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NOVEMBER/DECEMBER 1985 · CCAIA · VOL. 5, NO. 6

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CONTENTS

Fairfax Regional Library, Fairfax Architect: Bull Volkman Stockwell

Wayne Thom

IN THIS ISSUE/ARCHITECTS IN SPACE

DEPARTMENTS

COVER

Extravehicular activity along the hand rail system of the *Challenger.* Astronaut: F. Stary Musgrave. Photograph: NASA.

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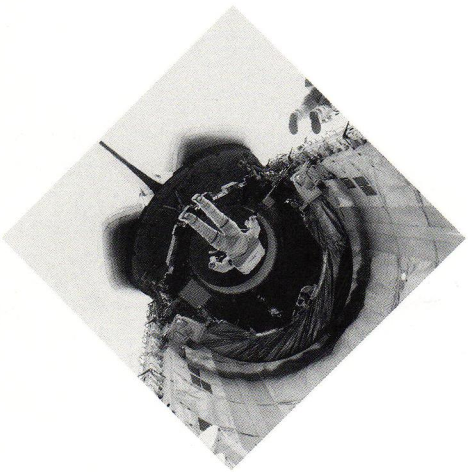
A Vocabulary for Space



Humans have lived in space for over 20 years. So far, our space habitats have been machines designed solely to enable life to exist in the quintessential hostile environment. But the primitive metal capsule is evolving to accommodate the growing number of people who are shuttling into space for extended tours of duty on behalf of their military/industrial sponsors. At NASA's request, a handful of aerospace companies are designing schemes for a space operations center—our first space station.

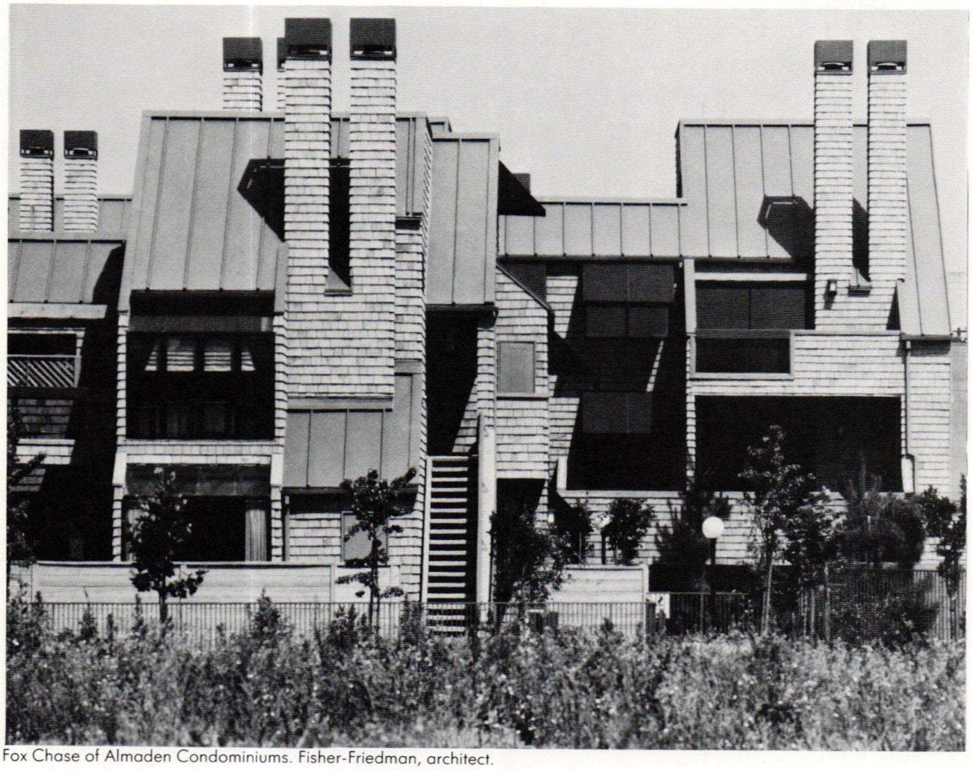
Architects are surprisingly active on the multidisciplinary teams designing these schemes. These pioneers are adapting the principles of architecture to an environment where "up" is a matter of definition. In the process, they are sculpting the building blocks that will be used to construct the ultimate urban environment, the space colony.

Shortly after *Pioneer 10* became the first Earth-made object to leave our solar system, astronomers announced the possible discovery of another solar system around Vega, the fifth brightest star in our sky. Whether humans are able to follow their imagination and technology into other reaches of the universe depends, to a considerable degree, on how sensitive space environments are to the human psyche. The ability of our species to inhabit space is linked to the ability of our designers to create environments that enrich, as well as sustain, life.

Space architecture is interior architecture. This issue's focus on "Architecture in Space" begins inside the brain, with a review of research into the effect that environment has on brain growth. An interview with a human laboratory animal who has lived in space gives a user's perspective on space architecture. An article identifying and applying "human factors" in space habitat design inaugurates this magazine's new department on interior architecture. Other articles show two space station concepts being developed in California, and address the design and construction of architecture in the absence of gravity.

Since space architecture is just emerging as a specialized field of practice, most of the problems are unresolved—some aren't even articulated yet. The architects working to extend the built environment into the void of space are giving architecture a new vocabulary, one inspired by the future, rather than the past.

—JF



Fox Chase of Almaden Condominiums. Fisher-Friedman, architect.

Six California architects received design awards in the Red Cedar Shingle & Handsplit Shake Bureau/American Institute of Architects 1983 Architectural Awards Program. First Awards went to Fisher-Friedman Associates of San Francisco for Fox Chase of Almaden condominiums in San Jose, with Cal-West Communities as contractor; Robert Zinkhan Architect, AIA/Gary A. Tobey, for Deer Run condominiums, Santa Rosa, Afco-Wilson as contractors; The Promontory Partnership, Palo Alto, for the Lake Mendocino Interpretive/Cultural Center, Mendocino County, Pacific Western Enterprises, contractors; Bull Volkman Stockwell, San Francisco, for Fairfax Regional Library, Fairfax, Mayta & Jensen, contractors; and Dutcher & Hanf Architects, Berkeley, for The College Preparatory School, Oakland, with MGC Company, Inc. contractors. A Merit Award went to Louis E. Rodwell, Pasadena, for Evergreen Office Center, Pasadena, with H. Robert Gluck, contractor. The jury was chaired by Norman Jaffe, AIA and included Bennie M. Gonzalez, FAIA and Curtis Finch, FAIA.

Design Competition for the New American House

The Minneapolis College of Art and Design and the National Endowment for the Arts, Design Arts Program are sponsoring a national architectural design competition: A New American House. The purpose of the competition is to design housing for people who live as members of nontraditional households, such as single parent families, singles and empty-nesters. The program is for the design of urban infill housing on a site located in the Whittier Neighborhood of Minneapolis. The housing should address the need for small, energy efficient and cost saving housing units. The central design criteria is to create and integrate a studio/workspace into each housing unit as the place of principal professional activity for the resident. Registration material is available November 1, 1983, and registration deadline is January 25, 1984. Contact Harvey Sherman, Minneapolis College of Art and Design, 133 East 25th Street, Minneapolis, MN 55404, (612) 870-3238.

Architecture Department Opens in Museum

The San Francisco Museum of Modern Art has announced plans to establish a Department of Architecture and Design to collect, exhibit and educate in all aspects of the two disciplines. "At present, such a department with full-time curatorial supervision does not exist in a West Coast museum," said Henry T. Hopkins, director of the Museum. "We believe that the rich creative heritage of the West and the rapidly growing audience for the design disciplines demand the development of such a program."

The Museum will mount an exhibition entitled "California Counterpoint: New West Coast Architecture 1982," from November 3, 1983 through January 15, 1984. The exhibition features 40 models and 70 illustrations of visionary and built work by Andrew Batey and Mark Mack, Frederick Fisher, Frank O. Gehry, FAIA, Craig Hodgetts and Robert Magurian (Studio Works), Coy Howard, Thom Mayne and Michael Rotondi (Morphosis), and Stanley Saitowitz. For further information, contact the Museum at (415) 863-8800.

Traditional African Architecture Project

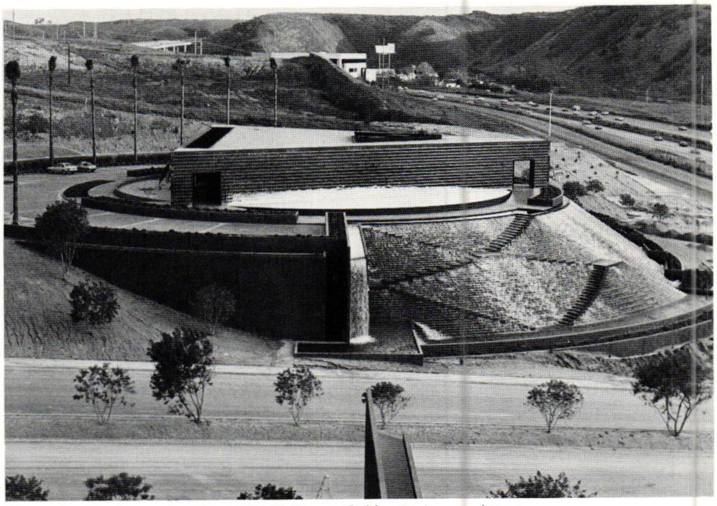
Field team members to explore and document vanishing architectural artistry in West Africa are being recruited by the University of California Research Expeditions Program (UREP). The work of major ethnic groups as expressed in diverse types of rural settlements and dwellings will be studied. Under the guidance of Professor Jean-Paul Bourdier, from the Architecture Department at UC, teams will work at representative homesteads in Mauritania, Mali, Upper Volta, Northern Togo and Benin, drawing plans of dwellings and mapping kinship relationships. Four sessions of the expedition, each three weeks long, are slated to begin in mid-January, 1984. Contact: UREP, University of California—Desk TAIA, Berkeley, CA 94720, (415) 642-6586.

Call for Presenters

CCAIA's 1984 Monterey Design Conference Committee has issued a call for presenters. Those interested in presenting their work at the Monterey Design Conference, March 30–April 1, 1984, should contact CCAIA, 1414 K Street, Ste. 320, Sacramento, CA 95814, (916) 448-9082. Deadline is December 15, 1983.

Offices of Stewart Woodward & Associates. Milroy/McAleer

Hughes EDSE Facility. Langdon & Wilson, architect.



Wateridge Marketing Pavilion. WZMH Group California, Inc., architect.

The Orange County Chapter of The American Institute of Architects recognized 15 architectural firms in its 1983 Design Award Program. Honor Awards were presented to Langdon & Wilson, Architects of Newport Beach for the 2.3 million square foot EDSG Facility in El Segundo; WZMH Group California, Inc. of Irvine for the Wateridge Marketing Pavilion in North San Diego County; and Stewart Woodard & Associates of Costa Mesa for the remodel of the firm's offices. Merit Awards were presented to Dougherty & Dougherty of Newport Beach; Bissell Architects of Newport Beach; Architects Orange of Orange; and Knowles and La Bonte Architects, Inc. of Irvine. LPA Architecture & Planning, Inc. of Orange received two Merit Awards. Honorable Mention went to David A. Price & Associates of Costa Mesa; Timothy Wilkes, AIA of Laguna Beach; Collins & Wraight, AIA of Santa Ana; LPA Architecture & Planning, Inc. of Orange; Thirtieth Street Architects, Inc. of Newport Beach; William L. Pereira Associates of Corona del Mar; Bissell Architects of Newport Beach; and Ralph Allen & Partners of Santa Ana. Serving as the jury were Marvin J. Malecha, AIA, Barbara Goldstein, Calvin C. Straub, FAIA, and Wayne Ratkovich.

CCAIA Energy Policy

The Board of Directors of the California Council, The American Institute of Architects adopted an Energy Policy Statement at its recent meeting. The Energy Policy is the work of CCAIA's Energy Committee, whose members include Wm. Stevens Taber, Jr., AIA (chair), Marvin Bamburg, AIA, Phillip Banta, Edward Dean, AIA, Anne Gummerlock, Scott Matthews, Tom McMillan, Thomas W. Menser, AIA, Thomas Tollefsen, AIA, and Clay Wardle, AIA. Charles Eley, AIA serves as consultant to the Committee, and John Hailey is an advisor. The Energy Policy states:

1. The CCAIA holds that energy policy should be based on the two principles of cost-effectiveness and effect on quality of life, and that energy use should be governed by the principle of minimum life-cycle cost from the point of view of society as a whole, taking into consideration all environmental and secondary costs.
2. The CCAIA supports the conservation of energy in the built environment and the conversion of the economy to the use of environmentally benign, renewable energy resources, because this strategy is, from society's point of view, much more cost-effective and environmentally benign than increasing the supply of fossil fuel and nuclear energy.
3. The CCAIA holds that many existing energy programs are clearly not cost-effective from society's point of view, and that existing public policy should be reviewed and revised in light of this principle.
4. The CCAIA holds that public energy policy should rely primarily on the marketplace, not on regulation, and that therefore the federal and state governments should restructure their environmental laws, tax policies, and public utilities' pricing policies to make the true and total costs of conservation and supply visible to the consumer in the marketplace. When this has been accomplished, the CCAIA holds that government intervention in the marketplace will be unnecessary and superfluous.
5. The CCAIA recognizes that these policies will require many years to implement in the construction industry, and therefore, for the present, the CCAIA supports the development and promulgation of mandatory design regulations for energy use, subject to the criteria that the standards be performance-based, be based on the principle of minimum life-cycle cost from society's point of view, and be environmentally benign. The CCAIA also holds that energy use should be a primary consideration in the development of land use policies.
6. The CCAIA supports the continued role of government in research and development, and holds that present government policy on research and development should be revised to favor conservation and renewable, environmentally benign resources over fossil fuel and nuclear energy resources.

Who's Buying Houses?

The nuclear family is still the leading homebuyer, according to the seventh annual survey of homebuyers conducted by the National Association of Home Builders (NAHB), and published in *Builder.*

- The buyer's average age is 34 years; nearly 79 percent of the heads of households are 25 to 44 years old;
- Combined household annual income is $37,131;
- The median price of the new home purchased is $74,790;
- Nuclear families make up 54 percent of new homebuyers;
- There were two or more wage earners in 56 percent of the households;
- About 35 percent of the homebuyers were first time buyers;
- The quality of insulation and energy efficiency is important to 72 percent of the buyers;
- The main source of financing the down payment is savings for 45 percent of the buyers; and
- Mortgage payment and utility costs of the new home are $923 monthly.

Shiplap Joints

The Office of the State Architect, Structural Safety Section (OSA/SSS) is revising the basis on which it accepts installations of plywood speciality siding with shiplap joints. Plywood siding using this type of edge joint is not covered in the State Building Standards, Title 24, but has been accepted by OSA/SSS as an alternate to the standard square edged joints permitted by Section 2-2514(c), Plywood Diaphragms and Tables 2-25J and K. Repeated problems with substandard nail edge distances encountered when this type of specialty plywood is spliced on the edge of two inch nominal thickness studs dictates that thicker numbers be used at shiplap edges of plywood sheets. For school or hospital projects filed with OSA/SSS after September 1, 1983, a minimum of three inch nominal thickness wood members will be required at the shiplap edge joints. For further information, contact Donald K. Jephcott, OSA, P.O. Box 1079, Sacramento, CA 95805, (916) 445-8730.

Architectural Review in Los Alamitos

The Los Alamitos City Council established an Architectural Review Committee, comprised of members of the Planning Commission, to review and approve all architectural plans and to develop standards and guidelines for the city. The enabling ordinance stated, "It is in the interest of the community to require all future development to become a compatible part of the total community environment." An architectural theme, "Early California," was chosen for the Los Angeles County community.

When the Earth Moves

"An Investigation of the Correlation between Earthquake Ground Motion and Building Performance," ATC-10, is available for $18 from Applied Technology Council, 2471 E. Bayshore Rd., Ste. 512, Palo Alto, CA 94303.

Toxic Smoke

Smoke inhalation causes most of the nation's 8,000 annual fire fatalities. The main toxic element in that smoke is carbon monoxide, emitted when wood and most other materials burn. But increasing use of plastic and other synthetic building materials, whose combustion products include hydrogen cyanide and other toxic gases, has raised the question of whether these materials heighten the danger of fire. Now a test for combustion product toxicity may identify the degree of building material toxicity.

A study by Arthur D. Little, Inc., reported in *Science News,* states that an LD_{50} test developed at the University of Pittsburgh can identify the amount of toxic gases emitted as specific building materials burn. (LD_{50} is the amount of a test sample needed to kill 50 percent of the test animals—in this case, mice—exposed to the material.) The study recommends that states require manufacturers of building and furnishing materials to submit toxicity data on these materials to a state agency, where the data could be made available to architects, engineers and the general public.

The Little study is criticized by industry officials for its failure to take into account other fire safety factors a material may possess, such as resistance to ignition, flame spreadability and extinguishability. Also, a report by the National Institute of Building Sciences contradicts the Little report, stating that tests available for combustion product toxicity are inadequate, and should not be used to promulgate codes or regulations.

But the New York state legislature currently is considering whether to adopt laws to implement the Little recommendations. That debate is being closely watched

by four other state legislatures, and could influence Congressional hearings on fire safety.

Preserving Hanford's Heritage

Renovation fever is epidemic in Hanford.

Enthusiasm for preserving the town's historic buildings began over a decade ago. Rather than demolish the Carnegie Library to make way for a parking lot, citizens of the Central Valley hamlet joined together to convert the building into the Carnegie Museum to showcase King County's history. In 1980, residents formalized their commitment to preserving the town's unique character by establishing the Historic Resources Commission to oversee the preservation of Hanford's architectural heritage.

"Twenty years ago, we used to tear things down," says Dan Christensen, AIA, the Commission's consulting architect. "Now we're going strong toward rehabilitation. People are beginning to value older things where they used to think new was good."

Hanford's six block historic district is the site of The Bastille, a stone jail remodeled as a restaurant and bar; the Victorian Inn, a specialty restaurant and hotel; the Old Phone Building, which now houses a variety of shops; Hanford Furniture, a three story building with elaborately decorated interiors; and the restored Hanford Theater, the largest single screen theater in the Valley. Even the Courthouse will get a new lease on life as a restaurant and shopping complex, complete with neighboring park and merry-go-round.

Max Walden, the developer behind many of Hanford's ambitious projects, says he originally entered the renovation business because he hated to see the disappearance of "old urban charm." In addition to capturing the flavor of small town Americana, the charm of renovated buildings is expected to act as a magnet to tourist dollars.

Developers shy away from discussing how much money is tied up in these projects, but most agree that remodeling costs are "significantly below" replacement costs. The tax benefits available for projects in designated historic districts make the economics of renovation even more attractive.

Hanford's renovation fever is far from over. Talk of a new convention center is in the air, and a proposal for renovating the Hanford Railway Depot into a communications center is being considered. "We're pretty much underway with 're-olding' the town," Christensen says. "In fact, I like to say that we're so behind now, we're way ahead of everyone else."

—Barbara Smith

A Great Service to Education

Your July/August issue is just great, a little jewel. You were able to obtain from the deans and other spokesmen from the six schools of architecture the best overall summary statements of the goals and objectives of the respective schools that I have seen, and I think it is a great service to education. And I think the statement by Joseph Esherick is more than a comment, more than a punctuation mark. His philosophy comes through and somehow adds meaning to each of the six separate statements on the California schools that might not otherwise exist.

I hope that the CCAIA has printed an extra quantity of the issue and you will be able to make it available to prospective and entry students in architecture as well as to university libraries across the country.

In other words, my admiration for a job well done.

—Elaine J. Sewell Jones
(Mrs. A. Quincy Jones)

I must congratulate you on the excellent articles on the California schools of architecture that appeared in the July/August issue. As a part time educator I believe that you have done more for architectural education in this one issue than any other article(s) that I have read. You provided reams of practical and comparative information with a minimum of pontification. Any student seriously considering an architectural career should have a copy.

Thanks again for a superb job!

—Stanley V. Goldin AIA

Tom Glass

"Frankly, I see myself as a Post-Modernist trapped in a Neo-Classicist body."

R. Buckminster Fuller

by Kelly Collins

R. Buckminster Fuller was an optimist. He believed that through improvements in technology, more goods could be produced using fewer resources, to provide adequately for the needs of all humanity. A man of action, Fuller wrote, "You can't better the world by simply talking to it. Philosophy, to be effective, must be mechanically applied."

Fuller began applying his philosophy of "more with less" to building design in 1927. His low cost, mass produced, easily installed, lightweight, readily transportable housing designs profoundly challenged conventional design theories.

The 4-D House (1928), dubbed by the press as the "House on a Pole," was a one story, hexagon-shaped dwelling hung from a central column and braced by cables. It was never built, not even as a prototype. But, Fuller's next house, the Dymaxion Deployment Unit (1944), was successfully used by the Air Force as temporary housing during World War II. The dome-shaped steel walls were designed to create an airflow, drawing the cool air underneath the house into the air vents on top. It weighed only 3,200 pounds and, including a stove and refrigerator, sold for $1,250.

Anticipating a housing shortage at the end of the war, the Air Force asked Fuller to design a house which could be built by the same factory that was making B29 airplanes. Fuller came up with his Dymaxion Dwelling Machine (1946), more commonly known as the "Wichita House" because it was first built at the Beech Aircraft plant in Wichita, Kansas. The house was perfectly round with a circumference of 118 feet, packed inside a 300 cubic foot crate for shipping, and cost $6,500. All three of these early Fuller designs employed technologies not then fully developed. None of the houses were ever marketed to the general public.

Because they were so far ahead of their time, Fuller's designs were widely criticized. The labor unions feared layoffs because the plumbing and electrical wiring were pre-installed. The construction industry saw lost profits. And at the 1929 AIA Convention, architects dismissed Fuller's designs, passing a resolution which stated, "The American Institute of Architects is opposed to any kind of house designs that are manufactured like-as-peas-in-a-pod." But Fuller was never

R. Buckminster Fuller
(1895–1983)

easily discouraged. With each new design, he realized that his ideas were being validated and taking shape.

While designing the "Witchita House," Fuller began playing with the idea of designing a map to eliminate the gross polar distortions inherent in standard mapmaking. He achieved this by deviating from the strict reliance on latitude and longitude, and by adding triangles to spread out the distortions evenly over all areas of the map. When his "Airocean World" map first appeared in the March, 1943 issue of *Life,* it was reproduced so that it could be cut out, folded and glued together to form a twenty-sided globe. During the calculations for his map, Fuller was struck with the idea that resulted in his most famous invention—the geodesic dome.

The dome's principal design is a direct manifestation of Fuller's belief that the basic building block of the universe is not the cube, but the tetrahedron (which can be thought of as a pyramid with a triangular base). "There are no square snowflakes, trees, leaves, or planets," Fuller was fond of saying. Applying his tetrahedron to building design, Fuller found in his geodesic dome a structure that was capable of evenly distributing a load no matter where it was applied. His domes proved earthquake proof, wind-resistant, lightweight, capable of spanning large areas without vertical supports, and structurally sound even under heavy snowfall.

Over 100,000 geodesic domes now exist in more than half the countries of the world. The first large scale dome was built in 1952 over the Ford Rotunda in Dearborn, Michigan. Fuller was given the commission only after Ford's own engineers had given up the project, claiming it was impossible. Since then, the geodesic dome has covered more space on Earth than any other single kind of shelter. The geodesic dome brought Fuller popular acclaim and professional recognition. Forty years after dismissing Fuller's ideas, the AIA awarded him its highest honor, the Gold Medal, in 1970.

Fuller's last great project, whose benefits and applications have yet to be fully realized, is the World Game. The Game uses a computer that is programmed with a complete inventory of the world's human and natural resources, to devise plans to meet future human needs. One World Game plan suggests building a worldwide electric grid that would allow global distribution of electric power. Power plants thus could operate at full capacity around-the-clock, delivering electric power to areas of peak demand.

To Fuller, the World Game was more than a mental exercise. He believed that intelligent management of our finite resources is essential to human survival. "Our children and their children are our future days," said Buckminster Fuller. "If we do not comprehend and realize our potential ability to support all life forever, we are cosmicly bankrupt."

Bucky's gone now. He died of a heart attack on July 1, 1983 at the age of 87, while attending the bedside of his stricken wife, Anne, as she lay in a coma. Anne followed her husband of 66 years into death two days later. Neither was left to suffer the loneliness of life without the other.

Buckminster Fuller was one of the great thinkers of our time. His vision of a future free from want, in which the Earth's resources are managed for the benefit of all its people, remains to inspire those of us still living on the planet Fuller christened Spaceship Earth.

Kelly Collins is an assistant editor at Architecture California.

UCSB Art Museum

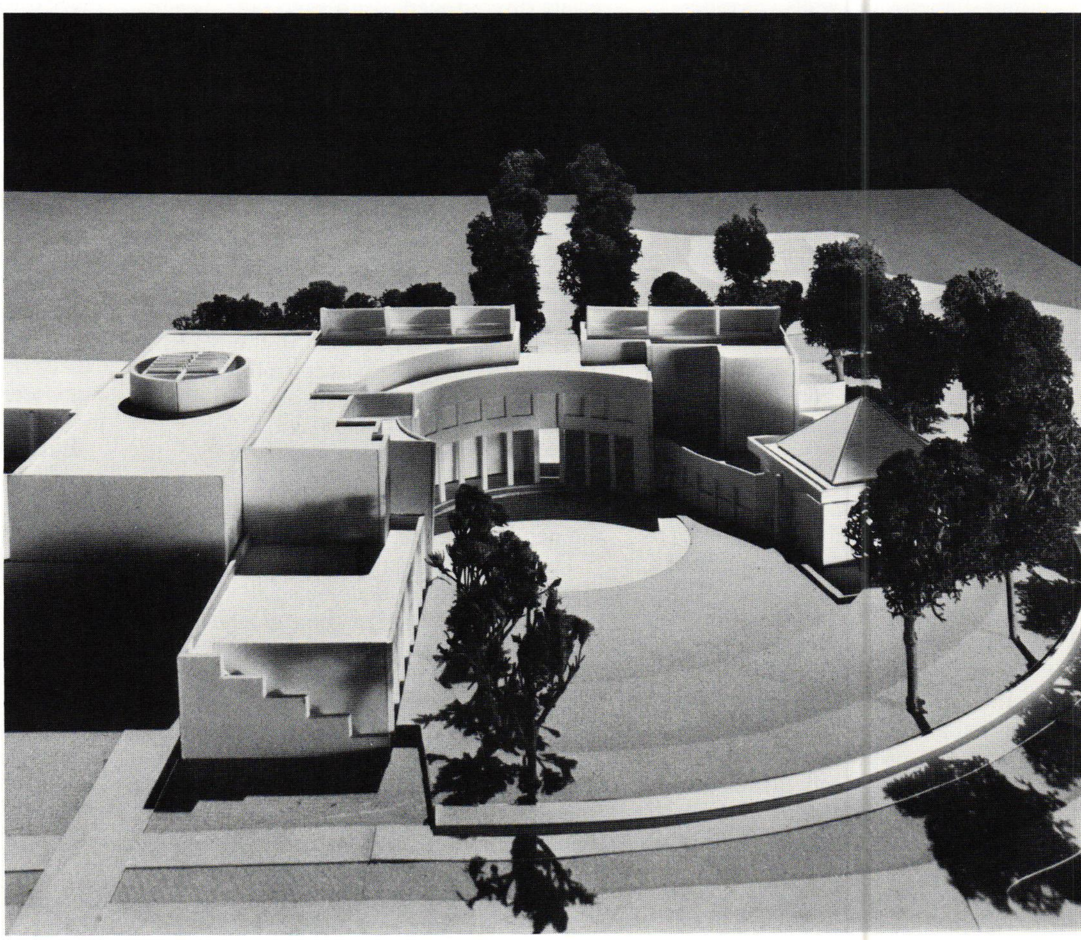
The University of California at Santa Barbara recently held a two-stage design competition for a $5.3 million, 18,270 square foot art museum and campus gallery space. Program elements included a 100 seat lecture hall, a 3,190 square foot program and research area for prints, graphic arts and architectural drawings, and administrative and gallery services spaces. The competition, which followed AIA guidelines, was funded by grants from the National Endowment for the Arts and the UCSB Foundation.

In the first stage of the competition, designs were submitted anonymously, and five finalists were selected from 256 entries. Submissions were anonymous to allow entries to be judged on merit, rather than on a firm's name or prestige. The second stage brought the five finalist teams to Santa Barbara for a three day charrette to create their final models and drawings in the public eye, and to make oral presentations to the jury.

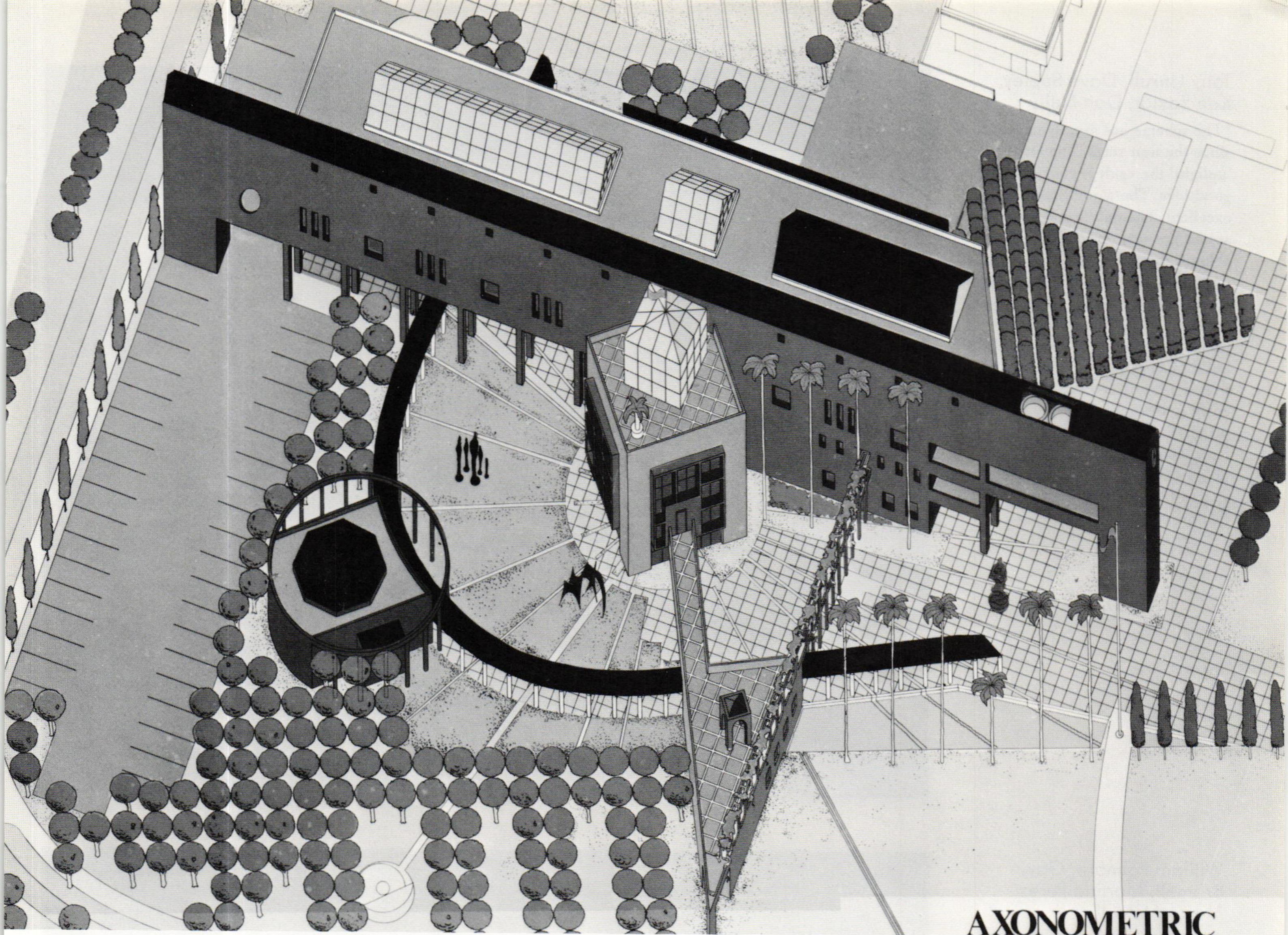
First place was awarded to the team of architects Michael Dennis and Jeffrey Clark, of Newton, Massachusetts, assisted by Greg Conyngham and Gary Lapera. In addition to a $5,000 award, the team will negotiate with the University for a contract to design the proposed museum. "The design is energy efficient, with excellent gallery space, and is very low key, with a nice kind of rambly quality about it," said J. David Farmer, director of UCSB's University Art Museum. "The design will provide a friendly, congenial and relaxed environment." William H. Liskamm, FAIA served as Professional Advisor. Jury members included Dr. Alfred Moir, art history professor, UCSB; Michael A. Arntz, chair of studio art, UCSB; Charles Eldredge, director of the National Museum of American Art; Dextra Frankel, professor of art and gallery director at California State University, Fullerton; Hugh Hardy, FAIA; James Edward Morris, AIA; and Thomas R. Vreeland, FAIA. Excerpts from the jury comments appear below.

Mark Cigolle, Kim Coleman, Boo-Woong Kim, Greg Lombardi

"The formal quality of the building is quite appealing. It fits into the campus environment well. The scheme's main virtue is its relationship to the site, but this alone was not sufficient to carry the scheme off. The scale of the building seems troublesome in relation to its neighbors. The elevations are stark—particularly facing Cheadle Hall. The building's form had tremendous landscape possibilities that were not realized. Natural light in the galleries is poorly handled. The light well carries noise from the lobby into the galleries. The curved roof shapes seem like a formal device with little lighting effect. Using the same standing seam roof on two different roof types seems odd. Turning the Architectural Drawing Room at an angle is nice for the outdoor space, but the materials and structure of it are a problem and seem unconvincing. The parking solution is outstanding. The premise for the scheme is very good, but its execution in the second stage lacks conviction and seems to waffle on design issues."



Lesley Newhart



AXONOMETRIC

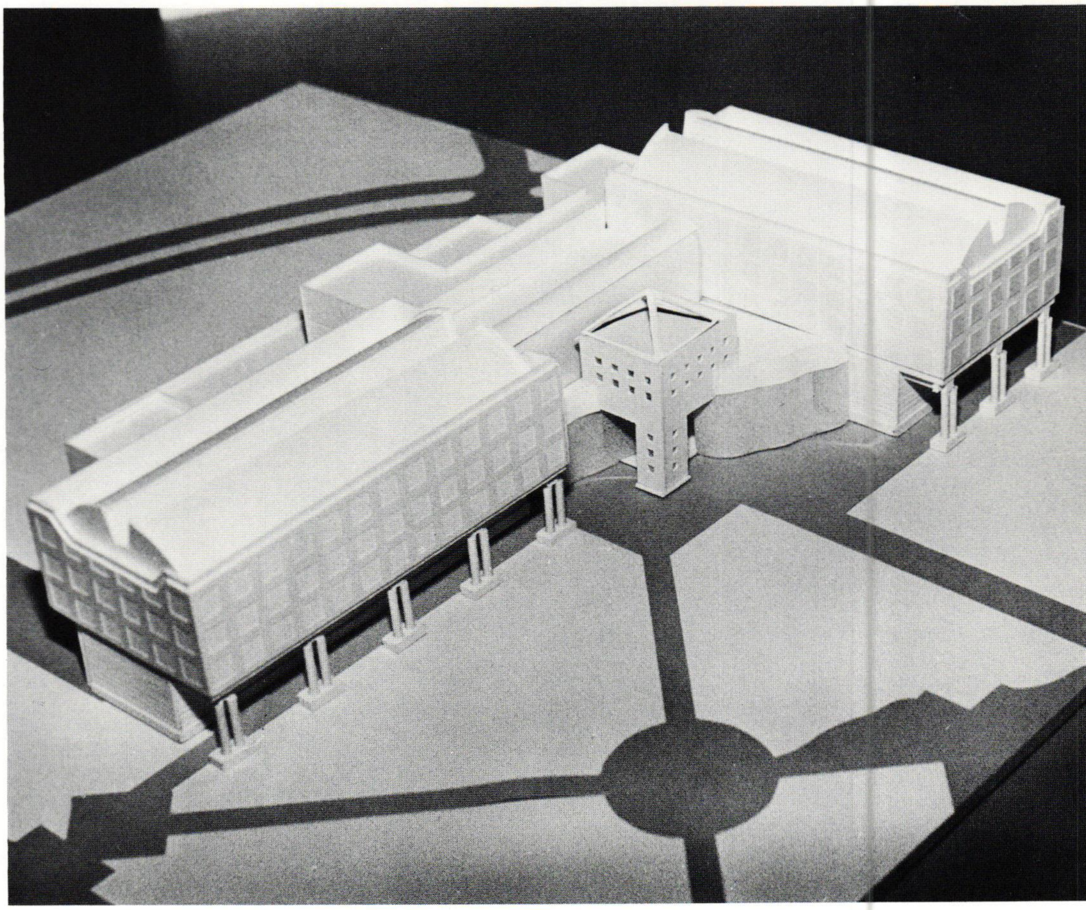
Vladimir Arsene,
Jim Lambros (A/L Design),
with Abby Suckle, David Hu,
and Anthony Z. Panu

"The scheme's concept is fascinating, imaginative and intriguing. Great improvement has been made over the first stage. The building's siting is well handled. The entrance is well located on the axis and at the focal point of the garden. The many colonnades could be confusing. The building is a catastrophe *vis-a-vis* the Cheadle Hall exposure, both architecturally and politically. The building doesn't seem real. It seems like stage set architecture. The low soffits in the galleries would be a problem. The long gallery spaces are not too interesting, and the corridor next to the galleries becomes a *cul-de-sac.* We question the free-standing walls in the galleries. This very dynamic scheme requires enormous architectural skills to implement. It is clearly an urban, town center, scheme. Would the other campus activities really come here?"

GALLERY PERSPECTIVE

Tony Unruh, Dave Seeley, Ken Saylor, Don Nulty

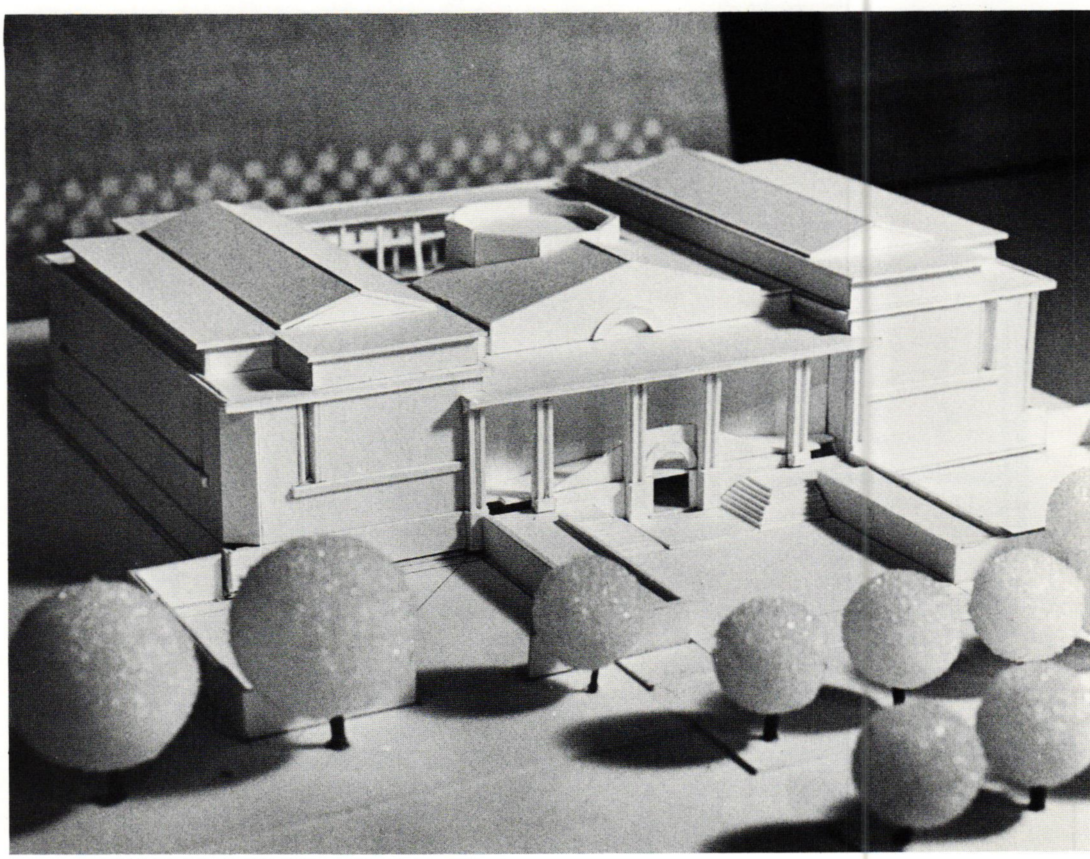
"The scheme has greatly improved since the first stage. The attempt to 'uplight' the vault is conceptually a good idea. The wood floors are excellent. The public and service spines are very good ideas. The column rhythm is askew in relation to the decorative treatment of the facade. The building seems massive and heavy. The side facing the public road (west) is poor until the building is expanded. The circulation is a bit bizarre, going from the entry to the galleries. The different orientation of the skylights reveals a problem of understanding. The image of large, blocklike gallery spaces is not in the spirit of looser, flexible exhibit spaces."



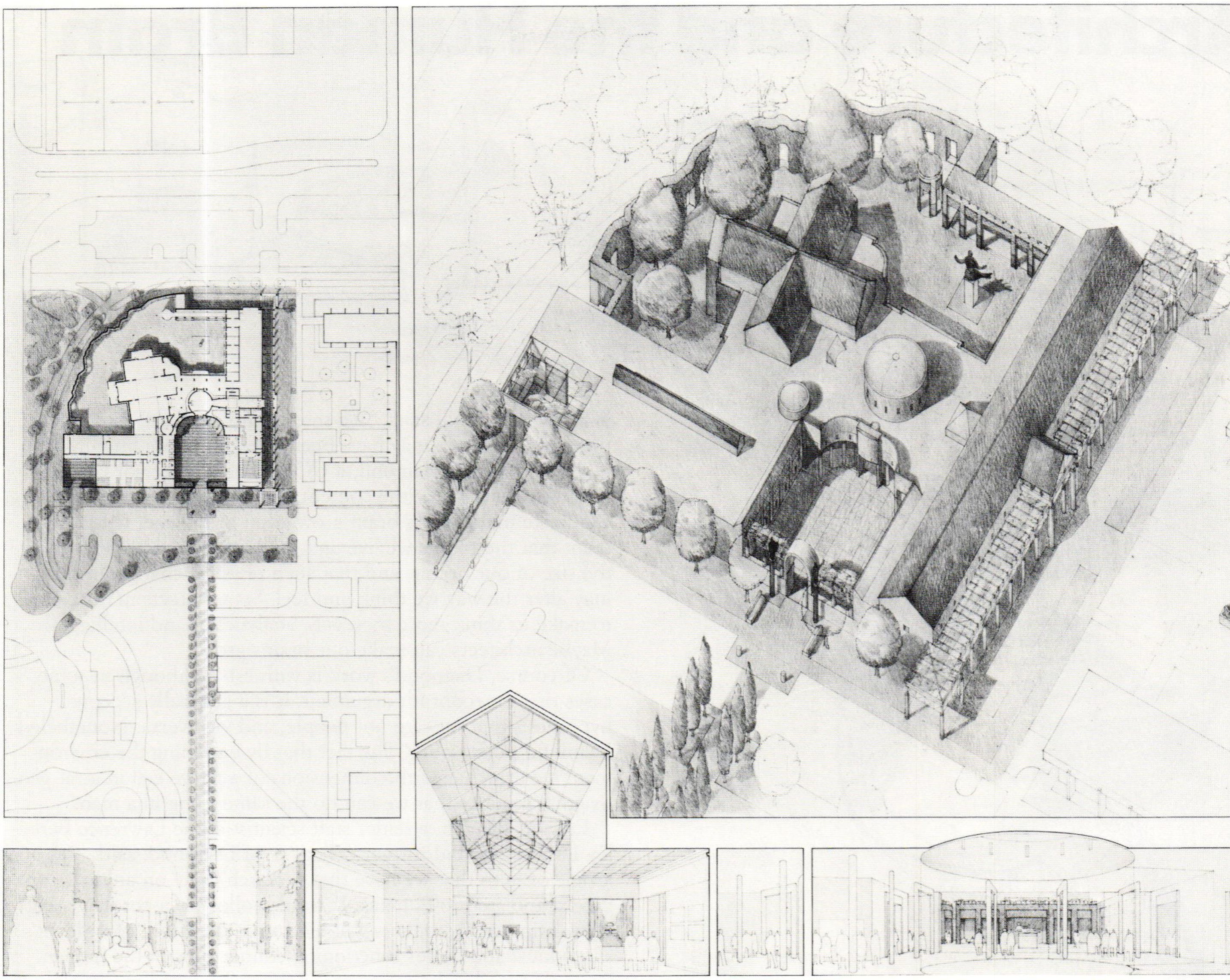
Lesley Newhart

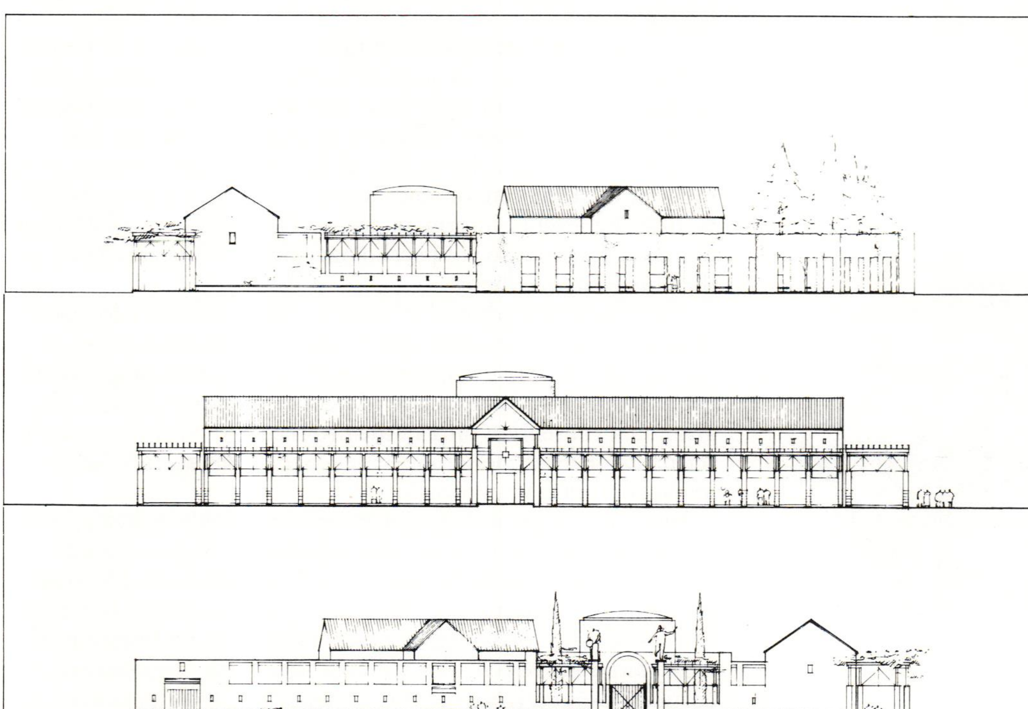
William Palmore, Gavin Bromell, Martina Perez, Marcy McInelly

"The scheme is a very interesting classical plan which seems to have become more rigid and formal since the first stage. Most of the charm of the original scheme has been 'classicized' out. The building is frighteningly formal now. A 16' octagonal exhibit room is impossible to use. The expansion is not resolved and doesn't meet the program requirements. The materials and color pallette are very restricted. The clerestory lighting works well, as does the corridor system."



Lesley Newhart

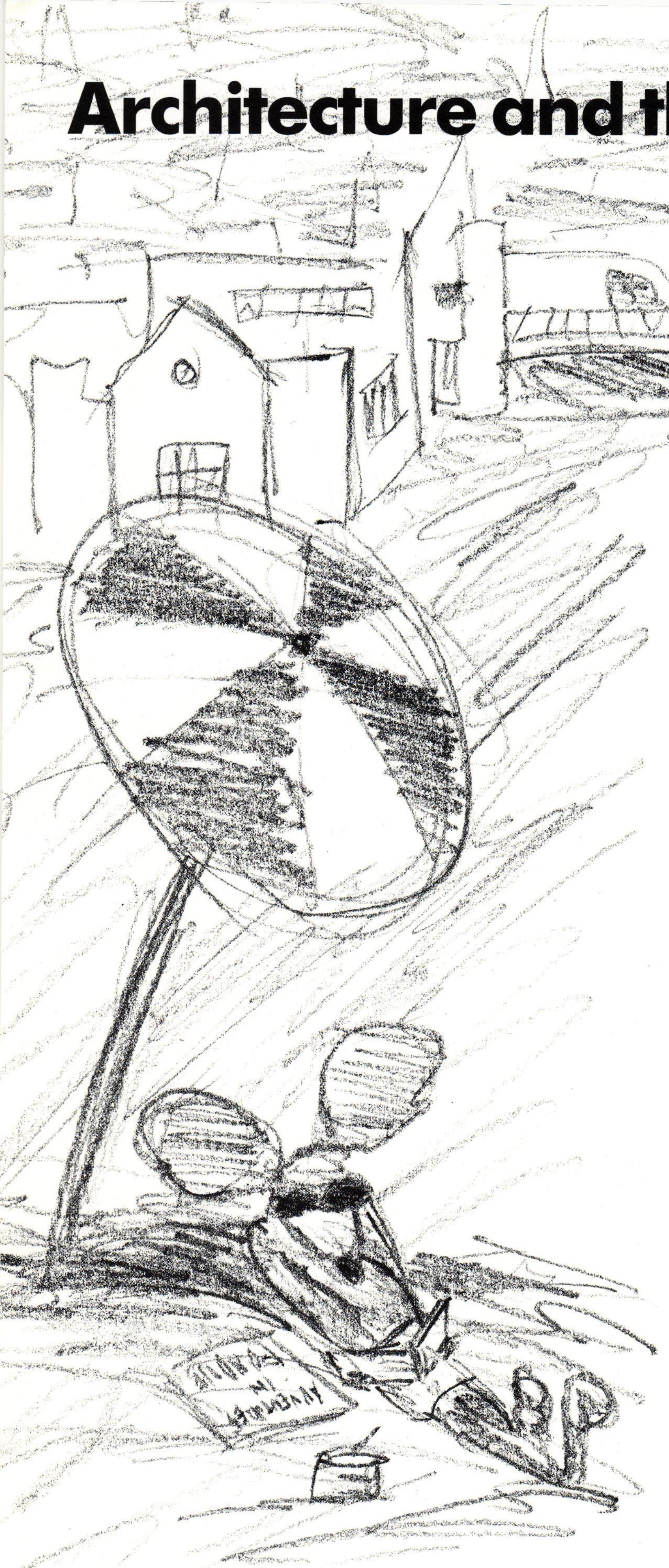




Michael Dennis, Jeffrey Clark, Greg Conyngham, Gary Lapera

"The scheme is immensely charming and functional. It will be a pleasure to walk through. We like the one story approach. The scheme has a nice procession of spaces, but the look of the east gallery and the angle of the temporary exhibition gallery are disturbing. The scheme is the most functional in terms of gallery management. The 30′ × 100′ gallery may cause problems, being too narrow. The dropped soffit in the small galleries and in the changing gallery could cause problems. The cross sections seem arbitrary, combining big, high spaces with low soffits. The service area works well. The scheme assumes an art preserve on this site, and provides a pleasant focal point for the campus."

Architecture and the Human Brain



Tom Glass

Winston Churchill said, "We shape our buildings; thereafter they shape us." He may have been speaking more literally than he knew. Marion Diamond, a UC Berkeley professor of anatomy, has proved that the content and design of an animal's cage can make the animal's brain grow, even in old age. It follows, then, that the rooms we live and work in may physically change the size of our brains, and that such physical change, in turn, may alter the way we think and feel. So architects may be able to make us think more incisively, analytically and intelligently. Maybe architects can make our brains grow.

Of course, Diamond's work is with rats. Although in some cases there is room for argument, it is a generally accepted hypothesis that rats are not people, and vice versa. Nonetheless, Diamond points out, "The fact that by enriching the environment we can change the dimensions of a nerve cell in a rat gives us great security that we can do the same thing in a man."

Edward Bennett, a senior staff scientist at the Lawrence Berkeley Laboratory and former colleague of Diamond, said, "It's an article of faith that we have that research done on animals can be extrapolated to humans. It would follow as a corollary that stimulating environments will tend to create more complex anatomical and better functioning connections in the human brain that lead to better mental performance and more intellectual capacity."

Of course, we are skating on thin ice here. Diamond, Bennett and other scientists stop short of promising that human brains change physically in response to architecture. Still, the researchers hold out high hope. "There is very strong evidence that during development the quality of the environment affects at the very least the rate of maturation of the brain and probably its ultimate level of information processing ability," said William Greenough, professor of psychology and anatomical sciences at the University of Illinois.

Even architects admit that there is more to the environment than architecture. It seems self evident that the interaction of people with people is a more powerful force in shaping thought processes than the interaction of people with architecture. Yet, given that contention plus all the provisos and disclaimers of the scientists, there is mounting evidence that architecture has an impact on brain physiology.

Diamond points to experiments proving that rats living in an "enriched" environment develop significantly larger cortices than rats limited to an "impoverished" environment. The highest thinking functions take place in the brain's cortex, functions such as advance planning, abstract thinking and refinement of ideas. Since nerve cells don't divide after birth, the enlarged cortices resulted from growth of dendrites. Dendrites are "branches" extending from nerve cells. It is through dendrites

by John Dreyfuss

that the brain's billions of cells "talk with each other," Diamond said. So the better developed the dendrite network, the more "talking" goes on and, in layman's language, the smarter you get.

One of the most exciting discoveries in Diamond's work is that, in an enriched environment, the cortex grows in rats of all ages. The implication is that old people can improve their thinking processes—a contradiction of the widely accepted hypothesis that thinking ability deteriorates with age. "The brain responds positively to an enriched environment at any age," Diamond said. "With a healthy environment you can have a healthy brain, even in a wrinkled old body."

Briefly, experiments by Diamond and her colleagues involved creating an enriched environment by putting 12 rats into a large cage containing numerous toys. To create an impoverished environment, the scientists put one rat into a small cage without toys. All the rats were fed the same food and their cages were cleaned regularly.

The rats were between 6 days and 650 days old, with the oldest rats analogous to humans of about 75 years of age. Regardless of age, the rats in enriched environments developed thicker cortices than their impoverished relatives. In some cases the difference in thickness reached 16 percent.

Diamond measured physical changes in the brains, not changes in the rats' behavior. But she said that other investigators have found that rats with thick cortices run certain mazes better than rats with thinner cortices, "indicating better problem-solving ability" on the part of rats with thicker cortices.

One problem with drawing parallels between work with rats and work with people is that it's hard to get people to spend their lives in predetermined environments before having their brains dissected on a time schedule convenient to the needs of scientists. There are, however, ways to examine human brains without dissecting them.

Dr. Ed Kaufman, director of psychiatric education at the UC Irvine College of Medicine, has studied the effects of solitary confinement on the human brain.

Kaufman said studies show that "periods of solitary confinement of only 24 to 48 hours cause brain wave changes. The longer a person is in solitary confinement, the longer the brain wave changes persist. After several weeks in solitary, the changes can last up to a few weeks. The altered brain waves indicate that physical changes are taking place in the brain, although we don't yet know their exact nature," Kaufman said.

One of the most extensive studies on the relationship between environment and human behavior recently was completed by Michael Brill, a professor of architecture at the State University of New York in Buffalo and president of BOSTI, an acronym for the Buffalo Organization for Social and Technological Innovation. His study considered relationships between office workers' environments and their happiness and productivity.

"One of the things we (observed) is not necessarily a drive toward richness and stimulation, but a drive toward control over richness and stimulation," Brill said. Workers produce more and are happier in offices where they can control factors like temperature, light intensity, privacy and noise, he said.

Brill added that, given some control over such factors, workers "are far more satisfied with their jobs and they produce between 4 percent and 5 percent more work relative to their salaries." Brill's four year investigation involved about 4,000 workers in 50 offices in more than 20 states.

Maria Giesey, a Los Angeles environmental designer specializing in behavioral aspects of design, said she has "surveyed about 7,000 people in seven or eight years, and the kind of results I get are fairly similar to the kind of results Michael (Brill) got."

Researchers studying the impact of architecture and other environmental factors on the brain and on human behavior tend to be extraordinarily cautious. Among the most cautious of those researchers is Richard Coss, professor of psychology at UC Davis. He holds an undergraduate degree in industrial design with a minor in architecture from USC, and a master's degree in design from UCLA.

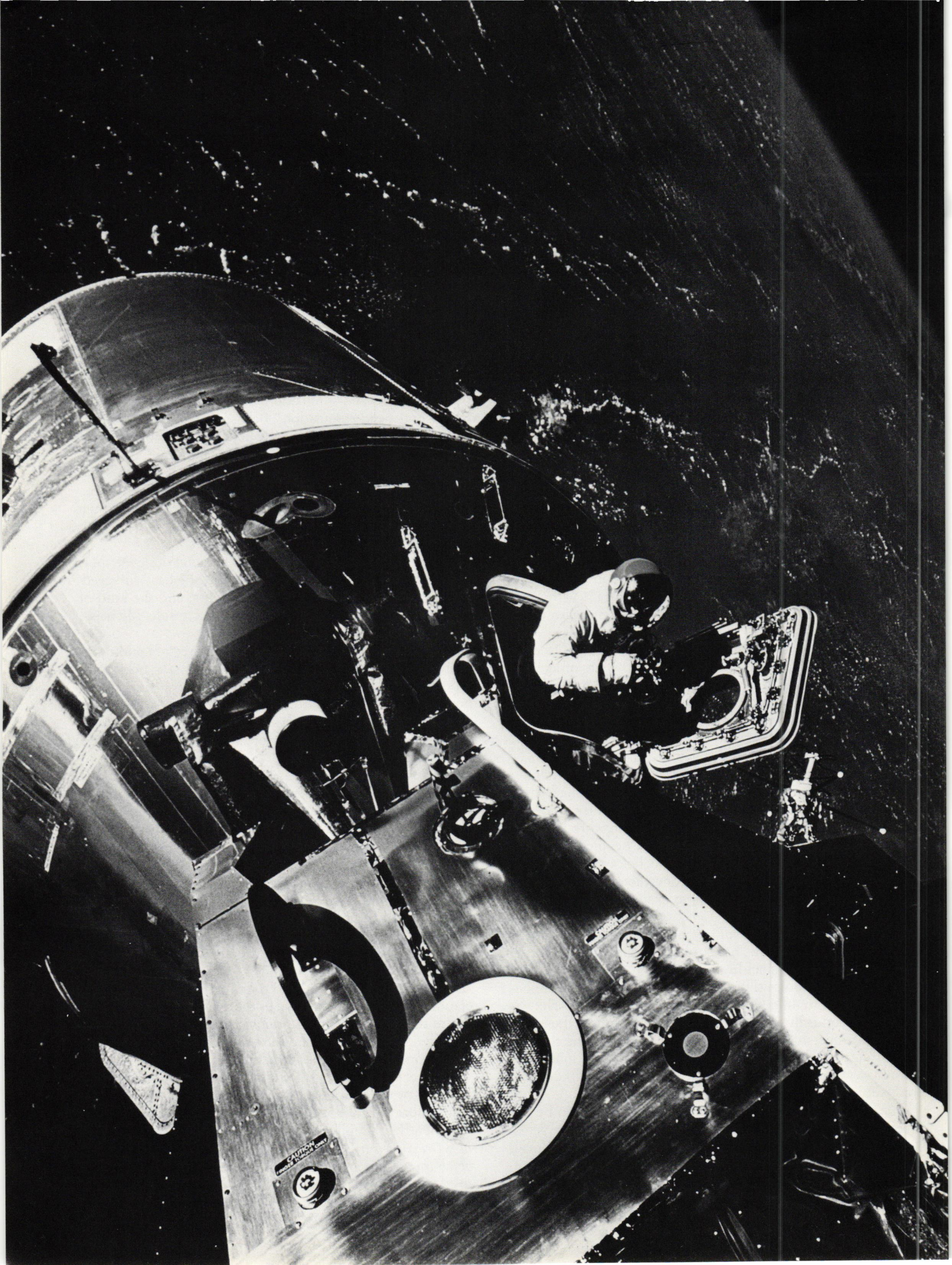
Working with fish, Coss has found that the brain is particularly sensitive to environmental variations during its early period of development. But compared with rat brains studied by Diamond, fish brains seem much less capable of adjustability in terms of physical change after their natural period of development, Coss said.

He would not extrapolate the results of his work to make comparisons with possible changes in the human brain. He did say that "architectural environment is much less important than social interactions, but still there might be some effects of architecture that would influence development of the human brain, but no one has studied that yet."

Perhaps no one has studied human brain development in relation to the environment, but the process is beginning. "We're starting with human brains now," Diamond said, explaining that she and some of her students have recently begun studying measurements of 40 human brains.

"We are, of course, just getting started," Diamond said. "I think our progress in relating human brain development to the environment is in about the same place the study of electricity was when Ben Franklin flew his kite."

John Dreyfuss is a feature writer for the Los Angeles Times, *from which this article is reprinted with permission (copyright, 1983* Los Angeles Times).


CAUTION

Interview: Russell Schweickart

California Energy Commissioner Russell Schweickart thinks in more dimensions than most of us. He's a former astronaut—a star voyager. Rusty lived beyond Earth's grasp for 241 hours during the flight of Apollo 9 in March, 1969. A tenant in one of humanity's earliest extraterrestrial residences, Rusty has an unique perspective on the design of space habitats.

What can you tell architects about designing habitats for people in space? In the Apollo 6, you weren't exactly in a palatial residence.

Right. But I was very much involved in our first relatively palatial residence—Skylab. It had about the same internal volume as a three bedroom home. Not only was the total volume fairly large, but in the experiment section we had a single large volume, a single free space. Skylab was the first opportunity to appreciate the full extent of the radical environment in space.

Up until that time, both we and the Russians had been operating vehicles where you could reach in any direction and touch at least one wall or one surface. In Skylab, you were quite literally faced with volumes where you could move in true weightlessness, without always having a wall or structure accessible to you. So the freedom intrinsic to the environment was for the first time realized on a subjective basis in Skylab.

Are there any elements in habitat design that can enrich the quality of human life in extraterrestrial habitats?

From a design standpoint, the most important one is windows. We had a hell of a time trying to get NASA to put a window in the Skylab. It offends a designer of a pressure vessel to interrupt the uniform cylindrical stress patterns by putting in a window frame and window with different thermal expansion characteristics and all of the other design complexity introduced by it. It is much nicer to deal with a windowless cylinder with rounded ends. But that is inhuman. We are talking about living environments and real people. The environment itself invites wide-eyed awe *if* you can see it. So to me, in terms of the inhabitability of an environment in space, windows are very important.

In a space colony, would there be windows, say, in every dwelling, or would there be an area where you could go to look out?

If you are talking about the really large space colony—20 miles long and several miles in diameter, or a torus several miles in diameter and at least several thousand feet across the inside—it becomes less important to have windows to the outside, in the sense that you have a large and interesting, even fascinating, internal visual field.

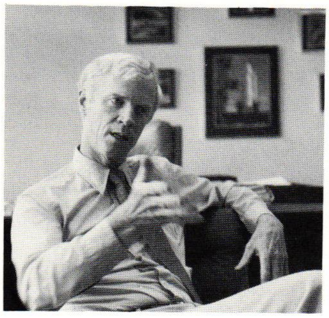
But if we are talking about the earlier design of habitats which might hold a hundred people or a dozen people, then the windows to the outside are much more important. Eventually, in extremely large structures, the internal visual experience can substitute in part for the outside. Nevertheless, even in a large, classical space colony, it is still important for the residents to see out and see the stars and the Earth, especially. Or even external operations around the environment, which will be fascinating. So there, you could move toward observation ports or observation rooms—the equivalent of the rotating restaurant on top of the space needle or on top of the hotel.

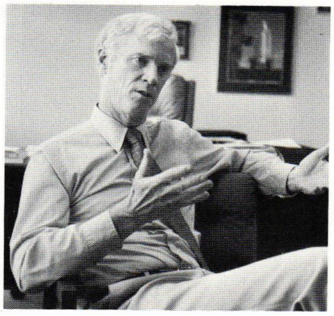
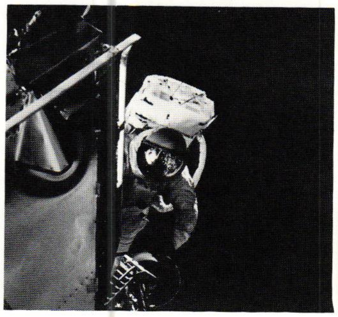
For example, I was brainstorming one day about a space colony with a Ratskeller type of restaurant, where everything gets turned upside-down. Put glass on the floor and you are looking past your feet at the Earth while you're eating your dinner. You can't conveniently look sideways at the Earth in that rotating environment, and so the design possibility of a transparent floor to see the Earth is interesting.

Wouldn't you feel an element of vertigo in that?

Well, it depends, of course, on the rotation rate. Now that's another factor which is going to dramatically shape design of habitats—the rotational complexities and physiological challenges of a rotating environment. Coriolis forces are generated in the inner ear by rotation of your head around anything other than an axis of rotation of the vehicle. If the axis of rotation is up on the ceiling behind us, and if we nod our heads up and down, there's no problem. But if we rotate our heads sideways, it generates tremendous internal torquing effects. If you close your eyes, and rotate your head to one side, you have a subjective sensation of tumbling forward to that side. You get very confusing signals into the inner ear, which generate nausea. There is an adaptation that has to go on in rotating environments by people who are living in them. We don't know a lot about the long term adaptation to environments like that, and whether one would develop an internal axis system that is totally tuned to where the axis of rotation is.

In the smaller artificial gravity environments or habitats, those Coriolis forces are going to clearly affect design. One would want to orient and locate work tasks and passageways, equipment that one would work in front of, to be sensitive to the required head motions in a particular task, so as to minimize the disturbing Coriolis inputs. And I suspect that in the same way that we are extremely oriented to the floor here on Earth,



one would become, design-wise, very sensitive to the axis of rotation as well as to the "floor"—which of course is no longer a plane, but the outer surface. In the smaller habitats a higher rotation rate is needed to provide the artificial gravity, so that influence will dominate design. When you get to very large environments, of course, the angular rates are significantly lower and the subjective effects are probably lessened; therefore, the design requirements are probably a good bit looser.

When you were living in space and designing and working with the Skylab, were there certain forms or shapes that increased your feeling of personal security?

Not that I'm aware of. I'm not sensitive to any changes from the ground environment to the space environment along those lines. Organic shapes are probably going to be received in a space environment in the same way they would in a terrestrial environment. But the freedom of design is greater in space.

You have a whole array of gravitational options to deal with in space. The extreme, of course, being zero gravity or weightlessness, in which case, you have total freedom. One doesn't have to have walls in space. Walls hold up ceilings in a gravity environment. But in a weightless environment, there is no need for that same mentality. It just isn't there. You have to be concerned with—or alternatively, have the opportunity for—total freedom in terms of the various surfaces all serving the same function, which is essentially utility. You end up with a much greater variety in a space environment when you go to that singular option of weightlessness.

Now as soon as you go to any gravitational environment, up to and including or beyond one g, then you once again go right back into this specialized function of the floor. It may be a curved floor, cylindrical shape even, but you still have a down and an up. Things may fall faster or slower than they do on Earth, but you still have the basic gravitational characteristics. So the unique opportunity is in the zero g environment. And there, so many things change that the design opportunities and challenges are phenomenal.

There's no such things as open containers—for liquids at least. You can't put things down. They have to have Velcro on them or they're going to float to the intake of the air circulation system, ultimately. When you lose something in space, you wait and then go to the intake duct on the airconditioning system. It will end up there; it's only a matter of time.

In a rotating environment, you have a variable gravity situation. On the ground floor you may have one g, but as you move toward the axis of rotation, ultimately it goes down to zero gravity. So you have the whole challenge of relatively robust structures at the outer perimeter of a rotating structure going down to very tenuous and flimsy structures as you move toward the axis of rotation. That, again, is unique, even though you have a gravity environment.

Now, what freedom that provides in terms of innovative design is really hard to say. It's just ripe for imaginative design. People play space games—imagining a gymnasium along the axis of rotation, so you have a weightless gymnasium. People talk about human powered flight—near the axis one can clearly flap one's wings and take off like a bird. There are possibilities which are fun to explore.

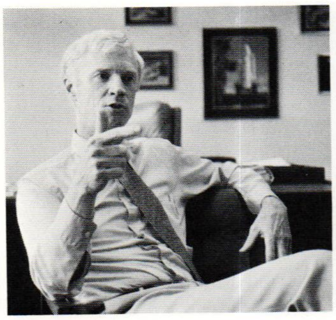
In the large habitat, another interesting phenomenon that's going to have to be analyzed and understood is the whole question of: What is the natural atmospheric circulation pattern? Do you end up with prevailing winds in a large rotating environment —the cylindrical city sort of environment? And how would that influence things? I don't know the answer, but clearly when you end up with an artificial gravity, you do have hot air rising again, but as it rises, the tendency to rise is less and less. Once again, Coriolis forces are going to affect the path of a rising air column as it would a falling object. So you have strange kinematic effects which will have to be accounted for in design.

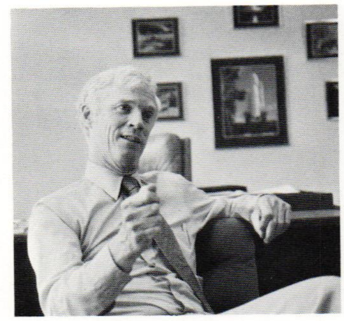
How will humans have to revise their attitudes about their living and working environments in order to live in space?

In a purely functional way, the distinction between the work place and habitat gets challenged, in the same way it does in a nuclear submarine or in a limited environment like an antarctic scientific research facility. You can't afford to have the kind of distinction we do here in the terrestrial environment between home and work place. Efficiency, the cost of space, in a sense, is quite high. The investment dollars involved in a nuclear submarine, for example, don't allow you to have a spacious living area which is separate and distinct from the work area. Now to a certain extent, you do do that—you do have crew quarters, and you do have the officers' mess. You don't eat at the periscope. So there are separations of functions. But it is a long way from driving my car from my office to my home.

In the space environment, we're going to start out in a way which is more analogous to the antarctic research station or a submarine, where your bunk is over here and your instruments are over there, and it's all one environment. Just because of the costs.

When you've got a dozen people up there whose job is to service communications satellites in geostationary orbit—those people are going to be living and sleeping and working and eating in a fairly integrated environment. When you get to the large space colony with 5,000 people, you're going to go in the direction of the living quarters and recreational facilities being






separate from the work environment or the laboratory. It is very size dependent. But there are very direct analogs to that here in our own experience.

On the other hand, the fly in space indicates some differences which are very interesting. Astronauts are a pretty bitchy lot. They're not terribly tolerant, let me put it that way, of designers. They let people know when they're dissatisfied. And they can get just downright nitpicky. When it comes, for example, to the controls and displays—to the behavior of the spacecraft and the design of the guidance and navigation system—we played a very direct and immediate and detailed role in how the spacecraft was designed, all the way from the shapes of the knobs and switches and hand controls to the response times of the attitude control system. Almost nothing escaped the critical design monkeying that the astronauts did. Yet I never once heard anybody complain about a sense of claustrophobia.

We complained about all sorts of storage problems. We had so much gear crammed into the spacecraft that an inordinate amount of time went to housekeeping. You would have to be meticulous about putting something away in its designated place, because the place would so rapidly become cluttered and unuseable. Yet, with all that equipment jammed in there, I didn't have any sense of living in something the size of a Volkswagen Rabbit. I never heard anybody else complain about it. And I have asked myself a number of times why.

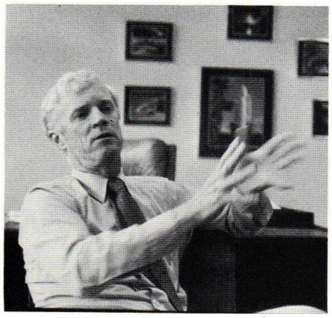
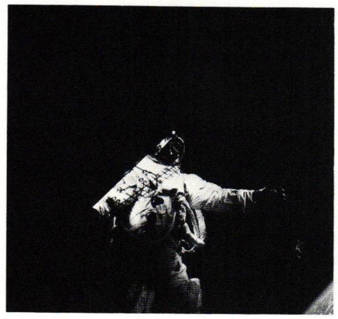
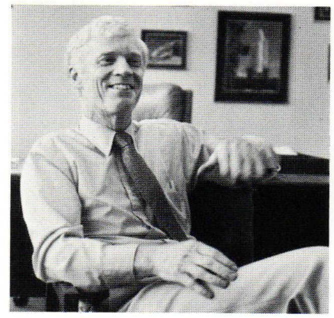
You would think if you were locked in a VW Rabbit for 10 days you would go berserk. Well, you never had the sense of claustrophobia, and I think it's because you had the total three dimensional freedom. The space seemed much more spacious than it would have in an environment where you've got to be on the bottom of something. Where there's a down and you're always on it. You could float around and between and over things in getting around, where on the ground you were flailing around, stumbling and crawling over things and having to move things out of the way to get to the commander's couch to retrieve a valve, or to do something. The ability to worm around and float around seemed to open up the space in a way which is really surprising. I think that resulted in very little complaining about claustrophobic sorts of things. I don't know where that's going, but that's a subjective impression that I had, that we haven't talked a lot about, but I think is real. You mainly want to have open spaces for fun, but functionally I don't think you need a lot of volume. Your volumetric packing can be fairly tight, without generating a sense of being closed in. Now that's going to be helped if you can look out, too.

The other thing which subjectively gets into design in a very real way—well, I should be careful—the subjective experience is strange and unusual. How it affects design or will affect design, I don't really know. But in Skylab, which is the best example of it, the equipment and experimental gear and the control panels and the gages and dials, that sort of thing, were oriented in different directions in different parts of the spacecraft principally because it was a series of modular components. The orbital workshop and the air lock module and the multiple docking adaptor and the Apollo telescope mount control panel and things of that kind were built in different places. Some were manufactured in a horizontal orientation and others in a vertical orientation. Because they had to be tested on the ground in a gravity environment, the technician would have to sit in front of the control panel in such a way that he could read the switches and dials. So the control panels and the switches and dials are built to be operated and tested on the ground, not because, in space, they need for some functional reason to be oriented that way. When you put the modular pieces together, you find some panels oriented on one plane and others oriented on another.

In the airlock module, things were oriented radially. So you had all different sorts of operational axes that you were dealing with. Forget where the Earth is, it's irrelevant. Your eyeball down is down. Your feet or rear end are down, and the top of your head is up, and your right arm is right and your left arm is left. I mean, you operate that way at the control panel. And if you turn your head sideways, forget about gravity, you feel as though you've got your head sideways. Put it upright and it feels as though you've got your head upright.

Okay. Now I go from one control panel to another that's oriented on a different plane. When I get over there, I feel like I'm on my side, even though I'm looking at the panel right side up. I'm still operating in the former axis system, until such time as I say, "That's up." And all of sudden, the axis system goes "boink," and now that's up. It doesn't happen automatically. You will it to be up and when you do, it is a sudden change. You don't gradually torque it over. You get there, and then you "cage your gyro."

The earliest demonstration I had of that was early in my career as an astronaut. We used to fly a zero gravity airplane, a 707, basically, with all the seats removed to create a big open space. You'd fly a parabola and generate real weightlessness for about 30 seconds. The whole inside of this airplane is padded. Obviously, you don't want people to bounce off the walls. On the ceiling of the airplane, we had two longitudinal nylon straps, that you could hold on to. On our first flight, we weren't doing any useful work; it was a familiarization flight in a zero g airplane. So you're playing games. You get in weightlessness and push off the back wall and soar down—the "look, Mom, I'm flying" sort of the thing. Well, when we got into the weightlessness, Walt Cunningham would sit on the ceiling. He said, "Hey, Rusty, I want you to do this." So, we got into the next parabola,


and I pulled myself up on the strap and just sat on the ceiling. Walt said, "Okay, you're on the floor." And I just went—click—and I was right side up. Everybody else was upside down. But until he said that, I was sitting on the ceiling. I was upside down. He said that, and it was clearly arbitrary, and all of sudden I'm right side up and the rest of the environment is upside down.

You experience that directing in space. So that when you move from one area to another, your axis system is arbitrary, but you retain it until you decide to change it. Now, that's a subjective environment. I don't know how in the world that will in the end affect design, but it seems to be a common experience. You need an axis system, you operate with an axis system, but in the absence of gravity, you can cage it in any orientation you want.

Will people born in space be born with that understanding?

Yes.

Is that orientation, that learning, going to be transmittable, or will it be the beginning of new beings?

That's a very interesting question. I tend to think that we're going to become spatially parochial. That is, I think that the gravitational environment to someone who is born in space, or perhaps even lived in space for a substantial period of time, will be very confining.

But visually, it's the opposite. You will be severely visually restricted in terms of a space habitat. Your normal perspective will be limited to the interior of some artificial volume. Whereas on Earth, your visual environment is infinity. We don't often think of it that way, but when you look at the stars, you're looking out into an infinity environment. We tend to see the blue sky as a ceiling. But psychologically, we know it isn't. And I think that that will be a profound difference in a space environment.

So coming to Earth will be different in the sense of operating on the external surface of a volume instead of on the internal surface. In some sense that will be visually liberating. But the gravitational environment will give people who come down from space a feeling of limitation and confinement. So a real parochialism will evolve. And I suspect that people who are born there will see that space environment and weightlessness as a more natural and more free environment in which to live and operate. Eventually, there will be a sense of "we space beings," not in just a physiological sense of that oppressive Earth environment or the heavy gravity. The sociological, the economic sense of "us" and "them" will evolve.

Some form of government or institutional structure will evolve as part of the space habitat. The space environment will perform services for the Earth for which there will be compensation, and there will be negotiations over prices and rates. All sorts of tensions will grow up between the colony and the home continent or the home country. Ultimately, the tensions and motivations toward independence and freedom will develop at the same time that the actual independence will increase. We will learn to do with less and less in terms of materials and necessities brought up from the Earth, and more and more with materials and energy available in space. And, at some point, you're going to have a revolution. The space colony is going to say, "Screw 'em. Why should we put up with this B.S. from the ground pounders? Let's get out of here." All that will be missing is a transportation system. When the space colony becomes independent in terms of life support and energy and material, the need to stay in immediate proximity to the Earth disappears. So hook a thruster onto one side of the colony and take off. It will happen.

You've hooked on a thruster and taken off. How has that changed your view of the Earth, and of human beings?

I think of the Earth and humans through an analog of cosmic birth. Humans, the fetus in the womb of Earth, have a dependent relationship with Earth which, as it reaches full term strains the resources of the mother. The legitimate global problems we see today are not unlike the demands people at eight or nine months place on the mother, and trigger birth pains. In the same way, the conditions we see today are an analog, at a planetary scale, to that natural process.

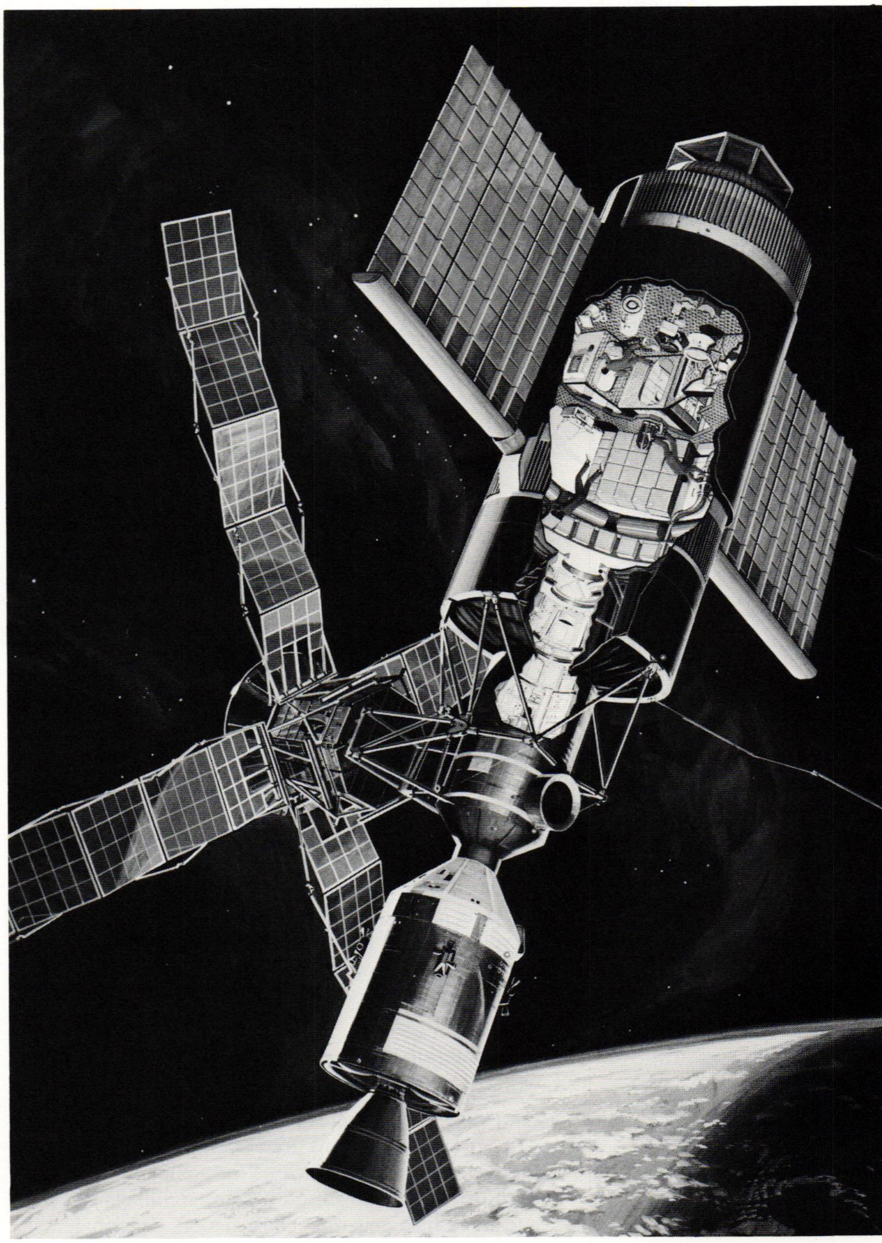
Within the womb, the close relationship is very dependent. After birth is when the real love relationship develops—the mutuality of love. In some part, the experience of humans seeing Earth as a whole one naturally stimulated the environmental movement. It was the beginning of a love relationship, seeing that we have a responsibility for the planetary environment. Our ultimate relationship with Earth increases as we have the freedom to move off Earth.

The relationship with the environment is enhanced by redirecting space resources to the Earth. It's the same relationship of a child caring for a parent as the child matures. The degree to which that realization is reflected in design is extremely important. We have to see it as the supporting environment, like the ones we provide for our children as they grow up, which allows responsible human beings to move to maturity as cosmic beings. The challenge to designers is to set up environments in which we can become mature cosmic beings.

Do we set up environments with laser weapons or zero gravity gymnasiums—that is the fundamental question. Are we thoughtlessly going off under the pretext of defense of freedom, or do we see the larger responsibility for where life is headed? That's the question I invite the design community to wrap its imagination around.

Space Station Design

by Fritz C. Runge



McDonnell Douglas Astronautics Company

The first U.S. space station, a three-man vehicle called Skylab, was launched in 1973, complete with payloads for research in solar physics, Earth phenomena, materials processing, and human performance in zero gravity. In addition to architects on the McDonnell Douglas team, outside architecture and interior design consultants were engaged for Skylab concept and design work. The flight activity spanned about a year and was a great success. During that period, with visions of the transportation and logistics needs of a future space station, NASA undertook the development of the Space Shuttle, which is now flying.

With manned-access to orbit routinely available via the Shuttle, NASA is proposing a Space Station Program starting with a six to eight person crew to fly in 1991, and doubling that number by the year 2000. The space station will accommodate a variety of uses for science, commerce, technology, on-orbit services and an inter-orbit transportation base. Concepts for the 1991 and 2000: versions of a NASA Space Station, as developed by the McDonnell Douglas Advanced Space Programs team in 1982, are shown in Figures 1 and 5. In the program development, architects and engineers will extend the roles they played in designing Skylab, and in the ensuing ten years of space station concept studies.

Space stations are analogous to many highly confined industrial and scientific facilities on earth which house complex human activities at remote locations in hostile environments. All are conceived and designed by a variety of skills inherent in the broad fields of architecture, human factors and engineering. Earth-bound facilities with functional, environmental and logistic similarities to a space station include oil well platforms, antarctic research stations, underwater oceanographic science habitats, and even remote, heavily sheltered rocket test and missile launch blockhouses. All are similarly accessible only by some type of shuttle vehicle (air, land or sea) which, like the Space Shuttle, sustains and supports the facilities' activities. The architecture is significantly impacted by shuttle constraints, such as limited cargo volume and transportation schedules, in addition to a myriad of other considerations. Also, the facilities mentioned all operate in relatively oppressive environments. The ultimate commonality among such facilities is, of course, the complex human activities which must be conducted in unusual confinement and circumstances.

Basic architectural considerations are a key part of the concepts being developed for the emerging NASA space station. The greatest challenge is to coordinate and fulfill the diverse functions inherent in a great variety of potential payloads, station subsystem installations, environmental protection, interfaces with other orbiting vehicles, basic crew sustenance, and the need for flexibility for growth into expanded services—a real mixed bag of requirements, constraints and objectives, particularly when compounded by safety and contingency considerations.

Space station system studies, performed for NASA for many years now, have developed detailed understandings of the many functions and relationships inherent in a space station. And, in the process, architectural and engineering techniques and lessons learned from analogous terrestrial projects have been routinely incorporated, particularly since some

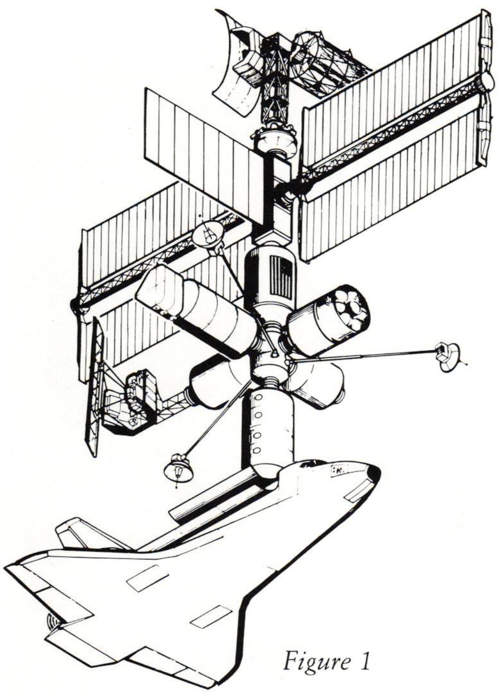


Figure 1

DEVELOPMENT OF SPACE STATION ARCHITECTURE

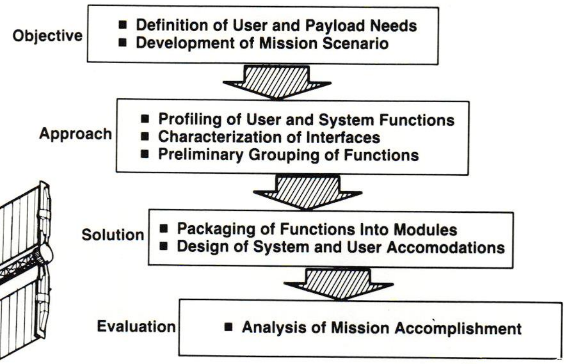


Figure 2

ARCHITECTURAL CONSIDERATIONS IN A SPACE STATION

• Uses (Missions)	Science, Applications, Commerce, Defense (Integrated and Isolated)
• Occupants	Scientists, Engineers, and Technicians
• Activities	Interior: Habitation, Control, Research, Production, Maintenance, Logistics with IVA Exterior: Berthing, Sensing, Assembly/Checkout, Maintenance, and Logistics with EVA
• Interfaces	Shuttle, Attached Payloads, Free-Flight Payloads, and Long- and Short-Range Excursion Vehicles
• Utilities	Atmosphere, Water, Power, Data, Communications, Thermal
• Locomotion	Orientation, Reboost, Manipulation, Excursion
• Environments	Exterior: Low Earth Orbit and Operations Interior: Life Sustaining and Protecting Stage and Payload Storage
• Technology/Cost	Budget-Dependent: Development vs Operations

Figure 3

INITIAL FUNCTIONAL GROUPING

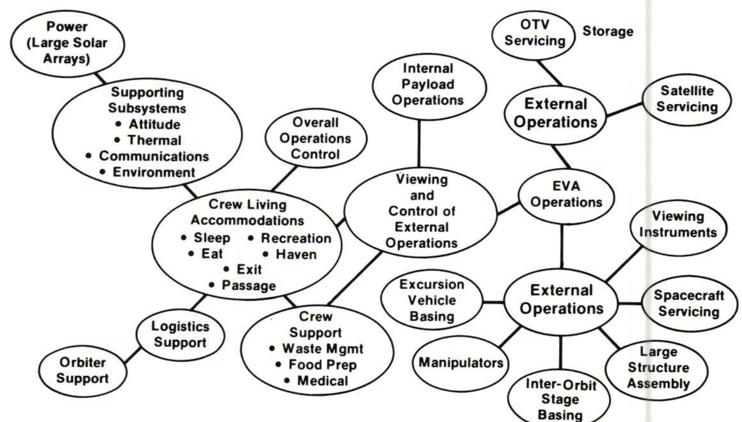


Figure 4

of the personnel involved have architectural and human factors backgrounds.

Since future plans of NASA call for increasing capabilities for space stations with large crews, an even greater need for classic architectural considerations and approaches will develop. Conversely, in the far distant future, lessons learned from compact habitats in space conceivably will contribute to the development of highly efficient, ultimate-urban facilities for the maximum use of crowded inner-city space on Earth.

Space Station Architectural Approach

The approach to developing basic space station conceptual architecture is shown in Figure 2. The architect functions are very much like those in the development of concepts for analogous facilities on Earth. In space station design, architects work as a team with engineering, construction, environmental protection, operations, logistics, interiors and human factors specialists. The objective of the team is to apply existing technology, related knowledge and experience to conceive of and design a space station facility which accommodates a general and dedicated laboratory, an observatory for viewing instruments, a transportation base for vehicles to transfer to other orbits, a servicing facility for other spacecraft, a manufacturing facility, an assembly facility, and a comfortable habitat for humans.

To conceive of an optimal space station layout, such considerations as interior and exterior functions, functional relationships, resource storage and access, circulation, access to other flight vehicles, sensitivities, contingencies and growth all must be integrated.

Our basic approach involves defining various optional configurations which generally fulfill the same objectives, and scrutinizing them in light of various criteria. As is so often the case in design activities, the final selection is a hybrid of those features which satisfy most of the design and user principles involved in the project. In the space station case, there are system-level and operations specialists and many subsystem specialists, in addition to many user (payload) specialists. Consequently, final design selection involves the same repetitious review process as all major architectural projects. Moreover, the client, NASA, also is intimately involved with numerous specialists, including astronauts, in continuous review before design selection takes place.

To optimize the location of functions in the orbiting facility, we use Function Proximity Value Analysis, with star charts and bubble diagrams, in our conceptual activities. Knowledge of factors affecting humans in space exists in considerable depth from Skylab and Shuttle experience. As the design for the new space station emerges, bio-technical work flow and crew/equipment "linkage" analyses will be performed, as they were on Skylab. Many permutations of functional relationships, circulation patterns and geometry will be studied before the final design is achieved.

Some examples of the process that our team went through to arrive at the configurations illustrated earlier is given here in brief overview fashion. Figure 3 lists the most basic considerations which dictate the gross character of the facility to be designed.

Equipment known to be necessary for a basic station is grossly categorized into modules, along with mission growth modules.

An initial bubble chart of the major functions, incorporating the results of adjacent value analyses, is shown in Figure 4. Certain readily apparent relationships dictate proximities. Figure 5, a line drawing of the final product, is a result of these analyses.

Although there are many constraining influences on the configuration—such as shuttle cargo bay size, flight schedule, minimal crew size philosophies, and safety—much effort is expended in organizing functions in the most efficient manner. This activity is complex by nature because of the great mix of complementary and noncomplementary functions involved, and the general plan to grow into areas not yet clearly definable. Basically, accommodating the routine existence of the crew can be fairly easy, but the many complex functions planned for them, and the significant difference in the many potential payloads, all combine to frustrate the search for optimum functional layouts. This area has been well studied since 1958, and a few space station designers exist who have a considerable understanding of the myriad considerations involved, not to mention actual experience from Skylab.

Configuration Architecture

One such highly experienced configuration designer is George King at McDonnell Douglas. He has probably designed more space station concepts on NASA contracts since the early 1960s than any other person. George is an architect by original training and uses time-tested architectural approaches to his designs. On our study team, George serves as the central figure in determining the configuration impact of all payloads, subsystems and operations.

George begins a project by surveying the team to establish functions anticipated on or around the space station and briefing them on related aspects. The variety of functions calls for a combined home/laboratory/factory/gym/construction shack/space port, a rather significant integration challenge. George's challenge is diplomatically to provide an efficient hybrid of all accommodations so as to assure broad acceptance by all users, subsystem designers and ground and flight operations specialists.

The role played by the architect in the development of the space station involves concerns beyond the purely functional systems and operational needs of the crew. George also must deal with higher level human needs: privacy, socialization and other quality-of-life issues. Using architectural analysis and design techniques, and other Earth precedents for long-term habitations and functional organizations, the space architect must coordinate with the aerospace equipment/operations engineers to find answers to complex problems concerning geometric organization, planning for growth, and internal arrangement. The architect brings to the space station design the expertise and techniques which enable people to perform in unique Earth environments. Transferring this knowledge to space station design enhances people's relationships with their space environments and enables them to better perform their functions while effectively coping with the hostile environment of space.

Fritz C. Runge is program manager for the Space Payload Programs at McDonnell Douglas Astronautics Company in Huntington Beach.

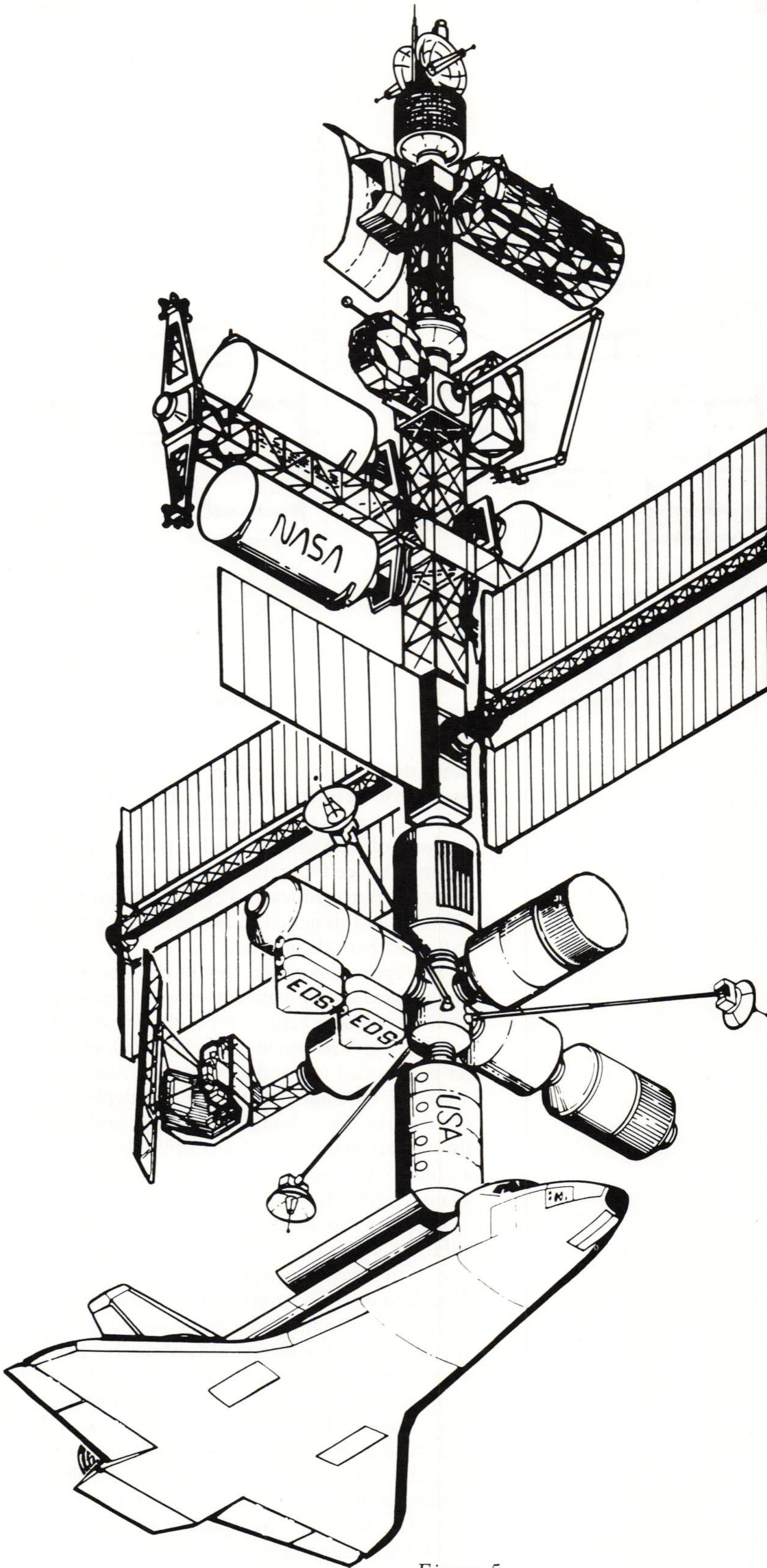
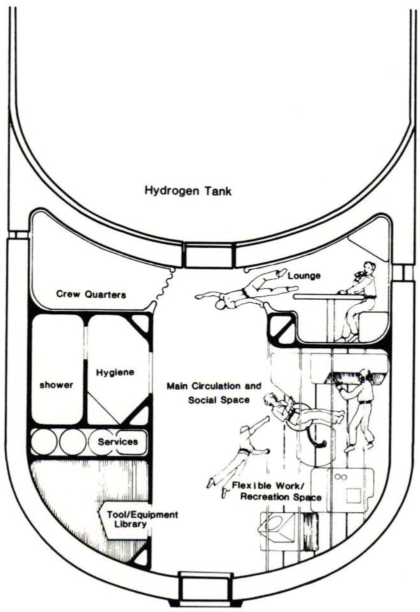


Figure 5

Space Habitat Design

by Robert Pemberton



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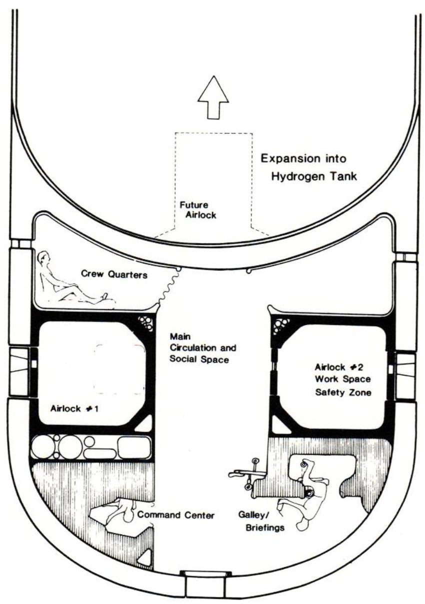

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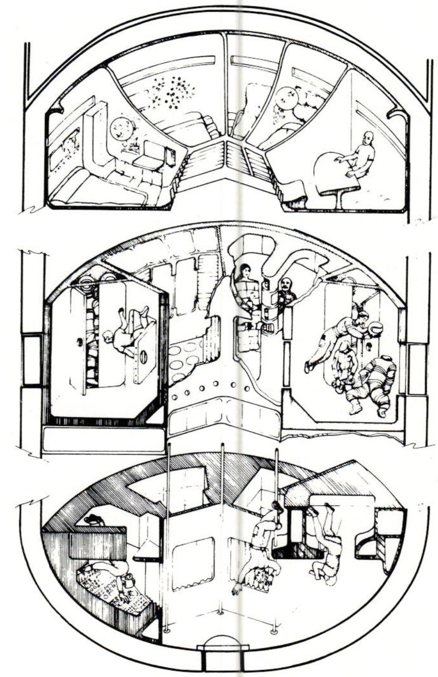


Aft Cargo Compartment

With the introduction of the space shuttle, we now are able to exploit a new and vast environment, deriving from it many benefits. The next logical step in the evolution of space industrialization will be a manned Space Operation Center, under study by the National Aeronautics and Space Administration (NASA) and designed to house humans in space for extended periods of time.

The Space Operation Center departs from previous space station concepts which were designed to serve as research centers for gathering data and conducting experiments. The Space Operation Center is intended to conduct space operations such as assembly, manufacture, service and deployment of satellites. Since humans will work and live in these space stations, permanently orbiting the Earth, architects are becoming more involved in the design of outer space habitations.

Our firm, Space Habitation Design Associates (SHDA), is designing a Space Operation Center for one of the private companies commissioned by NASA to develop prototypes. SHDA is a multidisciplinary research, design and construction team specializing in the design of facilities for harsh and isolated environments, including outer space. Our team consists of a civil engineer with experience in heavy construction in isolated environments, a sociologist who is an expert in space psychology, a physiologist who is an experienced aquanaut, a cultural anthropologist, an aerospace engineer heavily involved in designing the Apollo program, and two architects. Our emphasis is on creating concepts that combine human factors, technologies, and economics into well-balanced, successful environments.

SHDA is working on five different studies for the interiors of a four to six person space station to be located inside an Aft Cargo Carrier (ACC), a module attached to the bottom of the shuttle's external fuel tank. A principal in our firm, Thomas C. Taylor, became involved with the conceptual design of space stations using the space shuttle external tank in 1977. During design development for the ACC, Tom created and patented several innovative techniques for constructing facilities in outer space. The ACC proposal is receiving serious consideration from NASA, and may become the design for America's first space station.

Our work in space habitation design began with a year-long volunteer study for a rotating space station, and a study for a lunar laboratory. The moon base study continues to be researched in our office. On behalf of the European Space Agency, we are studying how to take the European Space Lab module and pallets out of the space shuttle cargo bay and use the bay as a free flyer that will remain orbiting in space. A group of Canadian investors has retained us to design a passenger module for the shuttle cargo bay which can be used to take tourists into space. (Lloyds of London may agree to insure tourist flights into space, thus overcoming one of the project's main problems.) And we are consulting with SRE Development Corporation to develop a \$165 million destination resort hotel, conference center and technology display center, located north of Los Angeles, which will simulate the experience of living in outer space.

Discussions have begun which may result in one of our principals and Director of Design, John Spencer, training as a mission specialist for a space shuttle mission. This would make John the first architect to travel into outer space.

Learning How

Being among the small group of architects who are pioneering a new interpretation of architecture, we began by asking ourselves: How do we design a space station? Where do we begin? There are no books on the state of space station design, no codes

to follow, and, at the time, no schools to attend. (This fall, the Southern California School of Architecture began a program, The Institute of Future Studies, which includes a course on designing for space. John Spencer is directing the faculty for this course.) In essence, we were on our own.

We've spent the past few years learning how to be astronauts, aerospace engineers and psychologists. Several of us have toured various aerospace facilities, sat in space simulators, and tried on space suits to get a better feel for conditions in space and to see how rockets and spaceships work.

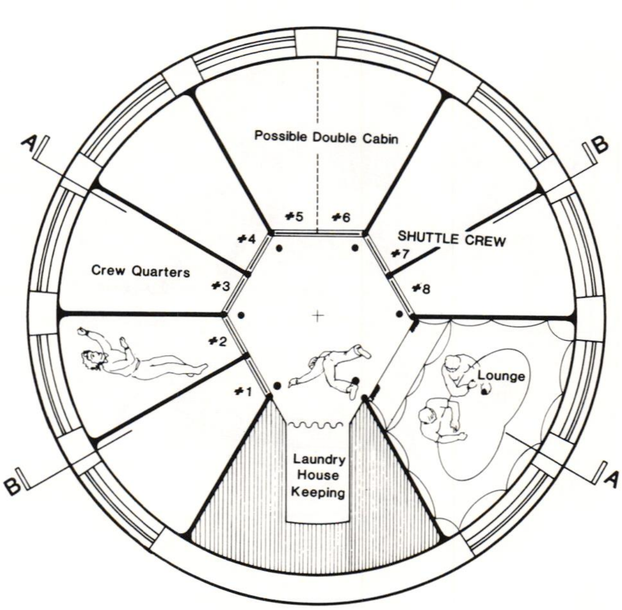
Our only resources on space design were NASA and the aerospace industry. Fortunately, we had excellent contacts with both, and an almost unlimited access to their resources. But everything in the aerospace industry is segregated into different departments, divisions, and sections. It took us four years to gather a fairly comprehensive library, and an understanding about the issues and systems involved. SHDA is now writing the first comprehensive book on basic space station design, operations and crew training. It will be a guideline for the aerospace industry, a *UBC* for outer space design.

In designing space facilities, we found that there are many similarities between the undersea lab, lunar station, arctic and antarctic camps, and off-shore drilling platforms. Their similarities lie in the fact that they are closed, isolated, and in hostile environments, which create life or death situations. Our current work includes a design study for an off-shore drilling rig crew quarters in the North Sea, and the development of interiors and training programs for the Western Regional Underwater Laboratory project, a six person underwater habitat funded by the National Oceanic and Atmospheric Administration. These projects have shown us that the concepts in designing for terrestrial and extraterrestrial hostile environments are different, but the issues tend to be the same.

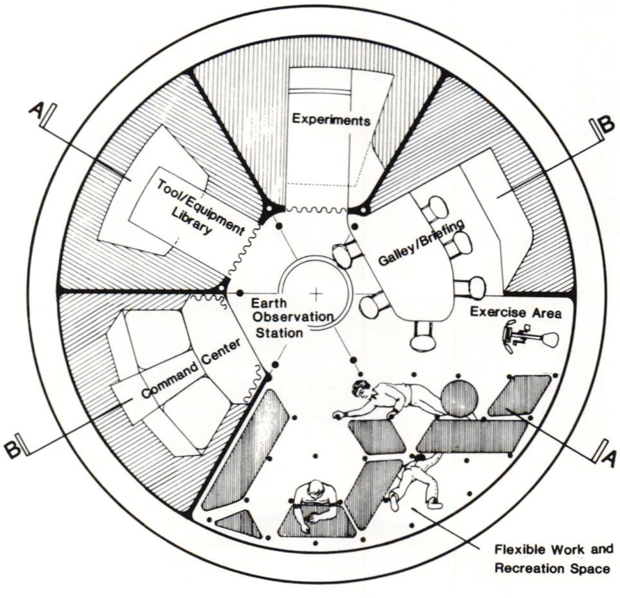
Habitats for both these environments are of limited size, and people will be living in them for extended periods of time. So the perceptions of spaciousness and privacy must be designed into the habitat. Privacy is an important issue. Experience in isolated living environments has shown, for example, that "hot bedding," where two people working alternate 12 hour shifts rotate use of the same bed, creates social tension, since neither person has a sense of privacy. These findings have a direct bearing on space habitat design.

We have learned a great deal from problems that occurred in space stations such as Skylab. Skylab, America's first attempt to live and work in outer space, was actually a third stage of the Saturn 5 booster rocket, which was converted to house three astronauts. One of the problems in Skylab was the location of the A/C vents. It was expected that exhaled air would simply float in front of the astronauts' faces in zero gravity. The A/C vents were set to blow directly onto the astronauts' faces to remove any carbon dioxide that might accumulate as the astronauts slept. The A/C vents so annoyed one astronaut that he slept inverted in his sleeping bag so the air would blow across his feet. It turned out that the airflow in Skylab was adequate to dissipate the CO_2.

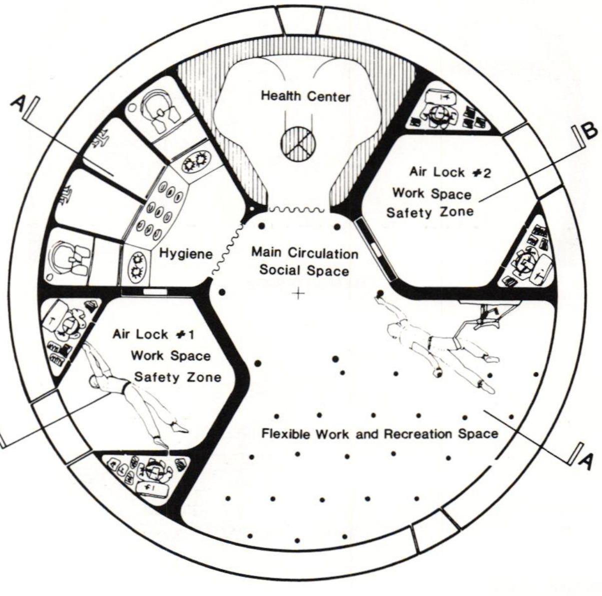
In space, the absence of gravity creates challenging problems. For example: On earth, we are able to walk from place to place because gravity helps create friction between our shoes and the floor, enabling us to move. In zero gravity, one tends to float, so new



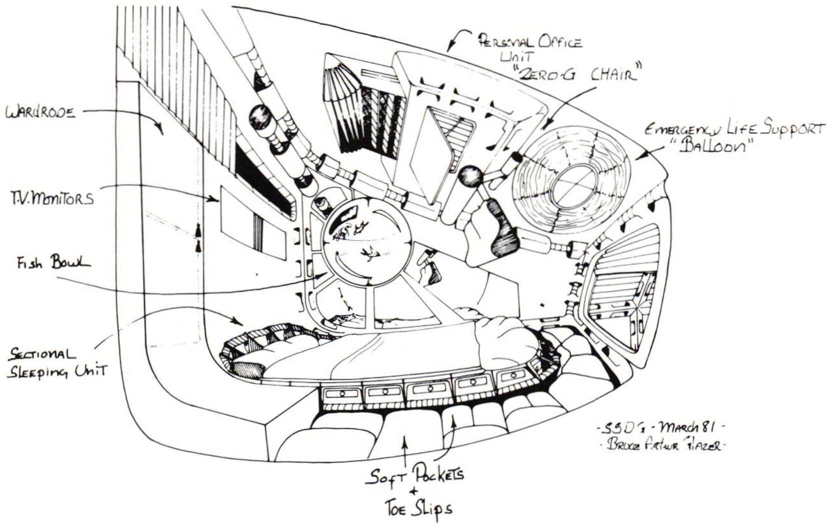
Crew Quarters and Housekeeping

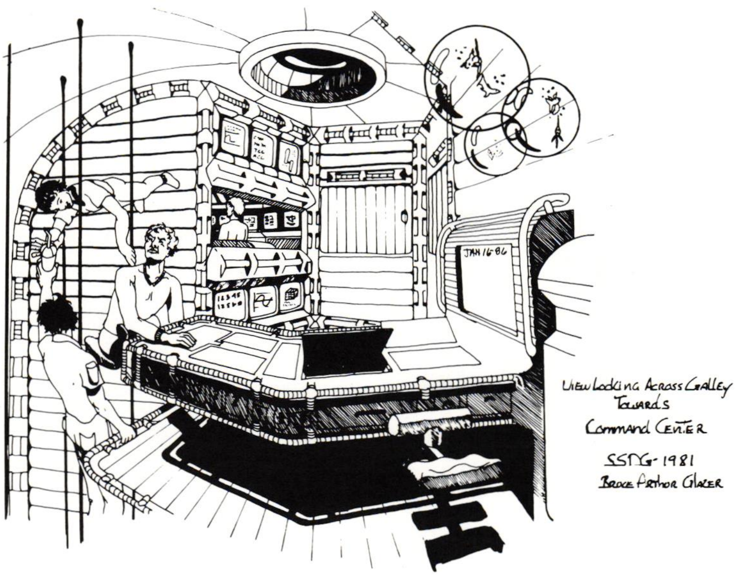


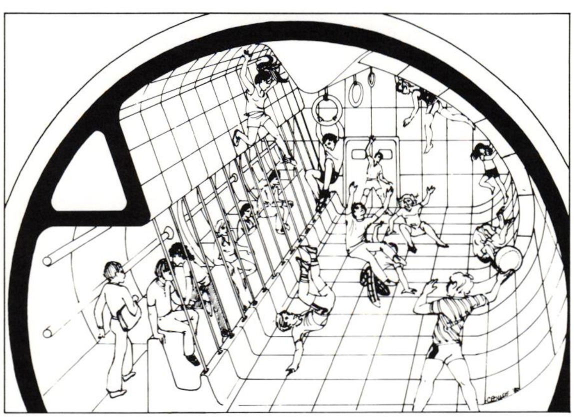
Command Center, Galley and Services



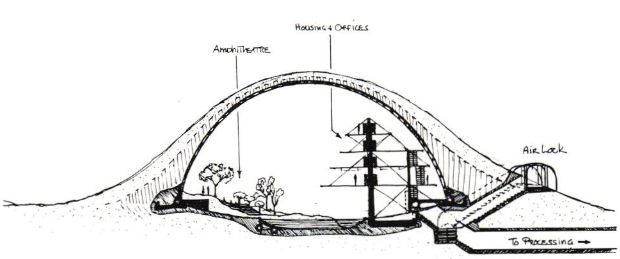
Airlocks, Hygiene, and Flexible Work Space







GYM INTERIOR



Moon base

ways of movement need to be devised. An open grid system was used on Skylab. Astronauts wore special shoes that, when inserted into the grid, created the resistance needed to move. Other methods enabling movement might be magnetic shoes or a network of soft cables throughout the environment, like a three dimensional spider web.

Studying the Russian Spacelab has yielded valuable information on humanizing space environments. The Russians are more tolerant than NASA, allowing cosmonauts to bring spirits and snacks (usually vodka and salami), musical instruments and movies along on their flights. Cosmonauts also design their own work schedules. One of the Spacelab's most important amenities is its 10 portholes (compared to Skylab's one).

Reconceived Ideas

Cultural differences will become increasingly important in the design and use of space habitats as multinational crews begin to live together in outer space. The interaction among people and cultures is the basic building block in space station, as well as terrestrial, design. Human beings always have related to each other on a variety of levels. In designing a space station, we have to consider and isolate those levels which are crucial to the design. Cultural anthropologists have identified 10 basic levels that make up man's activities. The different emphasis placed within these levels differentiates cultures. These activities are

- learning, which involves education;
- interaction through language;
- defense (militarily);
- play (games);
- territoriality (boundaries);
- temporality (cycles of time);
- association (organization);
- sustenance (occupation);
- exploitation (of technology);
- sexuality (behavior and dress of men and women).

These activities are all interrelated, and when one is changed, the others are affected. So in designing for a group of people, it is important to understand their culture in order to avoid problems with the use of the design.

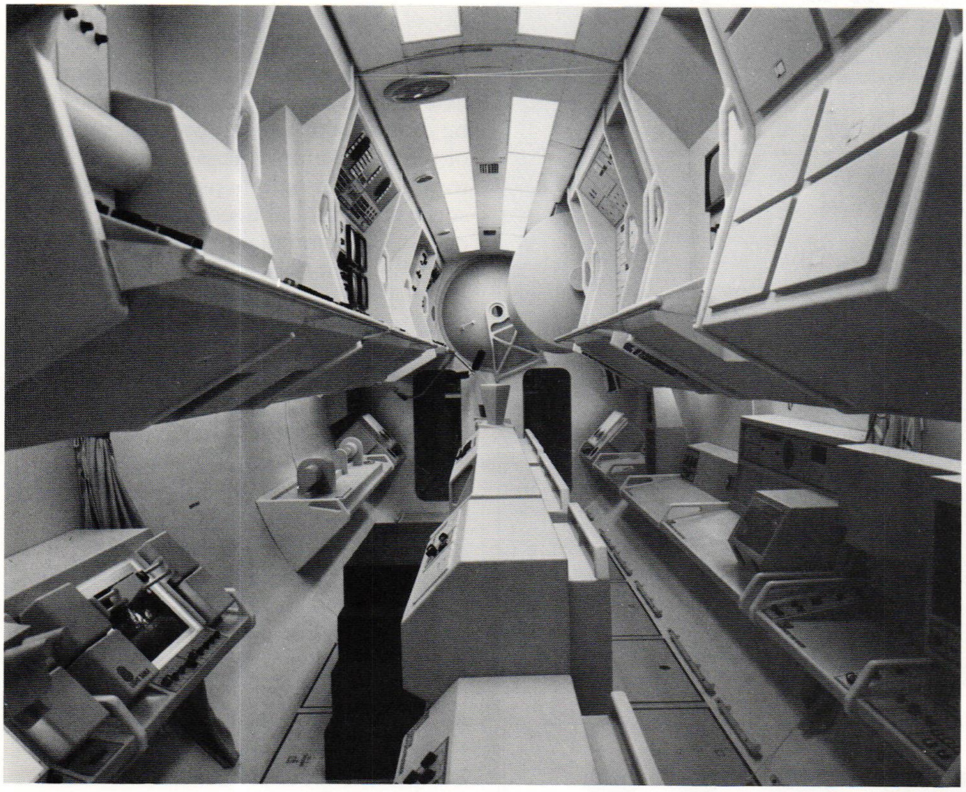
Here on Earth, design is two dimensional, since height restriction and orientation of the doorway, cupboards, desks and chairs are already established by the automatic restriction of gravity. But in space, gravity is absent, and design is three dimensional. There are no height or orientation restrictions. Door openings literally take on new meaning, as do chairs and desks. One could have a desk on the "ceiling," or a chair on the "wall." In designing for space habitats, one must constantly be conscious of breaking away from the traditional ideas used in Earthbound design.

Those of us who are designing space environments have a great opportunity to learn from the unique situations in space, and to transfer that knowledge to Earth. We also have an important responsibility to humanize the space environment and bring together the multitude of conflicting elements into a creative, cohesive, and humanistic design.

Robert Pemberton holds degress in physics and architecture. He is project manager for Space Habitation Design Associates and a design consultant for SRE Development Corporation.

Designing for Human Factors

by George King and Don Magargee



A Spacelab experiments laboratory in full scale mock-up form. Considerations of dense packaging, the feeling of spaciousness, the need for restraints, locomotion aids, lighting, temperature and humidity control and emergency provisioning are but a few of the requirements imposed by the zero-g space rules.

The tried and true architectural adage that "form follows function" continues into the space age, but with constraints. In space, the freedom of design enjoyed by Earth-bound architects is sharply curtailed and replaced with unique constraints and requirements.

To practice space architecture efficiently, one must reorient all prior "ground rules" and work to a new and constantly evolving set of "space rules." No longer is up or down associated with the "one-g" pull of Earth on man. "Zero-g" imposes requirements that, in a sense, limit the designer—but only if he or she interprets them as negative limitations. The secret is to be inventive and creative. One must use the positive advantages of zero gravity and make it work for a design or a specific application. In a space facility, nearly all available space within a given envelope is usable. To effectively integrate a given space and the occupants and functions it accommodates, the architect must adhere to a unique set of design rules.

The absence of gravity poses extremely interesting design challenges affecting most activity. In the world of zero gravity, "up" and "down" have little meaning—ceilings, walls and floors are interchangeable and all can be used as work surfaces. People can move about freely with no need for stairs. But to perform stationary tasks, they need some means to anchor themselves in place. Conventional furniture has little use in space. Without gravity to hold the body in a bent, seated position, one can only sit by continuously tensing the stomach muscles. Consequently, chairs aren't needed. Beds are not required, sleeping bags can be attached to walls or ceilings thus reducing space consumption.

Also, a designer of space architecture must constantly consider that nothing stays where you put it. Items float, get lost, get in the way, and must be contained or restrained. An everyday item such as a glass of water is a major problem. The drink must be contained, protected, restrained, volume consumed accounted for, unused portion disposed of. And finally, the water must be reclaimed or disposed of when expelled by the crew. The many forms of expulsion are all monitored as a facet of crew health and safety. In this function alone, all of the design, engineering, manufacturing and testing involved are quite challenging when compared to the everyday act of consuming a glass of water and using a toilet in our one-g society.

Other elements of daily space life vary in complexity from life on Earth. For example, sleeping restrained on the wall is not too great a challenge, but to prepare, consume, and clean up after a meal three times a day is a monumental task. The requirements and consequent discipline imposed by long on-orbit stays, aspects of large crews of men and women, and the activity of structural building and maintenance outside of the station are a significant challenge for the imagination.

Skylab demonstrated the ability of humans to adapt physically and mentally to extended missions in space, but providing facilities for larger, more diverse groups in the forthcoming space station will pose new challenges. The crew, being a critical part of the space station system, must be used effectively like other valuable resources. The crew will consist of a large number of trained individuals whose activity and participation will vary widely over the years of station operation. The crew makeup represents a range of technical and scientific disciplines operating as independently as any Naval vessel or remote expedition and/or outpost requiring periodic logistics support.

People tend to get bored during extended terms in isolation, which can be countered by including variety in planning menus, designing interiors and scheduling time. Reducing tensions among individuals living in close quarters with limited privacy is essential. While the Skylab proved that space is habitable, it also revealed situations that sometimes affected health and morale. The astronauts required extensive exercise to compensate for lack of gravity. Some had trouble holding down certain food; others had trouble sleeping, and were often awakened by the spacecraft's noises. The ability to maintain people in a healthy and contented state for long periods of time will be an important economic factor.

The longer the crew remains in orbit and the happier they can stay, the more productive they will be.

Crew composition of future space stations will demonstrate a striking difference from today's shuttle crews. Crew size will be much larger, with more specialization, and require more formal social and organizational structure. The diversity of crews presents the largest challenge to design. Mixed male/female crews will become commonplace, age range will extend in both directions, and crews will be drawn from a much broader spectrum of the population. These crews will bring to space flight unique psychological, social and cultural needs, including the need to be continually reassured of the safety of their habitat. The spartan accommodations accepted by the homogenous, highly trained, and motivated astronauts of today will not be acceptable in the space era of the next decade.

Habitability isn't new. Human beings have endeavored to make their living and working places more habitable since people lived in caves. Professions such as interior design and architecture were developed and refined to further the cause of habitability. The interior design/interior architecture of the space station—especially the habitation modules—uses the principles of architecture and interior design to maximize the livability of the interior space by increasing the apparent size of the spaces and providing sensory stimulus, spatial variety, and kinesthetic involvement.

In the design of manned spacecraft, engineers have addressed the human needs of the flight crew, but sometimes without sufficient understanding of what those needs are or how design can best satisfy them. Consequently, much research is planned. The needs such as privacy, variety, satisfaction, recreation, recognition, good health, cleanliness, social interactions, confidence in mission and safety, satisfying food, acceptance and spiritual support are some of the basic human needs of all people on Earth, but become more important for space missions. With long duration and larger, more heterogenous crews, failure to satisfy these needs can lead to morale breakdown, decreased motivation and even physical deterioration.

Since eating is important both physically and psychologically, food service planning must receive major design emphasis. Providing meals for a large crew poses problems which call for new approaches for bulk storage and preparation rather than individual self-serve packages. The need for satisfying food is much more important than the nutritional quality. Variety, appearance and taste, with proper provisions for preparation, serving, and

cleanup, are primary considerations of the habitat designer.

Good grooming is very important. On long-duration space flights, grooming is related to the need for acceptance by fellow crew members, and may be particularly important in maintaining morale. Therefore, grooming specialists and facilities may be one of the specialized areas in the space station.

Lack of privacy can be tolerated by most for short periods, but as stay times in orbit increase, crews' demands for privacy will increase. In addition to accepted needs for privacy when performing personal activities, crews will need private places where they can retreat for relaxation, solitude and contemplation.

Space flight jobs will never be just like jobs on Earth, but they will become more routine than now, so crews will place high value on off-duty activities. Facilities for off-duty physical fitness, recreation, social interaction and self-improvement will become very important, as will design configurations which separate work areas from off-duty areas.

The real challenge facing architects and designers today (to assure success of future space stations) is to develop crew-related designs that satisfy the following demands:

- Provide habitats that are aesthetically satisfying, psychologically and socially supportive, variable and safe.
- Place no time limits on the length of time crew members will voluntarily occupy the habitat.
- Accommodate the entire range of population selected to occupy the station in terms of body size, sex, cultural and educational background.
- Meet these demands within weight, volume, safety and cost constraints.

In the final analysis, whether the space station interior design satisfies the needs of the crew will be a subjective judgment by the individual crew members, but the habitat designer must be able to predict in advance whether his or her design will receive a favorable judgment. Thus, prediction of individual responses to specific aspects of the station design is one of the most important research challenges of designers, engineers, and architects.

Architect/civil engineer George King, formerly with DuPont Corporation's Architectural Group, is space station designer for McDonnell Douglas Astronautics Company in Huntington Beach. Don Magargee, a graduate of The University of Southern California School of Architecture/College of Industrial Design, is a member of the Crew Systems Group for McDonnell Douglas Astronautics Company in Huntington Beach.

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Over the last few years my architectural practice has taken a different path—one that I have found interesting and satisfying and which has been of considerable value to my clients. I am a consulting architect to several small institutions on matters pertaining to the periodic maintenance and renovation of portions of their physical plants. The institutions are all privately owned and have staffs of approximately 30 to 50 people. Because of budget limitations, they have either not been able to hire highly qualified buildings and grounds employees or else the personnel are too busy to perform proper maintenance. Work is performed haphazardly without regularly scheduled preventive measures, and the resultant crises always take precedence. The institutions' directors cannot depend on the necessary work being accomplished at the proper time, if at all. This has resulted in many problems relating to the condition of their facilities, such as:

1. Situations were allowed to develop into more serious or expensive conditions because the employees were either not sensitive to incipient problems or did not know how to deal with them.
2. When repairs were made, the costs were high. Often, full value was not obtained because the contracts were let without competitive bidding. Instead, the contract (if there even was one) might be let to a friend of a staff or board member.
3. Even when competitive bidding was used, unfamiliarity with the bidding process and lack of plans or specifications resulted in confusion. The owner had trouble evaluating the bids. Renovation, replacement and maintenance work is difficult enough to estimate or bid without compounding the problem with inadequate plans and specifications.
4. When work was performed, no one on the staff was familiar with proper

as Consultant

by S. Robert Bronfen, AIA

construction techniques and the work was not effectively inspected. This often resulted in substandard work, such as water heaters without relief valves or improperly flashed roof penetrations.

5. Because the job conditions were unpredictable, the scope of the work often changed or expanded during the repair process. Other contractors or subcontractors were required, and the owner was at the mercy of the original contractor concerning the selection of the additional workmen.

Traditionally, architects have not been involved in maintenance work for small institutions. Instead, an architect member or supporter of the institution might volunteer his services and then haphazardly become involved in the repair process, seldom inspecting the work. Hence, most of the above-mentioned problems still existed.

In my type of practice, the architect serves as a maintenance consultant to the institution, usually working on an hourly rate basis and being called as needed. The annual cost to the institution can be quite low—less than hiring a qualified professional as a full-time employee. Beyond this cost advantage, the architect can bring other values to the client in the process. An important one is the aesthetic awareness he or she brings to the work, an awareness that is sometimes either forgotten by, or lacking in, the staff.

Creative solutions to simple, everyday maintenance problems are more feasible with input from a trained person. The architect's critical examination may suggest changing the existing facility by rebuilding or repairing in a manner that enhances it or gives more flexibility.

A continuous, long-term relationship with one consultant provides consistency in solutions and in design. Also, the architect becomes familiar with all the buildings or processes and can quickly grasp

the problems and their interrelationships with other functions. This permits efficient use of the consultant's or staff's time in either defining or solving the problems.

Sometimes the very fact that an architect is consulted forces the client to more clearly define the need or to question the existing function of some part of the facility. Although the solution may then result in a greater cost, the institution is apt to feel the added value is worth this expenditure.

The architect's familiarity with the bidding process, often lacking in the staff, makes it easier to obtain competitive bids for the owner. This will probably save money; it will also minimize the pressure to show favoritism to contractors who are friends of staff or board members.

The architect, in conjunction with the staff, can formulate an overall redevelopment or maintenance plan that incorporates varying priorities, cost estimates, and the necessary interrelationships between different types of work. This will aid the institution's annual budgeting process in scheduling and allocating funds for repair work.

I prepared this type of plan for a private school. The plan called for complete redevelopment, including such items as upgrading athletic fields, installing yard irrigation systems, replacing electrical and mechanical services and fixtures, replacing windows, reroofing, repainting and new hardware. In addition, the plan calls for an annual allocation of funds for future replacement work as it becomes necessary over the projected life of the buildings.

For a museum, I prepared a $275,000 maintenance plan consisting of repaving, repainting, reroofing, new hardware, kitchen upgrading, new and renovated heating systems, and extensive plumbing and electrical work. I then obtained bids, inspected the work and processed all the paperwork.

Smaller institutions often try to manage without proper visual aids. I have observed board meetings where there were no maps, surveys or photos, and where the board members were not completely aware of the location of the particular property or area being discussed. For one institution, I suggested a compilation of existing surveys and parcel information into one overall plan, and we obtained an aerial photo including property lines. These items were quite inexpensive, considering the amount of information made available, and they are things most architects would readily recognize as being necessary for proper management. Yet many institutional personnel do not think of them. A second local institu-

tion has now authorized me to provide similar information.

Two other advantages to the client are that the work is better performed because the architect recommends better quality contractors and inspects the installation; and the staff is left free to perform its primary mission of teaching, research or management, while the architect basically handles all the construction work and paperwork associated therewith. One director has told me how pleased he is to be relieved of the inefficient use of his time acting as "general contractor."

The maintenance consultant concept might also lend itself to other kinds of building or development projects: apartment houses, hotels, industrial buildings and commercial structures. Similar advantages would apply where the size of the project makes it unfeasible for an owner to afford a full-time professional staff member.

There are also advantages to the architect, usually somewhat different than one experiences in traditional private practice. The architect becomes practically a part-time member of the staff, dealing with many of the people at the institution on a frequent basis. He learns interesting facts about different professions or disciplines. For example, I have been involved in the re-articulation of a 70 foot long whale skeleton at a natural history museum. I have also researched why there was an infestation of booklice in a botanic garden's herbarium (reason: high humidity).

The architect's work sometimes expands beyond the pure maintenance aspects of the institution's needs to involve other types of work. Because the architect becomes so intimately familiar with the client's operation, the management comes to rely upon him for space or land use studies, programming for future buildings, or cost estimates for future rehabilitation programs.

The work is often more people-oriented than that of a conventional practice. The architect deals with staff and contractors relatively more frequently and spends more time in the field. Less time is spent "on the boards." It is more dynamic! Conversely though, less design work is performed, and a design-oriented architect may not find the work satisfying.

The architect can develop a continuing financial relationship with the institution. Rarely does a month pass without some consultation work. It is a process that helps insure continuing income and is somewhat of a hedge against those times when general construction is down.

The maintenance consulting work fits well with a small or sole-professional office because the need for either preliminary or working drawings is minimal. The

institutions want to work with the principal, want the architect available for meetings, and, because of the continuing relationship, want priority given to their needs. But their needs are usually of short-term duration for the architect, counted in hours instead of in weeks or months as is common with conventional design and construction projects.

If an architect wants to develop this kind of practice, he must introduce the idea to institutional managers or directors that such a service is available and can be of value to them. One of the difficulties that must be overcome is the conventional wisdom that an architect is hired only for designing the institution's next building or addition or remodel. Because the maintenance or renovation consulting service is not a familiar one, it is difficult for the manager to conceive of the architect in that role. But once the architect has demonstrated the value of maintenance consultation with one institution, that example can be used in attracting other clients.

To obtain such work, the architect should first approach the chief administrative officer of the institution and not the maintenance superintendent who might consider the architect a threat. Actually, the architect can be quite supportive of the superintendent, because they are both concerned about the provision of adequate funds for necessary maintenance work, and the result will normally be an enhancement of the superintendent's position or activities. But the architect must be aware of the superintendent's needs and sensitivity, and should involve him in any investigations, using his opinions and experience whenever possible. A cooperative relationship is necessary if either is to be successful in his role.

There is one other advantage to the architect that deserves mention. Because of the frequent interaction with staff members, close friendships can develop. The architect becomes involved in many of the institution's social functions. The result is a warm, satisfying practice that enhances life, yet is interesting and challenging professionally. For the institution, faced with today's high cost of maintenance work and with the difficulty of raising operating funds, it means money no longer needs to be wasted on overpriced or inadequate work. The architect, acting in a maintenance consultant role, can be of great service to small institutions in helping them obtain optimum value for their money.

S. Robert Bronfen, AIA has his practice in Santa Barbara.

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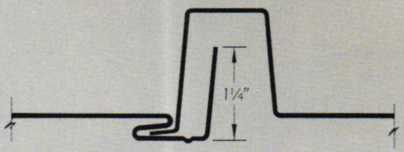

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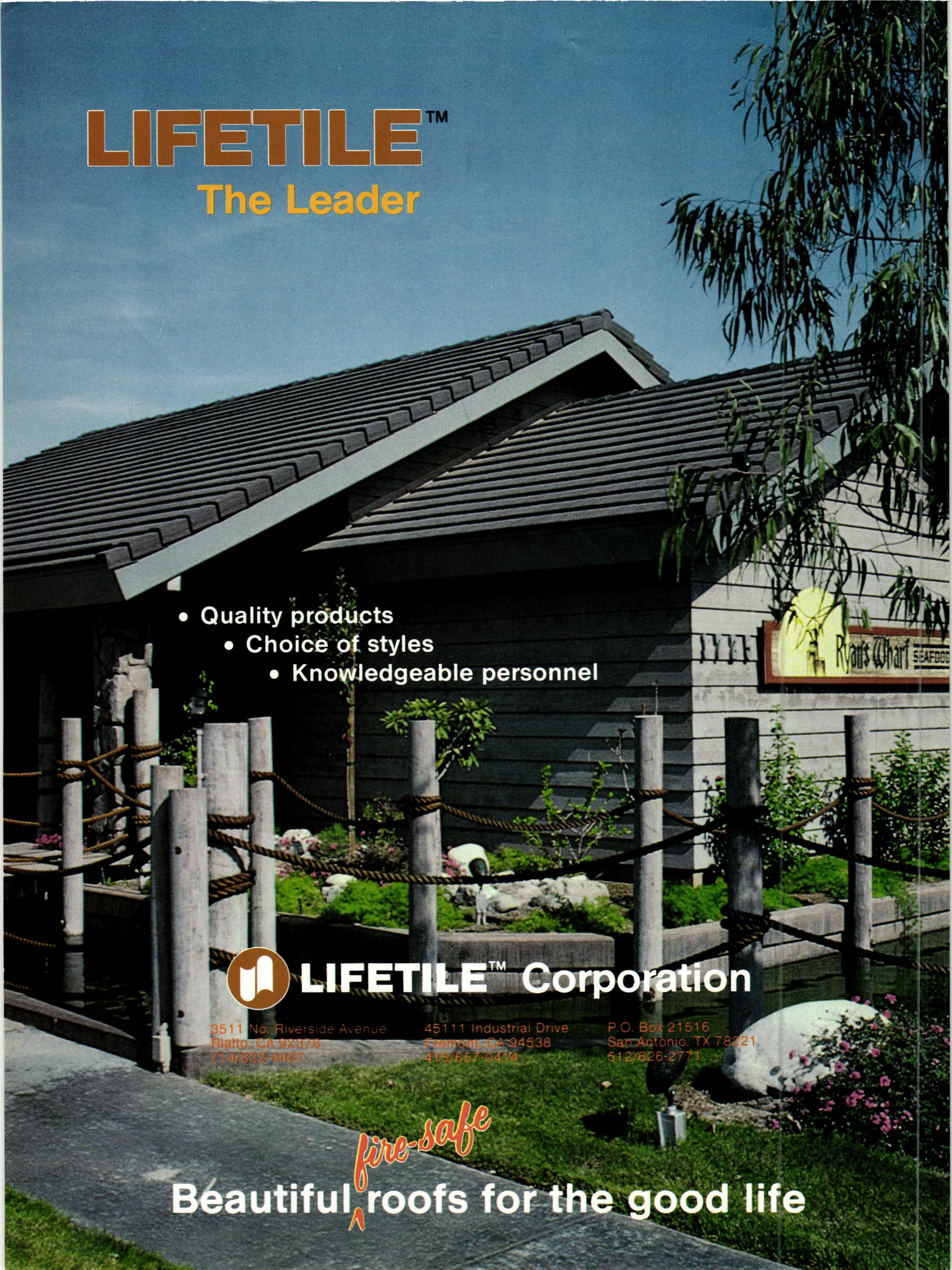
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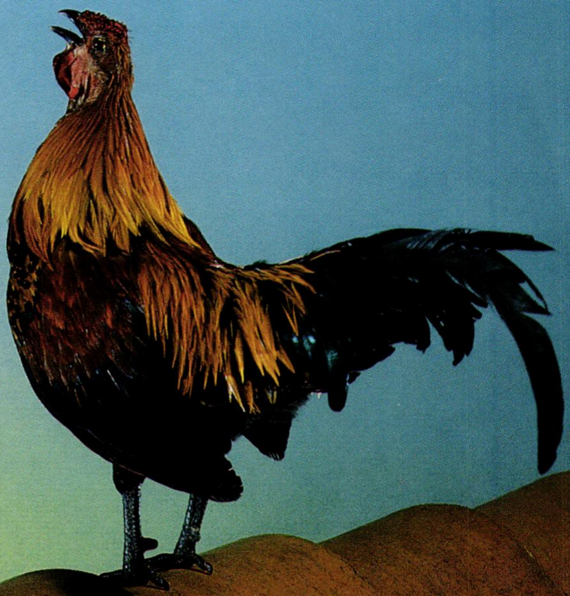


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