EARTH SHELTERED DESIGN

an ecclesiastical complex

by Ron La Rue
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Date  Dec. 14, 1979
EARTH SHELTERED DESIGN
by
Ronald Duane La Rue
A professional paper submitted in partial fulfillment
of the requirements for the degree
of
BACHELOR OF ARCHITECTURE

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MONTANA STATE UNIVERSITY
Bozeman, Montana
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Special thanks to my wife Susan. Her love and understanding over the last five years have been my source of encouragement.
<table>
<thead>
<tr>
<th>FIGURES</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>List of Figures</td>
<td>iv</td>
</tr>
<tr>
<td>Introduction</td>
<td>1</td>
</tr>
<tr>
<td>Thesis Statement</td>
<td>3</td>
</tr>
<tr>
<td>Project Statement</td>
<td>3</td>
</tr>
<tr>
<td>Earth Sheltered Design</td>
<td>4</td>
</tr>
<tr>
<td>Types of E.S.D.</td>
<td>8</td>
</tr>
<tr>
<td>Why a Returning Interest in E.S.D.</td>
<td>11</td>
</tr>
<tr>
<td>Psychological Reactions</td>
<td>16</td>
</tr>
<tr>
<td>Entrances</td>
<td>20</td>
</tr>
<tr>
<td>Imagery</td>
<td>23</td>
</tr>
<tr>
<td>Energy Factors</td>
<td>24</td>
</tr>
<tr>
<td>Structure</td>
<td>26</td>
</tr>
<tr>
<td>Moisture Control</td>
<td>27</td>
</tr>
<tr>
<td>Mechanical Systems</td>
<td>27</td>
</tr>
<tr>
<td>Project Program</td>
<td>29</td>
</tr>
<tr>
<td>Design Concepts</td>
<td>35</td>
</tr>
<tr>
<td>Bibliography</td>
<td>49</td>
</tr>
<tr>
<td>Drawings</td>
<td>52</td>
</tr>
<tr>
<td>FIGURES</td>
<td>Page</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>1. Types of Earth-Covered Structures</td>
<td>9</td>
</tr>
<tr>
<td>From &quot;Earth-Covered Buildings,&quot; by Kenneth Labs</td>
<td></td>
</tr>
<tr>
<td>2. View Limitations and Solar Angles</td>
<td>18</td>
</tr>
<tr>
<td>From Earth Sheltered Housing Design, by the Underground Space Center, University of Minnesota</td>
<td></td>
</tr>
<tr>
<td>3. Light Wells</td>
<td>19</td>
</tr>
<tr>
<td>4. Entrances</td>
<td>21</td>
</tr>
<tr>
<td>5. Insulation, &quot;To Build without Destroying the Earth,&quot; by Malcolm Wells, and Earth Sheltered Housing Design, Underground Space Center</td>
<td>25</td>
</tr>
<tr>
<td>6. City Map, Site Location</td>
<td>36</td>
</tr>
<tr>
<td>7. Circulation Study</td>
<td>37</td>
</tr>
<tr>
<td>8. Site Analysis</td>
<td>39</td>
</tr>
<tr>
<td>9. Spatial Relationships</td>
<td>40</td>
</tr>
<tr>
<td>10. Schematic of Sanctuary</td>
<td>44</td>
</tr>
<tr>
<td>11. Schematic of School</td>
<td>47</td>
</tr>
<tr>
<td>12. Problem Areas</td>
<td>48</td>
</tr>
</tbody>
</table>
Introduction

The world of urban growth and development is driven by an increasing need for sustainable and efficient solutions. In the past, urban planning and development focused on maximizing space and functionality, often at the expense of environmental considerations. However, in recent years, there has been a growing awareness of the importance of sustainable development practices.

This trend is evident not only in the construction of new buildings but also in the renovation and adaptation of existing structures. The aim is to create environments that are not only aesthetically pleasing but also environmentally responsible. This shift in focus has led to the development of innovative architectural designs that prioritize energy efficiency, water conservation, and the use of sustainable materials.

The active design system in contemporary architecture seeks to integrate the building structure with its surrounding environment. This approach not only reduces energy consumption and carbon emissions but also enhances the quality of life for those who live and work within these spaces. The future of urban development is characterized by a commitment to sustainability, and architects and urban planners are at the forefront of this movement, driving innovation and change.
The topic of underground architecture was first brought to my attention through the literature and lectures of Malcolm Wells. Wells is an architect that advocates underground building design. He proclaims a necessity for energy conservation and the preservation of the natural environment.

The 1973 oil embargo raised questions by the public about the fuel energy used annually in the United States. The majority of the modern architectural environment was built without regard to the energy consumption of its buildings. Many designers recognized the need for energy conservation before the embargo. These designers rejuvenated the theories of passive and active energy conservation. The active design system incorporates solar collectors for space and water heating. The passive design system uses the building structure such that the mechanical systems are decreased in size and energy consumption.
My thesis project explored the aspect of earth sheltered design in passive conservation. The intent was to explore the real alternative of an underground building. The project is the relocation of a local church. Due to present and projected energy costs the concept of energy conservation is important to the building committee. Their pursuit of an economically operational complex gives them options of an earth sheltered (passive) design and traditional construction.

The intention of this paper is to highlight the design determinants for an earth sheltered design. The technical information on construction and legal aspects are available in many resources. The major reference is Earth Sheltered Housing Design--Guidelines, Examples, and References, by the Underground Space Center, University of Minnesota.
THESIS STATEMENT

Earth Sheltered Buildings that are sensitively designed will provide a comfortable space with the benefit of energy conservation, whether it be a residence or a corporate headquarters.

PROJECT STATEMENT

I will examine the implications of an earth sheltered building by designing an ecclesiastical complex for a Bozeman church group.

The complex will include:

A. Sanctuary and related spaces
B. School and its administration
C. Multi-purpose building (gym and social meeting hall)
Earth Sheltered Design
EARTH SHELTERED DESIGN

The expensive costs of fossil fuels for environmental control within our structures calls for a stop to the practice of ignoring energy consumption. Energy conservative designs must be a primary concern of designers today.

Energy conservation through passive energy design is the method by which we can save the largest amount of energy over a long term. Passive Energy Design (P.E.D.) is the concept by which a building uses its structure as a heat storage unit. This building requires little, if any, mechanical application to maintain a comfortable climate.

The concept of using an earth covering over the structure is one element of P.E.D. Earth Sheltered Design (E.S.D.) is the application of an earthen mass to the exterior surfaces of a structure providing a protective/insulating layer to the building.

Man used the earth as a place for protection since his early beginnings. He needed protection from climatic changes, predi-
tors, and neighboring tribes. We no longer worry about the predators that early man had to face, but nature and man himself are a continuing threat. Nature's destructive forces of tornados, hurricanes, earthquakes and fires still threaten man's existence. The use of an earth sheltered structure lessens the destruction to man's buildings and himself. Most of the conventional building types would not have the structure and exterior surface materials that could withstand nature's forces. Man has become his own greatest enemy through the conception of nuclear weapons and the pollution he has caused through industrialization. Earthen structures provide the greatest resistance to the corrosive properties of pollution and the best protection in case of a nuclear explosion.

Earth sheltered designs have taken many forms from the early beginnings of man. We first used natural formations of caves and later used earthen materials to form structures. The first structures to be built were places of ceremonial rituals for the worshipping of different religions. Structures for the inhabi-
tation of multi-family use were built for mutual protection. The early inhabitants of the North American continent built pueblo structures. The settlers that crossed the plains of North America built sod houses into the earth. New technologies allow present day construction of factories, warehouses, shopping malls and systems of transportation to be built below grade. These relieve the congestion of the surface.

An example of a city that is using these new technologies is Kansas City, Kansas. The earth below Kansas City is a large limestone deposit which has been mined for many years. These mines cover about 150 miles underneath the city. The technology that has made it possible for the limestone to be mined has opened large areas of space that is conducive to many businesses. Factories and warehouses have moved into these spaces because of the inexpensive costs of maintenance and climate control. Noise factors from factories no longer disturb the neighbors. The temperature remains near a constant 50 degrees requiring less temperature control for frozen storage.
The country of Japan has four underground shopping malls that are frequented by thousands of people a day. Many cities have incorporated the use of subways and underground highways to reduce the cities transportation problems.
Earth sheltered structures are characterized by the use of an earthen mass in their design. There are three basic types that differ by their relationship to the finished grade. They are:

1) the Chamber, 2) Cut and Fill and 3) Berm. The Berm building type is a structure built on the existing grade and the earth brought to the site or from another portion of the site to be placed against the walls. The roof may also be covered with an earthen layer.

The Cut and Fill is where the structure is built on a partially excavated site and the soil returned to be placed against the walls and on the roof.

The Chamber is a structure which is built on an excavated site totally below the intended grade. The soil from the excavation is returned to cover the building.

Of the three E.S.D. types, there are four variations possible. The variation that provides the most security is the "true underground" which is totally surrounded by the earthen mass. There
EARTH-COVERED STRUCTURES

"TRUE" UNDERGROUND, INTERNALLY SIMILAR TO DEEP SPACE BY ITS ISOLATION

ATRIUM OR COURTYARD, USED FOR ENTRY, FOR LIGHT & AIR, FOR OUTDOOR ROOMS

ELEVATIONAL, FOR WINDOWS, FOR DOORS, OUTSIDE COURTS TO ACCOMMODATE SLOPES

SIDE WALL PENETRATIONS, FOR LIGHT, AIR, ACCESS VIEW; EXPANSION POTENTIAL

Figure #1
are no penetrations other than the entrance into the structure. Examples of this structural type are the building programs that require extreme climate and light control such as: bomb shelters, root cellars, museums, theaters, factories, warehouses, scientific laboratories, etc.

The second variation incorporates an "atrium or courtyard" around which the internal spaces are placed. This central element provides access to the space for the entry, light and ventilation. An example would be the Ecology Houses by John Barnard in Osterville, Massachusetts. The Terraset Elementary School, Reston, Virginia, by Douglas Carter uses the atrium as a central focus in its plan although entrance is on the elevation.

The third variation is the "elevational" in which one side of the structure is not covered by an earth berm, allowing penetration of entry and windows from that side. This elevation will open up onto a court or accommodate a hill slope into which the structure
is built. This is the first type to allow some possibilities of an extended view.

The fourth variation is the "side wall penetration" in which one or more elevations are partially bermed leaving some wall surface exposed to allow entry and window penetration. An example would be the Gier House by Philip Johnson in Cincinnati.

Why A Returning Interest in E.S.D.

When man's social character brought him to the need for interaction with others, his architecture became more than a place to live and provide protection. His buildings became places of social significance creating images of religion and government. Today's architecture expresses a new image of social significance. The large corporations are the new symbols of our social culture presented by their architectural style. These buildings were designed to monumentalize their company or product by creating images in glass and steel. In most examples little regard was given to energy conservation.
The wasteful misuse of our limited fossil fuel supplies has forced a return to the concept of energy conservation. This awareness of the need for conservation has reintroduced the advantages of an earth sheltered design.

There are three basic advantages of E.S.D. The first of these deals with energy conservation in which an earthen mass provides an insulating layer that will dampen the fluctuation of seasonal climatic changes. A contemporary building type of steel and glass must have large mechanical systems to control humidity, heating and cooling of the structure for daily temperature changes. In an earthen structure the daily temperature fluctuation is not noticed. A climatic influence on an earthen structure is only induced by seasonal change. The affect is thus a rhythm of change that is much slower and less extreme.

Another advantage to an earthen structure is the security this type of design can incorporate. The advantages of protection from natural disasters such as hurricane, tornados and fires were discussed earlier. The damages to be done to this type of structure
would be minimal. The destructive influences of man on an earthen structure are lessened. Acts of theft and vandalism are not as easily carried out due to reduced surface exposure. A major advantage to designing a structure that will be covered by an earthen layer is that it allows nature to reclaim the site. Wherever man has built his buildings, he has tried to allow some sense of nature to be present. He has designed structural elements in the image of nature. He has placed flower pots outside of his windows, and gardens on top of his skyscrapers. In a city where man's architecture has become so dense that it chokes out nature, a below grade building provides relief. The site is formally landscaped or covered with mulch allowing natural plant growth cycles to return.

Contemporary building types have caused a very harsh impact on the landscape. The ground that we cover with asphalt and concrete can no longer react to the natural cycle of nature. It is difficult for plants to grow where rain and snow precipitation can no longer be absorbed.
There are many reasons for building below grade other than climate and nature. The restraints of a building program or a given site may restrict the application of a contemporary building style. On a site where conflicts of spacial overlap, visual importance, circulation or surrounding functions occur, the solution could be a structure built below grade.

Some programs require a building that will not obstruct an important line of sight, or path of circulation. A solution that provides the freedom to expand under these paths is appropriate. A site that is unappealing to the conventional building because of functions bordering the site, such as airports, major highways or visual clutter could use an underground solution. The structure's orientation blocks from view the visual clutter and the earth covering accoustically deadens exterior noises. Examples are: Malcolm Wells underground office which is between two major highways, and the Abo Elementary School, Artesia, New Mexico, is built at the end of an airport runway.
Where additional building square footages are required on a limited site, an underground solution will allow expansion without destroying the above exterior space. An example is the University of Minnesota Book Store/Admissions and Records. This structure occupies a central location on the campus that is influential to activities around it. A major circulation path crosses the site. The site is an important open space, and it borders historically important buildings. An above grade solution would have adversely affected these factors: circulation, open space and visual importance (block view of old buildings).
Psychological Reactions

Reactions to the phrase "underground architecture" vary among professionals as well as the lay person. The image most people have is of a sub-terrainian cavern which is dark, damp and musty. The following passage from the *Hobbit* by J.R.R. Tolkien illustrates that an earth sheltered space can be comfortable with a pleasant appearance:

"In a hole in the ground there lived a Hobbit. Not a nasty, dirty, wet hole filled with the ends of worms and an oozy smell, nor yet a dry, bare, sandy hole with nothing in it to sit down on or to eat; it was a hobbit-hole, and that means comfort.

...The door opened on to a tube-shaped hall like a tunnel: a very comfortable tunnel without smoke, with panelled walls, and floors tiled and carpeted...The tunnel wound on and on, going fairly but not quite straight into the side of the hill...No going upstairs for the hobbit; bedrooms, bathrooms, cellars, pantries, wardrobes, kitchens, dining rooms, all were on the same floor, and indeed on the same passage. The best rooms were all on the left hand side (going in), for these were the only ones to have windows, deep set round windows looking over his garden, and meadows beyond, sloping down to the river."

The feeling of confinement doesn't have to apply. A view to the exterior by manipulation of windows and skylights allows a visual extension to open space.
The type of earth sheltered structure used will determine the visual limitations from within its space. The Chamber structure does not allow a visual extension from within because there are no penetrations. Figure #2 shows the limitations of the elevational and atrium structure types. The elevational plan restricts limitation by the depth it is recessed into the site. The atrium allows visual connection to the central court and the sky.

The availability of natural light into an earth covered structure is determined by the possible window variations, and solar angles as indicated in Figures #2 and 3.
**VIEW LIMITATIONS**

- **Semi-recessed (bermed)**
- **Fully-recessed (chamber)**
- **Recessed into hillside**
- **Above & below grade**

**Figure #2**

*Underground Wine Center, Univ. of Minn.*

- **June 22, Noon Alt 68°N**
  - **Dec 22, Noon Alt 11°30′**
- **Deep solar penetration in winter**
- **Sun shade**
- **Directional sky light**
- **Light limited by height & width of court**
- **Greater light penetration**
LIGHT WELLS

OPEN ELEVATION

PARTLY OPEN ELEVATION

ATRIUM

GREEN HOUSE

SKYLIGHT

SKYLIGHT WELL

UNI-DIRECTIONAL SKYLIGHT (CLERESTORY)

DIRECTIONAL SKYLIGHT

Figure #3
Entrances

Entry is another aspect of the psychological acceptance of an underground space. The topography and the design concept determine the type of entrance as shown in Figure #4. On a flat site the structure can be totally submerged below the existing grade, with an enclosed entrance from above or a court into which you descend and then enter the building. An elevational plan that is done by building on the grade and filling or by a cut and fill operation will allow an entrance at the floor level. If the individual is required to descend into the structure, it is a contradiction to his previous experiences. Past experience has been to enter a structure at the grade level or to ascend stairs to the building. A negative reaction results from descending into the structure. The descending entrance must be large enough in volume to relieve the feeling of a confining space. An atrium design such as the Ecology Houses by John Barnard in Osterville, Massachusetts, is entered by descending into the courtyard but the sense of
ENTRANCES

ENTER AT GRADE LEVEL

ENTER AT GRADE THEN DESCEND INTO SPACE.

DESCEND FROM GRADE TO ENTER

ENTER AT GRADE INTO AN INTERMITTENT LEVEL

ENTER AT GRADE AND ASCEND TO THE SPACE

Figure #4
enclosure is not present because the whole courtyard is open to the sky. To enter an underground structure at a grade level is the most desirable solution.

Another type of earth sheltered space that presents a different entrance is the structure that is built into a slope. The entrance into this type of a unit may be from above or below. Entering the unit at the low point of the building psychologically opens the structure thus being the most appealing psychological choice.
Imagery

Imagery for an earth covered building is difficult to express. One of the reasons for going underground is to make the building disappear or join with nature. When it disappears the purpose of the building is not evident. The building's function might be such that it needs an acknowledgement of its presence to bring people into the area. Methods by which an image can be formed vary with the function of the building. If the structure is a private residence, the image may be formed by an auxiliary building such as the garage. A public building could use the orientation to the street or a sculptural form presenting an image associated with that public function. The sculptural form may indicate entrance or hide the mechanical exhausts system.
Energy Factors

A building must use more than just an earth cover to facilitate an effective passive energy design. The major principal of an earth covering is to insulate the structure, but earth is a very poor insulator. Insulation must be used in conjunction with the earth covering. The placement of the insulation is determined by the climatic conditions and the function of the building. Figure #5 indicates the location of insulating material for different desired results. If the building is to incorporate the structure as a thermal mass in which heat may be retained, the insulation must be placed on the exterior surface. If the function of the building is periodic, and continued temperature control is not required, the insulation is best placed within the structure. To heat or cool an exposed thermal mass is wasteful of energy resources where that temperature will not be maintained.

The orientation and layout of the structure should place the areas of activity in a temperature zoning priority. The plan will put service areas in the zone of the least temperature control and
WARMER CLIMATES NEED THE HEAT DRAINAGE TO COOL THE SPACE.

COLD CLIMATES NEED THE THERMAL MASS PROTECTED FROM HEAT LOSS.

Adequate ventilation provides cooling.

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**Figure #5**

- **No Insulation**: Constant heat loss to the soil and air.
- **Interior Insulation**: No thermal mass to hold heat.
- **Insulate to 7 ft. below surface**: Good thermal mass for heating and cooling.

- **Insulate Exposed Surfaces**: Protects from air - heat loss to soil.
- **Insulate All the Structure**: Good thermal mass - no cooling properties.
- **Extended Insulation**: Adds soil to thermal mass.
areas of the highest activity into the zone of the greatest temperature control. The elevation that is orientated towards the sun should allow penetration of the sun's rays to best facilitate the properties of solar energy collection. An examination of solar angles will determine the size of the window penetrations. The sun's heat can be actively used in the winter time yet restricted in the summer time. Figure #2 shows examples of structural solar screens and solar angles. Example not shown in Figure #2 could be natural vegetation, such as deciduous trees which provide shade in the summer time and lose their foliage in the fall providing access of the sun's radiation in the winter.

**Mechanical System**

**Structure**

The structural system of an E.S.D. is heavier than the structure of a conventional building. This structure must carry an additional load of the earth and possible live loads of activities that would happen on the roof. The added strength of the structure provides an extended life expectancy of the building. The earth covering requires less external maintenance because
there is less possibility of damage due to freeze/thaw cycles and solar
deterioration caused by the sun's rays.

Moisture Control

The major problem to the exterior envelope of an earthen structure is waterproofing. There are many means to waterproof the building. Some of the most frequently used are a conventional built-up membrane of tar and felt, a Bentonite clay placed around the building, a butyl rubber/membrane, and a fiberglass membrane.

Mechanical Systems

The mechanical system for an E.S.D. does not have to be as large a unit as the mechanical system for a conventional building style. Although the square footages are the same, the BTU requirements of an E.S.D. will be less due to the insulating properties expressed earlier. The heat loss or gain from a structure depends on two factors: The ventilation load for heating or cooling intake air and the heat transmission to the building envelope. The thermal mass
of the E.S.D. gives a better regulation of this heat transfer, thus requiring less mechanical assistance.
PROJECT PROGRAM

The project for development is a design alternative for an ecclesiastical complex set in Bozeman, Montana. The requirements are based on the needs of Christian Center, a local congregation. Christian Center is an open denominational church that sponsors many ministries in the valley including a Christian school. The present location will no longer meet the spatial requirements of the church and its school.

The present building site is on the corner of 10th and Mendenhall. Recent expansion of the sanctuary allows seating for about five hundred but the congregation is over nine hundred. The limited space of the sanctuary requires three services to be given each Sunday. Two services are held in the morning separated by a Bible study and the third in the evening for families.

Recent growth in the number of people attending Bible studies requires more rooms in which to meet. A banquet room is needed for social gatherings that are inappropriate for the sanctuary.
Parking at the present location is a major problem. The street parking and a small side lot of the Safeway supermarket are all that is available. Congestion between the first and second services on Sunday mornings is complicated by the one-way traffic of Mendenhall.

The church sponsored Christian school includes grades kindergarten through high school. Seventy-three students attended the 1978-79 academic school year. The problems of zoning complications and spacial requirements compelled the church to drop junior and senior high school grades for the 1979-80 school year.

The students come from various religious backgrounds. For the 1978-79 school year the elementary classes were taught in pairs because of a lack of space and the small number of students. Kindergarten, first and second grades were held in a separate building on Ida Street. Third through sixth grades were held in the church annex with the seventh through high school grades being held in the basement of the sanctuary. The high school curricular requirements cannot be fulfilled within the small facilities at the present
location, so the students walked the single block to the public high school to take additional classes.

The new complex will consist of three major units: The sanctuary, school and multi-purpose hall. Financial commitment to the project will be such that it must be completed in stages. The sanctuary and Bible studies would be built first and used during the week as a school. When additional funds become available the school and multi-purpose hall would be added.

The focal image of the complex should be the sanctuary expressing a place of worship. The school and its activities should be secondary. The entrance to the complex should create an image that indicates a place of worship and education.
SPATIAL REQUIREMENTS

CHURCH

Sanctuary - seating for 750 7,875 sq. ft.

Bible study rooms 3,000 sq. ft.
  six rooms @ 500 sq. ft.

Baptistery 80 sq. ft.
  dressing rooms @ 200 sq. ft. 400 sq. ft.

Nursery 600 sq. ft.
  three rooms @ 200 sq. ft.

Sound/Project Room 200 sq. ft.

Coat Room 200 sq. ft.

Storage 600 sq. ft.

Restrooms @ 250 sq. ft. 500 sq. ft.

Vestabule 1,500 sq. ft.

Administration
  Pastor's Office 200 sq. ft.
  3 Asst. Pastors 600 sq. ft.
  Conference Room 300 sq. ft.
  Secretary/Reception Area 300 sq. ft.

APPROXIMATE TOTAL 14,500 sq. ft.
SCHOOL--Approximately 42,000 square feet. The principal prefers a closed lecture system of teaching where each class has privacy, not an open classroom plan. The spatial requirements listed are for three hundred students. The school will include classrooms, large meeting room, gym, locker rooms, softball diamond, and a play area for the younger children.

**Administration**
- Principal's Office: 250 sq. ft.
- Vice Principal's Office: 200 sq. ft.
- Secretary/Reception Area: 500 sq. ft.

**Classrooms**

<table>
<thead>
<tr>
<th>Enrollment</th>
<th>Projected</th>
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<tr>
<td>Kindergarten taught separately</td>
<td>40</td>
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<tr>
<td>Primary--Grades 1 &amp; 2</td>
<td>32-60</td>
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<tr>
<td>Lower Junior grades 3 &amp; 4</td>
<td>16-75</td>
</tr>
<tr>
<td>grades 5 &amp; 6</td>
<td>16-25</td>
</tr>
<tr>
<td>Junior grades 7 &amp; 8</td>
<td>20-30</td>
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<td>grades 9 &amp; 10</td>
<td>10-30</td>
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### Activity Areas

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<tr>
<th>Area</th>
<th>Square Feet</th>
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<tr>
<td>Library</td>
<td>12,000 sq. ft.</td>
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<tr>
<td>Rest Rooms</td>
<td>1,000 sq. ft.</td>
</tr>
<tr>
<td>Dining Room</td>
<td>1,000 sq. ft.</td>
</tr>
<tr>
<td>Teachers Lounge--Conference Room</td>
<td>400 sq. ft.</td>
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### Multi-Purpose Area

<table>
<thead>
<tr>
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<th>Square Feet</th>
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<tr>
<td>Gym floor and seating</td>
<td>7,280 sq. ft.</td>
</tr>
<tr>
<td>Locker rooms/showers</td>
<td>1,500 sq. ft.</td>
</tr>
<tr>
<td>three rooms @ 500 sq. ft.</td>
<td></td>
</tr>
<tr>
<td>Storage</td>
<td>1,000</td>
</tr>
<tr>
<td>Mechanical</td>
<td>2,000</td>
</tr>
<tr>
<td>Restrooms</td>
<td>500</td>
</tr>
<tr>
<td>Lounge</td>
<td>500</td>
</tr>
<tr>
<td>Stage</td>
<td></td>
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The project of an educational complex was chosen to meet an actual building program. The local church was an excellent giving use their facilities and property. The necessity for the church to move from its present location dictated the selection of a suitable site.

The site located on Figure 46 indicates the portion of land on which the church has an option to buy. The efforts began south of the university in a proposed new subdivision. The selection of this site is based on the spatial requirements and future possibilities of expansion. Sites within the city limits were restrictive in cost and size.

The proposed subdivision is presently used for agricultural purposes. The church has an option to buy 10 acres of this subdivision on the northwest corner. The topography of the site provides only a fifteen foot drop in elevation from the southwest to the northeast corner. The entire property is 10 to 15 feet above the water table in that area.

**Design Concepts**
DESIGN CONCEPTS

The project of an ecclesiastical complex was chosen to meet an actual building program. The local church acted as a client giving me their spatial requirements. The necessity for the church to move from its present location dictated the selection of a suitable site. The site located on Figure #6 indicates the portion of land on which the church has an option to buy. The site is located south of the University in a proposed new subdivision. The selection of this site is based on the spatial requirements and future possibilities of expansion. Sites within the city limits were restrictive in cost and size.

The proposed subdivision is presently used for agricultural purposes. The church has an option to buy 10 acres of this subdivision on the northwest corner. The topography of the site provides only a fifteen foot drop in elevation from the southwest to the northeast corner. The soil in the area is Bozeman silt loam and the water table is 10 to 12 feet below grade.

Figure #7 shows the proposed circulation that will happen around the site upon completion of the new roads. Figure #8 is a
site analysis indicating the possible views and the relationships of this site to the residential sites surrounding it.

Organization

The site organization was determined by the consideration of nature being the major view visible from the roadways. The extension of 11th Street from Kagy Boulevard will become the major access to the site. A secondary road will separate the site from the adjacent Summit Engineering property. The south and east boundaries will be residential lots.

The desire for landscaping to front the bordering roads influenced the grouping of the activities to the center and lower portions of the site. The spatial relationships of the functions are indicated in Figure #9.

The school and playground will generate the most activity. Their placement in the center of the site will provide controlled observation and solar orientation. The sanctuary will be used by the largest number of people but mainly on the weekends. The multi-purpose space would be
SPATIAL RELATIONSHIPS

- SANCTUARY
- GYM/MULTI-PURPOSE AREA
- SCHOOL-CLASS RMS/BIBLE STUDIES
- CHURCH ADMIN.
- SCHOOL ADMIN.

Figure #9
used for school activities during the school days and for general purposes at anytime. Access to all spaces is through the central court yard. The game fields that were specified for the site have been considered for general activities of both the school and church. There is not a large enough student body to form an interschool team competition, therefore the requirement for large spectator seating is not necessary. The playing fields buffer the site through the use of landscaping.

The parking requirements for the school and sanctuary are a major element in the organization. The size and visual impact would act against the low impact setting I want for the sanctuary. The placement of the parking underground will relieve the visual impact, and the football playing field above the parking continues the landscaping around the southern boundaries of the site.

The cost of such a parking structure will be restrictive to the initial budget. The solution would be the completion of the structure in construction stages. Stage one would be the excavation and surfacing of a parking area to meet the requirements of the sanctuary.
The structural footings for the structure must be set for later use before surfacing. The erection of the vertical structure would be the second stage. These members would be connected by temporary structure on which growth could be placed to cut the visual impact of the cars. The final stage would be the structure and decking to hold the playing field above.

Sanctuary

The sanctuary is the major function for the project and the focal point of the site. The form was derived by internal functioning of the religious service and its related spaces. The service is normally carried on by a single speaker. The congregation is set so that it focuses on the speaker's podium. The seating is in two levels. The lower main floor level seats five hundred and the balcony seats two hundred and fifty. The seating slopes for the optimum view. On the main floor the back areas are Bible study rooms used as additional seating areas when necessary. The administrative offices of the pastors and the secretarial staff are on the second level.
The mechanical area, storage, rest rooms, and nurseries are in the basement. The concept of earth sheltered design for the sanctuary was to make the structure energy efficient. The berming of the walls will dampen the temperature fluctuations but the structure cannot be used as a thermal mass. The periodic use of the structure would require high energy consumption if the structure acted as a heat reservoir. The insulation would be on the interior of the walls. The air in the space would be the only fluctuating element for control.

The roof of the sanctuary is the main element visible on the site. It is a large solar scoup that brings light into the alter area. The high sweeping form is intended to project the image of worship. The orientation of the church 28° from south is to catch the morning sun. The services are held mainly in the morning and the entrance will be warmed by the sun.
Figure #10

FIRST FLOOR
- SEATING = 30-500
- ALTER = CENTRALIZED
- BAPTISTRY = VISIBLE TO ALL
- DRESSING ROOMS = 2 @ 20' x 30'
- BIBLE STUDIES = 2 @ 20' x 50'
- ENTRY = SOUTHERN EXPOSURE
- COAT ROOM

SECOND FLOOR
- ADMINISTRATION
- OFFICES = 4 @ 20' x 20'
- RECEPTION
- WORK SPACE
- WASH ROOM
- STORAGE
- LIBRARY
School

The school is a passive energy design. The longest elevation of the structure oriented to the south for large openings of glass. The other three sides and the roof are covered with earth. The classrooms are set around a central sky lit court from which each room is entered. The wall materials of the classrooms are concrete block and glass block. The glass block allows light penetration but reduces visual contact. The classrooms that are on the northern elevation have sky lights for additional light and ventilation. The school functions for kindergarten through high school students. The rest rooms and library separate the elementary grades from junior/senior high school levels.

Gym Multi-Purpose Space

The gym is also covered with an earthen layer for energy conservation. The height requirements of the basketball courts required a deeply set structure. The entrance is at the same level as the school but the court level is twelve feet below. The basketball courts are of both high school and elementary sizes. Seating is on the court level with the possibility
of seating above on the entrance level. A stage is at the east end of the courts. Storage and locker/shower rooms are at the court level.

A solar collection system would be attached to the southern elevation of the gym. The arrangement of greenhouses and solar collectors will form a two level system for the use of the sun's radiant heat. The greenhouses will be at the ground level providing a passive collection method for supplemental space heating. The floor and rear wall will be thicker and insulated to act as thermal masses.

The solar collectors shall be an active system of collection for water and space heating. The collectors will be above the greenhouses with the storage tank below.
Figure #12

Problem Areas

North Wall Window

Solar Penetration
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SITE PLAN

1. Sanctuary
2. School
3. Multi-purpose Building
4. Parking Structure
5. Playgrounds
6. Baseball Field
7. Football/ Soccer Field
8. Open Grounds
SANCTUARY

Structure:
Walls
Glass block, concrete block, & poured in place concrete.
Slab
Poured in place concrete.
Roof
Steel girders, metal decking, insulation board, & copper roofing.

Interior Finishes:
Walls
Furred out two inches, two inch bead board insulation, five/eights inch gyp. board with oak trim.
Floor
Carpet in the bible study rooms and on the circulation paths. Exposed concrete under the seating.

Natural Light Penetration
Central sky light.
Side lights in bible study areas.
Southern glass block wall.
SANCTUARY

Upper Level
Administration
Four offices
Reception
Work space
Projection room
Sound - record or play
Movies
Lighting
Balcony seating
320 seats w/ 100 over flow
Fire stairs

Lower Level
Entrance
Crying room
Six bible study areas
Seating - 500 seating in pews w/
300 over flow in seating chairs
Alter
Baptistry
Dressing rooms
Prep rooms
Fire stairs
Passage to school below grade
Elementry/ Jr. & Sr. High (K-12)
Separate enterances, libraries, rest rooms.

Administration offices for principal and staff w/ a lounge for faculty.

Central sky light atrium for commons.
GYM

Structure:
Walls
Concrete block, poured in place concrete.
Steel truss for greenhouse & solar panels, steel truss roof framing
Metal decking
Butal rubber water seal
Exterior foam board insulation

Finishes:
Exposed concrete walls (thermal mass)
Hardwood flooring on court & stage
Solar panels
Glass in greenhouse

SCHOOL

Structure:
Concrete block, glass block, & poured in place concrete.
Precast concrete panels for the roof.
Heavy timber trusses in the atrium.
Exterior foam board insulation.

Finishes:
Exposed concrete walls (thermal mass)
Glass block
Ceramic tile circulation paths.
Carpeted libraries and classrooms.

PARKING STRUCTURE

Structure:
Precast double T concrete decking.
Sixteen inch concrete columns.
Artificial turf to cut weight, or two and a half feet soil.
GYM/MULTI-PURPOSE BUILDING

Upper Level
- Entrance
- Lobby
- Greenhouse
- Service entry

Lower Level
- Playing floor
- Locker/Shower rooms
- Stage
- Storage
- Mechanical
- Restrooms
SCHOOL STRUCTURE AND ELEVATION

Concrete and glass block south elevation, partially bermed. Separate entrances to the grade levels. Glass block interior walls for additional light from the atrium. Rear light wells in the back class rooms. Fire stair to upper grade level.

SANCTUARY STRUCTURE

Roof structure is of a compression system. A compression ring is over the alter and a tension ring is at the exterior walls. The fire stair structure forms the anchor to the tension ring. Passage between the sanctuary and the school is done through an underground corridor connecting the fire stair of each building.
VIEWS OF THE SANCTUARY ROOF

The sky light and stair towers are vertical projections from a broad base. The roof is meant to be the only element seen by a motorist passing by. The image of the site and its function should be seen in the roof. It is a brightly shining form reaching upward for light.