassing architecture, at first as a novel solution to our needs and then as an integral part of every designer's and user's thought and mood. Future users will reap the benefits of this new element and attitude, enabling them to put their saved energies toward more demanding and pressing problems."

RIGHT/Students compromised between the low building profile suggested by energy conscious design and the need to provide community with strong design statement and focal point.

Mardirosian reflects on the design process: "Through my working with energy conscious design, I learned to be less frivolous in my design decisions and to concentrate more on eventual consequences. I was forced to learn new sets of constraints and to design with them in mind. They didn't limit my creativity, but enabled me to design in a new architectural idiom."

The building's program and planning demonstrates these concerns. The students state: "We limited and defined the program more clearly as a result of energy considerations. Planning tolerances were reduced and the urge to be fancy was resisted. Room zoning was important. We had to resolve conflicts between the shape of the site and our func-

MARK M. MARDIROSIAN (student): "Eventually the concerns of energy conservation will face all designers of the built environment. The conservation and preservation of existing buildings will have to be stressed more as building supplies dwindle. New technologies will have to be developed to provide the architect with tools he or she needs. On-the-shelf supplies will have to be available to architects and the public alike. Economics will play a greater role in the decision making process so that construction time and cost will need additional study."

LEFT/Site analysis dissuaded students from river orientation in favor of southeastern orientation that takes advantage of existing community settlement and circulation patterns.

tional and circulation requirements for the building. We therefore emphasized compactness and minimized surface areas. We compromised between a low building form and a shape that a visitor could easily identify."

Each step of the design process called for integration of energy considerations, as reflected in this site analysis: "We chose the southeast portion of the site to be the focal area for entry, parking and outdoor leisure areas, allowing us to take advantage of solar orientation and wind protection. The eastern side offers a street with pedestrian and vehicular activity and the opportunity to use established community circulation routes, particularly in residential areas. The river at first seemed a natural orientation, but strong northeasterly winter winds prohibited this."

The balance of natural light and fenestration versus insulation techniques is also carefully analyzed. Design priorities include windows for areas where light and ventilation are most needed for activities; views were secondary considerations. Activities programmed for the north and north-eastern portions of the building were assigned windowless spaces and selected accordingly. Insulative qualities were further enhanced by a sod roof and berm to reduce infiltration and transmission.

MARK M. MARDIROSIAN (student): "There should be a gradual increase of energy consciousness in each project a student completes. Beginning with such basic considerations as orientation and fenestration, a student will eventually increase his or her ability to handle projects of a larger and more complex nature."

RIGHT/Main level floor plan shows library stacks tucked behind solar collectors, which obscure view of adjacent parking lot. An open plan is used where possible. Toilets, storage areas, multi-purpose kitchen and staff lounge are on north-west where they serve as thermal buffer zones.

MAIN LEVEL

FLOOR PLAN

3 COMMUNITY RESOURCE CENTER

The design process led Van Duren to the conclusion that "energy saving concepts and elements can easily be integrated into the total design package, while maintaining an exciting and aesthetically pleasing building and without restraining the structure by their impact."

JAY VAN DUREN (student): "Natural elements, including the wind, the sun and flowing water, can be used by man in his buildings and shelter just as the sailor used the wind for his sailboat and his muscles to row."

TOP LEFT/Lower level floor plan combines storage and mechanical areas, along with some private study carrels.

BOTTOM LEFT/Library mezzanine.

BOTTOM RIGHT/Public lounge area.

A GENERAL COMMENT ON THE COMPETITION

FRED DUBIN (juror): "The competition is an effective and useful program because it focuses the design profession on urgent matters of today. Some of the solutions in this competition are indicative of a change in thinking concerning energy utilization. Energy consciousness should be a design input."

TOP RIGHT/Section illustrating roof line, which is designed to deflect winds, and solar collector panels, which are integrated into the architectural profile of the building. The building is naturally ventilated with motor-operated skylights, which provide escape for rising hot air.

BOTTOM RIGHT/Illustration of convector heating system, which is operated and located according to user needs. There is, for example, no heat in storage or entry areas.

CONVECTOR DETAIL

SYSTEM SCHEMATIC

HEAT OF LIGHT SCHEMATIC

A GENERAL COMMENT ON THE COMPETITION

THOMAS VREELAND (juror): "What we are seeing now are equivalents to the horseless carriage which quite logically derived its form from the centuries of fine coach making which preceded it, but made no sense without the horse in front. It is going to take time for architects to fully absorb the new order; and ultimately it will take some genius like Wright when he took the lowly California bungalow and, understanding its true importance, restyled it, giving it back to the world as the highly successful rancher, -- the suburban middle-class American dream. Or Andrea Palladio who restyled the 16th century Venetian gentleman's rustic country farm house into one of the most successful architectural forms (the Palladian Villa) the world has ever known. Meanwhile we will continue to see ungainly concatenations of misapplied forms as we have seen in this competition: Whole Earth do it yourself domes or tepees, 'international' extravaganzas with stylish solar roofs, Sea Ranch adaptations to a wide variety of climatic conditions, Louis Kahn's heroic attempts to accommodate the excessive demands of mechanical equipment in the 50's and 60's now used for the opposite purpose, and so forth. I cannot honestly say I saw one really well integrated building design in this year's crop. But it will come -- it will come! We must keep battering away at it."

TOP LEFT/Schematic illustrates integration of lighting, solar and heat pump systems.

BOTTOM LEFT/Heat-of-light system includes water cooling system to cut down interior heat buildup and to recycle waste heat to storage tank.

Student: Donald Kraft

School: University of Wisconsin-Milwaukee

Faculty sponsors: John Schade,
Frederick Jules

Site: Mequon, Wisconsin

As in the other UW-M entry of distinction, this Community Resource Center is designed for a site in Mequon, Wisconsin. The student takes into account not only the energy to be consumed during use of the completed building, but also the energy devoted to production of building materials. Based on his analyses, concrete and wood offer the greatest advantages.

Kraft's goal has been to develop a design that is buildable in today's market, substantiated by sound, thorough economic analysis. In Kraft's words, "energy conscious design revolves around the dollar."

DONALD KRAFT (student): "In future, designs will not change as much as the design process. More concern will be given to the environment; modified design standards (size and lighting requirements, and acceptable temperature ranges) will have important roles. As fuel prices soar, recovery periods will become less important. Individuals will have to modify habits and adapt to slight changes in comfort. Most important, we must develop the desire to use less energy."

RIGHT/Exterior perspective showing entrance to CRC and use of vegetation especially suited to the specific requirements of each orientation.

He argues that "one could build an excellent, completely self-sufficient environment that has a cost recovery period of 200 years. Similarly, an adequately designed building might have a six-month recovery period, but would be unpleasant to the users. Finding the happy medium is the challenge of energy conscious design."

Kraft characterizes his CRC as a living greenhouse, which, with the addition of a dynamic skin, acts as a massive solar furnace. An electrically operated "mechanical eyelid" makes it possible to vary southern exposure in response to climatic conditions and occupant requirements. The south-facing greenhouse is open to all floors, providing natural ventilation and, when necessary, heat to interior spaces. The greenhouse is insulated by movable shutters, which are left closed during periods of greatest heat loss.

Heated air rises to the top of the three-story greenhouse, where it is collected and redistributed through a system of ducts and fans to interior spaces. Kraft also provides for natural cooling of the building through combination of a natural hot air exhaust and cool air intake (see section views in illustrations). Night air is cycled through a lower-level storage bin for daytime summer cooling.

Domestic water is heated by flat plate collectors mounted above one of the building's

TOP LEFT/Site plan and section. Location of functions and activity areas is based on climatic analyses, with building oriented for beneficial solar gain.

BOTTOM LEFT AND RIGHT/Kraft performed exhaustive economic analyses for his project; he estimated construction costs, potential savings and payback periods. The two diagrams show the payback period for his design as compared to a conventional gas-electric building (left) and to an oil-electric building (right).

entrances. Water for use in the greenhouse and surrounding gardens is provided by rain, which is collected and stored in an underground cistern.

Other energy conscious design considerations Kraft takes into account include proper orientation, siting, and careful choice of materials and components. The competition's jurors noted the depth of Kraft's analyses of economics and thermal performance. Fred Dubin called this entry "an excellent selection, with good life-cycle cost analysis." Lynda Simmons found it "most noteworthy for its thorough analysis of all factors of energy conservation and use."

Several jurors, while praising the student's analyses, expressed some reservations about the quality of his design. Thomas Vreeland suggested that the design reflected good ideas that had been thoroughly studied, but would have benefitted from more attention to architectural features.

TOP (opposite page)/Section through western end of building showing operable components and energy conscious design concepts. Kraft writes: "The three-story atrium allows natural air circulation and lighting. The northern exposures are buried to take advantage of the earth's constant temperature, while the southern portions are exposed for beneficial heat gain."

BOTTOM (opposite page)/Section through entrance area and solar water heating apparatus. Kraft estimates that the water heating system would "pay for itself," through savings in energy costs, in 1.64 years, compared to conventional electric water heating.

RIGHT/Diagrams showing design concepts developed by Kraft for eventual use in the project. Counterclockwise, they show: use of deciduous trees for solar screening in summer, penetration in winter; shaping of building profile to divert harsh winds and capture winter sun; use of cooled air for interior cooling and heated air for heating; and use of vegetation to mediate between climate and occupants.

TOP RIGHT/Lower-level plan showing atrium, stack areas and conference area. Access to lower floor is by elevator or interior staircases.

BOTTOM RIGHT/Upper-level plan, diminished in size compared to lower levels by curvature of building profile. Kraft characterizes the building as "a living greenhouse," where all levels are to benefit from air purified by plants.

BRAD PERKINS (juror): "This submission reflects extremely good analysis. The design is a good response to the results of the analysis, but, unfortunately, it is somewhat clumsy in its current form."

LEFT/Mid-level plan showing landscaped areas of outdoor "bazaar" and indoor greenhouse. Operable windows provide natural ventilation for greenhouse, while duct intakes remove air heated by sun for redistribution to interior spaces.

Students: James Gleason, Scott Stinson,
David Capelli, David Sadowsky
School: Rensselaer Polytechnic Institute
Faculty sponsor: Harry E. Rodman
Site: Troy, New York

A portion of this entry was actually constructed. An additional design scheme (see illustrations and captions) was later developed, based on lessons from the first experiments. A site for the eventual building was donated by Rensselaer Polytechnic Institute, and a concrete slab of a predetermined size was donated by a local contractor.

The program was simply to design a dwelling unit of approximately 600 sq. ft. which could serve as a prototypical married student apartment for the university.

The students state: "We have designed an entire house (structure, heating and ventilating, electricity and plumbing) to conserve energy, not only during use, but during production of its components. Since most of the materials that we have used are recycled, the natural resources involved and the energy used for production have already been paid for.

SCOTT STINSON (student): "A greater awareness of natural systems and orientation should produce architecture in which the technological-mechanistic aspects and the naturalistic aspects are better integrated, be they harmonious or contrapuntal. I personally feel that buildings will become inward looking worlds, with minimal outward expression. This should bring about a healthier interaction between the users, and a greater sense of community."

RIGHT/The prototype building is on a donated site. Typical construction details, using recycled waste materials, are used throughout for testing purposes. The change in texture on the wall results from use of glass jars and bottles for natural light, as contrasted to the #10 cans used elsewhere. Results of this experiment contributed to generation of another design, illustrated on the following pages.

"The concept of energy conservation goes much deeper than the design of low energy consumptive buildings. It involves principles of conservation throughout the entire design/building process. It begins with the careful and efficient planning and management of natural resources, and the subsequent refining and production of these raw materials into usable building materials.

"An ideal situation would be to have a continuous cycle of resource use and replenishment. Reforesting programs and government subsidies are already available to provide incentives, but we continue to increase our demands on our resources creating a spiraling effect. A way to reduce this demand is to curb our 'through-put' economy into more of a closed system. One method to accomplish this is the reuse of consumer waste.

"The basic philosophy of Garbage Housing is to minimize the total cost of a dwelling unit by reducing the energy cost of the building products. Industrial waste, the initial cost of which has already been absorbed, can be collected and assembled to form usable structural building elements, which can replace high cost (by comparison) standard building elements such as wood members, bricks, and shingles."

LEFT/RPI donated a site for construction of the prototype and a construction firm donated a concrete slab of a predetermined size. The proposed design is situated on the same site, in the same location, as the prototype.

RIGHT/Detailed site plan shows location of main components in solar space - and water - heating systems. A clivus mult-urum (self-contained waste disposal unit) is shown on upper left of floor plan in broken lines.

The original design called for use of solar collection devices fabricated from waste products. According to the students:

"The solar collector was one of our major concerns, not only because it was necessary to make the garbage house a viable solution, but because we felt that, using garbage components, we could build a collector as good or better than has been done.

"The collector consists of #10 cans stacked on top of each other to form a honeycomb wall. The cans are painted flat black, inside and out. Holes were punched in the back end originally, but later the entire back surface of each can was removed. A translucent cover allows sunlight to heat the cans, then air is drawn through them and heated.

"The honeycomb wall formed by stacking the cans on top of one another acts as a selective surface, and reduces the need for and cost of special low reflectivity paints."

The students performed various tests of components for the solar and structural systems. They also prepared analyses of how the proposed building would perform thermally:

LEFT/First and second level plans. The students note: "The main entry opens onto a foyer adjacent to the living room. A short flight of steps brings one up to the kitchen/bathroom level, which is situated over the rock storage and under the collector. Another set of stairs takes one up to the study and bedroom level, which is above the living room."

TOP RIGHT/Section view showing wood stove at left. Ventilator in roof is provided for elivus multrum.

BOTTOM RIGHT/Section view showing rock and water heat storage areas. In the proposed design, only a wood stove would serve to supplement solar system for space heating.

FIRST FLOOR PLAN

SECOND FLOOR PLAN

"When the solar storage system has too little heat to keep the house comfortable, a back-up wood stove can be utilized. Under the very worst conditions that we could imagine (no heat in storage, a completely black day, and a -10°F . outside air temperature) the house would lose 372,080 BTU over the length of the day, while gaining none from the collector. This means the house would need a supplementary heat source producing 15,503 BTU/hr. over a 24-hour period.

"The maximum output of a woodstove similar to the one that we propose is 22,500 BTU/hr. at an efficiency of 54 percent. At its maximum efficiency, 76 percent, the output would be 44,500 BTU/hr. Using these rates, we would need to burn 51 lb. of wood (1.5 cu. ft.) at a cost of \$.70 to heat the house on this day. These figures are based on buying the wood at \$70/cord."

Referring to their original design proposal and to experiences gained in construction and testing of the prototype, the students conclude:

"In dealing with the garbage house as a design problem, the trade-offs necessary to achieve the design we wanted became apparent very early in the design stage. Out of

TOP LEFT/South elevation shows solar collector surface consisting of cans fastened together in a honeycomb configuration and painted flat black on the inside. The students say: "The test collector cover is constructed of two sheets of polyethylene, spaced 1 in. apart. A test that we made showed that the light transmissivity of the two sheets was about equal to that of commercially-produced composite collector covers."

TOP RIGHT/All windows in the proposed design are recycled from demolished buildings.

BOTTOM LEFT/Thickness of the roof section results from design of truss constructed of 4 in. cardboard tubes (see detail on following page).

necessity, the collector took up much of the south face of the building, and all the light that was striking the south side. To bring natural light into the interior spaces, penetrations through the collector were needed.

"The final design of the collector, with the backs of the cans removed, allowed for this without losing any collector area. The use of garbage building components required smaller spans, but these resulted in smaller volumes that needed to be heated.

"From the research and testing we have done, we conclude that the garbage house is one feasible solution to the problem of energy conscious design. There can be no single answer to a problem of this size and nature, but we feel that we have addressed ourselves to a few facets of energy conscious design.

"The re-use of consumer wastes and, more specifically, their use to save and produce energy are viable alternatives to the needless waste of our natural resources."

LEFT/Typical wall section showing recycled components. The students say: "Prior to the actual design of the building, several building systems were designed and tested. Most of the wall systems that were proposed consisted of the same basic elements: cardboard tube columns for structural support and #10 food cans with mortar for infilling walls."

TOP RIGHT/Detail of solar collector and roof truss system. Collection surface and rain gutters are constructed from discarded cans. The truss is made from 4 in. cardboard tubes. Insulation is from recycled cotton.

BOTTOM RIGHT/The students write: "The lintel/beam is constructed in order to absorb increased bending moment. When these beams are strapped together side by side, they can be used as a structural floor. Tested in lengths in excess of 15 ft., they have proven capable of meeting code restrictions for residential construction. A finished floor can be obtained by topping the beams with a thin layer of cement to fill in the grooves."

PHILIP MEATHE (juror): "Ideas, ideas, ideas, questions, questions."

LYNDA SIMMONS (juror): "Thorough research and an interesting idea. Probably not applicable very often, but a special point of view that has been well developed and should be represented."

LEFT/Model of proposed residence showing exposed roof/collector truss system. Benjamin Forgey, art and architecture critic for The Washington *Star* writes: "... the polemical point of Garbage House is worth pondering. We are, let's face it, in a condition that, if not calamitous, is dangerous, the more dangerous the longer we allow it to go on. As an organized species we have almost forgotten how, as Ian McHarg says, to design with nature."

Student: Michael Berthold
 School: New York Institute of Technology
 Faculty sponsor: Frederick Bentel
 Site: Staten Island, New York

Designed for use by an architect as a residence and office, this design for a building on Staten Island strives to enjoy the benefits of underground construction with plenty of sunshine and views. The student's solution is an underground building that expresses itself architecturally above ground.

MICHAEL BERTHOLD (student): "There is beginning to be a concern in the architectural community for the design of new energy conserving buildings. If we don't take affirmative steps in this direction we will pay for our mistakes. A more difficult problem lies in the retrofitting of existing energy-wasteful architecture. We must begin to curb our huge energy appetite and become educated to a lifestyle more in tune with environmental and ecological needs."

TOP/Sectional model of the Berthold House showing the design of an underground building on a flat site. The house has been stepped into the site, taking advantage of the benefits of underground construction, while retaining living areas above grade.

BOTTOM/Elevation showing view from living areas looking east. The sunken greenhouse is used as a heat sink to store solar heat during the day and distribute it to the living areas at night.

Inspired by a land use study for Staten Island by Ian McHarg, Berthold examined regional ecological factors before designing the house. "I feel it is necessary to view the project from a larger perspective, on a regional basis. What is the sense in designing an ecological house in an area that will be damaged by its presence?" Berthold developed an analytical matrix that included variables such as aquifers, forest values and wetland values. He used the matrix to identify land suitable for development. Berthold's concern for energy conservation extends beyond the building. The house is within walking distance of mass transit systems and local shopping centers, complementing macro-scale ecological planning goals. It is used as both an office and a home, saving on fuel expended for commuting.

Berthold listed three major architectural goals in his design statement:

- to design an underground building on a flat site, retaining light and views;
- to integrate solar collectors and wind power systems into an earth-covered building;
- to create an architectural form suitable for solar and wind energy systems.

LEFT/The site is within walking distance of mass transit systems (bus, railroads, Staten Island Ferry). Local shopping centers are also easily accessible by foot. According to Berthold: "The site selection within the community was a conscious effort to practice energy conservation outside the home as well as in."

TOP AND BOTTOM RIGHT/Site plan and floor plan for the Berthold House. The residence is designed for use by an architect who would work at home. The studio, bedroom and kitchen/dining areas are located around the perimeter of the greenhouse to utilize the stored heat which can be released through sliding glass doors.

The underground plan surrounds a greenhouse (which serves as a heat sink and food garden) and a fish pond focusing on self-sufficiency within the home. The house is stepped into the site, using the earth for insulation, yet providing some open living areas.

A vertical-axis wind turbine captures winter winds, which are directed up and over the structure's north and west sides. Summer winds are directed into the turbine for natural ventilation. A rotating scoop at the top of the studio/workroom catches breezes and is also used for natural lighting.

Other energy conserving features are:

- insulation on the exterior of concrete walls;
- double glazing;
- beadwall insulation;
- hinged Kalwall roof insulation;
- a mechanical solar collection system;
- air-lock vestibules;
- heat-circulating fireplace;
- natural lighting, where possible.

SYSTEMS INTERRELATIONSHIPS DIAGRAM

RIGHT/Graphic illustration of interrelationships among various systems. Heat, electricity, food, water and waste are dealt with either by natural or man-made means. For example, rainwater is collected on exposed surfaces, troughed off, filtered and stored in an underground rainwater cistern. Solid and liquid organic wastes drain to a clivus multrum composting toilet and are recycled in the form of fertilizer for use in the greenhouse or vegetable garden.

This project's purpose is to unite existing technological methods with new architectural forms to create, in Berthold's words, "A more symbiotic relationship between man and his natural environment." Juror Brad Perkins agreed, calling the Berthold House, "A very credible approach to energy conscious design."

TOP/West elevation with minimum exterior exposure to the north and west. Maximum southern exposure allows use of mechanical solar collectors and passive solar heat gain in greenhouse.

BOTTOM/Insulation diagram showing effort to reduce heat transmission through use of earth cover and berming, insulation on the exterior of massive concrete walls, double glazing, beadwall insulation and hinged Kalwall roof insulation panels.

TOP/Diagram illustrating maximum use of winds common to the New York City area. Winter winds are directed up and over the structure as well as into the vertical axis wind turbine. Summer winds are captured by the wind turbine to provide natural ventilation. The scoop on the top of the studio rotates to catch breezes for ventilation and acts as a skylight and as a periscope permitting surface viewing from the studio/workroom.

BOTTOM/Diagram illustrating rainwater use. Earth covers allow rainwater to percolate naturally into ground water. Usable land is provided on roof area and no paving materials are used on the site. Open paving blocks and pebbles are used for driveways and walkways. Crown vetch is planted to restore nitrogen to the soil and to minimize lawn maintenance.

COMPOSTER TOILET

- a. toilet
- b. vent stack
- c. sink
- d. toilet wastes
- e. air vents
- f. kitchen wastes
- g. fertilizer
- h. cover
- i. vent
- j. earth bed

TOP/Diagram of solar collector system.

BOTTOM/Diagram of clivus multrum composting toilet. Liquid and solid wastes are composted, then recycled in the form of fertilizer to be used for food production.

Student: Menelaos Triantafillou

School: Harvard University/MIT "Joint Energy Studio"

Faculty sponsors: David Lord (Harvard), Tim Johnson (MIT)

Site: North Easton, Massachusetts

The program for this project was provided by a group of Massachusetts Quakers who are actually planning to develop a community for 275 people. From their statement:

"We hope to build a community in keeping with our Quaker testimony of simplicity. The design, construction, and details of the buildings and use of land should be direct and functional. The materials used should be native and inexpensive; they should be used as simply as possible.

MENELAOS TRIANTAFILLOU (student): "Energy conscious design is the only way of building the places we live in so that we don't waste and lose for good what is given to us, like the air we breathe, the trees we see, the water, the gas and coal and oil inside the earth. Solutions should be simple. We should not design for a sophisticated user."

FIGURE 14 The sketch shows typical residential units, which are oriented to gain maximum advantage from prevailing breezes and insolation. With respect to site vegetation, Triantafillou states: "On-site energy for food growing has great potential and is a direct form of energy conservation. Growing vegetables and fruit on the site will mean less dependency on the local market, thus saving energy in the form of money. It will mean less supply from regional warehouses to the local market, which means less energy use in the form of fuel."

"Our population of elderly people, often with limited maneuverability, will want to be able to handle as many details in their lives as possible. This necessitates low maintenance, no changing of storm windows, and as little painting as possible.

"We wish to strive toward self-sufficiency. This means energy conservation in all its forms, alternate energy sources, waste recycling systems, and food production."

The site is 87 acres, mostly wooded, in North Easton, Massachusetts. Triantafillou states: "Energy conscious design, in its generic meaning, is not confined only to the design and consideration of the functional and mechanical aspects of the dwelling unit; it extends beyond that to include the total site, with its tangible and intangible conditions and boundaries."

"Among such conditions and boundaries are those set by state and local regulatory bodies. Thus, a portion of this entry is devoted to a study of governmental regulations and their influence on energy conscious design objectives.

TOP/Site diagram showing principal design opportunities and constraints, based on an analysis of climatic and topographic characteristics. The student writes: "The 'sun-spot' area lends itself to a major open space, around which part of the community can cluster. Protection should be provided against the northwestern winter winds. Through selective cutting of existing vegetation, linear openings could allow summer breezes to enter the area of housing development."

BOTTOM/Site plan showing residential units and community building. Units are planned to focus inward. From Triantafillou's notes on the presentation: "The units are oriented at 17.5° east of south. All active spaces are located at southeast-facing portions of units. The determination of this orientation results from a study of the New York - New Jersey area that attempted to identify balanced orientations. Existing vegetation and new planting are used for protection against winter winds.

Triantafillou identifies a "balanced orientation" for residential units, based on the desire to expose them to maximum radiation during the "underheated" months (November through March) and to minimum radiation during "overheated" periods (June through September). He shows that such concerns must be balanced with existing zoning setbacks, building codes and property rights.

Triantafillou set the following objectives for his project:

1. Use passive approaches to energy conscious design for conservation, so that greater flexibility is built into all of the community components and all solutions are economically justified.
2. Use a total site/scale approach to the design for energy conservation and client requirements, by starting at the many site boundaries and gradually arriving at the building envelope.
3. Incorporate food gardens with built forms, to act as solar collectors and as a method of energy conservation.
4. Develop "non-exotic" solutions that will be accepted by the clients and by local governmental jurisdictions.

TOP/Portion of shadow analysis, in this case showing conditions at solar noon in March. The sun angle studies were an important part of analyses for both interior and exterior spaces.

BOTTOM/Site section through typical residential grouping. Unit spacing was determined by sun movement studies, in order that one building not block another's sunlight.

7 FRIENDS' COMMUNITY

Extensive site analysis precedes Triantafyllou's design. He investigates existing vegetation, microclimate conditions and on-site energy sources. From his project statement:

"Two major microclimatic characteristics are of importance for food growing and exposure of units to the winter winds. The first is a shadow-free area at the open field part of the site. Besides having free exposure to sun's radiation, its southwestern edges provide shelter to the northwest winter winds. Therefore, it lends itself to placement of units and vegetable growing.

"The second characteristic results from the presence of low-lying wetland areas, the marsh around the pond, the bogs, and the depressions. These areas are potential frost pockets during the night time, due to cool air drainage to low elevations. As such, the bogs and areas around the pond can lend themselves to cranberry raising. The depressions, which have resulted from earlier attempts at copper mining, are potential ice-skating areas since they retain ice much longer than the higher land."

TOP/Section through typical residence showing passive utilization of the sun's energy during winter months. This drawing shows conditions for December 12 at noon.

BOTTOM/Section similar to the one above, but drawn to show summer conditions and the importance of louvers, overhangs, vegetation and other shading devices.

He also estimates the energy and service requirements of Friends' Community residents and then explores a number of alternative ways to meet them, giving particular attention to methods of waste treatment and on-site power generation.

The final determination of unit locations on the site stems from considerations of vegetation patterns, prevailing breezes and winds, and from sun angle calculations. These concerns are carefully balanced against other programmatic requirements, which involve pedestrian and vehicular movement, desirable views, and patterns of social interaction.

Of this entry, juror Fred Dubin said: "A fine analysis of alternatives and excellent use of low-energy systems. It shows a detailed and successful study of the problem. The presentation is comprehensive. So many other entries were simplistic; this one reflects a fine consideration of mechanical systems and natural elements, aided and abetted by building design."

TOP AND BOTTOM/Site plan and section showing interaction of prevailing summer breezes with residential units and vegetation. Desirable summer cross-ventilation is achieved through control of orientation and size of openings, and through choice and location of trees. Similar studies were made of winter wind patterns.

LYNDA SIMMONS (juror): "The most praiseworthy entry. Exceedingly thorough in analysis, using a methodology which should be furthered for the benefit of schools and students generally. A non-exotic solution, one which can be used and can benefit the great mainstream of society."

LEFT/Plan, diagram and section views of proposed greenhouses. Triantafyllou states: "Several greenhouses are proposed in several areas for serving the needs of three or four groups of units. These can be used for a variety of purposes throughout the year. Their size is determined by user's requirements. For example, one tomato plant needs 4 sq. ft. of space and it can grow as high as 7 ft. One plant can yield (throughout the late fall-winter-early spring season) approximately 20 pounds of tomatoes. Twenty plants can be sufficient for 'treat' salads of the three to four unit groups. The basic plan would be built 3-4 ft. in the ground, in order to take advantage of warmer temperatures, as well as to keep the height of the tall wall 4 ft. lower. This height is determined by the pitch of the transparent roof, since its angle should be, as near as possible, perpendicular to the winter sun's angle. By utilizing the sun's energy, the greenhouse can contribute to energy conservation in the form of fruit and vegetables it can give to the Friends."

Student: Raymond Greco
School: Iowa State University
Faculty sponsors: Ray Crites, K. Kocimski
Site: Ontario, Canada

This entry, along with several others, is a response to EPROM '76, an international design competition organized for the United Nations Conference on Human Settlements (Habitat) held in Vancouver, B. C.

TOP/South Elevation, illustrating vertical-axis windmills, which will supply most of community's electricity.

BOTTOM/Housing units issue from hillside and cascade toward lakefront, deriving benefits from the earth's insulation and shelter from the wind.

SOUTH ELEVATION

The EPROM program calls for development of a model settlement for ten families in a semi-rural area of eastern Ontario. Broadly, design schemes are to demonstrate techniques of building for an ecologically balanced way of life. In particular, submissions to the EPROM competition are asked to employ the abundant energy of the sun, wind and rainfall; make provisions for food production; avoid pollution of land and atmosphere; and avoid excessive use of non-renewable resources in building (see also Entry of Distinction #9).

Greco states: "I found there are many devices one may use in design to significantly reduce energy consumption without the need for new technological breakthroughs. By using these devices to take full advantage of our surroundings we can become, to a large degree, autonomous."

Architecturally and systematically, Greco's solution centers around a "solar pond." From his project statement: "The habitat is using a solar pond as its primary source of heat. The seasonal storage capability of the pond is the determining factor for its use. Long-term energy storage is necessary, due to low mean monthly solar radiation values between November and February."

FIGURE 4

WIND TURBINE SYSTEM

LEFT/Wind turbine schematic.

FAR LEFT/EPROM site plan.

The project includes complete analyses of human nutritional needs and a tabulation of ways the community could meet these needs by raising crops and livestock. This would be achieved through aquaculture, staged in massive greenhouses, which would also help to humidify residential spaces. Greco enumerates the advantages of hydroponic growing inside his proposed greenhouses. The method:

- Grows five times more per square meter than outdoor gardens
- Promotes faster growth (as much as 20 percent faster for some crops)
- Extends growing season throughout the year
- Does not require heavy labor
- Does not involve insecticides
- Does not suffer losses due to wind, hail and/or freezing
- Makes transplanting easier
- Uses less water than conventional growing.

The project's response to solar energy is evident in its orientation and configuration, which are designed to take advantage of the earth as an insulating barrier. Greco seeks to make optimum use of winds and rainfall. He examines the possibility of providing for at least some of the community's electrical energy requirements through use of wind generators (see illustration) and provides for collection and purification of rainwater.

Greco states: "The elimination of the traditional toilet and the use of recycled water for greenhouse and laundry purposes will considerably reduce the habitat's annual potable water requirements. The 1,653,450 liters required will be supplied by rainfall, with the supplemental potential of a lake as a back-up. The roofs of the dwellings, the greenhouse and solar pond will provide 3,130 sq. m. of catchment area, which will provide 60 percent of water requirements."

In a summary of the measures and principles reflected in his work, Greco includes the following:

- Airlock entries act as buffer zones
- Skylights are double glazed with insulating shutters
- All work areas in dwellings are naturally illuminated
- Greenhouses provide humidification and reduce outside air requirements for living spaces
- Rooms within each residence act as passive solar collectors
- Orientation and size of windows and skylights permit natural ventilation with cool breezes from lake.

LEFT/Within apparently traditional building forms, the whole community is designed around the solar pond which defines its technological and ecological existence. According to juror Lynda Simmons, the entry "fulfills complete life needs. The biosphere is an excellent idea and demonstrates thorough research and successful integration of design systems. Expensive, but worth experimenting."

The jurors all expressed interest in the detailed analyses performed by Greco. Fred Dubin found the entry to be "a fine effort to integrate the structure, open space and energy systems with the natural environment." Anita Picozzi cautioned, however, that "the scope and analysis of this project are worth comment. But I do have reservations about it as effective community planning."

HENRY WRIGHT (juror): "Inside insulated shutters must be perfectly sealed and outside glazing vented to the outside to avoid damaging condensation. Outside shutters are much, much more practical. The plant-growing area is an extremely interesting application of solar energy. It could use shutters, too. The glazed pond is exposed to night-time heat loss. The collector surface is horizontal, and thus intercepts little solar energy in winter."

TOP/Solar pond schematic

BOTTOM/Hourly heat gains and losses were calculated for a typical January day to determine the energy requirements of the habitat. Heat exchange curves for the greenhouse and a typical dwelling unit were derived from climatic factors of eastern Ontario, heat transmission coefficients of construction, infiltration and assumptions about operation and comfort levels.

FIGURE 1 GREENHOUSE HEAT EXCHANGE CURVE

FIGURE 2 DWELLING UNIT HEAT EXCHANGE CURVE

8 COMMUNITY FOR TEN FAMILIES

INSULATED SHUTTER DETAIL

GREENHOUSE INTERIOR

RAYMOND GRECO (student): "I see architectural design in the future reflecting the long-term energy problem. Buildings will have to complement our natural environment. Design will be a direct response to proper orientation, weather exposure patterns, thermal efficiency characteristics and solar radiation. With the increased efficiency of building systems, owners will pay more initially, but their operating costs will be lower."

TOP/Section illustrating integration of structure and hillside.

BOTTOM, FAR LEFT/Insulated shutter detail.

BOTTOM LEFT/Greenhouse interior. The student made careful calculations of nutritional, growing and husbandry needs for the community, analyzing each kind of plant and even how many bees and how many rabbits (20 does and 3 bucks) needed.

Students: Alan Cobb, Ric Licata,
August Percha
School: Lawrence Institute of Technology
Faculty sponsors: Robert Powell,
Harvey Ferrero
Site: Ontario, Canada

This entry is a submission to EPROM '76, the competition offered in conjunction with the United Nations Habitat conference. The EPROM competition called for design of a model settlement for ten families in a semi-rural area. Entries were to demonstrate techniques of building for an ecologically balanced way of life.

The competition's objectives were to:

- Develop an ecologically satisfactory habitat having social, economic, and recreational benefits for a group of families desiring to combine work opportunities in a nearby industrial town with the production of food in harmony with nature.
- Respond to a desire among many young people for a semi-rural and partially autonomous life.
- Offer an alternative to the depopulation of rural areas.

ABOVE/Cobb, Licata, Percha

9 VILLAGE OF THE SUN

- Demonstrate settlement techniques producing minimal environmental damage.
- Employ the abundant energy of the sun, wind, rainfall and avoid excessive use of non-renewable resources.

The students write: "To create a climatic envelope for the ecologically self-sufficient survival of its inhabitants, we have united two organisms, man and site, into a single bio-organism. With man as its consciousness, and his structures as its body, the bio-organism comes to life.

"We have designed a ten-family cluster community which is a gestalt of two anthropological ideologies. First is the community awareness of primitive tribes as a social organism. Second is the modern concept of the city service center, which we have developed into the community node and satellite living capsules. With these ideologies as an approach, we feel we have created a self-sufficient and ecologically wise solution."

TOP (opposite page) View of community node from grape arbor shows interior of greenhouse, and area of solar collector on south face of barn large enough to heat community node and attached living capsules.

TOP/Section of the community node revealing interior of the greenhouse with fabric insulation panels, central kitchen, and resource loft. Also shown on exterior is rain collector trough, which funnels rainwater to cistern.

BOTTOM DIAGRAMS/An important eco-design consideration is to utilize the total solar potential of the site. The bio-organism physically represents its solar awareness through building orientation and large-scale crop production. Farm animals are raised to augment community food production and

ABOVE/Section of community node and living capsules showing the main structural column used as a flue system and heat storage element. The forms take advantage of natural air convection currents inherent in the topee shape. A series of vents at the top and bottom provide total control of interior air flow.

LONGITUDINAL SECTION

ABOVE/Plan of community node and node living capsules, excluding barn and craft area.

The Village of the Sun is envisioned as a living environment in which residents will be completely involved: "As this bio-organism evolves, it will function as a total system in which inhabitants will fulfill their needs and in turn use their knowledge, spirit, and by-products to replenish the earth.

"This harmonious union of elements creates a consciousness that manifests itself as the spirit of the community. The independence we seek, in the form of a partially autonomous life within the ecological bounds of nature, can become a reality through a community that is interdependent; each member contributes his or her hopes and dreams.

"Independence through interdependence is a basic element in the evolution of human settlements. Increased awareness is attained by having inhabitants participate in construction, using low technology."

Community energy requirements, matched against certain technical constraints, produced substantial effects on design: "We found that sufficient gas pressure could not be generated to supply ten living capsules with gas adequate for cooking. However, one central kitchen could be amply supplied with gas for 40 people if it were located near the digester. This need generated the idea of the community node."

TOP LEFT/Solar collector detail.

TOP RIGHT/In this system, two pumps are necessary, one for the closed glycol solution system and one for the hot water radiant floor slab. The water pump can be switched to run water through the wood stove's grating or directly to a fine mist shower. A final back-up system utilizes a heat pump. A "city sewer" system captures the wastes and by-products of the community.

BOTTOM/Section of community methane works. The wastes from 40 humans, 40 chickens, four cows, and two horses create approximately 13 cu. m. of gas. Methane is used for cooking in one central kitchen. Effluent is drained occasionally and used as liquid fertilizer.

This entry attempts to link individuals directly to sources and uses of energy. The students state: "Within this organism individuals are of prime concern. One can adjust the life-support systems to suit his or her needs. Wind generators power the systems, which control the building's climate. Luxury appliances are metered by the power company at the unit. Individuals may select their own degree of self-sufficiency."

Social goals and energy concerns are closely matched in the students' conception: "Each individual has the freedom to create a personal environment and to express identity. To achieve this, while maximizing heat radiation and air convection, we used an open floor plan. The only permanently enclosed space would be the bathrooms. Personal spaces would be defined by flexible tensile dividers."

FRED DUBIN (juror): "Very effective integrated design at reasonable construction costs. Shows understanding of the relationships inherent in nature and exploits them successfully."

JEAN BOULTON (juror): "The total ecological approach and humanistic design is of note."

RIGHT/Plan and sections of two living capsules showing air-locked entry hallway, wood stove with extended flue, and hot water storage to supply floor slabs of both units.

ABOVE/View of entire community showing relative building configuration, manways, and barnyard.

Concluding their statement on the project, the Lawrence group asserts: "Man is the controlling factor. He is the consciousness of the organism. The environment allows man to create such climatic envelopes now. The key is recognition of man's integral part in the formation of an ecologically balanced habitat. Introduce man into this scheme and the bio-organism takes life. Man and his environment are one, resulting in living architecture."

Students: Paul Flehmer, Bruce Flynn,
Colin Shimokawa, Russell Watson

School: University of Colorado at Boulder

Faculty sponsors: Phil Tabb, Chester Nagel

Site: Denver, Colorado

The Urban Survival Shelter is designed to promote energy consciousness and ecological awareness among residents of Block 11 of the Denver Urban Renewal Authority. Program requirements were determined through research of the existing urban conditions within Denver, and the predicted needs and energy demands of a future urban community.

The students write: "Project goals emphasized creation of a sense of place, interaction with the environment, and ecological

BRUCE FLYNN (student, left photograph): "Users of the built environment must take initiative to consciously monitor and control their physical environment...and then be willing to show greater tolerance for environmental fluctuation within acknowledged comfort levels."

RUSSELL WATSON (student, right photograph): "Environmental awareness should be a primary objective, because if people are conscious of their environment they can begin to voluntarily adjust their life-styles."

RIGHT/Lower two levels contain commercial office spaces; professional office spaces occupy third level; and remaining nine floors contain residential units. All are open on the south to winter sun and cooling breezes, while protected on the north from winter winds. Greenhouses and experimental solar collectors distinguish roofline.

10 URBAN SURVIVAL SHELTER

awareness. The design places emphasis upon energy use, food production, and recycling waste."

Levels one and two are commercial lease space; services responding to particular community needs are available on the sub-grade level. Professional office space is on the third level; the remaining nine skip-loaded floors contain 300 residential units.

LEVEL 1
COMMERCIAL

PAUL FLEHMER (student, left photograph): "Even in an urban setting, a building can be responsive in the areas of energy use, food production, and waste recycling to produce a syn-ecological habitat."

COLIN SHIMOKAWA (student, right photograph): "Solar collection and recycling of wastes can not only serve its functional role but can be effectively integrated in architectural design. It can also be a constant visual reminder of people's use of energy."

TOP/First level floor plan illustrates semi-conditioned atrium, for which structure on either side serves as a thermal buffer zone.

BOTTOM/Concentrating SRTA collectors, 45 ft. in diameter, will generate 25 percent of building's electrical power need, with waste heat providing most heating and cooling needs. Should taller buildings obstruct the sun, the collectors can be raised on towers.

The students give an account of considerations leading to their solution: "Climatological design response can be seen in the building form, illustrated by opening the southern facade to the sun and natural breezes, while minimizing the northern and western exposures. We used a semi-conditioned atrium as a thermal buffer to minimize impact on the mechanical systems. Natural lighting and flow-through ventilation are accomplished by operable skylights covering the atrium."

A ten-story open community space, centrally located in the complex, is to serve as a market for community goods and services. The designers envision it as a place for meeting and interaction among citizens, government and business.

The solar energy system is a major visual and mechanical component of their scheme. They write: "The mechanical systems are given strong expression for educational purposes, encouraging the inhabitants to become aware of life support systems. Active solar collection is accomplished with a 45-ft.-diameter SRTA steam system supplying 100 percent of absorptive cooling, 85 percent of hydronic heating and 25 percent of the electrical demand."

TOP RIGHT/Greenhouses provide 50 percent of residents' vegetable needs.

TOP, FAR RIGHT/Plaza is protected by building envelope; trees shade paved areas.

BOTTOM RIGHT/Greenhouse has controlled ventilation.

BOTTOM, FAR RIGHT/Greenhouses are designed to encourage community participation, providing self-sufficiency and an education on ecology and nutrition. A public observation area serves as a fulcrum.

GREENHOUSE SECTION

GREENHOUSE PLAN

The SRTA collector is an experimental device developed by Dr. W. Gene Steward at the University of Colorado. A fixed reflecting concentrator focuses the sun's energy, which is captured by an absorbing tube that travels to "track" the sun's movement across the sky. High temperatures obtained by the system are used to produce steam.

The students claim considerable advantages for the SRTA system, among which are economies resulting from smaller surfaces and lighter construction techniques than would be required for flat plate collection devices. They also note that in the event of encroachment by future development nearby, the collectors could be raised on towers to clear obstructions.

Their design also calls for recycling of wastes: "Recycle cores pneumatically carry metals, papers, and glass to processing for removal from the site. Processed organic garbage supplies compost for the roof top greenhouses, which in turn produce 50 percent of the vegetable needs of the residents. Filtered grey water, pumped by the wind generator, supplies the greenhouses with irrigation."

MECHANICAL SYSTEMS

15 30 60

SECTION

TOP/Northern and western exposures have minimum glazing and exposure to severe winter winds.

BOTTOM, FAR LEFT/Mechanical systems include wheel heat exchangers between atrium intake air and exhaust from unit bath and kitchen. Domestic hot water is preheated by coil heat exchange with grey water and solar storage. Low-velocity variable volume air handlers are used on every other floor and equipment loads are distributed evenly day and night, due to mixed-use nature of building.

BOTTOM RIGHT/Section illustrates integration of building systems. Juror Fred Dubin praised the entry as "an innovative and extensive effort to reuse and recycle materials and a very good analysis of all design aspects."

Several jurors commented favorably on the futuristic aspects of the entry. Lynda Simmons observed that the project demonstrated "good imagination applied to large scale housing as regards the total biosphere" and that while not presently feasible, it should stimulate further thought and research in this difficult area."

RIGHT/The students' concept of synecology describes their building: "To create an ecological awareness and to educate community residents in the various passive and mechanical environmental systems of the building with primary emphasis upon energy use, food production, and recycling waste disposal. In actualizing life support consciousness with inhabitants of the building, ecological awareness might be expended beyond the site as residents recognize harmonic relationships between life support systems, the natural and the man-made urban environments. The harmony is defined as synecology."

FAR RIGHT/Housing clusters are organized so that each has two exposures to facilitate natural ventilation and so that they can use maximum natural light; top units have skylights; and each unit has either an entry court or an atrium balcony.

SYNECOLOGICAL RELATIONSHIPS

TYPICAL HOUSING CLUSTERS

EFFICIENCY

TYPICAL

TYPICAL FLOOR PLANS

LEVEL 3

HOUSING

0 5 15 30 60

TOP/Community spaces provide opportunities for communication and interaction between various building populations, as well as a place to market community crafts and products. Bridges link housing units on opposite sides of multi-story atrium.

BOTTOM/Typical floor plans for housing units. The building is designed for 15 percent handicapped, 15 percent executive, 45 percent singles and professionals, and 25 percent students.

Students: Roger McLoney, Bradley Oberg,
Philip Skirball, Craig Stough
School: Ohio State University
Faculty sponsor: George Clark
Site: Columbus, Ohio

The energy requirements of an entire university campus are taken into account by this entry. In their analysis of the proposed International Student Center for Ohio State University, the students conclude that the new building would serve as a "net energy supplier" to the entire campus system.

The center, which is designed to serve a residential population of between 200 and 400 students, would consume 6.5 million BTU/day less than a student services building presently on the site. Excess heat gathered in summer by the building's solar system would supply steam for various uses in other parts of the university complex.

The students conceive of a prefabricated, "fast-track" construction scheme. From their project statement:

"This construction system is based upon the use of three basic building units - prefabricated structural steel truss elements, prefabricated living modules (single, double, and handicapped), and prefabricated translucent solar panels - assembled in four basic steps.

McLONEY, OBERG, SKIRBALL and STOUGH (students): "Our most intriguing discovery while designing the project was that the inclusion of energy conscious features does not adversely affect design potential. In fact, they may actually cause a more appropriate overall solution to be conceived."

RIGHT/Perspective of interior core or lobby. It is designed to serve as a heat sink and promotes natural ventilation of other building areas by drawing air upwards. Translucent solar collectors permit natural illumination of spaces below. Interior core space serves also to store heated or cooled air overnight.

11 INTERNATIONAL STUDENT CENTER

"The first step is site preparation. The existing student services building is demolished and the site cleared. Foundations for the new construction are poured. Structural truss members are fabricated off-site in small, transportable sections. Preparations are made for living module and solar panel production.

"With the site prepared, the prefabricated structural truss pieces are transported to the site and erected. The living modules and solar panels have been bid and production is started. Finished modules and panels are transported to the site for erection.

"The third step is the actual placing of the living modules and solar panels into the structural frame. Two living modules are lifted and placed at once, filling the width of one structural bay. Solar panels are placed on the upper south elevation and roof. Conventional construction and finishing of lower lobby levels begins.

"Finally, the mechanical penthouse and roof are enclosed, finished, and equipped. Pre-cast structural encasing panels and balcony railings are applied to finish the exterior. Interior module finishing and conventional construction are completed. The site is cleared and landscaped."

TOP LEFT/The student center is proposed for a site occupied by a student services building, which would be demolished. The International Student Center would serve between 200 and 400 residents. The students estimate that the new structure would demand 6.5 million BTU/day less than the existing building.

BOTTOM LEFT/The center's pyramid profile stems from stacking of prefabricated modules, two at a time, into massive prefabricated trusses. Speeded building process is designed to save energy during construction phases. Service core at center contains kitchen and dining facilities, meeting spaces and elevators.

The entire building is a massive solar collection and heat distribution system. A nine-story open lobby space acts as a heat sink, providing overnight storage for cooled or heated air. Large quantities of heated air -- for ventilation purposes -- are drawn by natural convection up through the central space.

Its solar system, composed of preassembled translucent panels, is designed to be integrated with the university steam and domestic water systems. The students write:

"Serving all areas of the building except room balconies with heat, the solar collection system meets the required capacity fully for ten months of the year, and has only a 20-25 percent 'deficit' during December and January.

"Serving enclosed, generic spaces, core, and living modules, two 397-ton absorption cycle chillers provide the capacity for the estimated 580-ton load. The absorption cycle reconcentration heat is provided by the solar collection system.

"The flow of heated air through the panels is essentially by convection upward and then with fan support to the two end bays of the building, which house the chillers. At this point, approximately 50 percent of the collected energy is used in the reconcentration cycle. The remainder of the heated water is sent through the waste heat side and then returned to the tie-in point to the campus system. During the cooling season, the

ISOMETRIC - BUILDING SYSTEMS

RIGHT/Axonometric view showing assembly of precast and prefabricated elements. This entry of distinction is the only one to make use of prefabrication techniques. Solar collectors are preassembled hot air units, composed of translucent fiber-glass panels.

stone storage below grade is allowed to cool and thus does not radiate heat into the building."

Juror Fred Dublin, commenting on the entry, said it "reflects innovative use of membrane materials to reduce heating costs" and that "mechanical systems and building design are well integrated and harmonious, to the benefit of both."

SINGLE LIVING MODULE

DOUBLE LIVING

MODULE SECTION

TOP LEFT AND RIGHT/Plans of single and double occupancy living modules. Each unit is naturally ventilated through use of operable windows, with large quantities of air drawn through to the interior core. A third typical living module was designed for use by physically handicapped residents.

BOTTOM LEFT/Section through typical modules. Overhangs and setbacks are set to block unwanted summer sun and admit winter sun.

ORIENTATION

THE BUILDING IS PLACED ON AN EAST-WEST AXIS. TWO-THIRDS OF RESIDENT ROOMS HAVE NORTH ORIENTATION, THE REST SOUTHERN. NO RESIDENT ROOMS RECEIVE HOT WESTERN SUN.

SOLAR COLLECTORS

PLACED ON SOUTH SIDE OF BUILDING AT 30° FROM VERTICAL, USED PRINCIPALLY FOR WINTER HEATING. ENERGY CONSCIOUS DESIGN THROUGHOUT THE BUILDING MAKES THIS SYSTEM A PRACTICAL INSTALLATION.

NATURAL LIGHT

THE SOLAR COLLECTORS, DESIGNED TO ALLOW SOME LIGHT TO PASS THROUGH, ALSO ILLUMINATE THE CENTRAL MALL, A SPACE OTHERWISE REQUIRING SUBSTANTIAL ARTIFICIAL LIGHTING.

NATURAL VENTILATION

ALL RESIDENT ROOMS ARE PROVIDED WITH OPERABLE SASH FOR FLOW-THROUGH VENTILATION TO THE CENTRAL MALL. ALSO, LARGE QUANTITIES OF AIR ARE DRAWN BY NATURAL CONVECTION THROUGH THE CENTRAL SPACE.

SHADING

WINDOWS ARE PROTECTED FROM UNWANTED SUMMER SUN EXPOSURE, BUT STILL PROVIDES FOR SOLAR GAIN FROM LOWER WINTER SUN ANGLES. A GREENHOUSE EFFECT IS CREATED BY LOWERED WINDOWS OVER BALCONIES.

INTERIOR AIR MASS

THE OVERNIGHT STORAGE CAPACITY OF THE CENTRAL AIR MASS WILL REDUCE THE NEED FOR HEATING OR COOLING SYSTEM OPERATION.

RIGHT/Isometric view showing system schematics. The left portion of the drawing shows the building in its cooling mode. The solar collectors heat air, which is distributed to chillers housed in the end of the building. There, half of the contained energy is used to reconcentrate heat for the chillers, while the remainder is delivered to the campus steam system. In winter, as illustrated on the right side of the drawing, heated air is forced downward to an underground rock storage bed, which then radiates heat to occupied spaces.

SOLAR COLLECTOR DETAIL SECTION

BUILDING ISOMETRIC - ENERGY CONSIDERATIONS

TOP/Graphic demand and supply charts showing annual energy characteristics of proposed center.

BOTTOM LEFT/Section through central core showing diagonal elevators and space-frame skylight. Spaces orienting toward open lobby are lounges, meeting spaces and a "solar garden."

Student: Allen Lowry, Henry Siegel
School: University of California, Berkeley
Faculty sponsor: Sandy Hirshen
Site: Sacramento, California

Located in Sacramento, California, this office building is designed to house the state's Energy Resource Administration. Employees of the building enjoy climatically responsive spaces in an efficient and congenial work environment. The program set forth by the University of California, Berkeley, called for a prototypical, low-rise state office building. Siegel and Lowry decided to add to the program:

"We chose a difficult problem — a mixed-use office building for an urban infill site, with the water table five feet below ground — not a problem ideally suited for many conventional energy conservation solutions.

ALLEN LOWRY (student): "At present, buildings persist as static and often malignant objects in an environment of rapid change. The ability of a structure to evolve over time in its function, operation, and size is increasingly important as our recoverable resources diminish. A specific building must mature and become more efficient in the course of its life. Users will initiate or promote this process if they are made to perceive the benefit to them."

HENRY SIEGEL (student): "Insulating existing buildings could conserve 50 percent of current energy use. It costs \$1 billion to build a nuclear power plant that provides 16,000 jobs. Spending the money on insulation would save three BTUs for every BTU created and provide 64,000 jobs."

RIGHT/Axonometric illustrating the Energy Resources Administration, a prototypical, low-rise state office building of 150,000 sq. ft. in Sacramento, California. The complex roof-scape expresses wind considerations and solar functions and emphasizes the decentralized nature of the mechanical systems.

With our design we intend to convey the image of an energy conserving building and a building designed to serve the needs of 1 worker at his or her desk."

A set of general concepts emerged before the students considered the specific elements of their design. These general concepts are summarized in the project statement:

- Balance between a comfortable work environment and the use of accepted energy conserving features, such as cubical massing and minimal glazing.
- Design using present solar technology and able to embrace new technologies in future.
- Mechanical distribution systems that are conventional and reliable, while able to adapt continuously to innovations in heat-gathering and heat-focusing equipment.

PLANS

LEFT/Third floor plan showing offices radiating, off center around an atrium. The modular structural system, permitting numerous light wells and dead end spaces, encourages small groupings of six to ten people and lends a personal scale to otherwise huge floor area.

The building employs decentralized mechanical systems. This zone approach allows the building to respond to the climatic and functional changes in individual spaces. Incremental system development, through placement of new equipment in specifically suitable locations, is also possible with this decentralized approach. Each of the numerous thermal zones of the building has unique requirements, which define unique performance criteria. Equipment assigned to meet these criteria in any particular zone can be evaluated and compared to equipment used in other zones.

Open plan office areas are flexible to allow changes in furniture and partition arrangements. Numerous light wells in the office areas encourage convivial and varied work areas. The floor openings allow dead-end spaces to create a sense of place for individual workers.

The students see potential energy savings in policies adopted for workers in the building: "Cooperation among office workers can result in energy savings. As the mechanical system cannot respond to every severe condition, policies are needed. Dress codes may dictate the wearing of shorts or a sweater for comfort. Smoking codes limit smoking areas and 'lights-out' rules could be put into effect."

FIRST FLOOR plan

RIGHT/First floor plan showing the arrangement of offices and commercial space. A goal of the project is to demonstrate the feasibility of a low-rise, mixed-use office building in an urban setting.

The building takes advantage of prevailing southerly winds for natural ventilation. Distribution is assisted by a conventional supply fan and duct system. Air returned vertically through the light wells is recycled or exhausted by a wind-induced vacuum behind the top edge of the roof's solar collector support structure.

Space heating is achieved through the use of solar collectors, domestic hot water waste and waste paper. In this decentralized system, air is heated locally (see diagram). Evaporative cooling by fountains and trees is effective in the temperate climate of Sacramento. Windows are operable and movable shades control heat gain.

SARAH HARKNESS (juror): "This approach to an urban problem is competently and humanly handled. The use of natural light and ventilation should be noted."

LEFT/Sections through building showing skylight and solar collectors.

The students enumerated the trade-offs they found necessary to achieve an energy efficient structure:

- "Flexibility -- a loose fit system instead of a fixed idea, equipment-specific system;
- Siting -- a prototype solution, most appropriate to urban infill, as contrasted to a site-specific solution which might utilize topography, and local heat sources;
- Natural light -- double-glazed skylights and perimeter glass, as well as stepped massing, instead of maximum insulative integrity;
- Mechanical systems -- minimum sizing of mechanical system to meet comfort needs 90 percent of the time with dress codes and operating policies, instead of an automatic system for 97 percent performance;
- Work -- a modulated environment, not warehouse paper-flow office architecture."

RIGHT/Fourth floor plan showing the observation deck and translucent roof of the atrium. Juror Lynda Simmons, commenting on the floor plan, said the students "recognize the problem of individualized environment for workers in a fairly large-scale office building."

LIGHTING

- NUMEROUS SKYLIGHTS BRING SUNLIGHT TO ALL FLOORS.

- DOUBLE GLAZING PERMITS LARGER WINDOWS.
- 'STEP-DOWN' MASSING ALLOWS SUN TO NORTH.
- TASK LIGHTING OF WORK SURFACES CUTS COST.

HEATING

- AIR RETURNED VERTICALLY THROUGH THE LIGHT WELLS IS RECYCLED OR EXHAUSTED BY MEANS OF A WIND-INDUCED VACUUM BEHIND THE TOP EDGE OF THE COLLECTOR SUPPORT STRUCTURE.

- THE ATRIUM IS HEATED BY THE SUN ENTERING THROUGH THE TRANSLUCENT ROOF. THE SPACE IS A MIDDLE THERMAL ZONE, BETWEEN THE OFFICES & THE OUTSIDE. OPERABLE PANELS IN THE ROOF ALLOW DIRECT SUNLIGHT INTO THE SPACE UNDER TEMPERATE

12 STATE OFFICE BUILDING

Jurors' comments were all favorable on this project. Phil Meathe commented on the "excellent scheme," Thomas Vreeland remarked that "all the drawings are outstanding," and Jean Boulin admired the "interesting urban site and series of energy conscious design concepts."

TOP AND BOTTOM/Diagram illustrating (clockwise) heating, ventilating and lighting systems. Juror Fred Dubin remarked: "Fine integration of the mechanical systems as a supplement to favorable natural elements. The architecture takes advantage of natural light and ventilation."

ABOVE/Plotted on the map are sites for the 103 final entries to the competition. Divisions on the map pertain to climatic regions, described briefly in the text on the opposite page. Dots on this map total fewer than 103 because many entries used the same sites.

CLIMATIC REGIONS OF THE U.S.

Many methods for identification of climatic regions have been proposed. We have chosen to rely on a relatively gross delineation of climatic zones, as our purpose is merely to group entries by their presumed responses to approximately similar climatic factors.

Some qualification is in order before proceeding to brief descriptions of these zones.

Climatic characteristics for each region are not uniform. They may vary both between and within regions. It is not unusual for one region to exhibit characteristics associated with every other climatic region. However, each region has patterns of weather that distinguish it from the others.

COOL REGIONS: Wide temperature ranges are characteristic of cool regions. Temperatures of minus 30° F. to plus 100° F. have been recorded. Hot summers and cold winters, with persistent winds year round, generally out of the NW and SE, are the primary identifiable traits of cool regions. Also, northern locations most often associated with cool climates receive less solar radiation than southern locations.

TEMPERATE REGIONS: An equal distribution of overheated and underheated periods is characteristic of temperate regions. Seasonal winds from the NW and S, along with periods of high humidity and large amounts of precipitation, are common traits of temperate regions. Intermittant periods of clear sunny days are followed by extended periods of cloudy, overcast days.

HOT-ARID REGIONS: Hot-arid regions are characterized by clear skies, dry atmosphere, extended periods of overheating, and large diurnal temperature ranges. Wind direction is generally along an E-W axis, with variations between day and evening.

HOT-HUMID REGIONS: High temperatures and consistent vapor pressure are characteristic of hot-humid regions. Wind velocities and direction vary throughout the year and throughout the day. Wind velocities of up to 120 mph may accompany hurricanes, which can be expected from E-SE directions.

FINAL ENTRIES

This section of the book publishes excerpts from all final entries to the competition. They are arranged according to site location in one of four climatic regions described below.

Each submission to the competition has undergone internal review at the schools in question. Schools were permitted to submit no more than three entries for consideration by the National Review Board. Thus, in some cases, the following submissions have been weighed by members of the school's juries against scores of other efforts.

RIGHT/Ralph Mursinna, Michael Coffee, Oren Lavee/Southern California Institute of Architecture/Title: Community Resource Center/Site: Phoenix, Arizona/Section through main space (Open above partitions) showing movement and venting of heat. The library (not shown) is partially below grade./No. 87.

TOP AND BOTTOM LEFT/James Sailor/Texas Tech University/Title: Insurance Company Regional Office/Site: Tucson, Arizona/Sailor's building is designed to respond to regional climatic influences. He states: "The primary conservation device is the shape of the building. The pyramid shape allows the north and east sides to be self-shading. On the south and west sides are double-roofed structures which carry away heat before it can penetrate interior spaces." His design also employs a self-orienting exhaust vane, which creates negative air pressures within the building to draw heated air out./No. 97.

BOTTOM RIGHT/Ron Heinmiller, John Paris/Southern California Institute of Architecture/Title: Community Resource Center/Site: Phoenix, Arizona/The students list the most important energy conscious design features: "Exposures to outside heat is reduced by sinking the building into the ground and providing berms on the east and west sides. Unprotected openings are avoided on the east and west sides and thick masonry walls provide a 12 hour time lag for heat infiltration. Heat gain is reduced by stacking floors and providing a trelles with seasonal vegetation. Landscaping on walls and floor areas reduce air temperature."/No. 86.

TOP LEFT/Dan Couturier, Bruce Allen/University of Arizona/
Title: Tucson Recreation and Athletic Center/Site: Tucson,
Arizona/In this lightweight tensile structure, the building
envelope is used as a selective membrane for thermal control.
The membrane is translucent for heat collection during winter.
In summer the envelope is adapted to an opaque surface to
reflect excess heat./No. 13.

BOTTOM, NEAR LEFT/Mark Swenson, Thomas Duhon,
Phillip Carroll/University of New Mexico/Title: Community
Resource Center/Site: Albuquerque, New Mexico/Site orien-
tation is an important consideration in this project. The
students write: "The steep slope of the site originally seemed
like a restraint, but studying it with the use of study models
and conceptual sketches we realized it was an advantage. It
was utilized by setting the building into it providing additional
insulation, interior and exterior level changes, facilitation of
some aspects of the passive system and defining and enhancing
the spaces." Juror Lynda Simmons praised the "clear presen-
tation and good analysis of the problem."/No. 75.

BOTTOM, FAR LEFT/Veronica Moreno, Roy Woods,
James Aquino/University of New Mexico/Title: Community
Resource Center/Site: Albuquerque, New Mexico/The students
explain their approach to energy conscious design: "Our ap-
proach was that an energy conscious design did not necessarily
require or mean the application of sophisticated energy con-
serving hardware or the reduction of area or volume, even
though we considered those alternatives. We felt it would be
more economically feasible and more psychologically satisfy-
ing to create ample spaces for the required functions and to
provide for the energy conserving requirements by a more sen-
sitive response to the site and climate. The primary restraint
involved in this approach was found to be the handling of open-
ings, glazing, etc. The factors concerned were the orientation
of the site regarding sun and wind, and the fact that there was
an excellent view from the site toward the mountains and the

RIGHT/Robert Redding/University of Texas-Austin/Title: Community Resource Center/Site: Austin, Texas/The three entries which appear on this page are the products of computer-aided analyses of building shape, orientation, surface and volume, natural and artificial lighting, wall systems and window shading. The basic elements relating to the use of the computer as a design aid for energy use are:

- The rate of internal heat generation;
- internal surfaces area to volume ratio;
- totally enclosed volume by external surfaces;
- amount of solar insolation due to orientation of surfaces.

In the project at right, heating and cooling is incorporated into the design in order to provide a comfortable and healthful environment. Prevalent weather conditions are generally mild in Austin; the average temperature is 68° F. However, abrupt temperature changes and winter and summer extremes make it difficult to provide a comfortable climate without a mechanical system for heating and cooling. It is also necessary to provide protection from humidity and temperature changes to written material and electronic equipment. An Energy Budget Guideline was established taking from the schematic plans the area of all internal surfaces including the insides of externally facing walls, floors and ceilings. These were plugged into a formula to determine the upper limits of energy consumption and internal heat generation./No. 103.

LEFT/James Crook, Rahib Sarela, William Shepherd/University of Texas-Austin/Title: Community Resource Center/Site: Austin, Texas/This project also uses mechanical systems and the Energy Budget Guidelines. Writing about the building's external geometry, the students explain: "One of the key ways of reducing a building's energy consumption is to minimize its external surface area while maintaining the required internal volume. The ideal solution to this approach is a sphere, but this is impractical in terms of construction problems and interior space utilization. Therefore, it was decided to take a slice out of the sphere, and generate a disk form with flat floors and ceilings. This allowed minimization of vertical external surface while maintaining a workable interior volume. The energy savings achieved with this external configuration allowed the use of an open plan interior arrangement while staying well below the energy performance guideline."/No. 102.

RIGHT/Phillip Pommier/University of Texas-Austin/Title: Community Resource Center/Site: Austin, Texas/This project uses a cubical building form in order to achieve energy efficiency and to "open-up" the design allowing visibility to many of the CRC activities. About internal spaces the student writes: "Energy costs for heating and cooling a structure can be minimized if the structure itself is subdivided into numerous smaller spaces. Further, the surface-to-volume ratio of an internal space and the rate of internal heat generation associated with that space are also important in determining a window size for that space. Windows and their solar controls, or lack of controls, can be useful in either gaining or dissipating heat where it is necessary."/No. 101.

LEFT/Russell Claxton, Kent Bell, Tom Ferry/University of Texas-Arlington/Title: Community Resource Center/Site: Arlington, Texas/According to the students, designers in the Arlington area are primarily concerned with problems of heat gain; the challenge is to keep buildings comfortably cool during the major portion of the year. Their project employs earth berms and site vegetation to advantage. The students state: "Constraints encountered in energy conscious design offer exciting form-giving opportunities. Decisions regarding form are logically based, not arbitrary matters of taste or doctrine; as the four-wheeled vehicle changed with the advent of internal combustion engines, so will buildings change with energy conscious design."/No. 98.

RIGHT/Ron Hagood, Dennis Gant, James Wallace, Faisal Richani/University of Texas, Arlington/Titles: Community Resource Center/Site: Arlington, Texas/Illustration shows a part of the center's floor plan. North-facing, triple-pane windows allow little heat gain. Exterior walls are 12 in. thick. The design of the building followed extensive data-gathering on massing and heat infiltration./No. 100.

HOT/ARID

/KYTHERM CONCEPT

LEFT/Mark Browning/Miami University/Title: A Boy's Home/ Site: New Oxford, Arizona/Illustration of the "Skytherm Concept," described by the student as a method to eliminate the high transmission of heat through the roof caused by solar radiation. Water is pooled on the roof at night for evaporative cooling, convection and radiation. In the morning, the cool water is stored in a PVC-lined flexicore for cooling. There is a constant flow of water during the day to prevent heat build-up./No. 64.

RIGHT/Steve Morgan, Kid Jameson, Kenneth Neill, David Petton/University of Texas, Arlington/Title: Community Resource Center/Site: Arlington, Texas/"Through the use of landscaping and depressing the building itself, we were able to significantly cut down on the amount of heat gain and loss without affecting the aesthetic interaction of interior and exterior spaces."/No. 99.

ABOVE/Polytherm Group/California State Polytechnic University (Pomona)/Title: Polytherm/Site: Pomona, California/An actual building was constructed in this project using a concrete shell 56 ft. long and 11 ft. wide. The skytherm technique of radiant heating and cooling is used. Water bags cover the roof of the building resting on a flat metal deck. The pond traps solar heat in the winter and, at night, radiates it through the building. In summer the system is reversed./No. 32.

TOP RIGHT/Craig Smith/California Polytechnic State University (San Luis Obispo)/Title: Community Resource Center/Site: Atascadero, California/Drawing shows orientation of building for natural ventilation and cooling with optimum view and sufficient solar gain for winter heating. In his project statement the student writes: "This energy conscious design problem involved itself with very few trade-offs. It used its system to express a new source and a new means by which to survive in the present state of energy addiction." This entry arrived late, through no fault of the student, and could not be considered by the jury./No. 29.

BOTTOM RIGHT/David Gilmore/California Polytechnic State University (San Luis Obispo)/Title: Community Resource Center/Site: Atascadero, California/The student discovered design opportunities in his solution: "Instead of a de-emphasis of the power system, I chose to accentuate the mass and form of the two systems. I developed the rock wall as sort of 'ruins' around which my spaces are gathered, protected and fed heat and coolness when necessary. Entering from the parking lot, the user approaches the solar air collector passing beneath it into a landscaped activity plaza. From here three avenues of pedestrian travel can be observed. This sequence of space would not have been possible had it not been for the passive system approach to energy conscious design." This entry arrived late, through no fault of the student, and could not be considered by the jury./No. 30.

SITE UTILIZATION

TOP FAR LEFT/Edward Kobus/Catholic University/Title: Community Resource Center/Site: Scottsdale, Arizona/ According to the student: "I located pools of water on a roof plaza overlooking the mouth of the lake. Cool water is pumped from the lake to a fountain which fills the system and cools the roof. The flow of the water is regulated to respond to the amount of heat gained by the use of locks. Cool water from exposed pools at night is trapped and retained by means of telescoping insulated covers. The water changes levels on hot, sunny days."/No. 33.

BOTTOM AND TOP LEFT/Michael Eberspacher/California Polytechnic State University (San Luis Obispo)/Title: Community Resource Center/Site: Atascadero, California/In his project statement the student lists his most important energy conscious design features:

"Site Planning:

- Use of existing trees on site to provide summer sun, shading and provide windbreaks for exterior areas;
- utilize desirable views to lake and river for primary form determinant;
- use cooling breezes off lake during the summer months to cool and ventilate building;
- use of earth berms and sod roofs to increase the insulative quality of the wall and roof structure;
- use of grass and vegetation to reduce outdoor temperature build-up and minimize heat transmission.

Building:

- Separating of building into activity and complementary mechanical zones; allows either of the two mechanical systems to operate when needed and to be closed down when not needed;
- grouping of activities having similar environmental requirements to maximize mechanical systems efficiency;
- areas that do not require natural lighting have been placed underground and/or bermed.

Energy Systems:

- Use of alternative energy systems to provide for 100 percent of heating and cooling loads;
- orientation and slope of solar air collector maximizes winter radiation for space heating;
- solar water heater oriented to maximize yearly radiation to provide building's hot water supply;
- use of other energy systems to store cool night air during summer months and hot air during winter nights (rock bed regenerator, rock bed storage, bead walls)
- use of passive architectural design elements to provide additional energy saving possibilities (natural cross-ventilation, insulating greenhouse, earth berms and sod roof)."

This entry arrived late, through no fault of the student, and could not be considered by the jury./No. 31.

TOP AND BOTTOM LEFT/Scott Fischer, Tom Casazza, King Pon, Kris Vader Meer/University of Idaho/Title: Integrated Community Megastructure/Site: Troy, Idaho/Program calls for: the energy efficient design of a theoretical new community to house people and to mine, assemble and process a rare metal. This community of 20,000 people has to be a fully integrated megastructure. In this project energy is generated from the incineration of solid wastes and through solar collectors. The perspective at left shows the front of the residential complex. Beneath this is a section illustrating how ventilation is achieved by opening louvered windows and roof skylights. A neoprene gasket seals the opening to keep heat in. Heat lost from housing units also helps to heat the open core./No. 51.

TOP RIGHT/John Simon/Kansas State University/Title: Community Resource Center/Site: Lakewood, Missouri/The building is designed to maximize the use of mechanically unassisted natural ventilation. By developing a highly functional ventilation system the student asserts: "The need for a mechanical system could conceivably be reduced to only four or five extreme temperature months in the year." Heat rises from the main body of library (a high-use area) to the loft/stacks area (low-use) where it is ejected from the building by convection, exterior negative pressure or mechanical devices./No. 59.

RIGHT/Gregory Herzog/Kansas State University/Title: Student chapel/Site: Manhattan, Kansas/This non-denominational chapel is sited on the university campus within walking distance of all major dormitories. The structure is buried into the side of a hill to use the earth as an insulator. The student also makes use of natural lighting, natural ventilation and early morning occupancy hours./No. 60.

ABOVE/Paul Sehnert/University of Cincinnati/Title: Instant Housing/Site: Cincinnati, Ohio/In this program, calling for the quick erection of housing units for 500 families, the student decided to use two independent energy systems. The greenhouse maximizes solar heat gain by allowing sunlight to enter through adjustable louvers. The Trombe-Michel concrete wall (at left of tree) provides a constantly tempered environment in the bathroom and bedroom zones. Massive construction and earth berming even out the daily range of temperatures./No. 36.

LEFT/Carl Jahnes/University of Cincinnati/Title: Housing Project (75 units)/Site: Cincinnati, Ohio/The student limited his considerations to architectural exploitations of the existing site and climatic features. Seeking a low technology solution, the student ruled out solar collectors and wind power generators. Illustrated at left are an operable canopy to shield sunlight and a portion of the greenhouse which serves as an air buffer./No. 37.

BELOW/Mark Smyth/Arizona State University/Title: Community Resource Center/Site: Denver, Colorado/Detail of a west-facing window showing a protective shield to prevent unwanted sunlight from entering the building. The window is operable sash providing natural ventilation to the lobby and multi-function areas of the CRC./No. 15.

WEST

RIGHT/Mark Schaefer/University of Illinois, Chicago Circle/
Title: Redesign of Existing Library/Site: Downer's Grove,
Illinois/In his project statement the student writes: "Plants,
trees, and bushes play important roles in conserving energy
in my library redesign. The trees act as a glare filter for
those windows exposed to direct sunlight. During summer
months, these same trees help to reduce heat gain through
the windows and partially shade the roof. During winter
months, the trees, having lost their leaves, permit available
heat and light to strike the windows. The trees also absorb
street noises before they have an opportunity to enter the
building. The types of plants and bushes used on the berms
provide a perennially green cover around the building and
also reduce heat gain from direct sunlight. Trees and berms
(in addition to the low building profile) direct winter winds
up and over the building."/No. 55.

BELOW/Frank Woodliff/University of Utah/Title: Residential
Complex/Site: Salt Lake City, Utah/The student uses the sun
to achieve his goal of energy conservation by orienting the
glass areas of the dwelling units toward the south. He esti-
mates that a two-bedroom unit receives a solar input of
581,929 BTU on a clear day in January. The units are designed
with materials which emit a heat loss of only 20,000/BTU/da./
degree day. Double glazing, quarry tile and insulation are
used. Major glass areas are protected from unwanted sunlight
by using walls and overhangs. An active solar collection sys-
tem is centralized to serve several units providing space heat-
ing and cooling and domestic hot water./No. 107.

RIGHT/Paul Thomas/University of Illinois, Chicago Circle/
Title: Low Profile Standard of Living Farmstead, LOPSOL/
Site: Woodridge, Illinois/Energy conservation on this farm-
stead is achieved through the use of direct solar gain as a
heat source. Glass walls become solar valves using a bead
wall or similar system. A central fireplace produces heat
and serves as a thermal storage mass. A solar pond provides
long-term heat storage while collectors supply auxiliary space
heat and domestic hot water. The farmstead has vented roofs
to induce a stack effect for summer cooling./No. 54.

TOP, FAR LEFT/David Donnellon/University of Detroit/Title: St. Augustine's House/Site: Oxford, Michigan/St. Augustine's House, a facility for a religious order, is located on a sun-drenched, wind-blown hill in Oakland County. In this entry the student has created a number of intra-cluster activity spaces protected from inclement weather. He also lists a number of other energy conscious design features: "1) Creation of an inter-unit heat source for spaces needing heat; 2) garden vestibules to reduce infiltration; 3) energy production devices making community self-sufficient; 4) use of natural vegetation to protect clusters from wind."/No. 44.

BOTTOM, FAR LEFT/David Gebhardt/University of Michigan/Title: The Recycling of the Architectural Research Lab/Site: Ann Arbor, Michigan/Program calls for the recycling of an abandoned building. The materials are to be reused and the building's function is to be changed from a research lab to a student commons. Of special consideration is the incorporation of energy conscious design features. The student submitting this entry maintains that extensive glazing can be used while retaining a high degree of energy efficiency. This is accomplished by enclosing the usable space with a double envelope. The glass (or plastic) walls serve as solar collectors. The resulting heat is then channelled to either the storage medium or the lounge space in winter, or exhausted before entering the lounge space in summer./No. 67.

TOP AND BOTTOM, LEFT/Sunchai Keuysuvan/University of Michigan/Title: Community Resource Center/Site: Ann Arbor, Michigan/The top drawing shows the large solar collector as part of the wall system. The student explains: "The collector has been treated as a wall system instead of a roof system because of its large size. There is a substantial saving of southern wall material while still meeting zoning and code requirements. The collector's impact on the design is significant and determines much of the plan layout (see section drawing on bottom). The library is the most suitable facility to place in the affected area. The function of the library requires flexibility and is used by the largest number of people."/No. 68.

TOP AND BOTTOM, LEFT/Tom Stohlman, Jr./Massachusetts Institute of Technology/Title: Friends' Community/Site: North Easton, Massachusetts/A central masonry core is employed to provide a seasonal heat storage system. The winter heat of the sun is stored and routed through the core. Kitchen heat can also be stored in the core. The stored heat stratifies into the upper portions of the core where, in winter, it is forced into rooms or, in summer, is vented, drawing cool outside air into the house by thermal siphon./No. 63.

ABOVE/Ann Rossbach-Munch/Massachusetts Institute of Technology/Title: Friends' Community/Site: North Easton, Massachusetts/The farmhouse is centered around a hearth located in the center of the home. The hearth is a symbol of family involvement which is in keeping with the doctrines of the Friends. The student writes: "The Friends' Community should be an intentionally spiritual community. The architect should encourage community, harmony, equality and simplicity as he encounters the land. The built environment should enrich the Friends' involvement with the land and with themselves."/No. 62.

LEFT/Eric Noble/Massachusetts Institute of Technology/Title: Friends' Community/Site: North Easton, Massachusetts/The diagram shows the collection of solar radiation in a typical dwelling unit in the Friends' Community. According to Noble: "Incoming radiation is intercepted, stored and reradiated by three elements: a masonry wall parallel to the south facade, low walls filled with containers of water behind the glazing in living spaces, and double layers of gypsum board on ceilings and high wall surfaces to which the sun is reflected. Warm air is transported to the north side of the unit through the masonry wall."/No. 61.

SECTION

BELOW/Gary Woodall/City College of the City University of New York/Title: Primary School/Site: City Island, Bronx, New York/The student states: "This building is based on a total environmental concept. It is oriented to take advantage of the prevailing winds enabling it to be naturally cooled during the summer and naturally warmed during the winter. Approximately 20 percent of the total exterior is exposed to the north. It is designed for a U factor of $U = .05$ for the roof and $U = .10$ for the walls. All glass is a high-performance, heat-reflective. The lighting fixtures remove and transfer heat from the lights as well as the rooms. Solar collectors are used as daytime collectors and nighttime radiators. A glass vault over an open court is opened at each end to provide natural ventilation."/No. 38.

ABOVE/John Guenther/University of Kansas/Title: Juvenile Shelter Home/Site: Liberal, Kansas/This building is seen as an alternative to Seward County's problems in aiding wayward youths. At present, according to material in Guenther's entry, only the county jail is available for short-term detention of lawbreakers. The community would benefit, he suggests, from development of a short-term residential facility. The section shows natural ventilation through interior spaces./No. 57.

LEFT/Tony Chapman, Scott Davies/University of Kansas/Title: Multi-Service Neighborhood Center/Site: Great Bend, Kansas/The center is envisioned as a downtown meeting and service facility for neighborhood merchants and residents. The transverse section shows a large meeting room naturally illuminated by glazed trusses overhead./No. 56.

RIGHT/David Nixon/University of Kansas/Title: Housing for the Elderly/Site: Lawrence, Kansas/Section and schematic showing interior spaces and energy system components. The studio assignment specified that units would be single story buildings, heated (and, if necessary, cooled) by solar energy. Nixon's design is substantiated by exhaustive calculations of building heat gains and losses, hot water storage requirements, and component sizes./No. 58.

- 1 motorized valve
- 2 expansion tank
- 3 globe valve
- 4 electric submersible heat exchanger
- 5 hot water tank
- 6 synchronous inverter
- 7 kal-wal vaulted skylights
- 8 pump
- 9 controller
- 10 jacob's wind generator
- 11 storage tank for cleaning

LEFT/David Baker/University of California, Berkeley/Title: State Office Building/Site: Berkeley, California/The student's goal is, as he states it, "to deliver 100 percent of the heating by natural (sunshine, heat of people) or incidental (heat of light) means." By eliminating auxiliary heating systems, users are forced not to depend on switching on mechanical heat. Insulating shutters on windows can be closed and the proper orientation of windows can result in effective heat collection. The student's approach is to "admit the sunlight, then provide ways to deal with it." Immediately behind much of the glass in the building is a concrete wall which absorbs much of the radiation. In all areas where people work, direct sunlight can be completely excluded or baffled by insulating doors. "The whole building functions as a solar collector. The excess solar heated air is collected by ducts at the high points of the building and used to warm a stone bin for later redistribution as needed to the individual spaces. Volume control dampers allow each space to be a separate zone. The use of landscape office planning reduces the number of zones simplifying the whole system. Ventilation and cooling are accomplished by opening the windows. If more cooling is desired, air drawn through a buried metal pipe is blown into the space. The effectiveness of this scheme depends on the surface area of the pipe and the thermal conductivity of the soil, which varies from place to place."/No. 27

NATURAL COOLING

LEFT/L. B. Dickenson/University of Virginia/Title: Branch Library (for 80,000 volumes)/Site: Albemarle County, Virginia/"The natural cooling concept is to bring outside air into the building through an underground pipe, where it loses heat to the constant 55° F. ground. The air would be collected in a cool sink until the stacks require the cooler air in addition to the ventilation to achieve a comfortable thermal environment."/No. 111.

EIGHT/Kerry Haber/University of Virginia/Title: Community Resource Center/Site: Charlottesville, Virginia/Site analysis for this project proved to be a major energy conscious design feature. A neo-classical railroad station (lower right hand corner) provides the backdrop to a planned pedestrian mall. The CRC is sited to complement the existing urban design and to employ energy conserving techniques. According to Haber: "... The CRC is viewed as an extension of the pedestrian mall, as opposed to an object placed at the end of the mall and separate from it."/No. 109.

LEFT/Lawrence Chu & Carl Franceschi/Cornell University/Title: Community Resource Center/Site: Boston, Massachusetts/The illustration shows an interior isometric. (A) Points to a cooling system designed to remove excess hot air by an exhaust fan mounted at the top of the pier. (B) Shows a cut-away of rock-filled pier which serves as a passive solar heating system. A large glass wall inclined southward is supported by the piers. (C) Is an auxiliary heating system./No. 43.

RIGHT/Donald Hasulak, Richard Herzer, Thomas Thi, Fred Weber/Cornell University/Title: Community Resource Center/Site: Ithaca, New York/The concept of this CRC is, as the students explain, "to provide a highly insulated floor. The walls are buried and the only exposed surface, the roof, is controlled by a system of rotating panels. The panels consist of two metal plates (one aluminum, one black anodized aluminum) which surround an insulating fiberboard core. By adjusting the angle of incidence, this panel system can reflect, absorb or store solar energy."/No. 42.

TEMPERATE

RIGHT/Robert Zandi/Ball State University/Title: Office and Warehouse Facility for R. W. Pool, Inc./Site: Valparaiso, Indiana/Within a tight construction budget, the purpose of this project is to demonstrate that an architect concerned about energy conservation can design a facility and not increase first costs. The main energy conscious design concept is to use the earth as a cooling and insulating envelope for the building. Spaces are organized according to their need for thermal control (see diagram on organizational concept at right). Those spaces needing no control serve as heat sinks from which heat and chilled air can be drawn. Assuming a constant price of fuel, this design is calculated to save \$99,500/yr. on fuel costs. The first cost increase is \$377,000./No. 22.

LEFT/Curtis Estes/The Rhode Island School of Design/Title: "The Natural House Revisited and Redesigned"/Site: Barrington, Rhode Island/Section through the house showing a vertical energy core. The student describes the core as, "rising through the house like a column and becoming the 'heat' of the house with other mechanical systems the appendages." The core stores heat from solar collectors and acts as a tower for the windmill./No. 85.

RIGHT/Kari Vilamaa/Ball State University/Title: Community Resource Center/Site: Indiana/In his project statement the student writes: "I don't believe it is enough to say, 'Sure, let's bury the building and throw some solar collectors on the roof' without considerable thought about what types of activities are being buried or how the collectors perform functionally and, most important, become a total design commitment. Energy conscious design will be successful only if applied at all levels and only if the facility allows the occupants to function efficiently and comfortably, thereby making a better total-design solution."/No. 23.

LEFT/Robert Parker/Virginia Polytechnic Institute and State University/Title: Junior Training Center for Mentally Handicapped Children/Site: Portsmouth, Virginia/According to Parker: "The sun roof system serves as a radiant heat collector, providing alternative supplemental heat to the mechanical units located in the same area. The skyroof also allows natural sunlight to pass into the building, decreasing the dependence on artificial light sources."/No. 108.

RIGHT/Fa-An Tan/Texas Tech University/Title: All American Life Insurance Company/Site: San Francisco, California/According to the student: "All the design details, such as vents, windows and skylights, should be adjustable to meet changes in weather and human needs." Illustrated at right is a greenhouse designed to balance inside and outside temperatures./No. 95.

TEMPERATE

LEFT/Bernie Johnson/University of Idaho/Title: Integrated Community Megastructure/Site: Troy, Idaho/Program calls for the energy efficient design of a theoretical new community to house people and to mine, assemble and process a rare metal. This community of 20,000 people has to be a fully integrated megastructure. The prevailing winds are the primary form generating factor. The need to effectively ventilate the structure determined the spiral layout./No. 53.

RIGHT/Putu Kamayana/Rensselaer Polytechnic Institute/Title: Community Resource Center/Site: Troy, New York/This CRC uses the nearby river to heat and cool building along with solar collectors on the south wall. Juror Henry Wright praised the juxtaposition of windows and collectors on the south wall. The student estimates that energy considerations increased first costs 20-30 percent but will reduce life-cycle cost by 50 percent./No. 84.

RIGHT/Christon Kellogg/Boston Architectural Center/Title: Mixed use development/Site: Lexington, Massachusetts/This project includes schemes for apartments and commercial facilities. The section diagram shows concepts for cooling and heating of residential spaces. From Kellogg's statement: "The wall contains all utilities; it is insulated and stores heat or cold. Above each structural bay, large fans remove heated air from the greenhouse and force it into the wall cavity. Cool night air is stored in the wall in summer. Infiltration of cool outdoor air through the store entrances should keep air in those spaces reasonably comfortable. In summer the glass skin opens everywhere to capture prevailing breezes."/No. 24.

FAR RIGHT/Scott Richardson/Boston Architectural Center/Title: Community Resource Center/Site: Boston, Massachusetts/The student designed his building to expand as the community which it serves grows in population. In his project statement, the student writes: "This is the type of building which grows with the community and my design reflects this anticipated growth. There are several bays and half-bays that can be walled-in using overhangs on windows and incorporating existing design ideas. When the building is expanded it will form two trapezoids joined by the display area, so that the energy design will not become obsolete by adding to the building."/No. 26.

LEFT/C. Philip Davis/Oklahoma University/Title: Community Resource Center/Site: Norman, Oklahoma/The CRC is oriented 23° east of south (north-south axis through the central circulation lobby) to follow the contours of the site, saving energy for earth-moving equipment. A large canopy covers an outdoor area south of the building allowing the winter sun to enter through the use of louvers. Summer solstice is reflected protecting the south-facing windows from unwanted solar gain./No. 81.

RIGHT/Ken White, Hank Coffin, Gregory Hill, Steve McDonald/Boston Architectural Center/Title: Suburban House/Site: Boston, Massachusetts/A live-in greenhouse which coordinates the life style of the interior with the exterior environment is the goal of this project. The students list the most important energy conscious design features: 1) Providing a thermal blanket on the southern exposure through use of a greenhouse and solarium; 2) thermal 18 in. time-lag wall on the southern exposure; 3) free standing solar collectors at back of reflective roof to reduce thermal massing and increase efficiency."/No. 25.

LEFT/William Andrews, John Bourdo, Carla Cooper, Scott Doellinger/Ohio State University/Title: International Student Center/Site: Columbus, Ohio/Explaining the HVAC system, the students write: "The flat plate collectors are oriented to receive maximum sunlight during the critical winter months. By a simple air convection system, the warmed air in the collector plenum rises to the top of the large rock storage tube. As heat is absorbed by the 'heat sink' effect of the rocks, the resultant cooler air falls to the bottom of the tube, only to return to the solar collector for reheating. The air system is not limited by boiling points and freezing points, and expensive plumbing."/No. 80.

RIGHT/Mark Welytok/University of Arkansas/Title: Community Resource Center/Site: Fayetteville, Arkansas/Diagram illustrating adjustable louvers. The sunlight to all interior spaces is controlled in winter and summer./No. 17.

TEMPERATE

LEFT/Richard A. Daley/Columbia University/Title: Resort for Low Income Workers/Site: Catskill Mountains, New York/Shown is a section through a typical dwelling unit. The primary energy conserving features include burying the structure into the ground, using the soil as roof insulation and using solar heat collectors. An extensive climatological study was done for the catskills area before approaching the problem./No. 41.

RIGHT/Martin Thomason, Mike McGowan/University of Arkansas/Title: Community Resource Center/Site: Fayetteville, Arkansas/"Built like a building, designed like a vegetable." This project used solar radiation patterns as the primary form determinant. The building "practically designed itself," according to the students who go on to explain that in much the same ways as a vegetable seeks sunlight to grow, this building is designed to use sunlight in the most energy efficient manner./No. 16.

LEFT/Robert Yennerell/University of Notre Dame/Title: Community Resource Center/Site: South Bend, Indiana/The student states: "Earth berms extend halfway up the walls on three sides of the building for increased insulation. Large roof overhangs shade windows from hot summer sun. The goal was to design a building using 'passive' means; costly 'active' systems were not considered."/No. 78.

RIGHT/Charles Marqua/University of Notre Dame/Title: Community Resource Center/Site: Southbend, Indiana/This design uses a minimal envelope approach. The problem of circulation was solved through the use of an open plan solution with a functional core in the center. The building is partially buried, covered on the northern exposure./No. 77.

RIGHT/David Scherry/University of Notre Dame/Title: Community Resource Center/Site: Southbend, Indiana/The design approach "...entails the development of a building assuming conventional mechanical systems, i.e., no use of solar or other alternative energies. The building assumes a low profile using the insulation qualities of the earth (the main floor is buried 6 ft.). Windows are protected from summer solar heat gain by overhanging roof lines."/No. 79.

LEFT/Raymond Urban/Harvard Graduate School of Design/
Title: Friends' Community/Site: North Easton, Massachusetts/
"The first criteria of any architecture is: Does it enhance the
basic quality of life for people? I see my design as a rich, ame-
nity-filled place for people to live that happens to use energy
in a frugal and sensitive way."/No. 47.

RIGHT/Peter Arendt/Harvard Graduate School of Design/
Title: Friends' Community/Site: North Easton, Massachusetts/
Section detail of a housing unit: (1) Frame supporting collector
doubles as sunshade to be used as base for trellis (summer) or
greenhouse (winter). (2) Patio has reflective surface. (3) South
window-wall system. (4) Built up roof with 9 in. insulation. A
vacuum tube solar collector is used for domestic hot water
heating./No. 48.

TEMPERATE

BOTTOM PANELS/Philip Bona, Robert McCullough/University
of California, Berkeley/Title: Solar Energy Research Institute/
Site: Berkeley, California/Illustrated in the bottom left panel
is the lobby area of the building which comprises the central
circulation core. The central circulation core combines verti-
cal and horizontal movement throughout the four main levels
allowing a greater diversity of public interaction. It also
allows natural light to the interior of each level. A detail
of the "elevator" heat pump is shown in the bottom right panel.
The greenhouse acts as a solar collector which absorbs daily
radiant heat and transfers it to the hot rock storage unit by
means of an elevator heat pump. This heat pump consists of a
hydraulic-tracked plexiglass cylinder. This entry arrived late,
through no fault of the students, and could not be considered by
the jury./No. 28.

CENTRAL CIRCULATION CORE
Lobby

ABOVE/Located between a women's dormitory on the left and
the University Art Museum on the right, the building is within
walking distance of campus activities and within easy access of
the BART rapid transit system. The floor area is 15,173 sq. ft.
and the building has five levels.

RIGHT/Dennis Orlowski/University of Washington/Title: Private Residence/Site: Seattle, Washington/Burying the house underground and massive concrete walls are the most important energy conscious design features of this project. The student saw design opportunities in putting a house underground: "I attempted to design a house that appears to be more naturally situated underground than on the surface. The massive curved surfaces are a natural response to the fluid forces of the earth. Responding to a fluid heavier than air requires a different emphasis in the ordering of design parameters."/No. 113.

LEFT/David Kammeraad/University of Washington/Title: Private Residence/Site: Seattle, Washington/Climatological considerations and siting were the primary energy conscious design features. Solar collectors were ruled out because of Seattle's "seemingly continual cloud cover." However, wind considerations became the form generator. According to Kammeraad: "The flat roofed structure created, in theory, an insulating area of air, yet allowed some air for internal circulation."/No. 114.

RIGHT/Marshall Rose/University of Washington/Title: Private Residence/Site: Seattle, Washington/According to the student: "The design concept is to take advantage of the heat conserving properties of a cubic volume. This shape seems especially well suited to relatively mild climates where average winter air temperatures are not far below ground temperature. In severe climates where the temperature differential is great low-lying bermed structures might offer better thermal solutions. Another advantage of the cubical design is that it maintains equidistance of all spaces to the central wood-burning stove."/No. 112.

10 AM
SUMMER

10 AM
WINTER

TEMPERATE

FAR LEFT/Wolfe, Beauchamp, Bridges, Frazier, Griffith, Llano, Leonard, Martinez, Rassouli, Sabella, Soltani, Taber, Wenzel, Vaillancourt, Williams/Florida A&M University/Title: Community for Thirty Living Units/Site: Gretna, Florida/This project represents the work of an entire third year design studio, most of which focuses on architectural adaptation to natural energy sources. The drawing shows uses of rain, wind and sunlight in a prototypical residence/No. 45.

LEFT/Bruce Wardell, Joseph Disponzio/University of Virginia/Title: Community Resource Center/Site: Charlottesville, Virginia/In their project statement the students write: "We have designed a new building based on old ideas. It is a building whose concept is less of an advance than it is a re-discovery of the past. It is a natural response, not overbunded with technology, which asks us to accept the environment, not ignore it." A seasonal solar screening detail is illustrated at left/No. 110.

LEFT/Glenn Wells/University of Idaho/Title: Omega Structure/Site: Troy, Idaho/This design for a residential megastructure uses deep underground spaces for long-term solar heat storage. The residential community is terraced down a hillside, as shown in the section, and heat from solar collectors is piped to underground rock beds. Wells states: "My primary goal in this project has been to heat the megastructure entirely by solar energy."/No. 52.

RIGHT/Paul Hardever/JPE Vocational Center/Title: Gothic Treehouse/Site: Doubleknit Knolls, Kentucky/According to his student statement, "It's not going to be easy." The jurors' comment: "A remarkably weak effort."

LEFT/Georgia Tech-Southern Tech Energy Conscious Design Team/Georgia Institute of Technology/Title: An Environmentally Responsive House/Site: Atlanta, Georgia/This design team developed a house which can open-up or close-in as required to cope with environmental changes without the aid of power-driven mechanical equipment. The house is designed to capture winter sunlight and shield out the hot summer sun. Bedrooms are placed around the perimeter and use cross ventilation to achieve a sleeping porch effect. Juror Thomas Vreeland commented favorably on the envelope design and termed the project's drawings, "very complete, a thorough, excellent job."/No. 46.

RIGHT/Robert Hogue, Charles Vinson/Clemson University/Title: Johnstone Solar Dormitory Complex/Site: Clemson, South Carolina/This photograph shows an aerial view of the dormitory complex. Primary energy conscious design features illustrated are sun screens, solar collector and greenhouse. This entry arrived late, through no fault of the students, and could not be considered by the Jury./No. 39.

FAR RIGHT/Wayne Johnson/Pratt Institute/Title: Community Resource Center/Site not known/Aerial view of model shows parking on the roof to conserve valuable land. Adjacent to the parking area is a roof garden which supplies vegetation used in interior for humidification. The building is streamlined to reduce wind impact and fenestration is minimized to reduce solar infiltration./No. 33.

RIGHT/George Way/University of Houston/Title: Community Resource Center/Site: Houston, Texas/The drawing at right shows a canopy of natural vegetation (wisteria) to cover the area adjacent to the southern exposure. The canopy, supported by stretched cables, would allow for shading in the summer and, after the leaves fall in autumn, would permit the sun's rays to penetrate and warm the interior. Juror Lynda Simmons stated the courtyard and canopy is "an excellent approach."/No. 49.

Section

TOP LEFT AND RIGHT/Fernando Abruna/Pratt Institute/
Title: Community Resource Center/Site: South Carolina/The purpose of this project is to create a totally responsive environment with the aid of the latest scientific and technological advances. An air pillow, located under a parking platform, is connected to double-wall inflatable spaces. As the cars move onto the parking platform, the dead weight of the cars compresses the air and forces it into the inflatable sections of the building. The more vehicles on the parking platform, the larger the inflated space. Users of the building are assumed to arrive by automobile, so the size of the building, the volume of air to be conditioned and the exposed surface are proportional to the number of people using the space. The illustration at left shows the building at minimum activity, the right drawing shows maximum. According to Abruna: "Buildings should grow and change like living organisms."/No. 82.

HOT/HUMID

RIGHT/Donald Peterson/Tulane University/Title: Community Resource Center/Site: Baton Rouge, Louisiana/According to the student, a simple plan was used to achieve energy conscious design. A low-profile configuration is bermed to reduce heat transmission and to serve as a noise buffer for library activities. Where possible, natural light is used instead of artificial lighting./No. 104.

FAR RIGHT/William Crockett/Tulane University/Title: Community Resource Center/Site: Baton Rouge, Louisiana/A significant portion of the student's design effort involved the forms and their respective energy consumptive implications. The student chose a warped trapezoidal form after studying the site and hot, humid climate of Baton Rouge. According to the student, the building's unique form gives it the potential to become a landmark for the community. He states, "The shading/structural roof is probably the most salient energy conserving aspect of the project and is intended to be the most visible to citizens of the community."/No. 105.

LEFT/Carlos Weinheimer/University of Southwestern Louisiana/Title: Community Resource Center/Site: Lafayette, Louisiana/Only the library in this CRC is provided with fixed windows and close temperature and humidity control; all other areas have operable sash. Outside air circulates above the uninsulated ceiling to provide cooling and ventilation. Insulated jalousies close automatically on extremely cold or windy days. Water is pumped from a nearby river to provide cooling roof sprays./No. 90.

RIGHT/Steve Heflin/University of Southwestern Louisiana/Title: Community Resource Center/Site: Victoria, Texas/Solar rays are absorbed by solar collectors mounted on the south facing surface of the skylights illustrated here. The collectors employ 2-ft. x 8-ft. copper sheets and rectangular copper tubes, blackened for maximum absorbing power./No. 88.

SECTION-AA

wall section

LEFT/Susan Quimby/University of Southwestern Louisiana/Title: High Rise Motor Hotel/Site: Lafayette, Louisiana/Section showing detail of internal wall air circulation. Convection forces heated air to rise through air space for eventual exhaust. All glazing for the hotel's 550 units is double-paned and shaded, with sections of operable sash for ventilation. Quimby strives to employ materials and methods that minimize the impact of Louisiana's extreme heat./No. 89.

RIGHT/Robert Messner/Syracuse University/Title: Solar Housing/Site: Owego, New York/The student states: "The southern exposure is designed to make maximum use of the winter sunlight. This is accomplished by allowing insolation through the glazed areas and collecting the remaining solar energy in semi-trapezoidal collectors covering 90 percent of the remaining southern exposure. The porches of the units have individual gardens and bands of collectors forming a horizontal slope that is rhythmically broken by the bearing walls of other horizontal bands./No. 91.

LEFT/Robert R. Green/Auburn University/Title: Community Resource Center/Site: South Alabama/Massive overhangs protect the center from direct exposure to the sun. The building is designed to accommodate the installation of solar collectors in the future. The exposed beams that extend from the ground to the top of the roof break the roof into segments in order to channel air over the roof in the summer./No. 20.

RIGHT/Dhiru Thadani/Catholic University/Title: Community Resource Center/Site: Charlotte, North Carolina/The student developed the building along a light shaft which runs east-west allowing northern light to enter. Solar panels extend over the light shaft to capture southern sunlight. The light shaft brings natural light into the exhibition/lobby space, the reading areas and administrative offices./No. 35.

LEFT/Foster Lynn/Auburn University/Title: Community Resource Center/Site: South Alabama/According to the student: "Through the manipulation of spaces, wind walls, inlets and outlets and a special wind capturing structure, this facility takes advantage of the prevailing summer winds from the south; establishing natural ventilation as a primary energy conscious design feature."/No. 21.

RIGHT/Bobby McAlpine/Auburn University/Title: Community Resource Center/Site: South Alabama/In this project, book stacks are used to shield glazed areas from direct winds in winter. Northern light is used for the study areas and reading terraces. Spaces for morning activity are located in areas with an eastern exposure.

HOT/HUMID

RIGHT/Hector Lasala/Texas A&M University/Title: Private Residence for Six/Site: Bryan, Texas/Section perspective showing operable shades on greenhouse. Lasala suggests that the shades will allow heat to be "localized for exhaust through vents to the outdoors in summer." The residence is solar heated, with flat-plate collectors installed on the roof. The section reveals pipes and ducts running beneath the second floor./No. 94.

FAR RIGHT/Clark Lundell/Texas A&M University/Title: Community Resource Center/Site: College Station, Texas/From the student's project statement: "Energy conscious design requires additional time spent analyzing site, climatic and topographic conditions. Limited mechanical intervention on the interior environment means we must expand the limits of comfort generally accepted for inhabited spaces. A greater reliance upon the use of climatically adaptive clothing, in conjunction with a climatically responsive structure (as opposed to a mechanically conditioned environment), will result in a dramatic reduction of energy consumed during the operation phase." The section shows interior spaces, recessed windows (right) and an arbor (above) for vegetation to shade roof areas./No. 92.

section

LEFT/Roney Mateu/University of Miami/Title: Community Church Center/Site: Miami, Florida/This entry uses the cross, one of the basic symbols of Christianity, to achieve both a functional and symbolic purpose. The cross is incorporated into the circulation spaces. Illustrated at left, two "rotating crosses" serve as windmills on top of the church./No. 66.

RIGHT/Eric de Neve/Texas A&M University/Title: Community Resource Center/Site: College Station, Texas/Detail showing method for ventilation and interior lighting. Areas employing artificial light and air conditioning are grouped together for efficient control. College Station's climate is classified by de Neve as "humid subtropical," with a "warm season" encompassing 274 days of the year; thus, cooling is a major concern./No.93.

LEFT/Brent Holmes, William Griffing/Mississippi State University/Title: Renovation of King Edward Hotel/Site: Jackson, Mississippi/The hotel is to be adapted for use as a continuing education center. The students write: "One of our strongest ideas involved opening the central core to natural ventilation and using individual heating/cooling controls for living units. Setting exterior walls on the east and west back into the existing structural frame also provided overhangs and shading from intense summer sun. We used roof tops for landscaped spaces, with the earth providing additional insulation. At the same time this allowed some public use of rooftops. Perhaps most importantly, the proposed redevelopment would serve to renew the entire surrounding area, and would thus save (or recycle) an existing resource."/No. 70.

RIGHT/Thomas Ballantyne/University of Houston/Title: Out-Patient Housing for Medical Center/Site: Houston, Texas/ This is one of the few submissions that suggests possibilities for use of wind generators and windmills. While Ballantyne has produced a complete design for the facility to be solar-heated (with an estimated "payback" period of 11 years), he suggests that water for the solar system could be pumped from rainwater collection areas by means of a combined wind generator (for electrical power) and windmill (for mechanical power)./No. 50.

CLOSEABLE VENTS

LEFT/Larry Albert, James Stergas/Mississippi State University/Title: Renovation of King Edward Hotel/Site: Jackson, Mississippi/The terms of the studio assignment specify that this building is to be redesigned for use as a continuing education center, serving Jackson and the entire state. From the students' project statement: "We opened the building through its middle (an existing light well) as a natural ventilation chimney. The walls just beneath the roof can be opened to draw air up through the atrium to the outside." Juror Sarah Harkness termed this an "excellent design and presentation."/No. 69.

RIGHT/Edward Stribling, Ruthie Wiley/Mississippi State University/Title: Renovation of King Edward Hotel/Site: Jackson, Mississippi/In this project the existing hotel is to be converted for use as light commercial space at street level with apartments for the elderly above. The students provide planting on the roof for increased insulation and for public garden space. They state: "The King Edward's masonry walls are almost a foot thick, providing good insulation and heat lag. Thus, HVAC equipment can be operated during off-peak periods."/No. 71.

BELOW/Susan David/University of Wisconsin-Milwaukee/
Title: Community Resource Center/Site: Mequon, Wisconsin/
In her project statement the student writes: "In this climate outdoor spaces are generally useful only a few months of the year. The addition of a glass and wood frame skin to keep out snow adds months of use to these south exposed courtyards. It also serves to keep the winter winds away from the exposed faces of the building. In summer the frames are removed and vines shade the courtyards to make them pleasant year-round spaces. The change is done manually twice yearly."/No. 115.

ABOVE AND LEFT/Phillip Tabb/University of Colorado/
Title: A Community of Ten Families/Site: Eastern Ontario/
Using the EPROM competition program (see p. 56 for program synopsis), the student's goal is to address energy concerns from a community scale. The student states: "Much of the current research and development in the areas of energy conservation and solar energy have dwelled on isolated measures or technologies and single structures or aggregate applications. Little has, unfortunately, been explored and revealed about the composition, organization, management and arrangement of groups of structures and their individual symbolisms within a given energy harmonic. It, therefore, is my primary objective to focus attention upon the elements and methodologies which combine to create a liveable, energy-responsive community comprised of several families." Within this framework a number of energy conserving concepts are used: 1)creating more efficient energy reservoirs (orientation, form, envelope, volume); 2)using energy recycling systems (water, waste, materials, heat/cooling); 3)responding directly to climate; 4)using high efficiency energy conversions; 5)smoothing out peak loads; 6)sophisticating of energy peak loads; 7)utilizing local and regional resources./No. 40.

TOP LEFT AND RIGHT/Bill Gisness/Montana State University/
Title: Community Resource Center/Site: Bozeman, Montana/
The student explains his most important energy conscious design
features: "The building is a two story, compact and rectangular
because less surface area means less heating demand. Minimum
interior walls and low ceiling also reduce heating load. At a
level of three and one-half feet the earth's temperature is a
constant 50° F. year-round which would result in an energy
savings of 60 percent."/No. 72.

BOTTOM LEFT AND RIGHT/Gerald Anderson, David Thompson/
Montana State University/Title: Community Resource Center/
Site: Bozeman, Montana/The students write: "A condensed
shape was assumed in order to lower the ratio of exterior wall
area to interior volume. The parts of the building oriented
south were exposed, while the parts oriented north were
bermed." The CRC's roof is sod-covered for pedestrian use
and for improved insulation. Slanted coffers (shown in section
at right) permit natural illumination./No. 73.

RIGHT/Donald Schuba/Miami University/Title: Boys' Home/
Site: Minneapolis, Minnesota/As a correctional home for way-
ward boys, this building would eventually house 200. Terms
of the project assigned in studio excluded use of energy systems
requiring elaborate mechanical engineering. Thus, Schuba's
design emphasizes natural ventilation and other relatively
simple measures. Section shows air movement in interior
spaces./No. 65.

FAR RIGHT/Robert Karn, Robert Gooyer/University of
Arizona/Title: Environmental Protection Model Settlement
(EPRC)/Site: Ontario, Canada/In their project statement,
the students write: "We knew that we were dealing with a
region that would require much more heat than cooling, so
we studied animals and humans living autonomously in similar
regions. We found that the basic concept was to protect, in-
sulate and share heat." The drawing shows suspended sun-
screens on southern facades./No. 14.

COLLECTOR
NOTE - ADJUSTABLE
SEE CLIMATE SUMMARY
AND FOR ANCHORAGE AND
CONSTRAINTS.

VENTILATION

RIGHT/David Hathway/Catholic University/Title: Community
Resource Center/Site: Manchester, New Hampshire/The student
stacked spaces in the CRC building in order to retard the en-
ergy waste of a horizontal building. Heat lost through ceilings
is reused in the space above. The upper level roof lines are
recessed to allow uniform lighting of the space with natural
light./No. 34.

LEFT/Mark Humphreys/Texas Tech University/Title: All Amer-
ican Life Insurance Co./Site: Des Moines, Iowa/This section
shows solar panels recessed into the interior of the building.
The heat is directed into the interior through double-pane glass.
Skylights provide indirect light. Maintenance can be done
from the interior (such as changing collector angles for the
sun)./No. 96.

LEFT/Robert Krebs/North Dakota State University/Title: New Facility for Dakota Business College/Site: Fargo, North Dakota/ This project is concerned with the reuse of existing buildings. The student explains: "Through the course of three phases, all existing facilities are renovated and proposed facilities built. Because solar energy is such a major form determinant, special attention is paid to proportion and detail. The facade of the north building is saved to emphasize the circulation tower. Materials are brick, which is similar to the existing buildings."/No. 76.

FAR LEFT/Brian Beaird/University of Arkansas/Title: Community Resource Center/Site: Christopher, Minnesota/ Perspective section of wall. In his project statement the student writes: "Walls take on a new dimension, both inside and out, depending upon the elements used in their construction. Increased insulation is essential for reducing heat transmission in summer and retaining warmth in winter. Color also has significance. The western wall should be of the brightest color to reflect heat, with the walls darkening slightly on the south and east to allow for appropriate seasonal adjustments and darkest on the north to absorb the lake breezes, which are cool in summer and warm in winter. Wall color is also important indoors; areas not directly illuminated by the sun can be brightened with reflected light."/No. 18

LEFT AND RIGHT/Gary Fowler/Tulane University/Title: Environmental Protection Model Settlement/Site: Ontario, Canada/In his project statement, the student writes: "The energy conscious program made it easier to select a concept and carry it to a logical conclusion. The design employs an efficient, integrated wind and solar energy system. My aesthetic choices were altered by a search for sleeker forms that were more frugal with surface exposure."/No. 106.

Participating students and faculty were provided with a short bibliography pertaining to energy conscious design. Although not inclusive, this list contains those works which we feel provide a basic guide to the student interested in energy conscious design. The following is a reprint of this bibliography.

AIA Energy Notebook. Washington, D.C.: American Institute of Architects. (Available through Publications Distribution Department, American Institute of Architects, 1735 New York Avenue, N.W., Washington, D.C. 20006. Order number PE 200A. Price to Schools: \$72.) A continuing information service on energy and the built environment. Covers design guides, regulations, tools and techniques, case studies, selected references. Updated quarterly. Includes 10 newsletters per year.

Clark, Wilson. Energy For Survival: The Alternative to Extinction. New York: Anchor Books, 1975. \$4.95. A well-documented overview of the energy issue with an emphasis on the need to develop alternative energy sources.

Crowther, Richard L. Sun/Earth: How to Use Solar and Climatic Energies Today. Denver: Hirschfeld Press, Inc. 1976. May be ordered through Publications Distribution Department, AIA, \$12.95. Comprehensive account of architectural adaptation to climate, with emphasis on the use of energy, amply illustrated and well documented.

Eberhard, John. "Architecture and Energy: The Need for a New Esthetic." AIA Journal, February 1976. A basic introduction to the concept of energy conscious design and a challenge to architects to respond to the need.

General Services Administration. Energy Conservation Guidelines for Existing Office Buildings and Energy Conservation Design Guidelines for New Office Buildings. Both documents are available from regional offices of GSA. \$2 per copy. The studies were done for the Public Buildings Service of GSA.

Griffin, C.W. Energy Conservation in Buildings: Techniques for Economic Design. Washington, D.C.: The Construction Specifications Institute, November 1974. (Available from AIA Publications Marketing Department, 1735 New York Avenue, N.W., Washington, D.C. 20006. \$20.) Discusses the economics as well as technical aspects of reducing energy consumption in buildings. Concepts of life cycle costing are stressed as sound business policy.

Knowles, Ralph. Energy and Form: An Ecological Approach to Urban Growth. Cambridge, Massachusetts: MIT Press, 1974. \$27.50. Deals with reducing the susceptibility of individual buildings or building groups to environmental perturbations by controlling their shape and structure, their scale and surface, volume ratio, their location and orientation, their insolation and insulation.

Olgyay, Victor. Design With Climate: Bioclimatic Approach to Architectural Regionalism. Princeton, New Jersey: Princeton University Press, 1963. \$25. Discusses the need for regionalized architectural solutions accomplished by scientific analysis and response to climatic conditions.

"Regional Climate Analysis Design Data: The House Beautiful Climate Control Project." Bulletin of the American Institute of Architects, September 1949 - January 1952. (Available from Xerox University Microfilms, 300 North Zeeb Road, Ann Arbor, Michigan 48106. Softcover reprint-\$28.40; hardcover reprint-\$31.40; microfilm-\$9.50. Order by number: PB 00272.) Presents climatological and design data on a regional basis throughout the country. Emphasis is on residential construction but the data are applicable for other building types.

Robinette, G.O. Plants/People/And Environmental Quality. A study for the National Park Service, U.S. Department of Interior in collaboration with the American Society of Landscape Architects Foundation. Washington, D.C.: Government Printing Office, G.P.O. No. 129.2: P69. \$4.35. Graphically refreshing, this study of plants and their environmental functions has a healthy section on how plants can be used to provide human comfort, both inside and outside a building, under various climatic conditions.

Steadman, Philip. Energy, Environment, and Building. A report to the Academy of Natural Sciences of Philadelphia, Pennsylvania. New York: Cambridge University Press, 1975. \$5.95. A comprehensive survey of methods of the conservation of energy in buildings, new sources of energy for building, and ways buildings may be designed to have less destructive impact on the natural environment.

The book, Performance Guidelines for Planning Community Resource Centers, an AIA/RC publication, was sent to schools using the CRC program.

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2	Kansas State Univ.	Bilski	De Vilbiss	9	3	14
3	Univ. of Mich.	Mardirosian, Van Duren	Oppermann	12	5	20
4	Univ. of Wis.-Milw.	Kraft	Schade, Jules	16	5	26
5	Rensselaer Poly. Inst.	Gleason, Stinson, Capelli, Sadowsky	Rodman	16	4	32
6	N.Y. Inst. of Tech.	Berthold	Bentel	12	5	38
7	Harvard/MIT	Triantafillou	Lord, Johnson	16	6	44
8	Iowa State Univ.	Greco	Crites, Kocimski	10	6	50
9	Lawrence Inst. of Tech.	Cobb, Licata, Percha	Powell	15	4	56
10	Univ. of Colo.-Boulder	Watson, Flehmer, Shimokawa, Flynn	Tabb, Nagel	10	5	62
11	Ohio State Univ.	Stough, Oberg, McLoney, Skirball	Clark	6	5	68
12	Univ. of Calif.-Berkeley	Siegel, Lowry	Hirshen	6	6	74
13	Univ. of Ariz.	Couturier, Allen	Medlin	11	4	83
14	Univ. of Ariz.	Karn, Gooyer	Medlin	14	4	112
15	Ariz. State Univ.	Smyth	Elmore	12	5	89
16	Univ. of Ark.	Thomason, McGowan	Lambeth	10	3	99
17	Univ. of Ark.	Welytok	Lambeth	10	3	99
18	Univ. of Ark.	Beaird	Karp	--	4	113
19	Auburn Univ.	McAlpine	Baxley	5	1	107
20	Auburn Univ.	Green	Wilkerson	5	2	107
21	Auburn Univ.	Lynn	Plaxco	5	2	107
22	Ball State Univ.	Zandi	Wyman	21	4	96
23	Ball State Univ.	Vilamaa	Macindoe	5	4	96
24	Boston Arch. Ctr.	Kellogg	Keck	5	3	98
25	Boston Arch. Ctr.	White, Coffin, Hill, McDonald	Papesch, Wetzel	5	2	98
26	Boston Arch. Ctr.	Richardson	Keck, Webster, Larson	5	4	98
27	Univ. of Calif.-Berkeley	Baker	Dean	6	5	94
28	Univ. of Calif.-Berkeley	Bona, McCullough	Dean, Hirshen	--	--	101
29	Calif. Poly. State Univ.	Smith	Haggard	8	4	86
30	Calif. Poly. State Univ.	Gilmore	Haggard	9	4	86
31	Calif. Poly. State Univ.	Eberspacher	Haggard	8	1	87
32	Calif. Poly. Pomona	(Entire studio)	Cavin	--	--	86
33	Catholic Univ. of Am.	Kobus	Sachs	4	4	87
34	Catholic Univ. of Am.	Hathway	Sachs	4	4	112
35	Catholic Univ. of Am.	Thadani	Sachs	4	4	107

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37	Univ. of Cincinnati	Jahnes	Smith	9	5	89
38	City College of New York	Woodall	Deans	13	3	93
39	Clemson Univ.	Hogue, Vinson	Davis	--	--	104
40	Univ. of Colo.-Boulder	Tabb	--	--	6	110
41	Columbia Univ.	Daley	Schwarting	6	5	99
42	Cornell Univ.	Hasulak, Herzer, Thi, Weber	Crump	3	4	95
43	Cornell Univ.	Chu, Franchesi	Crump	4	3	95
44	Univ. of Detroit	Donellon	Rombos	32	6	91
45	Fla. A&M Univ.	(Entire studio)	Genova	15	3	103
46	Ga. Inst. of Tech.	(Entire studio)	Clarke	15	6	104
47	Harvard Univ.	Urban	Lord	16	6	101
48	Harvard Univ.	Arendt	Lord	14	6	101
49	Univ. of Houston	Way	Rifaat	8	5	104
50	Univ. of Houston	Ballantyne	Bezman	12	4	109
51	Univ. of Idaho	Fischer, Casazza, Pon, Vander Meer	Bancroft	13	3	88
52	Univ. of Idaho	Wells	Eder	4	3	103
53	Univ. of Idaho	Johnson	Eder	9	3	97
54	Univ. of Ill./Chi. Cir.	Thomas	Whitmer	16	4	90
55	Univ. of Ill./Chi. Cir.	Schaefer	Whitmer	20	4	90
56	Univ. of Kansas	Chapman	Burgess	5	2	93
57	Univ. of Kansas	Guenther	Griffin	7	4	93
58	Univ. of Kansas	Nixon	Dean	15	4	94
59	Kansas State Univ.	Simon	De Vilbiss	9	3	88
60	Kansas State Univ.	Herzog	De Vilbiss	9	3	88
61	Mass. Inst. Tech.	Noble	Johnson	12	4	92
62	Mass. Inst. Tech.	Rosbach-Munch	Johnson	12	3	92
63	Mass. Inst. Tech.	Stohlman	Johnson	14	4	92
64	Miami Univ.	Browning	Moore	9	3	85
65	Miami Univ.	Schuba	Moore	9	3	112
66	Miami Univ.	Mateu	Orr	12	4	108
67	Univ. of Mich.	Gebhardt	Oppermann, Lytle, Hanamura	15	6	91
68	Univ. of Mich.	Keuysuvan	Oppermann	6	5	91
69	Miss. State Univ.	Albert, Stergas	Ford, Ruth	7	3	109
70	Miss. State Univ.	Holmes, Griffing	Ford, Ruth	7	3	109
71	Miss. State Univ.	Stribling, Wiley	Ford, Ruth	7	3	109
72	Montana State Univ.	Gisness	Wyatt	10	2	111

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74	Univ. of New Mexico	Moreno, Woods, Aquino	McConnell	5	2	83
75	Univ. of New Mexico	Swenson, Duhon, Carroll	McConnell	5	2	83
76	N. Dak. State Univ.	Krebs	Hatlen	12	4	113
77	Univ. of Notre Dame	Marqua	Featherstone	5	4	100
78	Univ. of Notre Dame	Yennerell	Featherstone	5	4	100
79	Univ. of Notre Dame	Scherry	Featherstone	5	4	100
80	Ohio State Univ.	Andrews, Bourdo, Doellinger, Cooper	Clark, Coddington	6	5	99
81	Univ. of Oklahoma	Davis	Yeh	8	6	98
82	Pratt Institute	Abruna	Lionni	12	5	105
83	Pratt Institute	Johnson	Porter	12	1	104
84	Rensselaer Poly. Inst.	Kamayana	Rodman	9	4	97
85	R.I. School of Design	Estes	Fink	12	2	96
86	So. Calif. Inst. of Arch.	Heinmiller, Paris	Simonian	5	6	82
87	So. Calif. Inst. of Arch.	Mursinna, Coffee, Lavee	Simonian, Glassman	5	2	82
88	Univ. of S.W. Louisiana	Heflin	Mross	8	3	106
89	Univ. of S.W. Louisiana	Quimbly	Mross	8	3	106
90	Univ. of S.W. Louisiana	Weinheimer	Mross	8	3	106
91	Syracuse Univ.	Messner	Scarbrough	9	4	106
92	Texas A&M	Lundell	Zweig	5	5	108
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94	Texas A&M	Lasala	Zweig	3	6	108
95	Texas Tech	Tan	Watts	4	3	97
96	Texas Tech	Humpheys	Watts	4	3	112
97	Texas Tech	Sailor	Watts	7	3	82
98	Univ. of Texas at Arlington	Claxton, Bell, Terry	Higgs	14	4	85
99	Univ. of Texas at Arlington	Morgan, Jameson, Neill, Petton	Higgs	10	4	85
100	Univ. of Texas at Arlington	Hagood, Gant, Wallace, Richani	Higgs	10	4	85
101	Univ. of Texas at Austin	Pommier	Dodge, Arumi	20	5	84
102	Univ. of Texas at Austin	Crook, Sarela, Shepherd	Dodge, Arumi	20	6	84
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106	Tulane Univ.	Fowler	Dean	7	3	113
107	Univ. of Utah	Woodliff	Brandle	13	--	90
108	Virginia Poly. Inst.	Parker	Egger	10	4	97
109	Univ. of Virginia	Haber	Dougald	4	5	95
110	Univ. of Virginia	Wardell, Disponzio	Dougald	4	5	103
111	Univ. of Virginia	Dickenson	Dougald	8	4	95
112	Univ. of Wash.-Seattle	Rose	Hildebrand	10	5	102
113	Univ. of Wash.-Seattle	Orlowski	Hildebrand	10	5	102
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NEW DESIGN CONCEPTS FOR ENERGY CONSERVING BUILDINGS

Results of a National Competition Among
Students in Schools of Architecture

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with support from the Federal Energy
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ABOVE/Percha, Cobb, Watson, Vonier,
Licata, Smeallie

This book publishes the entries to a national competition for energy conscious design among students in schools of architecture. Full credit should go to the hundreds of enthusiastic and industrious architecture students who invested their energy in preparing and submitting the entries which serve as the substance of this book.

Peter Smeallie, of the AIA/RC staff, acted as director of the competition and, along with Tom Vonier, also of AIA/RC staff, managed the production of this book. Margot Villecco provided editorial supervision. The mechanical work was laid out with the assistance of Tim Leahy. Manuscripts were prepared by Carolyn Tooles.

Alan Cobb, Ric Licata, August Percha and Russell Watson — some of the students whose work was selected as distinguished by the jury — spent a summer as interns with the AIA Research Corporation to assist in preparation of this book. They gave generously of their time and maintained the high level of enthusiasm and concern necessary to complete the work.

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