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ENVIRONMENT III

-ANTARCTIC HIGH STATION

-A COMPETITION TO DESIGN A SPACE ANALOG ON THE HIGHEST POINT OF THE POLAR PLATEAU

-SPONSORED BY THE NATIONAL SCIENCE FOUNDATION AND THE AMERICAN INSTITUTE OF ARCHITECTURE STUDENTS

-BY: SCOTT A. JONES

-SCHOOL OF ARCHITECTURE, MONTANA STATE UNIVERSITY

-ADVISORS:
- -FERD JOHNS
- -RON HESS
- -JUDY THEODORSON

THESIS STATEMENT:

THERE ARE MANY DEFINITIONS OF "ARCHITECTURE," BUT IT IS GENERALLY AGREED UPON THAT ARCHITECTURE MUST BE ENVIRONMENTALLY AND CONTEXTUALLY CONSCIOUS. IT MUST CREATE SPACE AND ANTICIPATE FUTURE SPATIAL EXPERIENCES.

MY CHALLENGE AND GOAL IN THIS THESIS WAS TO EXPLORE AND QUANTIFY THE DESIGN PROCESS IN APPLICATION TO A SPECIFIC PROBLEM. SOME ADDITIONAL ISSUES I WANTED TO RESEARCH WERE, ENVIRONMENTAL IMPACT, HUMAN BEHAVIOR IN RELATIONSHIP TO ARCHITECTURE, AND USE OF ADVANCED TECHNOLOGY IN PHOTOVOLTAICS AND ENERGY SYSTEMS. THE ENVIRONMENT III COMPETITION ALLOWED ME TO TAKE ALL OF THESE ISSUES TO THE EXTREME.

MAY 10, 1993

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TO MARK LANGAUNET (MY HIGH SCHOOL DRAFTING TEACHER) FOR HIS DEDICATION TO ARCHITECTURE AND HIS PERSONAL CONCERN FOR STUDENTS WHICH INSPIRED ME TO PURSUE THIS FIELD.

I WOULD ALSO LIKE TO THANK MY FAMILY AND FRIENDS, ESPECIALLY MY WIFE, ANNETTE, FOR THEIR SUPPORT THROUGH GOOD TIMES AND MORE GOOD TIMES. IT IS THESE PEOPLE WHO HAVE ADDED THE TRUE VALUE TO MY EXPERIENCE.

"WE DON'T INHERIT THIS EARTH FROM OURR ANCESTORS, WE BORROW IT FROM OUR CHILDREN" (Author Unknown).

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~ III. DESIGN PROCESS

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~ FINAL PRESENTATION SLIDES

INTRODUCTION:

I HAVE CHOSEN THE ENVIRONMENT III COMPETITION FOR MY THESIS PROJECT SPRING 1993. THE CHALLENGE IS TO DESIGN AN ANTARCTIC HIGH STATION TO HOUSE TWELVE SCIENTISTS FOR UP TO A YEAR. THE STATION WILL ALSO BE A SPACE ANALOG TO STUDY LIFE IN AN ISOLATED AND CONFINED ENVIRONMENT VERY SIMILAR TO A SPACE STATION OR A COLONY ON MARS. THE SITE IS LOCATED ON THE HIGHEST POINT OF THE POLAR PLATEAU NEAR THE MAGNETIC SOUTH POLE. FROM THIS LOCATION SCIENTISTS CAN STUDY AND TAKE MEASUREMENTS ASTRONOMICALLY WITH THE LEAST AMOUNT OF DIFFRACTION FROM MAGNETIC PULL. ALSO, ITS ALTITUDE, NEARLY 16,000 FEET, HELPS SCIENTISTS TO AVOID DISTORTION CREATED BY THE ATMOSPHERE ITSELF.

THERE ARE SEVERAL REASONS I HAVE CHOSEN THIS PARTICULAR PROJECT FOR MY THESIS. THE FIRST IS MY INCREASING CONCERN OF THE ENVIRONMENTAL IMPACT ARCHITECTURE HAS AT A GLOBAL LEVEL. THE PROMINENT ISSUE THIS COMPETITION ASKS US TO DEAL WITH IS TO MINIMIZE ENVIRONMENTAL IMPACT OF HUMAN PRESENCE.

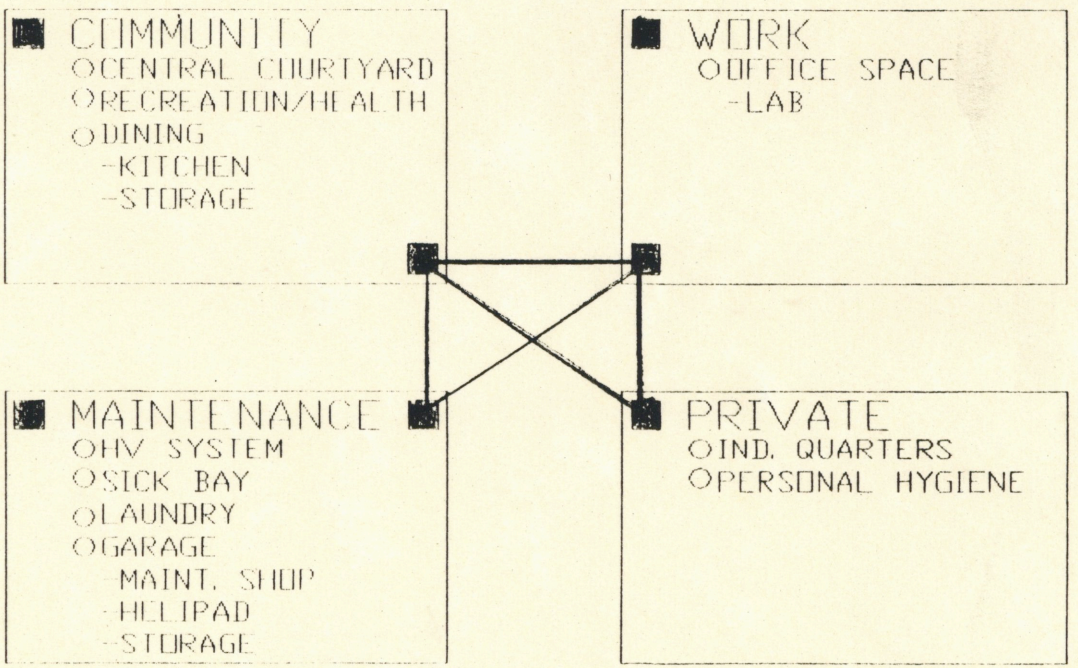
I HAVE ALSO CHOSEN THIS PROJECT BECAUSE MOST SCENARIOS INVOLVED WITH IT ARE TAKEN TO EXTREME LEVELS. FOR INSTANCE, DUE TO ITS LOCATION IT IS AS CLOSE TO A NON-HUMAN ENVIRONMENT AS ONE WILL FIND. OTHER EXTREMES INCLUDE SUNLIGHT OR LACK OF FOR THREE MONTHS A YEAR. IT ALSO CREATES AN EXTREME WITH DEVELOPING THE ERGONOMIC ISSUES OF THE PROJECT. UNLIKE TYPICAL LIFESTYLES PEOPLE ARE NOT CONFINED TO A PLACE EIGHT HOURS A DAY, BUT FOR UP TO TWELVE MONTHS AT A TIME. THE ISOLATION AND NEED FOR A SELF-SUPPORTING ENERGY SYSTEM GIVE ME AN EXCELLENT OPPORTUNITY TO STUDY CURRENT PHOTOVOLTAIC PRACTICES AND APPLICATIONS.

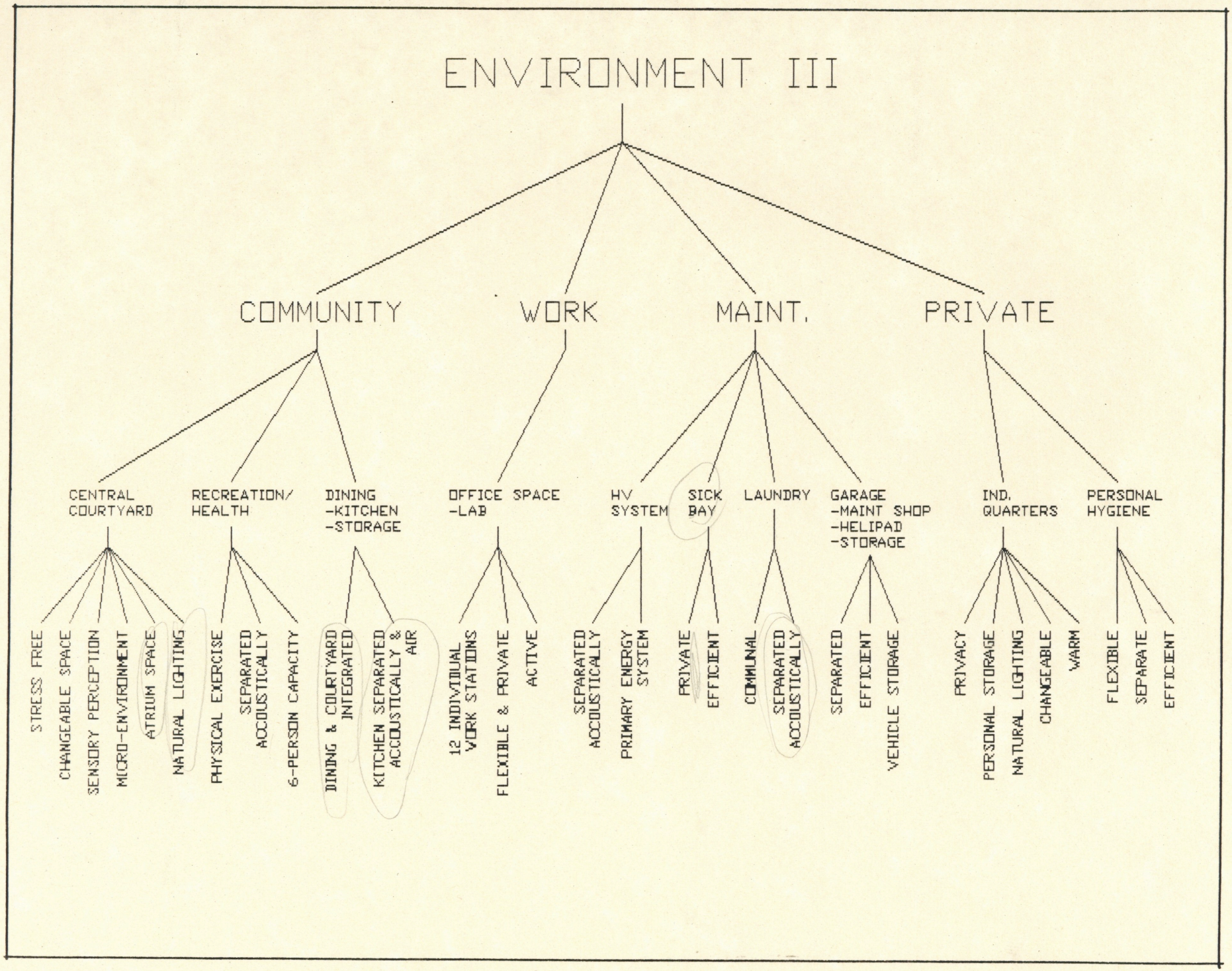
FINALLY, BY CHOOSING A NATIONALLY SPONSORED COMPETITION I HAVE PROVIDED, IN MY OPINION, A CHALLENGE FOR MYSELF, AND ALSO APPRECIATE THE REALITY AND GUIDANCE IT BRINGS TO MY THESIS.

I. DESCRIPTION OF VEHICLE

A. SITE (SEE APPENDIX A FOR COPY OF COMPETITION PROGRAM)

B. QUANTITATIVE PROGRAM (SEE DIAGRAM OF PRIMARY AREAS BELOW)




ENVIRONMENT III
COMMUNITY
WORK
MAINT.
PRIVATE
CENTRAL COURTYARD
RECREATION/ HEALTH
DINING -KITCHEN -STORAGE
OFFICE SPACE -LAB
HV SYSTEM
SICK BAY
LAUNDRY
GARAGE -MAINT SHOP -HELIPAD -STORAGE
IND. QUARTERS
PERSONAL HYGIENE
STRESS FREE
CHANGEABLE SPACE
SENSORY PERCEPTION
MICRO-ENVIRONMENT
ATRIUM SPACE
NATURAL LIGHTING
PHYSICAL EXERCISE
SEPARATED ACCOUSTICALLY
6-PERSON CAPACITY
DINING & COURTYARD INTEGRATED
KITCHEN SEPARATED ACCOUSTICALLY & AIR
12 INDIVIDUAL WORK STATIONS
FLEXIBLE & PRIVATE
ACTIVE
SEPARATED ACCOUSTICALLY
PRIMARY ENERGY SYSTEM
PRIVATE
EFFICIENT
COMMUNAL
SEPARATED ACCOUSTICALLY
SEPARATED
EFFICIENT
VEHICLE STORAGE
PRIVACY
PERSONAL STORAGE
NATURAL LIGHTING
CHANGEABLE
WARM
FLEXIBLE
SEPARATE
EFFICIENT

C. QUALITATIVE PROGRAM

1. KINETIC CYBERNETICIAN

a. Kinetic Art: An art form, such as an assemblage or a sculpture, made up of parts designed to be set in motion by an internal mechanism or external stimulus, such as light or air.

b. Cybernetician: The theoretical study of communication and control processes in biological and mechanical systems, especially the comparison of these process in biological and artificial systems.

c. Design Cybernetics: Various strategies to achieve desirable habitability or facility performance (Webster, 1986).

I HAVE CHOSEN THIS TERM TO DESCRIBE WHAT I FEEL IS THE "HEART" OF MY THESIS. IN ESSENCE MY CHALLENGE IS TO DESIGN A SELF-SUSTAINING CIRCLE OF LIFE, A MICRO-COMMUNITY IN WHICH ALL ASPECTS OF PHYSICAL LIFE AND SENSORY PERCEPTION EXIST. WE OFTEN RELY ON OUR ABILITY TO ESCAPE A PARTICULAR ENVIRONMENT TO SATISFY OUR BASIC NEED FOR A COMPREHENSIVE AND SANE EXISTENCE. BY LIMITING ONES ENVIRONMENT, EMPHASIS IS PLACED ON THE NEED FOR ALL FACTORS TO BE THOROUGHLY EXAMINED WITHIN THAT ENVIRONMENT. THIS REQUIRES A FLEXIBLE PROGRAM WHICH PROVIDES A MEANS FOR ACTIVE PHYSICAL PARTICIPATION AND SENSORY AND PSYCHOLOGICAL ESCAPE.

II. CASE STUDIES

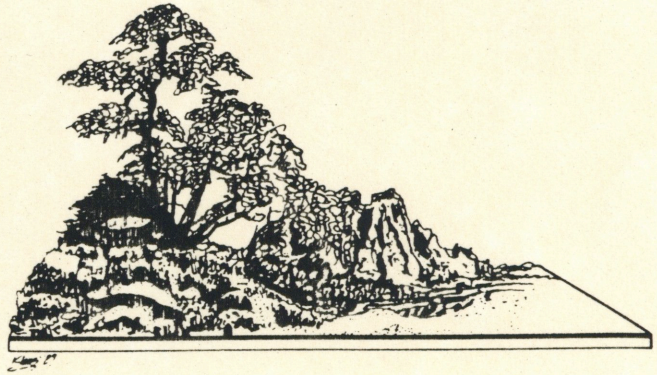
A. FROM ANTARCTICA TO OUTER SPACE (SEE APPENDIX B)

1. Life in Isolation and Confinement
2. Design in asperous environments
3. Micro-environments



A miniature forest on a lake.





A seashore microenvironment.

B. SUN ANGLE DATA (SEE APPENDIX D)
   1. Maximum sun angles
   2. Winter and summer solstice

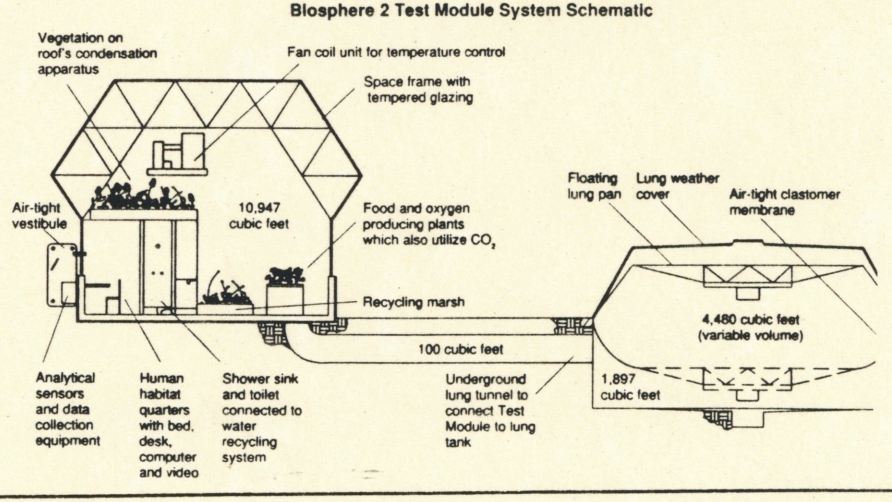
C. POLAR PROSPECTS (SEE APPENDIX B)
   1. US South Pole Station
   2. Geology



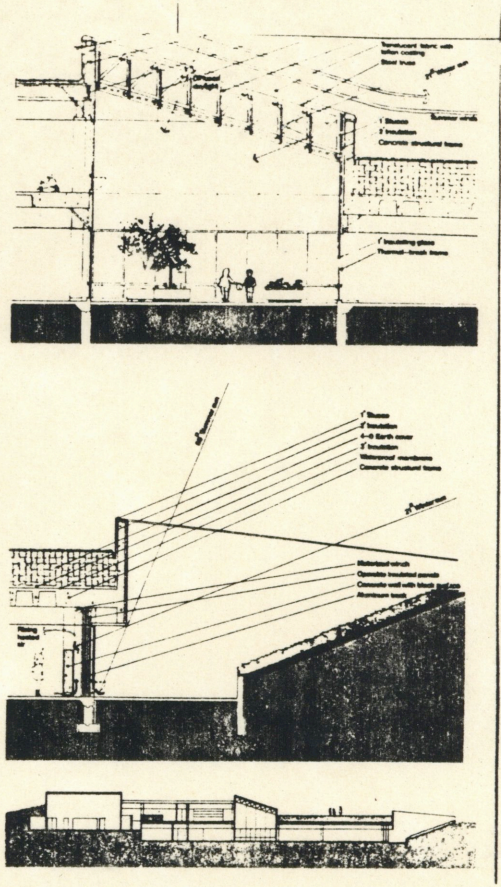
Photo credit: U.S. Geological Survey

Aerial view of the U.S. South Pole Station.

D. BIOSPHERE II (SEE APPENDIX E)
   1. Prototype for a space colony
   2. Self-sustaining micro-environments



E. ENERGY EFFICIENT BUILDINGS (SEE APPENDIX D)
1. Passive design
2. Photovoltaics

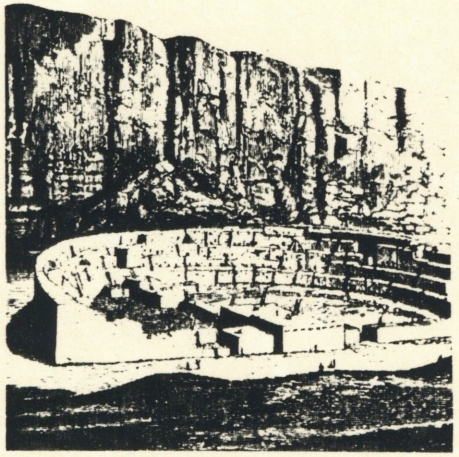


Elementary School Apple Valley, Minnesota

THREE PERSPECTIVES ON ENERGY

This essay argues that it is not nearly enough to concern ourselves with the technology of the energy problem—but that we also need to concern ourselves with its historical, economic, and cultural aspects if we are to solve it.

by Donald Watson



Pueblo Bonito in New Mexico. An analysis of the structure shows irradiation in winter to be constant from 8:00 A.M. to 4:00 P.M. and greater than in summer, during which it decreases during the hot afternoon (from *Contributions to North American Ethnology*, 1881).

-FOR ADDITIONAL CASE STUDIES AND RESEARCH DATA REFER TO APPENDIX TABLE OF CONTENTS

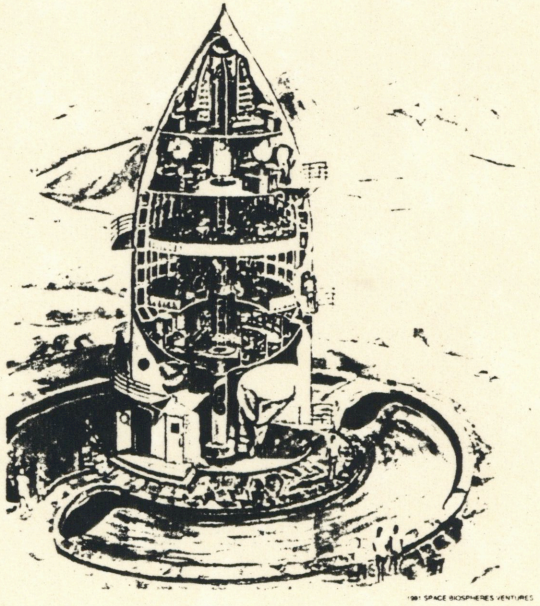
III. DESIGN PROCESS

A. RESEARCH

1. Antarctica
2. Environment III Program
3. See Case Studies and Appendix

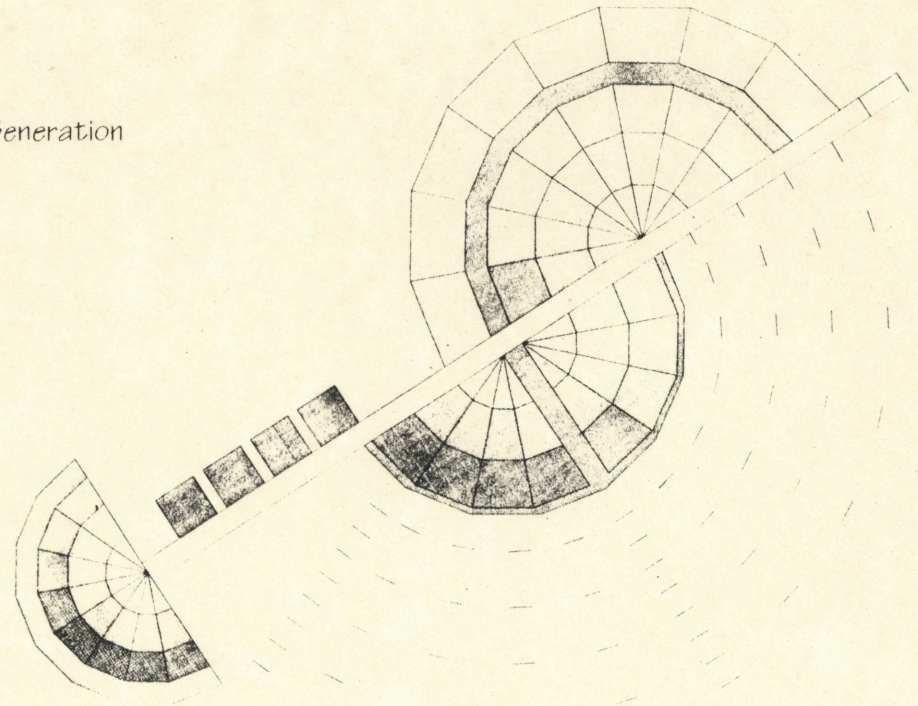
B. STUDY MODELS

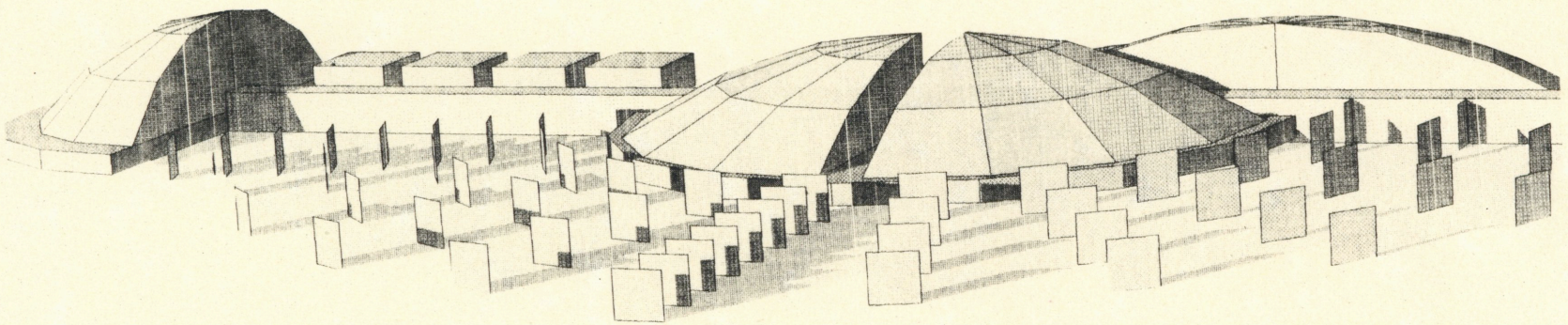
1. Light Study Model
2. Form Study Model
3. Circulation Study Model



C. PRELIMINARY DESIGN

1. Computer Aided Form Generation
2. Light Studies



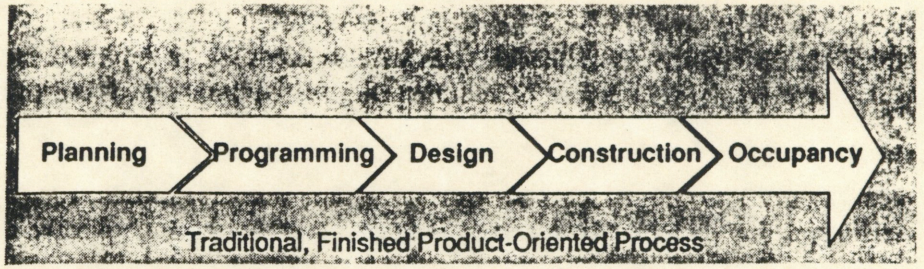


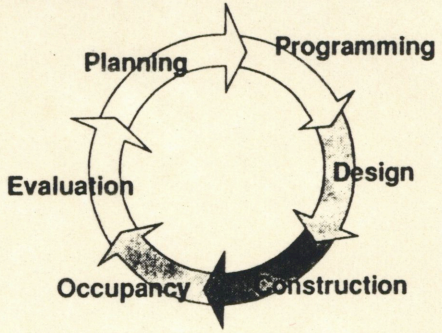
C. FINAL DESIGN

1. Design Process

   a. evolutionary, cyclic

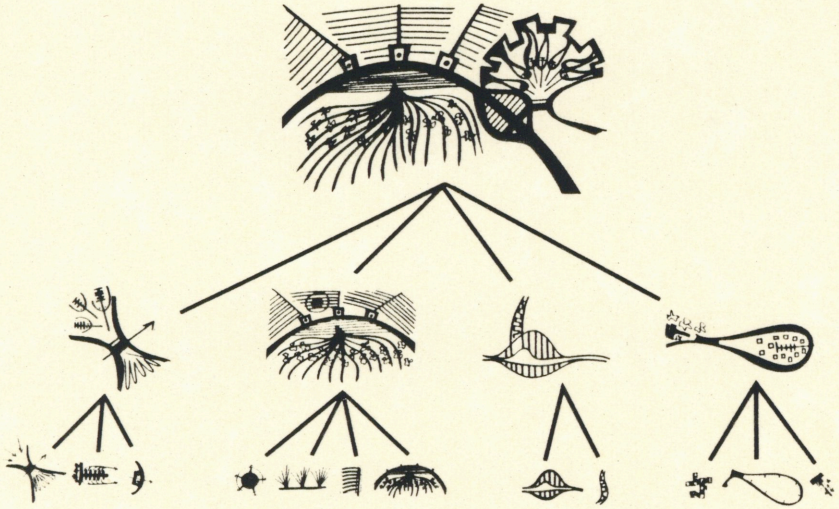
   b. (see kinetic cybernetician-lc)



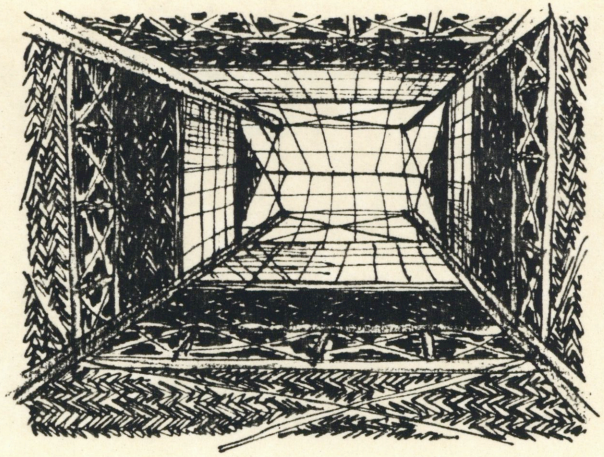


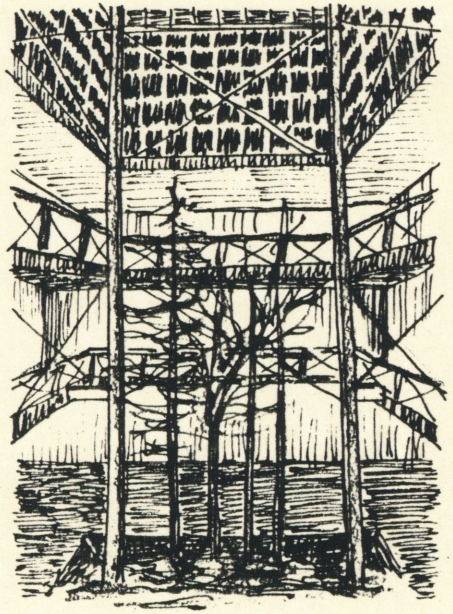
Evolutionary, Cybernetic Feedforward Process

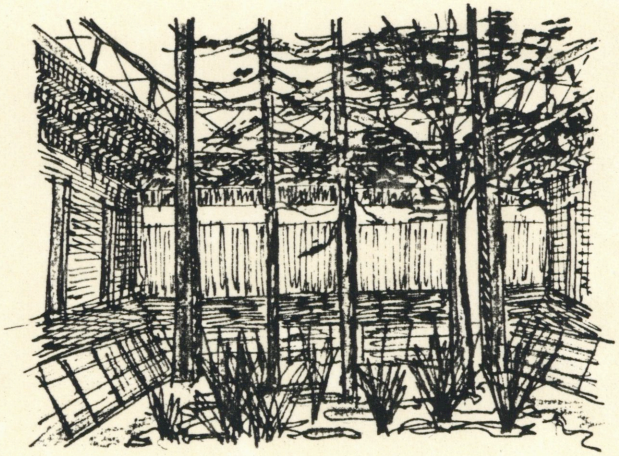
Evolutionary building delivery cycle vs. traditional process.

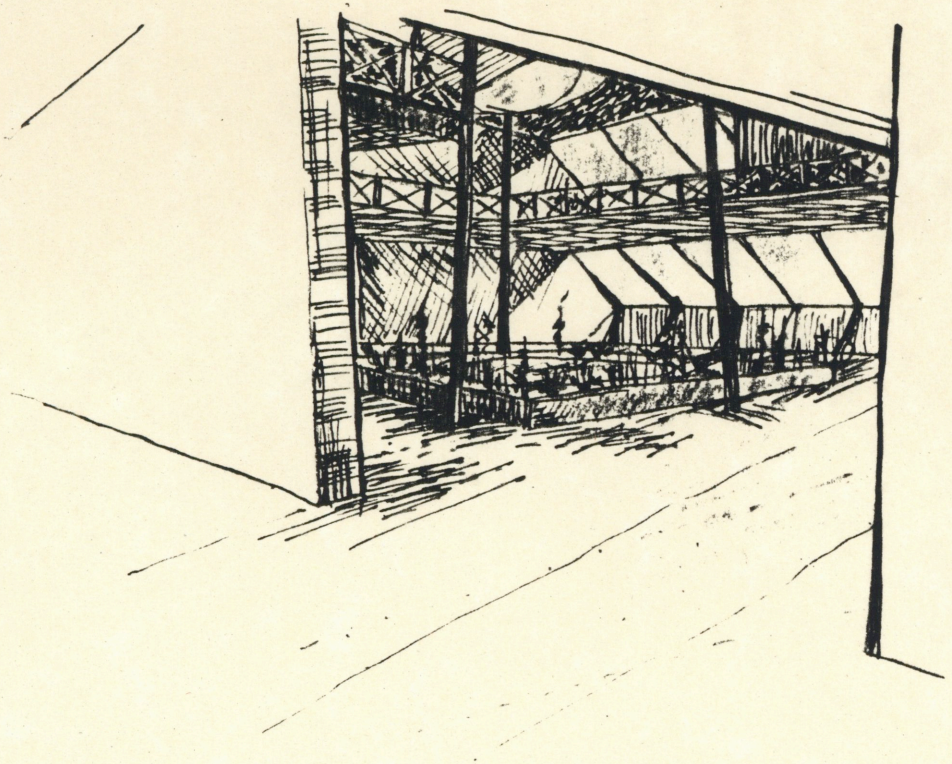


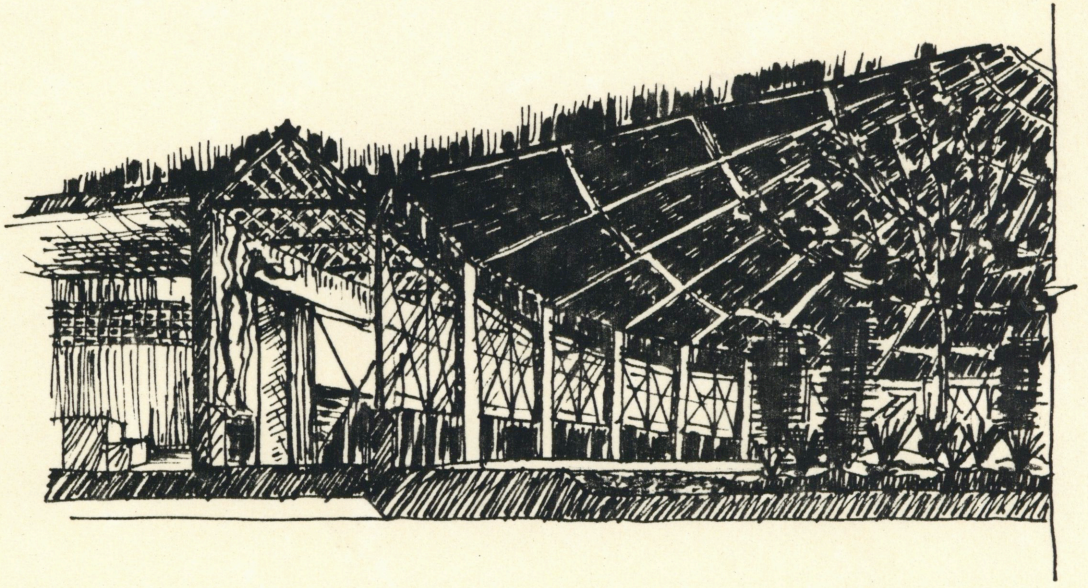
2. Interior Studies
    a. light
    b. organization



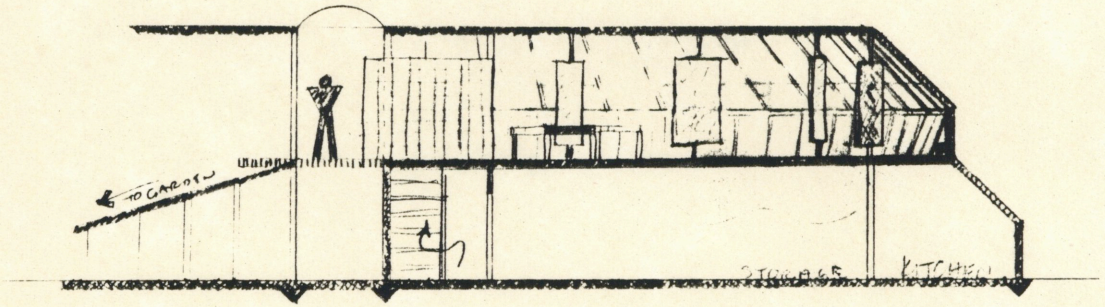


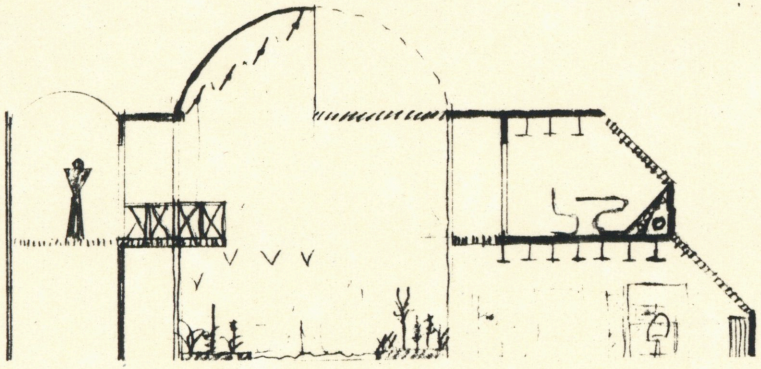


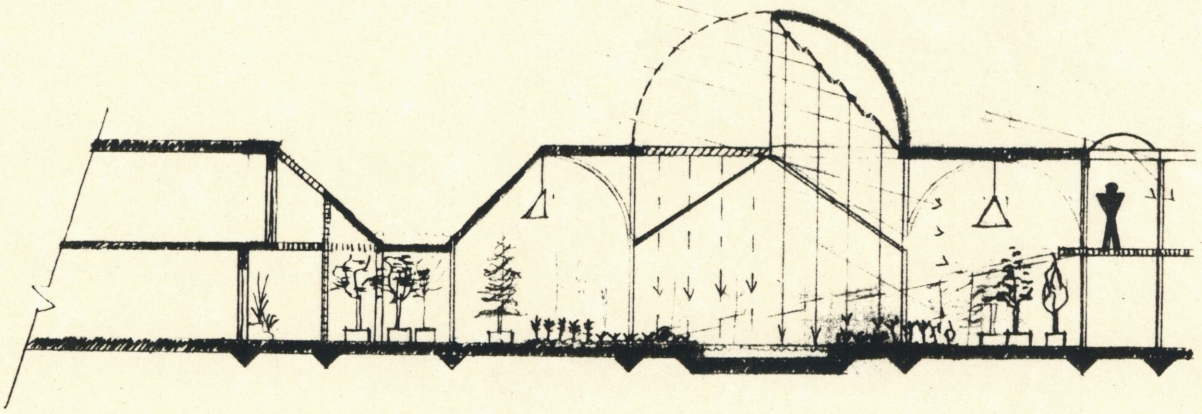


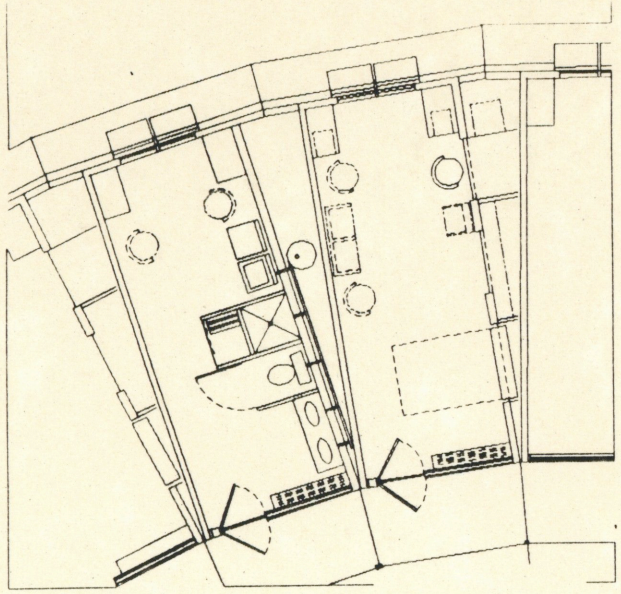


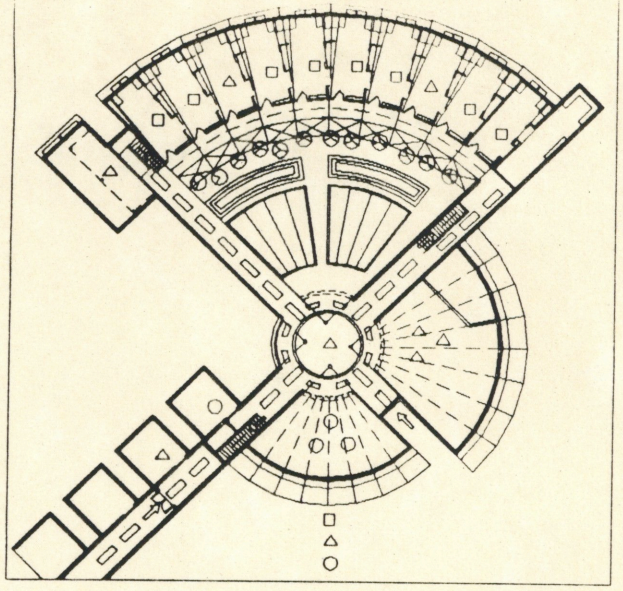
3. Final Design

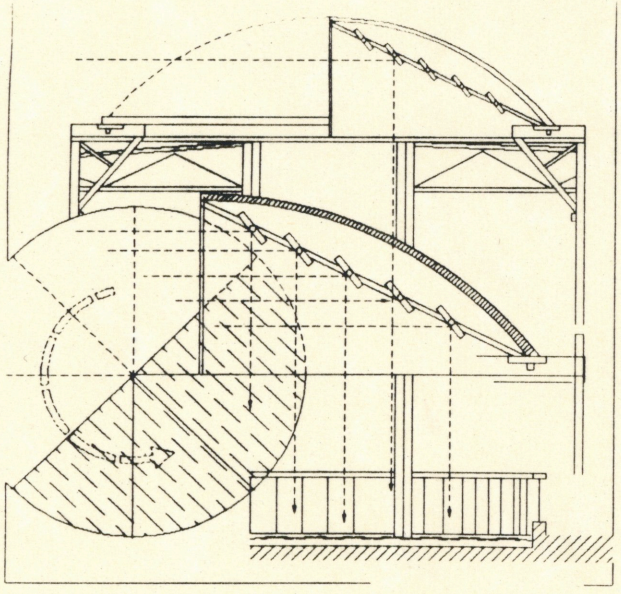












CONCLUSION

FINALLY, THE MOST EXCITING AND IMPORTANT PART OF THESIS IS THE CONCLUSION. ALTHOUGH FURTHER STUDY IS ALWAYS POSSIBLE I AM SATISFIED WITH MY COMPREHENSION AND EVALUATION OF MY INITIAL THESIS GOALS. FOLLOWING IS A BRIEF SUMMARY OF MY PROPOSAL FOR THE ENVIRONMENT III COMPETITION AND DESIGN PRINCIPLES STUDIED.

ONE OF MY PRIMARY THESIS ISSUES WAS CONCERN FOR ENVIRONMENTAL IMPACT AT A STRUCTURAL AND GLOBAL SCALE. I HAVE RESEARCHED MANY ALTERNATIVE ENERGY SOURCES AND DETERMINED A PHOTOVOLTAIC SYSTEM, BACKED UP CONVENTIONALLY, WOULD WORK BEST WITH MY SITE IN ANTARCTICA. THE COMBINATION OF AN EFFICIENT PLAN AND PHOTOVOLTAICS PRODUCES A CLEAN, RENEWABLE SOURCE OF POWER WHICH BECOMES MORE PROMISING AS BATTERY TECHNOLOGY IMPROVES. BY UTILIZING APPROPRIATE STRUCTURE AND PREFABRICATION MY BUILDING HAS MINIMAL ENVIRONMENTAL IMPACT AND HAS MULTI-USE POTENTIAL.

DUE TO THE NATURE AND LOCATION OF THE ENVIRONMENT III PROGRAM, THE STUDY OF ERGONOMICS AND INTER-PERSONAL DYNAMICS IS INTENSIFIED. IN ESSENCE I HAVE DESIGNED, NOT JUST A PARTICULAR BUILDING, BUT A MICRO-COMMUNITY. THIS STUDY LEAD ME TO REALIZE THE IMPORTANCE OF LIGHT USE AND THE NEED FOR FLEXIBILITY IN A DESIGN. THESE FACTORS APPLY ESPECIALLY TOWARD MY PARTICULAR PROGRAM WITH ITS ISOLATED SCENARIO. MY PROPOSAL CAPITALIZES ON NATURAL LIGHT COLLECTION AND PHYSICAL INVOLVEMENT WITH VARYING SPACES.

I OFTEN TRY TO ADD LINEARITY TO THE DESIGN PROCESS IN AN ATTEMPT TO SIMPLIFY AND CONTROL THE RESULTS. FOR ME, THIS PROJECT HAS REINFORCED THE NECESSITY FOR DESIGN PROCESS TO BE EVOLUTIONARY AND CYCLIC WITH CHECKS AND BALANCES OCCURRING IN ALL PHASES OF THE PROCESS.

APPENDIX TABLE OF CONTENTS

A. COMPETITION PROGRAM

B. COMMUNITY PLANNING

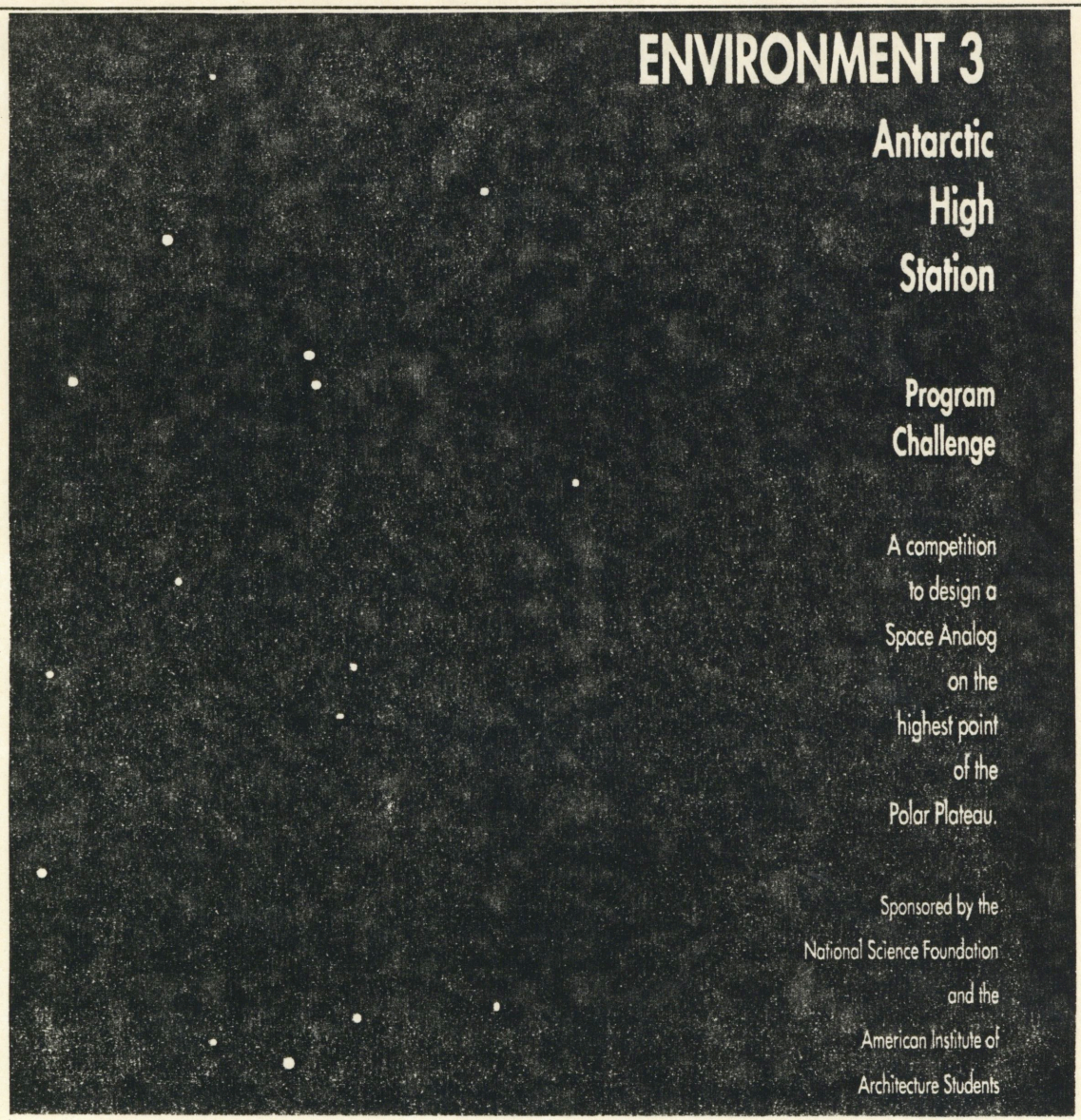
C. ENVIRONMENTAL IMPACT

D. ENERGY EFFICIENT DESIGN
- -Photovoltaic and Passive Systems
- -Sun Angle Data

E. BIOSPHERE II

F. ANTARCTIC CONSTRUCTION

APPENDIX A



The American Institute of
Architecture Students
1735 New York Avenue, NW
Washington, DC 20006
202-626-7472
202-626-7421 FAX

ENVIRONMENT 3
ANTARCTIC HIGH STATION

A National Student Design Competition
Sponsored by the American Institute of Architecture Students (AIAS)
Funds Provided by National Science Foundation (NSF) Grant DPP 91-20809 and the AIAS

I. INTRODUCTION

It's bitter cold, secluded and dark for five months. Yet, this forbidding site at the bottom of the world is a compelling attraction for some of the world's most distinguished scientists. The National Science Foundation is looking to build a research station on the Antarctic High Plateau to expand access to scientifically rich areas. A High Plateau Station, with international funding for construction and operation, could happen within twenty years. To date, Australia, France, Germany, India, Russia, and especially Italy have expressed interest.

The extremely dry and cold atmosphere above the highest part of the Antarctic plateau allows opportunities for astronomical observations at infrared and millimeter wavelengths substantially better than anywhere else on Earth. The region is magnetically connected to the polar cap, which is a portion of the magnetosphere that will be a focus of the world's solar-terrestrial physics community for the next decade or two. Moreover, the site is located above the subglacial Gamburstev Mountains, which are of great interest to the geological community.

A scientific research station on the Antarctic High Plateau also offers an analog for space exploration. International teams of scientists, as if in space, will live and work in a remote enclosure with a critical dependency on life support systems. Furthermore, the plateau's 5000 meter pressure elevation suggests a pressurized enclosure similar to planetary habitats that would be necessary on the Moon or Mars. This places additional requirements on modularity, materials, construction techniques, and a reliability on life support systems. This project, if undertaken, could provide unprecedented opportunities for science. Its value in promoting international cooperation on Antarctica through joint ownership and operation of facilities is immeasurable, and it can provide a test bed for manned exploration of the solar system.

Designers are challenged to understand the environment, to learn about reliable support systems, to accommodate interpersonal relationships in isolated enclosures, and most importantly, to enable the scientific process to continue.

The design for ENVIRONMENT 3 should keep in mind the preservation of not only Antarctica's ecosystem, but also the global habitat. Thus, the materials and techniques used in the construction and transportation of ENVIRONMENT 3 should be environmentally benign.

II. GOALS

Architecture, engineering, and environmental operations have generated interest among students concerned with interdisciplinary efforts. ENVIRONMENT 3 offers an opportunity for cross-fertilization of ideas and technologies. The thrust of ENVIRONMENT 3 is to encourage the sharing of knowledge regarding critical problems encountered in Antarctic design. By sharing information and methods that have useful applications, students of all disciplines will benefit within their own field of study.

ENVIRONMENT 3 is envisioned as a High Station on the highest point of the polar plateau designed to serve complex frontiers of science. The goals are:

- **To meet the research and living needs of the scientists and maximize their working effectiveness and comfort in the coldest and driest climate in the world.**

- **To minimize the environmental impact of human presence.**

- **To develop and utilize the most appropriate architectural concepts and engineering technologies.**

III. DESIGN CHALLENGE

*The **ANTARCTIC HIGH STATION** is envisioned as a self-contained outpost offering novel opportunities for research in earth and space sciences. Twelve scientists and a small support staff will inhabit the High Station. The comfort and safety of these people must be a primary consideration in the design philosophy.*

*Easy maintenance and reliability are crucial to the design of **HIGH STATION**. The base support systems are life-critical, and the remote nature of the station requires that maintenance must be performed by support staff.*

*On-site construction should be minimized to make the building of **HIGH STATION** practical. Consequently, internal design flexibility is desirable. Provision should be made for quick and easy base installation and removal. Over-land or air transport may be used but resources for return journey are a consideration.*

The stresses of living in close quarters with the same people for a year must be considered, thus interpersonal dynamics should weigh heavily in the design.

Environmental observation is to be maximized; environmental impact is not. Antarctica is a unique, pristine habitat; **ENVIRONMENT 3** ***ANTARCTIC HIGH STATION*** *shall strive to keep it that way.*

The scientific objectives of the base should not be undermined by other aspects of the design philosophy. Antarctica is one of the few ground-based analogs that would permit comprehensive and integrated studies of three areas deemed critical to productive and safe operations on the Moon and Mars: human health and productivity; innovative scientific research techniques; and reliable, efficient technologies and facilities.

1.0 HABITATION

1.1 **Private Quarters** Private quarters shall be provided for the scientists and support staff. (See Item 6.0) Each should accommodate sleeping, dressing, personal entertainment, communications and storage. All rooms shall be equally appointed with the exception of the Chief Scientist's, which must have expanded internal and external communications.

1.2 **Personal Hygiene** Facilities for whole body cleansing, dental hygiene, personal grooming and elimination of bodily wastes shall be provided.

1.3 **Food Preparation/Clean-up** In confined and isolated environments, good food and social dining are directly related to morale. Designers should establish an end-to-end concept for the storage, preparation, and clean-up of food and utensils. Also, a method for stabilization of waste food and trash should be developed.

1.4 **Dining** Accommodations for all 16 inhabitants (see Personnel) to eat together shall be provided. Because there will be limited space, it is reasonable to assume that the dining facility will also serve as the group meeting and entertainment area. (See Off-duty)

1.5 **Health Maintenance** There shall be sufficient space and equipment available for the scientists to maintain a regular exercise regimen. This area should be well ventilated, easily cleaned, and acoustically isolated. In addition to exercise, there should be a dedicated area for medical equipment, supplies, and pharmaceuticals. Special provisions for treating conditions resulting from exposure to extreme cold and/or high altitude are to be included.

1.6 **Laundry** A laundry system capable of meeting the needs of the entire group will be provided. The selection of the number and size of appliances should consider the type of clothing and linen to be cleaned, frequency of use, and compatibility with other systems.

1.7 **Off-Duty/ Recreation** An area for off-duty activities will be provided. It should include a video system and a small library for books, video/audio tapes, and board games.

2.0 MISSION

2.1 **Work Station** Space will be provided for a computer work station for each scientist. These spaces will have power and data access to a central computer capable of high speed scientific processing. Designers should consider this to be the scientist's principal work area and balance volume-limiting constraints with mission objectives. An office will be provided for the Chief Scientist for one-on-one discussions with other scientists.

2.2 **Communications** *HIGH STATION* will have data links with remote instrumentation and electronic communications intended for mission related discussions.

2.3 **Mission Equipment** *HIGH STATION* will include a small chemistry laboratory. Some generic equipment and facilities will be provided. However, if individual scientists plan on using the lab, they should bring their own equipment and supplies. Private secure storage will be provided.

3.0 BASE SUPPORT

3.1 **Active Systems** Base support systems provide active and passive "overhead" functions for the station inhabitants. The active systems are: electrical power, atmospheric conditioning, water supply, data management, communications, fire detection/suppression, and caution/warning. Because these systems require near continuous operation and are life-critical, they should be designed for easy maintenance and high reliability. The failure mode for these systems is fail-op, fail-safe,with critical spares on-site.

The **electrical power system** should include generation, distribution and conditioning for all station power. The **atmospheric conditioning system** provides temperature/humidity control and maintains a .7 kg/cm^2 internal pressure. The **water supply system** provides potable water for drinking, and hygiene water (drinkable but requiring less treatment than potable) for bathing and the laundry. This system also includes waste water and treatment. The **data management system** provides supervisory control of all base support systems. This system is separate from the scientific computer. The high station **communication system** provides a two-way voice link with polar stations, aircraft, local expeditions and home bases. The **fire detection/suppression system** shall monitor and alert the crew of critical anomalous conditions.

3.2 **Passive Systems** Passive base support systems include food, spares, tools, inventory management, and storage. The station shall accommodate **food and beverages** for the entire crew for one year. A stockpile of **critical spares** shall be conveniently accessible. A **tool crib** with hand tools and machine shop capability shall be provided. This area should be accessible from both protected vehicle storage and the inside of the base. An **inventory management system** must be included for arriving crews.

4.0 WASTE MANAGEMENT

Waste management is an important aspect of the station operation. Designers should provide for the collection, containment, stabilization, and disposal of waste products.

5.0 TRANSPORTATION/RESUPPLY

The only means of bringing construction elements, scientists, and resupply items to ***HIGH STATION*** will be aircraft or overland tractor transport. Therefore, with a limited number of deliveries, packaging efficiency must be considered. Light and temperature conditions will limit air access to the time period from November 1 through February 28. A minimum of three overland cold weather vehicles used for access to remote scientific sites shall be provided. Smaller summer vehicles will also be available. Facilities for the storage, refueling, and servicing of all vehicles should be included.

The nearest occupied stations are the South Pole (USA) and Vostok (former USSR) at 480 and 680 nautical miles respectively.

The nearest coastal ship supply sites are McMurdo (USA) at 1050 nm, Showa (Japan) at 740 nm, Belgrano (Argentina) at 780 nm, and Mirnyy (Russia) at 1120 nm.

Ski-equipped LC-130 aircraft with a cargo area of 12 x 3 x 3 meters are available, as are tractors. Materials to be transported, especially on the ground, must be able to withstand the lengthy trip to and from ***HIGH STATION***.

6.0 PERSONNEL

HIGH STATION personnel will include twelve (12) scientists, one (1) medical doctor, and three (3) support staff. Of the three support staff, two (2) are responsible for cooking, one (1) facility operation/cleaning/maintenance.

7.0 OTHER

HIGH STATION must accommodate various lifestyles and cultures. Provisions should be made for both smoking and non-smoking areas.

IV. BACKGROUND

General:

In contrast to the ice-free Dry Valley regions, very little field research is conducted on the polar plateau. Research efforts at these facilities are oriented toward observational science, such as upper atmospheric physics, solar astronomy, and infrared, submillimeter, and millimeter astronomy, conducted primarily from the confines of a structure placed on the plateau. Therefore, existing sites on the plateau, such as the South Pole Station, or perhaps another facility high on the polar plateau, might be valuable for simulating conditions encountered in spacecraft (rather than on planetary outposts) during long-duration flights or at an astronomical observatory located on the Moon.

Crews on Space Exploration Initiative (SEI) missions, including a lunar outpost, will cooperate closely in intrinsically hazardous conditions. Crews on Mars and the Moon will require provisions and procedures for on-site medical care, probably involving teleconsultation with physicians on Earth. Crew members will be continuously exposed to wholly artificial environments and will be totally dependent on life support. For the Moon, some resupply is feasible, although the costs and logistics involved dictate the advisability of at least partial closure of life support systems. Extreme cycles of light and dark

alter circadian rhythms of crew members placed in such an environment. These issues could be addressed in the *ANTARCTIC HIGH STATION*, giving mission planners valuable insight prior to the final design phase of a lunar outpost.

Site Characteristics:

This station would be located on the East Antarctic ice sheet at an altitude above 4,000 meters on Dome A, the highest point on the Antarctic ice plateau. The horizontal extent of its surface is hundreds of kilometers, so Dome A is essentially flat. The ice sheet thickness in this area is about 2,500 meters. The invariant geomagnetic latitude would be about 78 degrees South and the geographical coordinates would be about 82 degrees S, 85 degrees E. The wintertime pressure altitude would be over 5,000 meters, so high that it would be desirable, and possibly even necessary, to pressurize the station. The extremely dry and cold atmosphere above the highest part of the Antarctic plateau allows opportunities for astronomical observations at infrared and millimeter wavelengths substantially better than anywhere else on Earth. The region is magnetically connected to the polar cap, which is a portion of the magnetosphere that will be a focus of the world's solar-terrestrial physics community for the next decade or two. Moreover, the site is located above the subglacial Gamburstev Mountains, which are of great interest to the geological community.

The plateau is featureless and extends to the horizon. Wintertime lows reach -90 degrees Celsius. The dome's altitude and climate may provide better angular resolution, or "seeing," than anywhere else on Earth. Seeing is a measure of the distortion suffered by an initially plane wavefront propagating through the Earth's atmosphere. The relative lack of thermal inhomogeneity in the Antarctic will reduce this distortion and improve seeing. Clear skies are another significant aspect of good astronomical observation, and the the sky over the plateau is clear virtually year round.

The site sees little in the way of precipitation or wind. Wind speeds are approximately 3 meters per second in August, and the average precipitation is 1-5 centimeters per year. Absolute humidity is almost zero.

The Ice Sheet:

The Antarctic ice sheet is composed of three unequal parts. The largest portion lies in East Antarctica which reaches a maximum elevation of just over 4000 m at central Dome A. The Transantarctic Mountains (maximum elevation of 4528 m at Mt. Kirkpatrick) effectively divide this ice mass from the smaller ice sheet in West Antarctica which reaches a maximum elevation of 2300 m at Mt. Woollard. The West Antarctic ice sheet is flanked, in turn, by floating ice shelves in the Ross and Weddell Sea embayments. The Antarctic Peninsula comprises the third area of complex glacierization with several small merging ice caps, ice shelves, extensive mountainous terrain, outlet glaciers, and ice-covered offshore islands.

Energy:

Energy consumption and conservation provide particular challenges to the design of *HIGH STATION*. Diesel fuel may be transported here using the LC-130 aircraft. The LC-130 burns 1.5 gallons of fuel for every gallon that it delivers. South Pole Station uses approximately 175,000 gallons of fuel to meet its yearly energy needs. This adds up to a total fuel bill of over 500,000 gallons per year.

Alternative energies provide other challenges. Solar power storage through the long winter is one. To provide a true analog to a space station, sources of energy should be lightweight. However, these may be expensive and impractical for Antarctica.

V. DESIGN EVALUATION CRITERIA

The following evaluation criteria will be used to judge design submissions. These criteria are not listed in order of priority. Jurors may add additional evaluation criteria.

Architectural Issues: **ENVIRONMENT 3** *ANTARCTIC HIGH STATION*, should creatively fit into the physical and

psychological context of Antarctica. The layout and circulation of the analog and the relationships among the individual spaces should be effective, efficient, and safe. The sense of place should be inspiring to the people who live and work there.

Environmental Sensitivity: ***HIGH STATION*** must fully meet the needs of the scientific community, while protecting the purity of the Antarctic environment. Detrimental effects resulting from human habitation should be minimized. Waste treatment and alternative energy sources will be carefully considered.

Human Behavioral Factors: The design and operation of ***HIGH STATION*** should optimize personnel safety and performance. Means to enhance living and working environments during prolonged isolation are critical factors.

VI. DESIGN SUBMISSION: REQUIREMENTS

Eligibility: All participants must be registered full or part-time students at the time of submission. Entrants may be any major and must be enrolled in a United States institution of higher learning. Team entries of up to three students will be accepted for judging. Interdisciplinary teams are highly encouraged.

Schedule: Registration for the competition opens September 8 and closes May 21, 1993. Submissions are due May 28, 1993. The jury will be held June 5, 1993 in Washington, DC.

Presentation Requirements: All submissions shall be on no more than three (3) 20" x 30" boards, oriented vertically, and should include the following:

1. An overall site plan exhibiting access to ***HIGH STATION***.
2. Illustrative floor plans of major and minor spaces specified in the Design Challenge.*
3. Building sections which display design concepts.*
4. At least one (1) panoramic perspective (birds-eye).
5. Additional concept drawings or sketches, including interior perspectives and engineering schematics, that may assist in the explanation of the design intent.
6. A designer's statement of no more than 250 words, on the front of one of the three boards.

* Drawing scales may be selected by the designers based upon the requirements of their scheme. Please indicate the scale of each drawing.

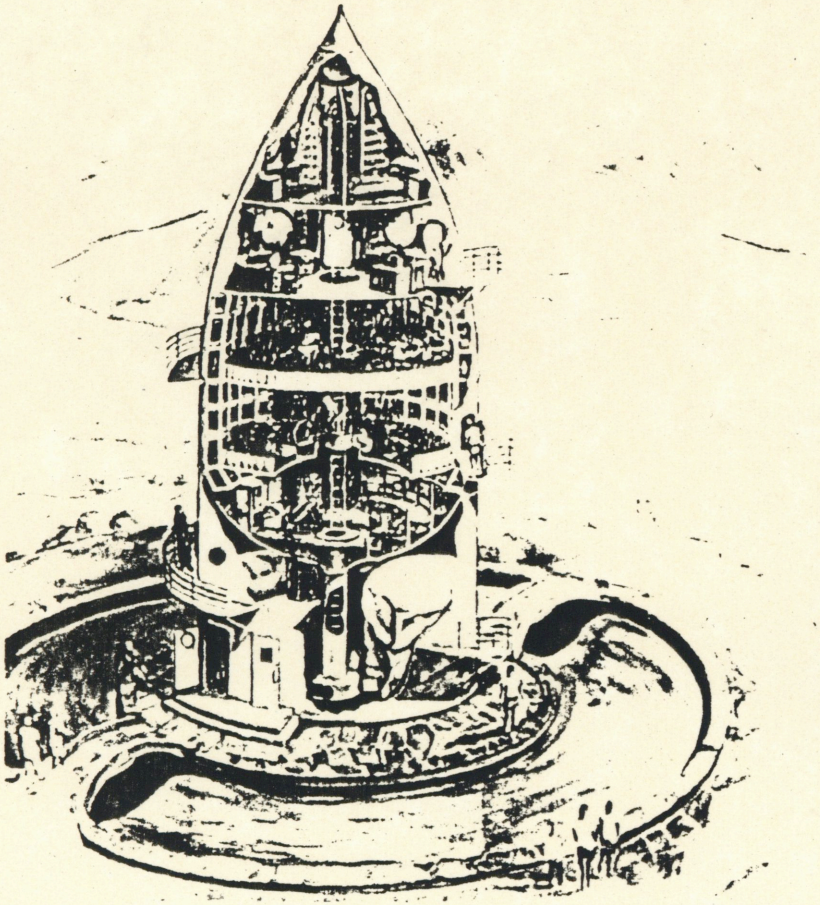
Submission Requirements: All submissions must arrive at the AIAS National Office no later than 5:00 EST May 28, 1993. Shipments should be addressed to:

ENVIRONMENT 3 *ANTARCTIC HIGH STATION*
AIAS Student Design Competition
American Institute of Architecture Students
1735 New York Ave., N.W.
Washington, D.C. 20006



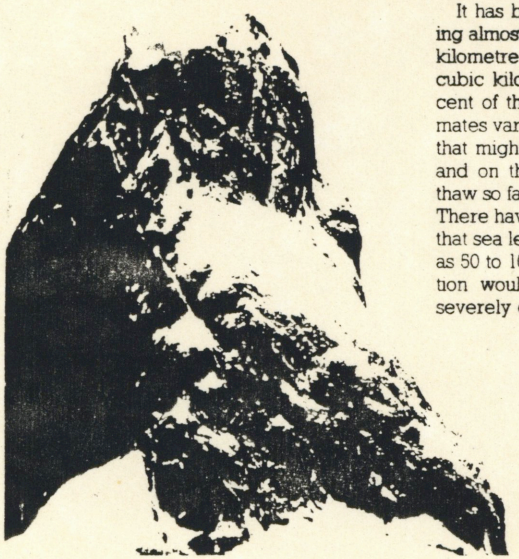
Photo credit: U.S. Geological Survey

Aerial view of the U.S. South Pole Station.



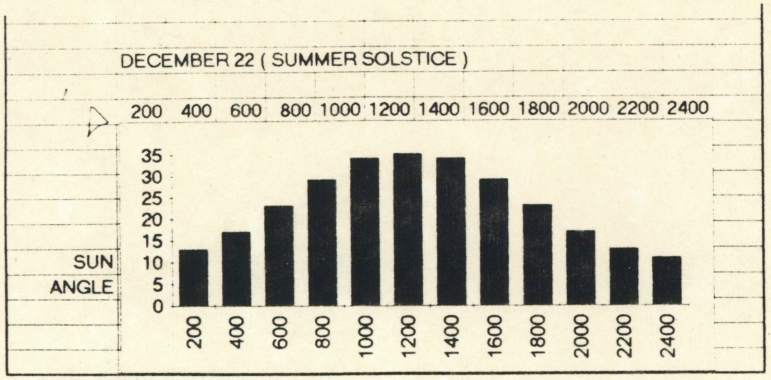
1991 SPACE BIOSPHERES VENTURES

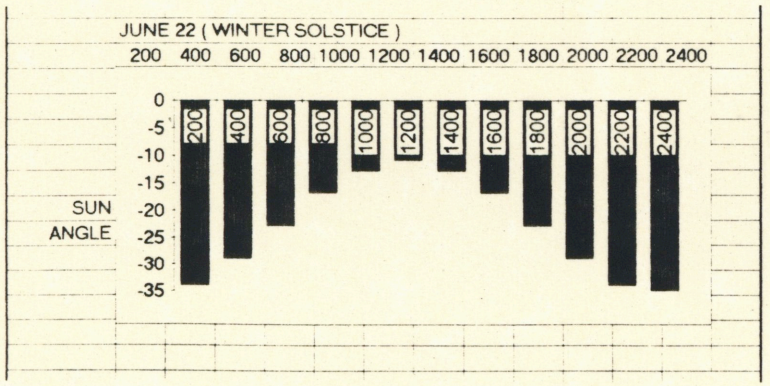
SBV is now preparing experiments in opaque conditions requiring artificial light for applications of biospheric knowledge in micro-gravity. This model is a possible use of the external fuel tank portion of the space shuttles which are currently jettisoned to burn up in the atmosphere when empty.



If the warming process continues unchecked and the hole continues to expand, the implications must be serious, not just for the polar regions, but *also* for the rest of the globe.

It has been calculated that with ice covering almost all of Antarctica's 14 million square kilometre-area, there is within the 30 million cubic kilometres of the ice-cap over 60 per cent of the world stock of fresh water. Estimates vary greatly as to the amount of this ice that might thaw in any climatic amelioration, and on the implications of any appreciable thaw so far as a rise in sea level is concerned. There have been 'worst-scenario' suggestions that sea levels might rise by perhaps as much as 50 to 100 metres, and the resulting inundation would cause massive destruction and severely disrupt civilization as we know it.

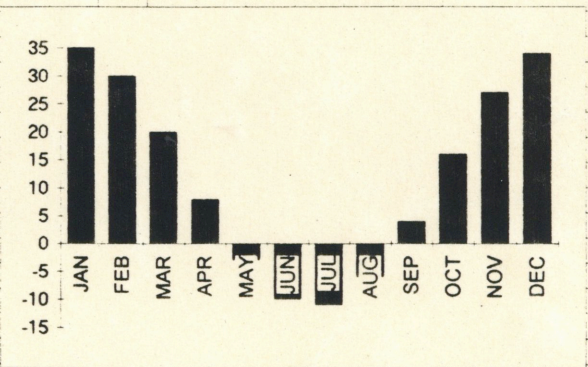




SUN ANGLES

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
T	200	13		-2		-25		-33		-18		5	
I	400	17		2		-20		-29		-14		9	
M	600	23		8		-14		-23		-8		15	
E	800	29		14		-9		-17		-2		21	
	1000	33		19		-4		-13		2		25	
	1200	35	30	20	8	-3	-10	-11	-6	4	16	27	34
	1400	33		19		-4		-13		2		25	
	1600	29		14		-9		-17		-2		21	
	1800	23		8		-14		-23		-8		15	
	2000	17		2		-20		-29		-14		9	
	2200	13		-2		-25		-33		-18		5	
	2400	11		-4		-27		-35		-20		3	

NO DIRECT SUNLIGHT ... APRIL 22 - AUG 21 (4-MONTHS)
DIRECT SUNLIGHT (24 HR) ... OCT 23 - FEB 19 (4-MONTHS)





New Cracks in the Glass House

The science advisers resign from Biosphere 2

Rabbinical legend has it that God tried his hand at creation a few times before getting it right in the six days chronicled in Genesis. So why should mere mortals succeed the first time *they* try to create a self-sustaining world? They haven't. The man-made world dubbed Biosphere 2, a 3.15-acre enclosed glass-and-steel dome in Oracle, Ariz., is turning out to be, well, a learning experience. And not everyone's happy with the curriculum. Last week, Ed Bass, the billionaire oilman financing the $150 million project, announced that the scientific advisory board created last year to give it scholarly heft had resigned. "I and several [others] found the working relationship at times to be frustrating," said chairman Thomas Lovejoy of the Smithsonian Institution. Others worried that Biosphere 2 was hurting their reputations.

It's been a clash of cultures from the start. Part education and tourism, part marketing and part science, Biosphere 2 attracted 230,000 visitors last year and rang up more than $4 million in gift-shop sales. But as science, Biosphere 2 is not living up to its billing. It is supposed to be a "closed" system, recycling air, water and waste, and receiving nothing from the outside but sunlight and electricity and computer and telephone communications. But last year engineers secretly "scrubbed" rising levels of carbon dioxide from the air in the glass dome. And last month, after oxygen had plummeted mysteriously from 21 to 15 percent of the atmosphere (a level found at elevations of 12,500 feet), they pumped in oxygen. By deviating from the rules, Biosphere 2 may lose the chance to find out whether the oxygen is, as geochemist Wallace Broecker of Columbia University suspects, going into the iron in the 34,000 tons of dirt in its rain forest, savanna, marsh, ocean and farm. It's more than an academic question: earth's oxygen levels are also dropping, though extremely gradually. As long as Biosphere 2 gets oxygen infusions, it cannot show how a self-sustaining world works—or fails.

The eight "Biospherеans" did learn from another setback. Crop failures limited them to 1,750 calories a day for much of last year. That deprivation led to the first scientific paper out of Biosphere 2, as Dr. Roy Walford reported that the low-calorie, low-fat regime cut cholesterol, blood pressure, blood sugar and weight. That had been shown in lab animals; Biosphere 2 may prove that a spartan diet retards aging and promotes health in people, too.

That might have been more likely if the advisory board had stayed on. It might happen, still, once Biosphere 2 appoints a science director, as the panel urged months ago. If Biosphere 2 aspires to be more than a spa under glass, it had best find a researcher to keep the experiment on track.

SHARON BEGLEY *with* MARY HAGER

A PROPOSAL FOR THE CONSTRUCTION OF A MODEL ANTARCTIC BASE[1]

Robert W. Risebrough and Donald J. McLaughlin[2]

To take possession of space is the first gesture of the living, men and beasts, plants and clouds, the fundamental manifestation of equilibrium and permanence. The first proof of existence is to occupy space.

Le Corbusier, 1945

Man has become a part of the Antarctic ecosystem. The magnitude of the continent – almost incomprehensively large – ensures that the impact of the expeditions and the construction of the scientific stations has been relatively small over the vastness of the interior. The coastal areas where stations and settlements can be built, however, are few, small, contained, and finite: islands, edges of glacial moraines, and the jutting tips of small peninsulas. These are also the breeding grounds of Antarctic birds, which require open and ice-free sites for nesting. Here also are found the few plants that inhabit the continent.

The visual appearance of an Antarctic station is frequently one of unnecessary waste and the conspicuous accumulation of waste. Nowhere else in the world are the problems of man's relationship with his environment outlined in bolder relief – how to survive and endure in a finite space, how to participate in an ecosystem but yet preserve its integrity, how to readjust technologies so as not to smother in their wastes, and how to re-cycle wastes back into the ecosystem. These problems are becoming formidible in all technological societies. Just as the study of the relatively simple plant and animal relationship in the Antarctic facilitates an understanding of the much more complex temperate and tropical communities, the study of man's long term involvement with his global ecosystem might profitably center in the more austere, demanding environments such as the Antarctic.

When a new species moves into an ecosystem, inevitably there are changes in the composition of the fauna and flora that had previously established an equilibrium among themselves. The recent history of the Sub-Antarctic Islands is a story of invasion by alien species and the

[1]We wish to acknowledge the support of the Office of Polar Programs, National Science Foundation grants GA-14202 and GV-23898 to the Institute of Marine Resources, University of California, Berkeley, H. S. Olcott, principal investigator. Donald McLaughlin was Officer in Charge, Palmer Station, 1970.

[2]Present address of R. W. Risebrough: Bodega Marine Laboratory, University of California, P. O. Box 247, Bodega Bay, California, 94923; Present address of D. J. McLaughlin: O'Brien-Armstrong A. I. A., 116 Caledonia St., Sausalito, California, 94965.

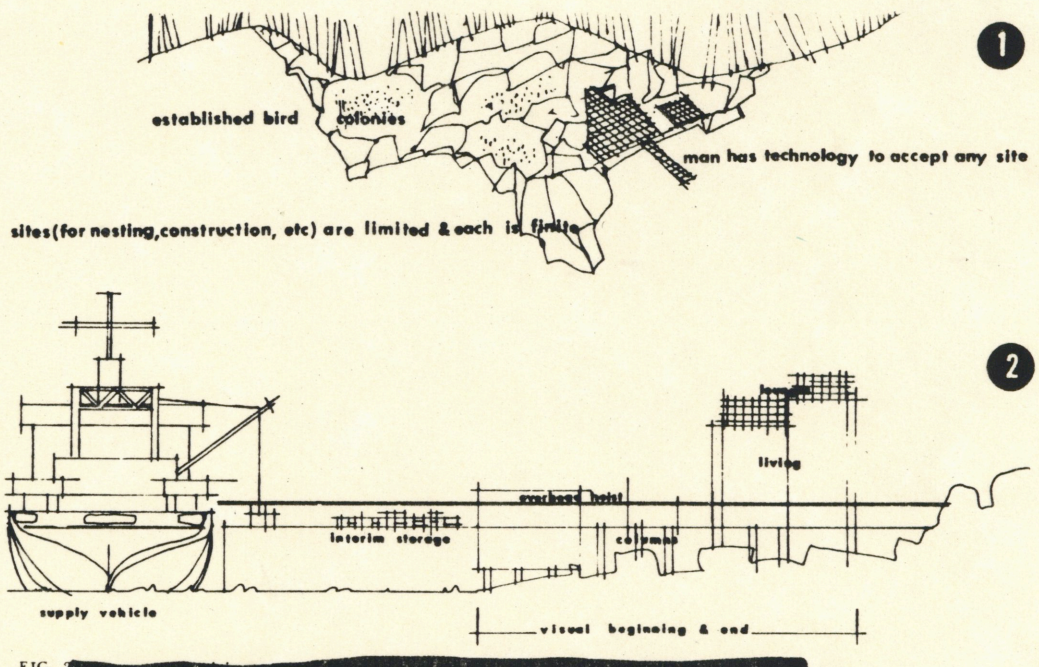
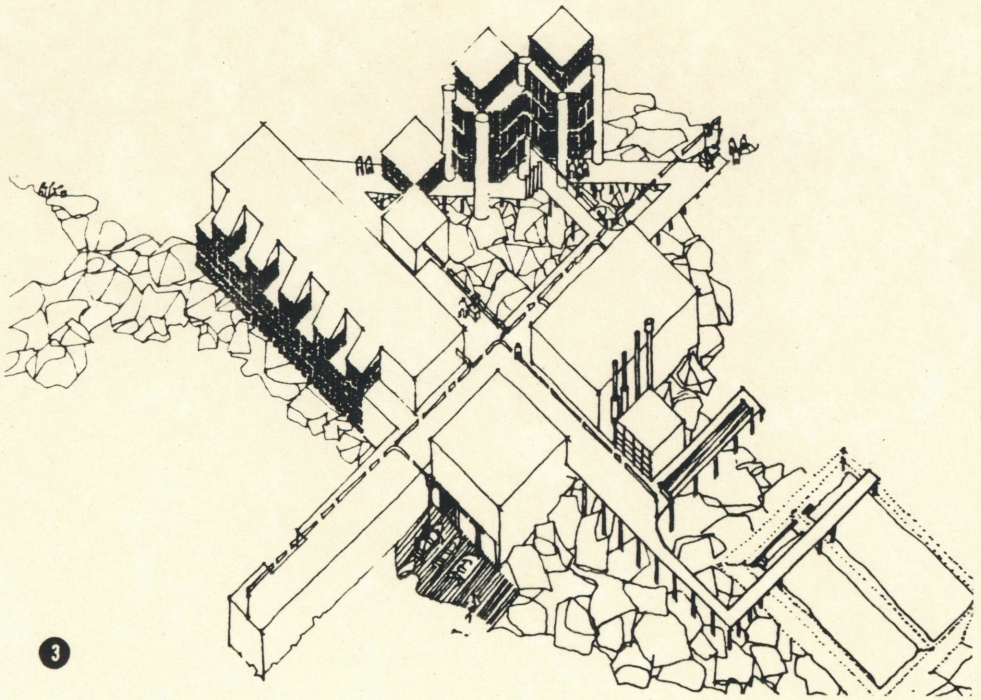


FIG. 2



3

exterpation and displacement of native species. In the process of building Hallett Station during the International Geophysical year, several thousand penguins were displaced from the seaward portion of the glacial moraine that became the site of the base. The penguins retreated to the periphery of man's activities and continue to rear their young in close proximity to the station. The buildings of man, however, are scattered and diffuse, rather than ordered and compact. Roads reach out through the penguin colony.

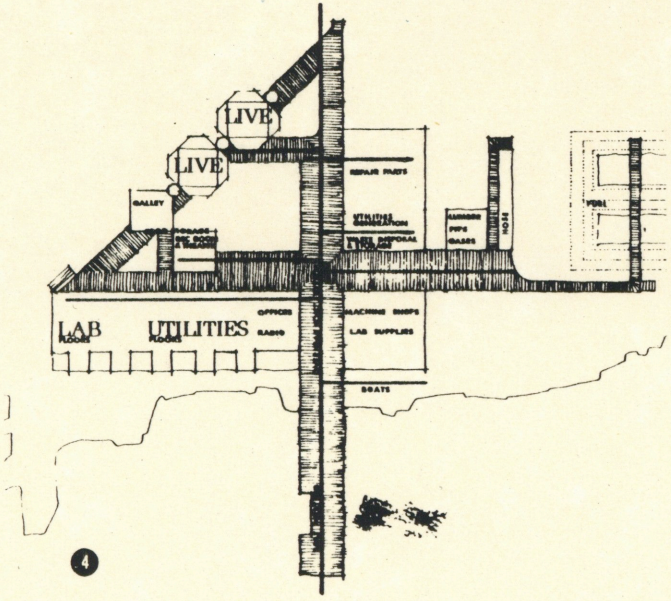
The available sites for the nesting of birds and for construction of buildings are limited and finite. The lack of economy or order in the concept of the buildings displaces the very animals which are to be studied.

To date, fifteen relatively small areas of particular biological interest have been designated Specially Protected Areas to which access has been limited by the terms of the Antarctic Treaty. They are equivalent to the nature reserves that have been established elsewhere. Traditionally the environment in these areas has been termed "natural" in contrast to the environment of cities and farms. Yet the birds and seals of Antarctica carry in their bodies man-made pollutants; their breeding territories receive fallout from distant atomic explosions and the fallout of pollutants released into the atmosphere of agricultural and industrial lands to the north or into the local atmosphere of Antarctica through the burning of refuse at the scientific stations. The problem is therefore shifting from the physical preservation of a relatively few reserves to the preservation of ecosystems in which man and all other species can endure, not only for the several decades of our lifetimes but over the centuries to come.

The scientific stations have been established to facilitate the study of the Antarctic environment. It would be tragic if they were to become centers of pollution, destroying the very areas they were constructed to study.

> Paradoxically, the most frightening aspect of human life is that man can become adapted to almost anything, even to conditions that will inevitably destory the very values that have given mankind its uniqueness . . . . .
>
> . . . . . History confirms present-day observations in demonstrating that man can become adjusted, socially and biologically, to ways of life and environments that have hardly anything in common with those in which civilization emerged and evolved. He can survive, mutiply, and create material wealth in an overcrowded, monotonous, and completely polluted environment, provided he surrenders his individual rights, accepts certain forms of physical degradation, and does not mind emotional atrophy.
>
> Rene Dubos, *So Human an Animal*, 1968.

The facilities at Hallett are becoming outmoded. If the station is to continue, new construction and the replacement of some of the



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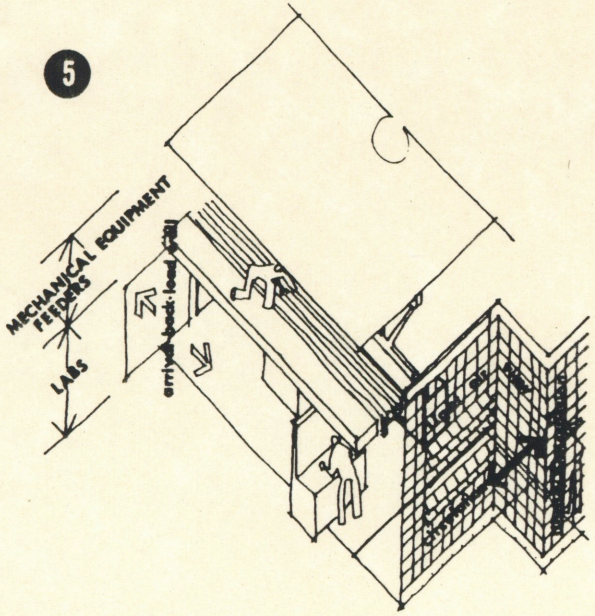
exist , buildings will be necessary. How might the new base and other future bases be made compatible with man's long term existence in the Antarctic, – and compatible with local ecosystems?

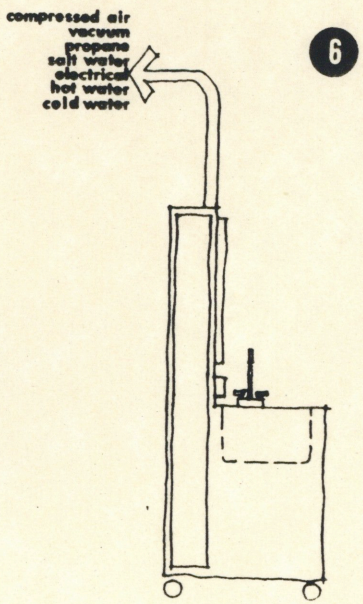
Primary among the ecological laws is that the waste products of a community are used to construct the next generation. They are therefore essential to its continuity, – to the temporal flow of mass and energy. Yet wastes in the Antarctic tend to accumulate rather than to recycle.

Plastics are useful because of their persistence and stability, but after the period of use their persistence becomes a liability. Discarded plastic containers are becoming an unacceptable part of the environment in the northern hemisphere. They have no place in the Antarctic where the temperatures eliminate any possibility of biological or chemical degradation. The use of plastic bags for the disposal of waste organic materials has been convenient but the bags will remain virtually forever on the beach at Hallett or as a layer at the bottom of the harbour at Palmer Station. Open burning of wastes is also convenient but releases large amounts of particulate materials and other pollutants into the atmosphere which then become components of local fallout. Thus, the vicinity of the Antarctic bases and field camps can no longer be used to measure the "natural" levels of metals, salts, or organic compounds in the snow.

Long term compatability of man with the Antarctic environment requires that the organic wastes of both the kitchen and the toilets be reduced to carbon dioxide, water, and salts before they are returned to the environment. Moreover, future scientific needs require that ashes and particulate materials not be strewn over the landscape. An incinerator unit, designed to be an integral component of the heating system, could accomplish part of this task. One of the scrubbing devices now being developed to reduce the emission of particulates into the local atmosphere might be attached. The ashes and other solid waste might then be compacted to blocks for back loading, disposal at sea, or local landfills that could extend the area available for penguin rookeries.

Why a road at a small Antarctic station? The scale of automotive vehicles in the Antarctic is absurd. To move the garbage to the dump at Palmer during the winter months requires the efforts of two or three men to wipe the snow from the caterpiller, recharge the battery, prime the carburator, and free the tracks from the frozen ground. It is also absurd to require an eleven-ton vehicle to move a hundred pound box, yet such vehicle is required for the movements of all equipment. An overhead monorail system, with an electrically operated chain hoist, could not only move containers from one part of the station to





another, but ld move all cargo between the pier and the station during off-loading and back-loading.

At Hallett the buildings are heated separately, a multiplication of inefficiency.

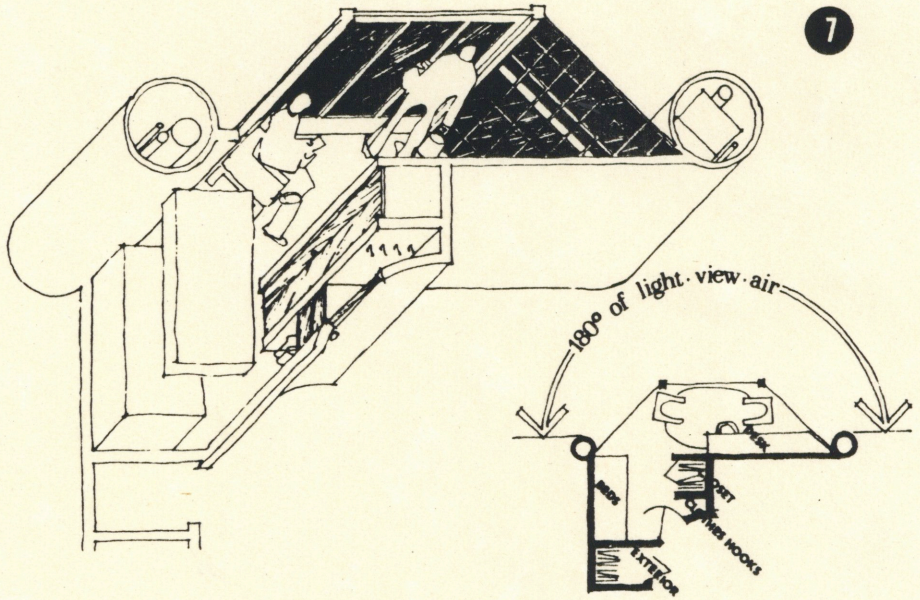
Why two storerooms and two machine shops at Palmer? – a duplication of the circulation space, a major part of the space requirements.

Laboratory work is dependent upon the efficient functioning of the utilities, yet the needs for utilities are different for each research project. The two functions, research and the provision of utilities, cannot occupy the same space. The laboratory is therefore considered to be a research floor, with a utility floor above where repairs and adjustments can be made.

The laboratory bench creates work space. Projects in the Antarctic are temporary and encompass a broad scope of research fields in the biological and physical sciences. Flexibility is essential. The needs are best served by moveable benches, to which the various utilities can be supplied as needed.

Living quarters could be built with greater economy of space from available industrial components, including thermal glass and plastic sandwich panels, to provide a view, compactness, and privacy.

The design and construction of a polar base might therefore acknowledge ecological principles and attempt to be consistent with them. The structure might also acknowledge the stresses upon human interrelationships under Antarctic conditions and attempt to alleviate them in the design of common rooms, a recreational area, and private quarters. The opportunities are exciting. The study of Antarctic ecology would at last include the study of man's involvement with the ecosystem.



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SCOTT A. JONES

Scott A Jones

Advisor FERD JOHNS

Second RON HESS

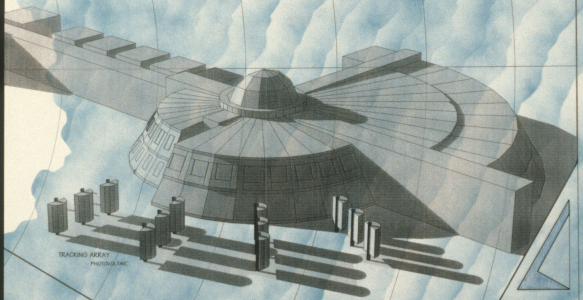
Third MAIRE O'NEILL

Director Thomas Wood,

ENVIRONMENT III







PRIMARY ISSUES:

1. PRESERVE INTEGRITY OF ECOSYSTEM AND LIMIT ENVIRONMENTAL IMPACT.

2. STUDY OF ERGONOMICS AND INTER-PERSONAL DYNAMICS IS INTENSIFIED

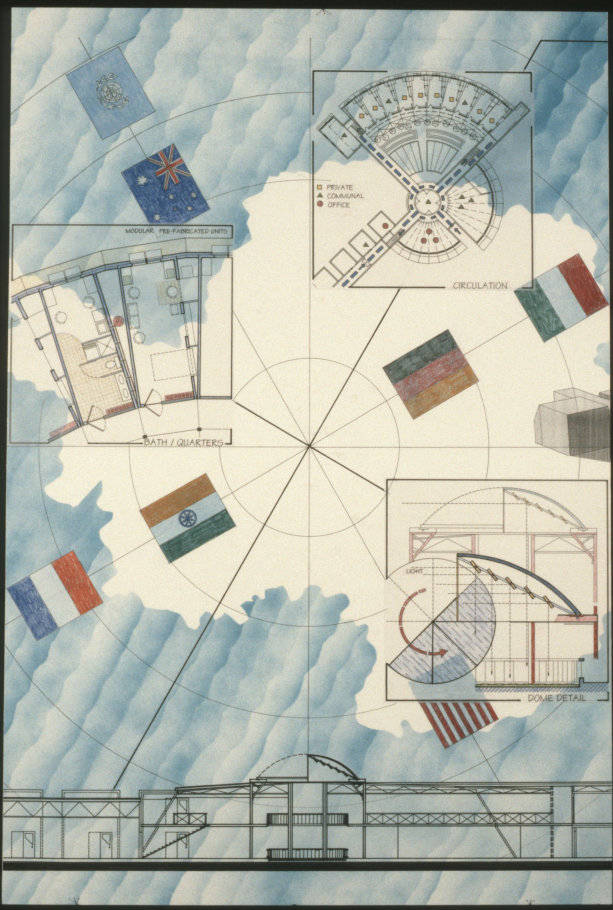
3. MAXIMUM EFFICIENCY IN A RENEWABLE ENERGY SOURCE.

"THE ESSENCE OF THIS PROJECT WAS THE CREATION OF A SELF-SUSTAINED MICRO-COMMUNITY POWERED PRIMARILY BY A TRACING ARRAY OF PHOTOVOLTAICS."

"...PRESENCE IS PERCEPTUAL SIGNIFICANCE IS COGNITIVE"
"...OFFER OPPORTUNITY RATHER THAN GIVE DIRECTION"

MICHAEL PRESPECT

1/8"=1'-0"


PRIVATE
COMMUNAL
OFFICE
CIRCULATION
MODULAR PRE-FABRICATED UNITS
BATH / QUARTERS
LIGHT
DOME DETAIL

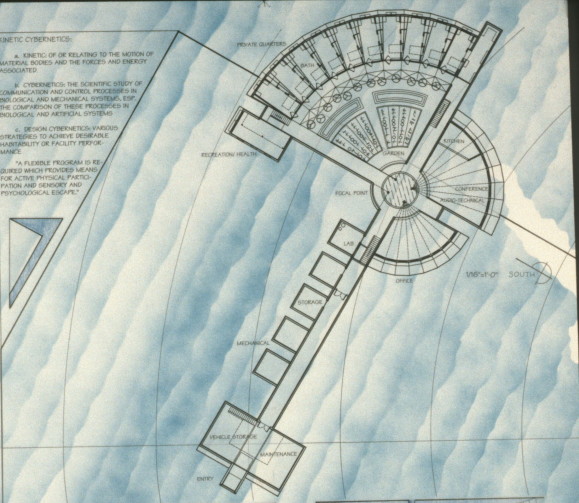
KINETIC CYBERNETICS:

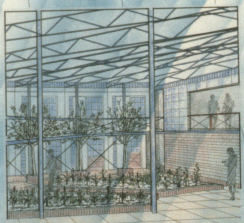
a. KINETIC OF OR RELATING TO THE MOTION OF MATERIAL BODIES AND THE FORCES AND ENERGY ASSOCIATED

b. CYBERNETICS: THE SCIENTIFIC STUDY OF COMMUNICATION AND CONTROL PROCESSES IN BIOLOGICAL AND MECHANICAL SYSTEMS, ESP. THE COMPARISON OF THESE PROCESSES IN BIOLOGICAL AND MECHICAL SYSTEMS

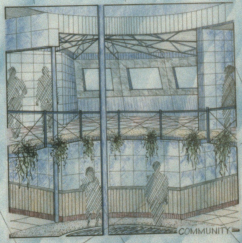
c. DESIGN CYBERNETICS: VARIOUS STRATEGIES TO ACHIEVE DESIRABLE HABITABILITY OR FACILITY PERFORMANCE

"A FLEXIBLE PROGRAM IS REQUIRED WHICH PROVIDES MEANS FOR ACTIVE PHYSICAL PARTICIPATION AND SENSORY AND PSYCHOLOGICAL ESCAPE"





SELF-SUSTAINMENT

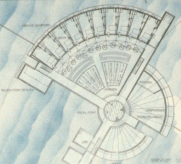


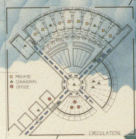
COMMUNITY



ANTARCTIC HIGH STATION

ENVIRONMENT III

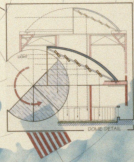


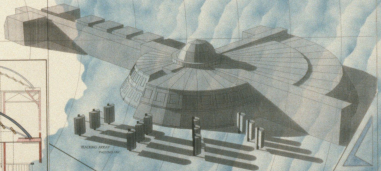


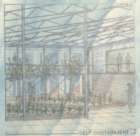








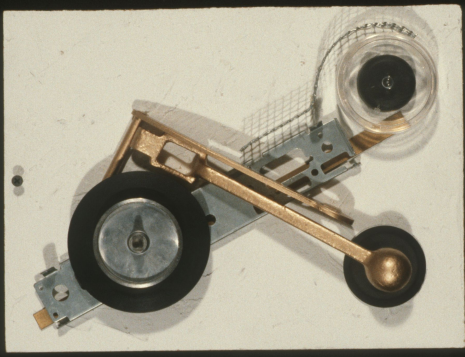


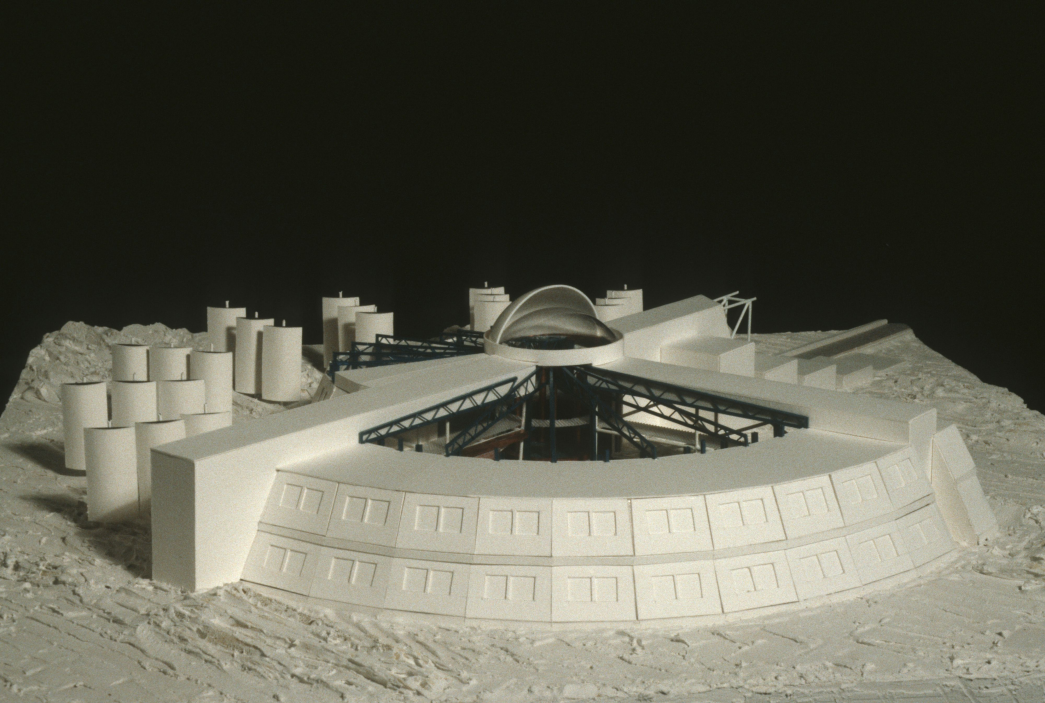






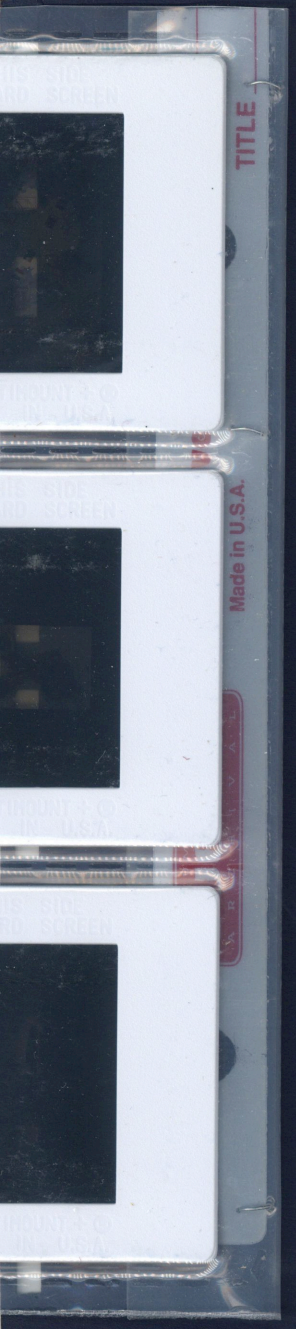
ANTARCTIC HIGH STATION











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