DAVID J. MAY

CLIMATICAL DESIGN CONCEPTS OF PRIMITIVES IN CONTEMPORARY DESIGN

P378
.M4508

MONTANA STATE UNIVERSITY
BOZEMAN

STATEMENT OF PERMISSION TO COPY

In presenting this thesis in partial fulfillment of the requirements for an advanced degree at Montana State University, I agree that the Library shall make it freely available for inspection. I further agree that permission for extensive copying of this thesis for scholarly purposes may be granted by my major professor, or, in his absence, by the Director of Libraries. It is understood that any copying or publication of this thesis for financial gain shall not be allowed without my written permission.

Signature June 7, 1979

Date

CLIMATICAL DESIGN CONCEPTS OF PRIMITIVES IN CONTEMPORARY DESIGN

by

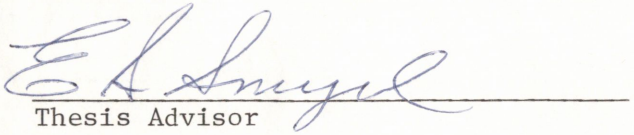
David J. May

A thesis paper submitted in partial fulfillment
of the requirements for the degree

of

BACHELOR OF ARCHITECTURE

Approved:



Thesis Advisor



Head, Major Department

MONTANA STATE UNIVERSITY
Bozeman, Montana

March, 1979

[redacted]
726.6
M76
P378
M4508

PRIMITIVE CLIMATICAL DESIGN RESPONSES CAN BE ALTERNATIVES TO MANY CONTEMPORARY MECHANISMS

I would like to acknowledge all who gave me moral and physical help during the many years it took to obtain this degree. Thanks are also extended to those faculty and staff who have helped give direction to my studies, and to those who served as my resource committee. Special thanks are in order to Myra Smyrl who as a teacher, advisor, and friend was there when help was needed.

I would like to dedicate this thesis to my wife and our parents and families who offered assistance when I really needed it, and who gave me the moral courage to complete this degree.

TABLE OF CONTENTS

THESIS STATEMENT

PART 1 Background . . . . . pg. 1

Chapter 1 Comfort Thresholds . . . . . pg. 3

Chapter 2 Comfort Zone . . . . . pg. 16

PART 2 Identification and Evaluation of Primitive Methods. . . . . pg. 31

Chapter 3 Primitives . . . . . pg. 31

Chapter 4 Mechanisms and Concepts. . . . pg. 47

PART 3 Direction of Application of Information. . . . . pg. 52

PART 4 Application. . . . . pg. 55

Chapter 5 Site selection and Urban Setting. . . . . pg. 55

Chapter 6 Climate Analysis . . . . . pg. 58

Chapter 7 Design Program . . . . . pg. 69

PART 5 Test Dwelling Analysis. . . . . pg. 71

PART 6 Design. . . . . pg. 79

Chapter 8 Goals and Philosophy . . . . . pg. 79

Chapter 9 Design . . . . . pg. 82

APPENDIX

SUMMARY

FOOTNOTES

BIBLIOGRAPHY

PART 1

INTRODUCTION

In order to facilitate the accurate determination of comfort, it is essential to establish a foundation of authenticated facts which will enable the evaluation of test conditions and guide the formulation of probabilities and or needs. Man has survived in most every climatic situation, from the top of Mount Everest to the bottom of the Marianus Trench. However extreme the environment, it is within the capabilities and knowledge of man to protect himself from the elements and achieve comfort.

The following section will review a basic group of comfort definitions, examine the extreme range of survivable conditions of man, and establish those criteria which provide comfort.

DEFINITIONS

Primitive peoples- generally those cultures or people who without formal training available to them were able to deal with their needs on a one to one basis.

Mechanism- Method, material, or concept used by peoples in their attempt to alter the natural climate and make their abode (space) more comfortable.

Comfort- The range or combination of elements which have been established as imposing the least physical stress on the body. (sociological modification assumed constant)

Harsh climate- Any set of climatic variables which require some form of shelter or protection to provide comfort, with the extent of the shelter an indication of severity.

Effective temperature- Scaled in terms of °F, a derivation of the following elements: Dry bulb temperature

Humidity

Air velocity

Formulated by Houghten and Yaglou, the numerical value is that of the temperature of still, saturated air which would induce an identical sensation.

Corrected effective temperature- The effective temperature as modified by radiant heat effects.

New effective temperature- The corresponding dry bulb temperature where the loci for constant body wettedness caused by regulatory sweating intersects the 50% relative humidity curve of the standard psychrometric chart; indicated as "ET" on the ASHRAE psychrometric chart.

Radiant heat- The form of heat which travels from one point to another in the form of light. It is present in forms of both visible and nonvisible light.

CHAPTER 1

In researching the areas of comfort for man, it became apparent that in order to understand the requirements of comfort, it is first necessary to be aware of the extreme limits of man's survival. With an understanding of this basic knowledge, it is possible to expand this foundation to encompass the fundamentals of comfort. "Survival", in its crudest form, is not the goal of design in our present situation. Knowledge of these thresholds, however, allow for a minimum design possibility, with the assurance that the inhabitants, although occasionally uncomfortable, would be able to maintain a minimal level of comfort.

Man is capable of overcoming wide range of temperature variation. High heat is withstood through body functions for the most part, with extreme cold tolerated to a much lesser degree. Through the use of clothing, body coverings, and

minimal shelter, the range of tolerable temperature is increased considerably. Although the body is capable of adaptation to some extent, man, no matter where he lives is biologically consistant and has the same body mechanisms operating to maintain the body.

The highest recorded temperature that man has withstood without injury is 266°F.[1] This laboratory test situation was endured for 20 minutes. The ability of the test subject to withstand the heat was due to three factors. The first was the high insulative value of air. A thin layer of surface air coated the skin, and buffered the surface from the high heat. The second was the cooling effect of the high rate of evaporation in the dry atmosphere. The third was the ability of the blood to circulate the heat of the surface into the deep body tissue. The heat could be tolerated only until the body temperature was raised to an unsafe level.

The coldest temperature that man has been exposed to without injury was -103°F., which occured during an Antarctic expedition.[2] The severity of this limit, is lessened considerably, however, with a longer length of exposure and less exercise. Even with the best insulation clothing, the limit to survival for extended exposure (6 hours) and total inactivity is only 20°F.[3]

The ability of the body to deal with variations in temperature is due to only a few basic mechanisms. When external

conditions are cooler, three mechanisms are employed. The first effect brought about is the closing down of the blood supply to the skin. This lessens the amount of heat lost through the skin. The cooler skin with its accompaning layer of fat then acts as an insulation blanket over the body. This mechanism makes the survival of the Austrailian Aborigines possible without the use of clothing in temperatures which occasionally reach freezing.

The second mechanism used by the body to combat cold is the process of shivering. Affected muscles rapidly contracting and relaxing generate heat as a by product of the increased metabolism. Since muscular fatigue will occur after only a relatively short period, this is only a short term answer to the cold.

The third mechanism of heat control is the overall increase of the metabolic rate of the body. Brought about to a large extent through the quantity and makeup of their diet, the Eskimos, for example, rely on a high rate of metabolism to keep their bodies warm. Physically, the Eskimos do not have the extensive layer of fatty tissue beneath the skin as Aborigines do.

With external conditions at temperatures above that of the body, two basic mechanisms are employed to maintain constant body temperature. The first regulatory control brought into employment by the body is the increased rate of blood

circulation. With the blood system drawing the surface heat away from the skin and depositing it in the inner body, short periods of high heat can be endured easily.

The second defense against increased body heat is the process of sweat evaporation. The limit of man's capability to operate in heat is directly linked to the volume of sweat that the body can produce and the heat exchange brought about by the evaporation of that moisture. For acclimatized subjects, the maximum sweat production is approximately one liter per hour. Although the attitude of the individual is important in being able to cope with high heat, for temperatures greater than that which can be controlled by sweating and blood circulation, only limited exposure can be endured before intolerable discomfort or injury will occur.

The skin surface of the body is capable of a great range of temperature without injury, and unlike the deep body region does not need to be held at a near constant temperature. The average temperature of the skin is normally 80 - 82°F. At higher temperatures of 84 - 88°F., the skin begins the regulatory process of sweating. At lower temperatures of 77°F., the sense of feel is lost.[4] (numbing)

Normal deep body temperature is 98 - 99°F., and critically requires a near constant level. With the raising of the deep body temperature only a few degrees, the danger of stroke is introduced. With the deep body temperature lowered to 95°F.,

the regulatory control mechanisms of the body cease to function. With the deep body temperature lowered to below 82°F., survival is improbable.[5]

Through acclimatization, the body can in part widen the range of conditions that the body can function in. The greater endurance brought about by acclimatization is, however, only moderately greater than with non-acclimatized individuals. With increased exposure to extreme conditions that acclimatization makes possible, there is also a danger of increased susceptibility to respiratory disease, arthritis or to other diseases or conditions. For the most part, however, nonphysiological factors such as increased training, experience and the ability to protect the body are more essential to survival than any physiological adaptation.

Almost the entirety of the world's population lives and works at elevations under 6,000 feet above sea level. At these levels, only minor discomfort occurs; through a change of elevation. Within a short period of time, acclimatization to the elevation occurs, and discomforts disappear. There are, however, difficulties, discomforts, and or problems brought about at extreme elevations. (greater than 6,000 feet).

The highest point on earth that man has ascended to without the aid of artificially introduced oxygen is the peak of Mount Everest at 29,141 feet. The accomplishment of the feat was an example of the extent that man can overcome through

training and conditioning. For the average individual, 20,000 feet is the limit of consciousness for periods longer than ten minutes.[6]

The highest permanent settlement on earth is at an elevation of 17,500 feet. This mining settlement located on Mount Aucuquilcha in Chile, is the base camp of operations for a mine located higher up the mountain. An attempt to locate the camp closer to the mine at a higher elevation of 18,500 feet failed due to high altitude deterioration in the men.[7]

The principal difficulties involved with high altitudes are mountain sickness, and anoxia. Anoxia, a condition of the lack of oxygen in the blood stream is aggravated by the reduced oxygen content of the atmosphere at high altitudes, excessive body heat, pulmonary circulation abnormalities, or respiratory interference. In disasters, such as the rapid decompression of an aircraft cabin, the problem of anoxia is the most critical problem in survival. The effects of anoxia are: headaches, dizziness, fatigue, sleepiness, loss of visual acuteness, and, depending on the individual, a condition of euphoria or depression. Anoxia due to atmospheric lack of oxygen is virtually non-existant up to altitudes of 8,000 feet.

Mountain sickness, can occur either from a rapid ascent of 6,000 feet or more, or from prolonged periods spent at high altitudes (greater than 18,000 feet). During the Himalayan expedition of 1960-1961, it was found that the men

who spent the winter months at the high altitude in an acclimatization effort were less able to sustain a work load than those men who spent a relatively shorter period of time in reaching the winter camp level.[8] Conditions of sleeplessness, and loss of appetite combine to cause a loss of weight in individuals, with headaches and nausea contributing to this high altitude deterioration.

Infertility of females is often a problem at high altitudes. Early Spaniards found that their women were unable to become pregnant at the high altitudes of the South American mountains, and that it was necessary to descend to much lower levels to bear children.[9] Even today, the wives of miners living at higher elevations descend in order to bear children.

Problems associated with ultra high altitudes, (over 30,000 feet) although most often fatal, occur rarely. At an altitude of 58.000 feet, the body fluid would boil at ambient atmospheric pressure. At the ambient atmospheric pressure of an altitude of 45,000 feet, atmosphere composed of 100% oxygen is necessary to carry on human life.[10] See Figure 1.

At sea level, the atmosphere is composed mainly of nitrogen and oxygen, with oxygen composing nearly 21% of the total by volume. Live can be sustained with that percentage reduced to 10%. The common gases dangerous to human survival are carbon dioxide and carbon monoxide. In the normal state, the atmosphere is composed of only 0.03% carbon dioxide, and only

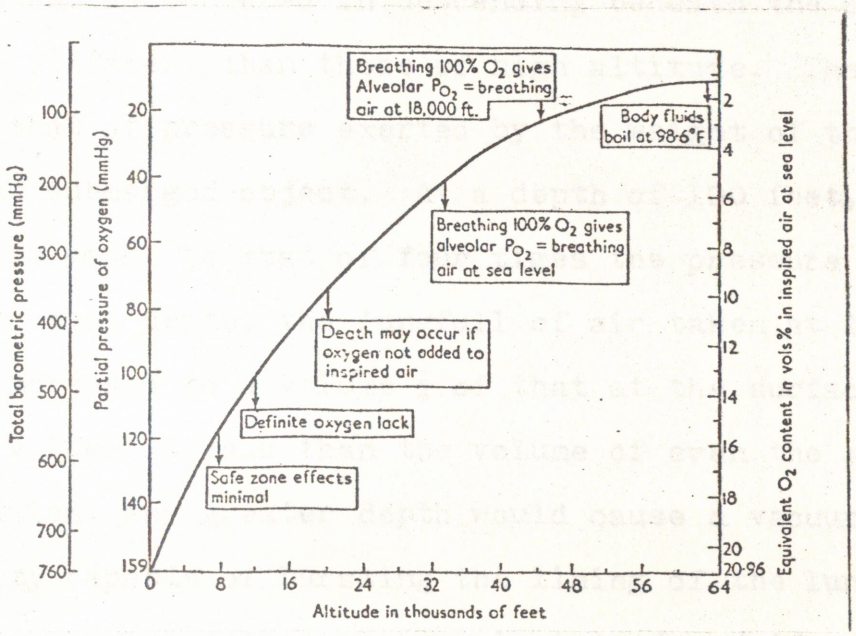


FIGURE 1

Curve relating the total barometric pressure (based on the International Commission for Air Navigation formula) with the partial pressure of oxygen at different altitudes between sea-level and 64,000 ft. Reductions in the percentage oxygen of the inspired air at sea-level equated with the oxygen tension observed at various altitudes.

from: Edholm, O.G., AND Bacharach, A.L., ed.,
THE PHYSIOLOGY OF HUMAN SURVIVAL

minute percentages of carbon monoxide. Depending on the length of exposure as little as 3% carbon dioxide and 0.5% carbon monoxide can be fatal.[11]

The problems encountered in descending beneath the sea are of course different than those of high altitude. The most prevalent is that of pressure exerted by the weight of the water upon the submerged object. At a depth of 100 feet, the pressure is equal to that of four times the pressure at sea level. At that depth, the lungfull of air taken at the surface is compressed to a volume ¼ of that at the surface. Because that volume is less than the volume of even the most forced exhalation, any greater depth would cause a vacuum in the lung cavity capable of bursting the lining of the lungs. Inversely, the danger of lung rupture is introduced if an ascent is attempted from that depth with any blockage of the respiratory system present.[12]

Extensive decompression is required after dives of even moderate depths. In order to prevent the bends, or the formation of bubbles in the bloodstream as rapid decompression occurs, extensive tables have been formulated and through experimentation have been developed to guide the pressure level and length of time spent at each level to safely decompress the diver.

The deepest dive without the aid of a pressurized vessel was 1,200 feet. With the aid of a pressurized vessel, man has decended to the lowest point on earth, the Marianas Trench (35,800 feet).[13]

Physiological factors are not the only variables that differentiate the capabilities of man. The psychological make-up of man also sets up conditions of extremes and thresholds. However, because of the individuality of man, and his capability of adapting to a wide range of situations, a precise definition of psychological needs of man changes in relation to the situation at hand. However, the most primeval requirement for psychological well being of man is a sense of privacy.

According to the inculturation of the subject, and the situation at hand, the extent of privacy can be taken to be a large geographical area, or as minimal as that of the mere confines of his immediate body. The early American pioneer felt his privacy imposed upon if he could see evidence of his neighbor. On the other end of the spectrum, Oriental peoples have for centuries been accustomed to very dense levels of population and visualize privacy in a much more personal spiritual dimension. Privacy can be tangible boundries, or psychological limits. The strip tease dancer, with no apparent limit to privacy, maintains balance through inner privacy. Although exposing her body, she maintains a barrier between her audience and her inner thoughts and personality.[14] The level of privacy acceptable to an environmental and psychological mores of his situation.

If the privacy experienced by the subject is not that level desired, he will employ actions to either limit social

interaction, or encourage greater interpersonal control mechanisms. See Figure 2.

Personal space, or that idea of comfort distance necessary for psychological balance, is somewhat changeable but necessary factor. This distance of comfort between two or more people is a by-product not only of the sex and age of the subjects, but also many other social differences, including family relationships or the race differences between the subjects. See Figure 3.

Above all, there is a heirarchy of needs of man which must be followed in fulfilling human comfort. See Figure 4. At the base of the pyramid are the physiological requirements necessary for survival. Before any other areas of human need can be fulfilled, pure physical survival requirements must be met. In many cases, a particular area of need such as security, is encompassed within the social framework, morality, or living environment, making that area of lessor importance.

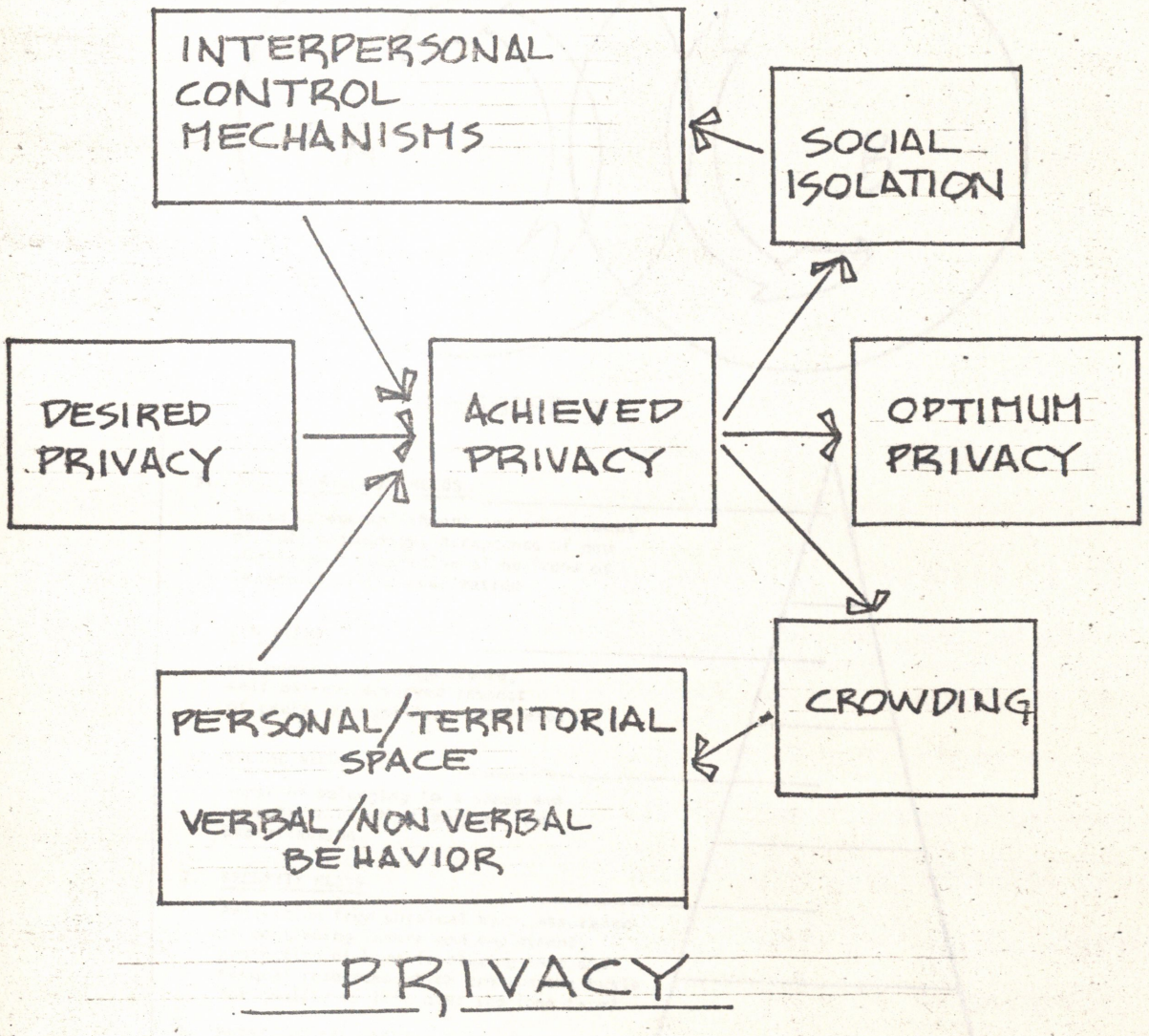

INTERPERSONAL CONTROL MECHANISMS
SOCIAL ISOLATION
DESIRED PRIVACY
ACHIEVED PRIVACY
OPTIMUM PRIVACY
CROWDING
PERSONAL/TERRITORIAL SPACE
VERBAL/NON VERBAL BEHAVIOR
PRIVACY

FIGURE 2

TERRITORY

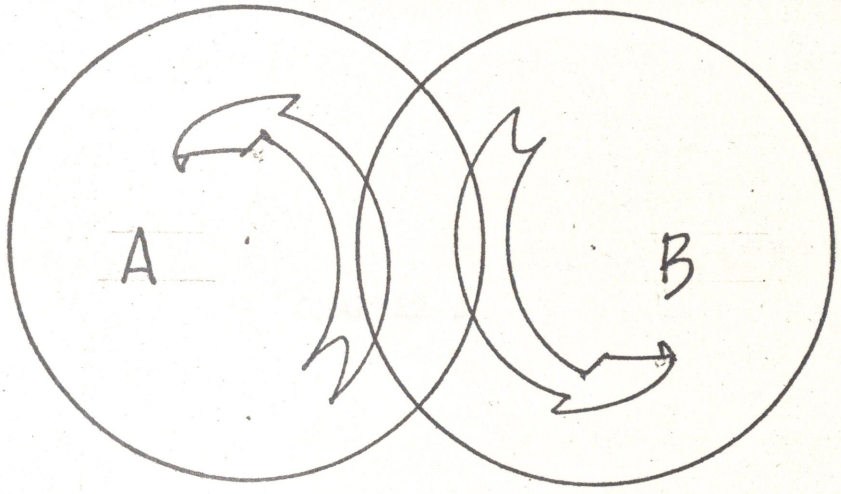


FIGURE 3

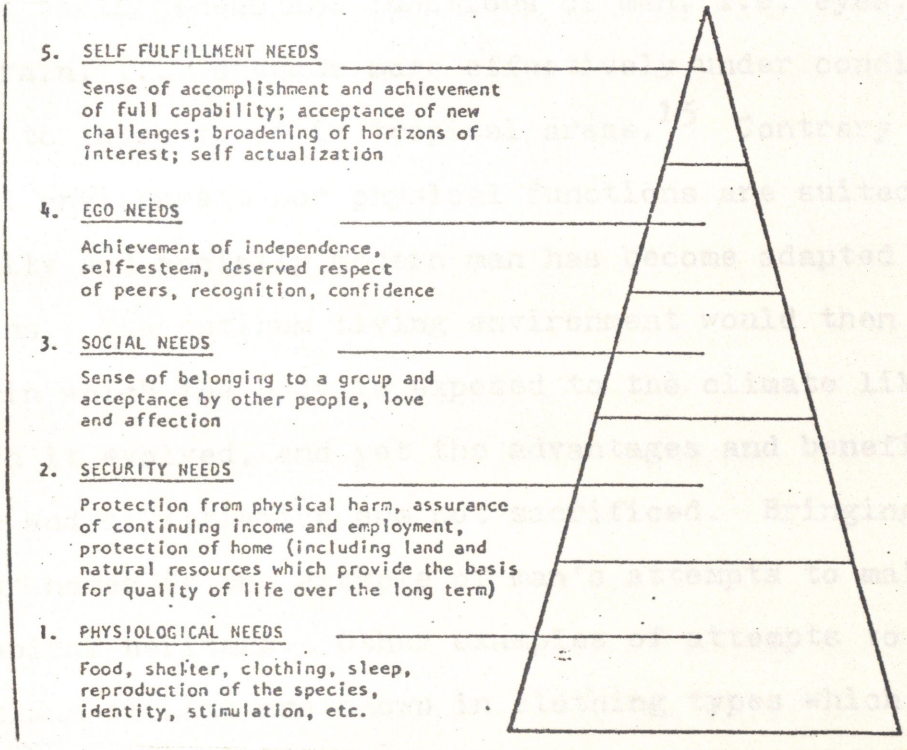


FIGURE 4

from: Environmental Protection Agency, ALTERNATIVE FUTURES AND ENVIRONMENTAL QUALITY

CHAPTER 2

The basic senses and functions of man, i.e. eyes, ears, skin, brain, ..., operate more effectively under conditions similar to those found in tropical areas.[15] Contrary to the tropical environment our physical functions are suited for, culturally and socially modern man has become adapted to cities and towns. The optimum living environment would then seem to be one in which the body is exposed to the climate like that in which it evolved, and yet the advantages and benefits of culture and civilization are not sacrificed. Bringing plantlife into our homes is one example of man's attempts to maintain his tropical heritage. Other examples of attempts to emulate the optimum climate are shown in clothing types which insulate, air movement devices, space heating, cooling, humidification or dehumidification, and other building practices aimed at adjusting the ambient climatical conditions.

For many years, dry bulb temperature was the only determinant of comfort. Early efforts by the British to more closely define comfort sensations were conducted in the late 1920's.[16] The scale of "equivalent temperature" was developed to signify the relationship between conditions of uniform enclosure, still air, and controlled dry bulb temperature to the actual situation with the dry bulb temperature of the controlled space the value of comfort. This equivalent temperature was valid only for ambient temperatures less than 75°F., and because it equated only those variables of air velocity and dry bulb temperature, was not a universally accurate indicator of comfort.

During the same time period in the United States, F.C. Houghten and C.P. Yagloglu developed a temperature scale which stressed humidity along with dry bulb temperatures and air velocity.[17] This scale or "effective temperature" was directed principally towards conditions of high dry bulb temperatures and the physiological cooling through the rate of evaporation of body sweat. This scale equates the test situation to that in which still air and full saturation is maintained. See Figure 5.

Scientists continuing to refine those systemsto more closely define comfort developed the "revised effective temperature" scale. This scale differs from the effective temperature scale with comparisons made in a room in which air movement is maintained at a uniform low velocity.

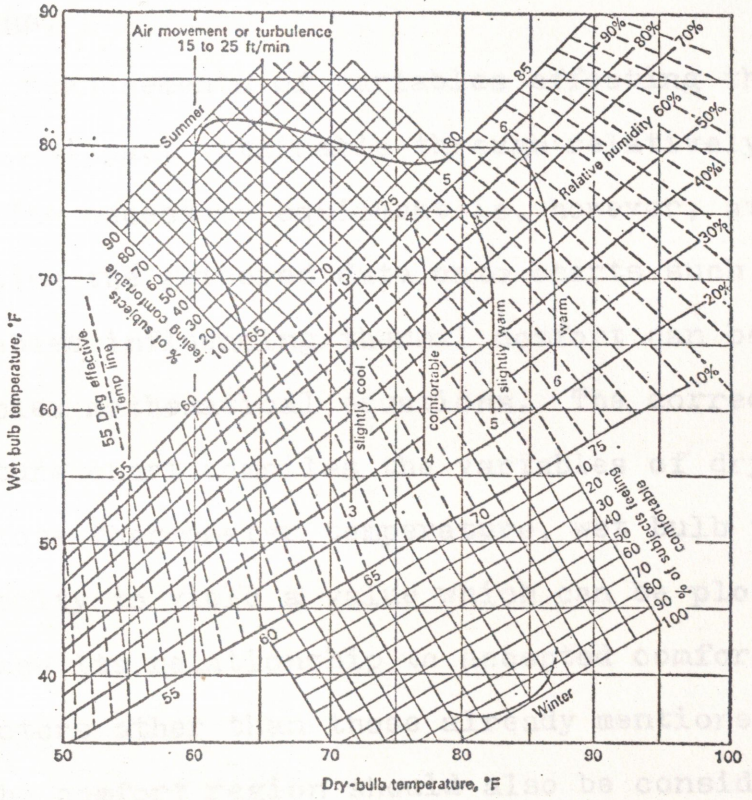


FIGURE 5

from: ASHRAE, GUIDE AND DATA BOOK

One step further in defining comfort came about with the addition of the effects of radiant heat. This more comprehensive scale, the "corrected effective temperature scale", takes into consideration more variables than any of the other equivalencies, and is therefore a more accurate indicator of comfort sensations.

The measurements of variables effecting thermal comfort are for the most part obtainable through relatively simple procedures. The necessary equipment is, however, at times costly. By plotting the gathered data onto charts such as that of Figure 7, variables influencing thermal comfort can be complied without complex mathematical equations. The corrected effective temperature chart compiles the variables of dry bulb temperature, globe thermometer temperature, wet bulb temperature, and air velocity to yield a value which can be plotted to graphically show its relationship to accepted comfort.

Factors other than those already mentioned which tend to shift the comfort region should also be considered in forecasting comfort probabilities. Two of these other factors are those of clothing types worn by the inhabitants, and the work level of the activity which takes place within that space. The insulative value of clothing is given as a numerical value in CLO rating. This value ranges from a rating of 0 for complete nudity to a value of 4 for the most extensive insulating clothing. See Figure 8.

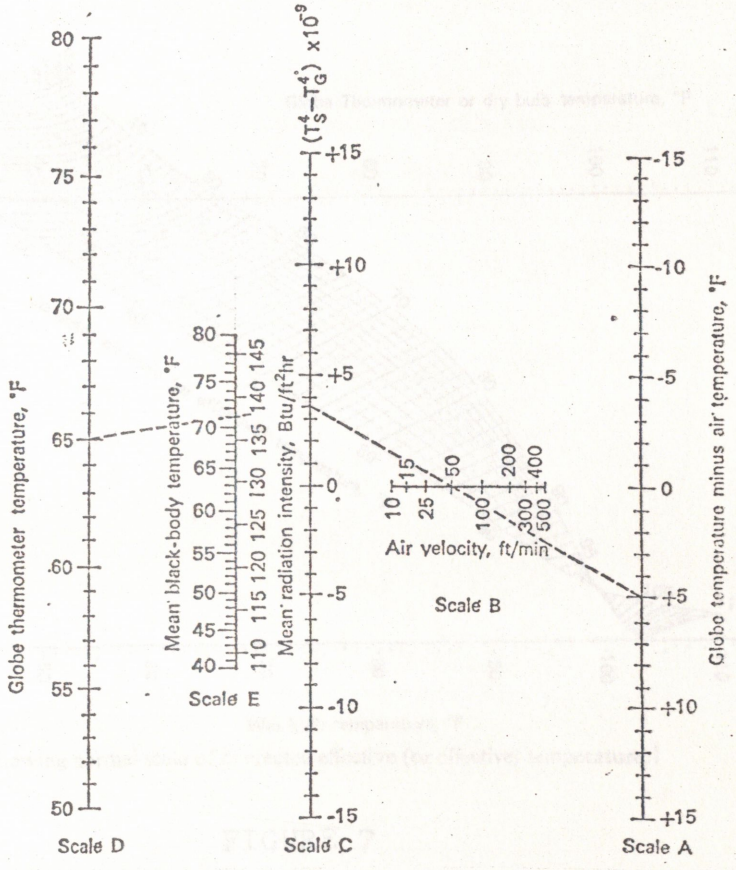


FIGURE 6

Chart for estimation of radiant heat from globe thermometer readings. (Through the appropriate points on scales A and B a line is struck to cut scale C. From this intersection another line is drawn through the appropriate point on scale D. The intersection on scale E gives the measure of radiation.)

from: Franger, P.O., THERMAL COMFORT.

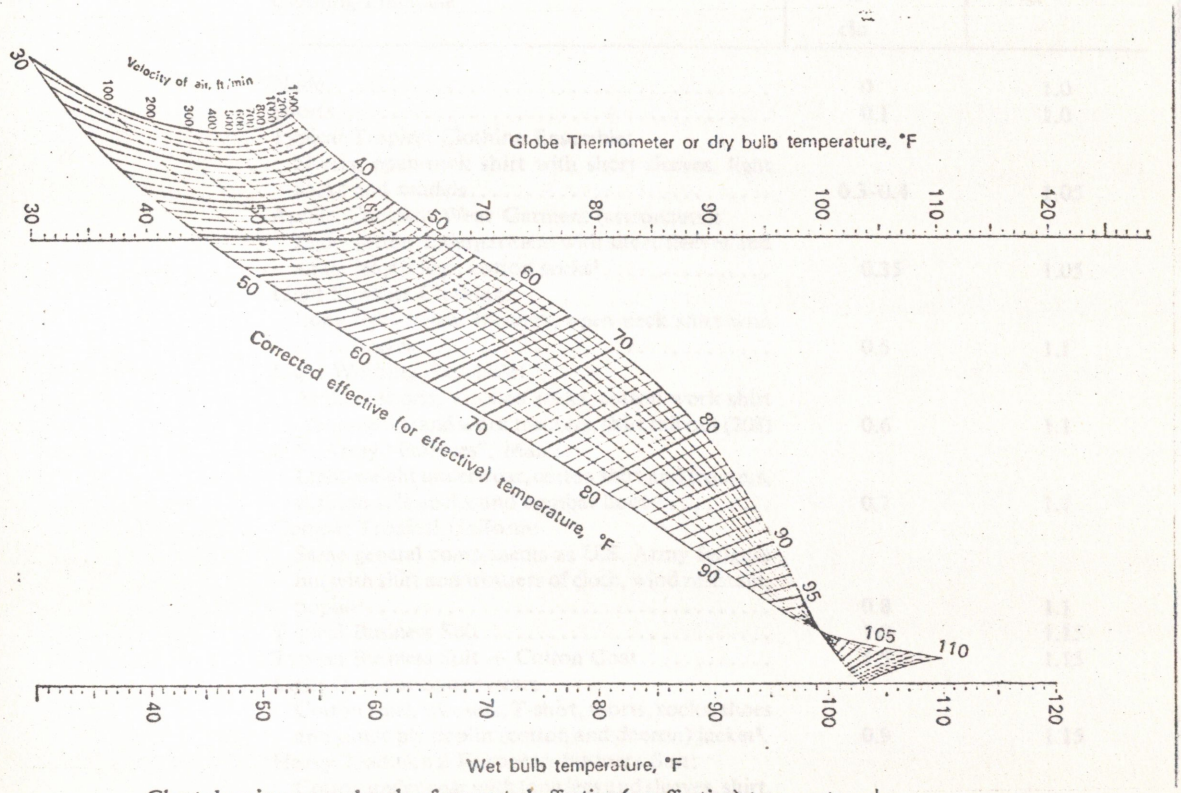


Chart showing normal scale of corrected effective (or effective) temperature.

FIGURE 7

from: Jennings, Burgess H., ENVIRONMENTAL ENGINEERING ANALYSIS AND PRACTICE

Data for Different Clothing Ensembles

Clothing Ensemble	I_{cl} clo	f_{cl}
Nude	0	1.0
Shorts	0.1	1.0
Typical Tropical Clothing Ensemble: Shorts, open-neck shirt with short sleeves, light socks and sandals	0.3–0.4	1.05
Apollo Constant Wear Garment (astronauts): Light cotton undergarment with short sleeves and ankle length legs, cotton socks[1]	0.35	1.05
Light Summer Clothing: Long light-weight-trousers, open neck shirt with short sleeves	0.5	1.1
Light Working Ensemble: Athletic shorts, woollen socks, cotton work shirt (open-neck), and work trousers, shirt tail out (208)	0.6	1.1
U.S. Army "Fatigues", Man's: Light-weight underwear, cotton shirt and trousers, cushion sole socks and combat boots[3]	0.7	1.1
Combat Tropical Uniform: Same general components as U.S. Army fatigues but with shirt and trousers of cloth, wind resistant, poplin[3]	0.8	1.1
Typical Business Suit	1.0	1.15
Typical Business Suit + Cotton Coat	1.5	1.15
Light Outdoor Sportswear: Cotton shirt, trousers, T-shirt, shorts, socks, shoes and single ply poplin (cotton and dacron) jacket[2]	0.9	1.15
Heavy Traditional European Business Suit: Cotton underwear with long legs and sleeves, shirt, woollen socks, shoes, suit including trousers, jacket and vest (256)	1.5	1.15–1.2
U.S. Army Standard Cold-wet Uniform: Cotton-wool undershirt and drawers, wool and nylon flannel shirt, wind resistant, water repellent trousers and field coat, cloth mohair and wool coat liner and wool socks[3]	1.5–2.0	1.3–1.4
Heavy Wool Pile Ensemble: (Polar weather suit)	3–4	1.3–1.5

[1] James M. Waligora, Manned Spacecraft Center, Houston, personal communication.
[2] J. Jaax, Kansas State University, personal communication.
[3] J. R. Breckenridge, U.S. Army Research Institute, Natick, personal communication.

FIGURE 8

from: Fanger, P.O., THERMAL COMFORT

Body heat given off as a by product of metabolism can shift the comfort zone. The BTU output caused by various activity levels can be estimated and used as a base in determining a predicted vote of comfort as determined by group tests. Examples showing the relationships of comfort as influenced by CLO values and activity levels are shown in Figures 9, 10, and 11.

Other factors which tend to shift the comfort zone are those of color, occupancy density, and, to a minor extent, acclimatization of the individual.

Test results obtained by Woods and Hohles show the wide range of the sets of variables which yield a comfort sensation condition. Note, the tests were conducted under conditions of sedentary activity and relatively still air (velocity approximately 20 feet per minute).[18] See Figure 12.

Victor Olgyay has developed an indice that simultaneously plots factors of humidity, dry bulb temperature, air velocity, and radiant heat. Using this chart, one is able to see where his particular situation lies in respect to the indicated comfort zone. However, it must be taken into consideration, that the zone indicated is satisfactory only for conditions when the inhabitants are stationary, and wearing light clothing. If more strenous activities are to take place within a space, or when the subjects will be wearing more or less clothing, care must be exercised to provide for the shift in the comfort

TOTAL HEAT DISSIPATION FROM INDIVIDUALS

Type of Activity	Heat Dissipation at Room Temperature between 60 F and 90 F (Btuh)
Adults at rest	
Seated	390
Standing	440
Moderately active worker	600
Metalworker	860
Walking, 2 mph	760
Restaurant server, very busy	1000
Walking, 3 mph	1000
Walking, 4 mph; active dancing	1390
Slow run	2290
Maximum exertion	3000–4800

FIGURE 9

from: Jennings, Burgess H., ENVIRONMENTAL ENGINEERING

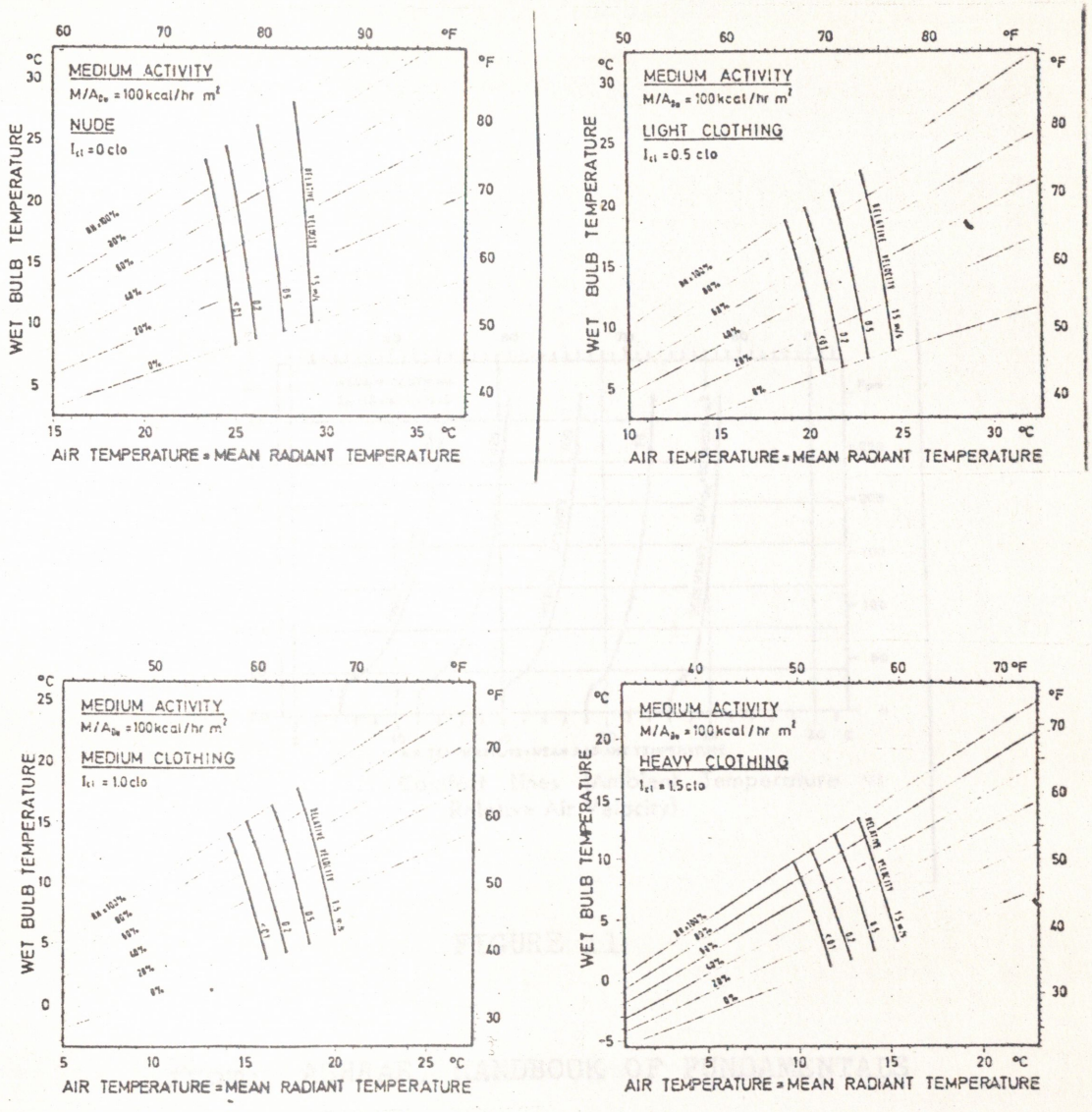
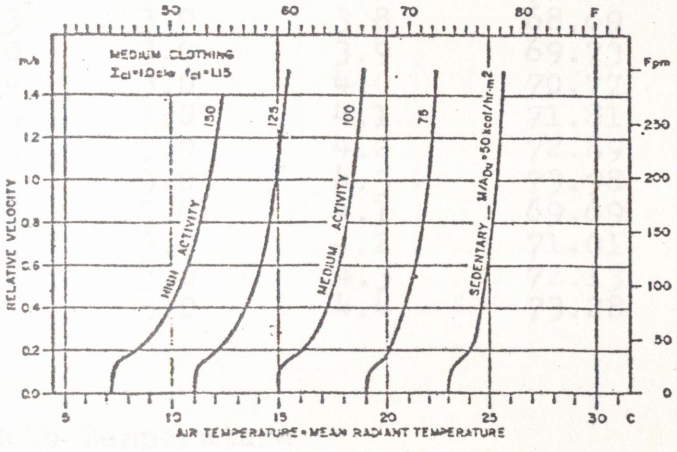


FIGURE 10

from: Fanger, P.O., THERMAL COMFORT



... Comfort Lines (Ambient Temperature vs Relative Air Velocity)

FIGURE 11

from: ASHRAE, HANDBOOK OF FUNDAMENTALS

VARIABLES WHICH YIELD COMFORT

TDB (F)	TWB (F)	TIME (HR)	VOTE (ND)	ET (F)	TEFF (F)
76.0	61.9	3.0	3.8	70.32	75.86
76.0	64.8	3.0	3.9	71.31	76.17
76.0	67.6	3.0	4.0	72.34	76.63
76.0	70.1	3.0	4.1	73.34	77.15
76.0	72.6	3.0	4.2	74.41	77.83
78.0	53.3	3.0	3.8	68.69	76.67
78.0	57.0	3.0	3.9	69.73	76.99
78.0	60.4	3.0	4.0	70.77	77.35
78.0	63.5	3.0	4.1	71.81	77.78
78.0	66.5	3.0	4.2	72.89	78.27
78.0	69.3	3.0	4.3	73.98	78.90
80.0	54.5	3.0	4.1	69.69	78.20
80.0	58.3	3.0	4.2	71.01	78.61
80.0	61.8	3.0	4.3	72.13	79.10
80.0	65.1	3.0	4.4	73.28	79.70

TDB (F)-Dry Bulb Temperature

TWB (F)-Wet Bulb Temperature

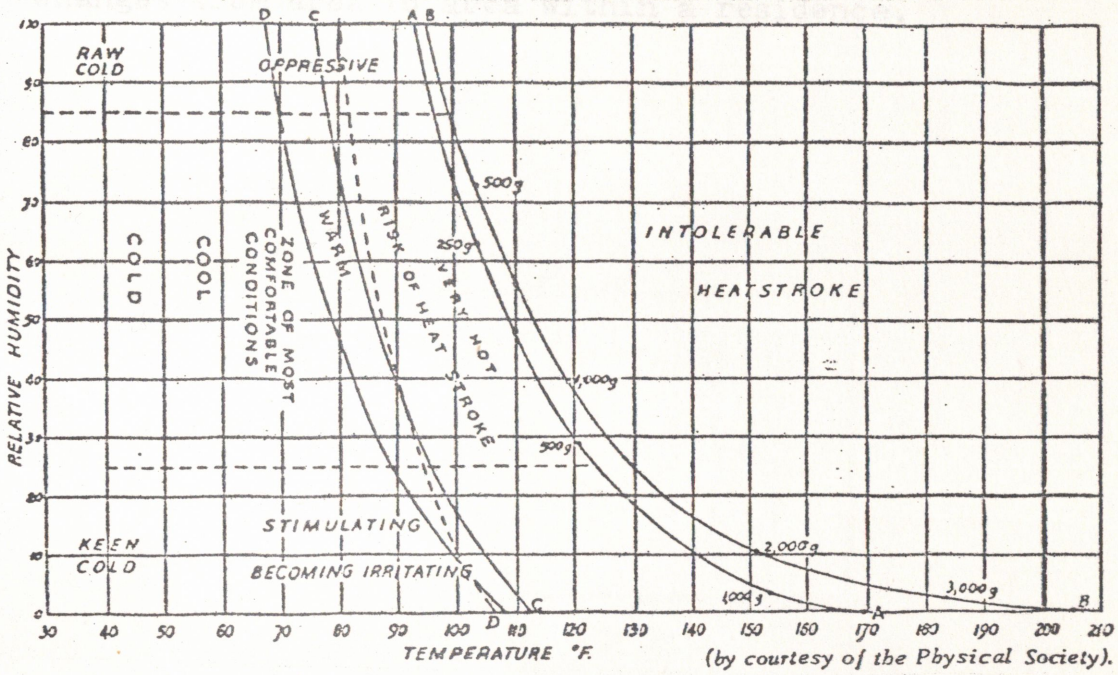
TIME-Time (hr.)

VOTE-Thermal Sensation. The values of VOTE are: 1 = cold; 2 = cool; 3 = slight cool; 4 = comfortalbe; 5 = slightly warm; 6 = warm; 7 = hot.

ET (F)-(Old) Effective Temperature

TEFF (F)-New Effective Temperature

Figure 12



(by courtesy of the Physical Society).

FIGURE 12A

AA. Heat-stroke limits for nude man resting in still air.

BB. Heat-stroke limits for nude man resting in air moving 200 ft/min.

CC. Limiting conditions for clothed man resting in sunshine with about one-third of skin wetted with sweat.

DD. Limiting conditions for clothed man walking 3 m.p.h. with about one-third of skin wetted with sweat.

The broken line represents equivalent temperature 80°F. The figures 500 g, etc., indicate rate of evaporation of sweat in grammes per hour for men of average size in order to maintain heat balance of the body.

from: Brunt, David, SOME ASPECTS OF HUMAN ECOLOGY IN HOT TROPICAL REGIONS

zone. Figure 13 shows how the shift in the comfort zone changes from area to area within a residence.



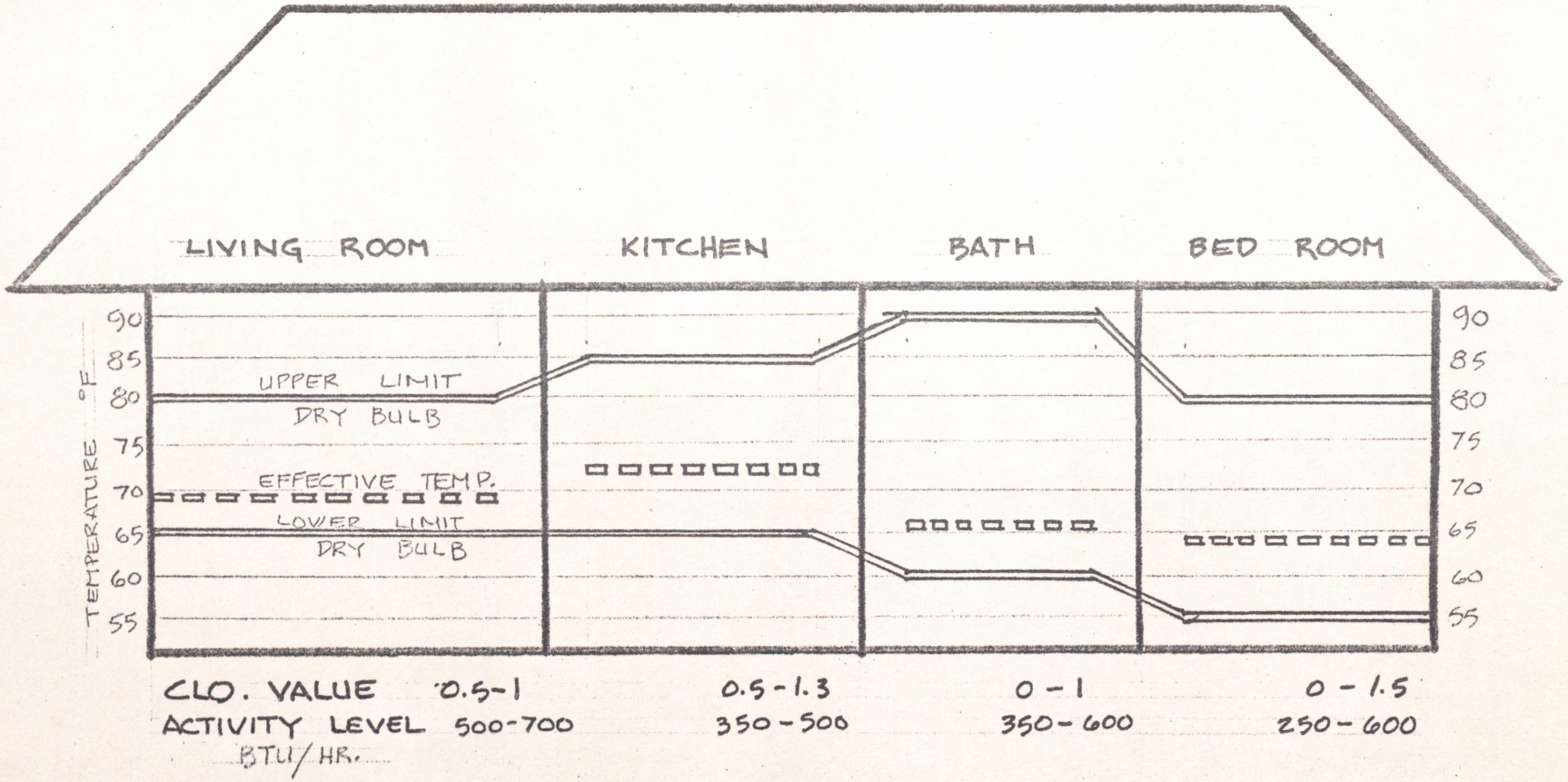

LIVING ROOM
KITCHEN
BATH
BED ROOM
TEMPERATURE °F
90
85
80
75
70
65
60
55
UPPER LIMIT
DRY BULB
EFFECTIVE TEMP.
LOWER LIMIT
DRY BULB
CLO. VALUE 0.5-1 0.5-1.3 0-1 0-1.5
ACTIVITY LEVEL 500-700 350-500 350-600 250-600
BTU/HR.

FIGURE 13

PART 2

CHAPTER 3

Centuries before man attended colleges, received degrees, and learned how to manipulate thermal comfort through the use of scientifically engineered systems, he was able to withstand the problems of climate through the use of indigenous materials and simple devices. The comfort range of those dwellings was often not within our present standards of comfort; however, those peoples found conditions well within survival limits.

Through pressures of population and food availability, man has been pushed to settle in all parts of the world where the climatic variables are not tolerable without some form of protection. In many cases, man's very survival depended on the success of their dwellings in protecting them from the climatic elements. Except for those elements of decoration, the dwellings of primitive people, faced with fulfilling physiological

needs as their prime daily function, reflect very closely those particular elements of their micro-climate. Additions of unnecessary items could hamper the effectiveness of their basic mechanisms or could place too great a pressure on their marginal existence.

Probably the best example of the philosophy of efficiency is the example of the igloo. The use of the materials and mechanisms give the igloo even greater efficiency as outside conditions become less favorable.

The outside form of a hemisphere is invaluable in many ways. The spiral-wound dome shape yields ease of construction and tremendous stability. Structurally, the igloo can withstand even the weight of an occasional polar bear. In the interior, the domed surface focuses all reradiation back into the center of the space. The dome also offers the most efficient floor area to exposed surface ratio. Also, because the normal posture of the Eskimo while in the igloo is either sitting or lying, peripheral areas with a lower ceiling level do not pose any discomfort.

Snow, upon first examination would seem to be a less-than-effective material. Composed of crystals and flakes, the snow crust contains by volume a large percentage of trapped air which gives it a good insulation value. With the addition of a coating of water which quickly freezes, the shelter becomes impermeable to even the strongest wind. Readily available and

easily worked, snow is the best possible material for the construction of the igloo.

Even though there are no formal space dividers, the interior is nevertheless apportioned into several activity areas. Storage, working and sleeping activities take place all within the same space, but only in certain specific areas of the "room".

Heat for the igloo is obtained through the latent body heat of the inhabitants as a primary source, and secondarily through oil burning lamps. These lamps not only give heat for space heating, but also cook or warm food, and give light for nighttime activities.

Ventilation is brought about through a small vent opening in the top of the dome. To control or halt any air movement, a small chunk of ice or snow is simply shoved into the opening.

Light within the igloo is accomplished in two ways. The first method, as already mentioned is the oil burning lamp. The second source of light is the ice pane window. Used only occasionally during long periods of immobility, the window gives the interior light enough to carry on those activities which in milder weather are normally accomplished outdoors.

The igloo, a perfect adaptation for Eskimo life is all but useless for any other climate area. Without those climatic conditions which contribute to the effectiveness of the igloo, only the ideas and principles behind the successful mechanisms

of the igloo would make this habitat valuable to other peoples in different climates.

It is not the intention or purpose of this thesis to give a systematic detailed analysis of every primitive people in the world. Following is a form analysis of six examples of primitive peoples. The six examples give a crude coverage of basic types of climatic responses in areas of humidity, aridness, hot and cold temperatures. This analysis serves only as a basis upon which other building types can be compared.

PEOPLE: Eskimo, Arctic North America

CLIMATE: Extreme cold - arid conditions
summers short and temperate to cool

CONTROL AREA	MECHANISM	FUNCTIONAL BASIS
	MAN	
BODY COVERING		Animal skin and furs - superior to manmade materials
PHYSICAL ATTRIBUTES		Some acclimation to cold and diurnal fluctuations
	HEAT CONTROL	
AMBIENT HEAT		Body heat reflected back into area
INTRODUCED HEAT		Oil lamp usually sufficient heat food eaten raw
INSULATION:	MASS	Thickness of snow acts to break wind
	THERMAL	Skins or summer tent inside of dome
	AIR MOVEMENT	
VENTILATION		Smoke vent (can be blocked if needed)
	MATERIALS -STRUCTURE	
ABSORBTION -REFLECTION		White snow dome reflects radiation back into inner space and retards loss to night sky
GENERAL SHAPE		Low dome
	SITE CONSIDERATIONS	
WIND		Site usually on lee side of cliff or ridge. See Figure 14

taken from:

Guidoni PRIMITIVE ARCHITECTURE

Rapoport HOUSE FORM AND CULTURE

Weyer PRIMITIVE PEOPLES TODAY

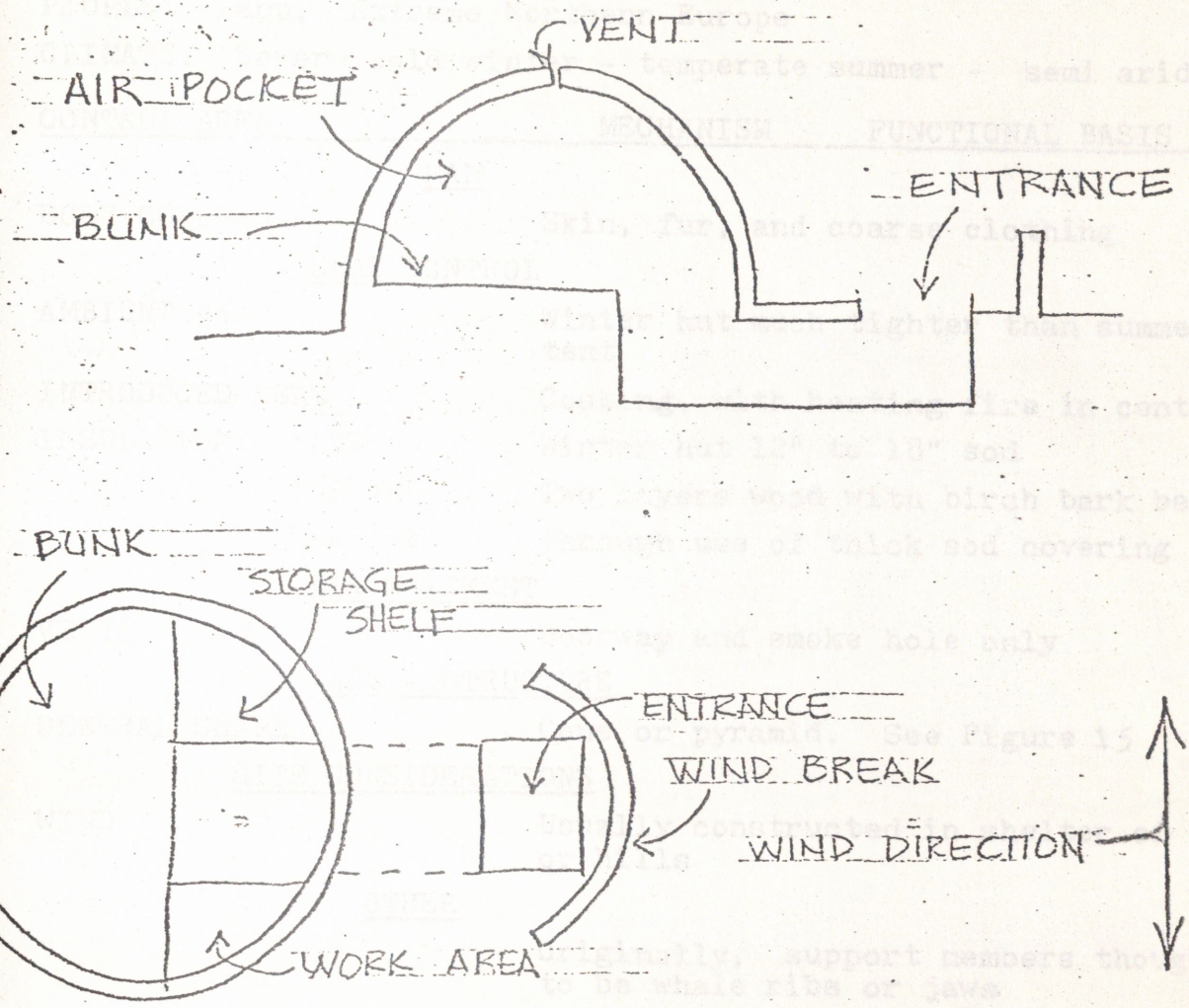

VENT
AIR POCKET
ENTRANCE
BUNK
BUNK
STORAGE SHELF
ENTRANCE
WIND BREAK
WIND DIRECTION
WORK AREA
WHITE SNOW RETARDS RADIANT HEAT LOSS TO COLD NIGHT SKY
HEMISPHERE FOCUSES RADIATION TO CENTER
60°F
40°F
20°F
0°F
-45°F
-50°F
-50°F
SKINS, OR SUMMER TENT PEGGED TO INNER DOME FOR ADDED INSULATION

FIGURE 14

PEOPLE: Lapp, Extreme Northern Europe

CLIMATE: Severe cold winter - temperate summer - semi arid

CONTROL AREA		MECHANISM FUNCTIONAL BASIS
	MAN	
BODY COVERING		Skin, fur, and coarse clothing
	HEAT CONTROL	
AMBIENT HEAT		Winter hut much tighter than summer tent
INTRODUCED HEAT		Cooking, with heating fire in center
INSULATION:	MASS	Winter hut 12" to 18" sod
	THERMAL	Two layers wood with birch bark between
	HEAT LAG	Through use of thick sod covering
	AIR MOVEMENT	
VENTILATION		Doorway and smoke hole only
	MATERIALS - STRUCTURE	
GENERAL SHAPE		Cone or pyramid. See Figure 15
	SITE CONSIDERATIONS	
WIND		Usually constructed in shelter of trees or hills
	OTHER	
		Originally, support members thought to be whale ribs or jaws

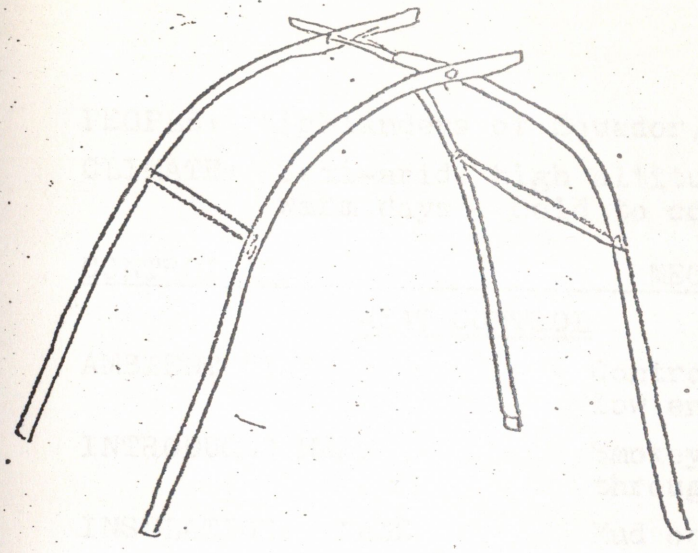
taken from:

Birket PRIMITIVE MAN AND HIS WAYS

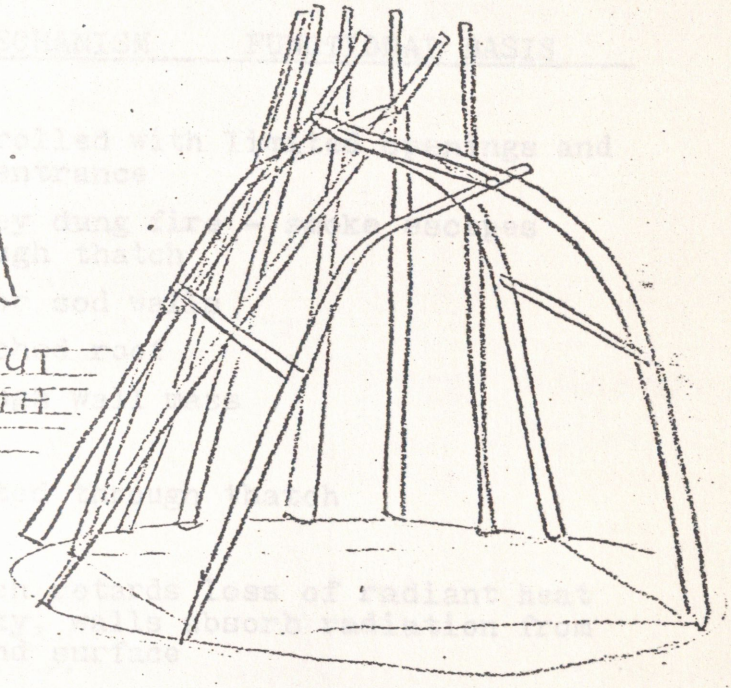
Guidoni PRIMITIVE ARCHITECTURE

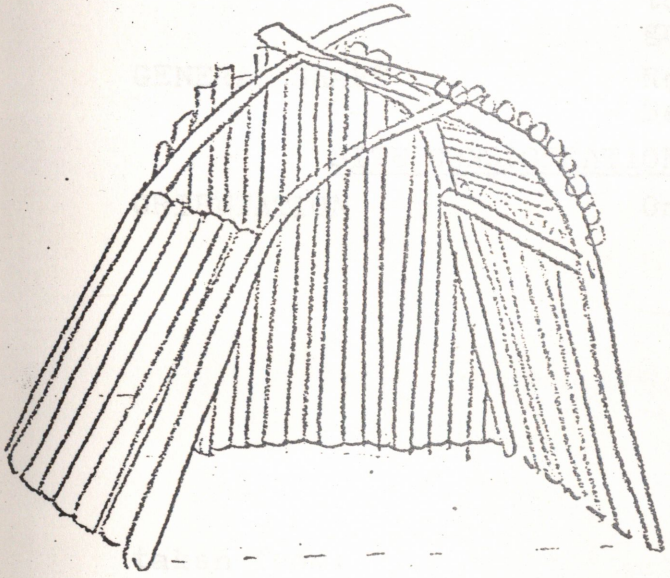
Weyer PRIMITIVE PEOPLES TODAY

BASIC FRAMEWORK
2 SETS HINGED CURVED POLES



KOHTI = SUMMER HUT
POLES COVERED WITH
SKIN TENT





GOATTE = WINTER HUT
SOD COVERED FRAME

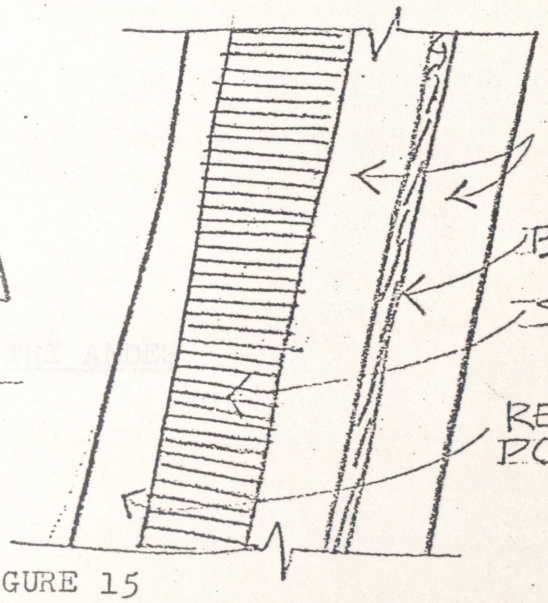


FIGURE 15

PEOPLE: Highlanders of Equador, Equatorial South America

CLIMATE: Semi-arid, high altitude
warm days - cold to cool nights

CONTROL AREA		MECHANISM FUNCTIONAL BASIS
	HEAT CONTROL	
AMBIENT HEAT		Controlled with limited openings and low entrance
INTRODUCED HEAT		Smokey dung fire - smoke escapes through thatch
INSULATION:	MASS	Mud or sod walls
	THERMAL	Thatched roof
	HEAT LAG	Through wall mass
	AIR MOVEMENT	
VENTILATION		Limited through thatch
	MATERIALS - STRUCTURE	
ABSORB/REFLECT		Thatch retards loss of radiant heat to sky, walls absorb radiation from ground surface
GENERAL SHAPE		Rectangular - flat or gable roof See Figure 16
	SITE CONSIDERATIONS	
ORIENTATION		On lee slopes

taken from:
Carpenter LANDES OF THE ANDES

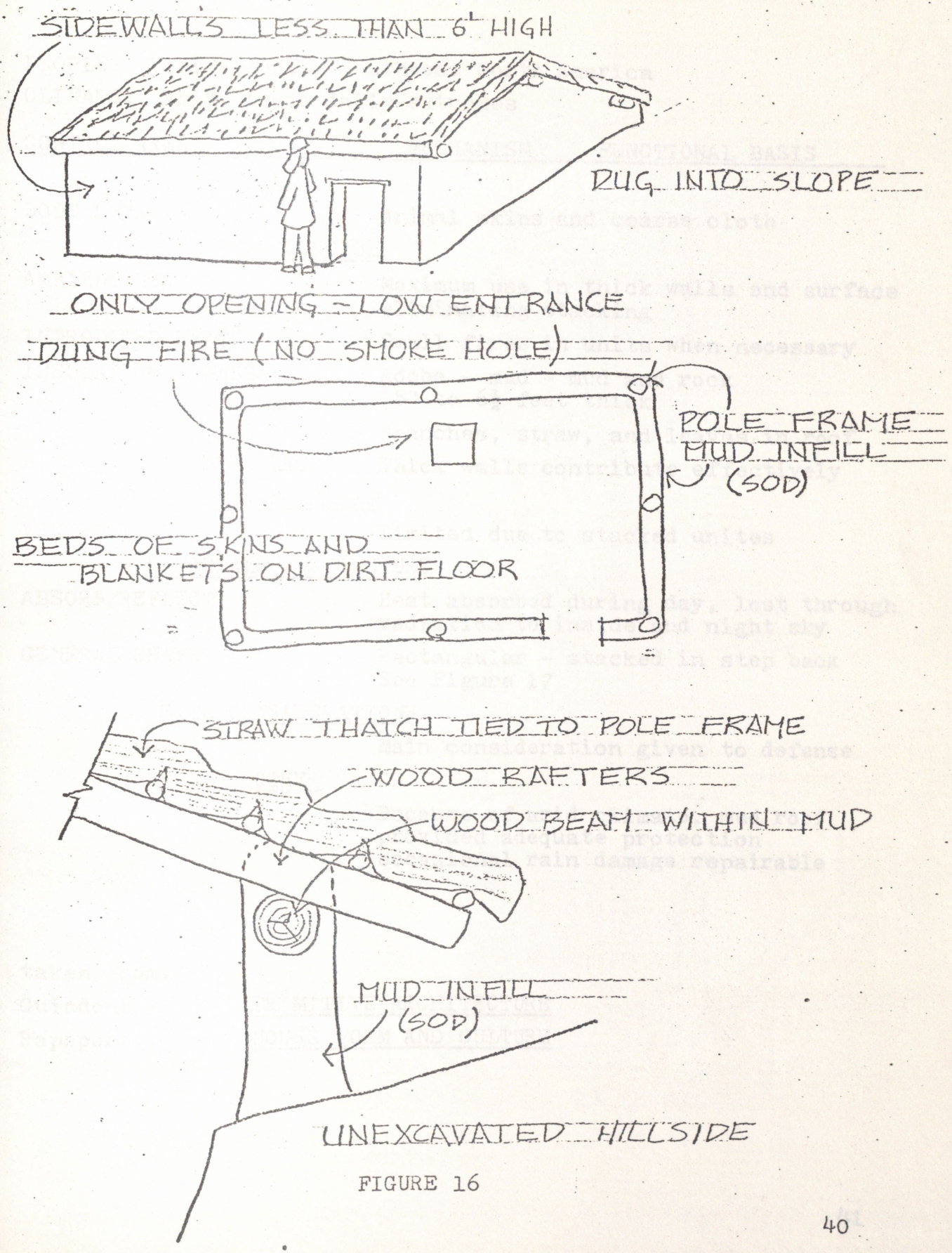

SIDEWALLS LESS THAN 6' HIGH
DUG INTO SLOPE
ONLY OPENING - LOW ENTRANCE
DUNG FIRE (NO SMOKE HOLE)
POLE FRAME
MUD INFILL
(SOD)
BEDS OF SKINS AND
BLANKETS ON DIRT FLOOR
STRAW THATCH TIED TO POLE FRAME
WOOD RAFTERS
WOOD BEAM WITHIN MUD
MUD INFILL
(SOD)
UNEXCAVATED HILLSIDE

FIGURE 16

PEOPLE: Hopi - Zuni, Southwest North America

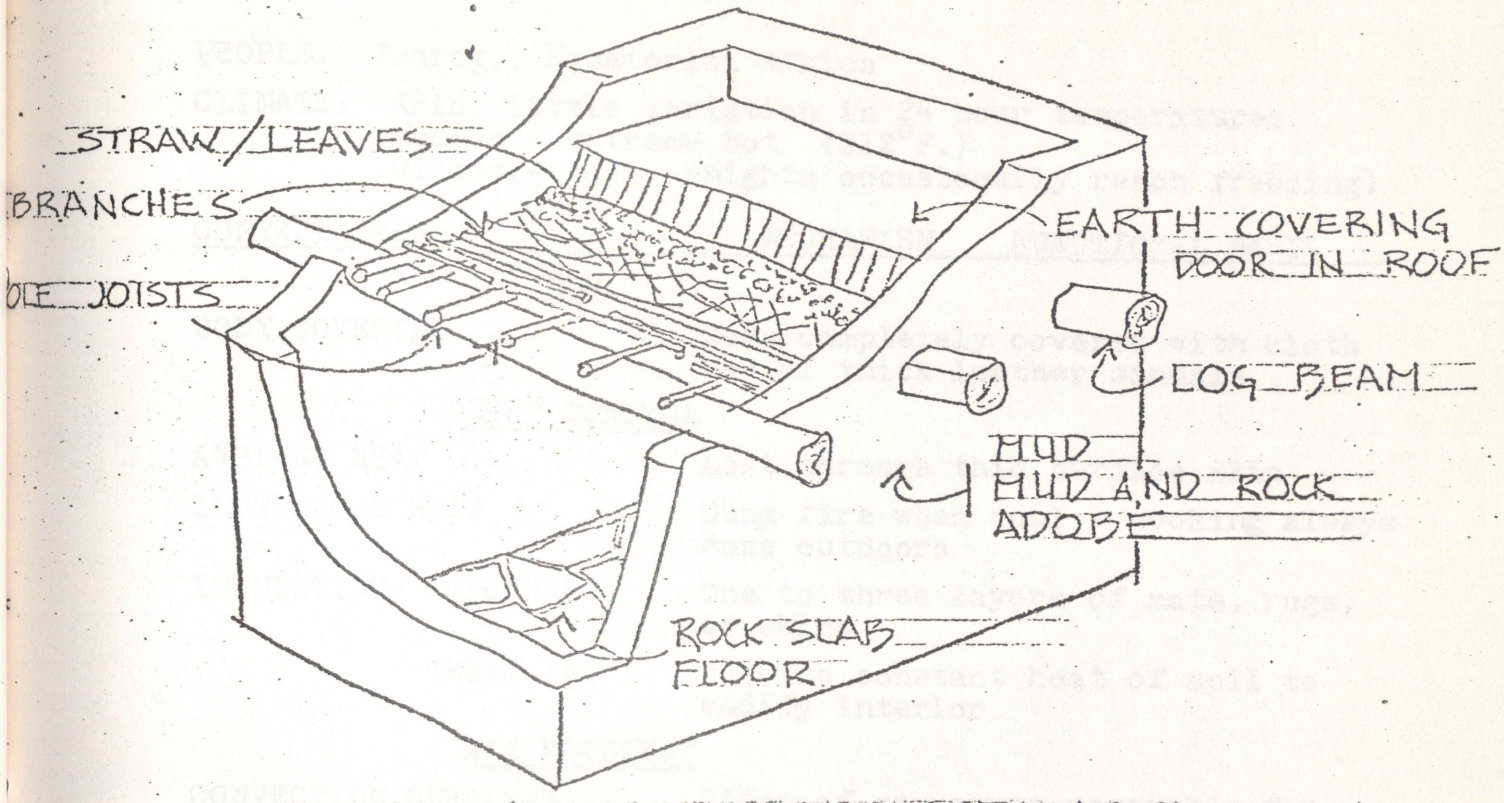
CLIMATE: Arid, broad daily extremes

CONTROL AREA	MECHANISM	FUNCTIONAL BASIS
	MAN	
BODY COVERING		Animal skins and coarse cloth
	HEAT CONTROL	
AMBIENT HEAT		Maximum use in thick walls and surface eliminating stacking
INTRODUCED HEAT		Small fires in units when necessary
INSULATION:	MASS	Adobe - mud - mud and rock 18" to 6½ feet thick
	THERMAL	Branches, straw, and leaves in roof
	HEAT LAG	Thick walls contribute effectively
	AIR MOVEMENT	
VENTILATION		Limited due to stacked unites
	MATERIALS - STRUCTURE	
ABSORB/REFLECT		Heat absorbed during day, lost through radiation to inside and night sky
GENERAL SHAPE		Rectangular - stacked in step back See Figure 17
	SITE CONSIDERATIONS	
		Main consideration given to defense
	OTHER	
		Because of arid climate, mud roof provided adequate protection occasional rain damage repairable

taken from:

Guiodoni PRIMITIVE ARCHITECTURE

Rapoport HOUSE FORM AND CULTURE



DURING HOT MONTHS, USED AS STORAGE
ALL ACTIVITIES TAKE PLACE OUT SIDE
SLEEPING ON ROOF - COOKING OUT DOORS

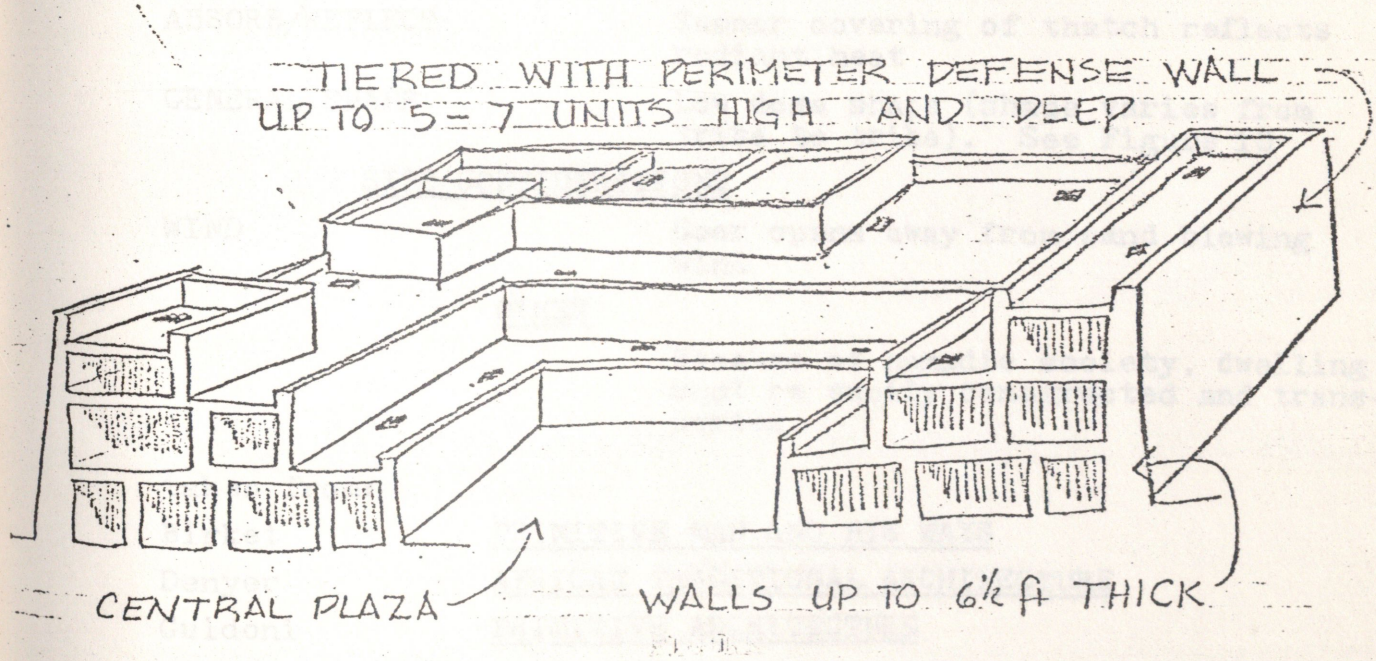


FIGURE 17

PEOPLE: Tuareg, Equatorial Africa

CLIMATE: Arid, little variation in 24 hour temperatures
summer - extreme hot (112°F.)
winter - cool (nights occasionally reach freezing)

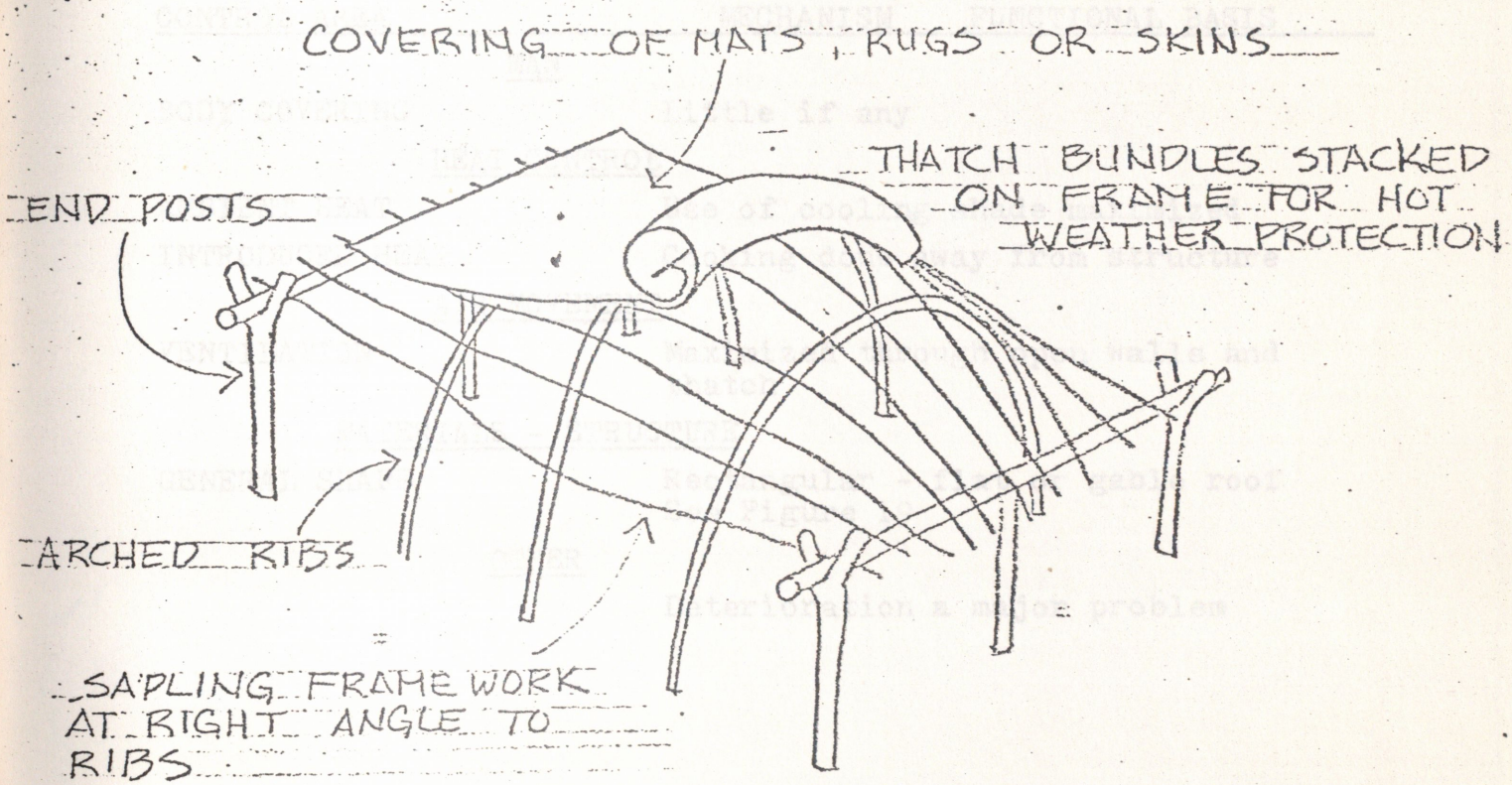
CONTROL AREA		MECHANISM FUNCTIONAL BASIS
	MAN	
BODY COVERING		Body completely covered with cloth use of thick leather sandals
	HEAT CONTROL	
AMBIENT HEAT		Lost through thin surface skin
INTRODUCED HEAT		Dung fire when cool - cooking always done outdoors
INSULATION:	THERMAL	One to three layers of mats, rugs, or skins
	HEAT LAG	Use the constant heat of soil to modify interior
	AIR MOVEMENT	
CONVECTION CURRENTS		Sides of structure removable for maximum ventilation
VENTILATION		Sides removable
	MATERIALS - STRUCTURE	
ABSORB/REFLECT		Summer covering of thatch reflects radiant heat
GENERAL SHAPE		Low dome shape (shape varies from tribe to tribe). See Figure 18
	SITE CONSIDERATIONS	
WIND		Door opens away from sand blowing wind
	OTHER	
		Because of nomadic society, dwelling must be easily constructed and transported

taken from:

Birket PRIMITIVE MAN AND HIS WAYS

Denyer AFRICAN TRADITIONAL ARCHITECTURE

Guidoni PRIMITIVE ARCHITECTURE



EXCEPT FOR EYES, BODY COMPLETELY COVERED WITH FLOWING CLOTH
THICK LEATHER SANDALS PROTECT FEET (160° SAND)

COOKING FIRE ALWAYS OUT OF DOORS.
WHEN NECESSARY, A DUNG FIRE WILL BE BUILT INSIDE

FIGURE 18

PEOPLE: Amazonian Headhunters (Yagua), Tropical South America

CLIMATE: Tropical, humid, hot unfluctuating daily temperatures - equatorial

CONTROL AREA	MECHANISM	FUNCTIONAL BASIS
	MAN	
BODY COVERING	Little if any	
	HEAT CONTROL	
AMBIENT HEAT	Use of cooling shade maximized	
INTRODUCED HEAT	Cooking done away from structure	
	AIR MOVEMENT	
VENTILATION	Maximized through open walls and thatch	
	MATERIALS - STRUCTURE	
GENERAL SHAPE	Rectangular - flat or gable roof See Figure 19	
	OTHER	
	Deterioration a major problem	

taken from:

Guidoni PRIMITIVE ARCHITECTURE

Rapoport HOUSE FORM AND CULTURE

Up De Graff HEAD HUNTERS OF THE AMAZON

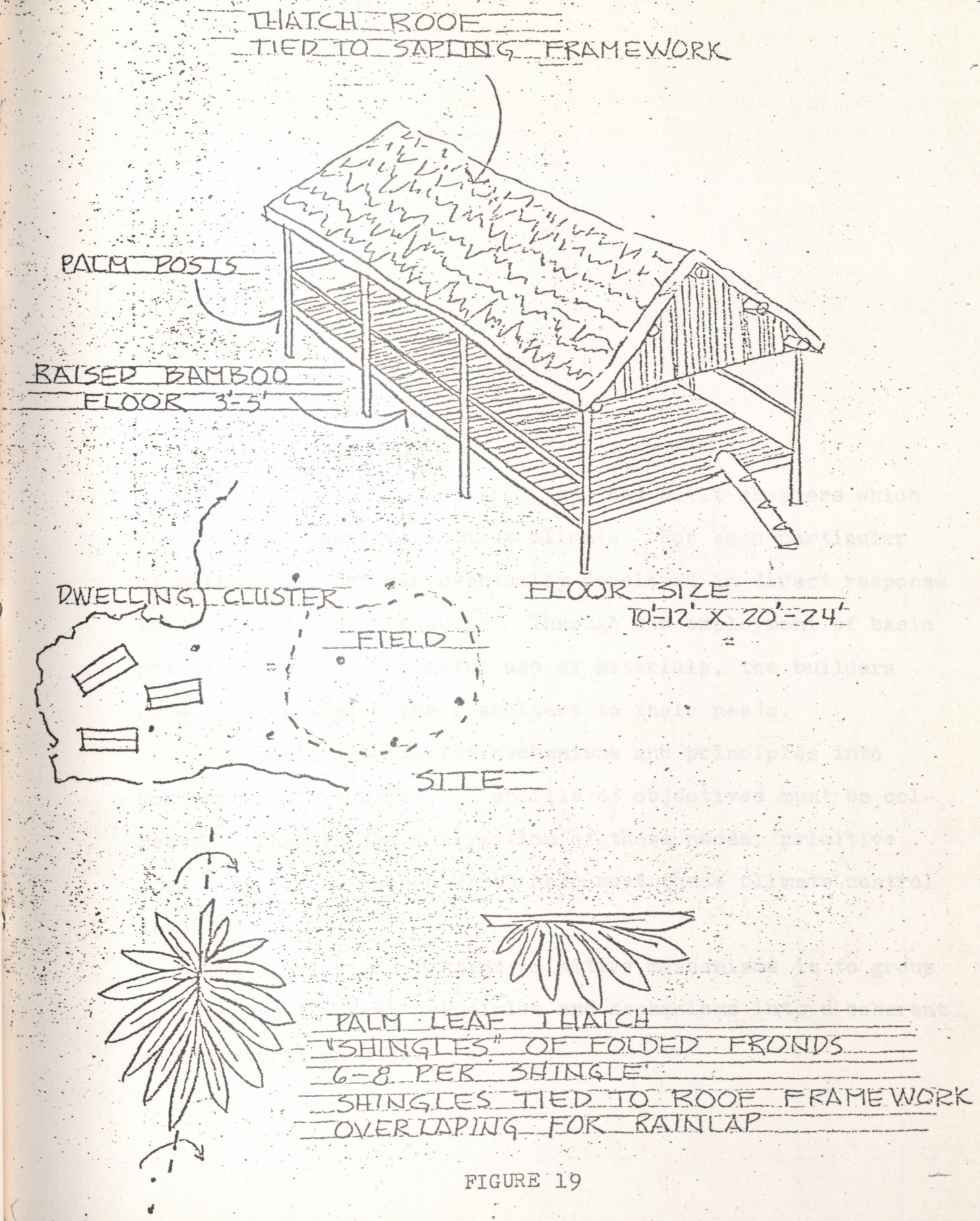

THATCH ROOF
TIED TO SAPLING FRAMEWORK
PALM POSTS
RAISED BAMBOO
FLOOR 3'-5'
FLOOR SIZE
10'-12' X 20'-24'
DWELLING CLUSTER
FIELD I
SITE
PALM LEAF THATCH
"SHINGLES" OF FOLDED FRONDS
6-8 PER SHINGLE
SHINGLES TIED TO ROOF FRAMEWORK
OVERLAPING FOR RAINLAP

FIGURE 19

CHAPTER 4

In all parts of the world, man has built shelters which enable him to survive in that climate. For each particular climate, a shelter was eventually developed in direct response to the climatical pressures. Through the employment of basic principles and a purposeful use of materials, the builders were able to taylor their shelters to their needs.

In adopting primitive mechanisms and principles into contemporary situations, a profile of objectives must be collected. Through the analyzation of these needs, primitive practices can be chosen which help meet these climate control levels.

The final step of using primitive mechanisms is to group and arrange the best principles and mechanisms into a coherent architectural package.

CLIMATE OBJECTIVES	REASONS BEHIND OBJECTIVES	PRIMITIVE RESPONSES
1. Keep low ratio of surface to volume	1. lessen heat loss potential 2. lessen ambient heat impact 3. maximize material usage	1. ESKIMO-Igloo-hemisphere 2. LAPP-Cone-floor area to volume not good 3. N.A. Indian-Cone-floor area to volume not good
2. Keep interior air velocity low during heating periods	1. lessen evaporative cooling 2. lessen cooling sensation of moving air	1. ESKIMO-cold trap entrance (sealed interior) -small vent
3. Increase air movement during cooling periods	1. maximize evaporative cooling 2. maximize cooling sensation of moving air	1. LAPPS-controlled smoke vent 2. N.A. Indian-Tipi-open flaps-raise walls
4. Ventilate high humidity areas kitchen, bath, laundry	1. to replace with lower humidity air	1. Primitives increase air movement through enhancement of exterior air
5. Block wind on NW/SE exposures	1. lessens heat loss through stripping warmer surface air away	1. ESKIMO-build on lee side of cliffs or hills 2. LAPPS-build in dense brush or forest
6. Place entrance NE/SW exposures	1. keeps wind from blowing directly into opening 2. keeps area snow free	1. ESKIMO-orientation of entrance perpendicular to wind direction

MINNEAPOLIS

CLIMATE OBJECTIVES	REASONS BEHIND OBJECTIVES	PRIMITIVE RESPONSES
7. Orient on NW/SE axis	1. lessens wind effect 2. catches afternoon sun	1. Primitives use dominance of sun directions to orient buildings. Usually ENTRANCE TO EAST, W/N/S AXIS
8. Use deciduous shading devices	1. effective in summer-void in winter	1. construct in forested areas
9. Allow for screened outdoor areas to North	1. keeps bugs out 2. lets air move easily 3. building provides shade 4. gets some sun early A.M. and late P.M.	1. N.A. Indian-tipi-raised sides with exception of bug protection
11. Ventilate and or heat below surface areas	1. avoid dew point temperatures 2. avoid high humidity build-up	1. ESKIMO-summer dug out-with skin roof allows free movement of air
12. Provide artificial light in winter Provide natural light in summer	1. winter conditions-overcast 2. summer conditions-very sunny	1. ESKIMO-winter, use oil lamps -summer, use ice window

CLIMATE OBJECTIVES	REASONS BEHIND OBJECTIVES	PRIMITIVE RESPONSES
1. Keep house sealed during cooling periods	1. eliminate hot exterior air 2. retain cool interior atmosphere	1. HOPI/ZUNI-pueblo and adobe huts-interior used only during cool night hours
2. Increase interior air movement during cooling periods	1. enhance cooling properties of sweating 2. natural cooling sensation of moving air	1. EAST INDIAN-use of wind scoops
3. Introduce humidity possibly Nov.-Mar.	1. bring up to comfort levels	1. SE ASIA-water trickling over moss mats
4. Plan for or utilize early morning cool period	1. use to cool during cooling periods 2. avoid during heating periods	1. HOPI/ZUNI-pueblo
5. Allow solar penetration into space Nov.-Mar.	1. Nov. and Mar. use heat lag only 2. De. - Feb. use direct and heat lag	1. Primitives used exterior spaces to utilize suns radiant power
6. Avoid west windows	1. low P.M. sun too strong	1. Primitives avoided windows for the most part (partially due to other protective drawbacks)

CLIMATE OBJECTIVES	REASONS BEHIND OBJECTIVES	PRIMITIVE RESPONSES
7. Utilize deep recesses	1. shades windows	1. HOPI/ZUNI-thick walls and small windows prevented solar penetration
8. Use west wall moderating mass	1. stores powerful P.M. sun for use in night 2. allows for S and E wall fenestration	1. HOPI/ZUNI-uses thick adobe walls or large rock mass as a temperature moderator
9. Use long low windows	1. allows light without need of large overhangs	1. HOPI/ZUNI-typical small windows prevented solar penetration
10. Use double shell roof	1. allows for ventilation of hottest area 2. protection from solar radiation 3. opportunity to use moderate mass	1. EAST INDIAN-thatch in combination with a mud mass roof provided a dual purpose element. thatch as an insulation and radiation shield and mud as a temperature moderating mass
11. Provide outdoor living areas	1. expands useful floor area 2. provides relief from hot or cold interior 3. removes undesirable elements from interior, cooking odors, humid heat	1. All primitives utilized exterior spaces to a large extent, and whenever conditions permitted

PART 3

As shown, primitives throughout time have protected themselves from the adverse conditions of their micro climatic setting through the implimentation of basic mechanisms and principles in habitat design. In our day of scientifically advanced technology, responses are frequently costly, inefficient, energy wasting, high tech systems. Because of the tendency of many designers to impress their clientele with their advanced technical knowledge, many basic principles and inherent protective qualities have been neglected or simply overlooked in favor of exploitation of contemporary systems. The many simple mechanisms that primitive man employed to combat harsh climates continue to be viable alternatives to advanced systems in use today. These mechanisms, if understood, could be used in contemporary design to provide climatic protection and, in many cases, offer a more consistant energy conservatism, as well as an easily maintained climatic protection.

The direct relationship between climate and design can be shown through the development of a design program which limits all variables and accents climatic differences. In selecting the sites for this problem, several criteria were taken into consideration. First, there must be enough material easily at hand to sufficiently document the climatical conditions of the

area. This criteria limited the selection area primarily to the United States. Secondly, the urban settings of the two sites must be closely aligned to minimize design criteria differences. The two sites must be similarly populated areas with consistant services, schools, and transportation needs. Thirdly, the two sites must be dissimilar enough in climate to make climatical design comparisons easily identifiable. Using the climatic make-up of these two dissimilar climates as input data, design responses relative to pressures of that climate can be compared: i.e., heat vs. cold; humid vs. arid; moderate solar radiation availability vs. overbearing solar radiation; wind direction and consistency, and should demonstrate the folly of the disregard shown toward climate and site by the typical designer/builder.

In each design setting, the same program requirements will be applied so that all extraneous differences can be avoided in order to further illuminate the climatic differences. In each instance, the initial action will be to analyze a spec house in terms of conscious or accidental steps taken to meet and or avoid climatic design needs, or the total disregard toward those elements.

The final step will be the conscious design of a dwelling specifically directed toward the climate present. Using the input of the typical residential unit, and substituting applicable primitive responses in place of contemporary

mechanisms, a design sensitive to its climate, and benefiting from the inherent qualities of primitive responses will be demonstatred.

The success of these designs will be judged on the basis of the ability of the house to protect the inhabitants from the given climate, and the inherant climate modifying systems which do not depend on complicated controlling devices to continue in operation.

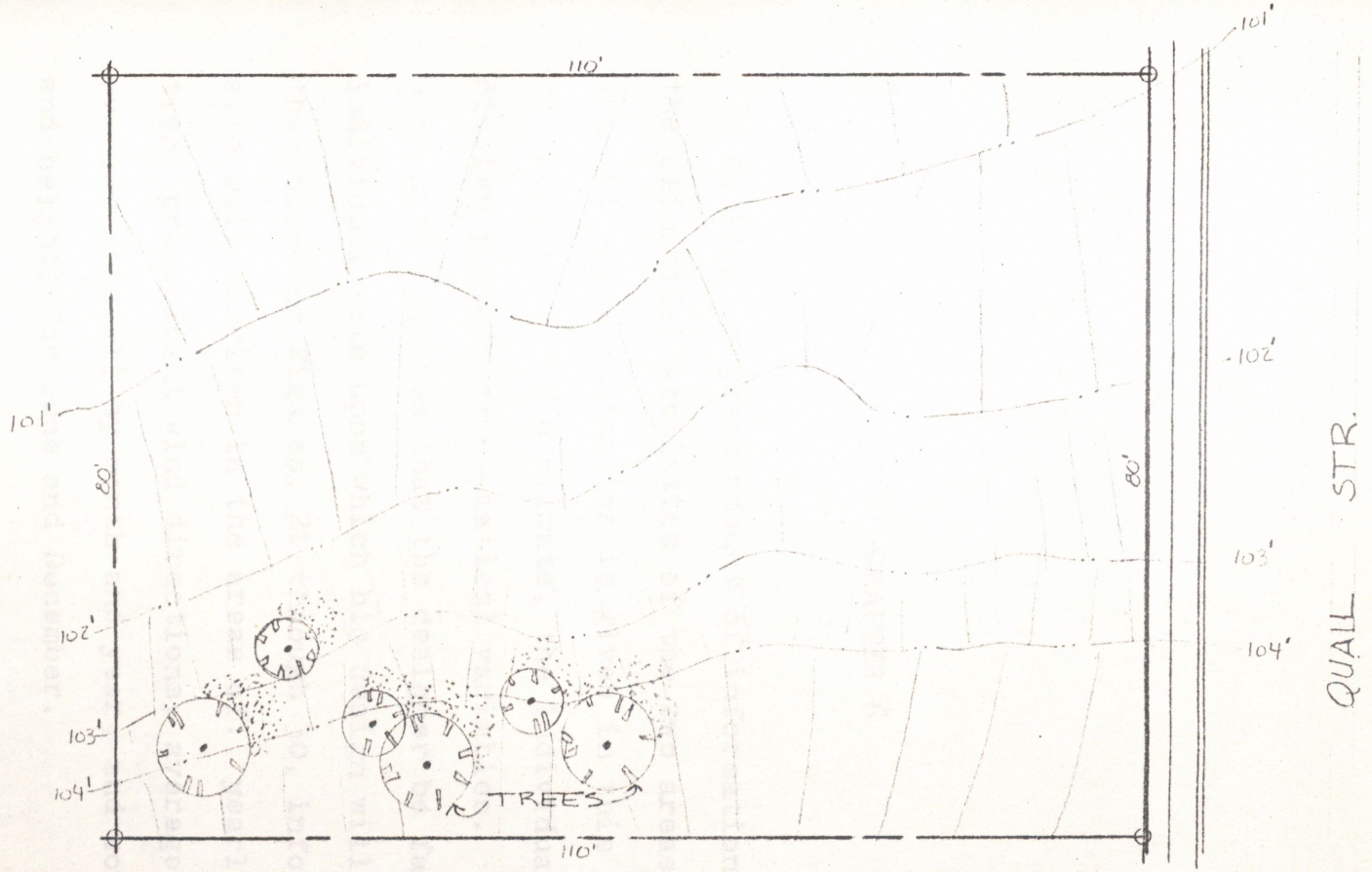
PART 4

CHAPTER 5

The two sites selected are in suburbs of Minneapolis, Minnesota, and Phoenix, Arizona. Streets are on a grid pattern with the majority of the houses either single level or split level height. The central shopping area of the city is approximately one mile distant, with neighborhood grocery stores and gas stations within close proximity. The well established neighborhoods have mature vegetation and the site topography is on a gently varying slope. See Figure 20. Small neighborhood parks are located only a few blocks away, and a combined elementary/day care school is located within three blocks. In all, the area is predominantly inhabited by skilled workers and professional people.

The area is in its second generation of families, with the original owners, their families raised and gone, replaced by younger families. With a few retired couples still mixed into the area, the community is composed mainly of families with children in the zero to fifteen year old age group.

Community interaction takes place through the neighborhood grocery/gas station and the small localized parks. Buses give the opportunity for commuting workers of the area to assemble on a local level. In all, the neighborhoods have the flavor of the typical television suburban setting.



SITE PLAN

1" = 20'-0"

Figure 20

CHAPTER 6

Although a great amount of information is available on the climatical statistics of the two areas chosen, only general area information is given in this section. No matter the region or basic climate, the individual site has an exclusive pattern of climatical variables. The uniqueness of each site requires that the designer be familar with that individual site upon which his design will be constructed. In the following Figures, 21 through 30, information for each site will be given in the areas of: yearly temperature variation, predominant wind directions, average relative humidity, average rainfall by month and year, and solar radiation (angle and height) for June and December.

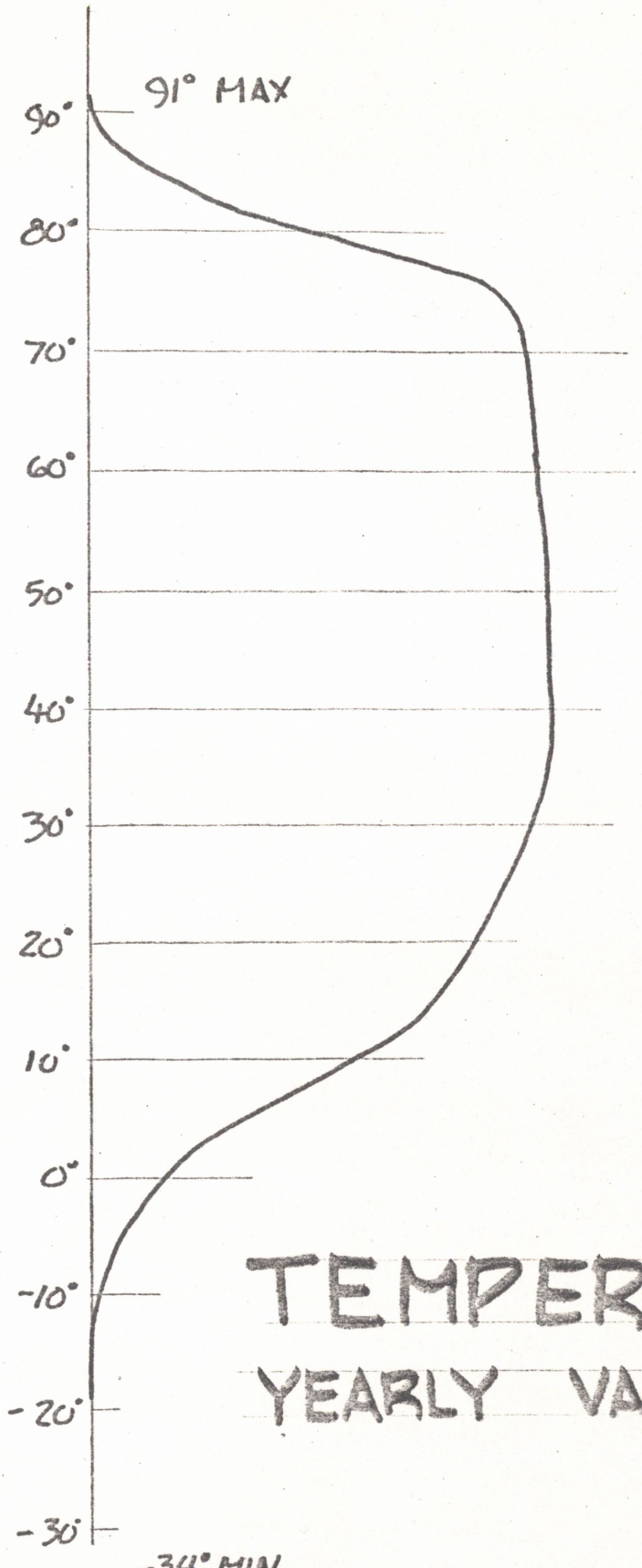
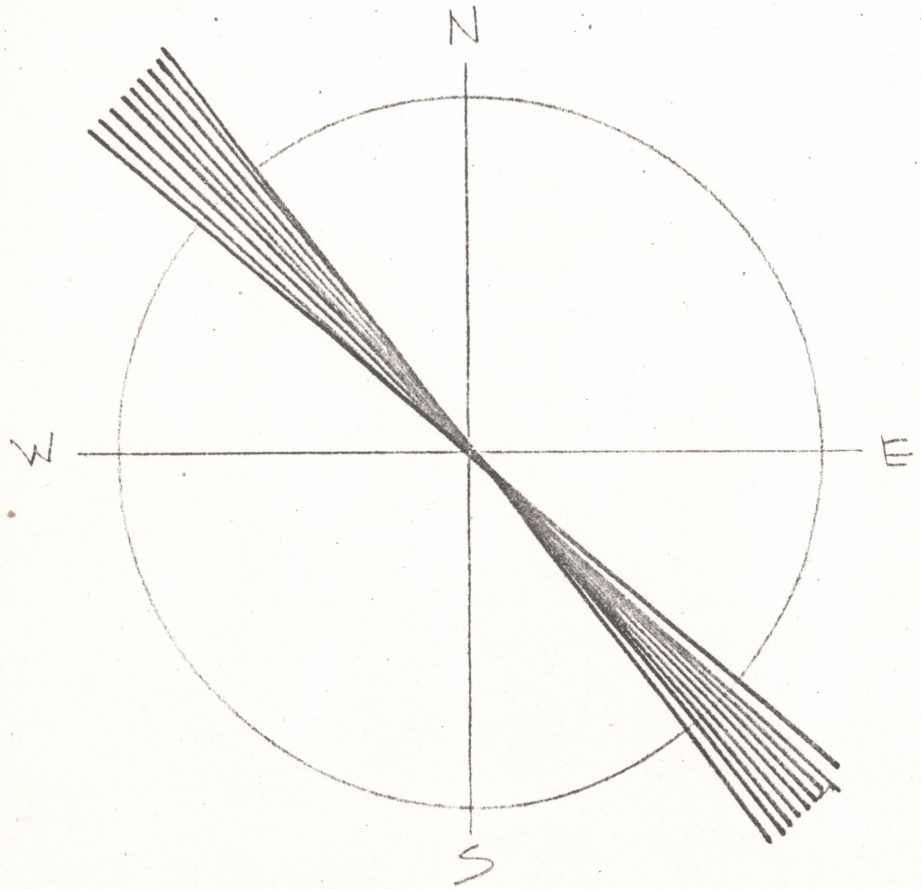

91° MAX
90°
80°
70°
60°
50°
40°
30°
20°
10°
0°
-10°
-20°
-30°
-34° MIN.
TEMPERATURE
YEARLY VARIATION
MINNEAPOLIS

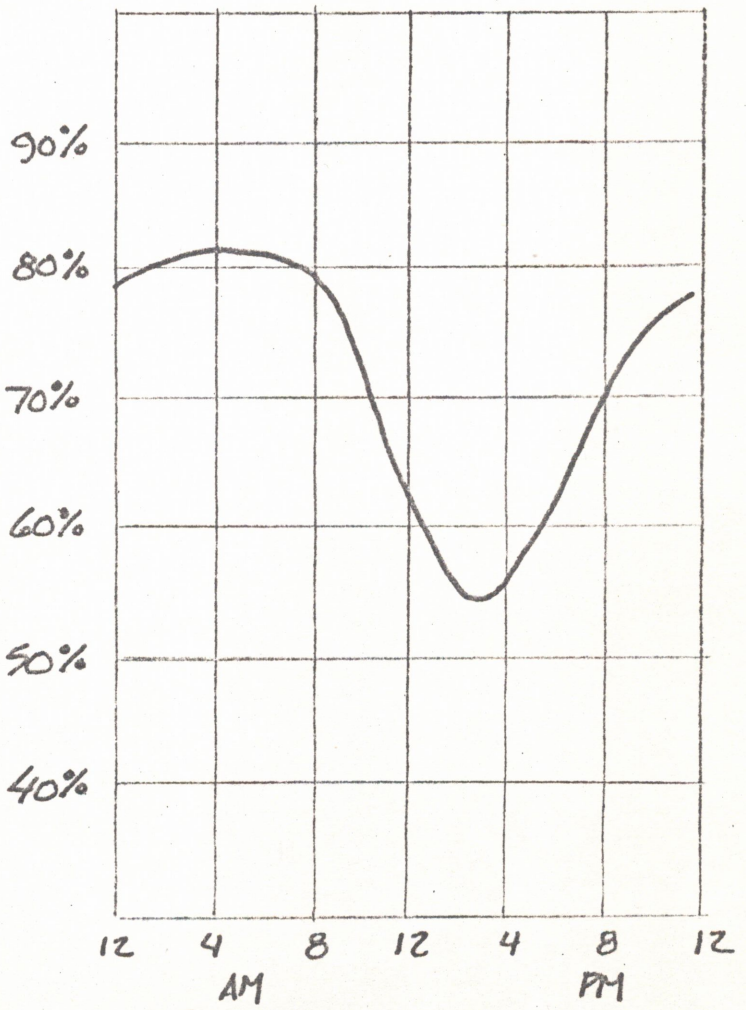
FIGURE 21



WIND

MINNEAPOLIS

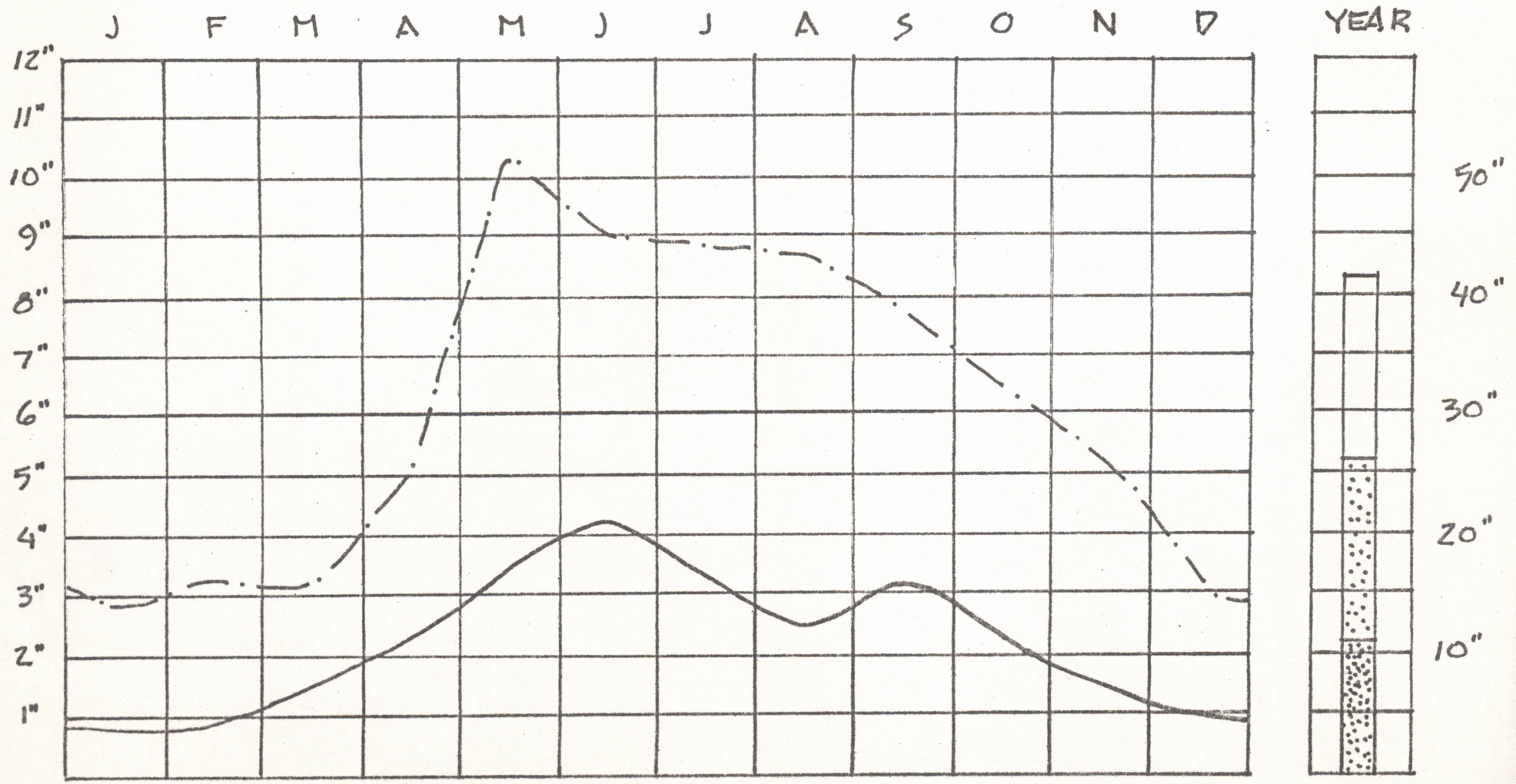
FIGURE 22



AVERAGE REL. HUMIDITY

MINNEAPOLIS

FIGURE 23

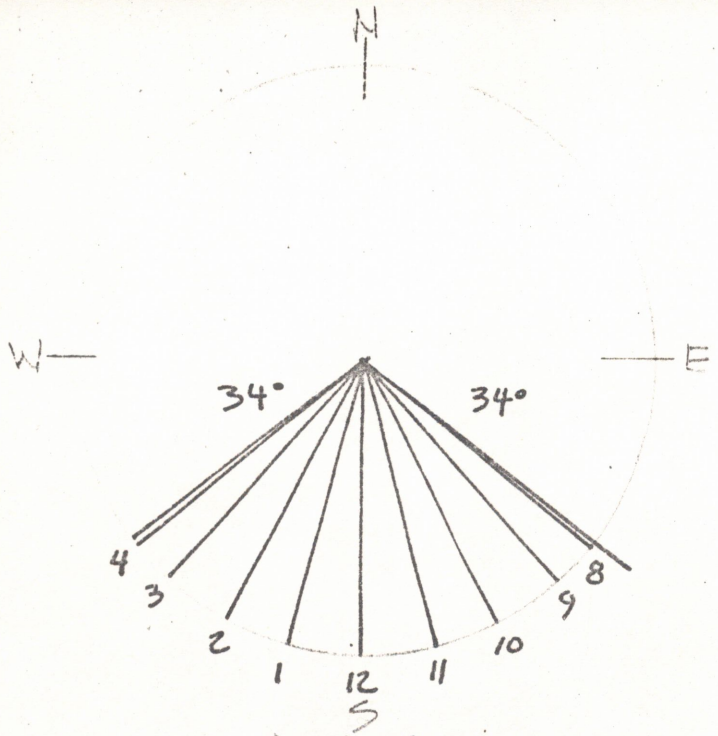


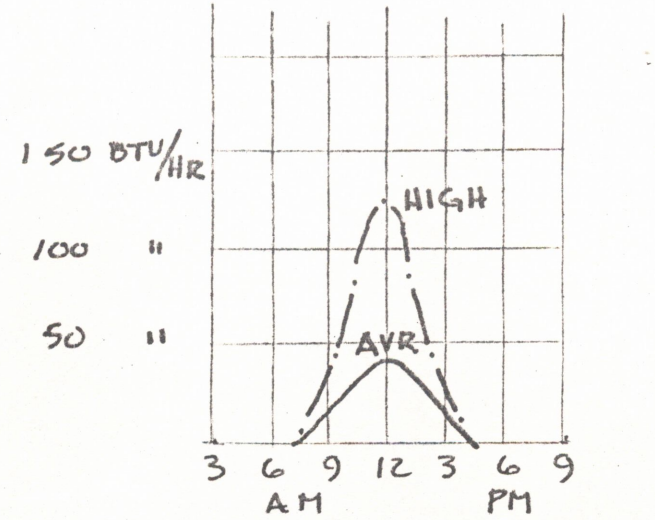
AVERAGE RAINFALL

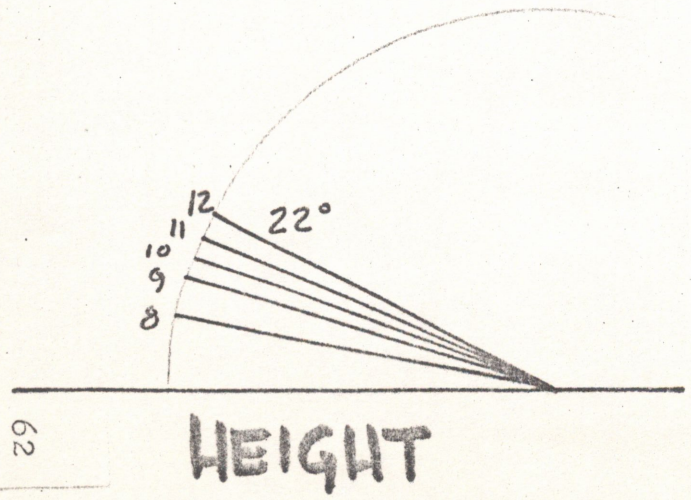
FIGURE 24

MINNEAPOLIS

T9





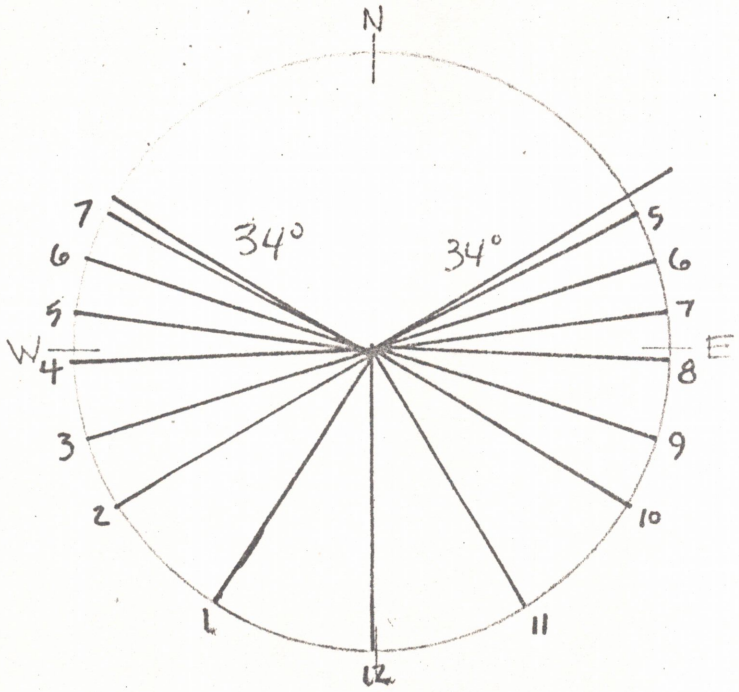


DEC.

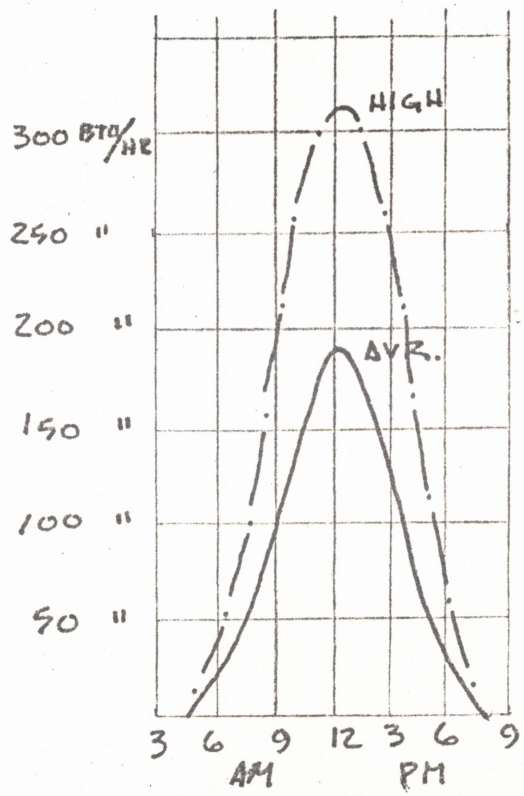
SOLAR

MINNEAPOLIS

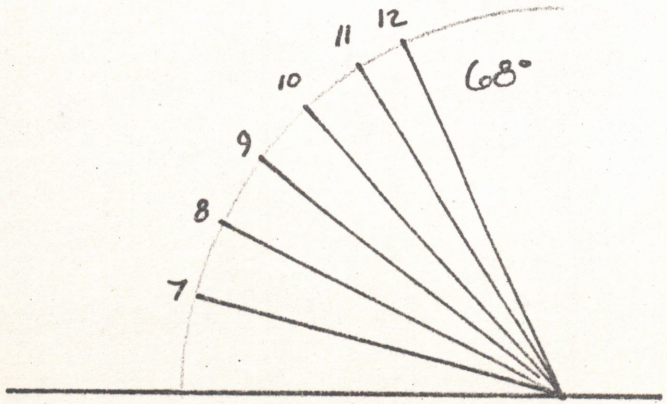
FIGURE 25



ANGLE



RADIATION



HEIGHT

JUNE SOLAR

MINNEAPOLIS

FIGURE 26

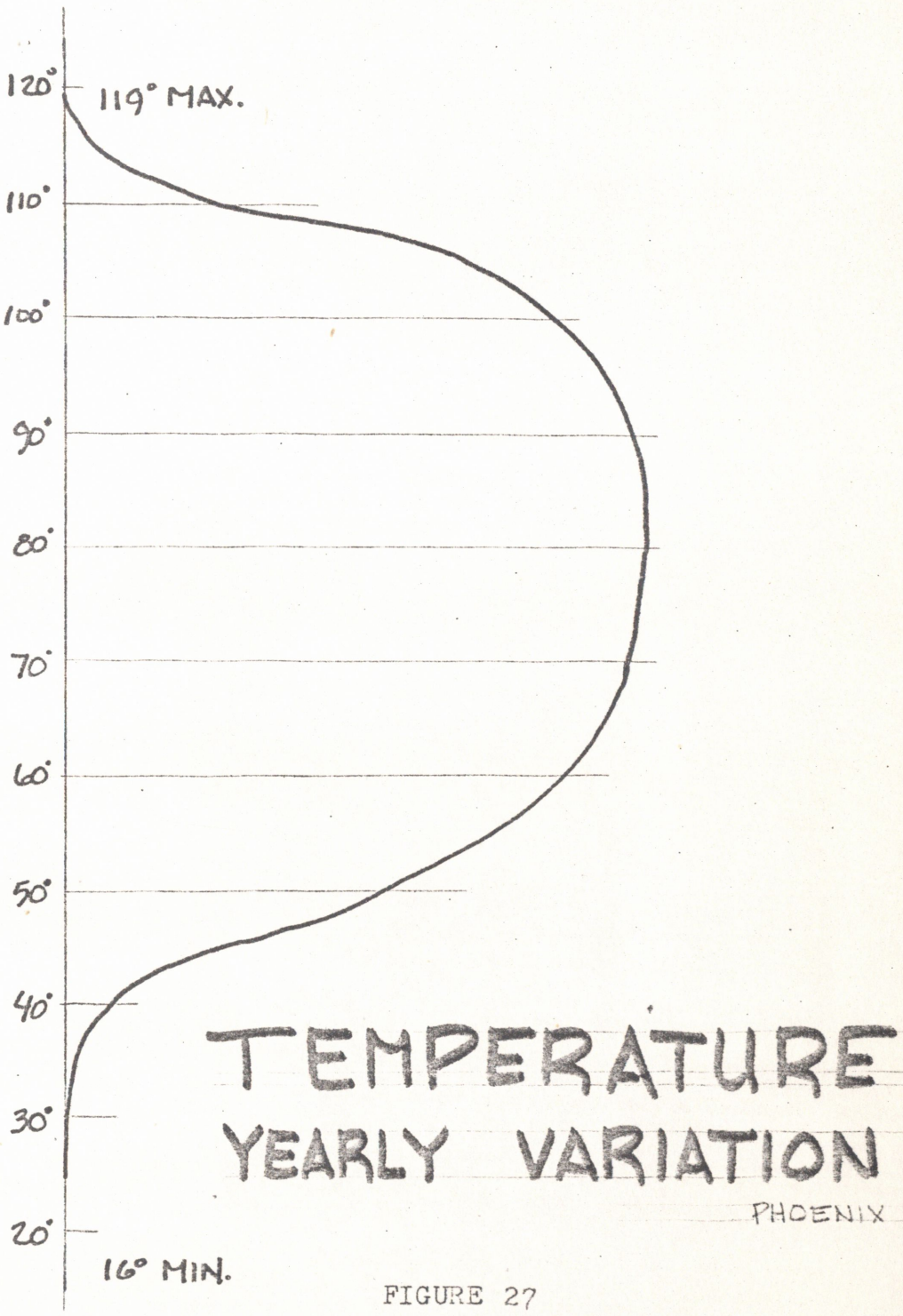
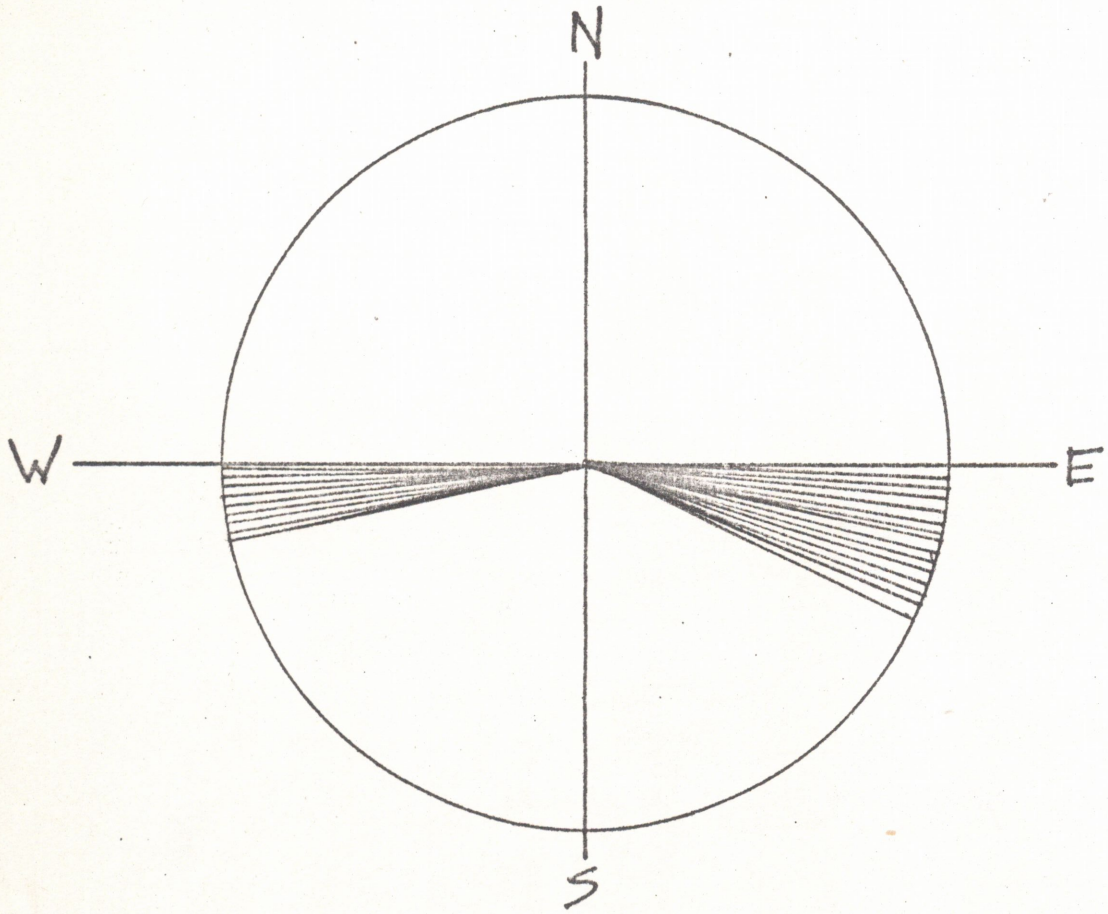
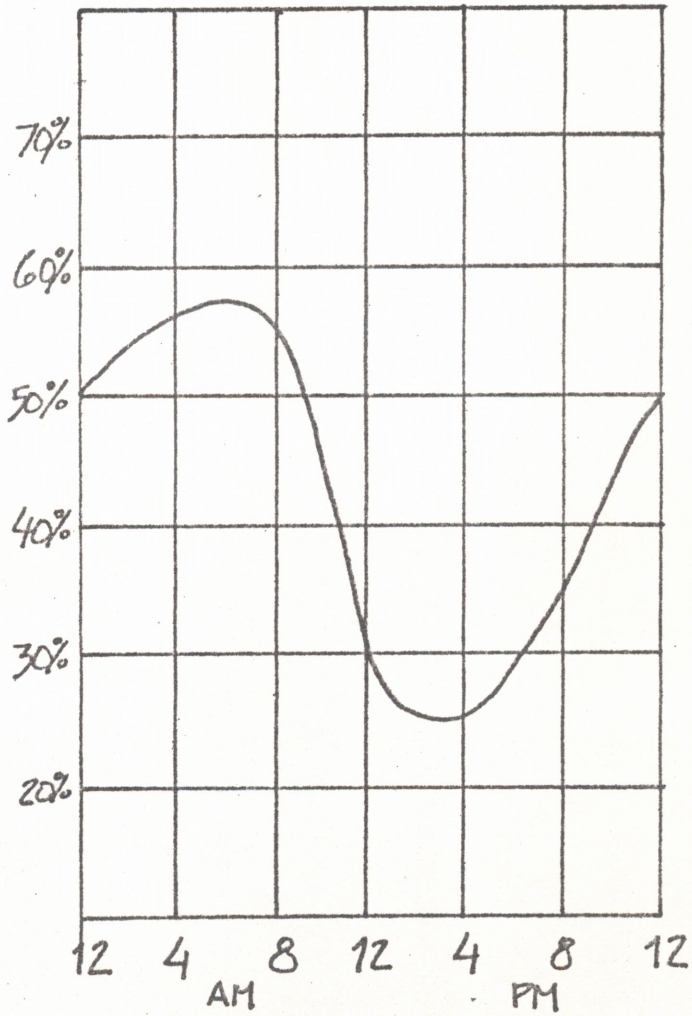

120°
110°
100°
90°
80°
70°
60°
50°
40°
30°
20°
119° MAX.
16° MIN.
TEMPERATURE
YEARLY VARIATION
PHOENIX

FIGURE 27



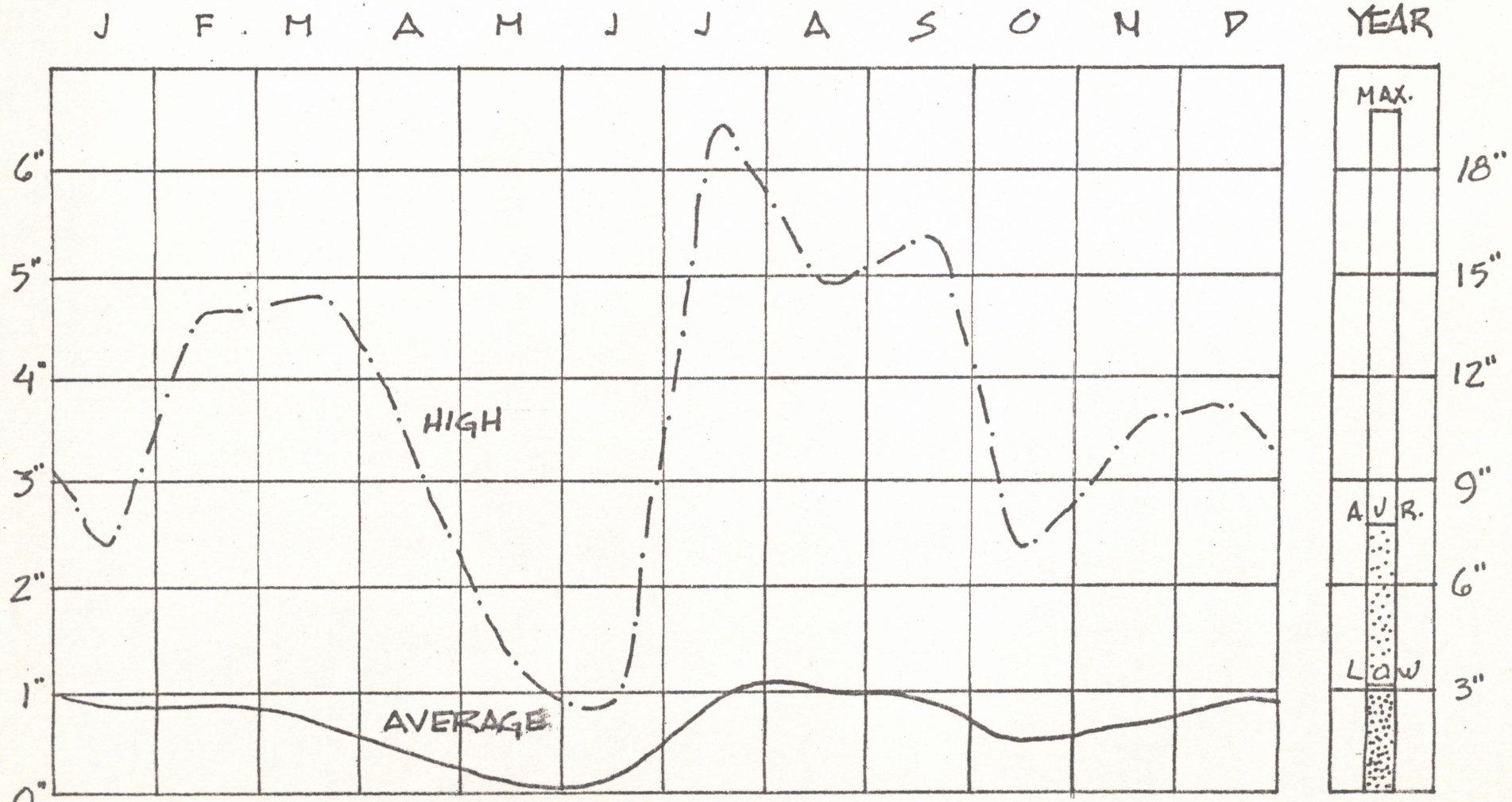
WIND PHOENIX

FIGURE 28



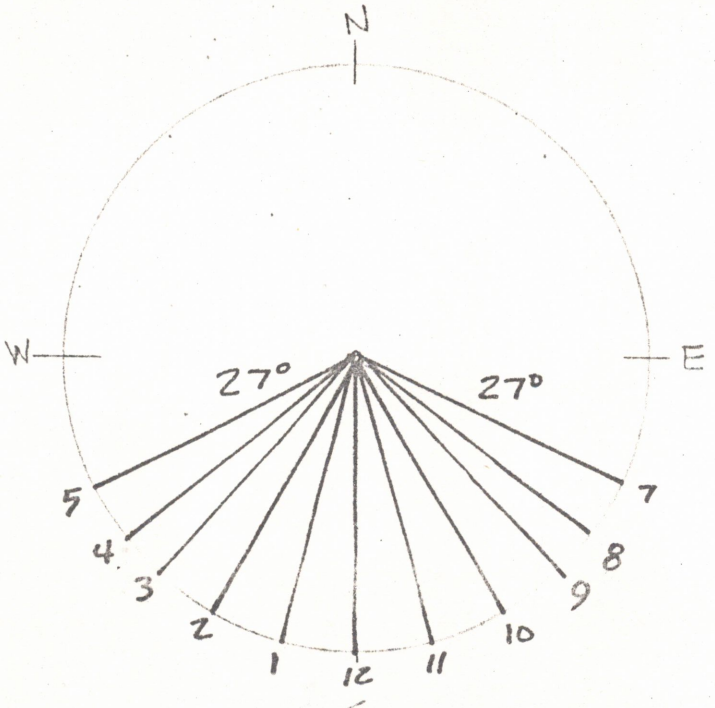
AVERAGE REL. HUMIDITY PHOENIX

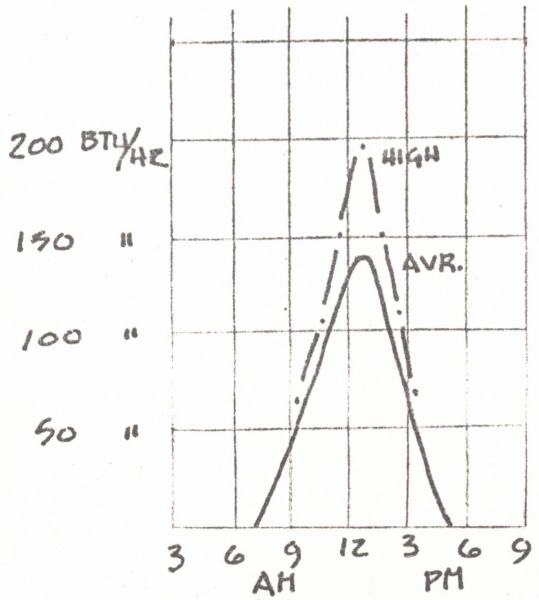
FIGURE 29

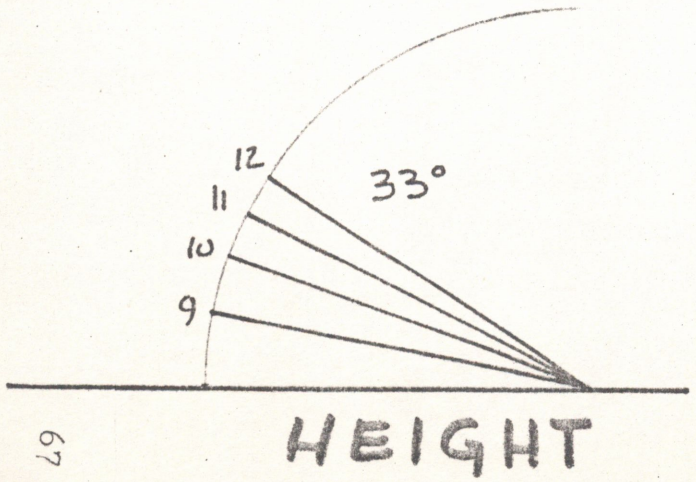


AVERAGE RAINFALL

FIGURE 30 PHOENIX





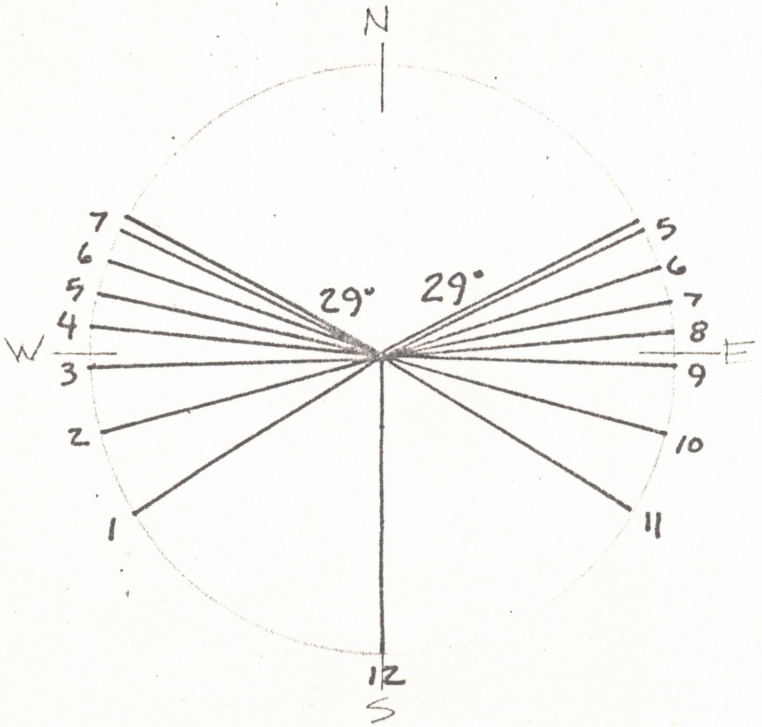


DEC.

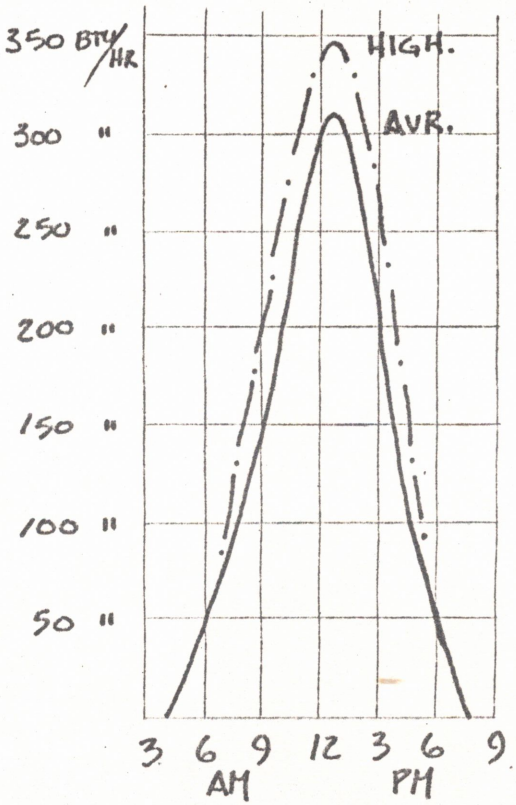
SOLAR

PHOENIX

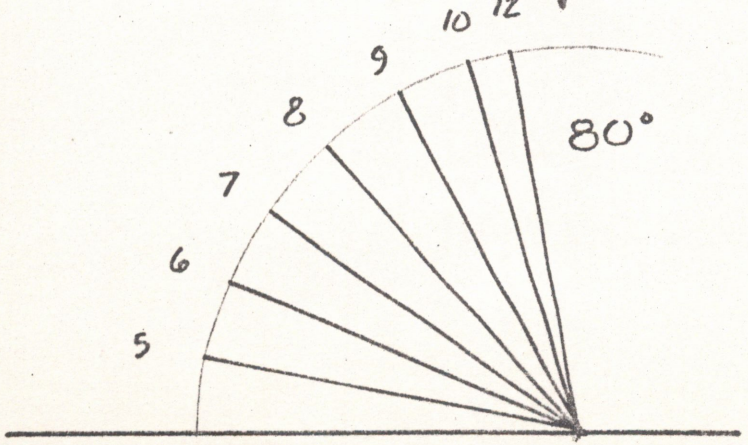
FIGURE 31



ANGLE



RADIATION



HEIGHT

JUNE SOLAR

PHOENIX

FIGURE 32

CHAPTER 7

DESIGN PROGRAM

Family.....Four members

Man-Works 8 a.m. to 5 p.m. at a Printing Shop
Takes bus to work
Bus stop is two blocks from the Shop

Woman-Works 9 a.m. to 4 p.m. at Local Branch Library
Walks the four blocks to work

Two Children-Boy, age 8
Walks three blocks to elementary school
Girl, age 5
Babysat by neighbor 9 a.m. to 12 p.m.
Walks three blocks to daycare center
At daycare center 12 p.m. to 3 p.m.

Space needs and requirements

Living area-Sufficient area for general activities
Television viewing
Music listening
Conversation
Entertainment

Space needs and requirements continued

Dining area-Sufficient room for family meals
Occasional entertaining

Kitchen-Room for two to three adults to work simultaneously
Appliances as justfied

Bathing facilities-Number and location as justified
One toilet minimum
One lavatory minimum
One bathing and shower facility minimum

Sleeping-Divided as needed
Be adaptable to allow for guests
Provide privacy for dressing
Provide privacy for intimacy

Other optional areas -Recreation area (larger space for more active activities)
Hobby area
Garage or auto repair area

PART 5

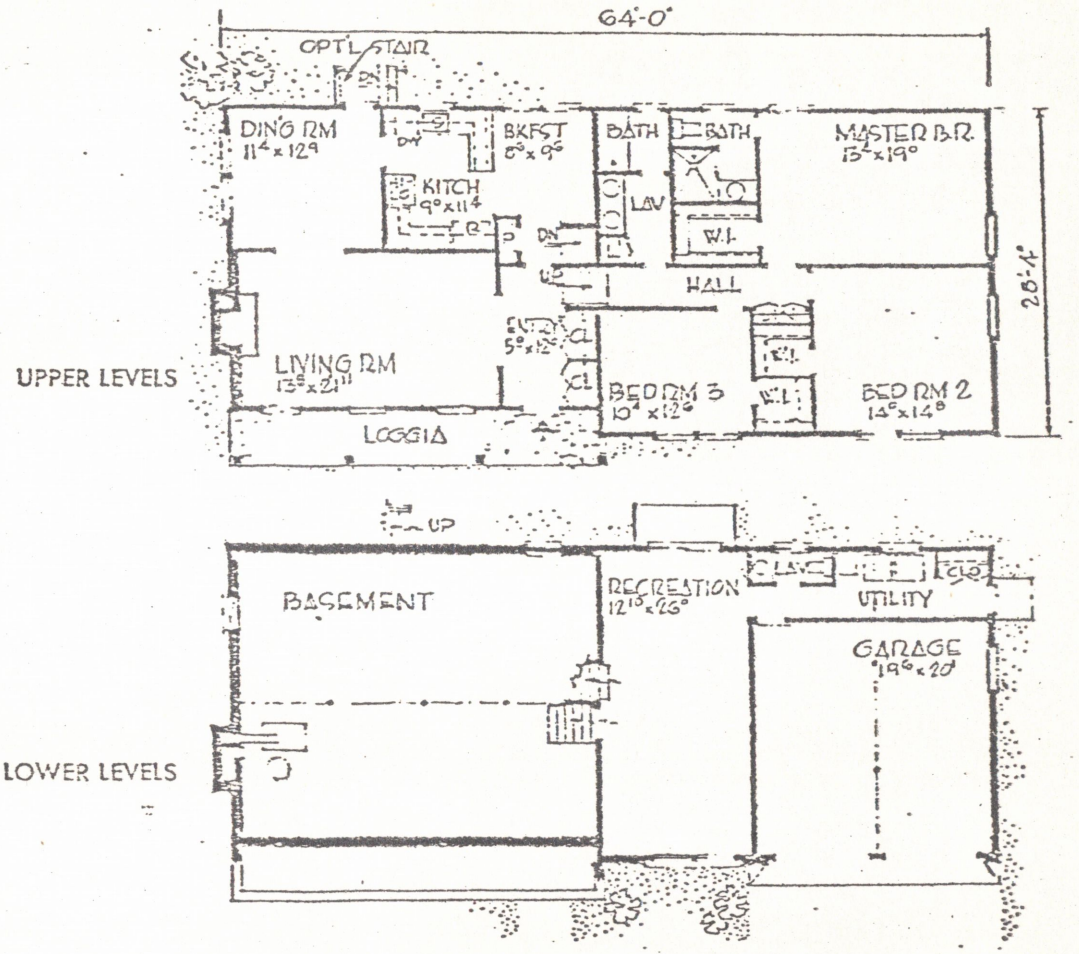
In all areas of the nation, and in fact all over the world, examples of "spec" houses can be found. Built to provide shelter for clients by using the least expensive materials and fastest building methods, these houses at times comprise the sole structures of entire subdivisions. However, the designer either does not have sufficient training to deal with climatical design requirements, or more than likely has no idea where his mail distributed plans will be used.

In order to substantiate my claims of inadequacy on the part of spec homes in dealing with climatic elements, a residence was chosen out of a magazine specializing in selling building plans through the mail. By randomly placing this house on the given site, a test situation is established by which to determine the success of the structure in dealing with the climatic pressures of that particular site.

The analysis of the spec house will be in the areas of: materials and their usage, the insulative value of the walls and ceiling, problems associated with the use of an external exposed masonry fireplace (See Figure 36), the relationship of the building with the climatic variables of the site (See Figures 37 and 46), and the relationship of the building form with the trajectory of the sun. See Figures 38-45, and 47-52.

In examining a typical section of the building (See

Figure 35), specific materials used in construction can be analyzed. This analysis is presented in tabulated form, and sumultaneously compares the appropriateness for both sites.



FLOOR PLANS

HOUSE PLAN #7555-Y NO SCALE

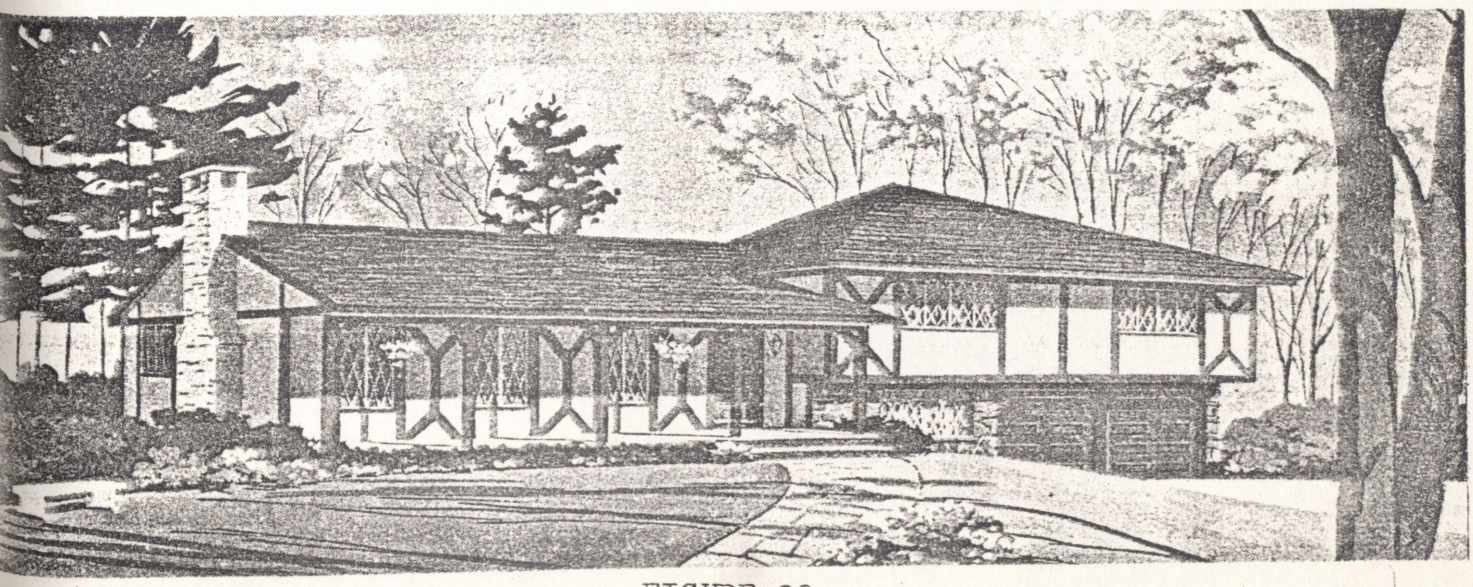
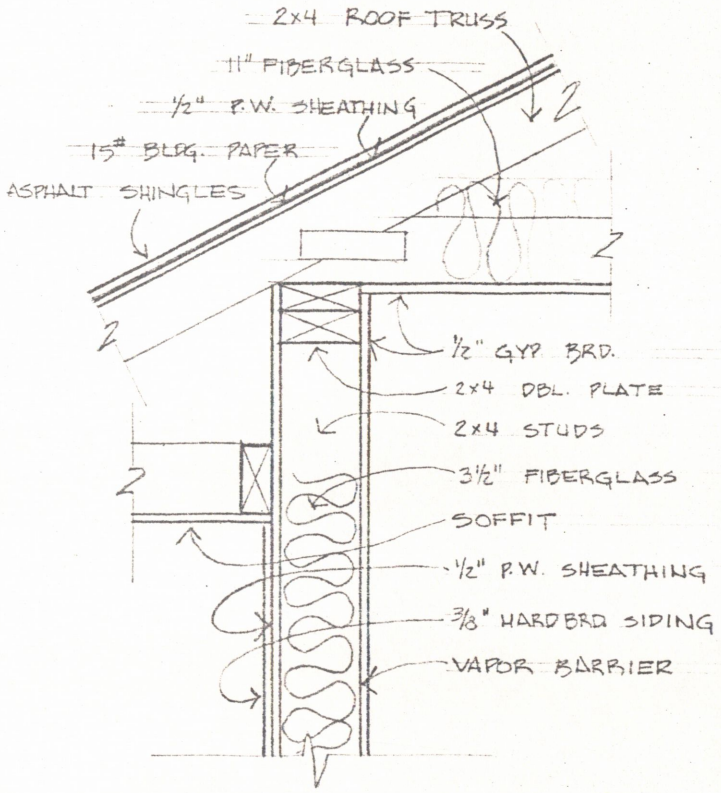


FIGURE 33



TYP. SECT.

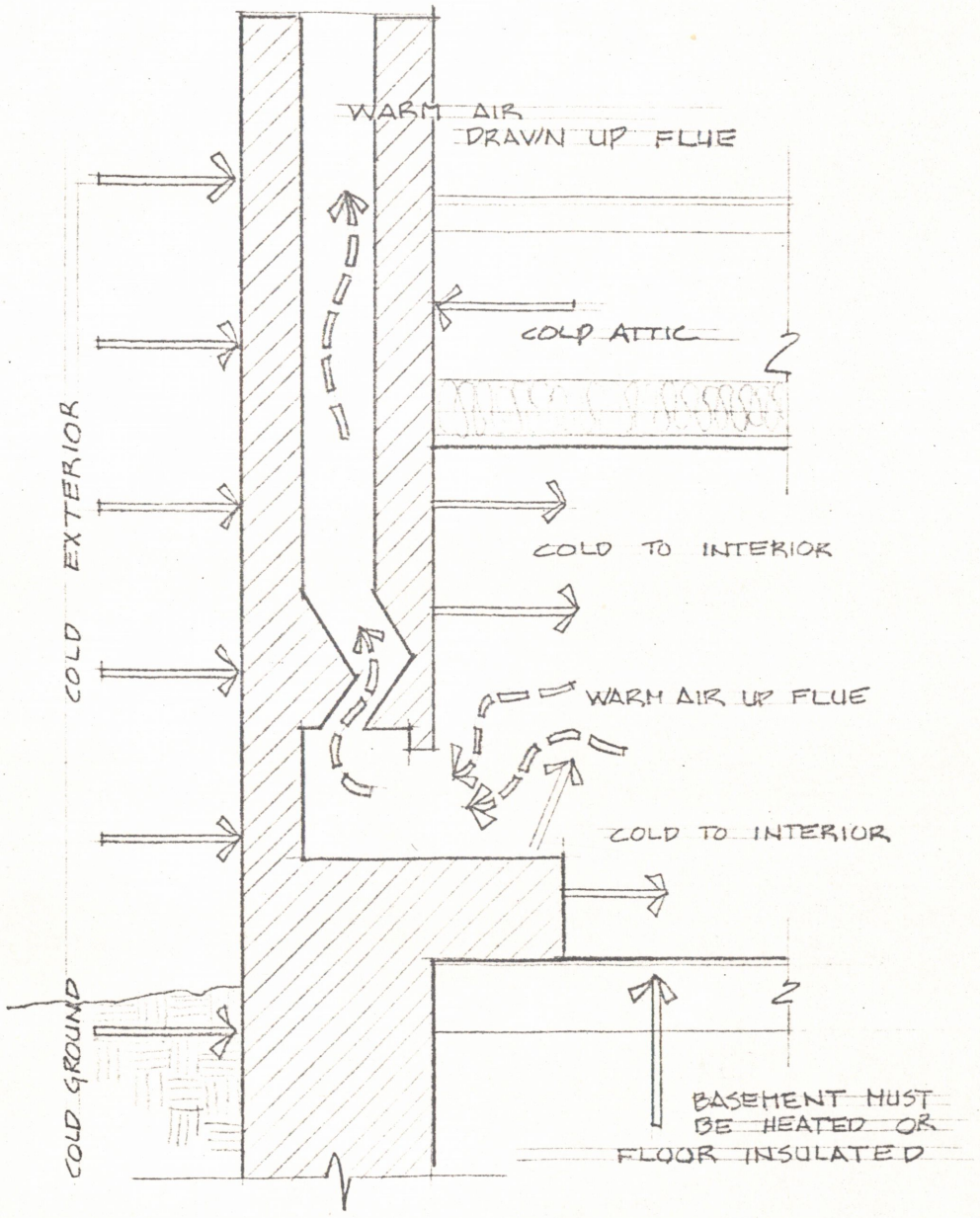
NO SCALE

FIGURE 34

EXAMPLE: American Spec House

CLIMATE: Phoenix-hot, arid, wide range of daily extremes
Minneapolis-seasonal temperature extremes, humid

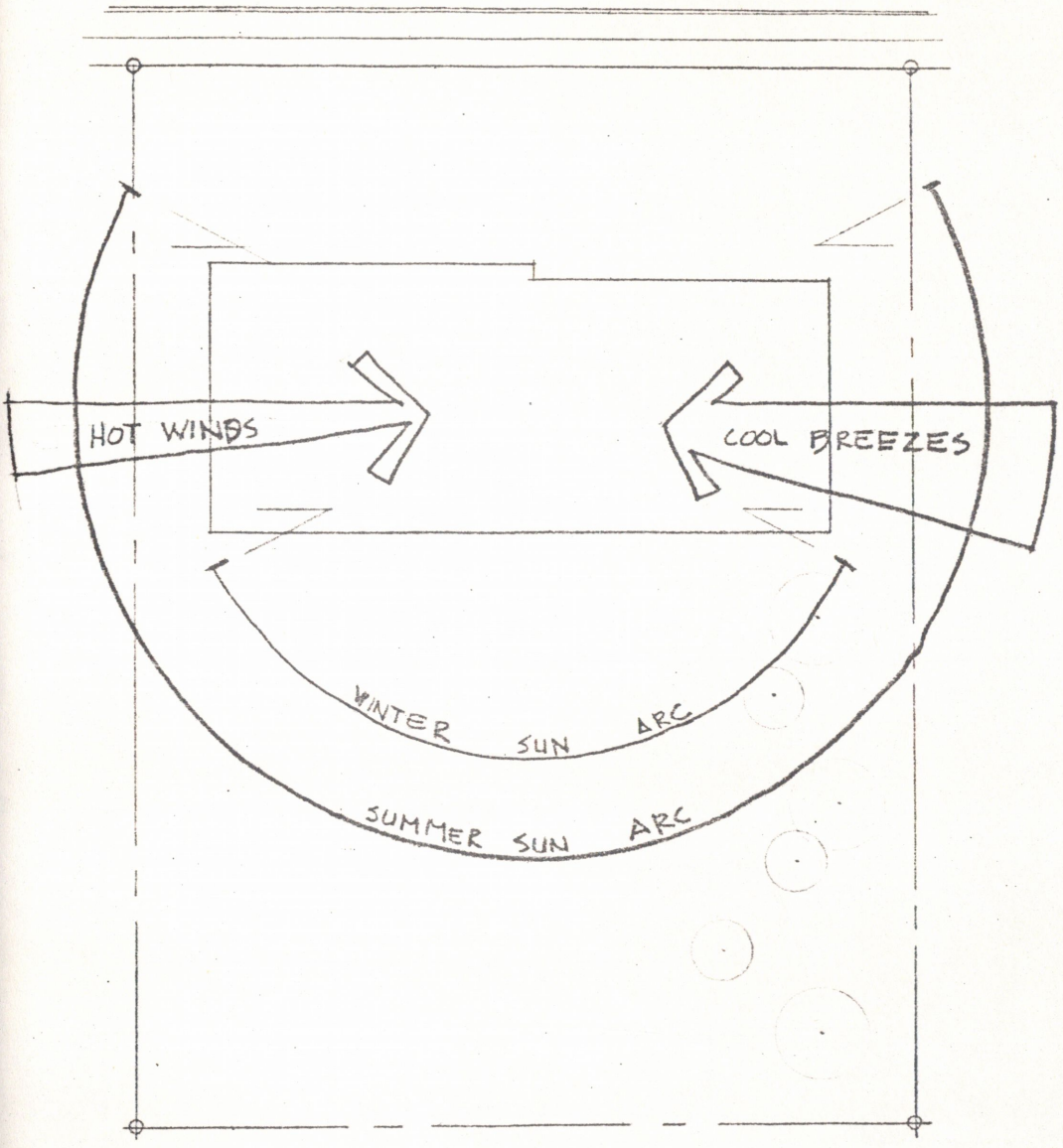
CONTROL AREA	MECHANISM	FUNCTIONAL BASIS
	HEAT CONTROL	
AMBIENT HEAT	Vented or lost through walls	
INTRODUCED HEAT	Gas furnace	
INSULATION: THERMAL	3½" fiberglass batt	
	AIR MOVEMENT	
VENTILATION	Open windows or use of heat pump devices	
	MATERIALS-STRUCTURE	
ABSORBTION-REFLECTION	Largely reflective color, all walls treated identically	
GENERAL SHAPE	Rectangle	
	SITE CONSIDERATIONS	
GENERAL	No consideration given to wind or sun, principle emphasis on orientation given to street location	
	OTHER	
PHOENIZ AREA	In general, the spec house fails to protect the inhabitants from solar gain, and fails to make use of the daily fluctuations of temperature. Minimal consideration given to exterior spaces	
MINNEAPOLIS AREA	In general, the spec house fails to protect the inhabitants from seasonal extremes in external temperature. Little use of exterior space planned for	



FIREPLACE DET.

NO SCALE

FIGURE 35



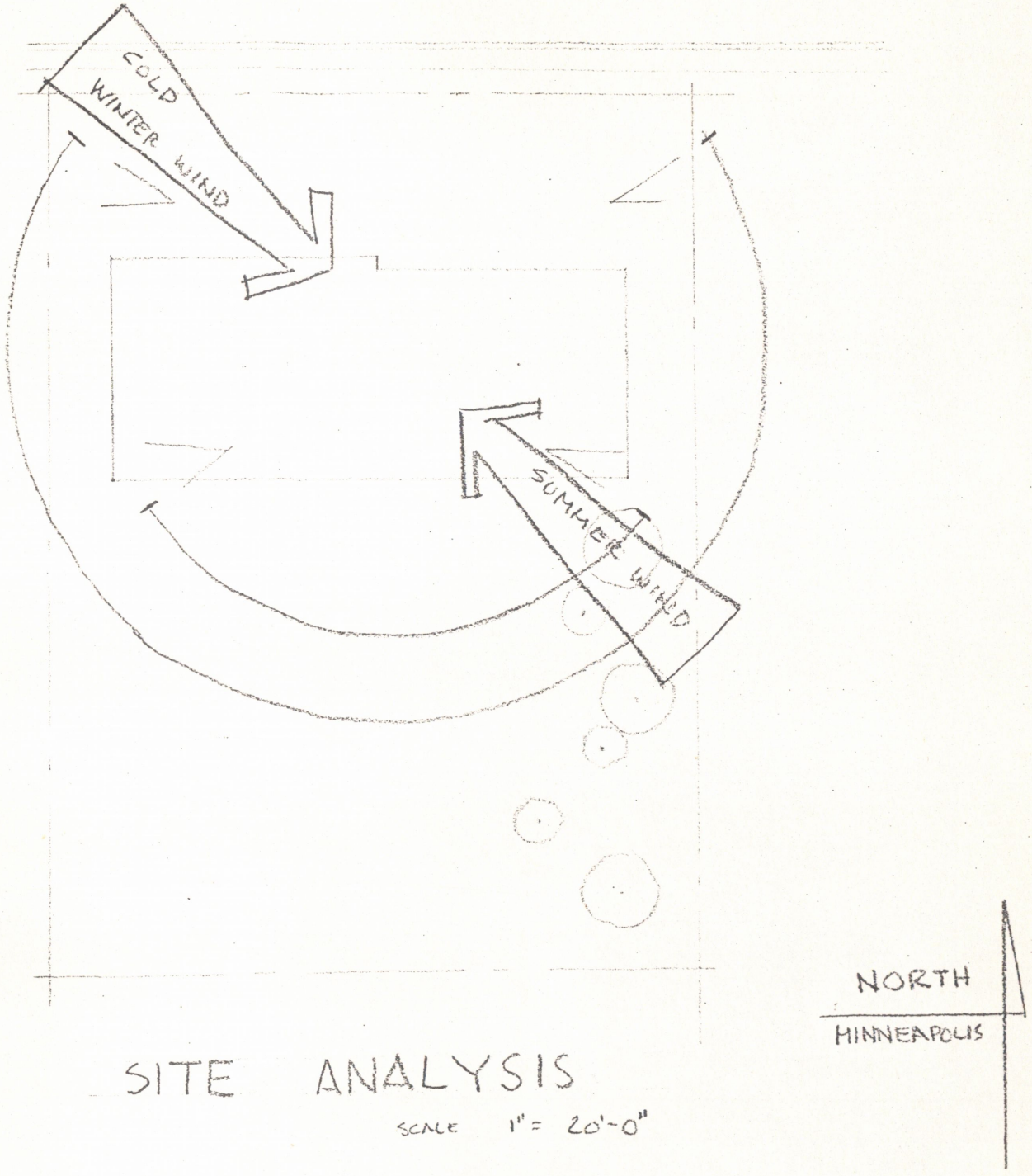
NORTH

PHOENIX

SITE ANALYSIS

SCALE 1" = 20'-0"

FIGURE 36



SITE ANALYSIS

SCALE 1" = 20'-0"

FIGURE 37

PART 6

CHAPTER 8

Apart from the employment of primitive mechanisms to counter climate discomforts, the final criteria of success for any structure is the fundamental success of the architecture of the building. The building is not only a shell acting independently to the climate control mechanisms, it is an integral part of all protective and comfort maintaining elements.

As shown in Chapter 4, primitive design mechanisms are for the most part applicable to contemporary situations. The successful grouping and use of the mechanisms will yield a habitation fine tuned for its climate.

My initial attemps to develop solutions for the chosen climates, although employing primitive mechanisms and principles, failed for lack of successful architectural foundation. The mechanisms themselves operated, but without architecture as a unifying element, the project failed to provide the high degree of protection that was possible.

Because of the social and cultural differences between our contemporary situation and primitive peoples, certain adjustments have to be planned for in the incorporation of primitive elements into contemporary situations.

Our society, for example, does not allow for the body exposure evident in Eskimo daily life. We have a much warmer temperature standard than do the Eskimo, and at the same time, a much cooler standard than African desert peoples. Instead of dressing for external conditions, or accepting wide deviations in comfort conditions, we place the task of climate control almost entirely on our buildings. Because of this demand, and other problems of our contemporary situation, primitive mechanisms are not always effective enough to meet our demands. In particular, because of water restrictions in the Arid South West, primitive mechanisms of using water for humidity control, such as large pools of water or exposed running water cannot be utilized.

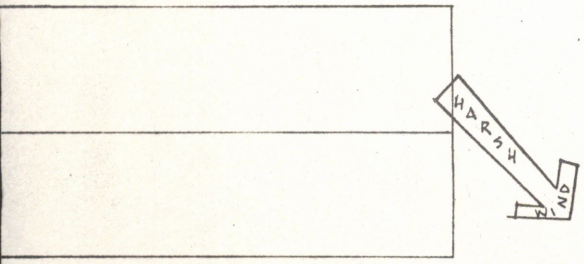
Because of this fact, other humidifying techniques have to be used. Therefore, the implementation of primitive principles must be accompanied by many restrictions, alterations, and intensification of comfort levels, brought about by the accepted norms and increased restrictions of our contemporary situation.

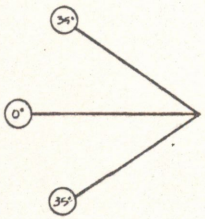
The success of this design is in providing a space where the family can interact to form stronger bonds of family unity.

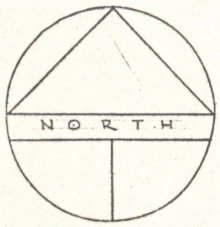
QUAIL St.

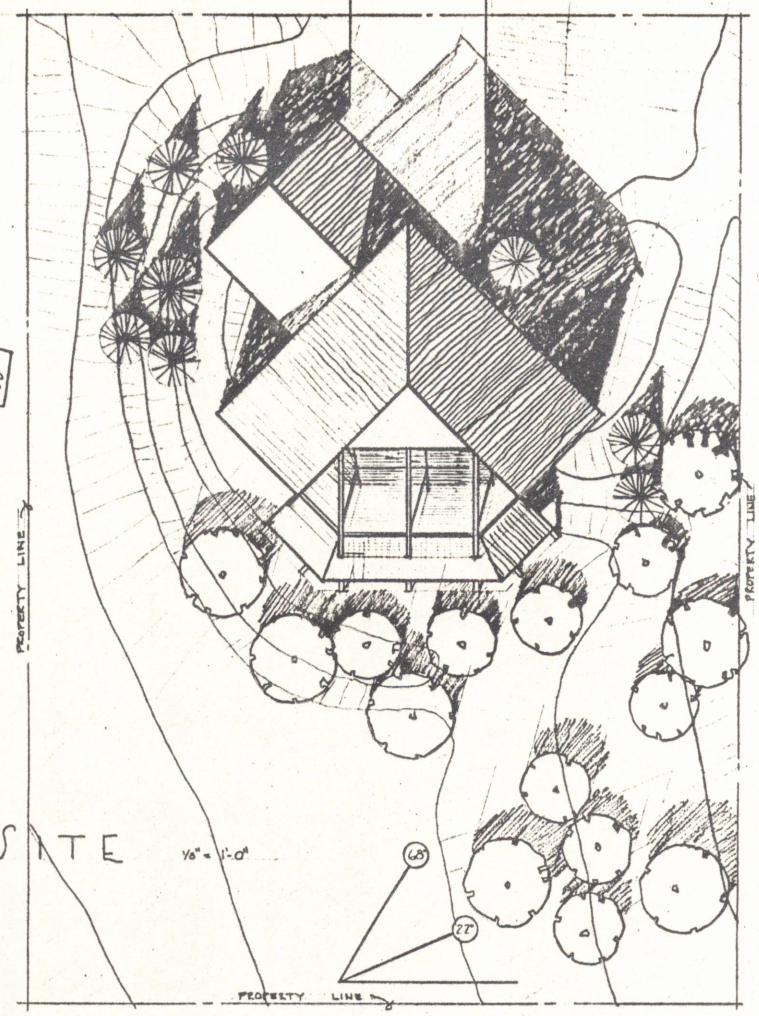
MINN.

1

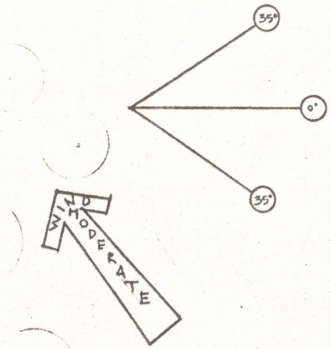






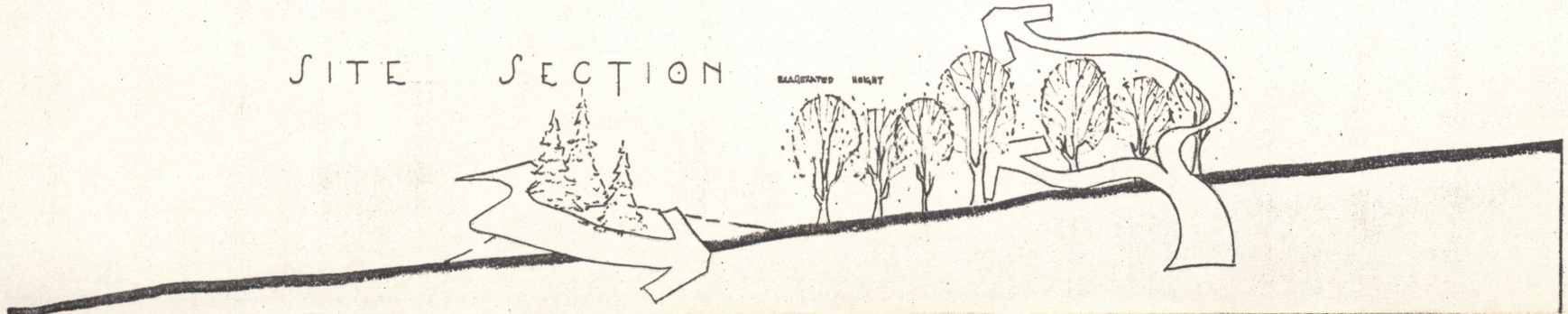


SITE 1/8" = 1'-0"

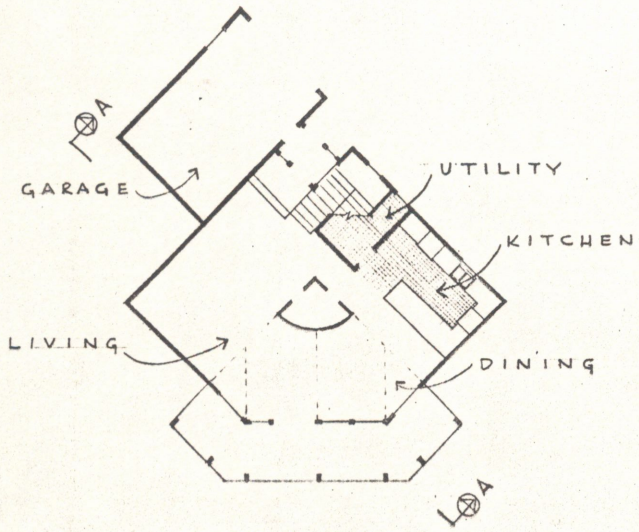


SITE SECTION

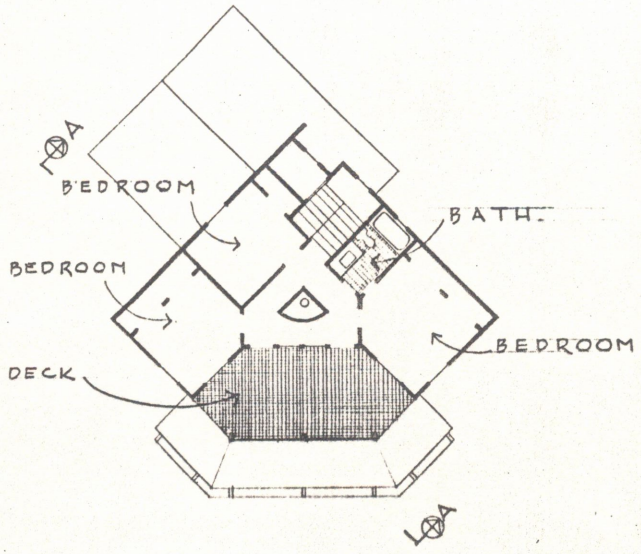
EXAGGERATED HEIGHT



MINN.
2

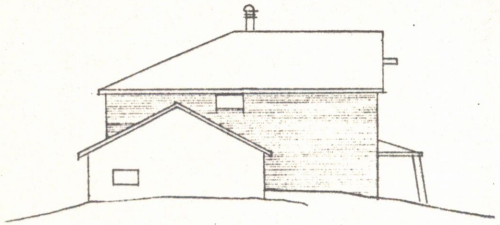


MAIN FLOOR PLAN

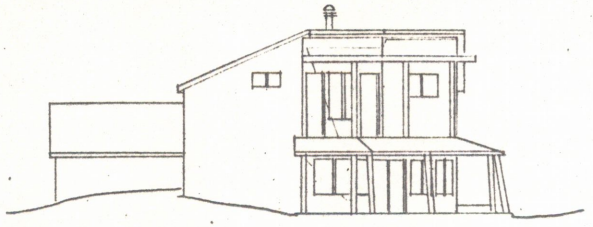


SECOND FLOOR PLAN

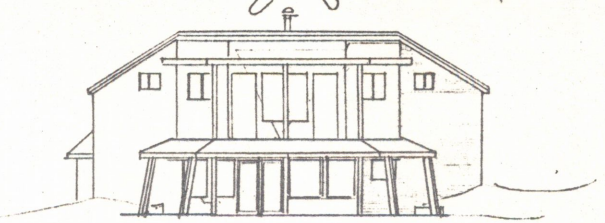
MINN.
3



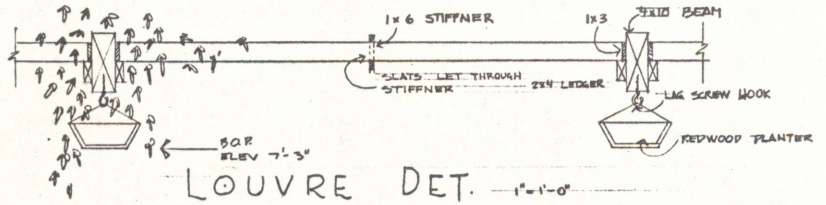
NORTHWEST



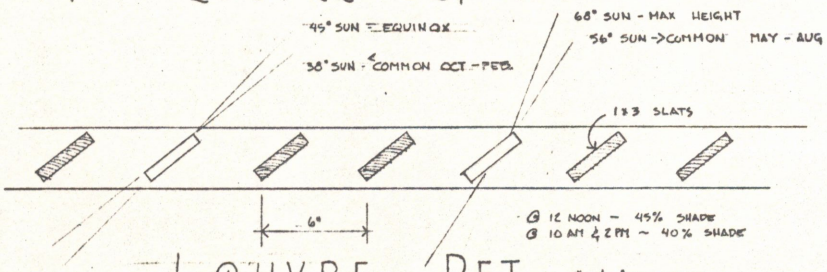
SOUTHWEST



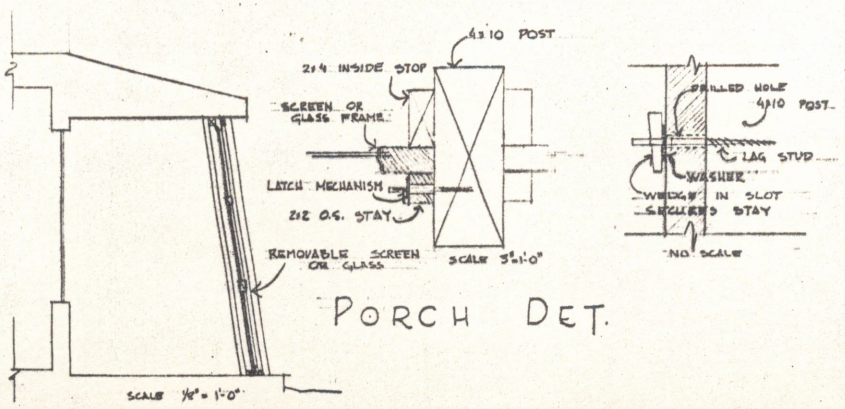
SOUTH



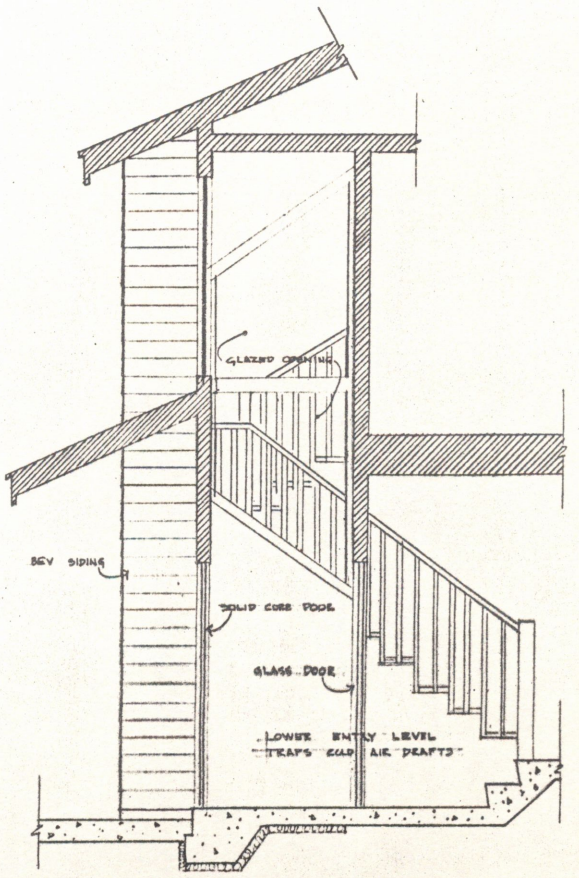
LOUVRE DET. 1"=1'-0"



LOUVRE DET. 3"=1'-0"



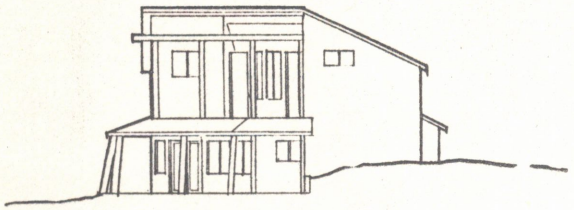
PORCH DET.



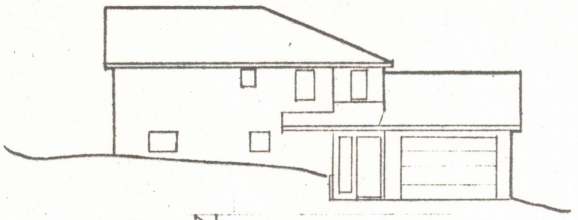
ENTRY DET. 1/2" = 1'-0"

MINN.

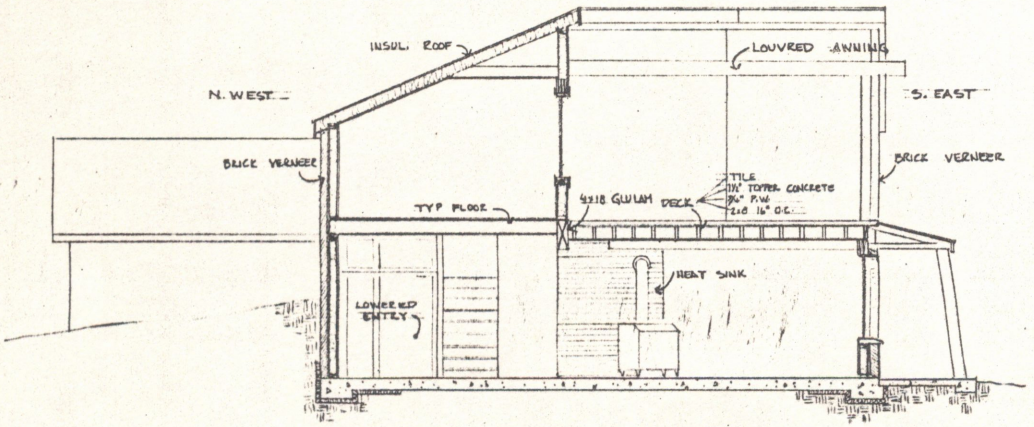
4



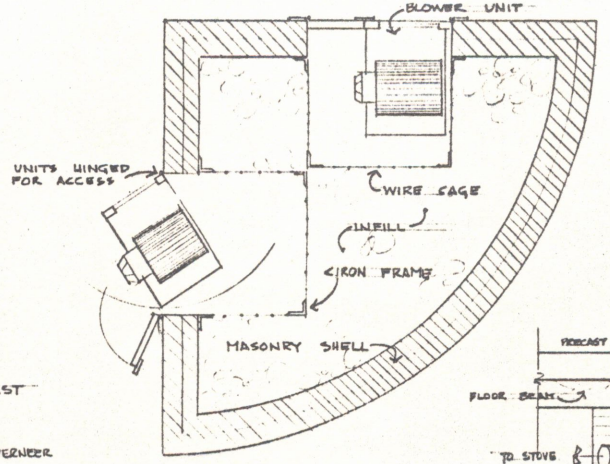
SOUTHEAST



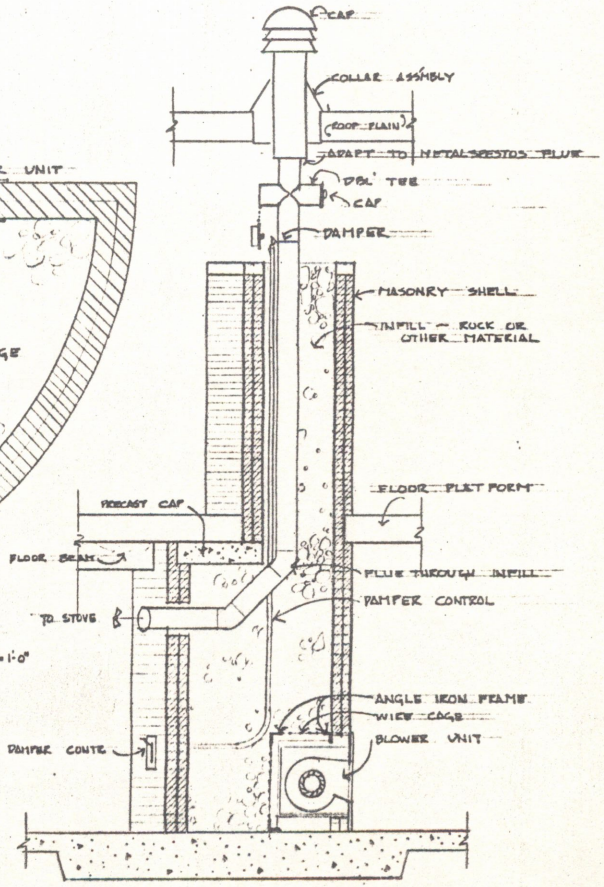
NORTHEAST



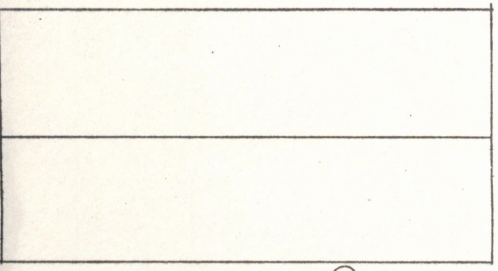
SECTION A-A 1/4"=1'-0"

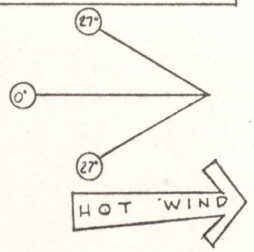


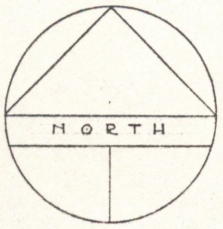
HEAT SINK DET. 1"=1'-0"

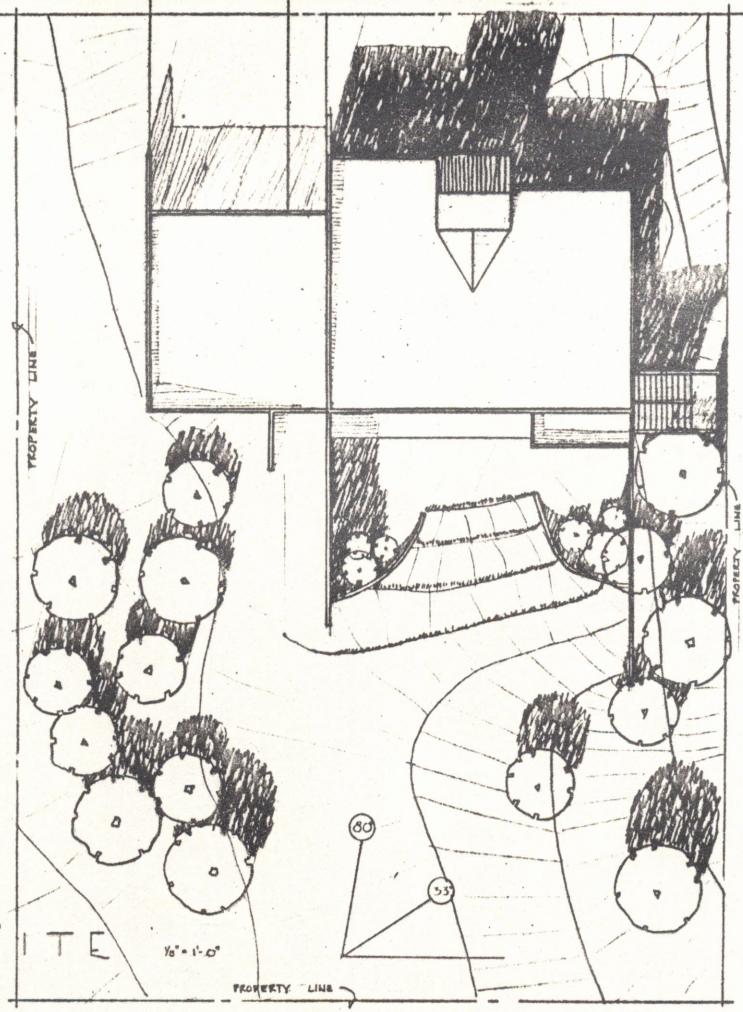


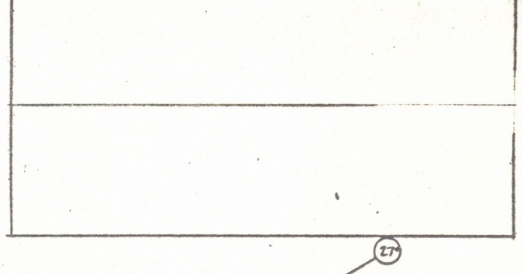
HEAT SINK DET. 1/2" = 1'-0"

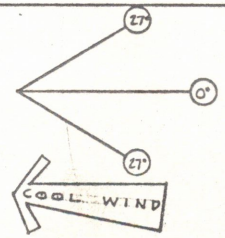


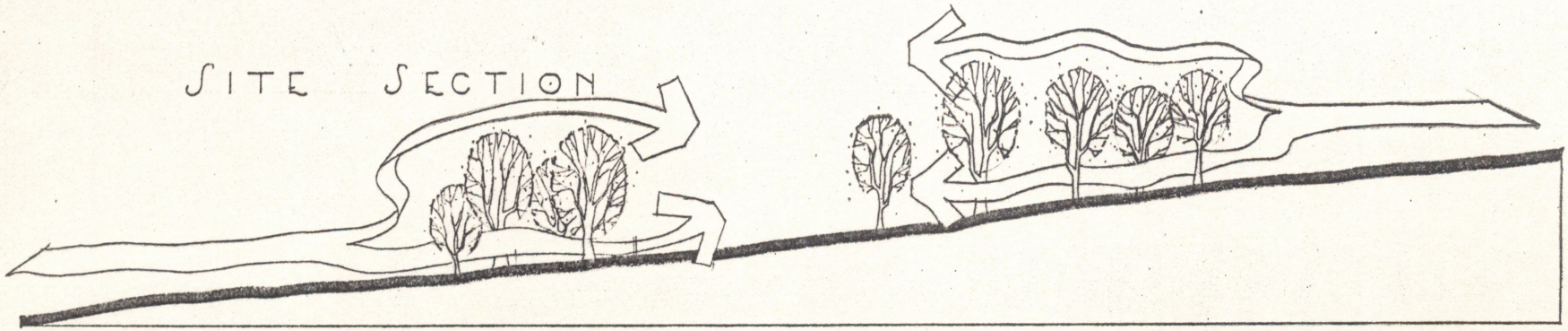

27°
0°
27°
HOT WIND

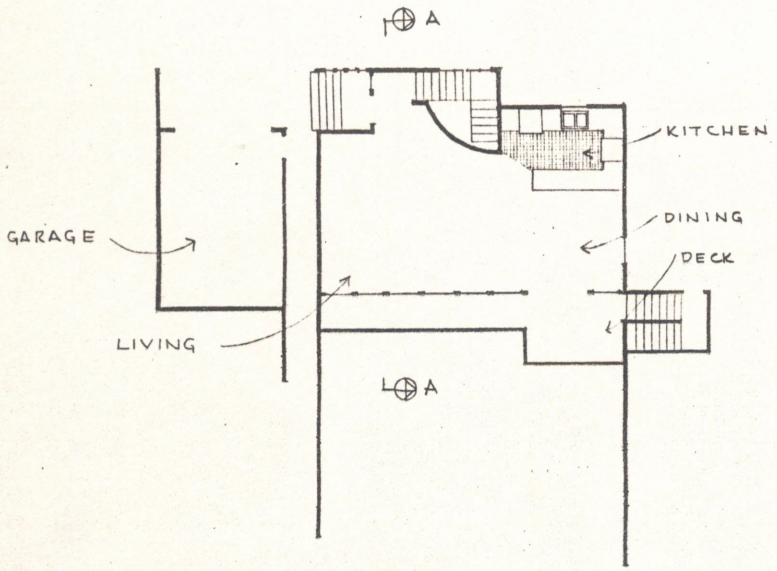

NORTH


PROPERTY LINE
PROPERTY LINE
80
55
SITE
1/8" = 1'-0"
PROPERTY LINE

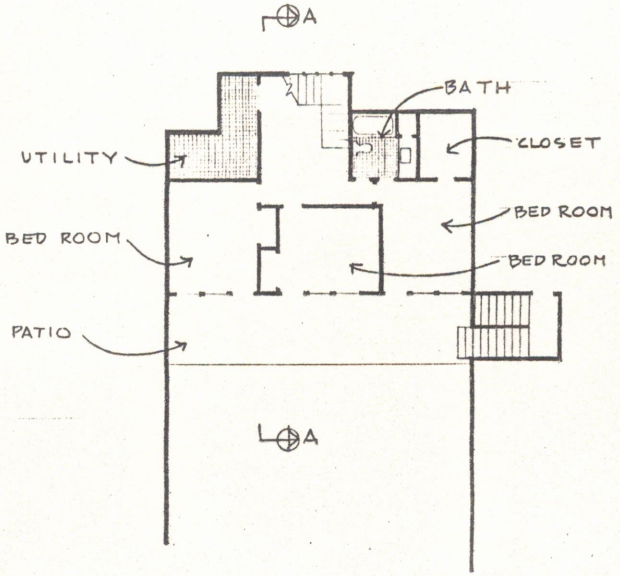



27°
0°
27°
COOL WIND


SITE SECTION



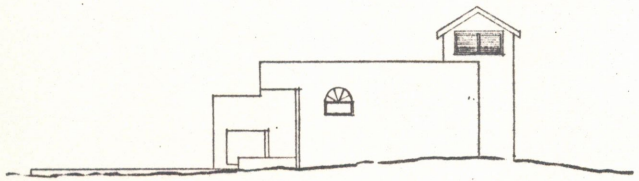
MAIN FLOOR PLAN



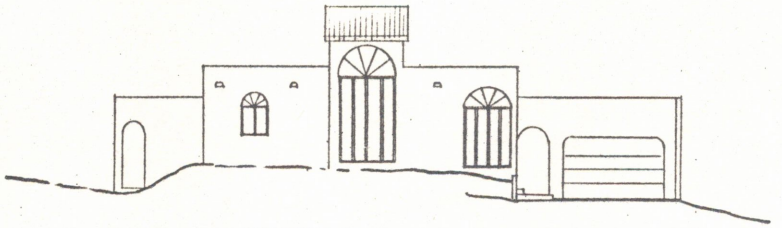
LOWER FLOOR PLAN

ARIZ.

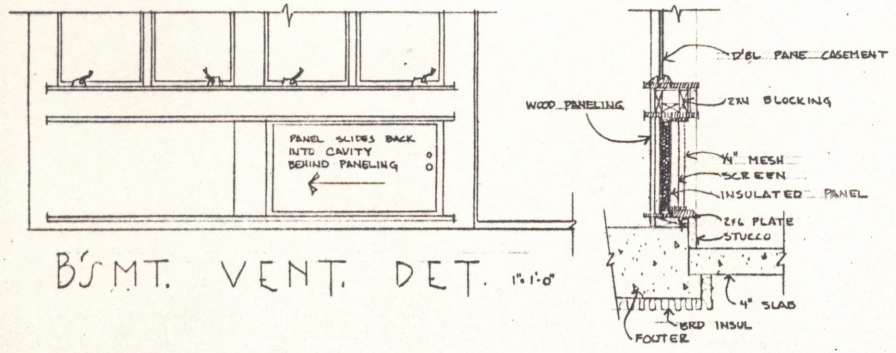
3



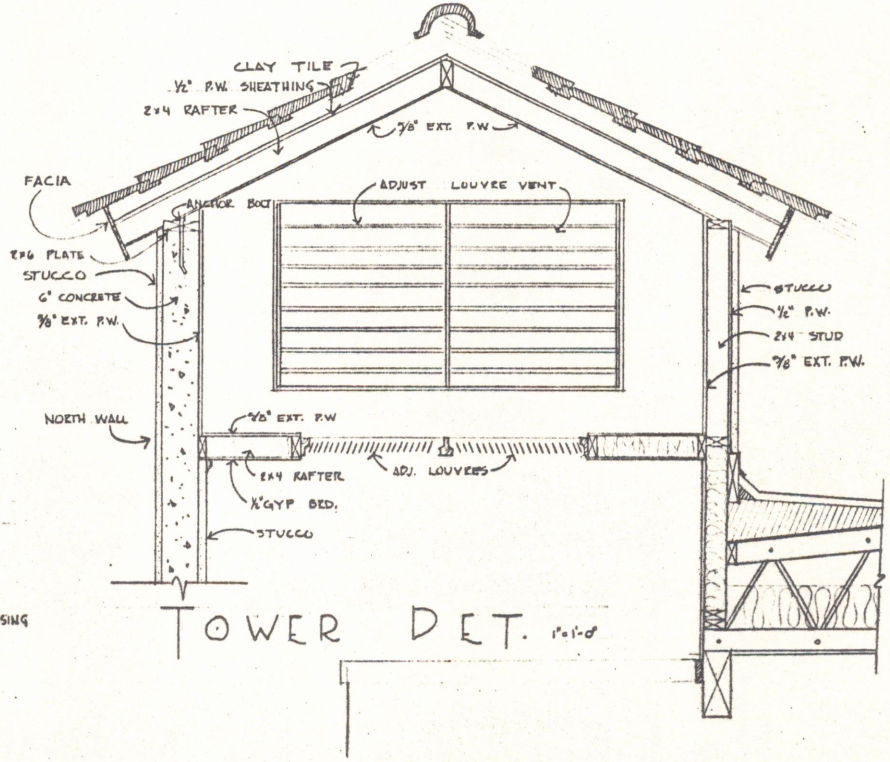
EAST



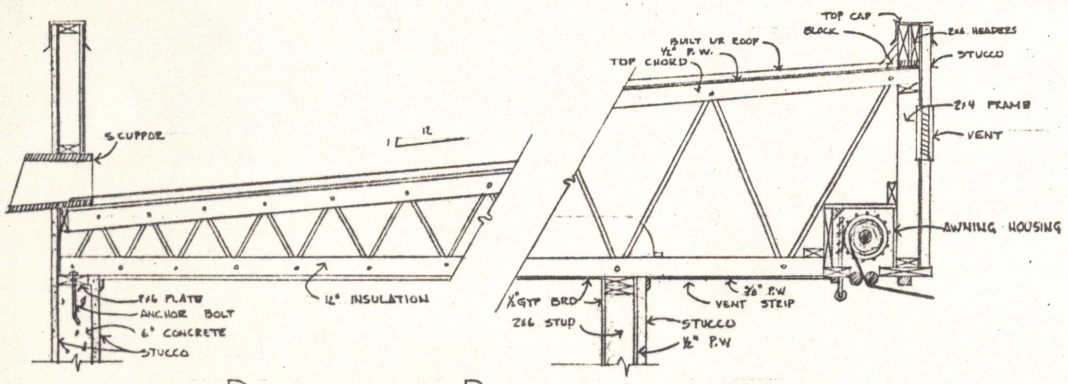
NORTH



B'S MT. VENT. DET. 1"=1'-0"

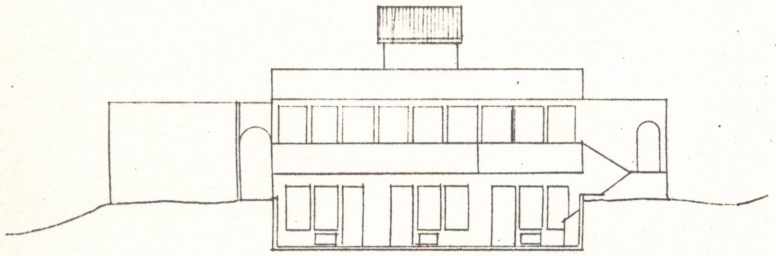


TOWER DET. 1"=1'-0"

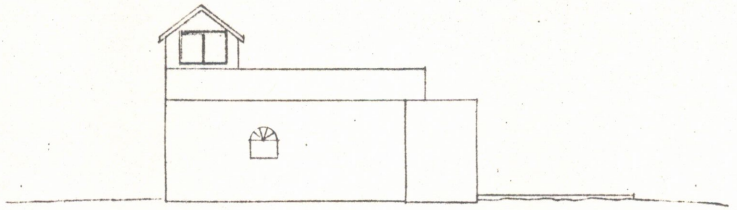


ROOF DET. 1"=1'-0"

ARIZ.
4

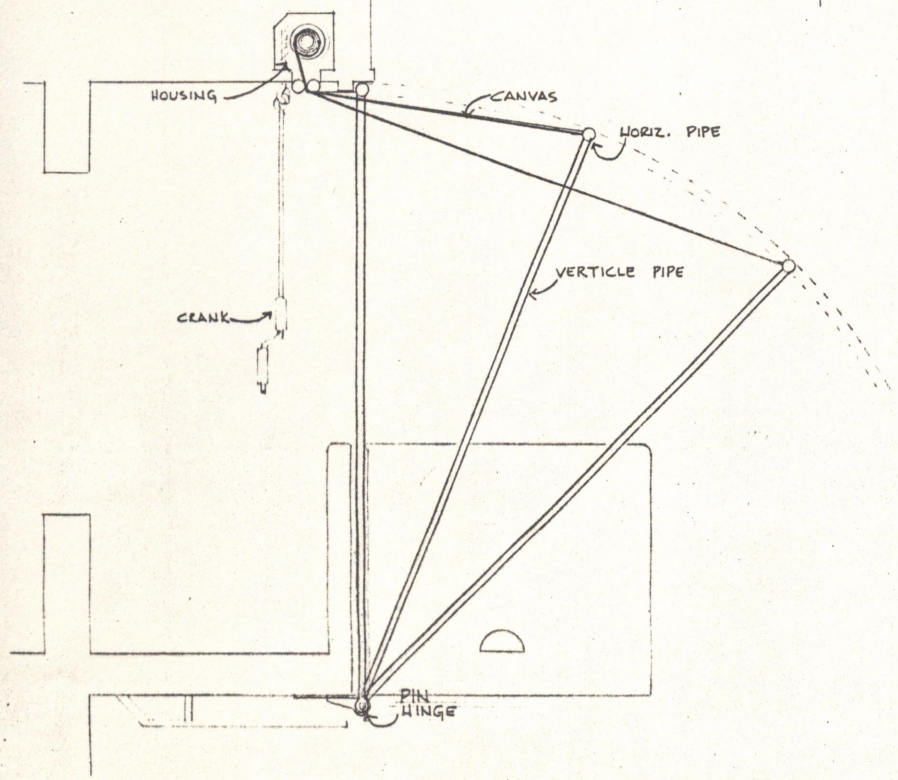


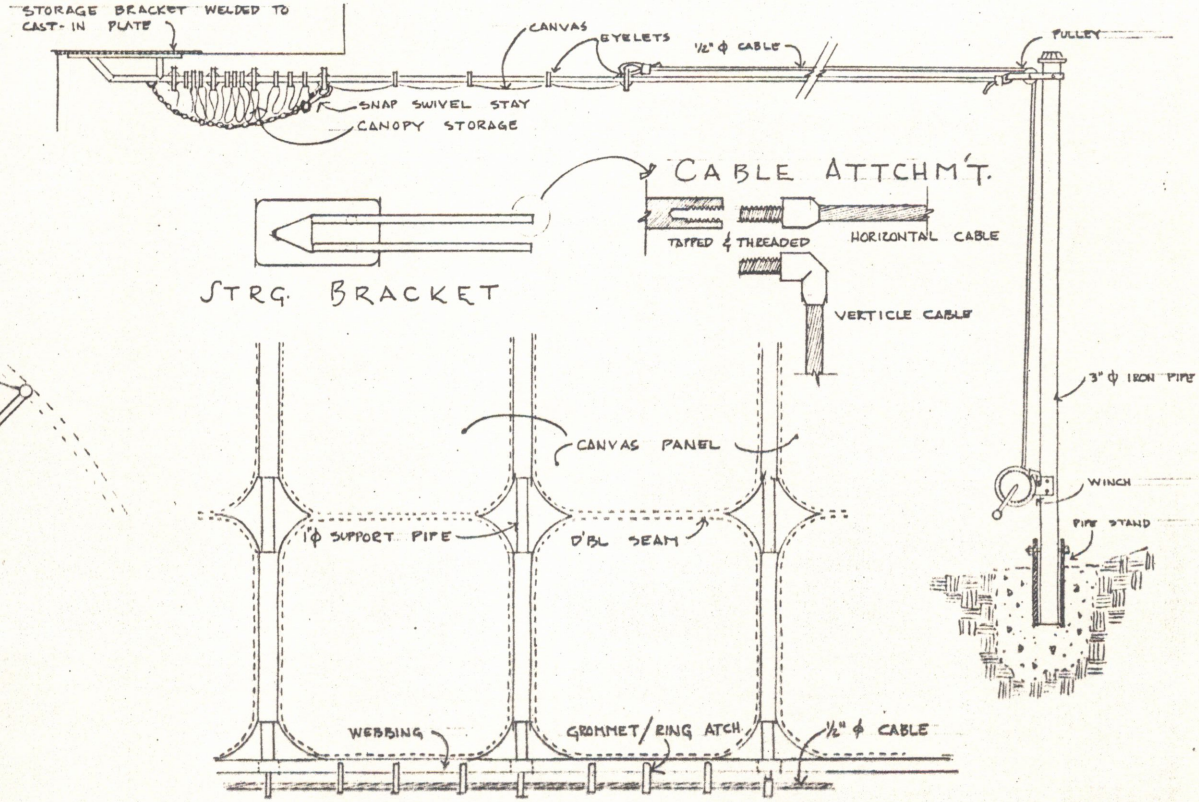
SOUTH



WEST

AWNING DET.

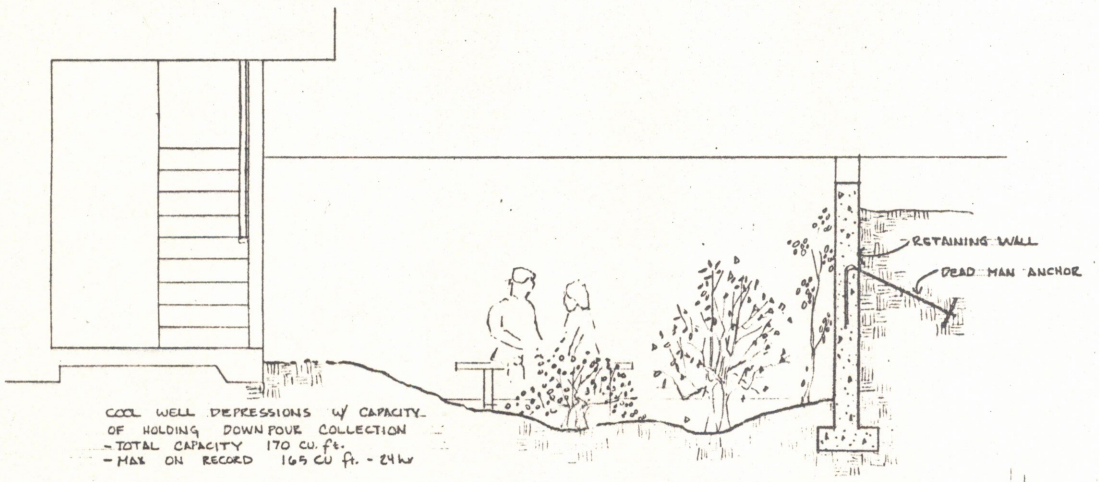




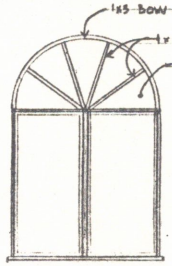
CANOPY DET.

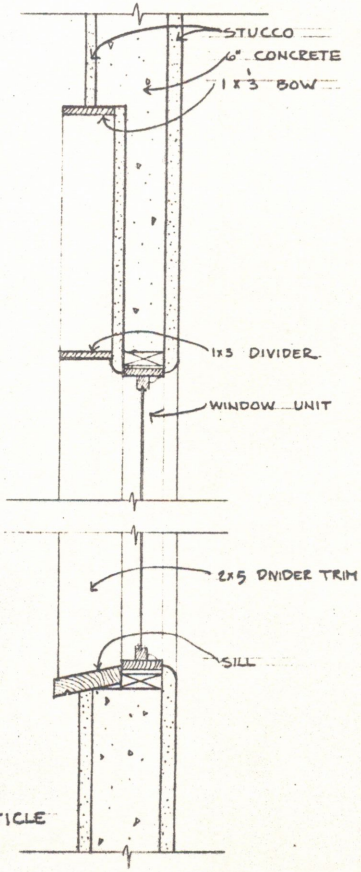
ARIZ.

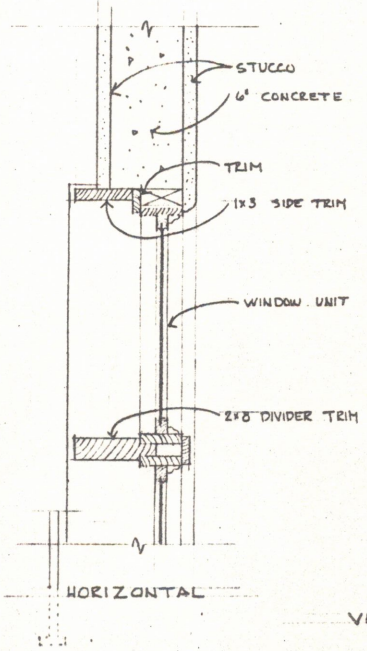
5

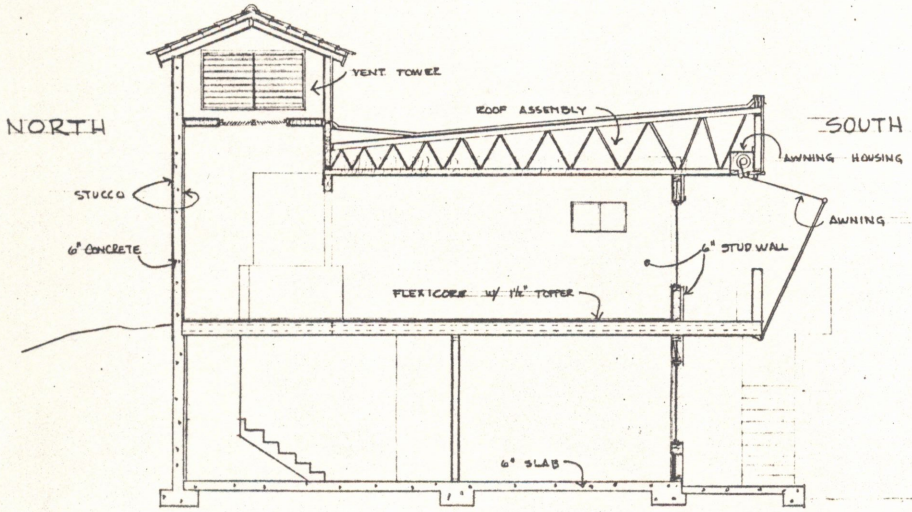


DEPRESSION DET.









SECTION A-A

NE WALL WINDOW DET.

S U M M A R Y

Our energy future is dependent on the wise use of our resources. The contemporary practice of selling residence designs to potenial builders without regard to climate, site, orientation, or client usage should be of great concern not only to the inhabitants of those residences, but to all of us who are greatly effected by the high volume energy requirements of these unplanned buildings.

I feel that the necessity of dealing with climatical elements is paramount in architecture. Architects should not only be acutely aware of primitive principles and practices, but should be able to incorporate them into design, and be able to alter and accent them with modern materials and technology.

FOOTNOTES

PART 1, CHAPTER 1

1. O.G. Edholm and A.L. Bacharach, eds., THE PHYSIOLOGY OF HUMAN SURVIVAL, New York: Academic Press, 1965, p. 212.

2. O.G. Edholm and A.L. Bacharach, eds., op. cit., p. 215.

3. O.G. Edholm and A.L. Bacharach, eds., op. cit., p. 216.

4. American Society of Heating Refrigerating and Air Conditioning Engineers, Inc., ASHRAE HANDBOOK OF FUNDAMENTALS, New York, New York, 1972, p. 132.

5. Ibid.

6. O.G. Edholm and A.L. Bacharach, eds., op. cit., p. 86.

7. O.G. Edholm and A.L. Bacharach, eds., op. cit., pgs. 122-123.

8. O.G. Edholm and A.L. Bacharach, eds, op. cit., p. 124.

9. O.G. Edholm and A.L. Bacharach, eds., op. cit., p. 123.

10. O.G. Edholm and A.L. Bacharach, eds., op. cit., p. 83.

11. Gifford H. Albright, ed., PLANNING ATOMIC SHELTERS: A GUIDEBOOK FOR ARCHITECTS AND ENGINEERS, Pennsylvania State University Press, 1961, pgs. 27-28.

12. O.G. Edholm and A.L. Bacharach, eds., op. cit., p. 114.

13. Ibid.

14. M.I. Bossley, PRIVACY AND CROWDING: A MULTIDISCIPLINARY ANALYSIS, Man-Environment Systems, Vol. 6, No. 1, pg. 14.

CHAPTER 2

15. I. Norman Smith, ed., THE UNBELIEVABLE LAND, Queens Printer for the Department of Northern Affairs and National Resources and the Northern Service of the Canadian Broadcasting Corp., 1974, p. 14.

16. Burgess H. Jennings, ENVIRONMENTAL ENGINEERING ANALYSIS AND PRACTICE, Scranton, Pennsylvania: International Textbook Co., 1970, p. 121.

17. Ibid.

18. Fredrick H. Rohles, Jr., "The Modular Comfort Envelope and Its Use In Current Standards", HUMAN FACTORS, Williges, Robert C., ed., Baltimore, Maryland: The John Hopkins University Press, 1974, p. 320.

B I B L I O G R A P H Y

Albright, Gifford H., ed., PLANNING ATOMIC SHELTERS: A GUIDE-BOOK FOR ARCHITECTS AND ENGINEERS, Pennsylvania State University Press, 1961.

Altman, Irwin, THE ENVIRONMENT AND SOCIAL BEHAVIOR, Monterey, CA: Brooks/Cole Publishing Co., 1975.

American Society of Heating Refrigerating and Air Conditioning Engineers, Inc., ASHRAE HANDBOOK OF FUNDAMENTALS, New York, New York, 1972.

Angus, T.C., THE CONTROL OF INDOOR CLIMATE, Oxford, England: Pergamon Press, 1968.

Arthur, Don R., MAN AND HIS ENVIRONMENT, New York, N.Y.: American El sevier Publishing Co., Inc., 1969.

Ashcraft, Norman and Scheflen, Albert, PEOPLE SPACE, Garden City, New York: Anchor Books, 1976.

BEST HOME PLANS, New York, N.Y.: Archway Press, Inc., 1977.

Birket-Smith, Kaj, PRIMITIVE MAN AND HIS WAYS, New York, N.Y.: New American Library of World Literature, Inc., 1960-1963.

Bossley, M.I., PRIVACY AND CROWDING: A MULTIDISCIPLINARY ANALYSIS, Man-Environment systems, Vol. 6, No. 1, pg. 8-19.

Boucher, Keith, GLOBAL CLIMATE, New York: Halsted Press, 1975.

Brunt, Sir David, Some Aspects of Human Ecology in Hot Tropical Regions, BIOLOGY OF DESERTS, Cloudsley, Thompson, ed., New York: Hafner Pub. Co., 1954, pg. 213.

Cain, Allan, Afshar, Farroukh and Hohn, Norton, INDIGENOUS BUILDING AND THE THIRD WORLD, A.D. (Architectural Design), April, 1975.

Carpenter, Frank G., LANDES OF THE ANDES AND THE DESERT, Garden City, N.Y.: Doubleday, Page and Co., 1926.

Central Air Conditioning Department General Electric, PSYCHROMETRIC CHART, Louisville, Kentucky.

Chute, Robert M., ENVIRONMENTAL INSIGHT, New York, N.Y.: Harper and Row, Publishers, 1971.

Denyer, Susan, AFRICAN TRADITIONAL ARCHITECTURE, New York: Africana Publishing Co., 1978.

Edholm, O.G., Physiological Effects of Cold Environments on Man, BIOLOGY OF DESERTS, Cloudsley-Thompson, eds., New York: Hafner Pub. Co., 1954, pgs. 207-212.

Edholm, O.G. and Bacharach, A.L., eds., THE PHYSIOLOGY OF HUMAN SURVIVAL, New York: Academic Press, 1965.

Environmental Protection Agency, ALTERNATIVE FUTURES AND ENVIRONMENTAL QUALITY, Office of Research and Development, Washington Environmental Research Center, Environmental Studies Division, May, 1973.

Esser, Aristide H., MAN ENVIRONMENT SYSTEMS, Orangeburg, N.Y.: Asmer, Inc., 1977.

Evans, Lewey, BUILDING DESIGN AND CONSTRUCTION FOR SUB ARCTIC CONDITIONS IN THE USA, Paper submitted to Board of Engineers and Architects Examiners, State of Alaska, 1970.

Franger, P.O., THERMAL COMFORT, Copenhagen: Danish Technical Press, 1970.

Flaherty, Bernard E., ed., SYMPOSIUM ON PSYCHOPHYSIOLOGICAL ASPECTS OF SPACE FLIGHT, New York: Columbia Press, 1961.

Freeman, Jonathan L., CROWDING AND BEHAVIOR, San Francisco, CA: Jonathan L. Freedman and Co., 1975.

Fuchs, Robert A., EXPERIMENTERS DESIGN HANDBOOK FOR THE MANNED LUNAR SURFACE PROGRAM, Hughs Aircraft Co., 1967.

Guidoni, Enrico, PRIMITIVE ARCHITECTURE, New York: Harry N. Abrams, Inc., 1975.

Handler, Philip, ed., BIOLOGY AND THE FUTURE OF MAN, New York: Oxford University Press, Inc., 1970.

Jennings, Burgess H., ENVIRONMENTAL ENGINEERING ANALYSIS AND PRACTICE, Scranton, Pennsylvania: International Textbook Co., 1970.

Kammermeyer, Karl, ed., ATMOSPHERE IN SPACE CABINS AND CLOSED ENVIRONMENTS, New York: Appleton, Century, Crofts, 1966.

Knott, Albert, DESIGNING SHELTER IN NEW BUILDINGS, Pennsylvania State University Press, March 1967.

Lee, Douglas H.K., PHYSIOLOGICAL OBJECTIVES IN HOT WEATHER HOUSING, Washington, D.C.: United States Housing and Home Finance Agency, June 1953.

Leopold, A. Starker, THE DESERT, New York: Time Incorporated, 1962.

Levi, Lennart and Anderson, Lars, PSYCHOSOCIAL STRESS: POPULATION ENVIRONMENT AND QUALITY OF LIFE, New York: Spectrum Publications, Inc., 1975.

Lovins, Amory, THE PLOWBOY INTERVIEW, Hendersonville, North Carolina: The Mother Earth News, Nov./Dec. 1977.

Maholy-Nagy, Dibyl, NATIVE GENIUS IN ANONYMOUS ARCHITECTURE, New York: Horizon Press, Inc., 1957.

McGuinness, William J. and Stein, Benjamin, MECHANICAL AND ELECTRICAL EQUIPMENT FOR BUILDINGS, New York, N.Y.: John Wiley and Sons, Inc., 1964.

Nogami, Glenda Y., "Crowding: Effects of Group Size, Room Size, or Density?", JOURNAL OF APPLIED SOCIAL PSYCHOLOGY, 1976, Vol, 6, No. 2, pp. 105-125.

Olgyay, Victor, DESIGN WITH CLIMATE, Princeton,New Jersey: Princeton University Press, 1973.

Rapoport, Amos, HOUSE FORM AND CULTURE, Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1969.

Rohles, Fredrick H., Jr., "The Modular Comfort Envelope and Its Use in Current Standards", HUMAN FACTORS, Williges, Robert C., ed., Baltimore, Maryland: The John Hopkins University Press, 1974, pgs. 314-322.

Smith, I. Norman, ed., THE UNBELIEVABLE LAND, Queens Printer for the Department of Northern Affairs and National Resources and the Northern Service of the Canadian Broadcasting Corp., 1974.

Sommer, Robert, PERSONAL SPACE, Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1974.

Sommer, Robert, TIGHT SPACES, Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1974.

Space Science Board, National Academy of Sciences, National Research Council, HUMAN FACTORS IN LONG DURATION SPACE-FLIGHT, Washington: National Academy of Sciences, 1972.

Trewartha, Glenn T., THE EARTHS PROBLEM CLIMATES, Madison, Wisconsin: The University of Wisconsin Press, 1961.

Up De Graff, F.W., HEADHUNTERS OF THE AMAZON, Garden City, N.Y.: Garden City Publishing Co., 1923.

Weiner, J.S., "Human Adaptability to Hot Conditions of Deserts", BIOLOGY OF DESERTS, Cloudsley-Thompson, ed., New York: Hafner Pub. Co., 1954, pgs. 207-212.

Weyer, Edward Jr., PRIMITIVE PEOPLES TODAY, Garden City, New York: Doubleday and Co., Inc., 1962.

MONTANA STATE UNIVERSITY LIBRARIES
stks 720.6.M76M451
Climatical design concepts of primitives
CA
3 1762 00158177 4

[redacted]40
~~720.6~~
~~M76~~
M451