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SPACE AND ENERGY CONSERVATION HOUSING PROTOTYPE UNIT DEVELOPMENT

FINAL REPORT - APRIL 1975 - AUGUST 1975

NASA GRANT NSG 1162

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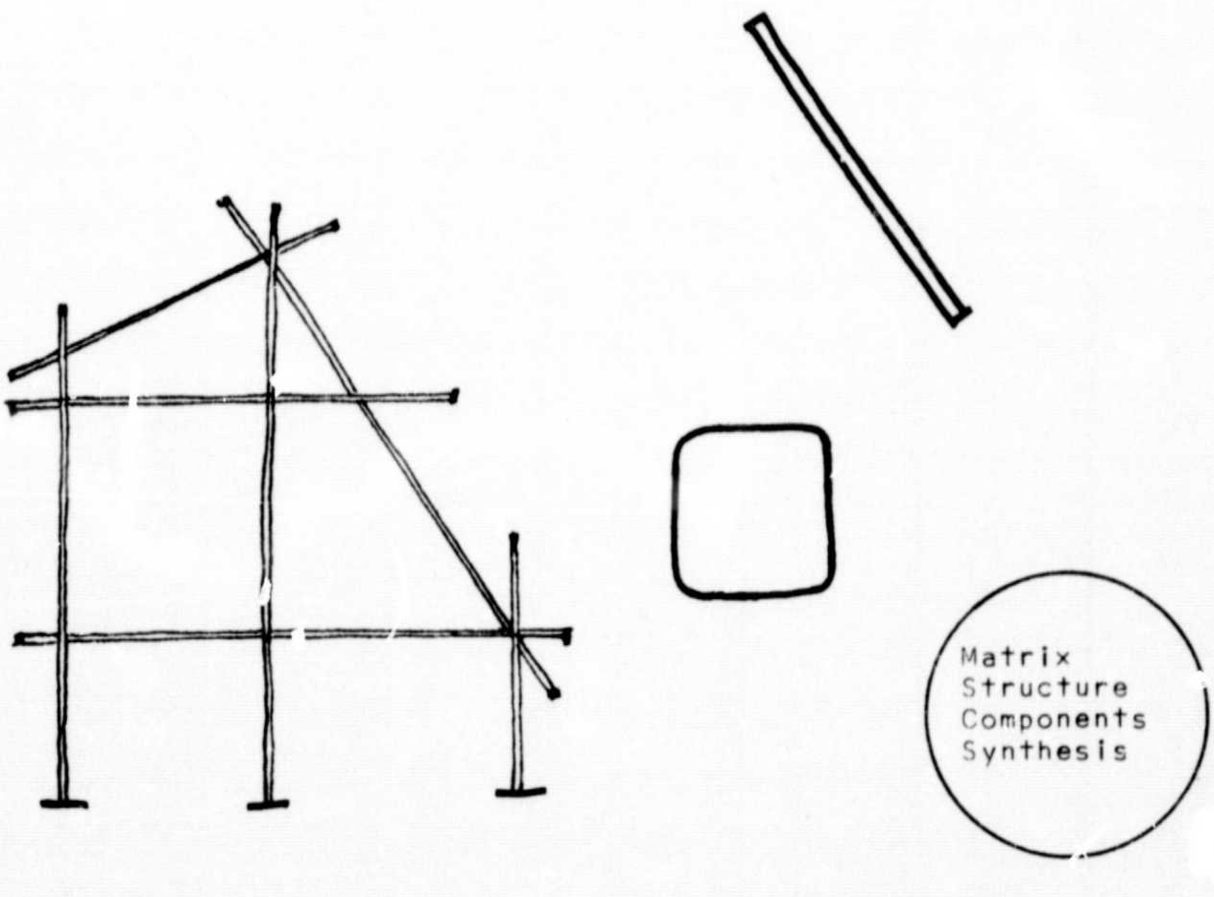
PROJECT
TECH


Matrix
Structure
Components
Synthesis

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The following individuals should be recognized for their participation in this study:

NASA, Dr. Cecil Kirby and Mr. Charles B. Marushi, Technical Officer

Consultants: Dr. Juanita F. Strawn, Director, Division of Social and Environmental Studies, Hampton Institute and recent participant on the Virginia Governor's Electrical Energy Commission

Mr. John H. Spencer, AIA, Chairman, Department of Architecture, Hampton Institute, Architect, Landscape Architect and Climate Research

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INTRODUCTION:

Included, as follows, are excerpts from the original study proposal:

> "<u>SPACE AND ENERGY CONSERVATION HOUSING PROTOTYPE UNIT DEVELOPMENT</u>
>
> Energy conservation in housing, including solar energy application, is imperative. Together with the challenges of energy consumption, a foremost problem facing our country now and in the future is the quality and quantity of housing available.
>
> The desperate quantitative problems of housing need, financing, minimum room sizes, etc., have tended to impose and fix certain space-use patterns which are self-defeating in their inefficiency. Further, qualitative issues are generally ignored and in no sense does housing for the vast majority contribute positively to the quality of life.
>
> Just as new and innovative strategies must be developed to solve our energy problems, highly imaginative and new patterns of housing which are not only more efficient but which are more socially responsive, must be developed.
>
> Consider the possibility of housing sites in the air over roadways, units hung from a bridge spanning a river, or hung from a structure in the water. Consider such possibilities within the dwelling unit as a plug-in, moving, open up tech center and new multi-use furniture and thus "building less and using more." Consider a storage/study/sleeping unit like a berth on a train that is fun for a child rather than a larger (but too small) typical 8' x 10' bedroom. Consider the implications of new lifestyle possibilities.
>
> Thus, while the application of new energy saving technology to current housing situations is possible, an important opportunity is the application of this technology to highly innovative explorations into the housing of the future."

NASA's primary objectives under this program are to construct a house which will demonstrate the application of advanced technology in order to minimize energy requirements and to help direct further development in home construction by

Introduction continued ...

defining the interaction of integrated energy and water systems with building configuration and construction materials.

Consistent with the foregoing, this study not only provides housing unit designs, but attempts to initiate the development of procedures for the analysis of a variety of housing strategies. These procedures which are inter-related to an eight point goal statement included development of the following:

1) Matrix
2) Structure
3) Components

The goals and stated procedures were then applied to the development of the submitted housing unit solutions with numerous solutions developed utilizing these procedures.

These analytical procedures will be more fully explained elsewhere in this report. While these procedures have been applied to the submitted designs, the primary purpose of their development is in anticipation of their future use in research and ultimately for the consumer.

It is anticipated that the fully developed matrix could provide in excess of 360,000 combination of factors resulting in possible different housing designs. These

Introduction continued ...

alternatives could be computer developed. Further, utilizing a flexible structural framework and prefabricated components, certain strategies could be "mocked up" full size for the comparative analysis of physical properties (not dissimilar to wind tunnel tests or crash tests). Such mock ups could also be used for behavioral psychology studies.

Finally, the ultimate application of the foregoing would be for the consumer/user and architect in the selective sampling of a variety of alternative strategies with "total" energy consumption for each and schematic space organization computer reported.

GOALS:

The following is an enumeration, and where appropriate, an explanation of the applicable goals:

1) MAXIMIZE RESPONSIVENESS TO THE NATURAL ENVIRONMENT - Implicit in this goal are a variety of considerations related to the natural physical environment, such as sun, wind, trees, topography, etc., with the understanding that maximum utilization of these factors will result in major energy conservation. Recently in congressional testimony by John P. Eberhard, AIA, President of the AIA Research Corporation, concerning the EDRA plan, Mr. Eberhard said, "buildings were built for thousands of years before there were any mechanical systems available." Architects found "sensible things to do in order to utilize the heat of the sun in cold periods and reduce the impact of the sun's heat in hot periods." Such "sensible design decisions should be made first," he said, "and then supplemented with solar energy activated mechanical systems."

2) MAXIMIZE RESPONSIVENESS TO THE BUILT ENVIRONMENT - This goal suggests consideration of surrounding land use influences such as buildings, paving, etc.

Goals continued ...

3) ENERGY AND RESOURCE CONSERVATION -

The emphasis in this goal is on "total" energy and resources as distinguished from operating fuel consumption. Thus, the technological impact, energy consumption and renewable aspects of construction materials used and building site impact as well as building use operations are considered.

4) MINIMIZE TOTAL VOLUME -

As the building volume is reduced, potential for the reduction of materials, land, energy consumption and costs exist.

5) MAXIMIZE PERCEIVABLE SPACE -

While we attempt to conserve, we must not overlook the fact that the physical environment that is developed must enhance the human activities for which it exists to serve.

6) ARCHITECTURALLY INTEGRATE NASA TECHNOLOGY

7) PROTOTYPICAL DEVELOPMENT -

This goal addresses itself to the continuing lag of mass production industrial application to the construction industry. While many building parts are mass produced and "prefab" houses are built, individual on site

Goals continued ...

construction is none-the-less common, costly and time consuming.

8) MAXIMIZE RESPONSIVENESS TO THE INDIVIDUAL USER'S CHANGING NEEDS -

The vast majority of people (low and middle income) have had no opportunity to participate in the development of the housing units in which they live. Thus, with the exception of minor superficial changes, they must accept and adapt to that which is imposed. This goal seeks ways to enable significant participation in the housing unit design by the actual user. Further, it is recognized that most user's needs change dramatically over time from a young couple, to a family with children, to an older couple.

MATRIX

As previously indicated, the purpose of the matrix is to provide a tool for the analytical investigation of the numerous possible housing designs as related to the stated goal influences. The matrix consists of the following:

1) A summary of goal related parameters for the categories of site, user, conceptual strategies, and building strategies.

2) Activity space parameters for each space.

3) Parametric explanation (an example has been included for future development, see recommendations).

4) Parametric strategies (an example has been included for future development, see recommendations).

The foregoing, with appropriate parameters considered and options selected, forms the basis for a housing unit prescription for the stated goals. The completed prescription for the submitted housing unit is included.

The full development of the included matrix "outline" and its use has been briefly described in the introduction herein. This methodology is in fact employed in perhaps a less elaborate and formal way by many architects today. Of particular importance here is the application of this methodology to the particular goals, the more formal organization, the future parametric elaboration and computer model and the potential full scale resultant prescription mock ups for testing.

Matrix continued ...

Such testing is implemented with the development of flexible components and structure for the construction of such "laboratory" test models.

MATRIX

SITE

Factors / GOALS	1 Maximize Responsiveness To The Natural Environment	2 Maximize Responsiveness To The Built Environment	3 Energy and Resource Conservation	4 Minimize Total Volume	5 Maximize Perceivable Space	6 Architecturally Integrate N.A.S.A. Technology	7 Prototypical Development	8 Maximize Responsiveness To Individual User's Changing Needs
Sun	○		○	○		○		○
Wind	○		○	○				○
Rain	○		○	○				○
Snow	○		○	○				○
Topography	○		○				○	○
Sub Surface	○						○	
Trees	○		○				○	○
Views	○		○		○		○	○
Adj. Land Uses		○	○				○	○
Vehicular Access		○	○					○
Vehicular Storage		○	○					○
Pedestrian Paths	○	○						○
Public Places		○						○
Private Places	○	○			○			○
Utilities		○	○			○	○	
Other								

MATRIX

USER

Factors \ GOALS	1 Maximize Responsiveness To The Natural Environment	2 Maximize Responsiveness To The Built Environment	3 Energy and Resource Conservation	4 Minimize Total Volume	5 Maximize Perceivable Space	6 Architecturally Integrate N.A.S.A. Technology	7 Prototypical Development	8 Maximize Responsiveness To Individual User's Changing Needs
Group Activities	O	O	O	O	O			O
Individual Activities	O	O	O	O	O		O	O
Support Facilities		O	O	O		O	O	O
Entrance		O	O	O				O
Kitchen		O	O	O		O	O	O
Bath		O	O	O		O	O	O
Laundry		O	O	O		O	O	O
Storage			O	O			O	O
Clothes			O	O				O
General		O	O	O				O
Auto		O	O	O				O
Mech. Equip.		O	O	O		O	O	
Other								

MATRIX

CONCEPTS

Strategies / GOALS	1 Maximize Responsiveness To The Natural Environment	2 Maximize Responsiveness To The Built Environment	3 Energy and Resource Conservation	4 Minimize Total Volume	5 Maximize Perceivable Space	6 Architecturally Integrate N.A.S.A. Technology	7 Prototypical Development	8 Maximize Responsiveness To Individual User's Changing Needs
Fixed Volume			O	O		O	O	
Fixed Point			O			O	O	O
Fixed Points			O			O	O	O
Expandable - Contractible	O	O						O
Repetitive 2 D or 3 D Unit			O	O	O	O	O	O
Vertical Components			O	O	O	O	O	O
Horizontal Components			O	O	O	O	O	O
Linear Components			O	O		O	O	
Multi Level			O	O	O			
"Saddle Bags"			O	O	O	O	O	O
"Tree House"	O		O		O		O	O
Amorphous Form	O	O			O			O
"Plug-Ins"		O		O			O	O
Inflatable		O			O			O
Core			O	O		O	O	O
Community Shared Systems		O	O	O		O	O	
Other								

MATRIX

BUILDING

Strategies / GOALS	1 Maximize Responsiveness To The Natural Environment	2 Maximize Responsiveness To The Built Environment	3 Energy and Resource Conservation	4 Minimize Total Volume	5 Maximize Perceivable Space	6 Architecturally Integrate N.A.S.A. Technology	7 Prototypical Development	8 Maximize Responsiveness To Individual User's Changing Needs
Mobility			○				○	
Multi-Environment	○		○					
Flexibility			○	○	○			○
Modular			○				○	
Construction			○					
Conventional			○			○		
Unconventional			○	○	○		○	○
Natural	○		○	○	○			
Off-Site			○	○	○		○	○
Multi-Level			○	○	○			
Orientation	○	○	○					○
Ground Relationship	○	○	○					
Heating - Cooling			○			○		
Mechanical			○			○	○	
Natural	○	○	○					
Water	○		○			○		
Natural Recycle	○		○			○		
Heat Prod. Appliances			○			○		
Other								
Ventilation			○			○		
Mechanical			○			○	○	
Natural	○	○	○					

MATRIX Activity/Space Relationships Characteristics	Within Space	Close to Space	Controlled Access To	Remote	Private	Public	Quiet	Noisy	Activity	Inactivity	Formal	Informal	Other		
Group Activities															
Individual Activities															
Support Facilities															
Entrance															
Kitchen															
Bath															
Laundry															
Storage															
Clothes															
General															
Auto															
Mech. Equip.															
Light															
Ventilation															
Exterior Activities															
Exterior View															
Other															

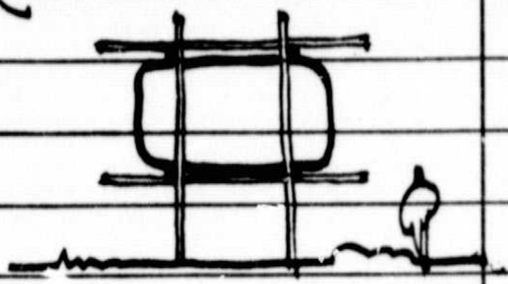
MATRIX

GROUND RELATION

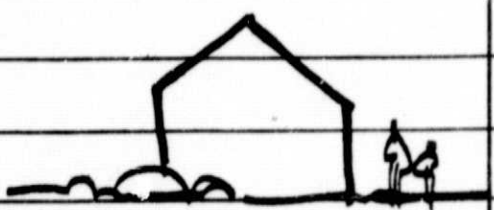
building

EXPLANATION — GOALS	1 Maximize Responsiveness To The Natural Environment	2 Maximize Responsiveness To The Built Environment	3 Energy and Resource Conservation	4 Minimize Total Volume	5 Maximize Perceivable Space	6 Architecturally Integrate N.A.S.A. Technology	7 Prototypical Development	8 Maximize Responsiveness To Individual User's Changing Needs

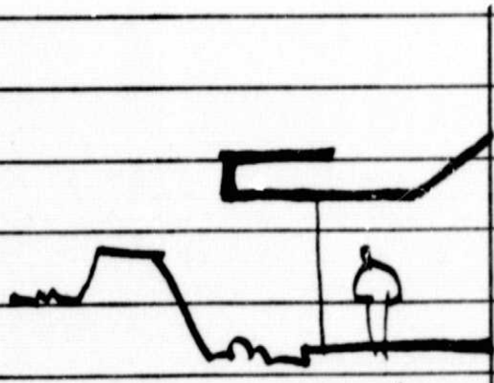
(EXAMPLE FOR FUTURE FULL DEVELOPMENT)



Above



On



Below

MATRIX

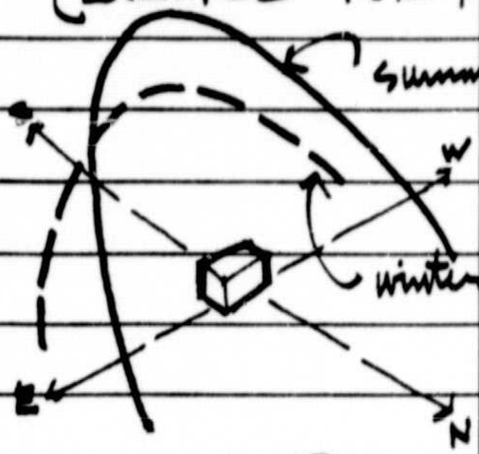
SUN

site

GOALS	1	2	3	4	5	6	7	8
	Maximize Responsiveness To The Natural Environment	Maximize Responsiveness To The Built Environment	Energy and Resource Conservation	Minimize Total Volume	Maximize Perceivable Space	Architecturally Integrate N.A.S.A. Technology	Prototypical Development	Maximize Responsiveness To Individual User's Changing Needs

EXPLANATION

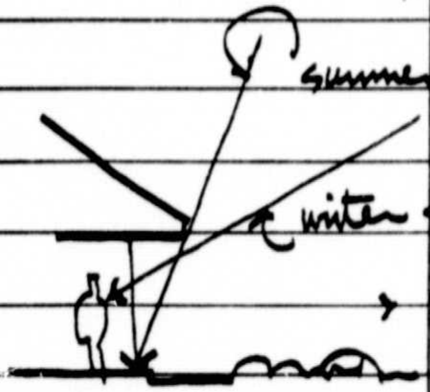
(EXAMPLE FOR FUTURE FULL DEVELOPMENT)



summer sun path

37° North latitude

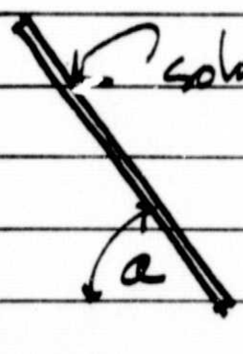
winter sun path



summer sun path - conventional roof overhang shades

winter sun path - same overhang lets sun in

south



solar collector

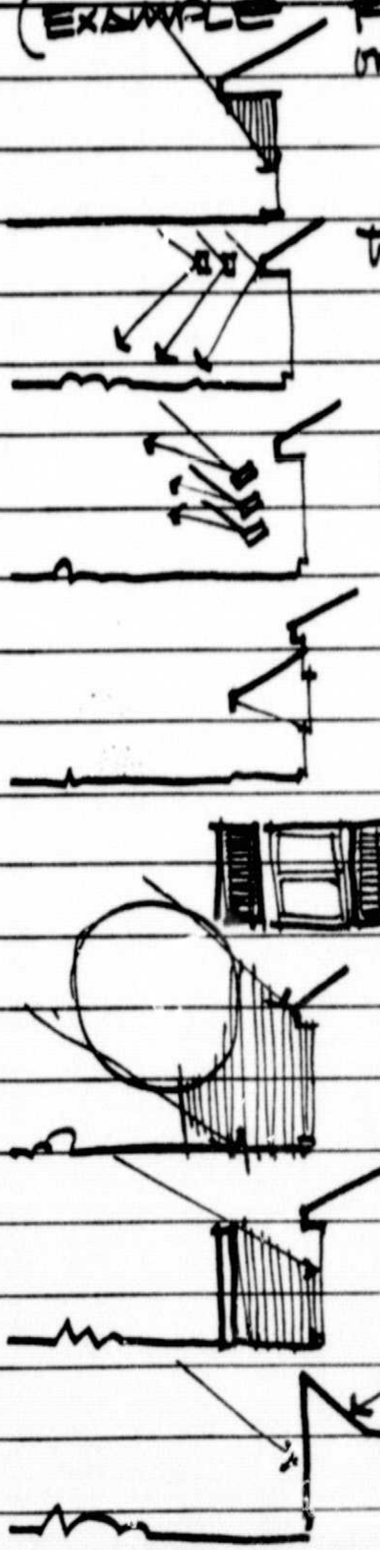
collector area approx. 1/3 of floor area

a for house = 58° per N.A.C.B.

MATRIX

SUN

site



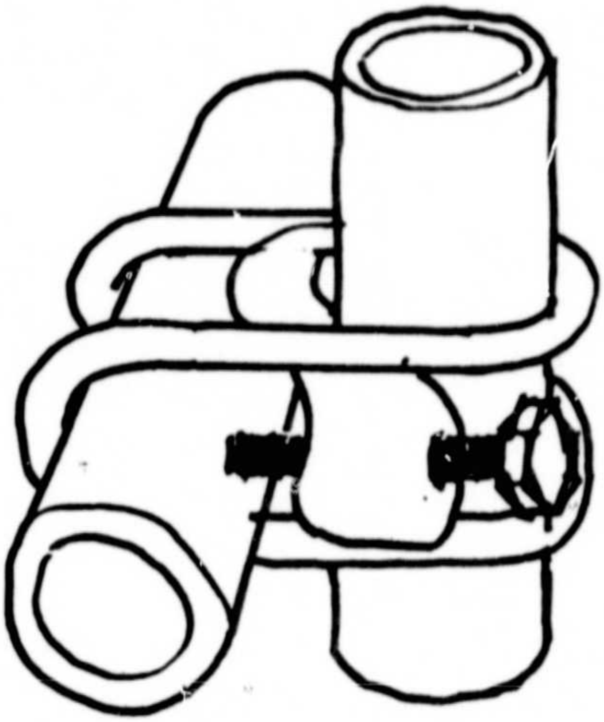
STRATEGIES / GOALS	1 Maximize Responsiveness To The Natural Environment	2 Maximize Responsiveness To The Built Environment	3 Energy and Resource Conservation	4 Minimize Total Volume	5 Maximize Perceivable Space	6 Architecturally Integrate N.A.S.A. Technology	7 Prototypical Development	8 Maximize Responsiveness To Individual User's Changing Needs
(EXAMPLE FOR FUTURE FULL DEVELOPMENT)								
overhang								
trellis								
louvers								
awning								
shutter								
tree								
garden wall								
skylight								

STRUCTURE:

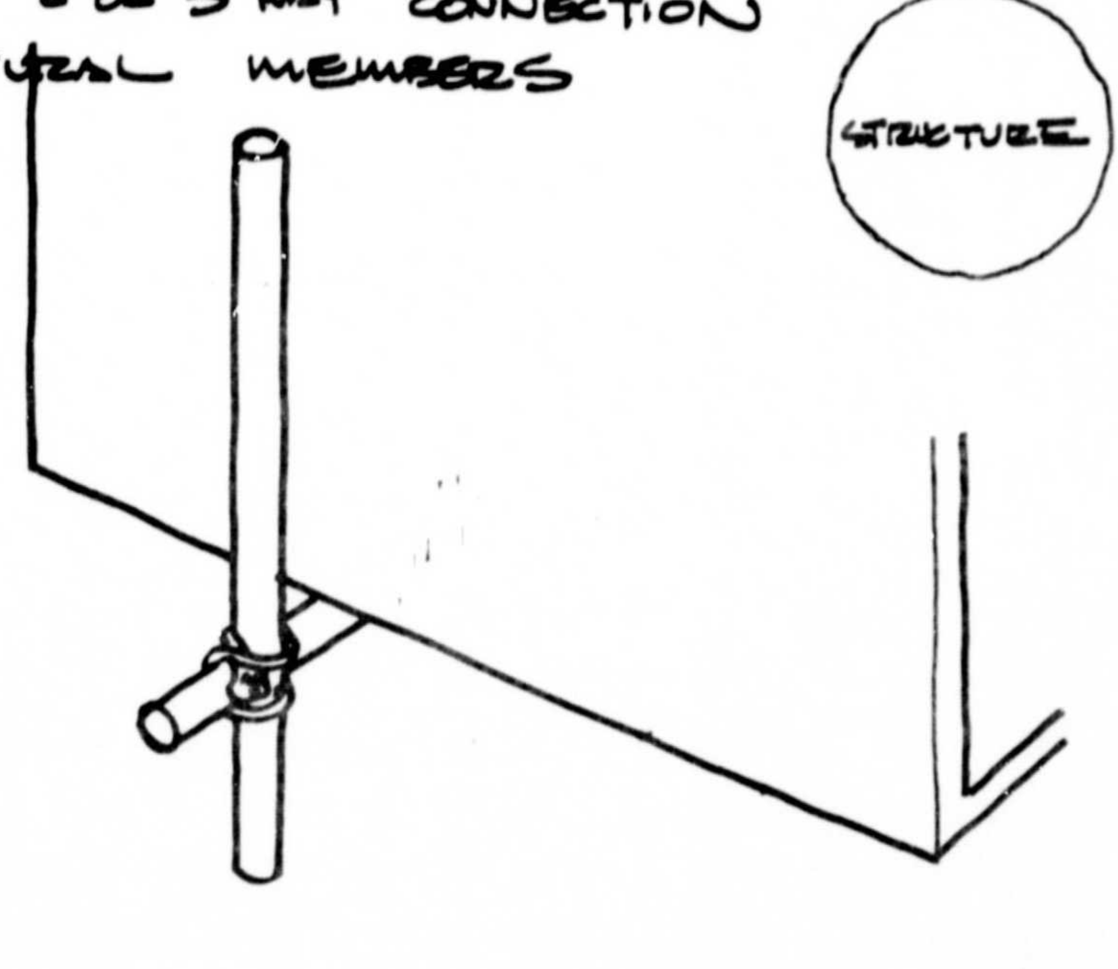
The purpose of this structure is to provide a flexible volumetric framework which is for housing unit testing what the wind tunnel or "crash structure" is for that testing. Such a framework should be simply and quickly erected and dismantled and totally flexible. It would be a three dimensional framework that panels could be applied to in order to enclose space, and into which pre-constructed "packages" could be set.

Scaffolding and warehouse storage systems are current examples of these principles applied to other uses.

Diagrammatic drawings of such a system are included herein for future structural development.

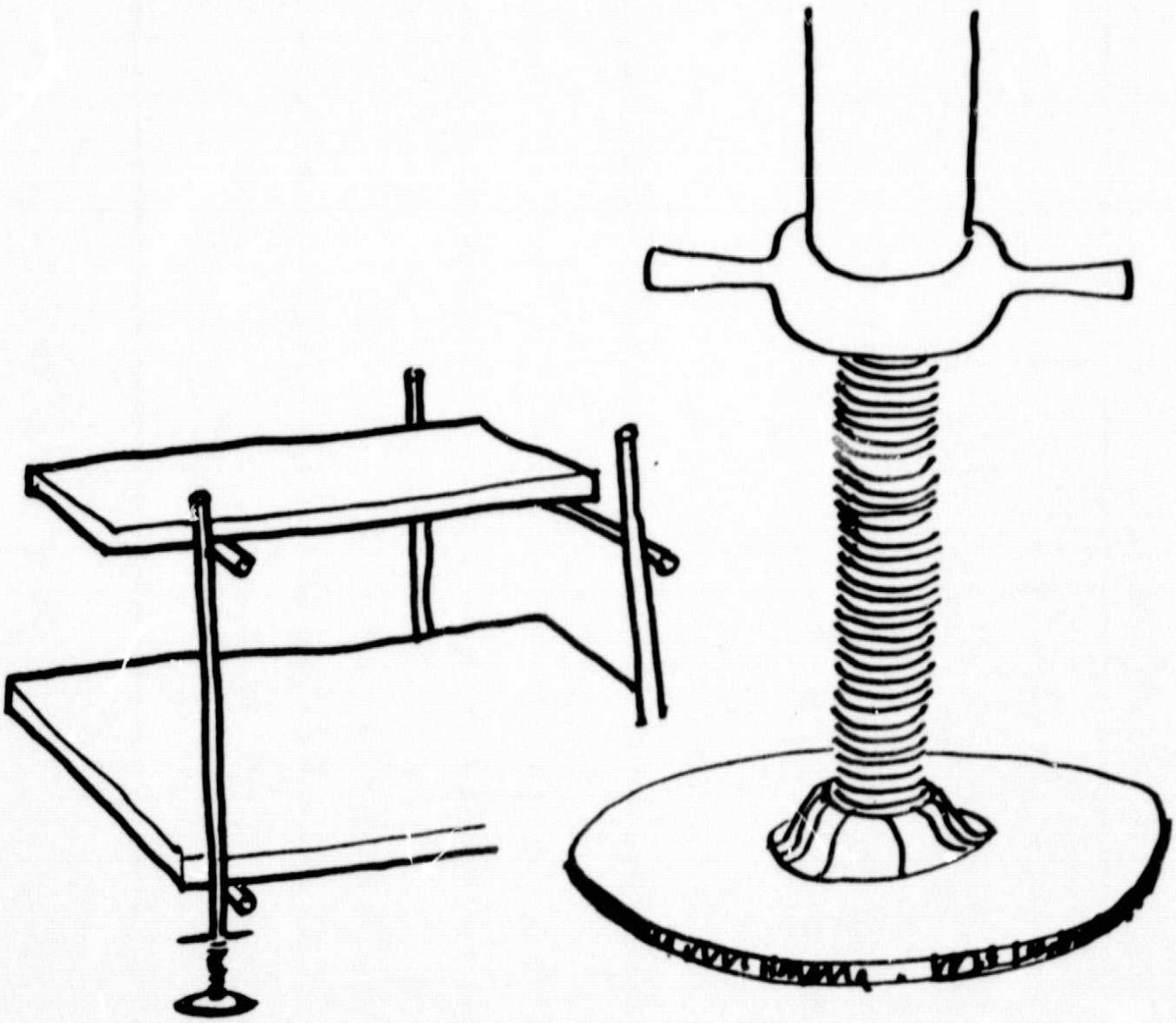


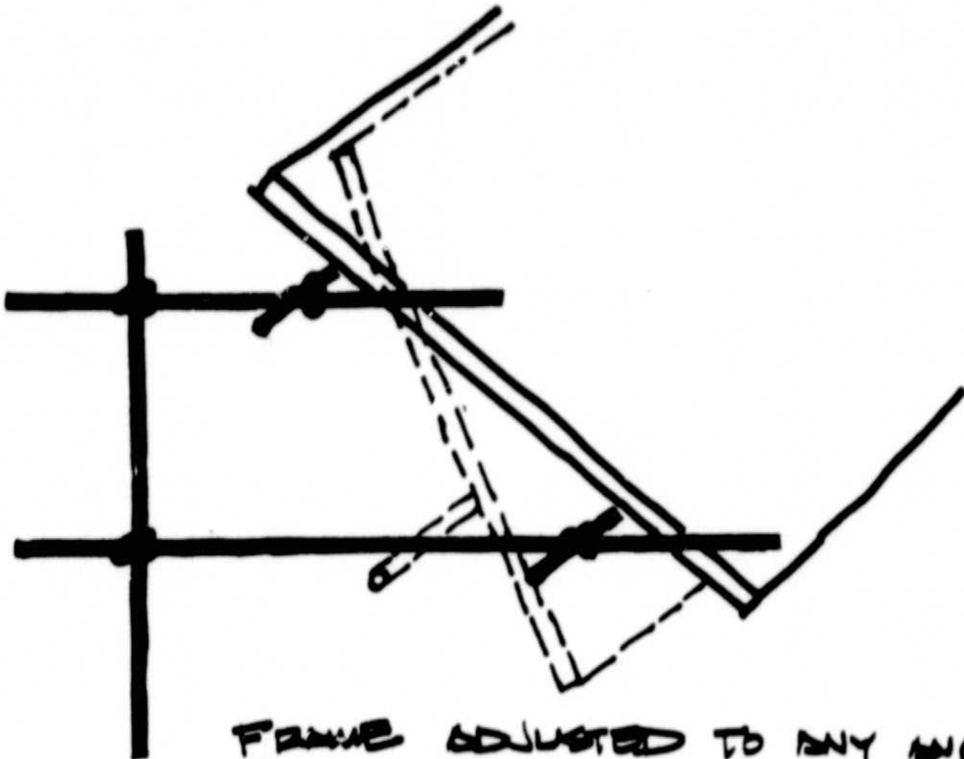
FLEXIBLE 2 OR 3 WAY CONNECTION
AT STRUCTURAL MEMBERS



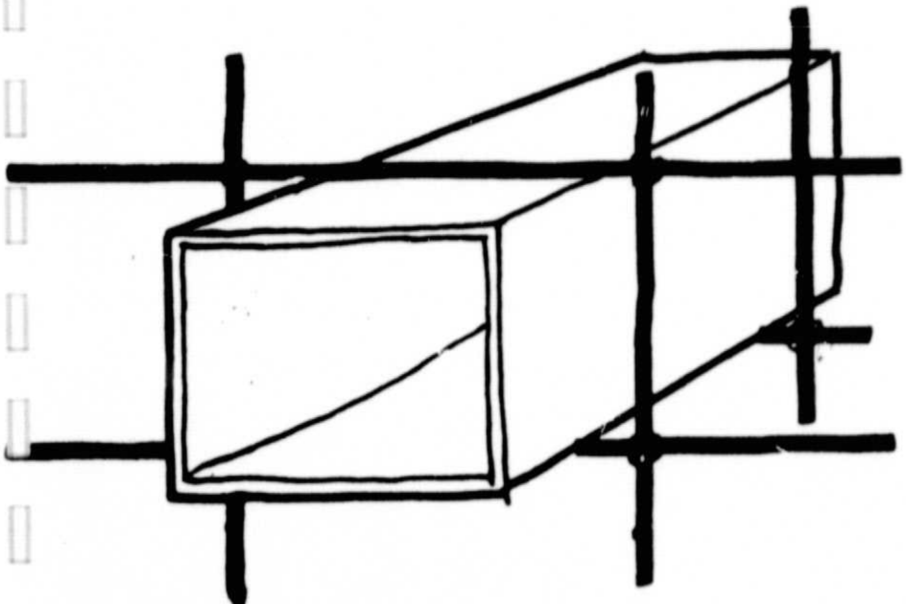
ADJUSTABLE LEVELING DEVICE
AT STRUCTURE BEARING

STRUCTURE



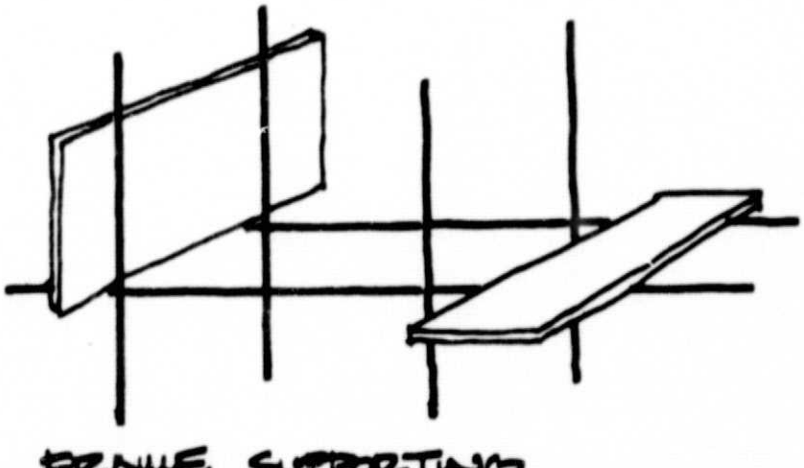


FRAME ADJUSTED TO ANY ANGLE
FOR SOLAR COLLECTOR SUPPORT



FRAME SUPPORTING
COMPONENT PACKAGE

STRUCTURE



FRAME SUPPORTING
COMPONENT PANELS

COMPONENTS:

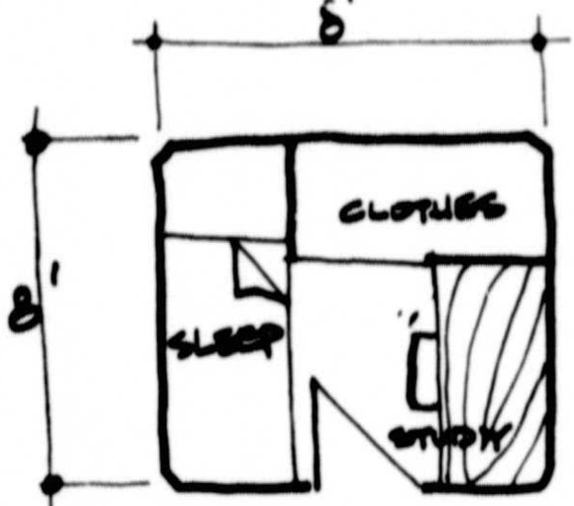
As previously indicated in the goal explanation under prototypical development and user responsiveness and also for "test model" application, a system of prefabricated reusable components is necessary, which is for this housing unit what furniture is for any room.

Such component packages include kitchens, bathrooms, mechanical spaces, stairs, moveable wardrobes and privacy spaces. The privacy spaces, particularly those for children, are thought of as self-contained "furniture" units which could be exchanged for another model or expanded and which include a place for study, lounging, sleeping, clothes storage, etc. As such spaces are made more efficient, the goals of minimizing total volume and/or maximizing perceivable space are addressed. Such an individual "hideout" is quite acceptable as long as an alternate larger family (group) space is available.

The component package thus can provide small individual space needs and support functions. The remaining group spaces for dining, informal family activities and more formal adult activities can be of any size or form and are attached utilizing component panels which are vertical or horizontal, opaque, translucent or transparent in order to accomodate any form or construction system.

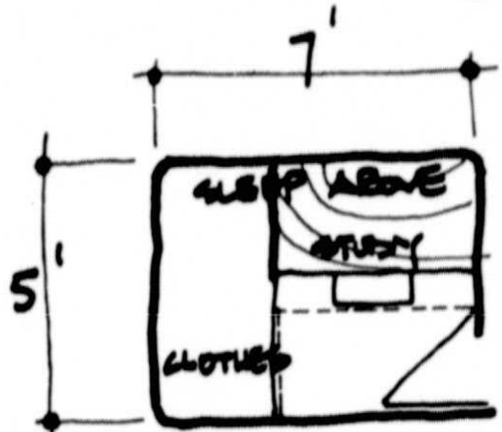
Components continued ...

The component drawings included herein diagrammatically describe such elements for future design development.



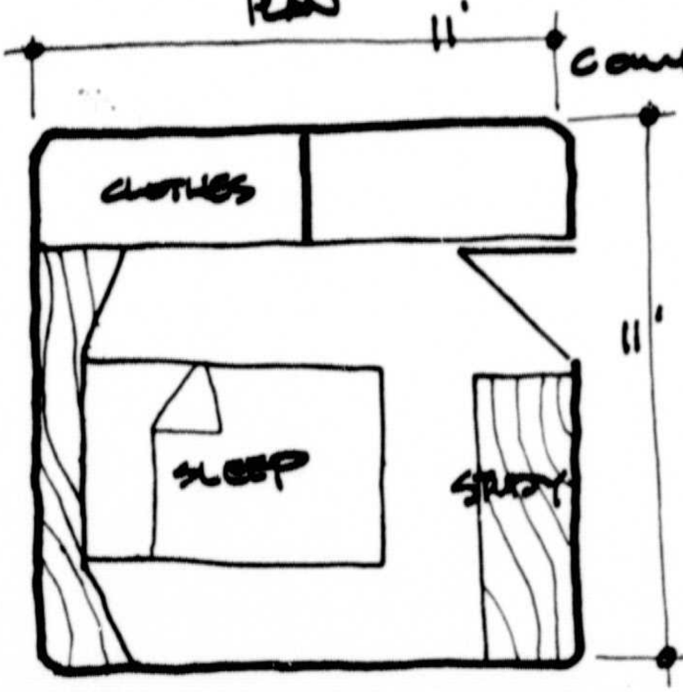
PLAN

COMPONENT B

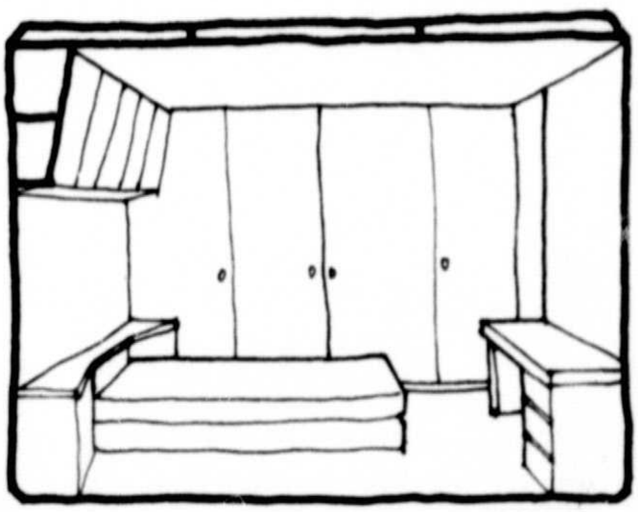


PLAN

COMPONENT C



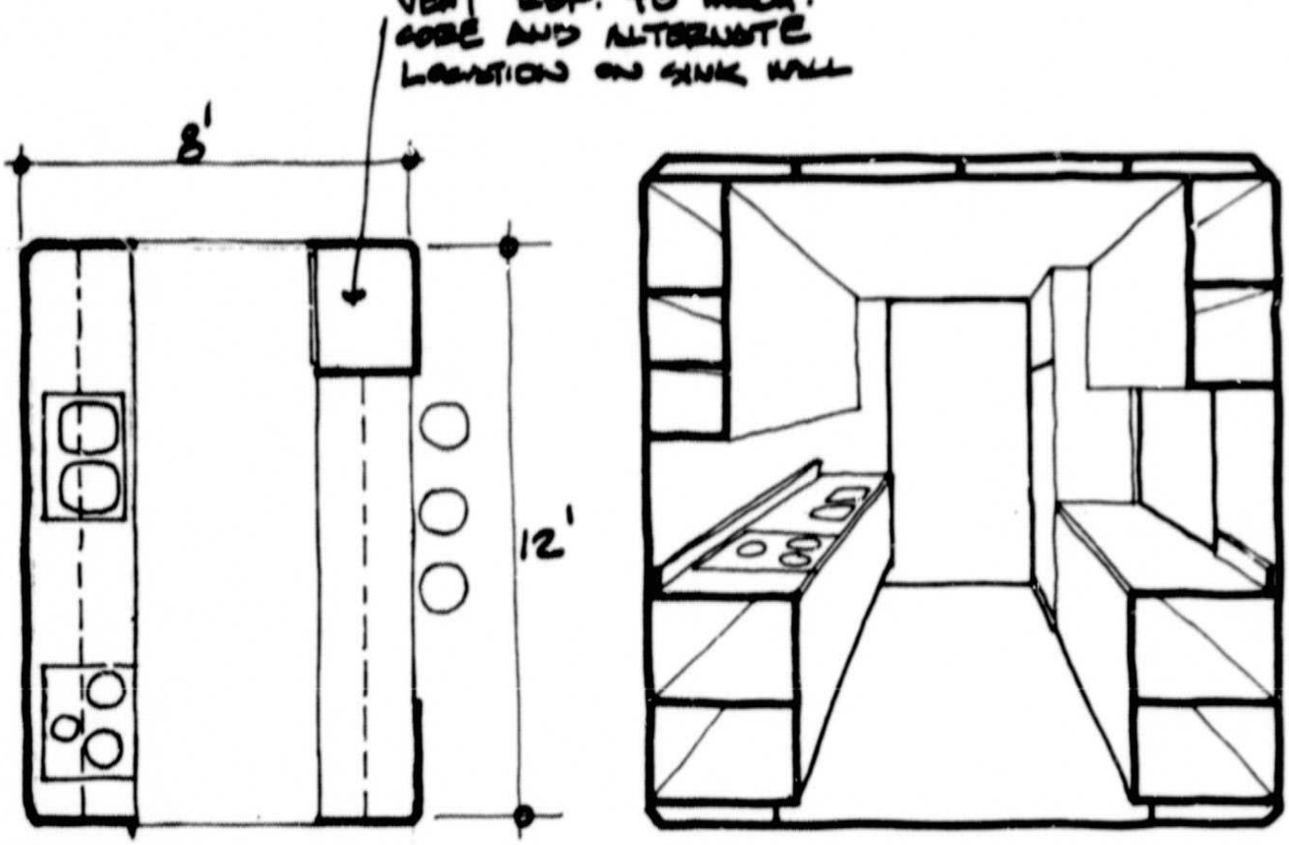
PLAN



COMPONENT A

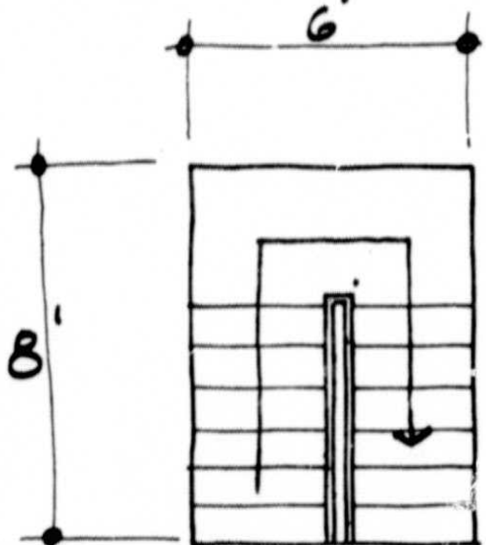
PRIVACY SPACES

COMPONENTS



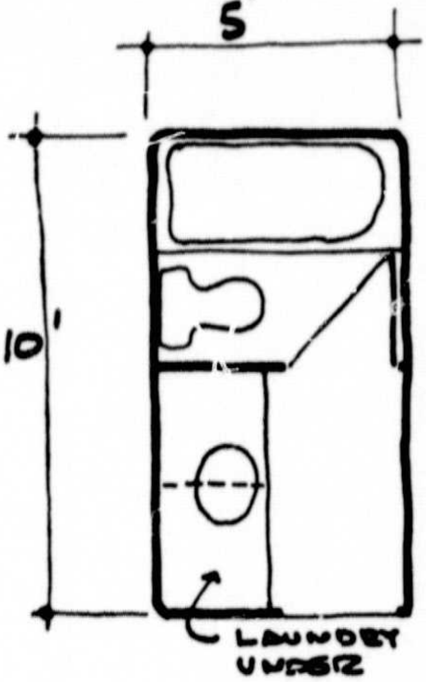
PLAN

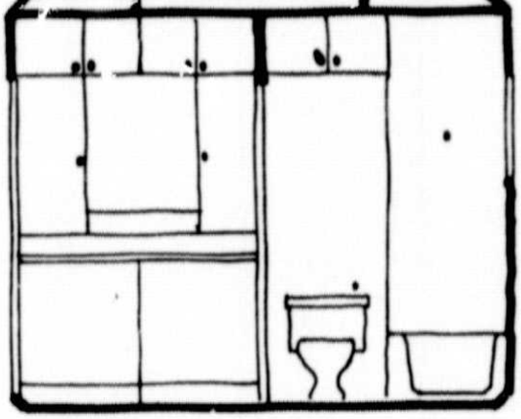
KITCHEN · CORE 1



PLAN
STAIR · CORE 2

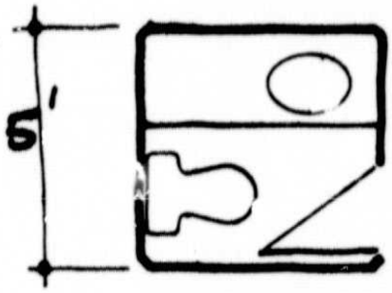
COMPONENTS



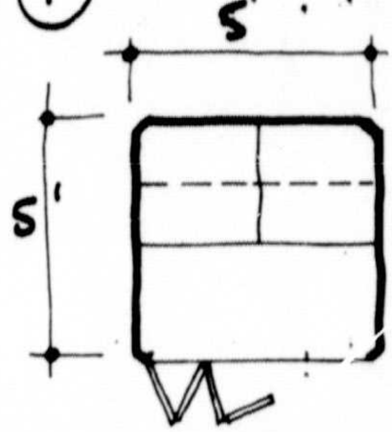


ELEVATION

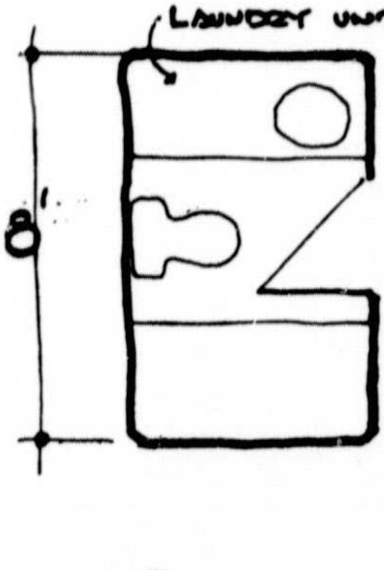
BATHROOM (1)



1/2 BATH

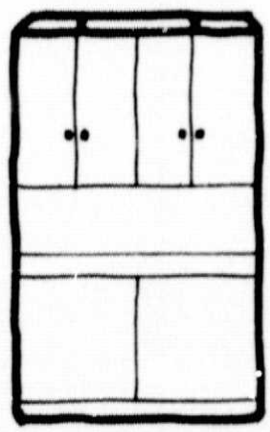


LAUNDRY UNDER OR SEPARATE



LAUNDRY

BATHROOM (2)



PLAN

COMPONENTS

PROJECT TECH

SYNTHESIS

NASA Technology Utilization House:

The foregoing methodology and systems have thus been applied to the design of the subject single family dwelling unit for the particular program and specific intended building site.

During this work, certain "stylistic" concerns were expressed to the researchers presumably with the home building market and the housewife in mind. In the previously referred to congressional testimony, Mr. Eberhard indicated that the EDRA plan should address aesthetic concerns and drew an analogy to automobile design. "The earlier automobiles were literally horseless carriages, that is, they looked like carriages that were no longer pulled by horses. It took a lot of early design experiments before a vehicle began to emerge that was clearly an automobile. Similarly, solar assisted houses that look like traditional houses will be the Model T Fords of solar energy," he said, but he "predicted that new designs that are clearly the result of solar energy thinking will eventually emerge."

This study strongly agrees with Mr. Eberhard. The aesthetic beauty of a sail boat results from the integrity of the functional solution. Obvious further analogies can be drawn

Project Tech continued ...

to NASA's space technology solutions in the most positive sense. Thus while a variety of appearances can be achieved, as demonstrated by the number of drawings done during the development of this work (not included herein), the primary concern was the form of the volume and other appearance influences as goal related.

The drawings for the housing design included herein indicate the schematic solution for further design development.

MATRIX

SITE "NASA PROJECT TECH"

Factors / GOALS	Notes	1 Maximize Responsiveness To The Natural Environment	2 Maximize Responsiveness To The Built Environment	3 Energy and Resource Conservation	4 Minimize Total Volume	5 Maximize Perceivable Space	6 Architecturally Integrate N.A.S.A. Technology	7 Prototypical Development	8 Maximize Responsiveness To Individual User's Changing Needs
Sun	- use low south winter sun for natural heating	○		○	○		○		○
Wind	- use S.E. summer breezes for cross vent. - shield from N.W. winter wind	○		○	○				○
Rain	- overhang protection + positive site drainage	○		○	○				○
Snow	- none	○		○	○				○
Topography	. flat	○		○				○	○
Sub Surface	- high water table	○						○	
Trees	- at north - should provide good winter wind break	○		○				○	○
Views	- to trees at North	○		○		○		○	○
Adj. Land Uses	- Negative to S.E. & W. - public parking, buildings, roads		○	○				○	○
Vehicular Access	. at West		○	○					○
Vehicular Storage	- at west		○	○					○
Pedestrian Paths	- from West	○	○						○
Public Places	- S.E. & W.		○						○
Private Places	- N. - other orientation would req. visual screen	○	○			○			○
Utilities	- see site plan		○	○			○	○	
Other									

MATRIX

USER

NASA "PROJECT TECH"

Factors	GOALS	1 Maximize Responsiveness To The Natural Environment	2 Maximize Responsiveness To The Built Environment	3 Energy and Resource Conservation	4 Minimize Total Volume	5 Maximize Perceivable Space	6 Architecturally Integrate N.A.S.A. Technology	7 Prototypical Development	8 Maximize Responsiveness To Individual User's Changing Needs
Group Activities		○	○	○	○	○			○
"LIVING" (conversation, etc)									
FAMILY									
DINING									
Individual Activities		○	○	○	○	○		○	○
2 ADULTS									
CHILD - 1									
CHILD - 2									
Support Facilities			○	○	○		○	○	○
Entrance	✓		○	○	○				○
Kitchen	✓		○	○	○		○	○	○
Bath	1 1/2		○	○	○		○	○	○
Laundry	✓	under counter at lavatory at sleeping		○	○		○	○	○
Storage	✓			○	○			○	○
Clothes	✓			○	○				○
General	✓		○	○	○				○
Auto	1 1/2		○	○	○				○
Mech. Equip.	✓		○	○	○		○	○	
Other									

MATRIX

CONCEPTS

NASA "PROJECT TECH"

Strategies	GOALS	1 Maximize Responsiveness To The Natural Environment	2 Maximize Responsiveness To The Built Environment	3 Energy and Resource Conservation	4 Minimize Total Volume	5 Maximize Perceivable Space	6 Architecturally Integrate N.A.S.A. Technology	7 Prototypical Development	8 Maximize Responsiveness To Individual User's Changing Needs
Fixed Volume				O	O		O	O	
Fixed Point	✓			O			O	O	O
Fixed Points	✓			O			O	O	O
Expandable - Contractible		O	O						O
Repetitive 2 D or 3 D Unit				O	O	O	O	O	O
Vertical Components	✓			O	O	O	O	O	O
Horizontal Components	✓			O	O	O	O	O	O
Linear Components				O	O		O	O	
Multi Level	✓			O	O	O			
"Saddle Bags"	✓			O	O	O	O	O	O
"Tree House"		O		O		O		O	O
Amorphous Form		O	O			O			O
"Plug-ins"	✓		O		O			O	O
Inflatable			O			O			O
Core	✓			O	O		O	O	O
Community Shared Systems			O	O	O		O	O	
Other									

MATRIX

BUILDING

NASA "PROJECT TECH"

Strategies	GOALS	1 Maximize Responsiveness To The Natural Environment	2 Maximize Responsiveness To The Built Environment	3 Energy and Resource Conservation	4 Minimize Total Volume	5 Maximize Perceivable Space	6 Architecturally Integrate N.A.S.A. Technology	7 Prototypical Development	8 Maximize Responsiveness To Individual User's Changing Needs	
Mobility	✓			○				○		
Multi-Environment		○		○						
Flexibility	✓			○	○	○			○	
Modular	✓			○				○		
Construction				○						
Conventional				○			○			
Unconventional	✓			○				○	○	space components + panels + flexible structural framework
Natural		○		○	○	○				
Off-Site	✓			○	○	○		○	○	
Multi-Level	✓			○	○	○				
Orientation		○	○	○					○	long sides face N. & S. for max. sun and cross ventilation
Ground Relationship		○	○	○						lower floor at grade - no below grade const. in this area
Heating - Cooling				○			○			
Mechanical	✓			○			○	○		
Natural	✓	○	○	○						fireplaces in group spaces
Water		○		○			○			
Natural Recycle		○					○			cistern to store rain water - all water except kitchen for w.c. reuse.
Heat Prod. Appliances				○			○			ref. stove. dryer - vent to centeral system for reuse or exhaust
Other										
Ventilation	✓									max. natural-cross vent. high S. low N. roof top summer exhaust and winter recirculate
Mechanical	✓			○			○	○		
Natural	✓	○	○	○						

MATRIX

Activity/Space

LIVING

NASA "PROJECT TECH"

Relationships

Characteristics	Within Space	Close to Space	Controlled Access To	Remote	Private	Public	Quiet	Noisy	Activity	Inactivity	Formal	Informal	Other		
Group Activities						✓	✓			✓	✓				
DINING		✓													
FAMILY				✓											
Individual Activities															
CHILD				✓											
ADULT			✓												
Support Facilities															
Entrance		✓	✓												
Kitchen			✓												
Bath			✓												
Laundry				✓											
Storage				✓											
Clothes			✓	(COATS)											
General				✓											
Auto			✓	✓											
Mech. Equip.				✓											
Light	✓														
Ventilation	✓														
Exterior Activities			✓												
Exterior View	✓														
Other															

MATRIX

Activity/Space

DINING

NASA "PROJECT TECH"

Relationships / Characteristics	Within Space	Close to Space	Controlled Access To	Remote	Private	Public	Quiet	Noisy	Activity	Inactivity	Formal	Informal	Other	
Group Activities						✓	✓			✓	✓			
LIVING		✓												
FAMILY				✓										
Individual Activities														
CHILD				✓										
ADULT			✓											
Support Facilities														
Entrance			✓											
Kitchen		✓												
Bath			✓											
Laundry				✓										
Storage														
Clothes			✓	(COATS)										
General				✓										
Auto				✓										
Mech. Equip.				✓										
Light	✓													
Ventilation	✓													
Exterior Activities		✓	✓											
Exterior View	✓													
Other														

MATRIX

Activity/Space

FAMILY

NASA "PROJECT TECH"

Relationships

Characteristics	Within Space	Close to Space	Controlled Access To	Remote	Private	Public	Quiet	Noisy	Activity	Inactivity	Formal	Informal	Other	
Group Activities						✓		✓	✓			✓		
LIVING			✓	✓										
DINING			✓	✓										
Individual Activities														
CHILD		✓												
ADULT			✓	✓										
Support Facilities														
Entrance			✓	✓										
Kitchen	✓	✓												
Bath			✓											
Laundry			✓											
Storage														
Clothes			✓	✓										
General		✓	✓											
Auto		✓	✓											
Mech. Equip.				✓										
Light	✓													
Ventilation	✓													
Exterior Activities	✓													
Exterior View	✓													
Other														

MATRIX

Activity/Space

CHILD 1 & 2

NASA "PROJECT TECH"

Relationships / Characteristics	Within Space	Close to Space	Controlled Access To	Remote	Private	Public	Quiet	Noisy	Activity	Inactivity	Formal	Informal	Other	
Group Activities					✓		✓			✓		✓		
LIVING DINING				✓										
FAMILY	✓	✓	✓											
Individual Activities														
CHILD 1/2			✓											
ADULT			✓	✓										
Support Facilities														
Entrance				✓										
Kitchen			✓											
Bath		✓												
Laundry		✓												
Storage														
Clothes	✓													
General			✓											
Auto				✓										
Mech. Equip.				✓										
Light	✓	✓												
Ventilation	✓													
Exterior Activities														
Exterior View	✓	✓												
Other														

MATRIX

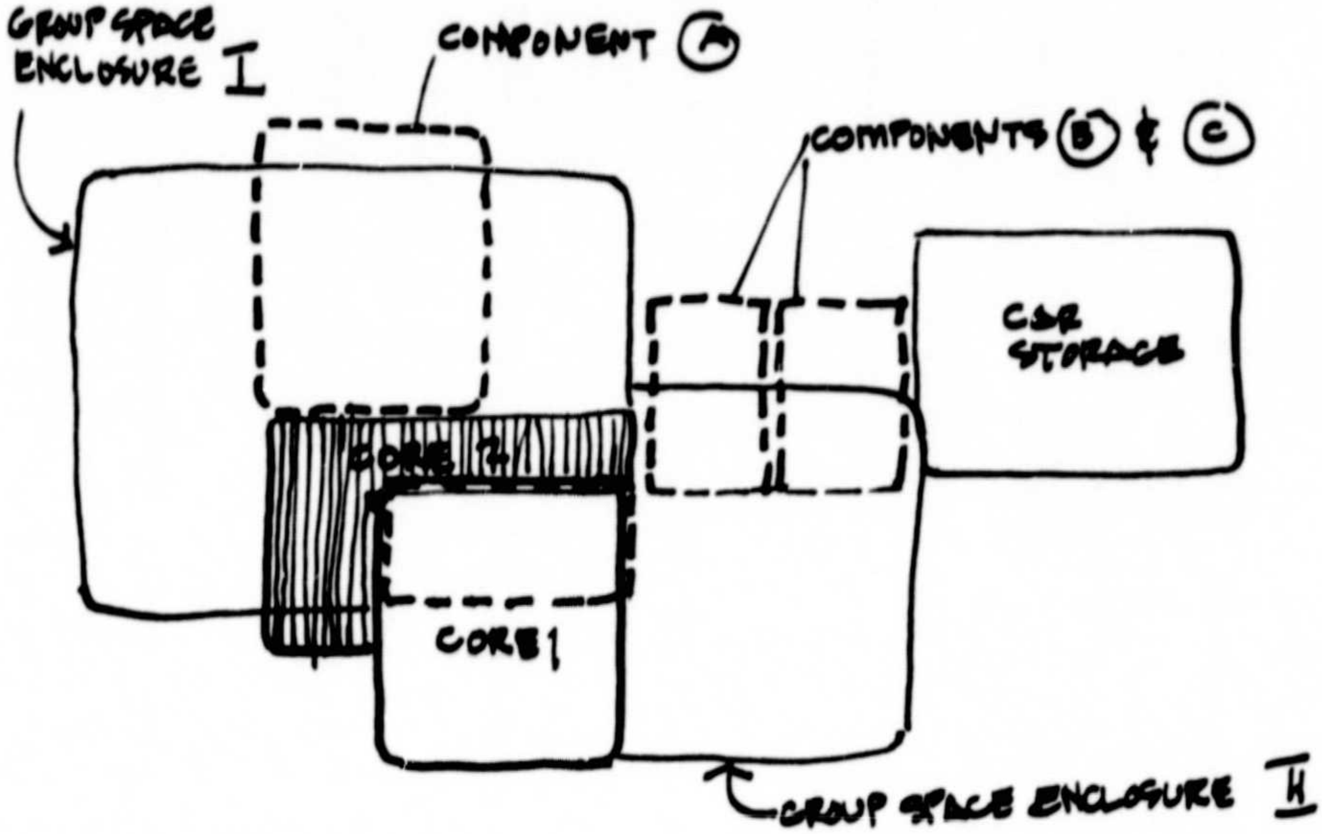
Activity/Space

ADULT

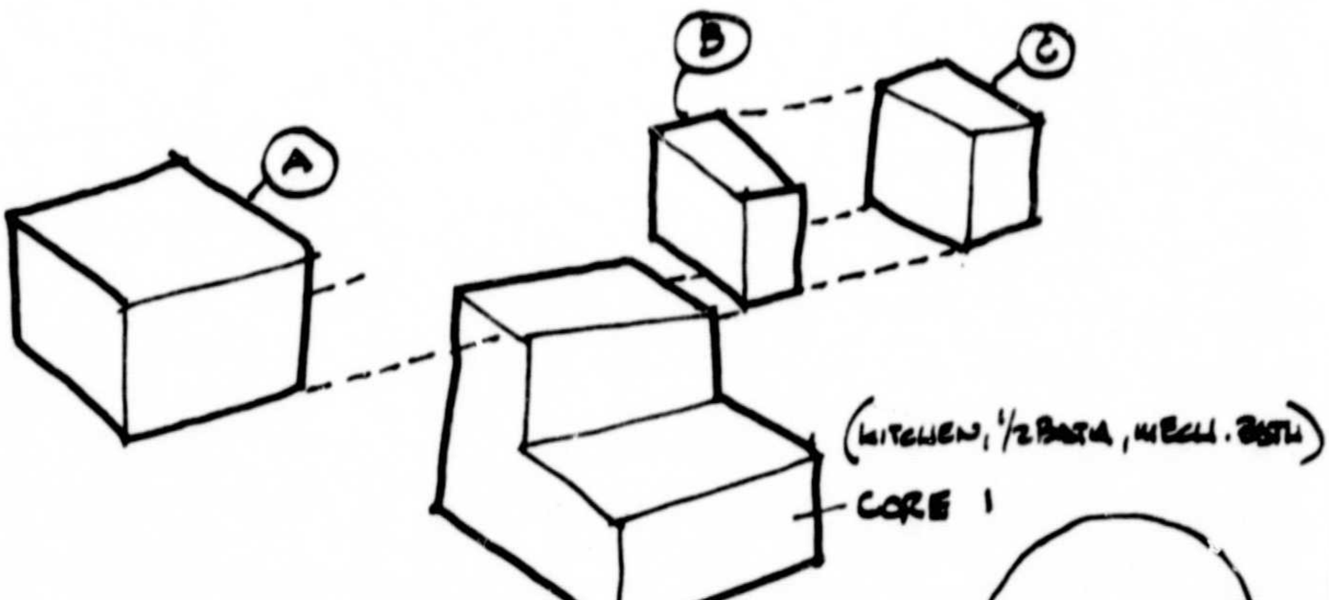
NASA "PROJECT TECH"

Relationships

Characteristics	Within Space	Close to Space	Controlled Access To	Remote	Private	Public	Quiet	Noisy	Activity	Inactivity	Formal	Informal	Other	
Group Activities					✓		✓			✓		✓		
LIVING DINING		✓	✓											
FAMILY				✓										
Individual Activities														
CHILD 1&2			✓											
Support Facilities														
Entrance				✓										
Kitchen				✓										
Bath		✓												
Laundry		✓												
Storage														
Clothes	✓													
General				✓										
Auto				✓										
Mech. Equip.				✓										
Light	✓													
Ventilation	✓													
Exterior Activities														
Exterior View	✓													
Other														

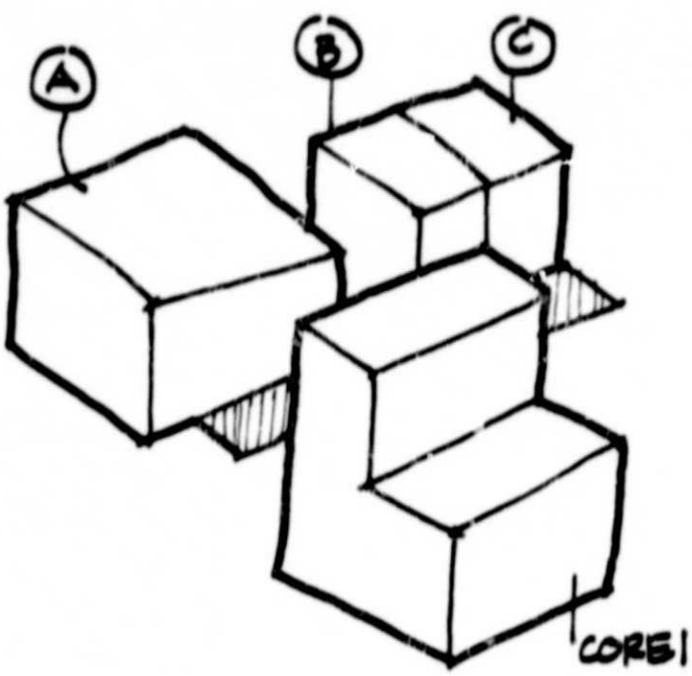


ORGANIZATION STRATEGY DIAGRAM

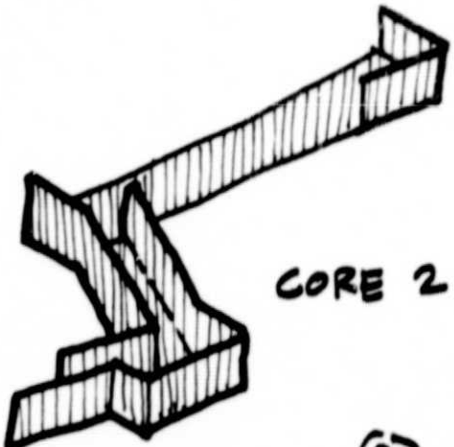


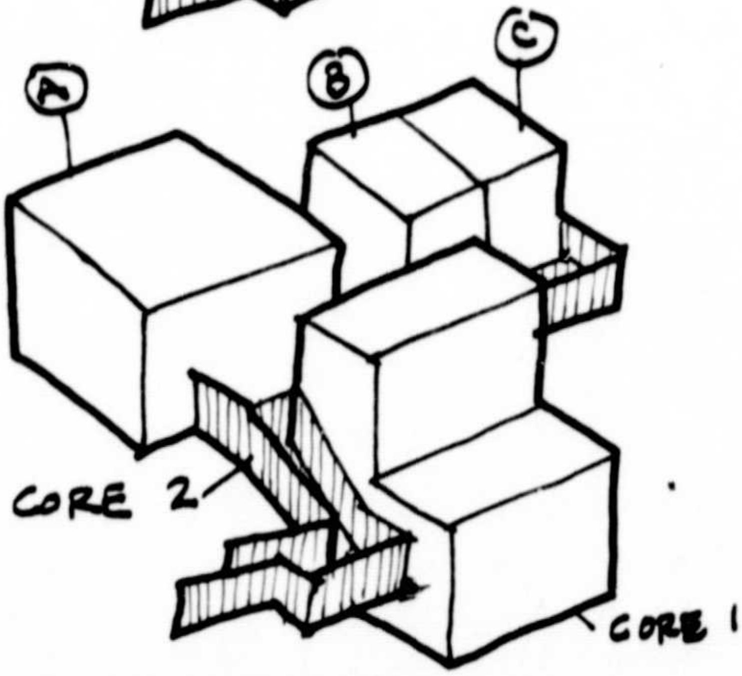
COMPONENT + CORE 1

ORGANIZATION
STRATEGY



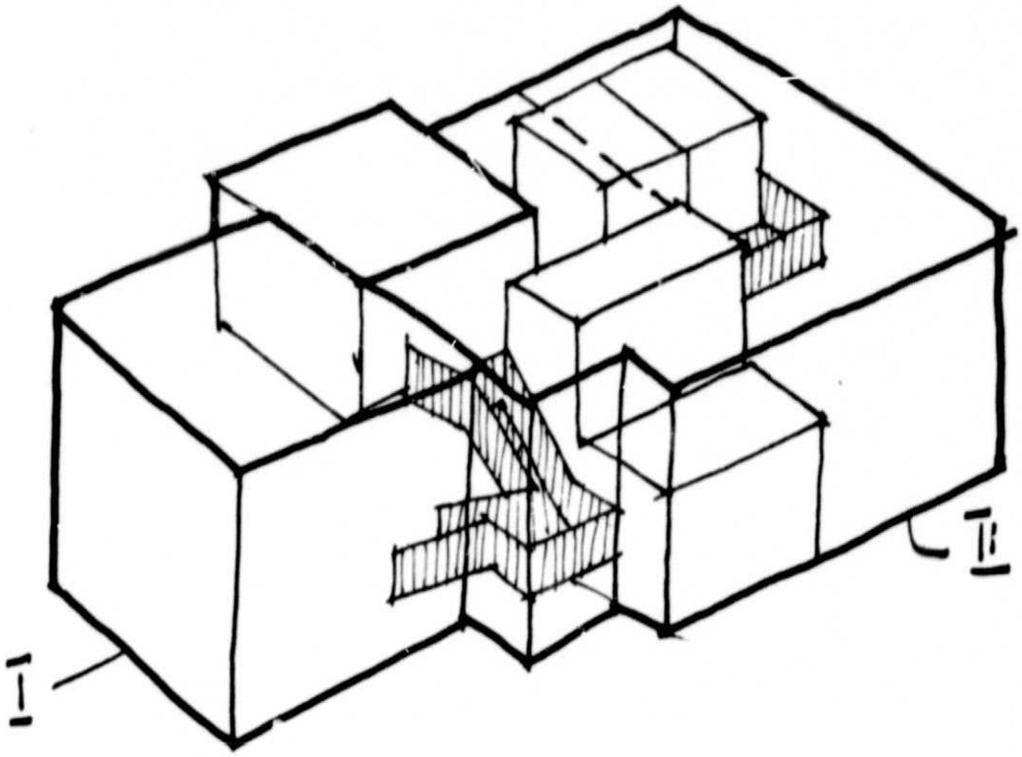
COMPONENT + CORE 1



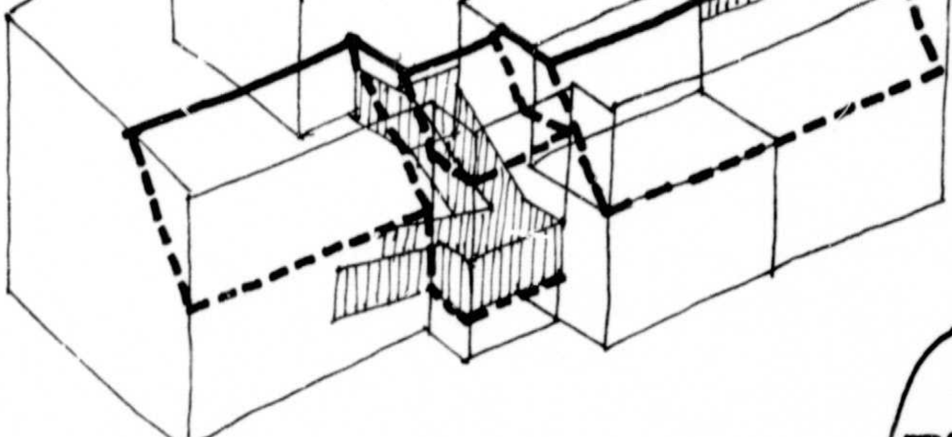


COMPONENT + CORE 1 & 2

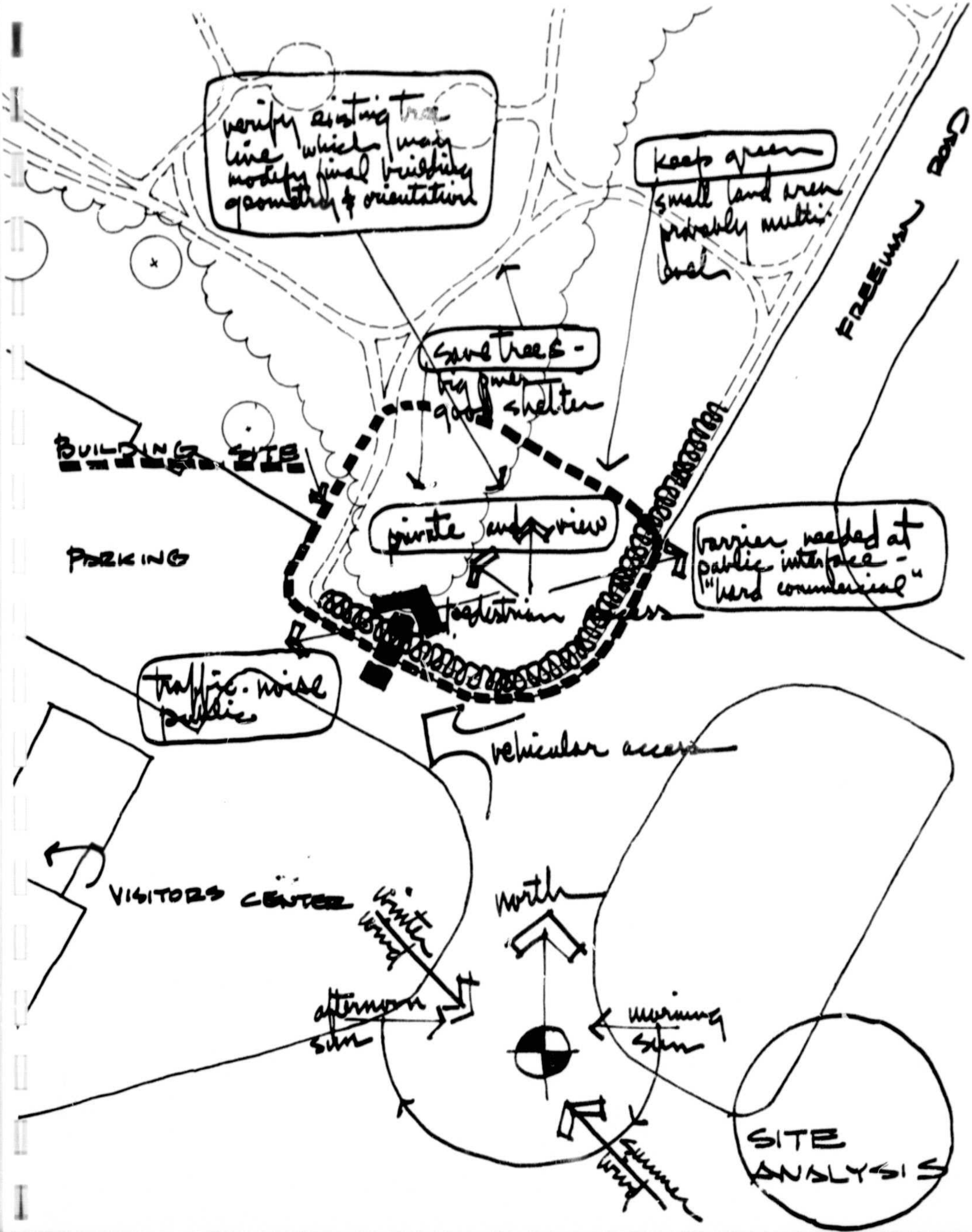
ORGANIZATION STRATEGY

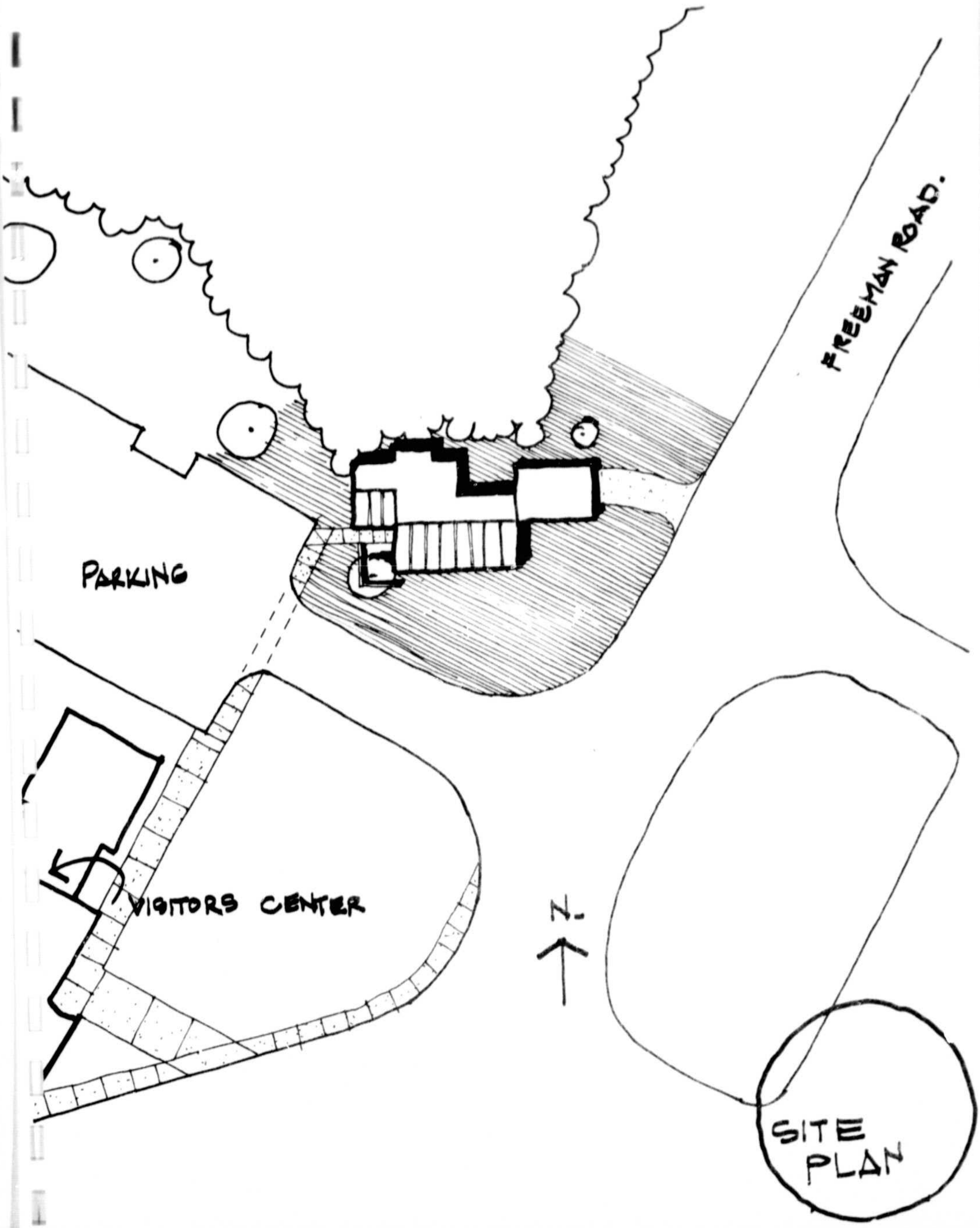


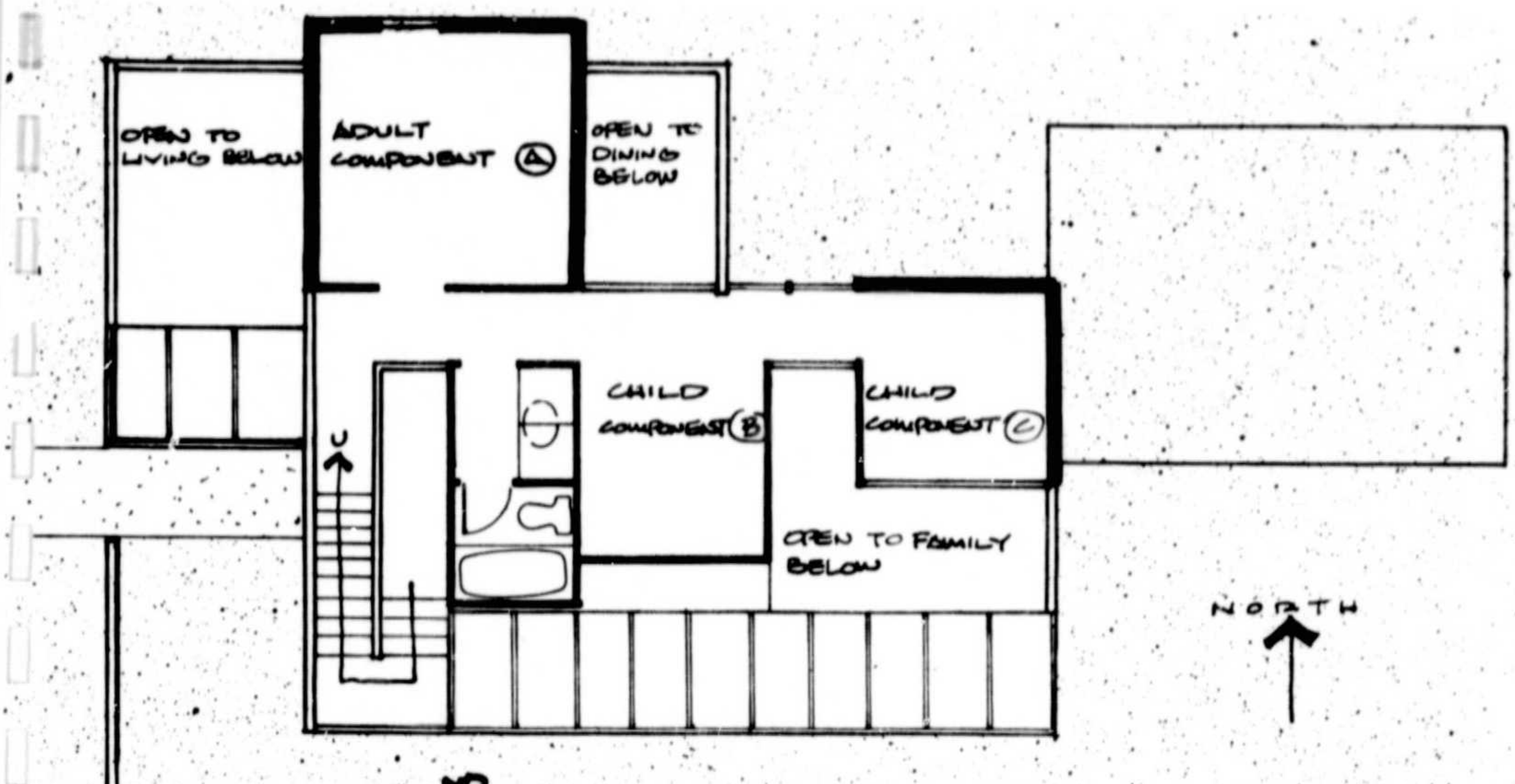
COMPONENTS + CORE 1 + CORE 2 + GROUP SPACES



ORGANIZATION STRATEGY


keep green
small land area
probably multi level
FREEWAY
save trees -
big ones -
good shelter
BUILDING SITE
PARKING
barrier needed at
public interface -
"hard commercial"
pedestrian
traffic noise
public
vehicular access
VISITORS CENTER
winter wind
north
afternoon sun
morning sun
summer wind
SITE
ANALYSIS


FREEMAN ROAD.
PARKING
VISITORS CENTER
N.
SITE PLAN

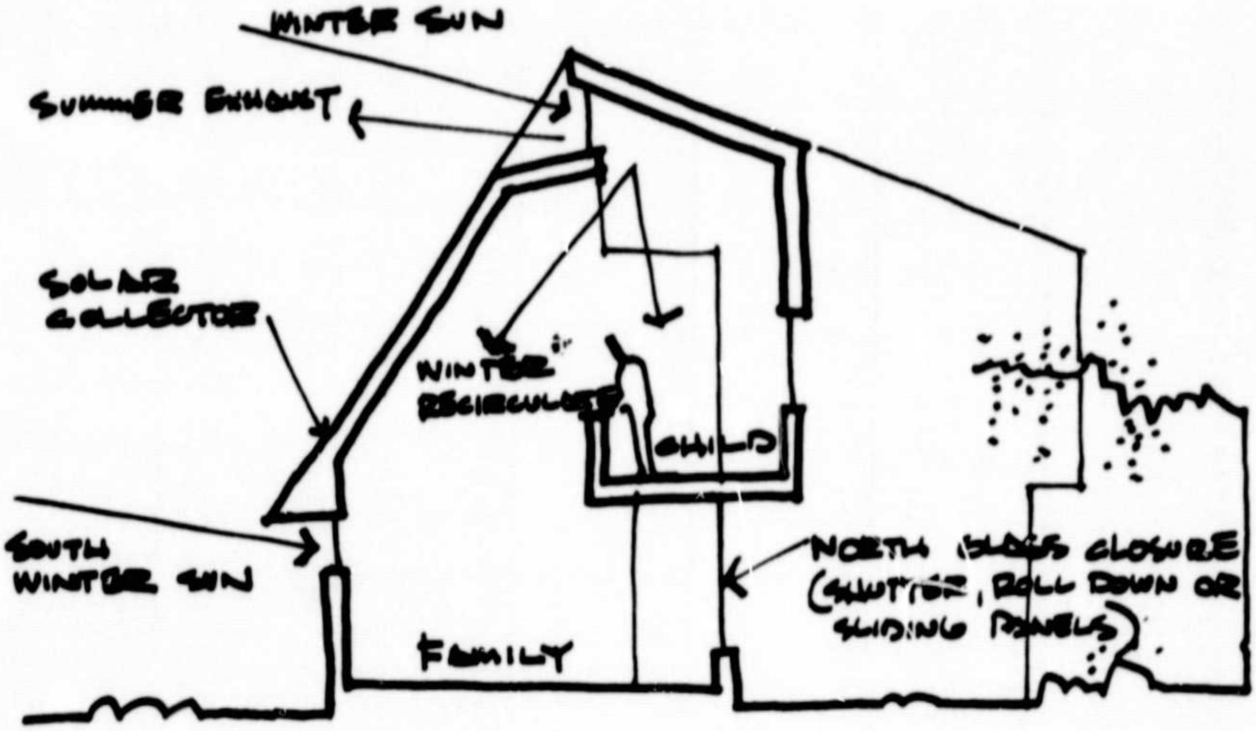


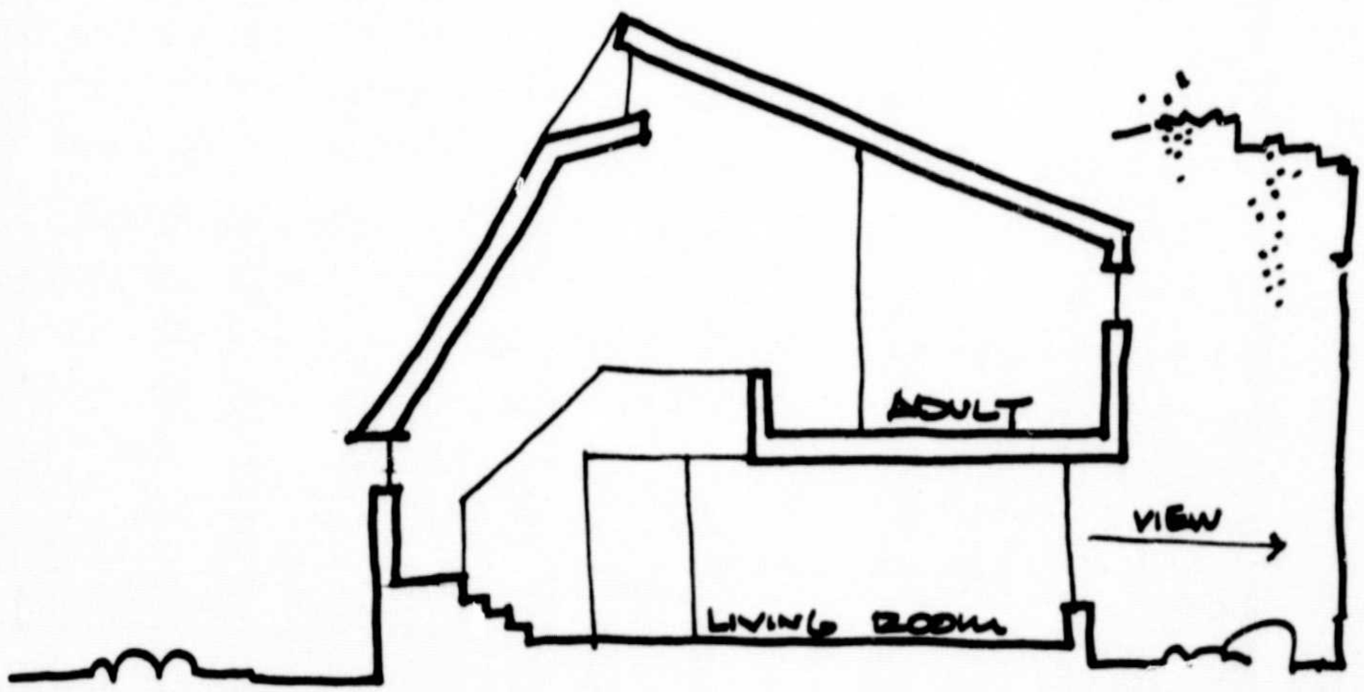
2ND FLOOR PLAN

1ST FLOOR PLAN

AREA = 1400 S.F.

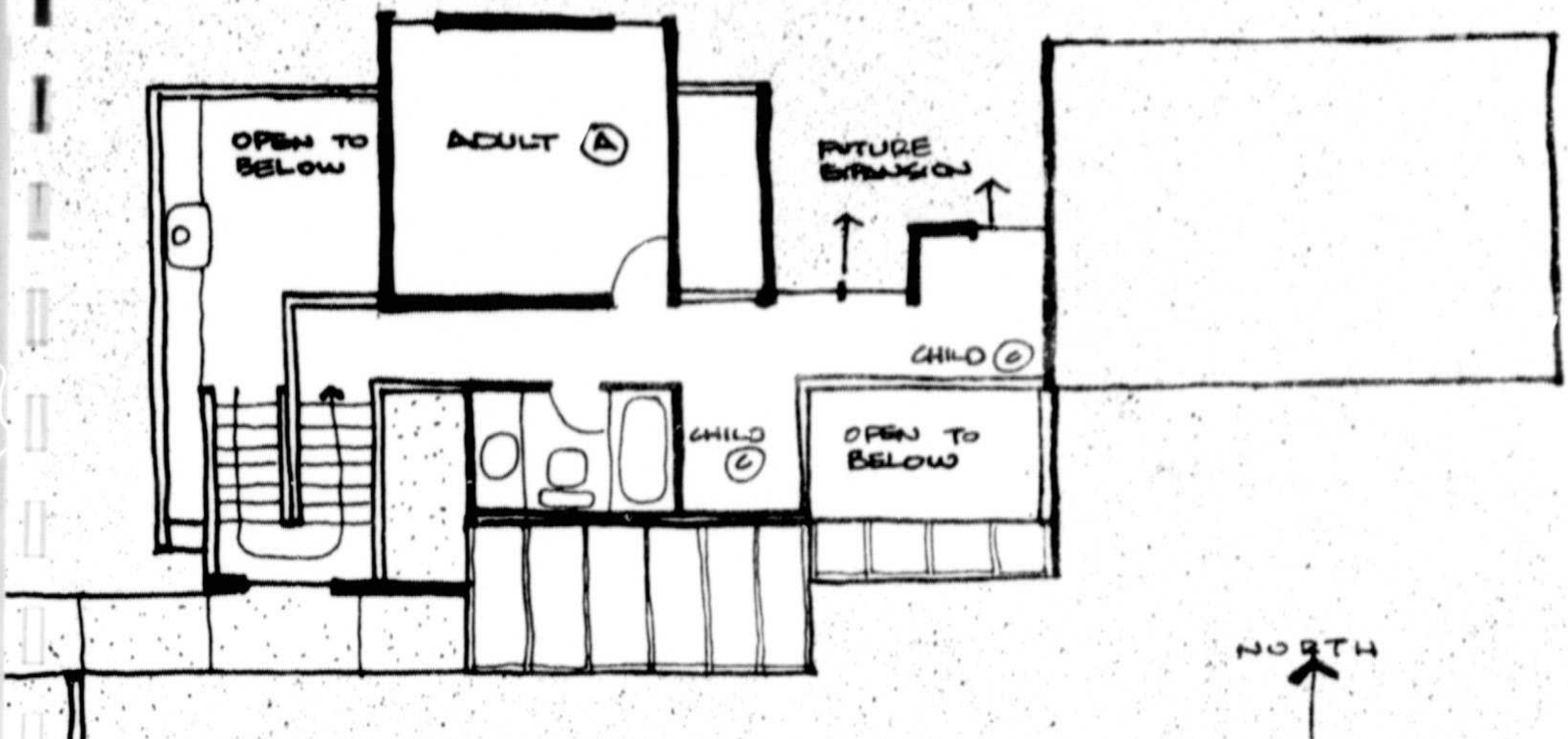
FLOOR PLAN





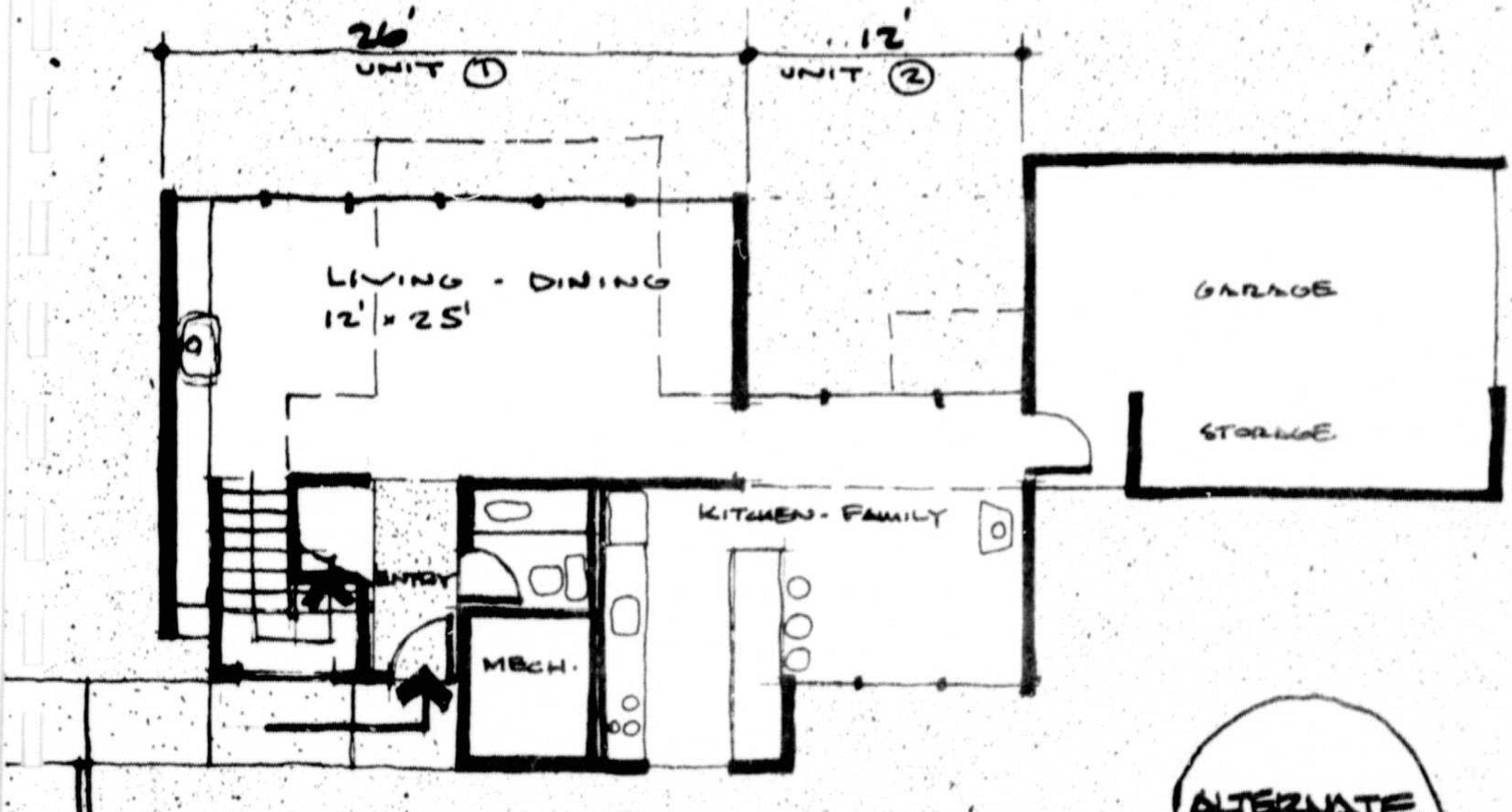
BUILDING SECTIONS

AERIAL VIEW



2ND FLOOR PLAN

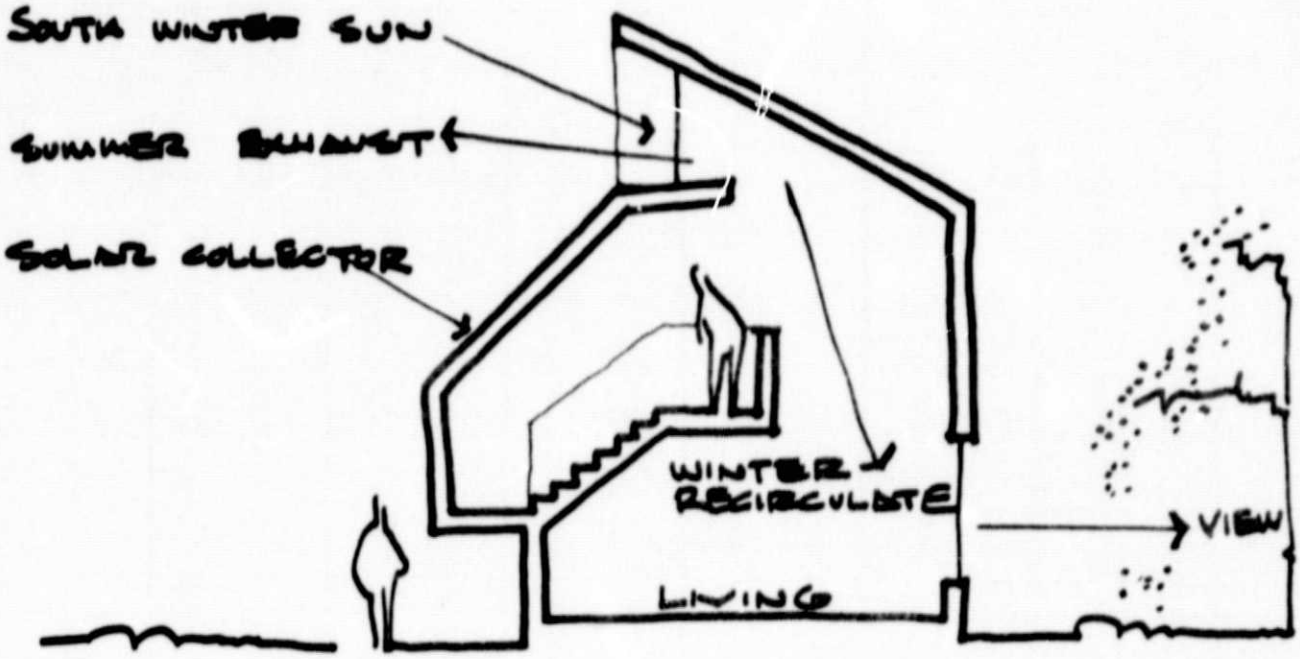
* UNIT 1 CAN BE 2 PHASES
1 - ALL EXCEPT A & C = 750 S.F.
2 - A & C = 150 S.F.

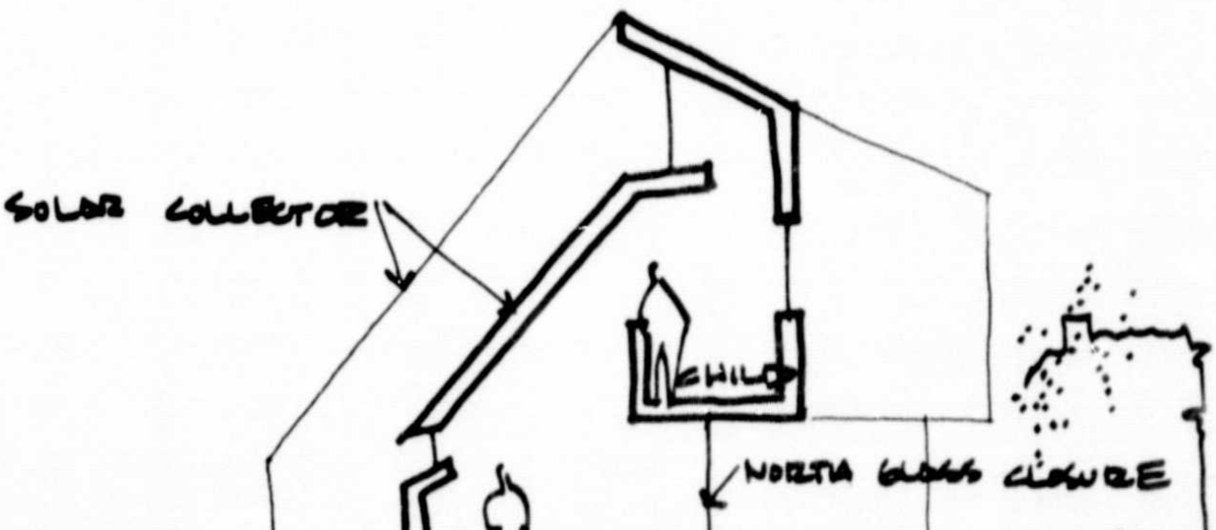


1ST FLOOR PLAN *

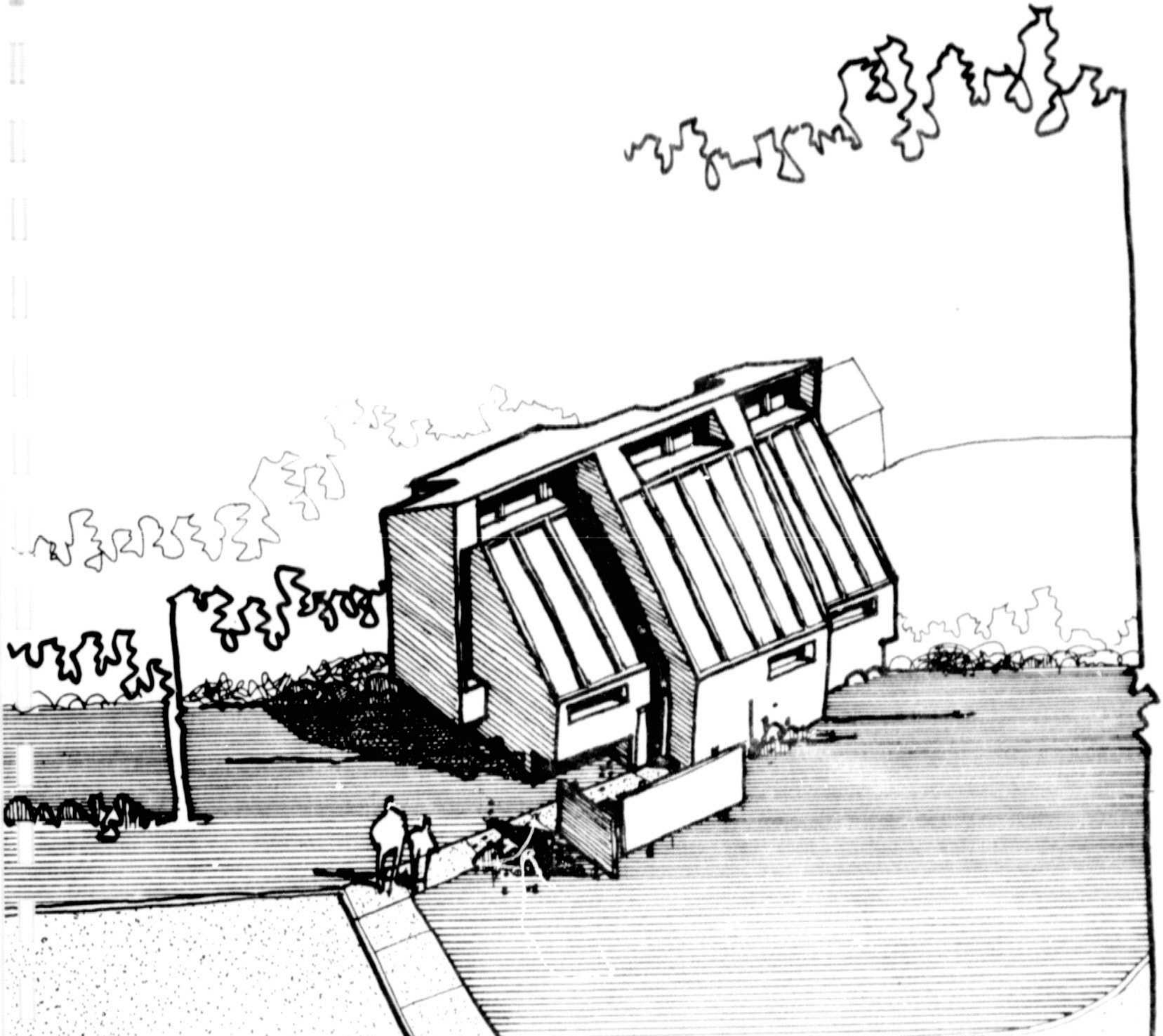
UNIT 1 AREA = 900 S.F.*
UNIT 2 AREA = 250 S.F.

ALTERNATE FLOOR PLANS





ALTERNATE BUILDING SECTIONS



ALTERNATE
DESIGN
VIEW

CONCLUSIONS AND RECOMMENDATIONS:

While this study attempts to provide the preliminary information for the design of the NASA Tech House to be built at the Langley Research Visitors Center, the study also attempts to establish the ground work for future research grants to be undertaken hy this investigator as follows:

1) Should any portion of the housing designs included herein be selected for further development, this investigator should be the architect for such development as well as live in testing, an explanatory visitor brochure and questionnaire.

2) This investigator should develop the complete matrix as herein described.

3) This investigator should pursue the development of a computerized program utilizing the completed matrix. As indicated herein, such a computerized program would not only indicate research alternatives, but ultimately could be utilized by the consumer/user and architect in order to generate strategies and resultant energy-environment impact.

4) This investigator should develop the flexible structural framework and the component space packages and panels.

5) This investigator should develop and pursue the full scale testing of the physical properties as well as psychological behavioral implications of various housing unit designs utilizing the methods and information developed herein and to be developed in the foregoing recommendations.

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