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Date 6/17/81

FLIGHT RESORT / HANG GLIDING SCHOOL FOR PARADISE VALLEY, MONTANA

by

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A professional paper submitted in partial fulfillment
of the requirements for the degree
of
BACHELOR OF ARCHITECTURE

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STATEMENT

THE DESIRE AND ABILITY TO FLY ON THE SIMPLE FORCES OF NATURE MAKE HANG GLIDING AN ULTIMATE EXPRESSION OF PERSONAL FREEDOM. A MAN-MADE FACILITY BUILT TO PROMOTE THIS SPORT SHOULD REFLECT THE SPIRIT OF HANG GLIDING BY USING THE SIMPLE FORCES OF NATURE TO CREATE A PASSIVE ENERGY-EFFICIENT ENVIRONMENT.

Gary Braun

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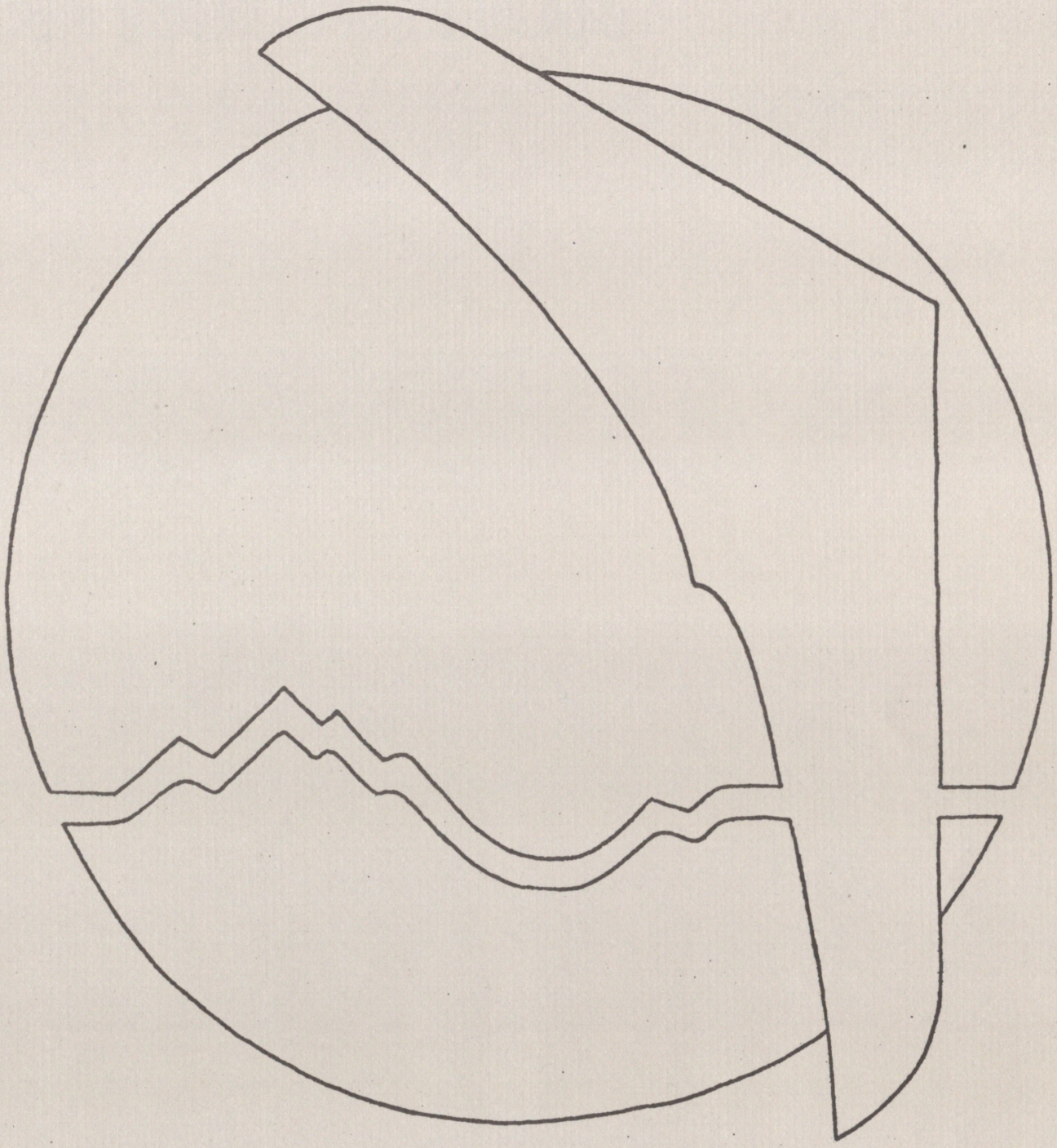
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INTRODUCTION

. . . there's a reason to life! We can lift ourselves out of ignorance, we can find ourselves as creatures of excellence and intelligence and skill. We can be free! We can learn to fly!

- JONATHON LIVINGSTON SEAGULL

The telephone had been ringing for quite sometime. Max Soarmore heard it and struggled to the surface of his deep sleep. He crawled over his wife, got out of bed and answered it.

"Thank you", he said and hung up.

His wife awoke from the commotion and couldn't seem to believe it was already morning. With her eyes half open she listened to Max as he bustled about the room getting dressed and organizing his equipment. It was only eight o'clock but Max wanted to eat some breakfast and have his glider on the first truck up to take off.

"Whats it like outside?" she asked in monotone.

"Beautiful!" Max replied.

The sky was clear and the sun was already beginning to heat up the south side of The Hogback in Paradise Valley. The view from the Soarmore's room was magnificent. Emigrant Peak to the south, Antelope Butte to the west, the Absaroka Range to the east and the Yellowstone River below. Max had his eyes glued to the windsock instead of the panorama.

"Are you going to watch some flying today?" Max asked enthusiastically.

"Maybe some beginners", she replied more awake now. "I get bored watching you and the other advanced pilots become specs in the sky. I think I'll go on the float trip scheduled this afternoon."

"Sounds great. If its not soarable, I'll join you and bring my fishing rod."

"Alright", she said agreeably and rearranged a pillow. "I'm going to skip breakfast and sleep in. Lets meet in the lounge at noon."

"Sure", he said while juggling his harness, helmet and jacket. "I'll see you then."

On the way to the restaurant, he reminisced on the events of the last couple days.

He first heard about Paradise Valley from his hang gliding friends in Minnesota. Max was tired of flying flatland hills located hundreds of miles from where he lived. Here in Paradise Valley he could stay right at a flying site and be within a few miles of some of the best sites in the country. His wife, who

doesn't fly, could enjoy the various outdoor activities the valley offers.

Reservations for a week were made and the dream became a reality when the wheels of the jet skidded to a landing in Bozeman, Montana. Their ride to Paradise Valley was waiting and before long they were headed toward the flight resort at The Hogback. Max anticipated an interesting week. In a few days a Regional Meet was scheduled. Some of the best pilots from Montana and nieghboring states were going to be there. He was looking forward to discussions about flying and inspecting the latest glider designs. Maybe he'd even get some helpful tips on how to improve his flying skills.

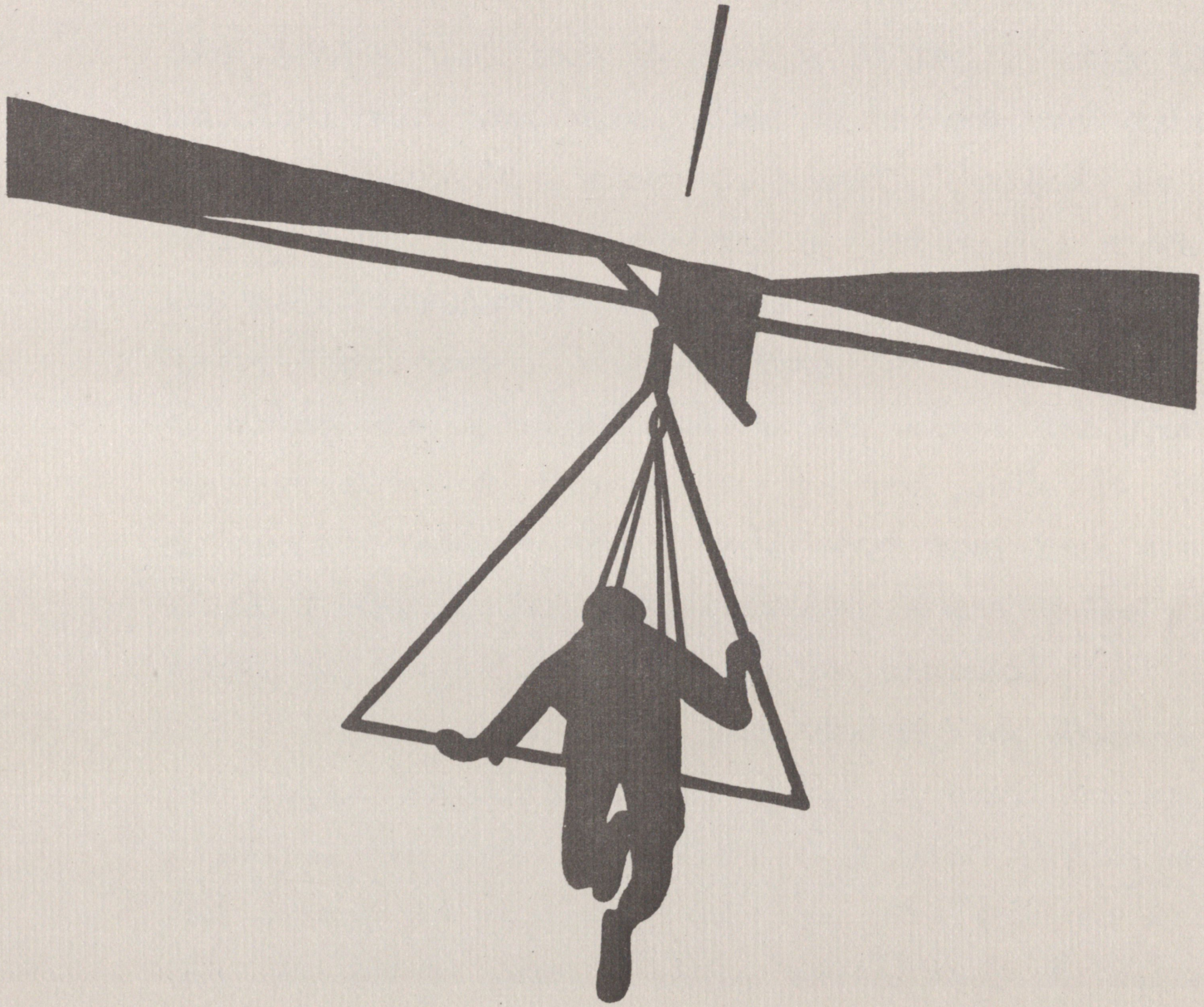
The day dream vanished as he approached the restaurant. A small group of local pilots were already gathered over coffee discussing the previous day of flying. Some of the pilots rubbed red eyes from last nights partying and swimming at Chico Hot Springs. Some had been to the weather service and were making predictions about the days potential flying conditions.

Max finished breakfast while other pilots, people,

and families wandered in. A drone of discussions and conversations about fishing, hiking, floating or horseback riding filled the atmosphere. After finding a few other ambitious pilots to join him, Max got his glider on the truck and helped load the other gliders. While bumping up the road to take off, a pilot reminded Max about the parachute seminar that was being held that evening. Max made a point of it to attend.

At take off, he could see the instructors below on the lower part of the slope setting up training kites and getting students ready for lessons. The wind was light, perfect for a short practice flight to start the day off. Soon the take off area was cluttered with colorful sails and pilots with attitudes of anticipation.

Max and the other pilots are about to pursue a sensation man has dreamed about for centuries. A sport with a quality of experience completely unique, a personal satisfaction with intense exhilaration and timeless tranquillity. They are going to fly!



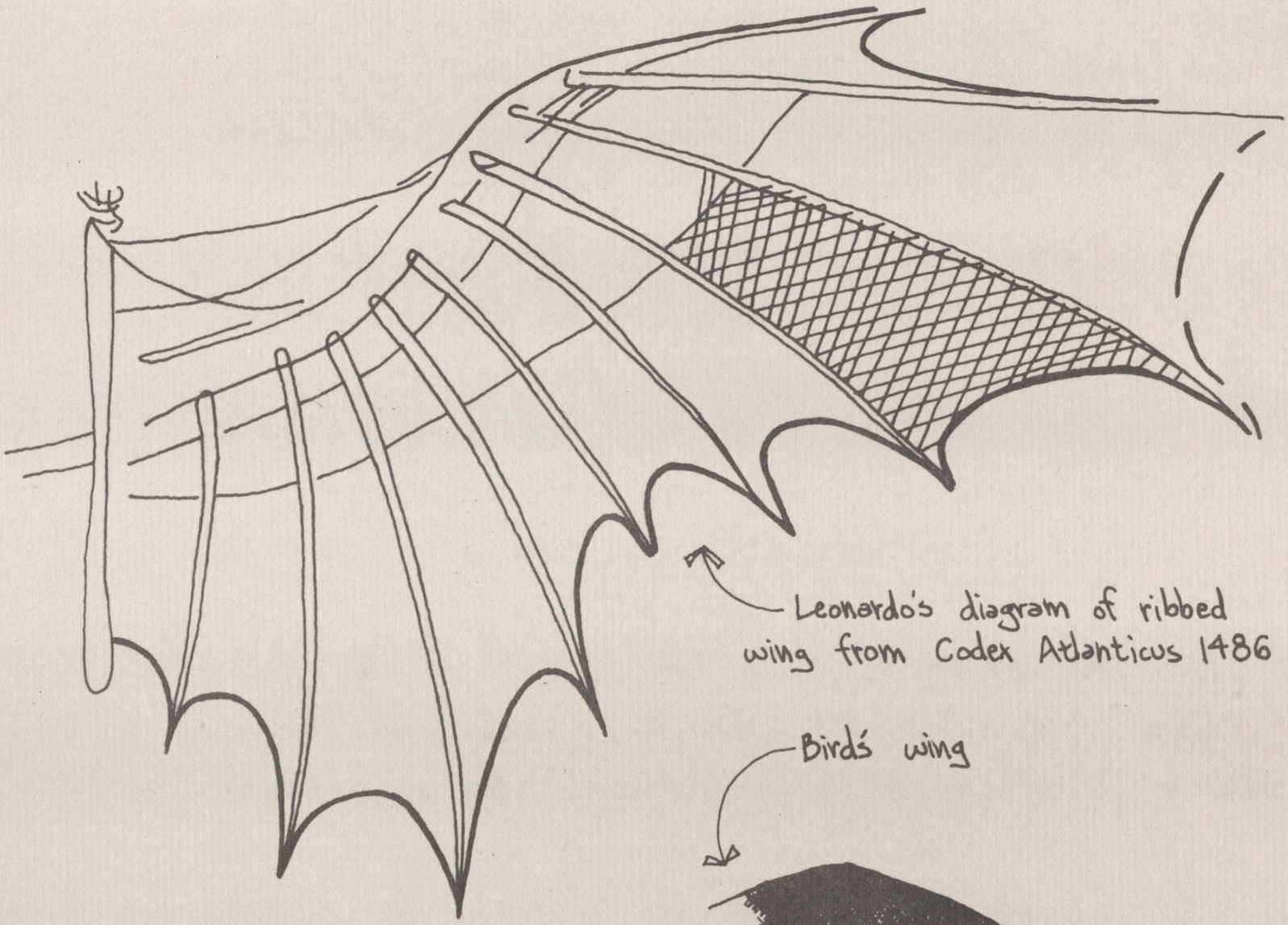
HISTORY OF HANG GLIDING

From dreaming of flying like a bird to a state of doing actually that took an evolution of time. In order to understand how hang gliding came to be, one must realize that it is as much a science as a sport[1]. Thoughout its history, there have been pioneers of aerodynamic research who made revolutionary discoveries to cheat the law of gravity. These pioneers became heroes to the participants of modern day ultralight aviation. For without the efforts and innovations of these people, the sport, with its state of the art technical level, would never have been contrived. A few of the most outstanding heroes in the history of hang gliding will now be introduced.

As early as 1486, Leonardo da Vinci observed the flight characteristics of birds. He based his applications on the direct observation of a birds flapping motion that caused its propulsion while the wing provided its lift. His designs were based on various kinds of mechanical

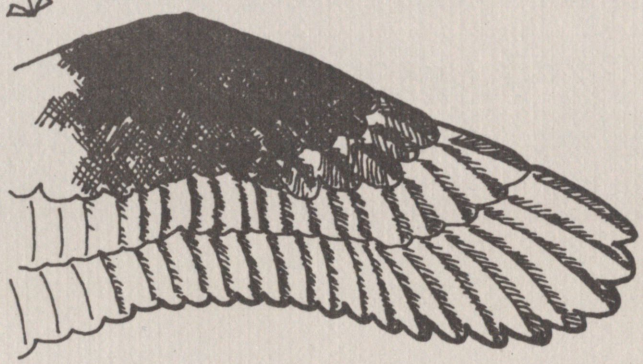
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[1] Mendelson, The Complete Outfitting and Source Book for Hang Gliding, p. 15.



Leonardo's diagram of ribbed wing from Codex Atlanticus 1486

Bird's wing



pumping devices, imitating the anatomical structure of a bird. Because a bird's muscles make up half their body wieght and homan's only a fifth, Leonardo's inventions never got airborn.[2]

From 1891-1893, Otto Lilienthal built and flew dozens of mono and biplane glider designs near Berlin, Germany. By 1893 he had perfected a glider that was controlled by shifting his wieght. Lilienthal made thousands of controlled glides from small hills. On some he flew further than 750 feet and rising, at times, to 75 feet. His last words before his death from a fall in 1896 were "sacrifices must be made".[3]

At the turn of the century an engineer and bridge designer named Octave Chanute developed a box kite structured bi-plane design. He was influenced by Lilienthals designs but wanted to make a glider with better inherent stability and strength.[4] He incorporated a bridge truss system of diagonal wires into his biplane which provided

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[2] Ibid., p. 24.

[3] Ibid., p. 25.

[4] Ibid., p. 26.

strength without added wieght. The bi-plane proved so successful and easy to fly that in gentle winds the engineer would let spectators run off sand dunes with it at Lake Michigan.[5]

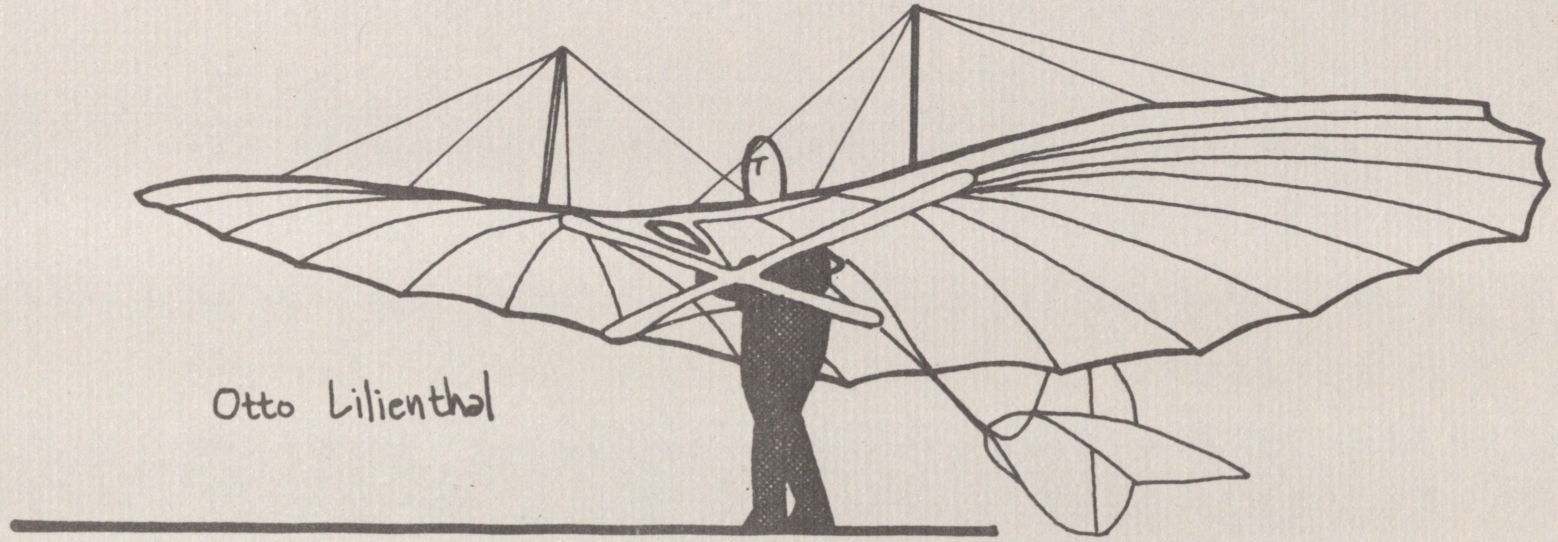
In 1900, with Chanutes experience and advice, the Wright Brothers built a model of his biplane in their bicycle shop and tested it. Their correspondence with Chanute enabled them to build and test several full scale gliders. These designs were flown in 1901 through 1902 and had the pilot prone rather than hanging. The Wright Brothers added a front elevator to Chanutes biplane structure and a moveable rudder behind for lateral control. They applied for a patent on their glider in 1903 and began the development of a motor for it.[6]

During the early part of the century many variations of the Chanute trussed-bay bi-plane were developed and made popular. Little innovation, however, occured beyond the bi-plane concept until the late 1940's.

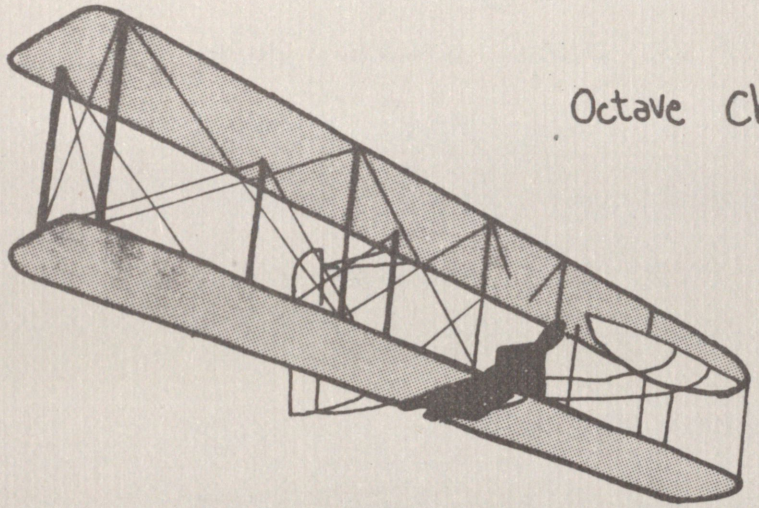
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[5] Ibid., p. 26.

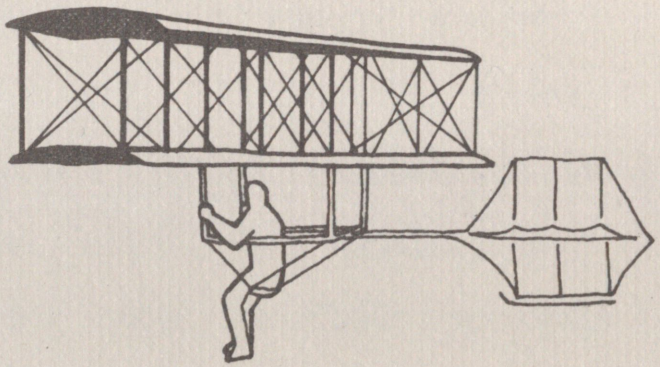
[6] Ibid., p. 27.



Otto Lilienthal



Octave Chanute





Wright Brothers

Francis M. Rogallo, an engineer for NASA, holds all the praise for his concepts of kite designs which lead to the development of the modern day hang glider. Along with his research concerning the stability of conventional aircraft, he was also fasinated with the hobby of designing kites. He felt that not only could kite designs be improved, but that the flexible surface and easy dismantling of kites could in some way be adapted to low speed flight situations.[7]

Through experiments in 1948, he developed a design which became known as the parawing. This concept involved a delta shape with a flexible fabric fitting. In flight, the bi-conical form exhibited stable flight characteristics by a balance of forces on the fabric and tension in the suspension lines. The parawing could maintain forward glide by venting air out its loose trailing edge.[8] NASA experimented with the parawing concept and tested it in hundreds of variations and thousands of flights. It was programed as a possible re-entry vehicle for space

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[7] Ibid., p. 29

[8] Ibid., p. 31

equipment.

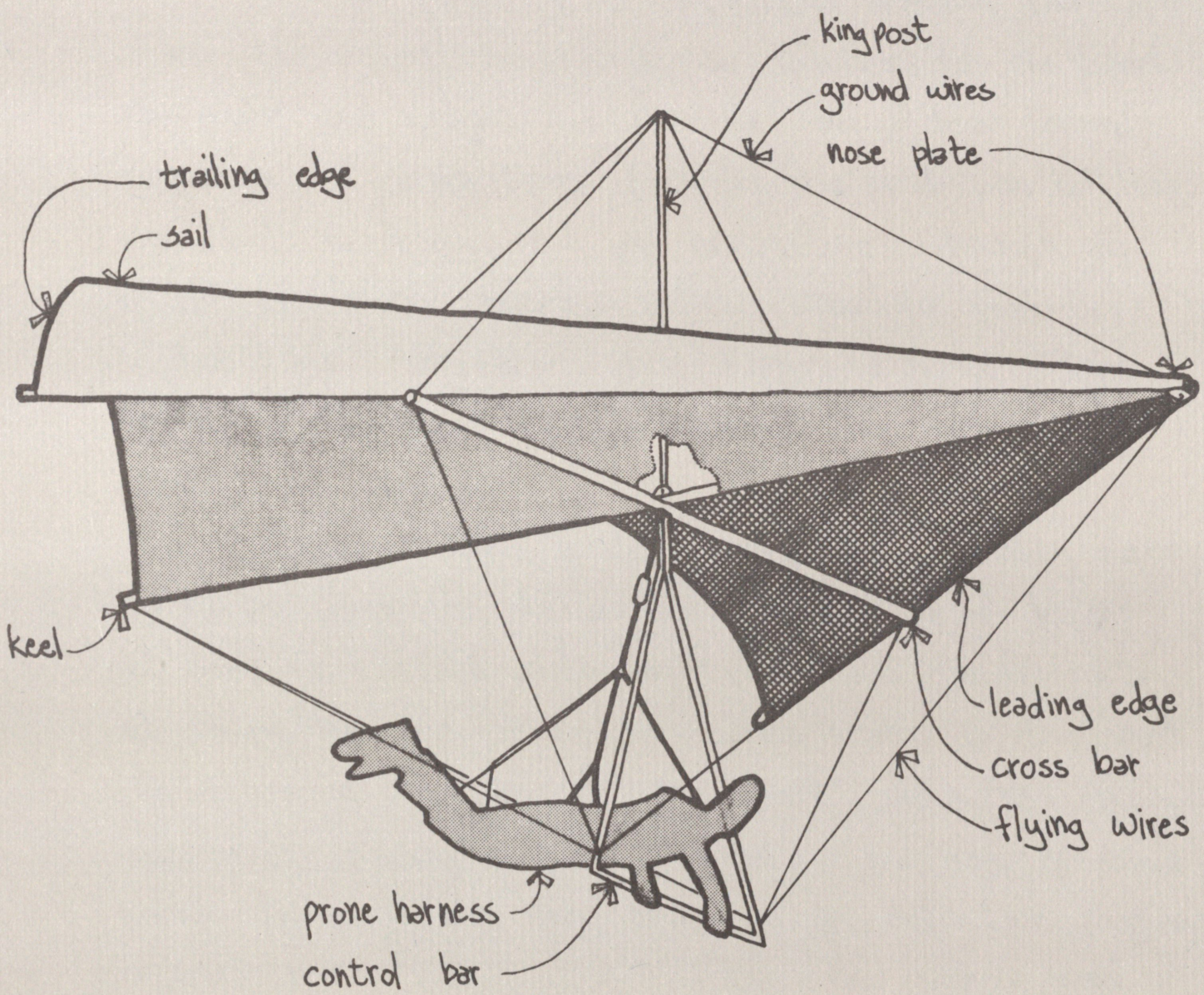
By 1961 and into the mid 60's the parawing concept began to become popular among early hang gliding enthusiasts. Delta kite designs were towed behind boats with water skis. Makeshift designs of bamboo and plastic started being flown off small hills and sand dunes. The revolution created what is now called the standard rogallo hang glider design.

By late 1971 clubs and organizations concerning the sport were established. At the end of 1974, the United States Hang Gliding Association had a membership of over 10,000 participants.[9] Today the sport hosts over 250,000 participants the world over!

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[9] Ibid., p. 36.

STANDARD ROGALLO HANG GLIDER



FACILITIES CREATED FOR HANG GLIDING

As the popularity of hang gliding increased, there also became an increased need of service facilities for the sport. The people who designed and manufactured gliders formed companies and corporations. Factories and production buildings were built to design, test and manufacture gliders. A few of the established companies include: Ultralight Products, Electra Flyer, Delta Wing Kites, Eipper-formance, Flight Designs, Manta Products, U.S. Moyes, Wills Wing, Sky Sports, and Stratus.

Shops became located throughout the country to distribute kites for the companies. These retail dealers not only stock their shops with kites and specific parts for them but also other accessories related to the sport. The accessories may include harnesses, parachutes, flying instruments, reading material, helmets, sail bags or wind socks. These dealers may also run an instruction program to teach people how to fly. Often the money paid for lessons by the students is used as a downpayment toward a kite bought from that dealer. There are currently over 100 schools and dealerships in operation

throughout the United States.

Perhaps the largest hang gliding school in the country is Kitty Hawk Kites, Nags Head, North Carolina. Their success in teaching people has been extraordinary. Since the inception of their facility in 1974, they have taught over 20,000 people to fly. Their youngest student was 9 and the oldest was 76. In 1979 alone they launched over 200 people who were over 40 years old! George Worthington, who is 68, currently holds the official world distance record of 111 miles flown in 4 hours and 40 minutes.

The concept of a flight resort has become a reality in the last few years due to the sports increasing popularity. An example of this is Crystal Flight Resort, Chattanooga, Tennessee. At Crystal pilots can stay at the Air Sport Motel and fly the local sites. They also teach the sport and cater to other tourists as well. In this case the motel already existed near a flying site. The owners there saw the potential for a business and started the flight resort, merely adopting the appropriate name.

EVENTS

Resorts and similar facilities have become attractive places to hold major free flying and competitive events. The American Cup was held this year at Lookout Mountain near Crystal Flight Resort. Teams of 7 pilots from Great Britain, France, Canada, Brazil, Australia and Japan all competed in the event. 71 pilots attended the national championships held this year at Ellenville, New York. Other yearly events include the Cross Country Open, The Masters, The World Cup (biannual), Regionals, Invitationals and Flyins. In the International / Intercollegiate meet, participants from colleges and universities competed in advanced, intermediate, novice and beginner classes. In competition, pilots are judged on either duration or speed on a predetermined course of pilons or the accuracy of a spot landing. Clinics and seminars concerning the sport are also held throughout the year.

PHILOSOPHY OF HANG GLIDING

Hang gliding often holds the mistaken image that its participants are dominated by thrill seeking, drug crazed hippies practicing a new fad to tempt death, that will be out as soon as it was in. Clearly, this is not the case. Hang gliding has become a very established, technical, respected and serious sport. The number of accidents and fatalities that occurred during the first years was alarming, but with better kite designs and more extensive and accessable training, the number of accidents per capita has declined dramatically.[10]

Nothing compares to the excitement, exhilaration, beauty and satisfaction of hang gliding. The sport is becoming available to anybody anywhere. The only physical requirements are the ability to run and hold the kite aloft for take off. Once in the sky, it is not strength but educated instinct, practice and skill that make a good pilot." Control is simply accomplished by slightly

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[10] Ibid., p. 13.

" Ibid., p. 13.

shifting the pilots' body in relation to the kites center of gravity. Unlike conventional aircraft, no motors or mechanical levers are involved which may require prolonged preliminary instruction. While flying the pilot becomes in touch with an experience found nowhere else. Flying only the glider and his body, the pilot can feel the elevator sensation of lift, watch his take off point shrink as he rises above it, or experience a finely banked turn.

Hang gliding is a dynamic, 3-dimensional sport as compared to the 2 dimensionality of other sports. This 3-dimensional psychological level, once only experienced by birds, can now be understood and percieved by man. Now the sky can be explored in the same way that forests, rivers, mountains, and oceans have been explored for ages: not as passengers or observers, but as participants in the natural environment.[12] This attitude can be sumed up in one line of wisdom: if God didn't want man to fly, He would have given us roots.

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[12] Ibid., p. 13.

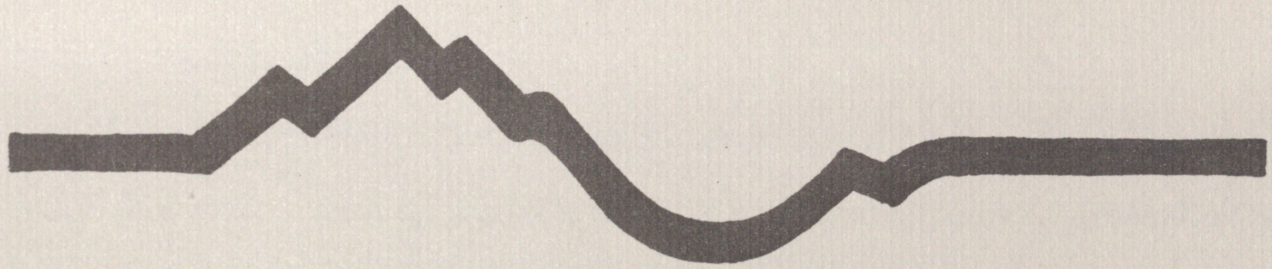
PARADISE VALLEY

Paradise Valley is located 8 miles south of Livingston, Montana. In this valley are 5 soarable flying sites located within a 5 mile radius of each other. The sites include The Hogback (north and south sides), Johnsons Hill, Antelope Butte, and Suce Creek Ridge. If weather conditions cooperate, one of these sites is always flyable. When conditions become soarable, flights lasting hours are common.

On December 20, 1980, two local pilots launched from the 200 foot take off on the south side of The Hogback, soared above The Hogback and Paradise Valley and flew to the east of Livingston for a total of 17 miles! Local pilots log between 20 and 50 hours of airtime here every year. The potentials for cross country and sustained flights make Paradise Valley an attractive area for hang gliding enthusiasts. Livingston is the second windiest city in the country, what could be a better place for hang gliding?

Besides the great flying, Paradise Valley hosts a large variety of alternative outdoor activities. These include Chico Hot Springs, year round fishing and floating

on the Yellowstone River, and others which will be discussed in the Program chapter. The flying and alternative activities in Paradise Valley make the application of a flight resort here a definite possibility.



HISTORY AND REGIONALISM OF PARADISE VALLEY

The best example of the oldest and most popular resort in Paradise Valley is Chico Hot Springs Lodge. People come here to enjoy swimming in Montana's largest mineral hot spring and to relax in the rustic 1880's atmosphere. The resort also provides a restaurant for dining and outdoor activities which include horseback riding, fishing, hiking and cross country skiing. The uniqueness of Chico is mainly due to its long history and timely existence. As early as 1865, miners from Emigrant Gultch used the hot springs for bathing and laundromat purposes.

Observing the success and popularity of other bathable hot spring operations, the preliminary investors saw Chico as a profitable investment. On June 20, 1900, Chico Hot Springs Hotel opened to the public. The original hotel still stands and is in good use today. Through the years the hotel was expanded and today it can efficiently accomodate up to 150 guests.

The turn of the century imagery still exists at Chico. Collonaded board-walked verandas surround the lodge. Gable roofs with dormer windows surmount the 2

story structure. These simple forms and building elements give Chico a truely original western atmosphere. Its historic fabric should be recogyized and respected by architects in this area so the western spirit of Paradise Valley is maintained.

While the precious metal and mineral mining was done at Emigrant Gultch, mining for coal was extensive between Livingston and Bozeman during the late 1800's and early 1900's. Coal mining towns with populations up to 500 people thrived in the Trail Creek area west of Paradise Valley and the Hogback. The coal that was mined was burned to produce coke that was shipped to Butte, Helena and Great Falls. Coke is made by heating coal to a degree at which gases and impurities are driven off. Coke gave smelters the high degree necessary for refining minerals. The decrepit quarter mile ruins of coke ovens can be observed on Trail Creek Road near Bozeman where the mining town of Storrs once stood. Other small mining towns which existed on Trail Creek Road include Maxey, Hoffman, and Chimney Rock.

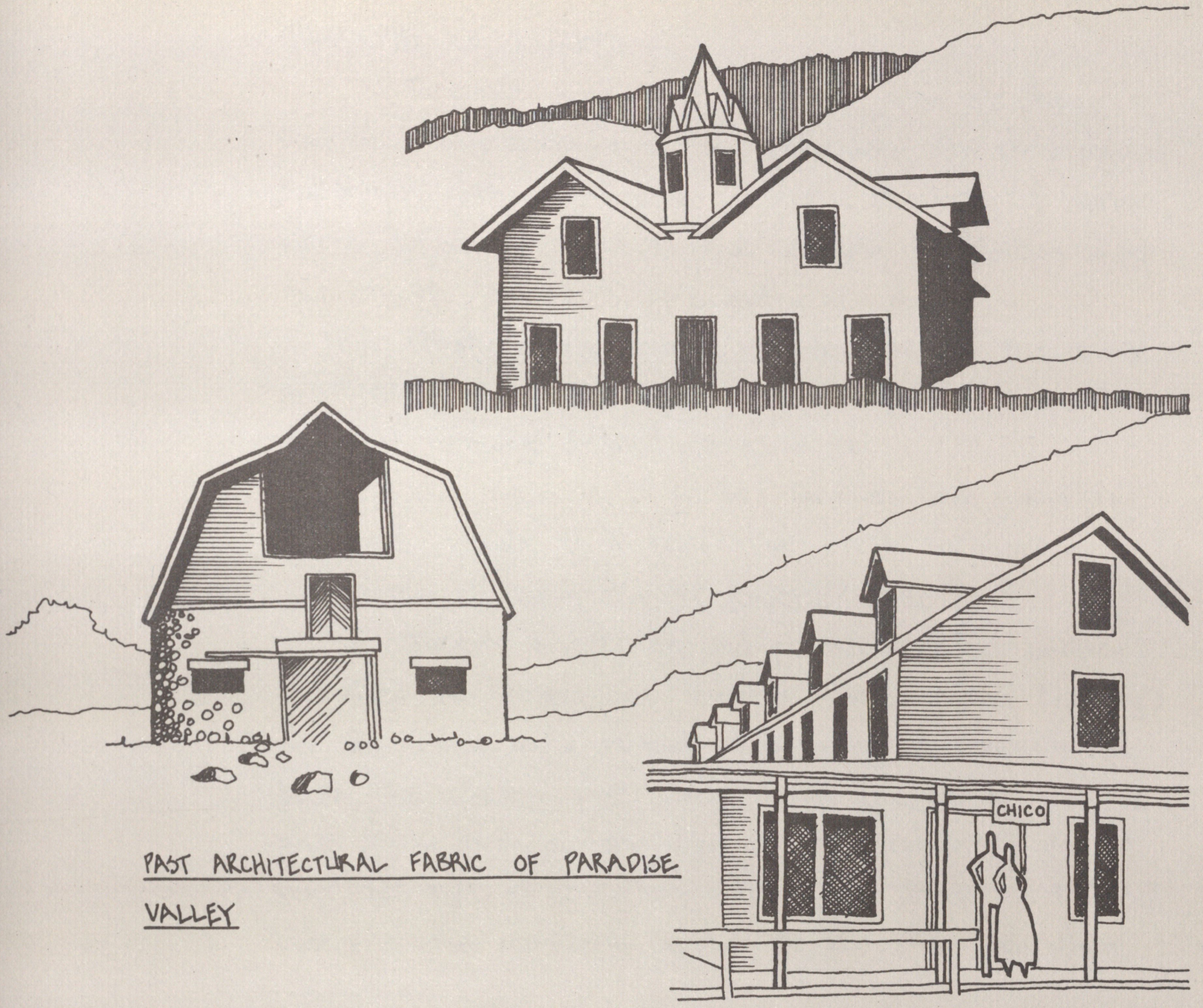
By 1910, the coking operations died as fast as they were born. This was caused by the depletion of mining quality

coal and the decreasing demand for coke as electricity and gas became more popular for industrial processes.[13] Besides the rubble of foundations and coke ovens, little is left of these towns. The unsuspecting public would have no idea of what once existed on Trail Creek Road if they weren't told about it.

While the coking operations have become somewhat of a legend, the descendants of the forgotten miners who choose to stay in Montana still survive. The mining spirit and imagery are still alive in this area today, and like Chico, should be recognized.

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[13] Whithorn, Photo History of Livingston-Bozeman Coal Country, p.1.



PAST ARCHITECTURAL FABRIC OF PARADISE VALLEY

PHILOSOPHY OF TOURISM

To create a new aesthetic for a given situation, traditional adaptations should be reexamined for their regional suitability. Such is the case with the philosophy of tourism, where it can be observed that complete satisfaction is not met through the presently accepted standards.

What is the tourist and tourism? Is the tourist different than a traveller or the participant in a specific activity? Formally defined, tourism is:

> . . . the migration of people, families and groups to places outside their residential areas for limited periods of time and by personal choice.[14]

Through advertising and promotion, places become recognized as centers for tourism. These centers typically see the tourist as a market which brings in revenue and keeps the economy alive. Even though the tourist may be part of the main economy, he is still considered an outsider, not part of the local culture. The tourist is tolerated because of the monetary surplus he brings in. Are there

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[14] Architects Journal, Principles of Hotel Design, p. 7.

not visitors that are not really tourists or revenue builders? It seems as though another classification should be considered. Before this can be done, the compromise of creating a special breed of tourist and the center of tourism maintaining a profitable business, must be acknowledged. How can this special tourist bring a profit to a center while experiencing an intense relationship with a culture and environment?

A solution would be to have the tourist participate in a new activity or experience which would compliment the quality of life. A dynamic relationship could be established between experiencing a discovered or pursued activity and the culture or environment which hosts the activity. In this case, both aspects of tourism benefit from the relationship. The participant has a purpose to patronize the center. And the center, a purpose to promote the activity experienced. In essence, the participant becomes a hang glider pilot, and the center, a flight resort.

The human being naturally possesses a hedonistic attitude of life. Man seeks pleasure and avoids pain and believes the pursuit of pleasure is the principle of good.

Pleasure is often obtained in the form of relaxation and escaping all the responsibilities of life. However, total uninvolvement does not remedy the most important human desire. This desire is the refreshment of mind and body through an intense involvement in a new experience. This involvement enables one to become more aware of his natural and cultural environment. The awareness comes about only through the commitment and desire to pursue an activity.

But what about the typical hedonistic tourist? What if no motive is available for becoming involved in a new experience? In this case another relation must be established. This concerns a dynamic built environment which will attract this type of tourist. Committing the tourist to become aware of the natural and cultural environment is acheived by his desire to visit and experience it.

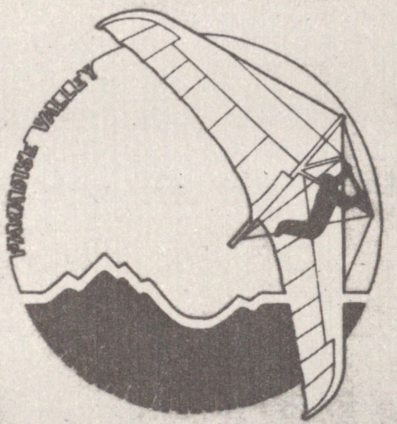
A flight resort accomodates two types of tourists: the hang glider pilot and the typical tourist who is commonly refered to as an onlooker. In order to have a mutual experience exist, interaction between the pilots, onlookers, and owner/operators must occur. The flight

resort establishes a place for interaction by providing an experience in learning, participating or observing the sport of hang gliding. Through this interaction, it is hoped the quality of Paradise Valley will be respected and that the tourist will become an intimate part of the visited environment, not just an outsider with money.

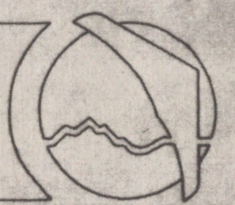
Today, modern forms of signage for advertisement follow the theory of "the bigger the better." Massive signs front tourist facilities that are more distracting than attracting. Tourist facilities in urban strip locations seem to construct the most elaborate signs to outdo their nearest competitor. The sign itself becomes the tourists preference for choosing a facility. The facility is often represented by the quality of its sign, rather than the quality of the built environment.

Fortunately, Paradise Valley has established restrictions on the types of signage that can be put there. Billboards and other large scale signs are now illegal to erect. This will protect the quality of the panorama from being cluttered with neon, artificial paint, and other disco-related atrocities.

Small scale signage in Paradise Valley must be carefully delt with to be effective. The sign must attract yet not distract from the natural environment. A suggestion would be to label all facilities in the valley with a recognizable logo. This logo could somehow graphically represent a specific facility and be displayed on a legend of logos at certain locations in the valley. The legend sign would identify the logos and show their location.



logotype



MONTANA AND TOURISM

Last year a study of Montana's tourist industry was compiled by Davidson-Peterson Associates, Inc. of New York City. They interviewed the states prime market for tourism which includes Washington, Oregon, northern California, Idaho, Utah, Colorado, Wyoming, the Dakotas and Minneapolis-St. Paul. Only 2 percent of the people interviewed listed Montana as their number one vacation choice. The study analyzed some of the reasons for this.

To start with, only a third of the potential tourists view Montana as friendly. When tourists think of Yellowstone National Park they usually think of Wyoming. This attitude exists even though 3 of Yellowstones 5 entrances are in Montana.

A lack of tourist interest in Montana is also due to the fact that it lacks sun, sand and sea. These ingredients are tourists' main attractions. Montana boasts about its big sky country, but tourists will not travel miles just to see wide open space. Also, viewing scenery alone does not have a unique enough appeal to draw people to visit a state. 16 percent of those surveyed say Montana is too far, time

consuming, costly and difficult to get to. Ironically, Montana is not widely thought of as a good place to attend rodeos, fish, camp, backpack, hike, engage in winter sports or visit museums.

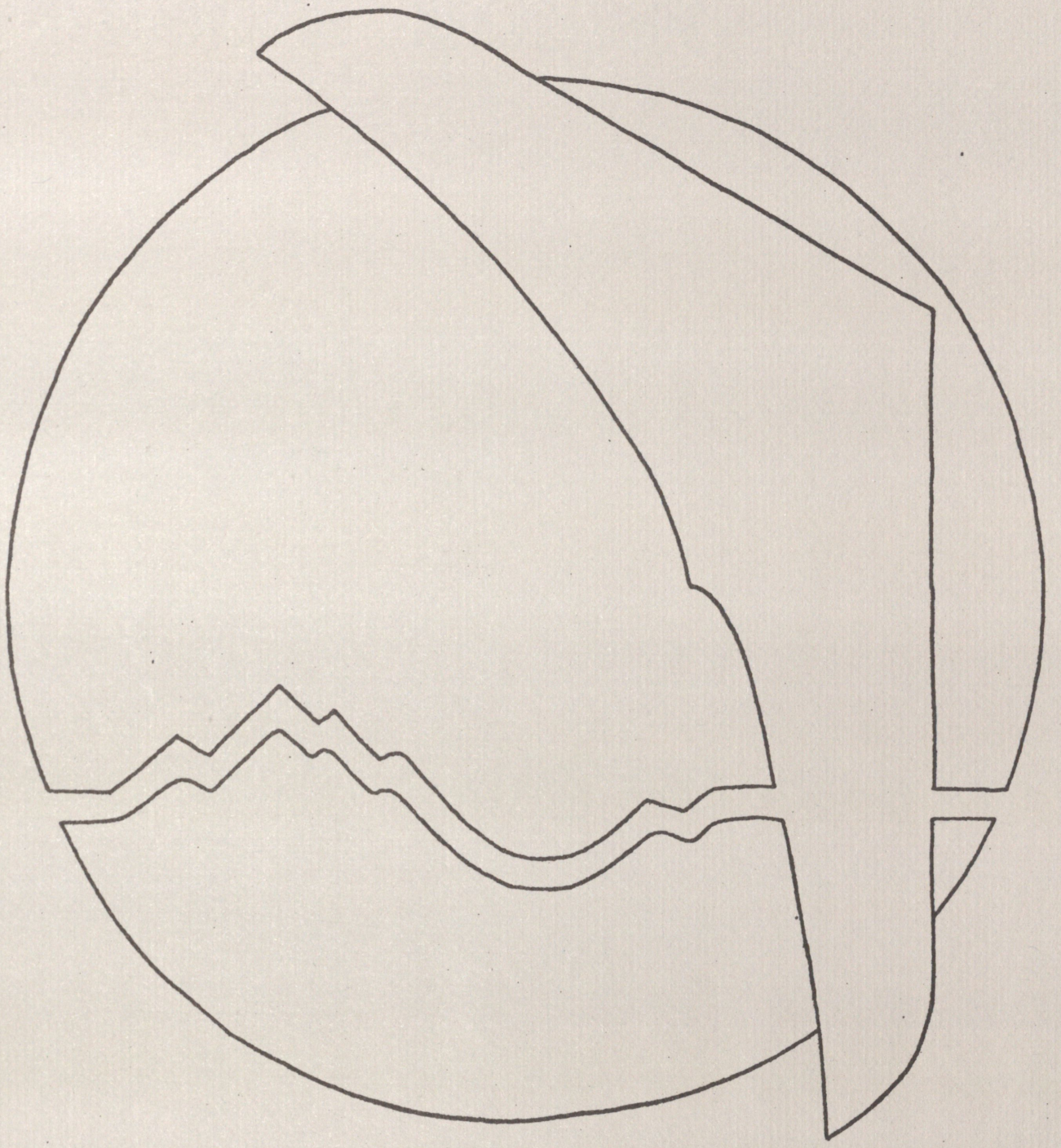
The study says it is not negative views but a lack of any view that is the crucial problem. About 29 percent of the prime market tourists drew a blank when asked to list Montana attractions. There is a market for people who want to vacation in Montana, but the people don't know what the state has to offer. Montana seems to fall short on its current tourist promotion advertising efforts.

Part of the problem is that Montana spends little money to promote tourism. Montana spends $616,000 a year to lure tourists, ranking ninth among the ten Rocky Mountain States. By contrast Alaska spends 3.3 million and Alberta 6.1 million. With little invested in promotion and advertising Montana may be hurting it's second largest employer. The tourist industry alone generated $900 million last year including $172 million that stayed in the state. With a small tourist promotion budget the whole states economy is effected, not just the

motel-hotel industry. Tourists fill their cars with gasoline and contribute to the gas tax fund which funds highway construction and repairs. They patronize retail merchants and boost the economy of communities and their residents who benefit from the property taxes paid by the local merchants.

Developing new brochures centering on the states attractions is a suggestion recommended by the study. The promotional efforts should be focused on the tourist market place that would appeal to the state's attractions.

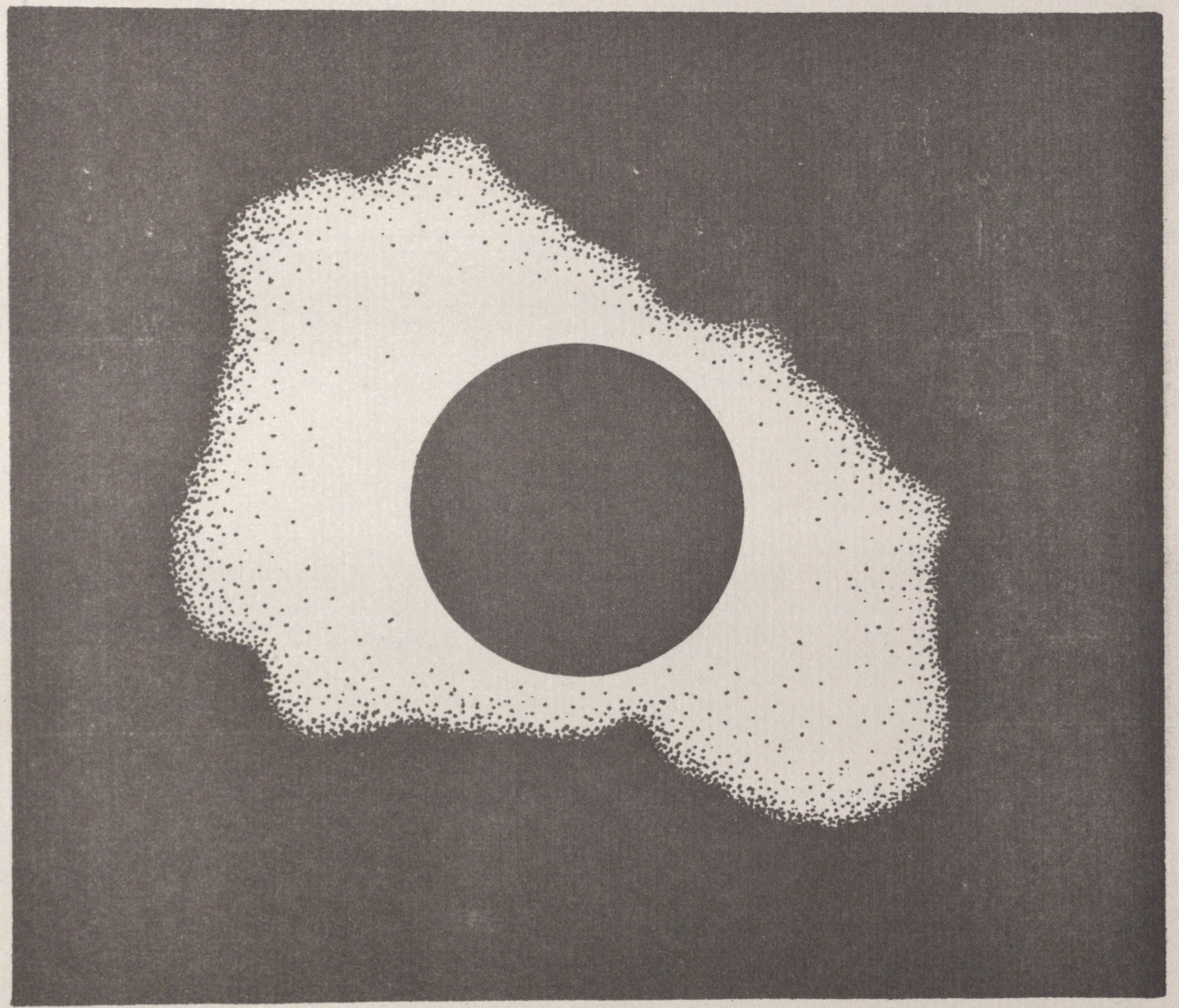
It also suggests spending $1.9 million in the first year of a 5 year program to develop public and private tourism. By 1985, the state and private industry would be spending $2.6 million to attract tourists. This budget is predicted to give the industry an annual growth rate of 10 percent compared to the current rate of 3 or 4 percent.



PASSIVE SOLAR

. . . the rewarding thing about flying is that there is no power source other than the air currents that you're using.

-TOM HADDON (current U.S. national champion)



THE SUN

The sun is the only one source of energy that we can rely on for the infinite future. Without it no plants would grow and wind and weather would no longer exist. It is the only source of energy that, unlike fossil fuels, is inexhaustible.[1] Some of the characteristic attributes of solar energy include: no thermal pollution because no heat energy is being added, no by-products or physical wastes occur from its utilization, i.e. the net energy gain is positive, and the systems operate at a scale which a community itself can control.[2]

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[1] Curl, Winona - Towards an Energy Conserving Community, p. 6.

[2] Davis - Schubert, Alternative Natural Energy Sources, p. 15.

INTRODUCTION

In order to make a flight resort as feasible as possible passive solar energy concerns must be taken into account. With the cost of space heating on the increase, the more energy efficient and energy self-supporting a facility is, the more attractive it will be from an economic standpoint. The wasteful use of energy in our present day built environment should no longer be tolerated. There is existing and increasing knowledge of various methods of solar gain, insulation, materials and orientation that can be combined for an energy efficient solution.[3]

For the flight resort, I will be concerning myself with the alternatives of passive solar heating systems. A general description of each system and materials will be discussed. This should give one a reasonable understanding of what systems are available and how they function. Please see The Passive Solar Energy Book by Edward Mazria for a further investigation of the concepts presented in this study. This study is by no means an end in itself, where the innovations

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[3] Davis-Schubert, Alternative Natural Energy Sources, p. 12.

and technologies of solar design are ever changing and improving.

NATURAL LAWS OF PASSIVE SOLAR ALTERNATIVES

The concepts of passive solar alternatives in building design are much the same as those a hang glider pilot depends on for sustained flight. At this point 3 basic terms of heat transfer should be explained which include convection, conduction, and radiation.

Convection occurs when gases or fluids are heated and they become less dense and rise. In this process, heat always moves from warm to cool. The greater the temperature difference in a substance, the more heat is transferred. Thus a continual movement of the gases or fluids is created as the heated portion of the substance is constantly replaced by the cooler portion.[4]

This is the same method that creates thermal lift for a hang glider. The sun locally heats the air near the earth's surface and causes the air to rise amidst the surrounding cool air. The greater the lapse rate, or temperature

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[4] Mazria, The Passive Solar Energy Book, p. 21.

difference, the more powerful the thermal becomes as more heat is transferred.

Conduction is the transfer of heat through a substance by direct molecular interaction. The thermal conductivity is the rate of heat flow through a substance and depends on the substances ability to send and recieve heat.[5] For example, a pilot soaring a ridge with sections of trees and rock slides will tend to keep himself above the rocky areas. The rocks conduct more heat from the sun radiating warm rising air for precious lift.

Radiation can best be described as the energy a substance gives off or radiates. The amount of thermal energy a material radiates depends on the temperature of the radiating surface and the surfaces quality or emissivity[5]. Some substances are better emitters of thermal radiation than others. For instance, a black body is the most efficient emitter and absorber of radiation verses a highly polished or shiny surface.[6] In this case, a pilot who is seeking the best thermal lift will

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[5] Mazria, The Passive Solar Energy Book, p. 23.

[6] Davis-Schubert, Alternative Natural Energy Sources, p. 22

concentrate his location over a plowed black field. The field has the best thermal producing potentials as compared to, for example, a large body of water.

PASSIVE SYSTEMS

Passive systems are the simplest, least technical and non-mechanical forms of solar heating a building. The basic elements of these systems involve south facing glass and a thermal mass for heat absorbtion and storage. The transmission of heat occurs naturally by the principles of conduction, convection and radiation. No other energy besides the sun is needed to make these systems operate. The alternatives of passive systems can be divided into 3 catagories: direct gain, indirect gain, and isolated gain.[7]

Direct Gain

The basic concept of direct gain is that the building and actual living space become a solar collector and storage unit. Sunlight enters south-facing glass being absorbed and

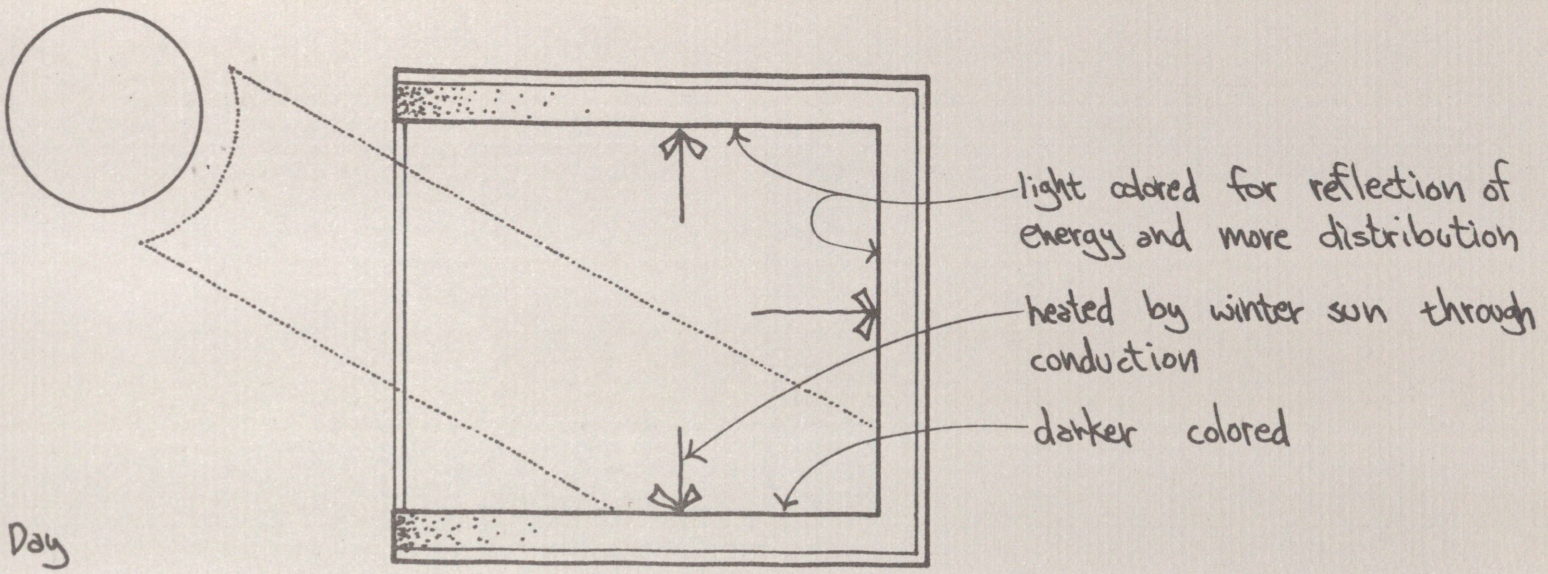
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[7] Mazria, The Passive Solar Energy Book, p. 29.

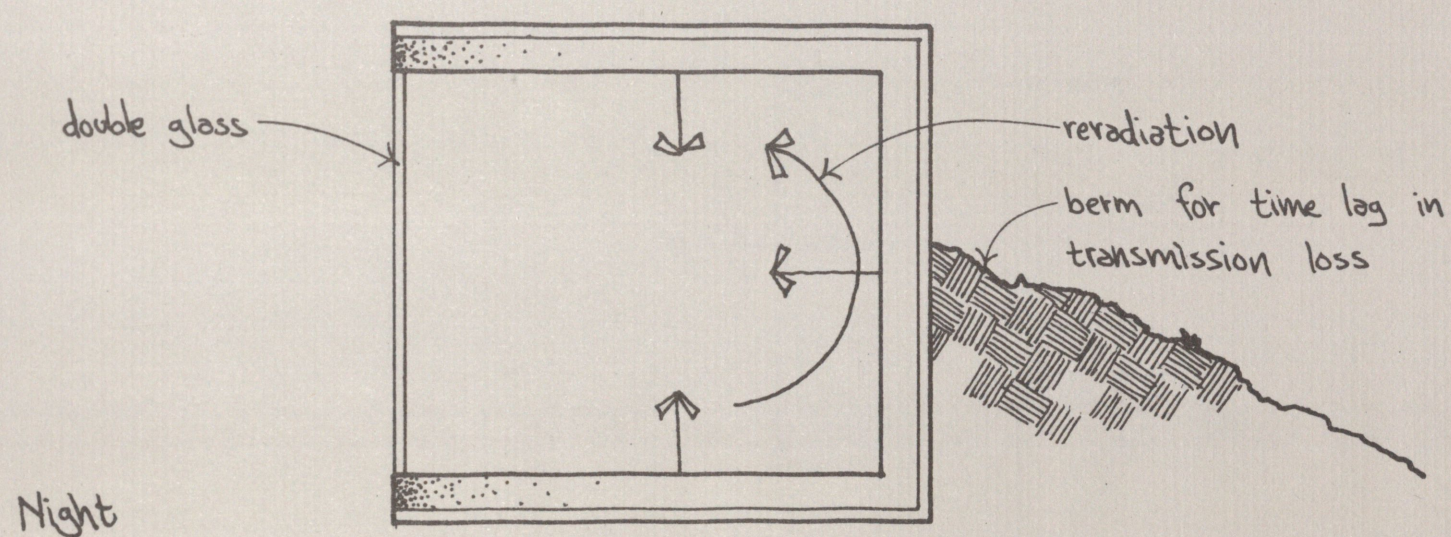
stored in a mass within the building. The light and radiant energy from the sun changes to thermal energy when it strikes an interior surface or mass. It is crucial that this mass be strategically located to receive direct or reflected radiation from the sun. The thermal heat capacity of the mass must also be high enough to store heat for night time reradiation. The glass and walls of the living space should be properly insulated to avoid unnecessary heat transmission losses at night. Some type of shading or moveable insulation devices are required to prevent over heating and night time heat losses through the glass.[8]

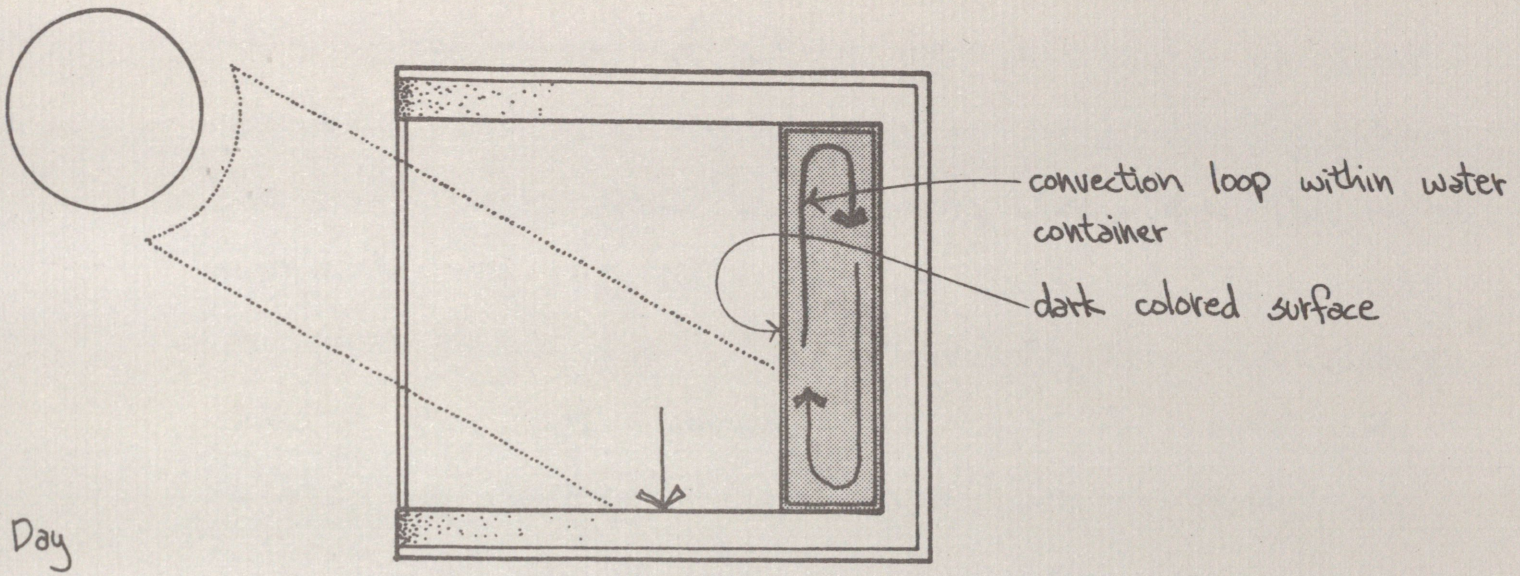
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[8] Ibid., p. 29.

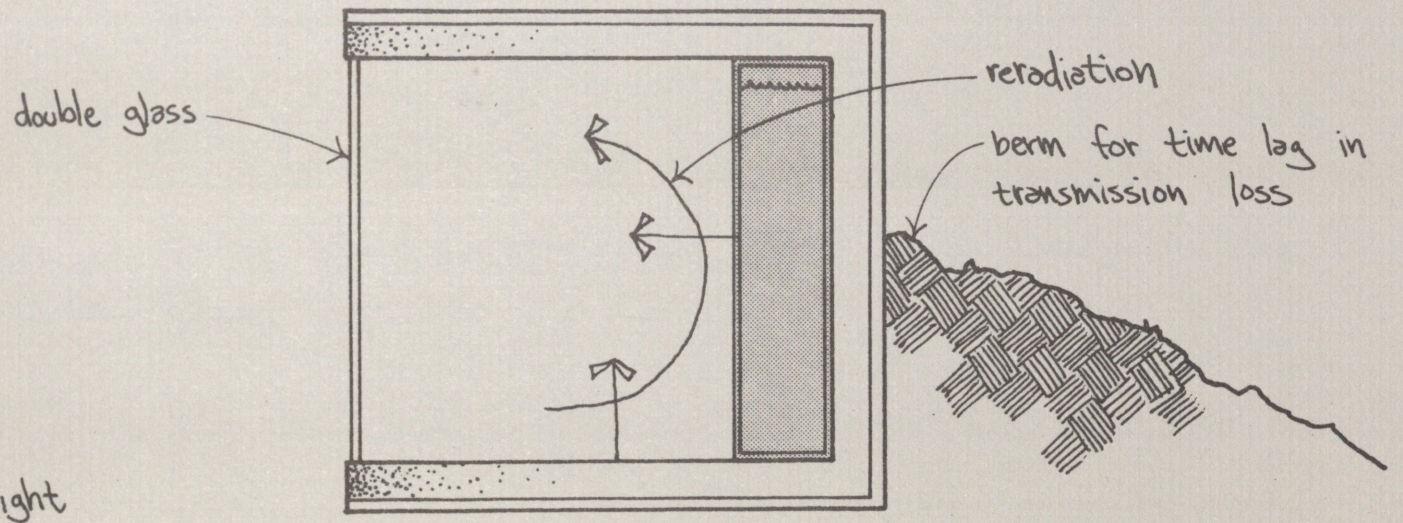


MASONRY STORAGE FOR DIRECT GAIN





MASONRY & WATER HYBRID STORAGE FOR DIRECT GAIN



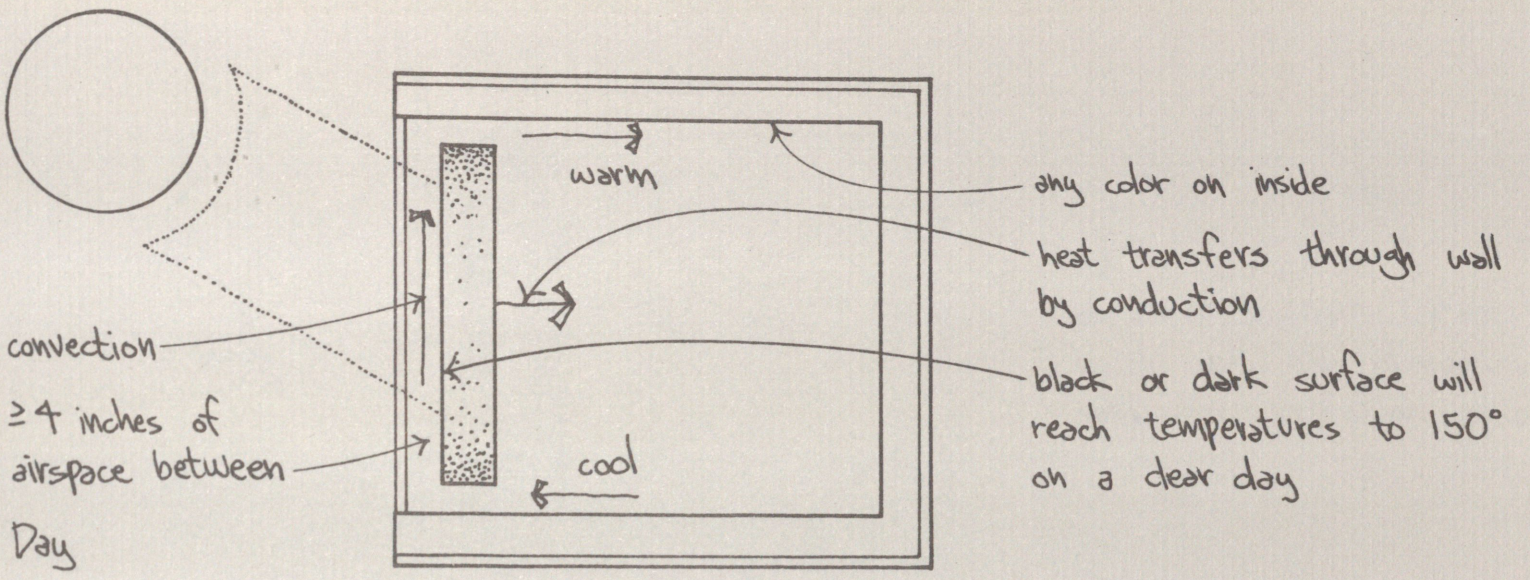
Indirect Gain

The concepts of indirect gain are similar to direct gain except that the thermal mass is placed directly behind the south facing glass for maximum absorbtion. The entire system becomes integrated into the south wall. Here again, the mass should have a high conductivity and heat storage capacity. The most commonly used types of indirect gain include the masonry thermal storage wall or Trombe wall, water thermal storage wall, and the greenhouse.

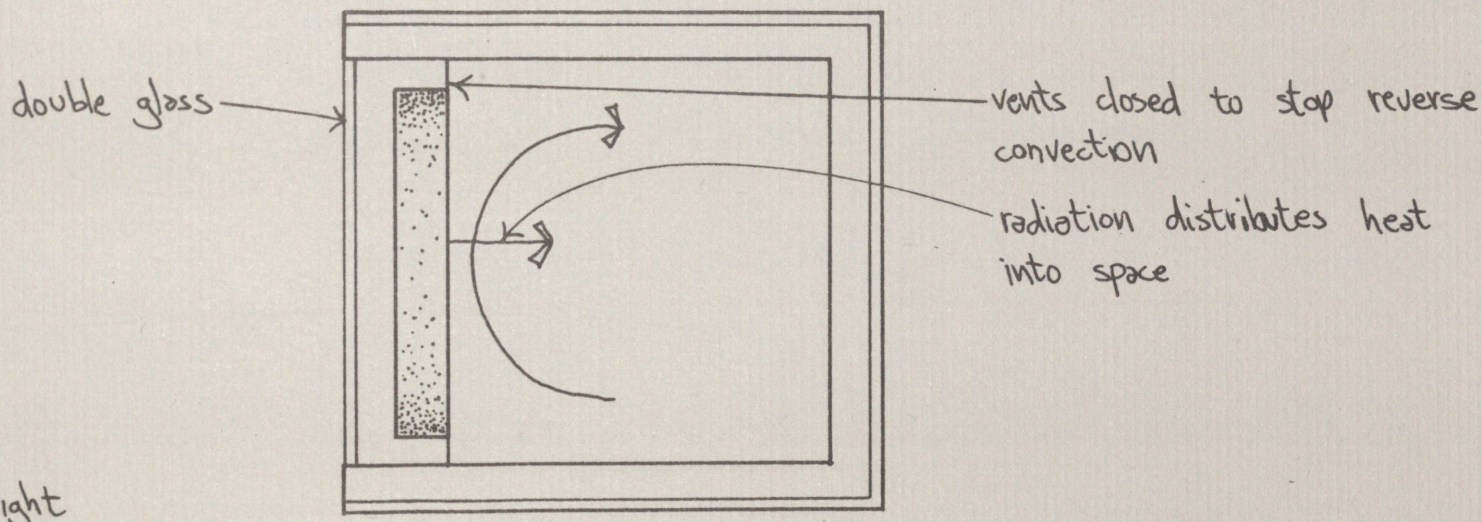
Usually refered to as an attached sun space, the greenhouse is simply a hybrid of direct and indirect gain systems.[9] In this case, a space is created in front and behind the thermal storage wall when it is seperated from the south facing glass. The space behind is heated indirectly by conduction through the thermal storage wall. The space in front receives direct gain which heats itself and the thermal storage wall.

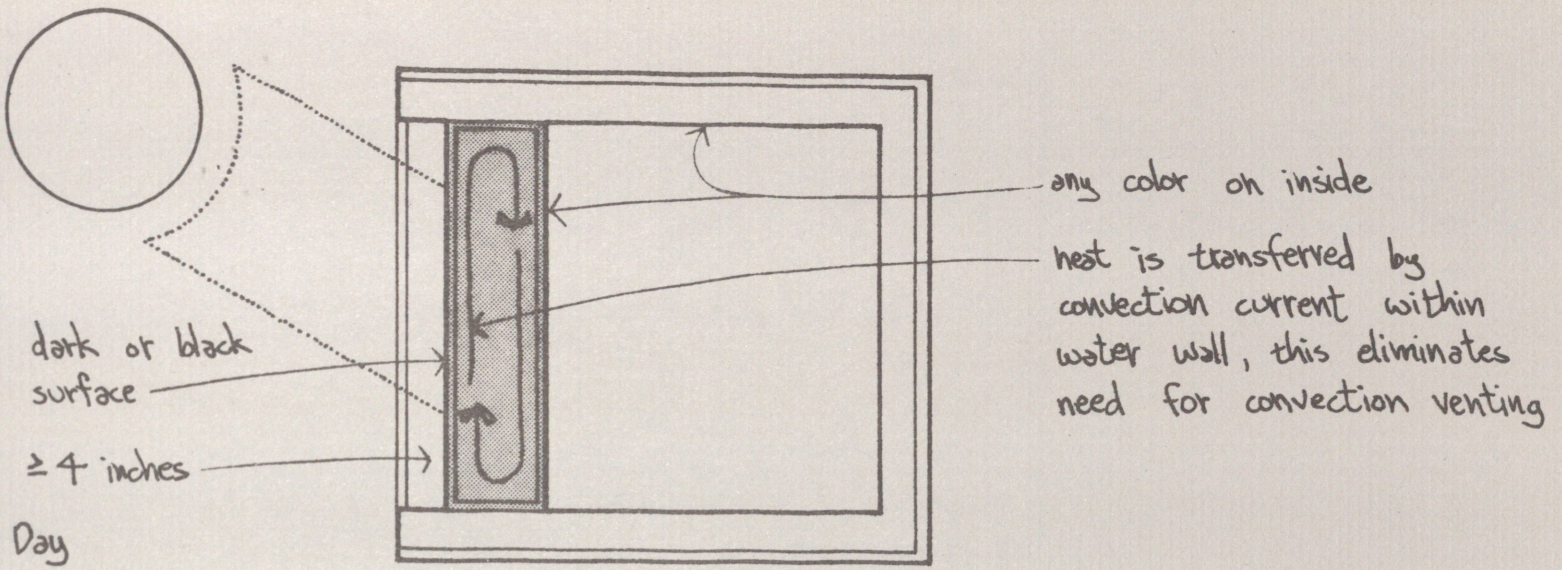
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[9] Ibid., p. 52.

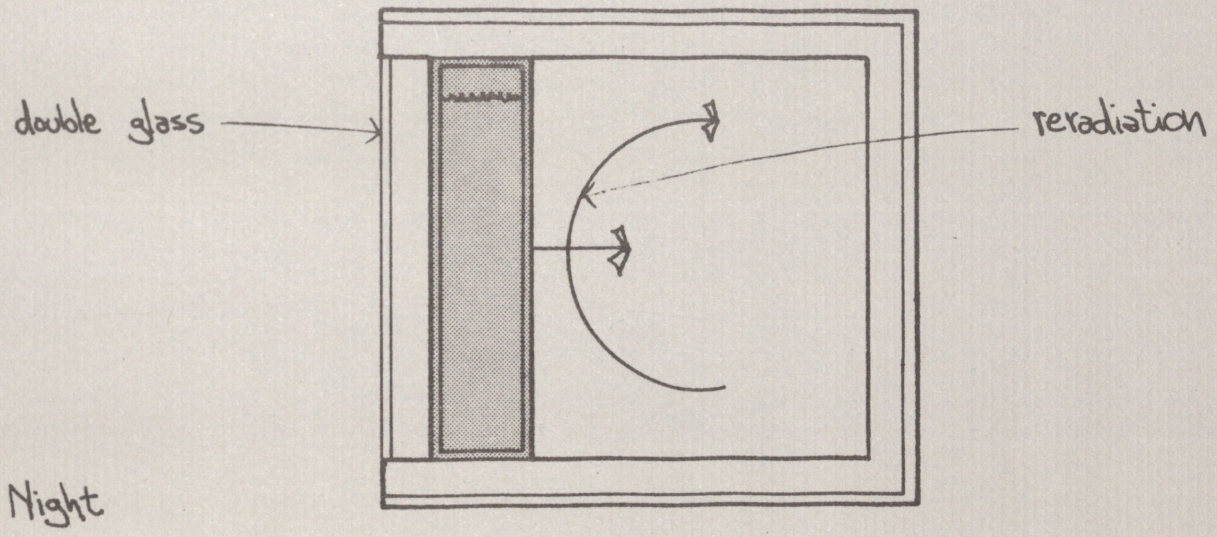


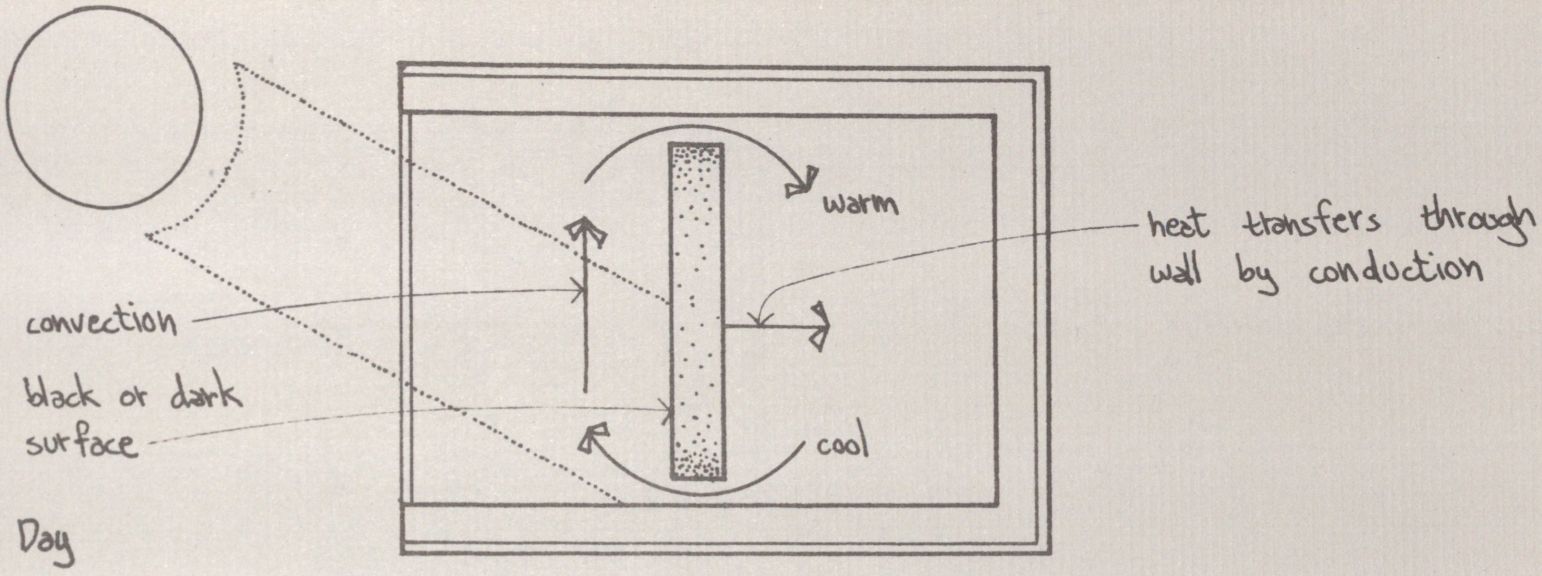
MASONRY THERMAL STORAGE WALL FOR INDIRECT GAIN



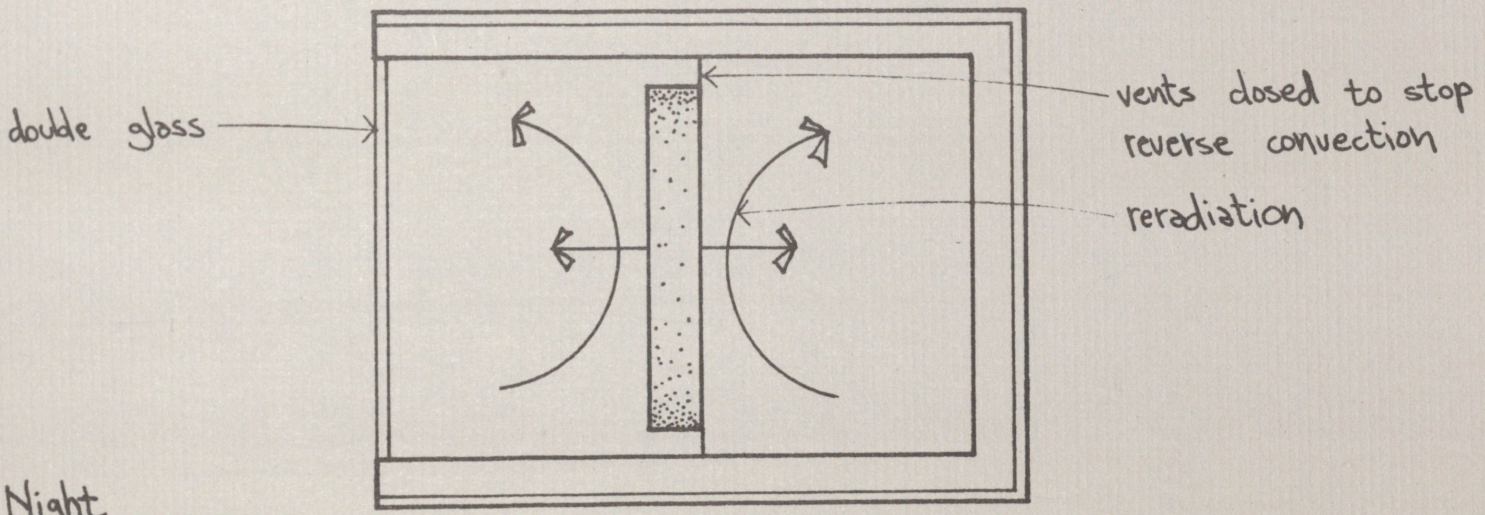


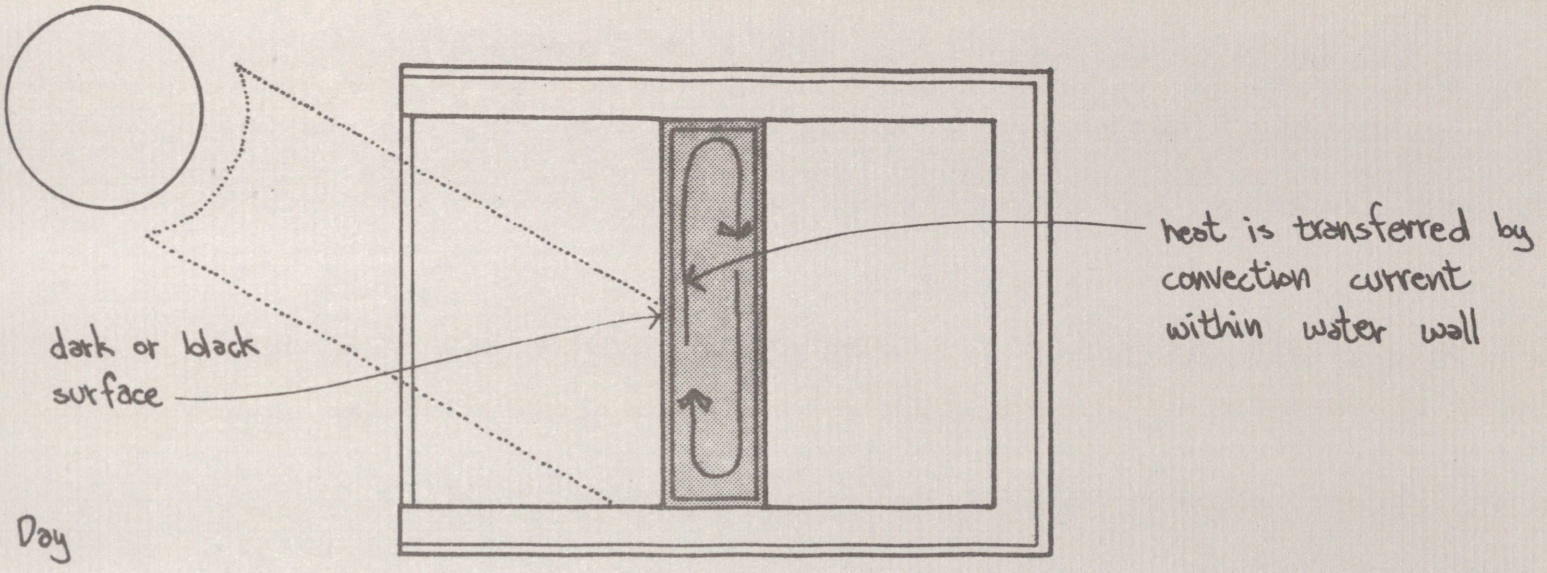
WATER THERMAL STORAGE WALL FOR INDIRECT GAIN



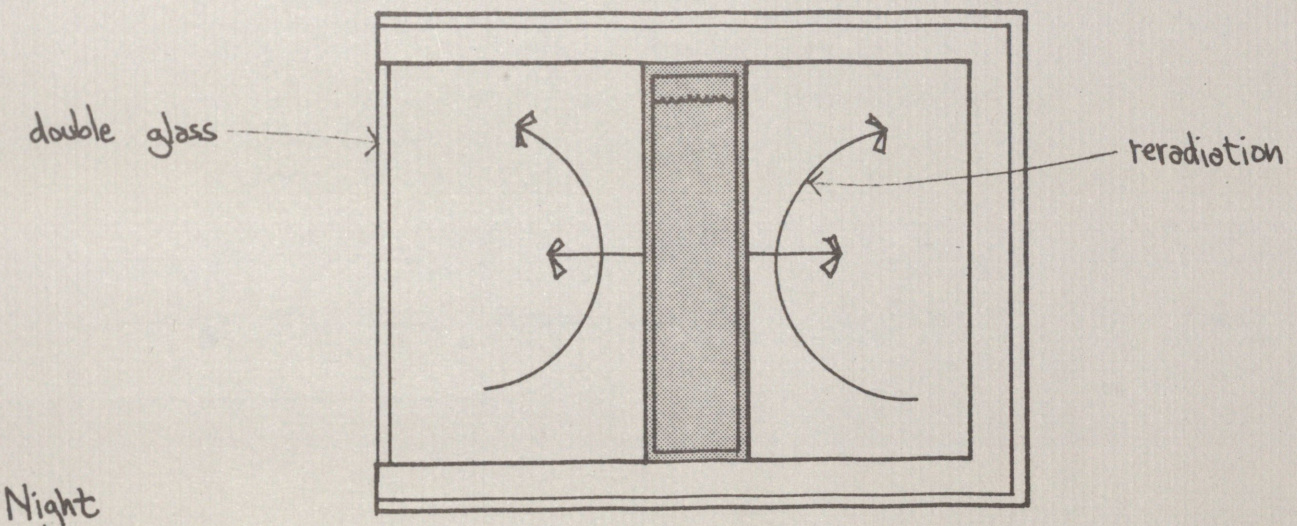


GREENHOUSE WITH MASONRY STORAGE WALL





GREENHOUSE WITH WATER STORAGE WALL



Isolated Gain

The concept of isolated gain, unlike direct or indirect gain, is that it functions independently of the actual living space. The system can be used only when needed and is mainly used for back up water heating. The natural convection loop is most commonly applied to this system and should be described at this point.[10]

The convection loop or thermosiphon process involves the use of ducts and pipes between a seperate collector and thermal storage area with air or water as the heat transfer medium.[11] If the collector is located below the thermal storage area, natural convection circulates the warm transfer medium from the collector to storage area and back again. Solar heated water in the collector rises by thermosiphon action to the water storage tank while cool water from storage flows down to the bottom of the collector. This cycle will continue as long as the sun shines on the collector.[12] The same cycle

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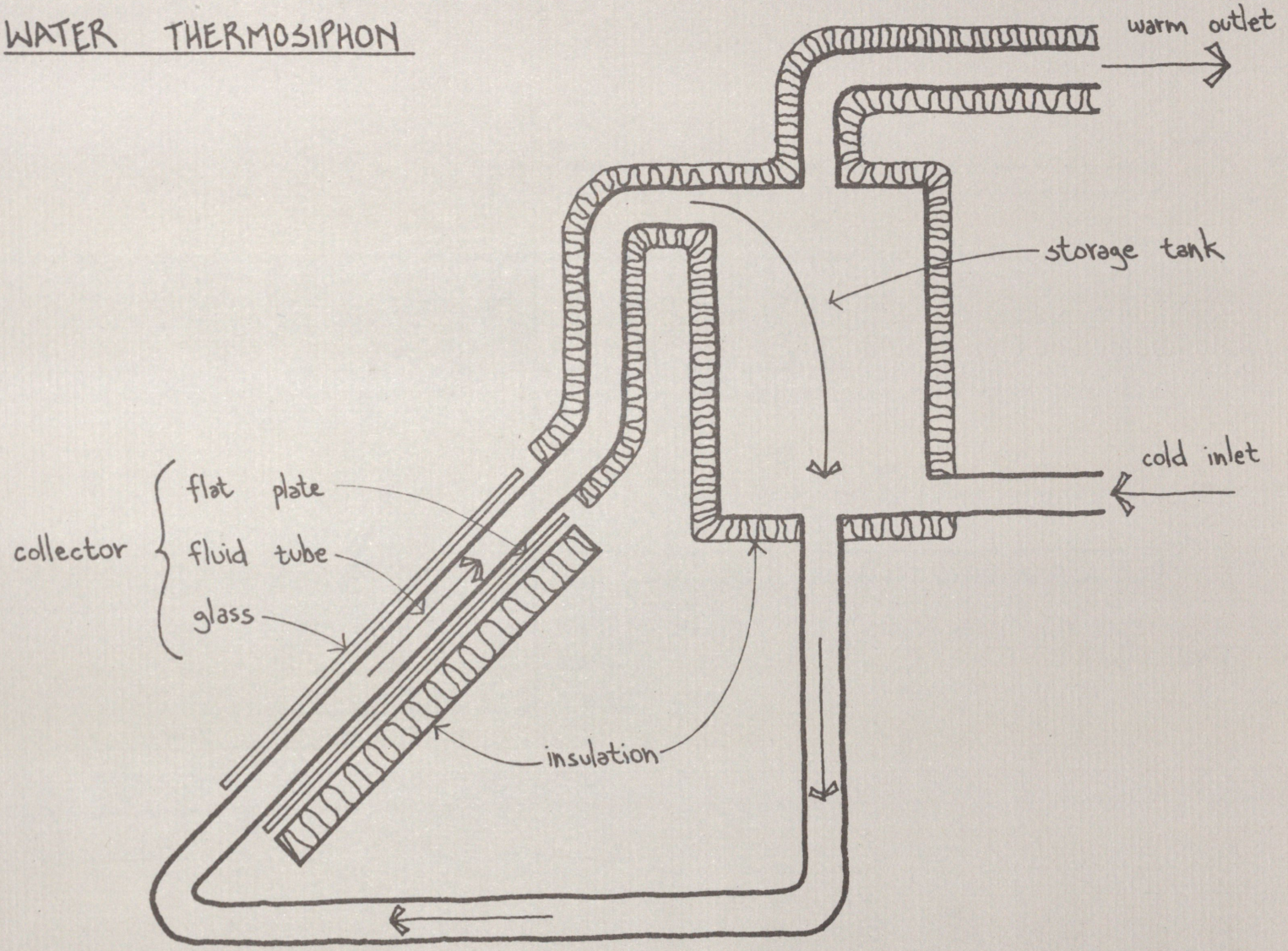
[10] Ibid., p. 59.

[11] Ibid., p. 60.

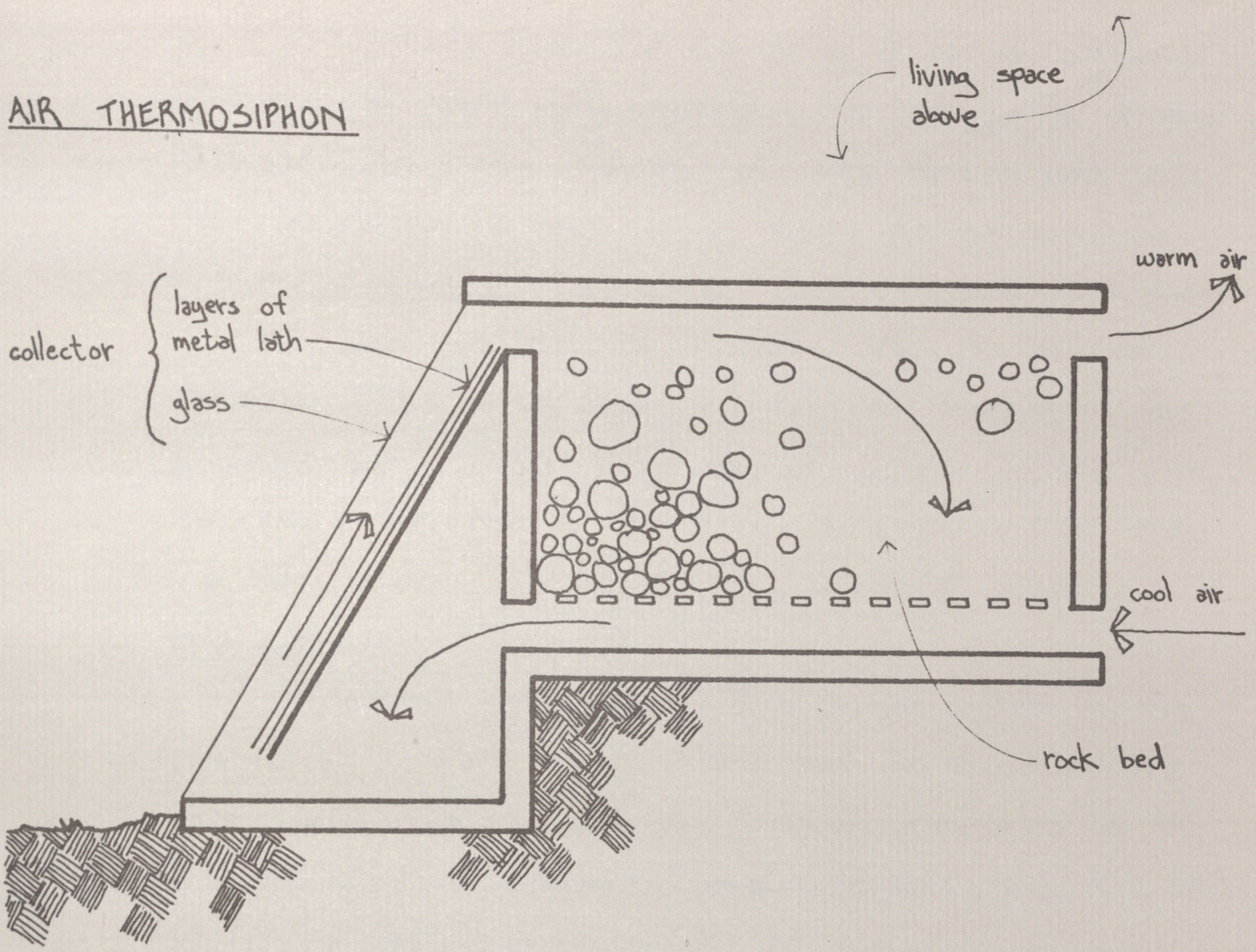
[12] Ibid., p. 60.

occurs when air is used as the transfer medium. In this case, a rock bed is used for heat storage.

WATER THERMOSIPHON



AIR THERMOSIPHON



CLIMATOLOGY

A crucial element in the design of energy conscious buildings and passive solar systems is the analysis of climatic parameters. The passive system must work hand in hand with the microclimate of the site to assure its maximum performance. A complete ignorance of climatic factors at a given site may cause the elements of passive design to be over or undersized. This would cause an unbalanced response of the passive designs relation to a specific climate. If this were the case, the user of the passive built environment may find the extreme temperature fluctuations of a space undesirable.

To avoid the imbalance of a passive system to the environment, certain considerations must be accounted for. These considerations include the building's orientation on the site, temperature extremes, wind conditions, and the sun's location in the sky throughout the year.

In this study, an explanation of the sites specific climatic characteristics will be presented as a supplement to the site analysis. The recommendations for sizing the passive solar systems will then be discussed in proportion

to these characteristics.

Temperature

The region surrounding the site can be described as a cool, modified continental type climate. Located at 4800 feet above sea level and between 45° and 46° north latitude, the site experiences a wide range of temperatures. Even though temperatures of above 100° F and below 0° F have been recorded, the sites temperatures are relatively mild for its latitude and elevation. The average monthly high temperature for January (coldest month) is 24.5° F while the high temperature for July (warmest month) is 85.6° F. Only 10 days of July are as warm or warmer than 90° F. Summers are arid and uncomfortable humidity is rare. The annual average heating degree days, or the number of degrees that the daily mean temperature is below 65° F, is 7281 for the site.[13]

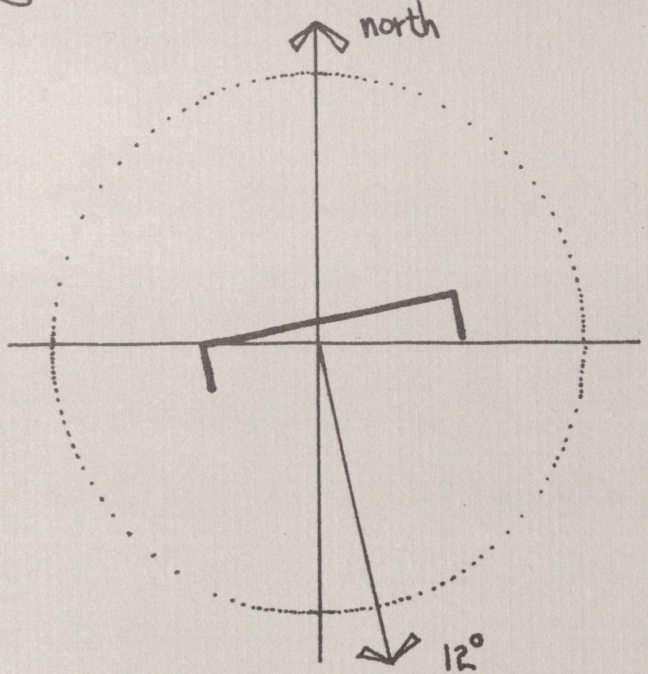
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[13] Pightman, Climate Analysis and Weather Conditions for Livingston and the Encompassing Area, p. 47.

Orientation

From the Regional Orientation Chart in Design with Climate by Victor Olgyay, the maximum gain of solar insolation for this region is 12° east of south.[14] Insolation is the rate at which solar energy is received on a horizontal surface per unit of measurement.[15] The best orientation for a building recieving solar gain would be slightly east of south on a south easterly slope.[16]

COOL REGION - 46° NORTH LATITUDE



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[14] Olgyay, Design with Climate, p. 61.

[15] Davis-Schubert, Alternative Natural Energy Sources, p. 25.

[16] Ibid. p. 36.

Precipitation

The site averages 14 to 18 inches of annual precipitation.[17] Most summer rain falls as local showers from the over-development of cumulus clouds in the afternoon. These showers are usually accompanied by thunder and lightning and sometimes hail. Most winter time precipitation falls as snow. The heaviest precipitation occurs in the late spring and early summer.[18]

Wind

Located near the top of the Yellowstone River wind shed, the site's strongest winds occur in the winter season. These winds are generally from the southwest during the months of December, January and February. They occur when the high pressure, relatively warm air masses from the southwestern U.S. flow over Western Montana into the low

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[17] Soil Conservation Service, Livingston, Montana.

[18] Dightman, Climate Analysis and Weather Conditions for Livingston and the Encompassing Area, p. 47.

pressure zones of the Northern Great Plains caused by cold artic air.[19] Referred to as Chinook winds, they sometimes produce temperature rises of as much as 50°F to 60°F in 24 hours, often disrupting the winter cold spells.[20]

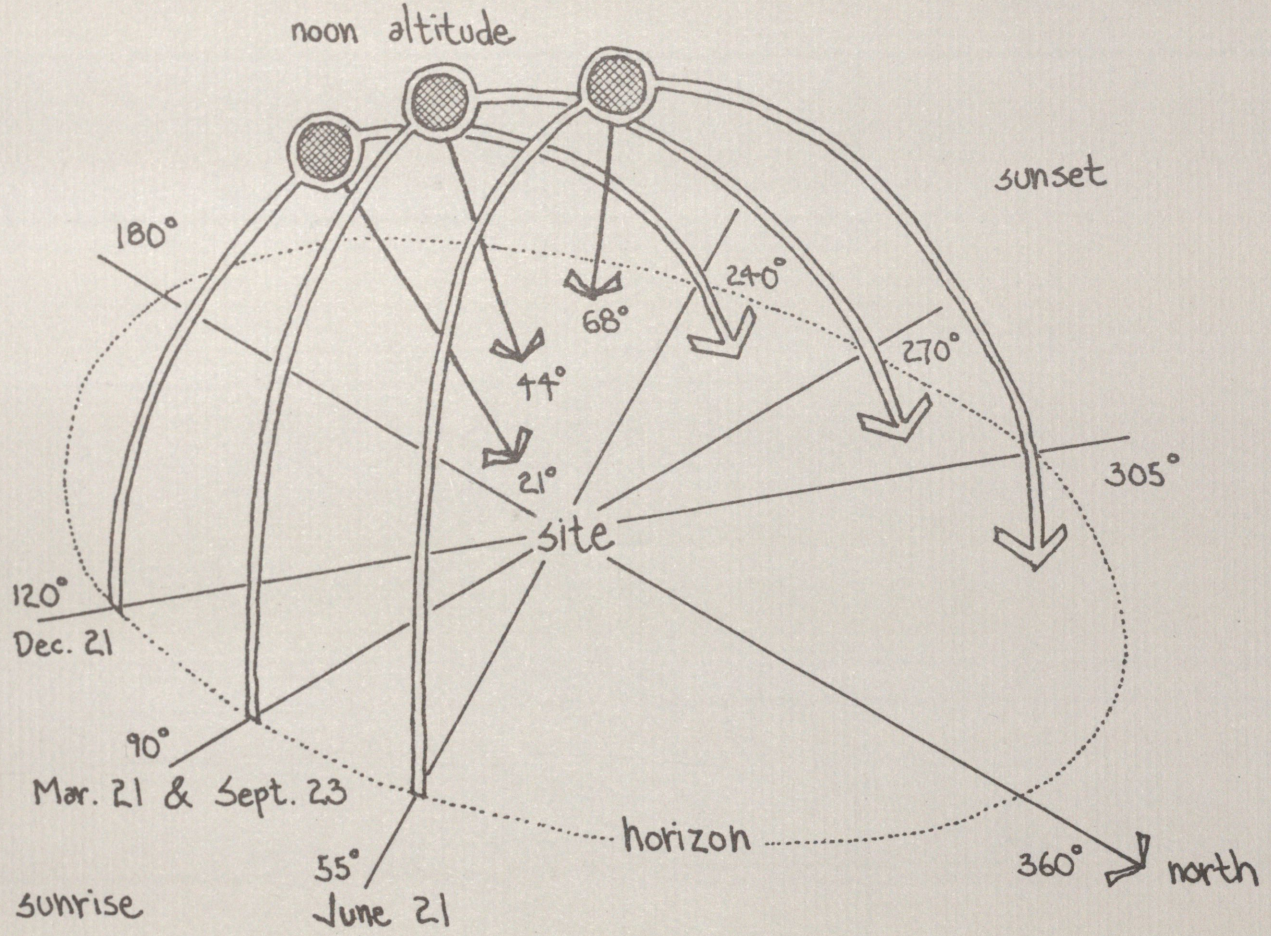
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[19] Bredsford Engineering, Wind Energy Survey, Livingston to Springdale, Montana, p. 4.

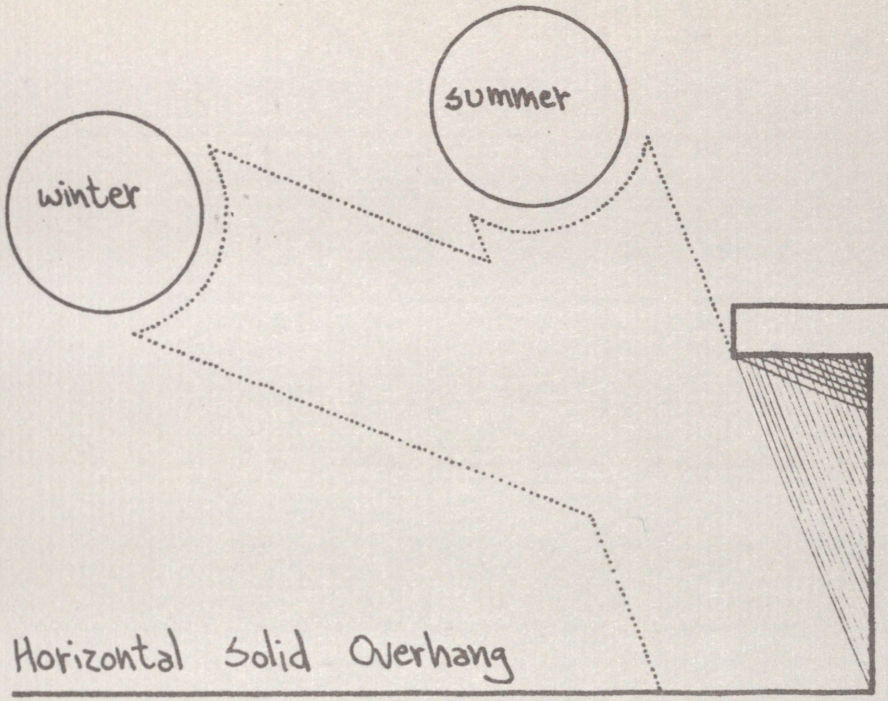
[20] Dightman, Climate Analysis and Weather Conditions for Livingston and the Encompassing Area, p. 47.

Sun

The sun's location in the sky throughout the year is by far the most important parameter of passive solar design. Its maximum angles of altitude and azimuth must be analyzed to effectively admit light for winter heating and shade it for summer cooling.

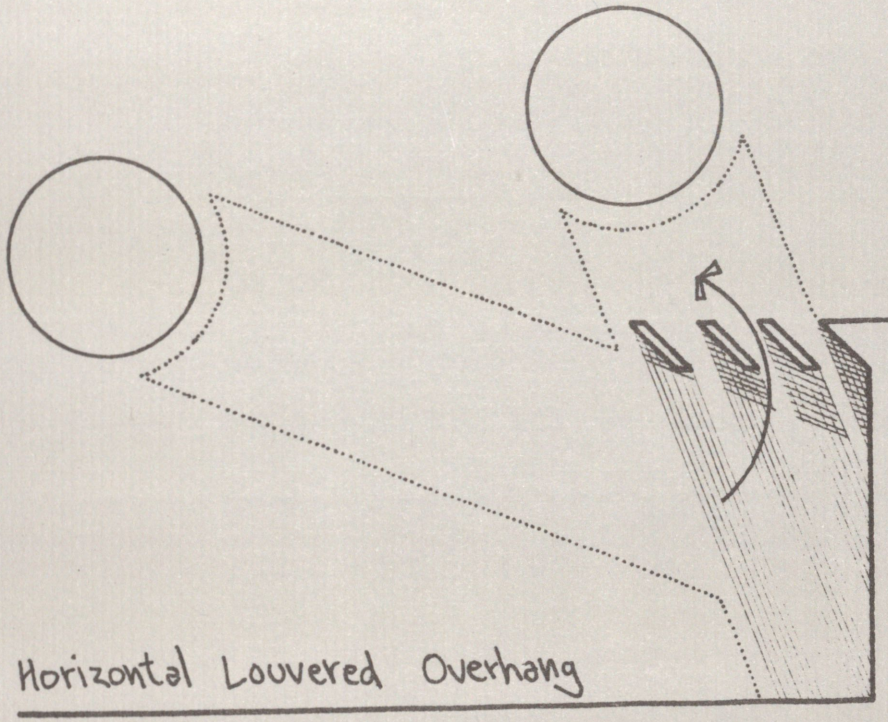


SUN PATH DIAGRAM FOR 46° NORTH LATITUDE



Horizontal Solid Overhang

blocks summer sun and admits winter sun on exterior surface



Horizontal Louvered Overhang

permits air circulation and reduces conduction heat gain on exterior surface

SYSTEMS APPLIED TO CLIMATE

Solar Windows

The size and placement of window openings are the most important factors in collecting the suns energy. For this climate, Mazria recommends using ±.36 square feet of south facing glass for each one square foot of floor area. This ratio will admit enough sunlight to keep the space at an average day temperature of 65° F to 70° F during much of the winter.[21]

Masonry Heat Storage

The objective of sizing masonry for heat storage is to minimize indoor temperature fluctuations. Mazria recommends that masonry interior walls and floors be a minimum of 4 inches thick. An 8 inch thickness is best for cloudy day storage. Direct sunlight on dark masonry surfaces should be avoided. This can be accomplished by using a number of small windows, which would admit light in patches, or by using translucent glass. One of the delights of passive solar

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[21] Mazria, The Passive Solar Energy Book, p. 119.

design is the feel of a warm floor. Therefore, it is not suggested to carpet masonry floors wall to wall.[22]

From Mazria's data, the most effective configuration of masonry heat storage is when the entire space, walls and floors become the thermal storage mass. He recommends that the surface area of masonry exposed to direct sunlight be 9 times the area of the south facing glass. Using this ratio, the daily space temperature is only 13° F.[23]

Interior Water Wall

Unlike masonry heat storage that needs light diffused over a large surface area, water in containers can absorb heat efficiently even if sunlight is concentrated on it. When using a water wall, the greater the absorbtion of sunlight, the smaller the daily temperature fluctuation in the space will be. Mazria recommends that the water wall be strategically located so that it recieves direct sunlight between the hours of 10 o'clock a.m. and 2 o'clock p.m.

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[22] Ibid., p. 134.

[23] Ibid., p. 139.

The surface of the water container exposed to light should be a dark color. He suggests using about one cubic foot of water (7½ gallons) for each one square foot of south facing glass. This ratio will give a space temperature fluctuation of 17° F.[24]

Thermal Storage Wall

For this climate, Mazria recommends the use of .94 square feet of south facing, double glazed, masonry wall for each one square foot of interior floor area.[25] The vents at the top and bottom of the wall can be about the same size as the thickness of the wall. Each row of vents total area should be equal to roughly on square foot for each 100 square feet of wall area.[26] For a water wall, he recommends .79 square feet for each one square foot of interior floor area.[27] At this climates latitude, these ratios could be sized slightly larger

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[24] Ibid., p. 149.

[25] Ibid., p. 153.

[26] Ibid., p. 159.

[27] Ibid., p. 153.

for more heat storage.

Greenhouse

When properly sized, the greenhouse not only heats itself but also the spaces adjacent to it. Mazria recommends using 1.41 square feet of of south facing glass for each one square foot of adjacent floor area with a masonry thermal storage wall.[28] If a water thermal storage wall is used in addition to the greenhouse space, it is recommended that 1.18 square feet of south facing glass be used for each square foot of floor area.[29] In all cases the glass should be double glazed. Mazria also recommends that elongated green house use the east and west walls of the building for common partitions. This reduces heat loss of east and west glass partitions and increases the amount of heat transferred to the adjacent spaces.[30]

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[28] Ibid., p. 173.

[29] Ibid., p. 175.

[30] Ibid., p. 177.

Air Thermosiphon

In this climate, with below freezing temperatures in the winter, the water thermosiphon system has some unattractive characteristics. This system would have to use some sort of anti-freeze solution as a heat transfer medium because the water in the system would freeze during the winter months. With an anti-freeze solution, a heat exchanging device would have to be incorporated. This would raise the technical level of this system beyond the scope of my research. So, keeping with the passive solar theme, the water thermosiphon system will no longer be pursued.

However, the air thermosiphon system is an attractive alternative for this climate. A great amount of rock is needed for this method requiring a large storage area capacity. A rough ratio for this system is one cubic foot of rock for every square foot of collector area.[31] The collector should be tilted at the angle of latitude (in this case it's 46°) plus 12° to 15° so that it's surface is

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[31] Davis-Schubert, Alternative Natural Energy Sources, p. 138.

perpendicular to the sun's radiation during the winter months. Its interesting to note that a collector at a 90° angle facing south provides good winter absorbtion and decreased summer absorbtion when its least needed.[32] The rock storage unit should be located so that the heat losses from the storage go into portions of the living space. For maximum efficiency, the storage space should be located as close to the collector as possible.[33]

MATERIAL PROPERTIES

As the passive solar space collects and absorbs heat, it must be able to effectively retain that heat. It is crucial that the floors, walls openings and cielings of the space be well insulated. Mazria recommends that, when using a masonry wall for thermal storage, the insulation should be placed on the outside of the wall.[34] This will prevent any heat stored in the wall from being conducted to the outside and keep

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[32] Ibid., p. 130.

[33] Ibid., p. 139.

[34] Mazria, The Passive Solar Energy Book, p. 260.

the heat inside the space.

R-values for floors, walls, and ceilings have been recommended by Owens-Corning Fiberglass, Farmers Home Administration, Federal Housing Administration, and the National Association of Home Builders.[35] These figures were compiled as guidlines for conventional homes. But, in the case of a passive solar design, the building should be insulated to the maximums shown.[36]

	OCF	FmHA	FHA	NAHB
CEILINGS	38,33	38	38	21-35
WALLS	19	19	19	12-18
FLOORS	22	19	19	16-22

note: for climate with annual degree days above 7000

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[35] Lees, Popular Science Solar Energy Handbook 1979, p. 72.

[36] Ibid., p. 73.

It is important to choose building materials that can store solar heat energy in the daytime to keep the building warm at night.[37] For best results, the heat capacity of the building material should be large. The heat capacity is the number of Btu absorbed by a cubic foot during a 1° F temperature rise.[38] For example, concrete and rock store almost twice the heat per unit volume as do pine boards. Water is by far the best heat storage material. It has a heat storage capacity 3 times greater than masonry but the fabrication of containers and structural integrity are its main disadvantages.[39] Considering cost, availability, and ease of construction all point to the use of masonry materials like adobe, brick and concrete.[40] For masonry materials there is a range of optimum thicknesses which effect the indoor temperature fluctuations.[41] As a

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[37] Mazria, The Passive Solar Energy Book, p. 26.

[38] Anderson, The Solar Age Resource Book, p. 26.

[39] Ibid., p. 26.

[40] Ibid., p. 26.

[41] Mazria, The Passive Solar Energy Book, p. 163.

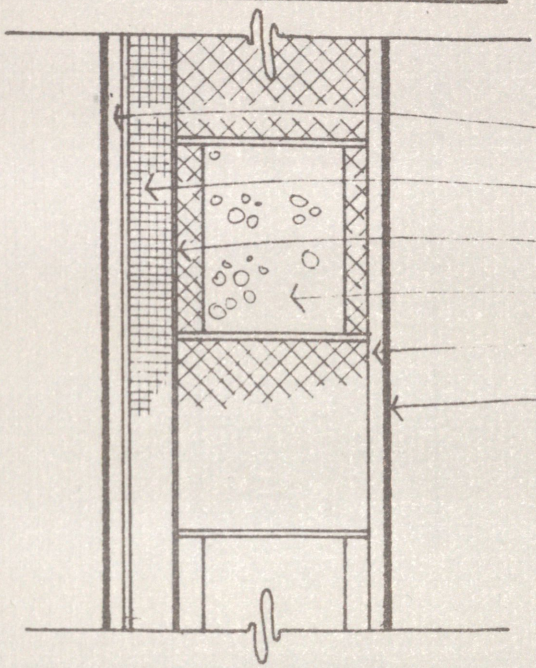
general rule, the greater the wall thickness, the less indoor temperature fluctuations.[42]

	specific heat Btu/lb/°F	density lb/ft³	heat capacity Btu/ft³/°F	thermal conductivity Btu/hr-ft-°F	most effective thickness inches	indoor temperature fluctuation °F	
						8"	12"
adobe	.22	63	14	.30	8-12	18°	7°
brick	.20	130	25	.42	10-14	24°	11°
concrete	.23	140	22	1.00	12-18	28°	16°
water	1.00	62	62	—	6+	18°	13°
steel	.12	490	59				
rock	.21	170	36				
sand	.19	95	18				
oak	.57	47	26				
pine	.67	27	18				
air	.24	.075	.018				

[42] Ibid., p. 163.

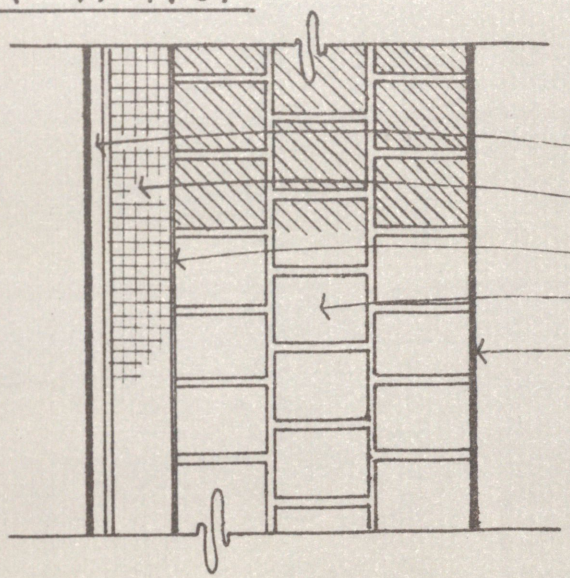
Wall Sections

CONCRETE BLOCK R=19.95



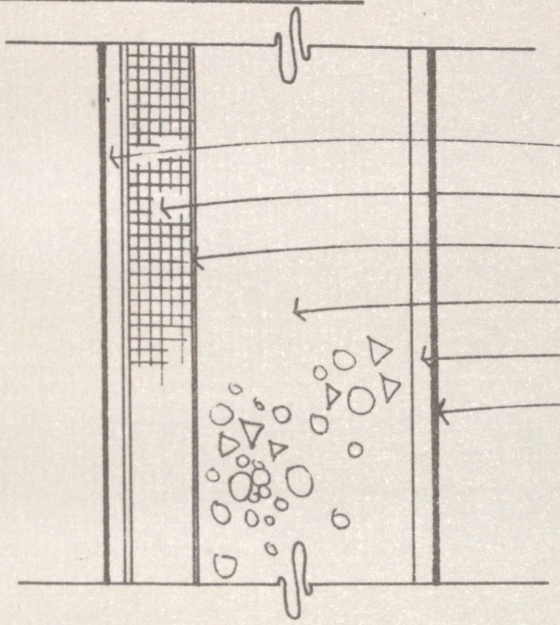
3/4" stucco r=.2
2" rigid insulation r=11
vapor barrier
12" concrete block with filled cores r=7
3/4" cement plaster r=.2
interior surface

BRICK R=19.07



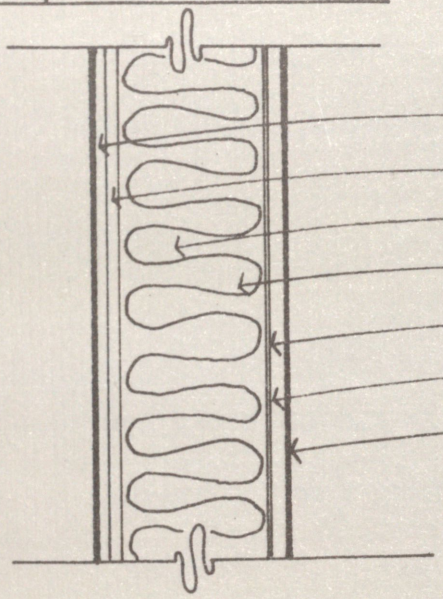
3/4" stucco
2 1/2" rigid insulation r=15
vapor barrier
3 course brick r=2.1
interior surface

CONCRETE R= 20.73



3/4" stucco
2 1/2" rigid insulation r= 15
vapor barrier
12" concrete r= 4
3/4" cement plaster
interior surface

WOOD FRAME R=20.32



1/2" siding
1/2" sheathing
2x6 studs
6" fiberglass batt r= 16
vaper barrier
1/2" gypsum wallboard r= .45
interior surface

For more information on the resistances (R) of building and insulating materials see ASHRAE Handbook of Fundamentals.

CONCLUSION

Active systems which involve the use of collectors, circulation apparatuses and storage areas, are basically applied to a building's structural envelope. At this point in time, the maintenance of these systems seems to be a constant problem. This is due to their relatively high technology of moving mechanical parts and fluids. Inevitably, the fluids leak and the mechanical parts must be maintenanced to insure their continuing performance.

In terms of cost, longivity, ease of maintenance, and system operation, passive systems make the most sense. These systems have no mechanical devices like fans, pumps or heat exchange units. They physically integrate the collector, storage and building into a single composite structure.

Masonry and glass are the most common materials used to construct passive systems. These materials are readily available and their fabrication is already familiar to builders. Because of this, it is often said that the costs tend to be low for passive systems. But, concerning their fabrication this belief is not necessarily true. Even though the

materials offer a two part role: glass providing natural light and views, and masonry, providing structure as well as thermal storage, their fabrication in passive solar applications still confuses builders.[43] As soon as they realize the building is out of the ordinary, they up their costs for services. The complexity of the structure is magnified because the building's structural and thermal mass is located inside the insulation envelope. There are also applications of elaborate shading and insulation devices to prevent overheating and heat loss over the large surfaces of south facing glass.

Since passive systems have slightly higher initial costs than conventionally designed buildings, the client must be convinced of the advantages of his investment. This is hard to do because the client is generally interested in systems that show an early return on his initial investment. For this reason, inexpensive buildings are erected that incorporate principles of higher energy consumptions to reduce initial costs. However, if a comperative cost analysis were to be done over a period of time,

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[43] Balcomb, Progressive Architecture, April 1979, p. 106.

the overall cost and energy expenditure would be lower for a passive system.[44]

States have now established financial incentives to make solar building alternatives more attractive. In Montana, a public utility is allowed to lend capital for installation of solar systems in dwellings at a rate not exceeding 7% per year. Also allowed is a personal and corporate income tax deduction for a capital investment in a building for a solar system. Maximum deduction for a residence is 1800 dollars and 3600 dollars for a non-residential building. This information was compiled in 1978 by Montana's public service commission and state department of revenue.[45]

Limited applications and performance measures are involved with passive systems in general. One cannot rely on a passive system to supply 100% of a buildings heating and cooling demand. The addition of some conventional back up heating system is inevitable. This

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[44] Davis-Schubert, Alternative Natural Energy Sources, p.40.

[45] Smay, Popular Science Solar Energy Handbook 1979, p.12.

is due to the fact that each system's heat storage capacity is an integral part of the building's structure. The system's ability to respond quickly to outdoor temperature changes is greatly impeded.[46] The building's space fluctuates in temperature along with the heat storage mass. Back up heating is needed to reduce excessive temperature fluctuations. This is especially true in the morning hours when the heat storage mass has cooled down and is no longer radiating heat into the space.

Concerning specific systems, a thermal storage wall will maximize the the heat gain more than direct gain which allows greater temperature fluctuations. However, thermal storage wall is harder to insulate than a direct gain system. This is because of the limited space to work with between the glass and the wall. An attached greenhouse is subject to larger temperature swings than other systems but it offers more flexibility with regard to useable living space.[47] It also offers a view and natural light as compared to a thermal storage wall which can block views.

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[46] Mazria, The Passive Solar Energy Book, p. 65.

[47] Balcomb, Progressive Architecture April 1979, p. 107.

The complications of these systems can be easily overcome with a little innovation. Clear glass or plexiglass tubes filled with dyed water for greater absorbtion would give a thermal storage wall both views and light. These tubes could incorporate an internal plane of dark material. By simply rotating the tubes, one could achieve direct and thermal storage wall gain in one system.

If properly designed the temperature fluctuations of a passive system can be reasonably controlled. Still, cloudy days are inevitable in any climate. However, these systems are capable of collecting every bit of energy that passes through the glass being either direct or diffuse.[48] Without properly designed shading devices, the collection of energy in the summertime may cause the space to become overheated. One must realize that glass can act as a radiation trap and create an excess buildup of unwanted solar radiation. The way to avoid this excess build up of heat is to place a shading device outside

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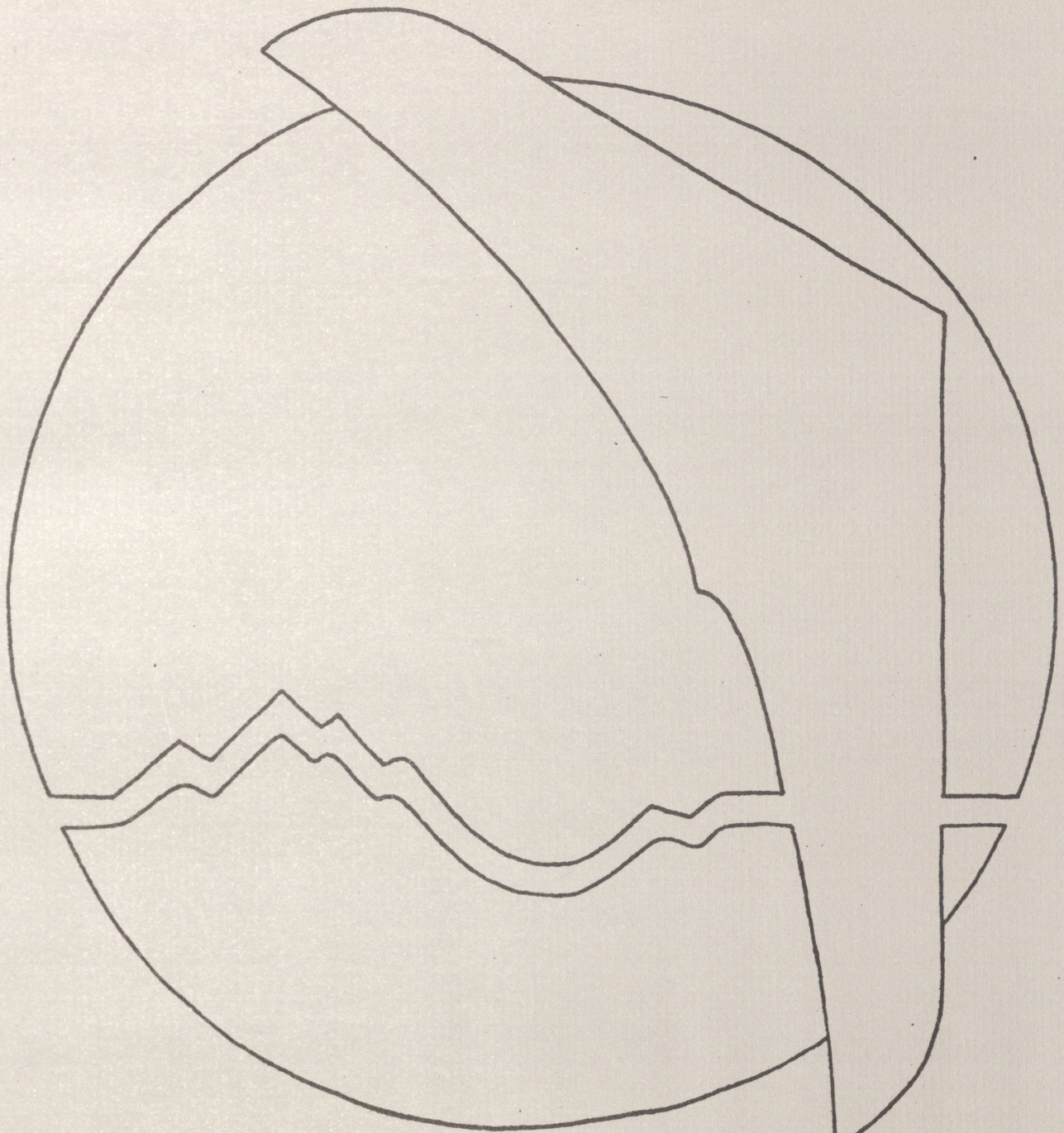
[48] Mazria, The Passive Solar Energy Book, p. 29.

the glass surface.[49]

Passive solar design has added a new dimension to the ever-dynamic concepts of architectural space. I feel that as the publics' awareness of solar systems increases, the demand for it will increase proportionally. The advantages are not only economic, but aesthetic as well. I wish to behold a revolution of solar architecture. Architecture that will modulate spaces with natural, energy producing light. Light that will help plants to grow or warm a floor to be touched by a bare foot.

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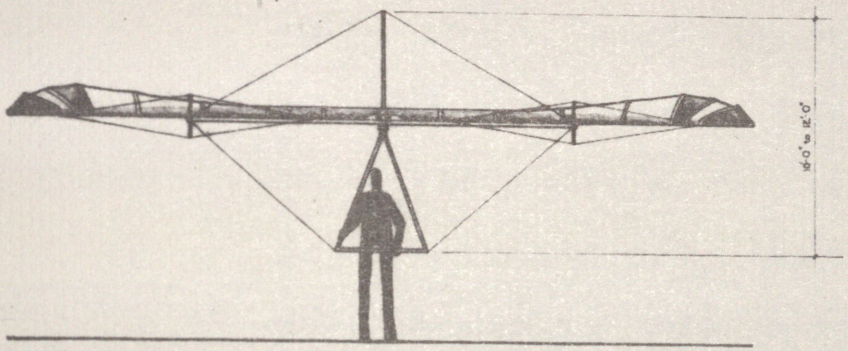
[49] Davis-Schubert, Alternative Natural Energy Sources, p. 32.



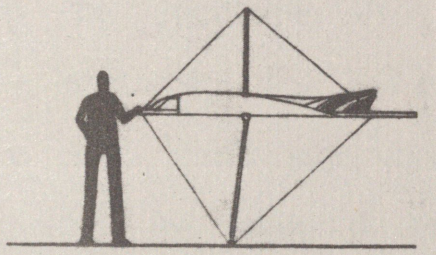
PROGRAM

... Jonathon saw that there was as much to learn about flight in this place as there had been in the life behind him. Here were gulls who thought as he thought. For each of them, the most important thing in living was to reach out and touch perfection in that which they most loved to do, and that was to fly. They were magnificent birds, all of them, and they spent hour after hour every day practicing flight, testing advanced aeronautics.

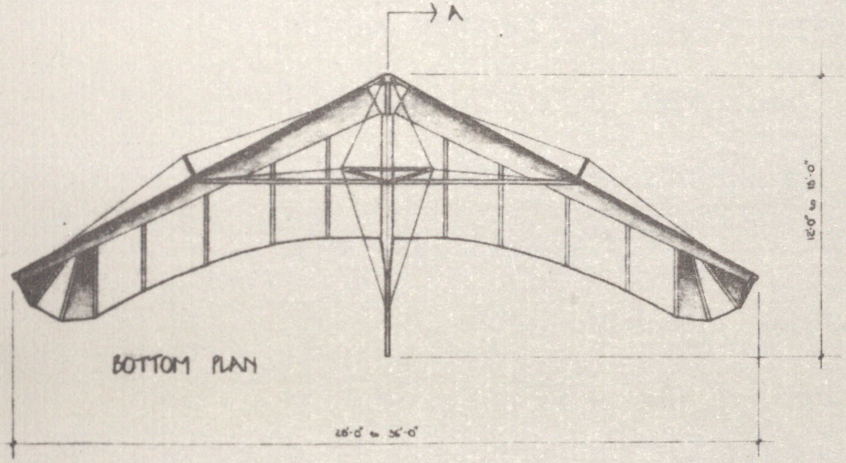
- JONATHON LIVINGSTON SEAGULL



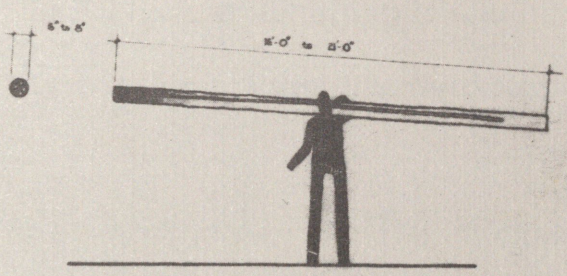
FRONT ELEVATION



SECTION A



BOTTOM PLAN



FOLDED VIEW & SECTION

GOALS

The paramount objective at this point is to articulate a concept for a flight resort. I feel that a facility for hang gliding should present an expression of the sport. Like the sport, the built form should be perceived by its users as an environment that is exciting, safe and efficient. The building should be strategically located to have the least interference with the natural wind flow on the site. An image of the areas history should somehow be applied which includes the mining towns on Trail Creek and Chico Hot Springs. The building must be sensitive to the natural environment and communicate the spirit of hang gliding to those individuals who experience it.

This facility, located on the southside of The Hogback in Paradise Valley will be defined as a total flight resort. The facility will be controlled by an owner/operator who resides at the resort. Four major services will exist within the facility. These include: a school for learning hang gliding, a retail shop for hang glider parts and supplies, a restaurant with a small menu, and accommodations for lodging. The lodging accommodations will furnish beds, storage and bathrooms

but meals will be prepared by the owner and served in the restaurant. Having the guests assemble for certain regular meals will enable them to interact with other tourists as well as the owner. It is hoped this interaction will help achieve a better quality of tourism at the flight resort.

The flight resort will be designed in a 2 phase series. The 1st phase will include the four major sevices at a small scale. This phase will allow the resort to operate and become recognized until it can expand. The 2nd phase will basically be an elaboration of the 1st phase, with the most emphasis on the addition of private rooms for lodging.

COMMON SPACES

LOBBY

square feet: 400

considerations: arrival area, small gallery/museum for rotating displays and exhibits

LOUNGE

square feet: 200

considerations: social area, fire place or wood burning stove, adjacent to restaurant

RESTAURANT

square feet: 600

considerations: bar area for special events and occasional parties, dining area for guests

OBSERVATION DECK

square feet: NA

considerations: adjacent to lounge/restuarant, tower for pilots and spectators to observe site

RESTROOMS

square feet: 2 @ 80 = 160

considerations: for public access, adjacent to lobby

CORRIDORS / CIRCULATION

square feet: 5 to 10 percent of total

considerations: NA

PILOT SERVICE SPACES

RETAIL SHOP

square feet: 800

considerations: display area for 3 gliders, accessory showroom, adjacent to maintenance space

WEATHER SERVICE

square feet: 70

considerations: teletype terminal, wall area for maps, adjacent to lobby and public

CLASSROOM

square feet: 600

considerations: meeting area for school, clinics, seminars, area for simulation mechanism, audio-visual

MEDICAL ROOM

square feet: 150

considerations: bed, first aid supplies, adjacent to garage

WORKSHOP

square feet: 800

considerations: sail loft for one laid out sail, area for one assembled glider, sewing machine, 50 foot by 3 foot chute repacking table, storage area for 100 gliders cieling suspended

LODGING SPACES

BUNKHOUSE

square feet: 800

considerations: area for 12 beds, common area, 2 bathrooms, sauna and hot tub room, storage

SINGLE PRIVATE ROOMS

square feet: 5 @ 200 = 1000

considerations: bed and bathroom, storage

DOUBLE PRIVATE ROOMS

square feet: 5 @ 300 = 1500

considerations: bed and bathroom, storage

OWNERS DWELLING

square feet: ± 2500

considerations: 2 bedrooms, family room, bathroom, dining and kitchen, storage

ADMINISTRATION SPACES

OFFICES

square feet: 200

considerations: school - retail area, restuarant - lodging area, adjacent to reception, desks, storage

RECEPTION

square feet: 80

considerations: information / registration counter, adjacent to lobby

MAINTENANCE

square feet: ±900

considerations: personel workshop for school, lodging, restaurant, adjacent to retail shop and pilot service workshop, storage for tubeing, hardware, tools, harnesses, 10-25 gliders, rafts and canoes

MAIDS

square feet: 200

considerations: washing and drying machines, storage for linens and cleaning supplies

KITCHEN

square feet: 300

considerations: refrigeration, pantry, cooking, washing, storage, adjacent to garbage

MECHANICAL

square feet: 5 to 10 percent of total

considerations: NA

GARAGE

square feet: 600

considerations: parking for ambulance, 2 access vehicles adjacent to maintenance

PARKING SPACES

PUBLIC

square feet: 4800 plus drives

considerations: area for 30 cars, adjacent to lobby

GUEST

square feet: 3200 plus drives

considerations: area for 20 cars, adjacent to private rooms and bunkhouse

SERVICE

square feet: 600 plus drives

considerations: adjacent to garage, garbage, owners dwelling

COMPLETE PHASE I FACILITY

square feet: ± 18,000

COMPLETE PHASE II FACILITY

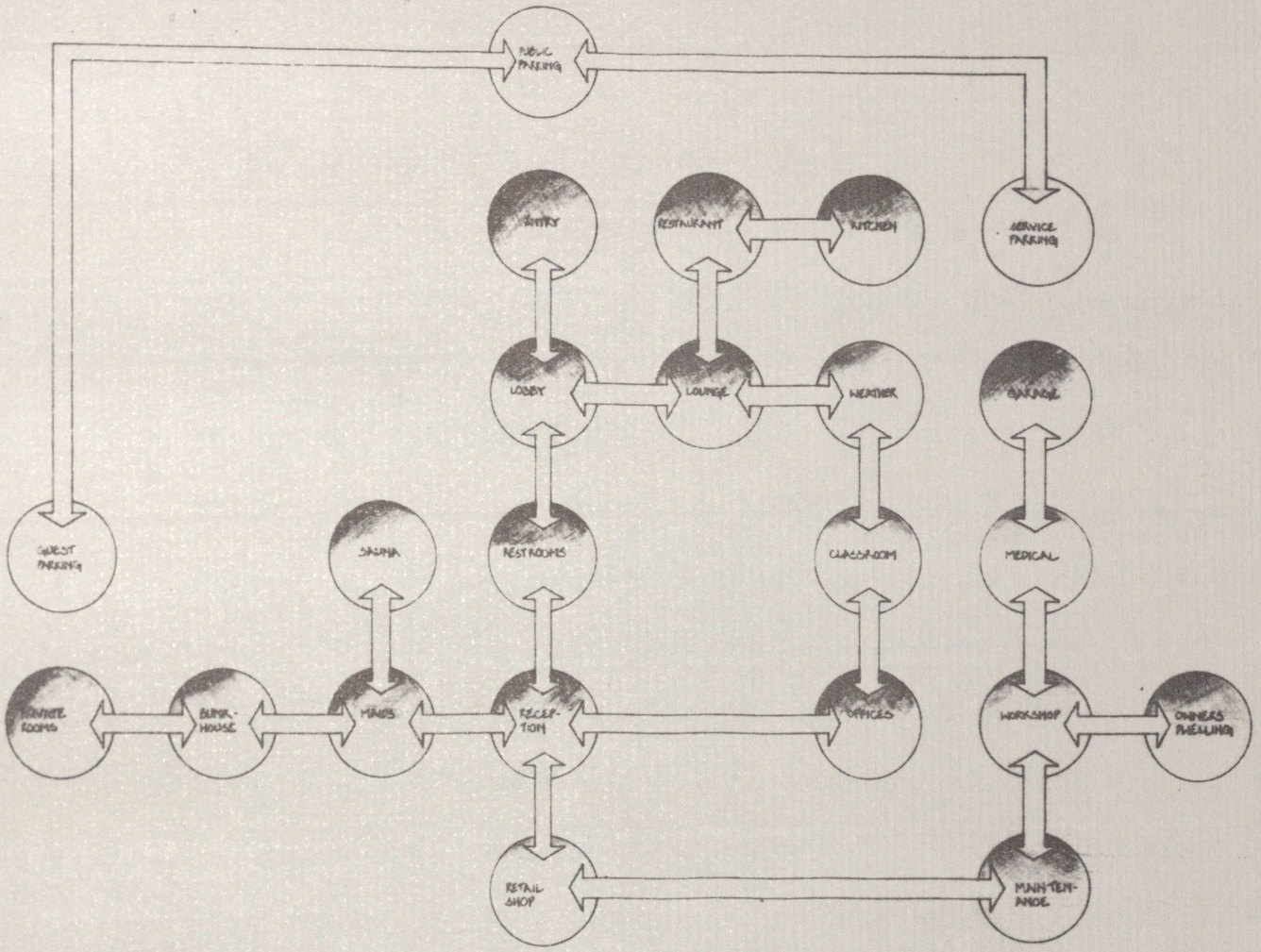
square feet: ± 20,000

CLASSIFICATION	SPACES	ZONES						ENVIRONMENT										QUANTITY		
		ACTIVE	PASSIVE	SECURE DAY	SECURE NIGHT	OWNER/OPERATOR	GUEST/PUBLIC	COOL	WARM	ARTIFICIAL LIGHT	NATURAL LIGHT	NOISY	QUIET	WINTER VENTILATION	SUMMER VENT.	VIEW REQUIRED	VIEW NOT	PHASE ONE	PHASE TWO	APPROXIMATE □′
ADMINISTRATION	OFFICES	○			○	○			○	○	○		○	○	○	○			○	200
	RECEPTION	○				○	○		○	○	○	○		○	○		○	○		80
	MAINTENANCE/STORAGE		○	○	○	○		○		○		○			○		○	○		900
	MAIDS/LAUNDRY	○	○	○	○	○		○		○			○	○	○		○	○		200
	KITCHEN	○			○	○			○	○	○	○		○	○	○		○		300
	MECHANICAL		○			○		○		○		○					○	○		500
	GARAGE		○	○	○	○		○		○	○	○			○		○	○		600
LODGING	OWNERS DWELLING	○	○		○	○			○	○	○		○	○	○	○		○		2500
	BUNKHOUSE	○	○				○		○	○	○	○	○	○	○	○		○		800
	PRIVATE ROOMS		○				○		○	○	○		○	○	○	○			○	2500

spatial analysis

SPACES	CLASSIFICATION	ZONES						ENVIRONMENT										QUANTITY		
		ACTIVE	PASSIVE	SECURE DAY	SECURE NIGHT	OWNER/OPERATOR	GUEST/PUBLIC	COOL	WARM	ARTIFICIAL LIGHT	NATURAL LIGHT	NOISY	QUIET	WINTER VENTILATION	SUMMER VENT.	VIEW REQUIRED	VIEW NOT	PHASE ONE	PHASE TWO	APPROXIMATE □′
COMMON SPACES	LOBBY	○					○		○		○	○			○	○		○		400
	RESTROOMS		○			○	○	○		○			○	○	○		○	○		160
	RESTAURANT	○			○	○	○		○		○	○		○	○	○		○		600
	LOUNGE	○					○		○	○	○	○		○	○	○		○		200
	OBSERVATION DECK	○					○					○				○		○		
PILOT SERVICE SPACES	RETAIL SHOP	○			○	○	○		○		○		○		○		○	○		800
	WORKSHOP/STORAGE		○	○	○		○	○		○			○		○		○	○		800
	WEATHER SERVICE	○			○	○	○	○		○			○				○	○		70
	MEDICAL ROOM		○			○		○		○			○				○	○		150
	CLASSROOM	○					○		○	○	○	○		○	○	○		○		600

spatial analysis



SPACE ADJACENCY STUDY

spatial analysis

FEASIBILITY

The question of a flight resort operating as a money-making investment must now be investigated. This thesis will explore the positive and negative parameters of making a flight resort a reality for Paradise Valley.

Unlike the sport of skiing, hang gliding is not a volume business. The number of people that hang glide is significantly lower than the number of people who participate in skiing. However, skiing is a much older sport and has had more time to be accepted and tried. The sport of hang gliding is relatively brand new. Since its birth in the mid 60's, the public is just now becoming more aware and interested in the sport. As the popularity and interest in hang gliding increases, there becomes a need for a facility to teach and promote the sport. Without this kind of facility, the public becomes exposed to the sport through rumors and prejudice. People hear the stories of the hang glider pilot who was killed years ago instead of the flights that are now lasting hours from a 200 foot hill. A facility is needed to offer professional instruction and to educate the public on the advancing technologies of the sport. With this kind

of facility in Paradise Valley, the sport could be promoted, encouraging more people to participate in it.

Hang gliding will always maintain a limited audience of participants. The sport isn't for everyone, especially those with a fear of heights. However the sport has an amazing ability to attract the spectator/tourist. The facility could also capitalize on the profits supplied by onlookers and spectators. These people could be catered to by means of lodging, dining and other activities besides hang gliding. In this case, Paradise Valley offers a large variety of outdoor activities. Some of these

indude: year round fishing and floating on the Yellowstone River, hiking, horseback riding, cross country and helicopter skiing, snowmobiling, and Chico Hot Springs. These activities are not only attractive to the tourist, but also as alternative activities for the hang glider pilot on non-flyable days.

Paradise Valley is located between Livingston and the north access to Yellowstone National Park. A constant flux of tourists travel through Paradise Valley to and from the park on U.S. highway 89. Having the flying site visable from the highway is a stimulus for promotion and the curiosity of passers-by. This would be especially true when

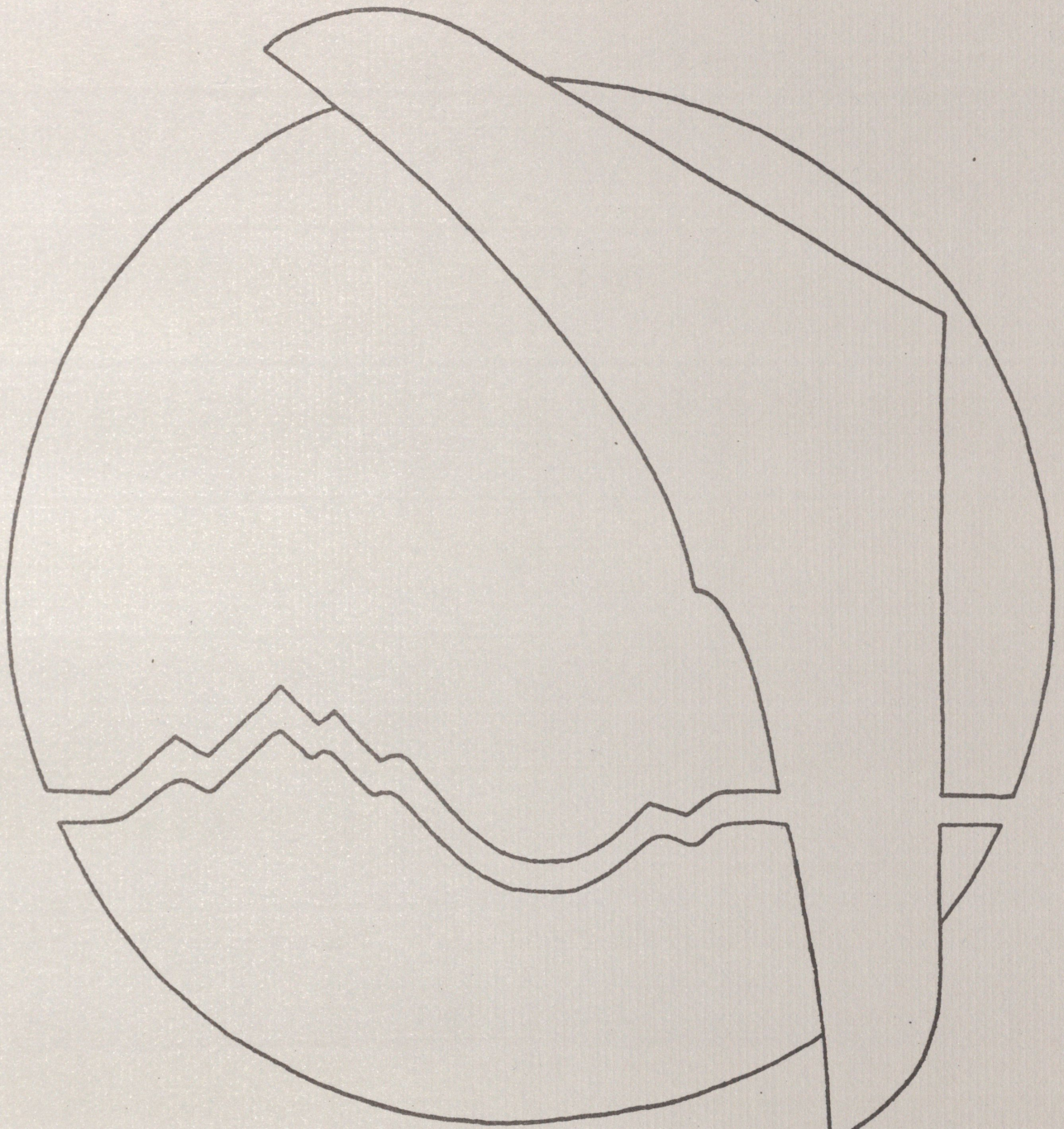
a number of hang gliders are soaring. The brilliant colors of hang glider sails in the sky would be more effective than any billboard could be to advertise the facility.

As the technology and design of hang gliders is ever-improving, so are the methods of teaching the sport. The more accident-free the sport becomes to learn, the more desirable it will become for people to at least try it. For example, Crystal Flight Resort is now experimenting with a cable system which suspends a hang glider from take off to landing. This system enables the beginner to experience the sensation of flight without becoming discouraged from a bad take off or landing. Also, this system will provide an additional attraction for tourists, as they will be able to "ride" a hang glider.

The average cost for a beginning hang gliding lesson is around 40 dollars a day. The lesson includes classroom introduction, audio visual simulation, hands-on experience, and actual flying from a small slope. Optional lessons are usually available for the novice and intermediate pilot to improve their skills. With the Montana State University campus 32 miles away in Bozeman, a hang gliding school

would be a very profitable source of income for a flight resort. The university would provide a constant turnover of students interested in hang gliding and even offer credit for a course if such an operation existed. Hang gliding can be practiced year round. Where snow is essential for skiing, a slope and wind is all that is needed to fly.

The flight resort would also attract people who fly in places where the flying sites are few and far between. Here, they would be able to stay for the week or weekend, fly the nearby sites, socialize with other participants of the sport, and enjoy the other activities Paradise Valley has to offer. At times, the community of Livingston would also prosper, as the flight resort would have the option to hold a national meet or local fly-in. The overflow of pilots and onlookers would generate income for surrounding businesses during the event.



SITE



the hogback - aerial view

THE HOGBACK

The Hogback is located 8 miles south of Livingston and 1 mile west of U.S. highway 89 on Trail Creek Road. It is a 3 ½ mile, 1700 foot ridge that runs east and west, facing north and south. The specific site for the proposed flight resort will be located on The Hogback's south side.

The south side has a wide variety of plant types and wildlife. Rangeland or pasture, in fair or poor condition, exists on the lower part of the south slope. Some of the plant types in this rangeland include Blue Bunch Wheatgrass, Prairie Junegrass, Western Wheatgrass, and Sagebrush. The upper portion of the south slope is covered mostly with forest. The types of trees which make up this forest include Subalpine fir (65%), Douglas fir (25%), and Engelmann spruce (10%). Observing wildlife at The Hogback is a common occurrence. Deer, elk, gophers, grouse, ravens, hawks, bald and golden eagles are seen most often. Moose, mountain lion, bear, and rabbits are only seen occasionally.

The geology of the south side can be described as mostly Laporte (65%) and Musselshell soils over granite

and limestone outcroppings. The depth to the granite and limestone bedrock through the upper soils is typically less than 48 inches. Even though these soils are classified as well drained mountain soils, their erosion potentials are maghified as the steepness of the slope is increased. This erosion is also due to the shallow soil depth to the bedrock. However, low precipitation statistics for Paradise Valley make it possible to succussfully develop the south side regardless of the erosion potentials. Areas of severe erosion should be analysed to determine the best areas of development on the site.

The site is bordered by Trail Creek Road to the south and the steep proclivity of the south slope to the north. Bozeman is located 25 miles to the west on Trail Creek Road. This road is gravel, moderately used, and is often termed the scenic shortcut to Paradise Valley from Bozeman.

The lower south slope can be best described as vast. This vastness is due to the lack of trees and the presence of grassy rangeland. The lack of natural obstructions on the site provides a very scenic panarama of Paradise

Valley. There is also unlimited areas to land a hang glider. It is an undesirable situation, especially for beginners, to land a hang glider in a predetermined area.

According to the Park County Planning Office, the area on the south side is in an unrestricted building zone. If the land is purchased, the owner has the power to develop it any way he pleases. For example, someone could construct a highrise apartment building, while someone owning the adjacent land could develop a pig farm. Land in this area of Paradise Valley is generally divided and sold in 20 acre parcels for 1500 dollars an acre. The most desirable situation for a flight resort would be to initially invest in 20 acres near the top and 20 acres near the bottom of the south slope. This would secure a takeoff and landing area for the future, regardless of what was done with the adjacent sites, although some land use restrictions should be investigated to prevent someone from building a high-rise near the flying areas.

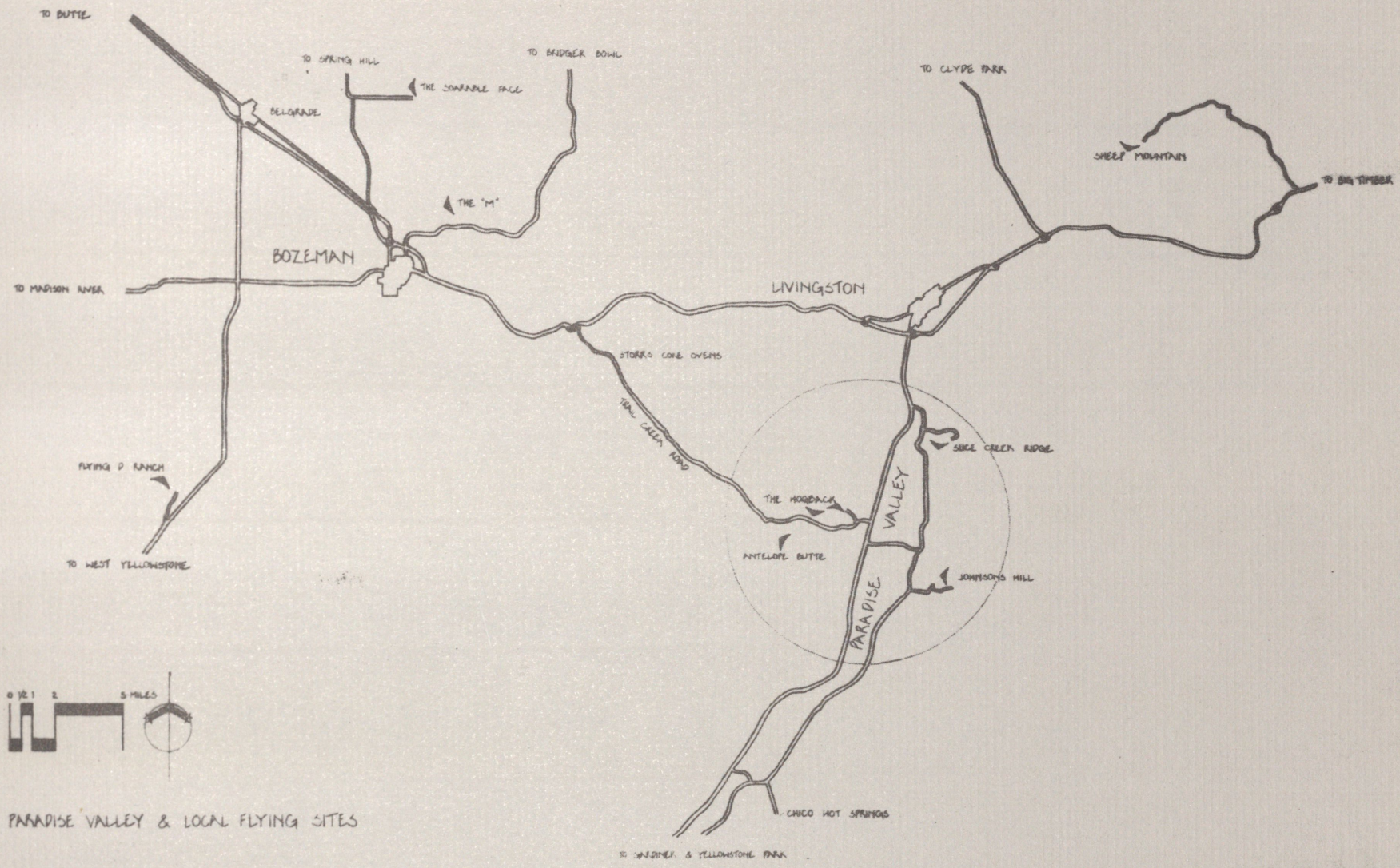
In the sport of hang gliding, land use is intensive, especially for training beginners. A mild slope is needed that may be up to 100 feet above a large unobstructed

landing area. Someone learning the sport will progress from the lower part of the slope to the higher part. Short, straight flights, lasting only seconds, are practiced until takeoff and landings are smoothly executed and under control. Progressing to the higher part of the slope will enable the beginner to make small turns and glide further into the landing area. An advanced pilot can easily land his glider in a predetermined area.

While in the air, hang gliders have no impact on the environment. Only the takeoff area, the landing area and the access to the takeoff are the most heavily used by the sport. The access to the takeoff area for this particular site can be accomplished by a road or hiking trail. The road would have its use limited to the authorized access vehicles of the resort. This would prevent excessive maintenance and erosion if many pilots drove to the takeoff area independently.

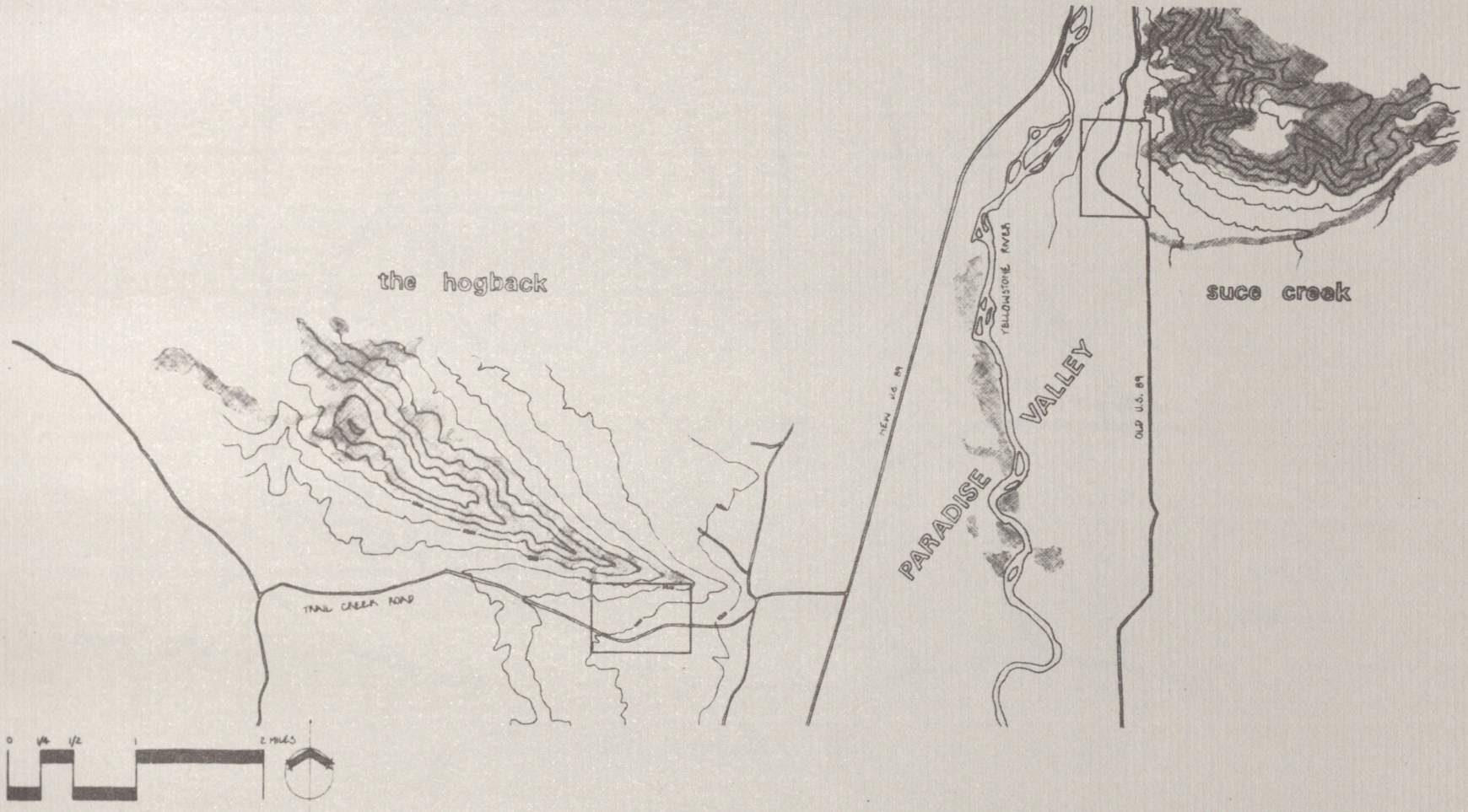
Another consideration for a means of access to the takoff area is a lift. At Hager City, Wisconsin, a custom tramcar, that carries 5 pilots and their gliders to the top of a 330 foot bluff, is used. But, according to Boris

Popov, who owns the site, the upkeep of the lift is a "constant hassle". I feel that a road with access vehicles will be the most reliable form of transportation to the take off area. Repair and maintenance of an automobile would eliminate the employment of a specialty maintenance person to keep a custom lift in operation. Of course there would be a minimum charge to the pilots for a ride to the take-off. However, this would not approach the lift ticket situation at Hager City which now charges pilots 10 dollars a day to use the lift. Also, at The Hogback, pilots would have the option of hiking their gliders to avoid an access vehicle fee or waiting for a ride to the top.



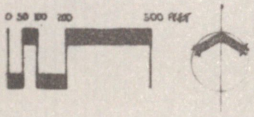
PARADISE VALLEY & LOCAL FLYING SITES

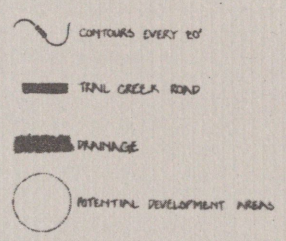
site analysis



site analysis

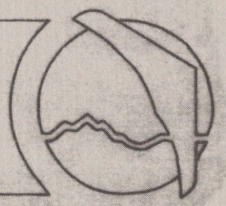


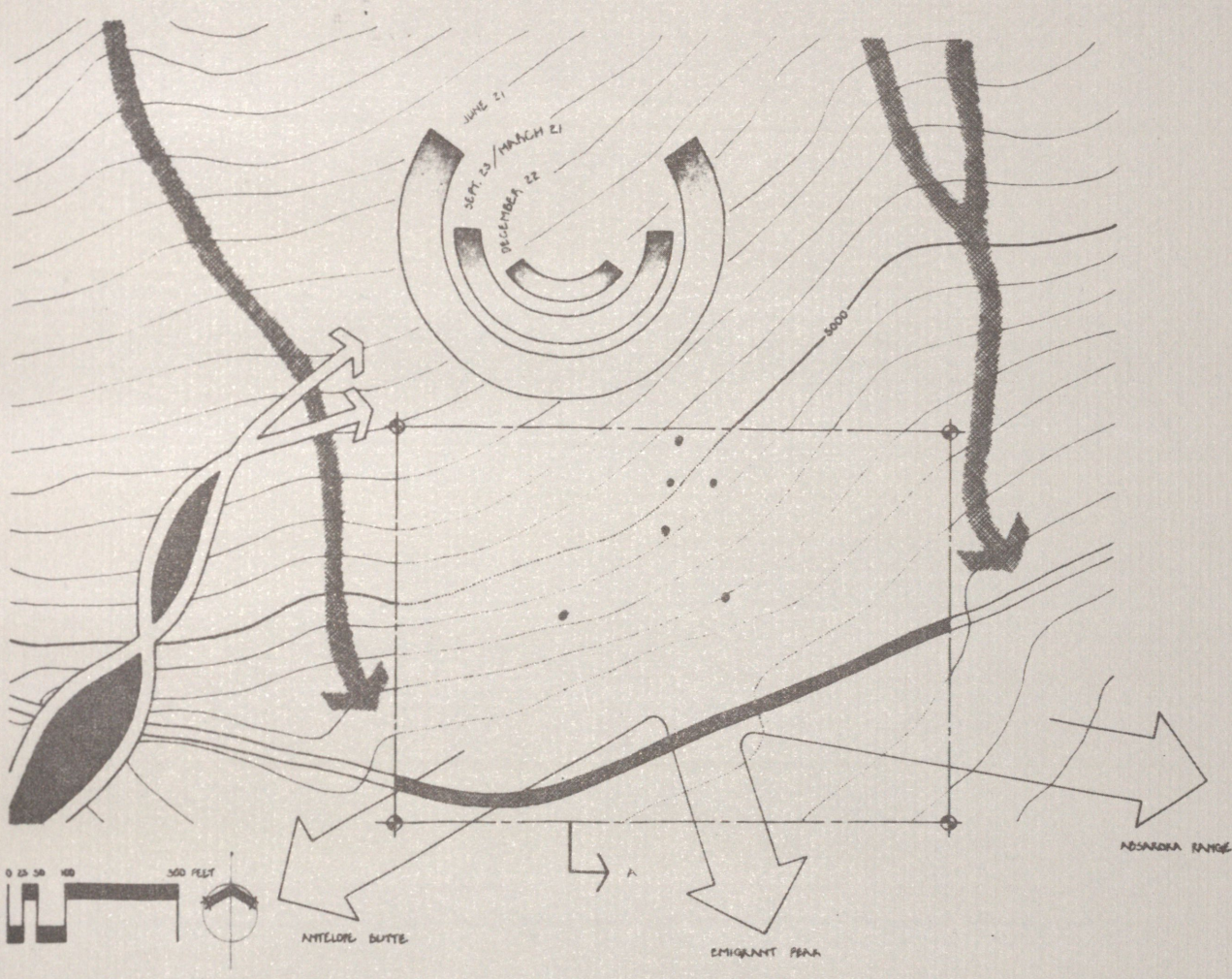


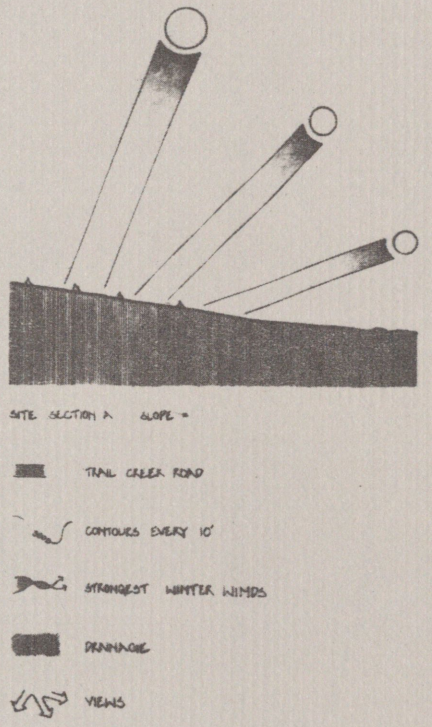


the hogback

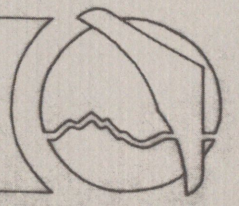
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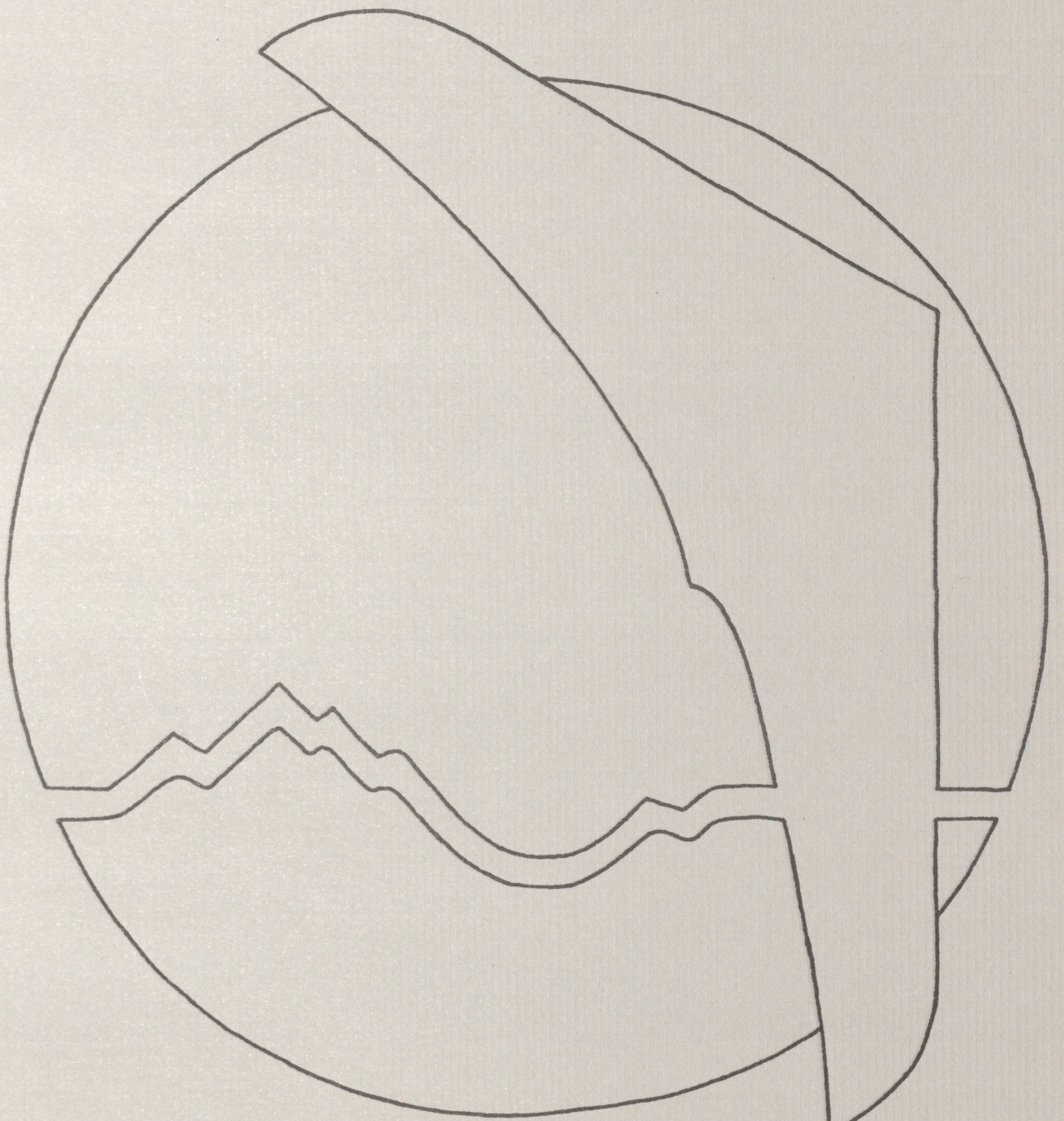




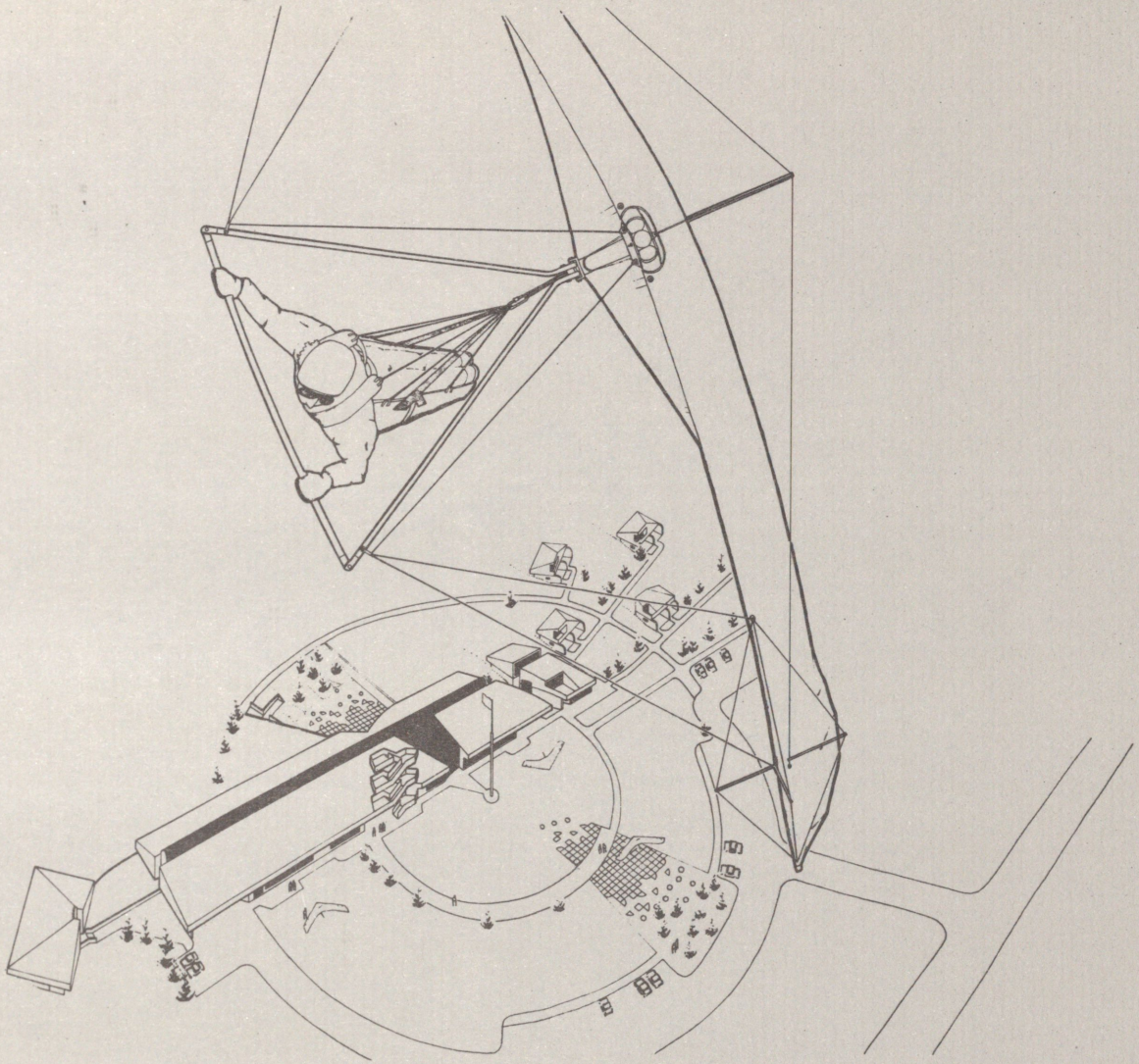


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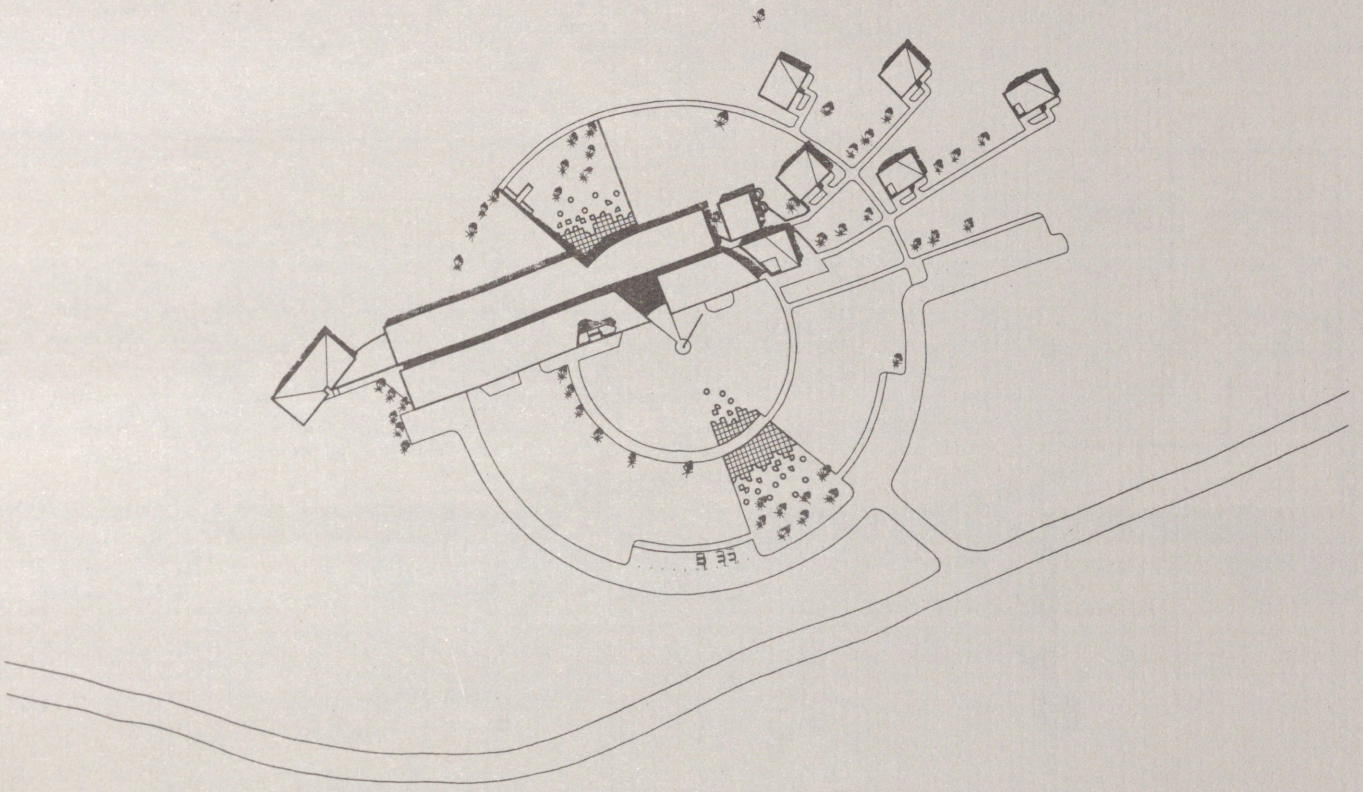




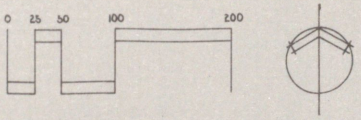
PRESENTATION

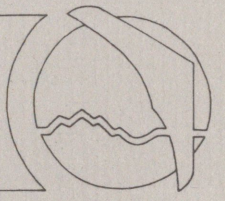


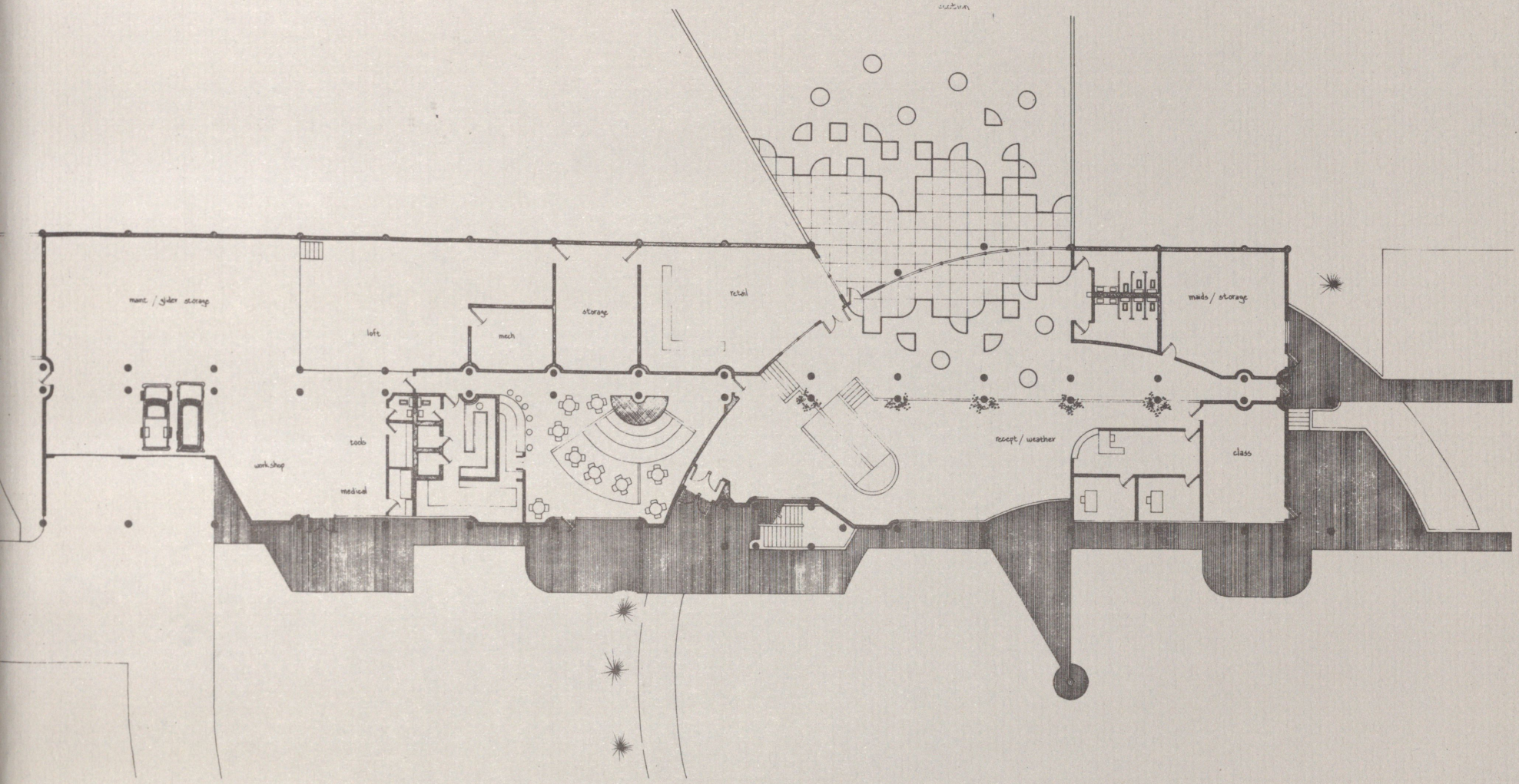
paradise valley flight resort



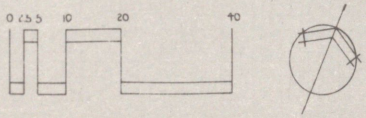
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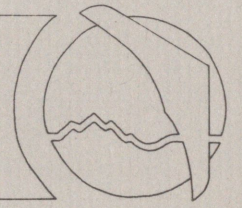


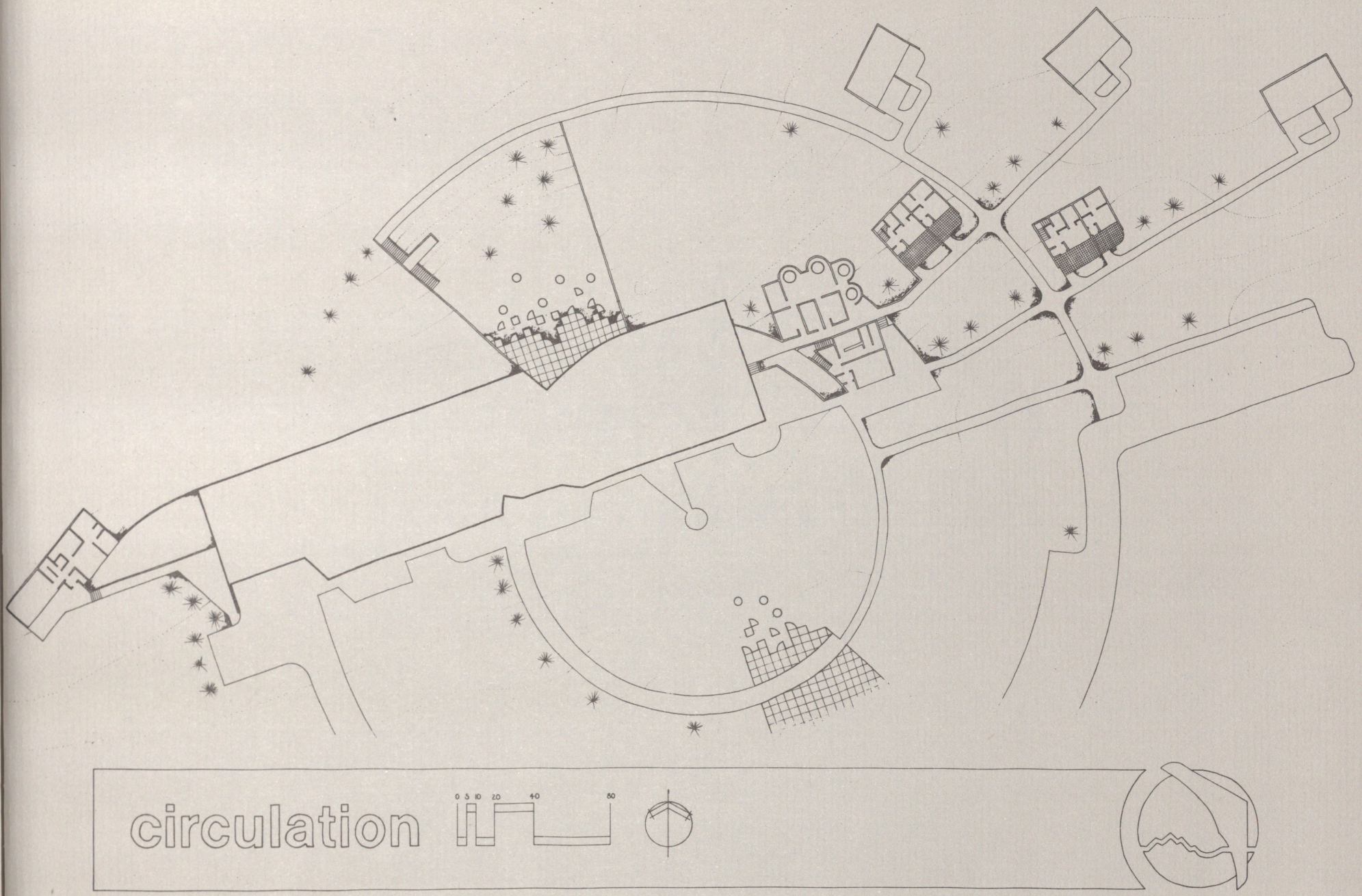

maint / glider storage
loft
mech
storage
retail
maids / storage
tools
work shop
medical
recept / weather
class

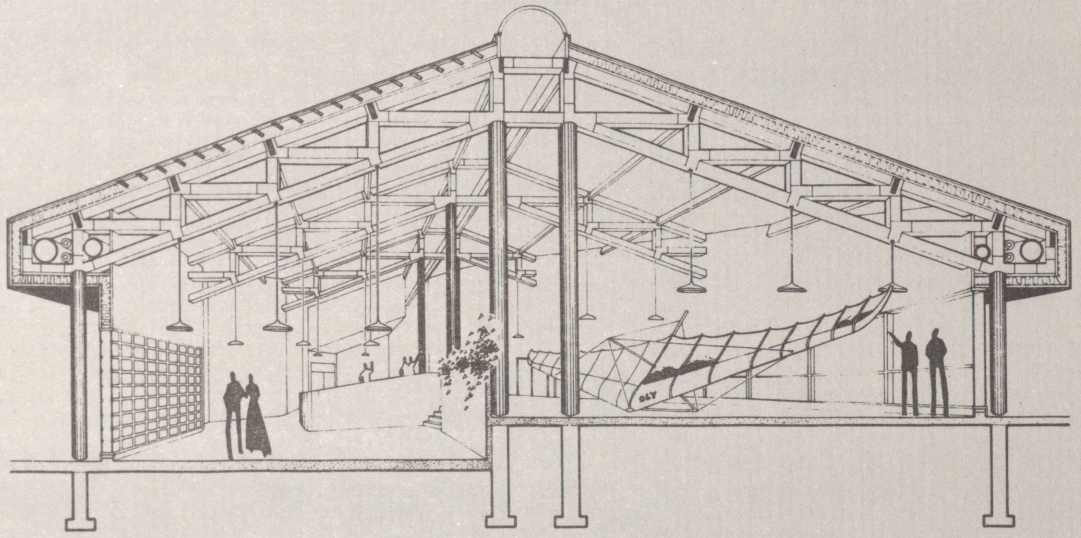
plan


0
5
10
20
40

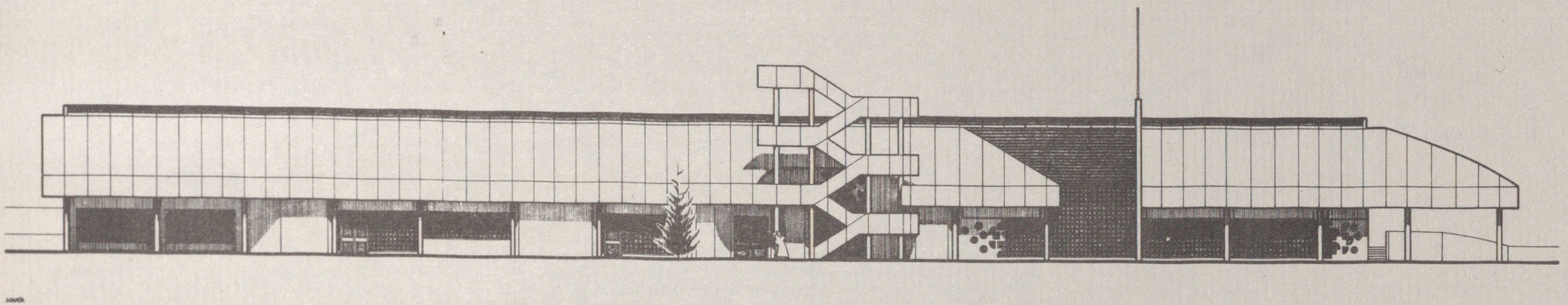




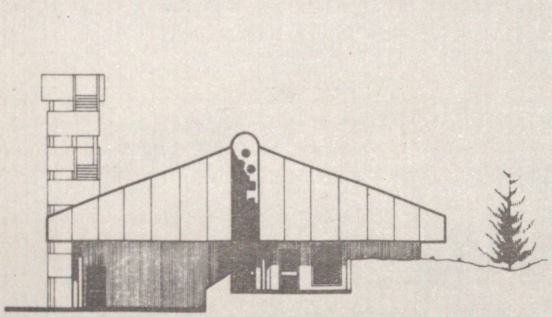

circulation
0 5 10 20 40 80



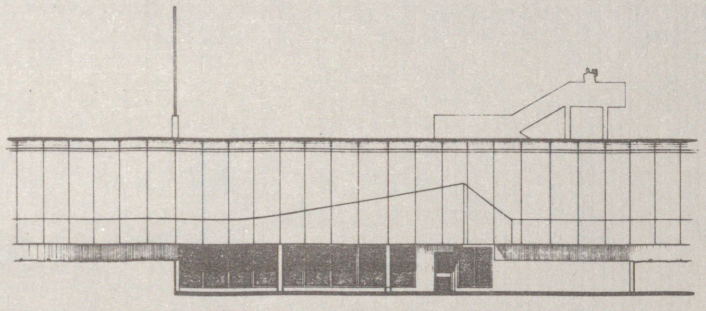
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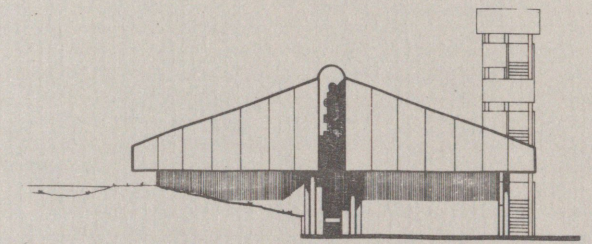
south



east



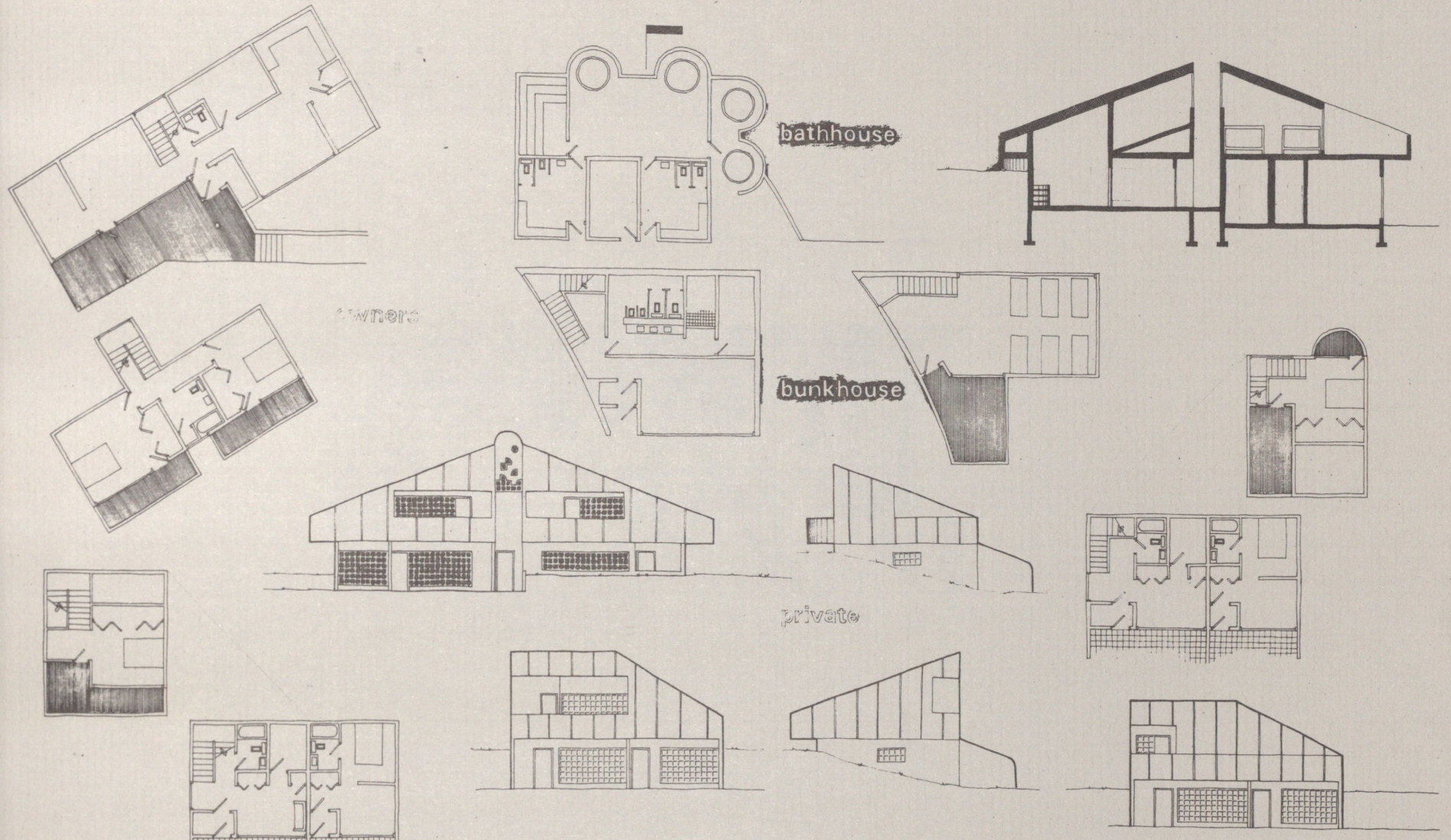
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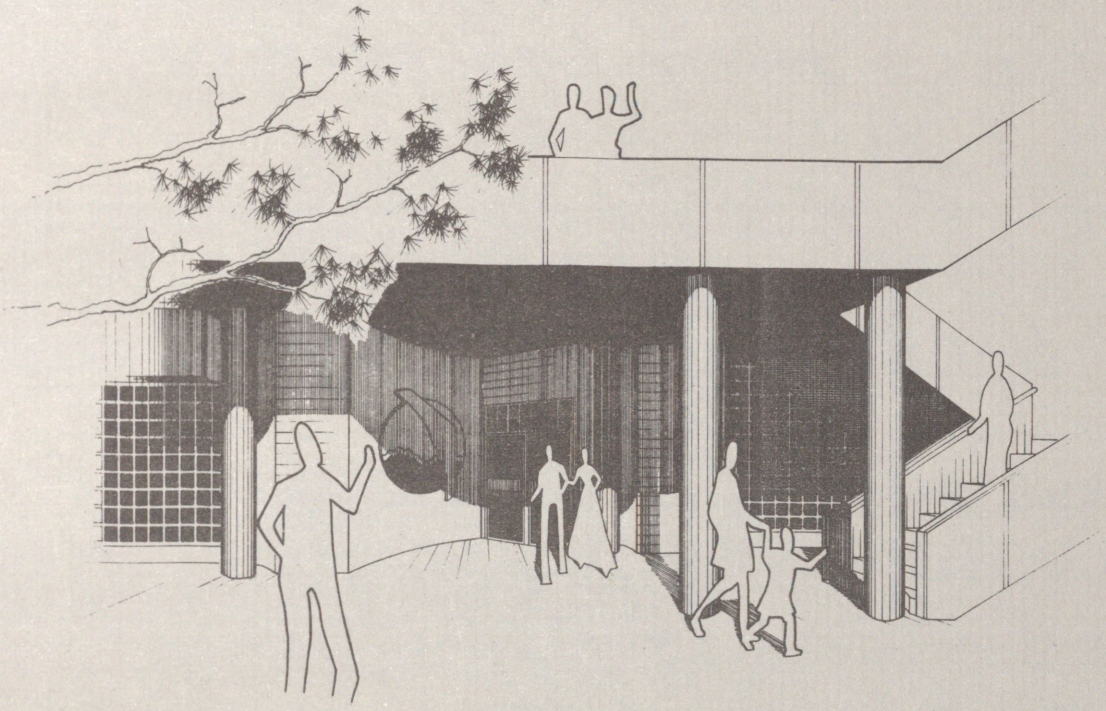


west

elevation

0 2.5 5 10 20 40


bathhouse
owners
bunkhouse
private
0 2.5 5 10 20
dwellings



arrival

BIBLIOGRAPHY

Anderson, Bruce. The Solar Age Resource Book. Pickering, Ontario: Beaverbooks. 1979

Architects Journal. Principles of Hotel Design. Hayes, England: Harrison & Sons Ltd. 1970

Balcomb, Douglas J. "The Heat Also Rises". Progressive Architecture, April 1979, pp. 106-109

Bennett, Robert. Sun Angles For Design. Bala Cynwyd, Pa: Robert Bennett. 1978

Brelsford Engineering, Wind Energy Survey - Livingston to Springdale Montana. Bozeman, Mt. 1979

Curl, Huldah. Winona - Towards an Energy Conserving Community. University of Minnesota. 1975

Davis, Albert J. and Schubert, Robert P. Alternative Natural Energy Sources. New York: Van Nostrand Reinhold Company. 1977

Dightman, D.A., State Climatologist. Climate Analysis and Weather Conditions for Livingston and the Encompassing Area. Helena, Mt: Weather Bureau Airport Station

Lees, Al. "Insulating for Solar Heat". Popular Science Solar Energy Handbook 1979, p.p. 71-74

Mazria, Edward. The Passive Solar Energy Book. Emmaus, Pa: Rodale Press. 1979

Mendelson, Michael. The Complete Outfitting and Source Book for Hang Gliding. Sausalito, Ca: The Great Outdoor Trading Company. 1977

Olgyay, Victor. Design with Climate. Princeton, New Jersey: Princeton University Press. 1963

Smay, V. Elaine. "Solar Tax Incentives". Popular Science Solar Energy Handbook 1979, pp. 6-12

Soil Conservation Service, Livingston, Montana

Whithorn, Bill and Doris. Photo History of Livingston-Bozeman Coal Country. Pray, Mt: The Wan-I-Gan

Whithorn, Bill and Doris. Photo History of Chico Hot Springs Lodge. Pray, Mt: The Wan-I-Gan

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