Major view must include the view level identified as surround.
This level contains the majority of visual stimulation and
image content.
Due to the basic horizontality involved in eye movement and
information gathering, the most likely view scan will be in
a horizontal motion. This is usually the most satisfying im-
age scan and should be the single most important view level
provided for in the underground building.
The distant view object does not require as large an aperture due to the fact that the eye perceives less detail at that distance and the view angle allows wide surveillance of the object.

As the focal point object moves closer the "eye" requires greater detail to be satisfied. The closer the object the larger the aperture. The farther object will not dictate the size of aperture to as great a degree as the closer object.

When a full range of view objects is provided the closest object of significant size will determine the necessary aperture opening.

Generally, windows facing atrium which provide the only view need to be large enough to facilitate a view of the entire atrium.
Also important to understanding the amount of view needed is the relationship between aperture size and field of view. Standing 5' from an aperture that is 4' wide will provide a field of view 8' wide at 10' from the aperture. When viewing objects at one mile away while standing at the same point, the field of view becomes 1400 yards wide (.8 mile).

With a 2 foot wide window the field of view is 4' wide at an image distance of 10 feet and 700 yds. wide at a distance of one mile.

Not only does the eye not require as much detail to be satisfied with the view of a particular object at a distance, the field of view at a great distance allows more visual stimulation from a variety of objects.
The relationship between window form and providing adequate visual stimulation is based on the content of information in the view plane. There is also the obvious relationship between view angle and the location of major activities in a space.

A horizontal window should provide a view of the surround rather than the sky or ground because the surround has the greatest information content.

A vertical window will provide a view of all three levels of image but a limited view of each at one time.

The eye will spend more time scanning the surround because of the higher information content.
The size and form of the aperture will affect movement in a space. In an attempt to view the exterior environment, building occupants will move through a space based on the amount of view a particular window gives.

A thin vertical aperture can facilitate a wide view angle but a person must move through a wider angle to see the entire possible view.

A horizontal window allows a wide view angle. However, the viewer does not have to move through the space to see the entire view. Therefore an ample view is available throughout the entire space.
In determining the amount of aperture area needed several criteria must be considered as a complete system. The view content provided by the site context, the distance to this view element, the provision of an atrium, and the level of interior visual stimulation must all be considered.

The content of view is important to exterior view needs. If an important site feature is known to exist by the building occupants then they may want to see it. The distance to the object will determine the size of aperture necessary to see that object. If an atrium or nearby activity space is provided, the need for a view by building occupants may be greater than it would be if that area did not exist. If the atrium or activity area exists, then not providing a view of it may cause a higher perception of confinement. People will want a greater sense of connection with that atrium/activity area. A high level of interior visual stimulation may result in a lower level of exterior visual access needed.
Circulation must be open within the building. A central node or zone of activity which is easily visible and easy to reach by any place in the building should be provided. The structure, which should be open and light, reinforces the open centralized circulation concept.

Motion from place to place in the building should be along paths which are easily perceived as circulation paths. These paths should be simple and direct in plan.

A perceivable connection, which is simple and direct, must be included between the exterior circulation or activity node and the interior node or zone.
Structure is an important defining element in any building. It is used to create spatial volumes, determine organization, and indicate movement by its expression. In the underground the outer structure acts like any building membrane, but in this case it must be a very strong skin to hold out the earth. Conceptually, the walls facing the earth sides are massive, thick, and opaque. There must be basic punctures within this membrane for light, view, and air.

Interior structure must be thin, light, and open. This reduces any obstruction that might occur in the view or circulation.

Any interior planes should be as transparent as possible and parallel to the line of major view so as not to obstruct the view in building, excluding those walls necessary for visual privacy.
The ability to move in and out of a space at more than one point, preferably at opposite sides of a room, will greatly enhance the activity of a space, the openness, and perceived size.

In large structures the view horizontally is very important to the total perception of the space. If this is completely cut off as a means of egress then the space is significantly more confining.

Though the means of egress from a space does not have to be to the exterior it is always better to provide exterior egress when possible.
Markers draw attention by causing the eye to pause at each point to gather information. This increases the perception of spatial depth.

The same situation holds true on a wall. As the eye scans a wall, the individual markers cause the eye to pause at individual points and thus read the wall as multiple sections rather than a whole piece. This emphasizes the perception of depth.

Patterns can also draw attention and be markers based on their perceived importance to the path of movement in a space. A tight pattern on a wood floor would not be as much of a marker as a series of stepping stones where each stone represents a single step. A person would tend to read the floor as a single plane. This would reduce their relative importance as markers.
PRINCIPLE SYNTHESIS
The principle synthesis section simply serves as a mode for putting together the detailed principles as they relate to a major psychological design concept. To fully understand all of the intricate perceptual relationships a concept must be analyzed under more realistic conditions. Conditions where a myriad of design elements act upon each other and individually, as well as collectively, act on the perception of a space. It is to serve only as a guide and baseline for putting principles together. There may be several more intricate relationships in a realistic design which must be analyzed to arrive at a totally successful solution.
In an underground building reducing confinement on occupants is one of the most significant design concepts. Wall, ceiling, and floor planes may be manipulated to provide spatial variety and help to open up the volumes of interior space. Within a particular space, planes or elements which are a part from a wall will act as barriers. Confinement will be less if these barriers are barriers to movement which can be crossed and not barriers to visual stimulation within the space, excluding necessary visual separation for privacy. The structure should be as open as possible with any load bearing elements at places where they will not interfere with main views in space. Patterns in materials will affect the perception of spatial proportion. Dark tones in colors should be avoided, particularly on ceilings and walls. Multiple egress/access points will reduce the perceived level of confinement in a space. Windows should provide a view of all three levels of view where possible and be located to provide maximum horizontal view at any one point. The reduction in perception of edges at the ceiling/wall joint and window/wall joint will increase perceived size of space.
1 - FORM - WALL
2 - FORM - FLOOR
3 - FORM - CEILING
8 - SCALE

13 - PATTERN AND SPATIAL PERCEPTION
15 - PATTERN AND TEXTURE AT APERTURES
18 - TEXTURAL VARIATIONS - PLANES
20 - TEXTURAL VARIATIONS - PLANES
22 - SPATIAL PROPORTIONS
26 - BARRIERS AND MOVEMENT/VIEW
30 - VIEW OF ATRIUM EDGE
32 - COLOR & TONE VALUE - PLANES
38 - WINDOW FORM AND MOVEMENT
41 - STRUCTURE
42 - MULTIPLE EGRESS

Note: The numbers above refer to principle numbers in preceding section.
Visual stimulation and visual contact with the exterior environment is vital to the satisfactory underground environment. The view should include the sky, surround, and foreground levels of view if possible. The atrium form should be such that it allows maximum view angle. A stepped or sloped form can provide this. The relative distance from the aperture to the major element of the view will control the size of aperture needed. The closer the element the larger the aperture necessary. Interior barriers must not restrict the view of the exterior atrium particularly if there is no other view of the exterior environment from that area of the interior space.
4 - PERCEPTUAL EFFECTS OF ATRIUM FORMS

26 - BARRIERS AND MOVEMENT/VIEW

31 - EDGE DEFINITION AND ATRIUM PERCEPTION

34 - SATURATION OF IMAGE AND VIEW CONTENT

35 - APERTURE SIZE & IMAGE DISTANCE/LAYERING

37 - WINDOW FORM

38 - WINDOW FORM & MOVEMENT

Note: The numbers above refer to principle numbers in preceding section.
The depth that a space may recede from an aperture that provides the major exterior view is directly dependent on the sense of confinement an occupant feels in that space. By raising the floor and ceiling levels as the space recedes from window may reduce the underground perception by virtue of the upward motion. An easily perceived circulation path and multiple egress at the rear of the space will reduce the perception of confinement. Introduction of natural light will help reduce confinement. Patterns should be placed to reduce the perceived depth of a space. Textural variation should not be so great that it becomes visually heavy. The window should be arranged to allow maximum view from any place within the space.
2 - FORM - FLOOR
3 - FORM - CEILING
9 - PATTERN OF MATERIALS
12 - PATTERN AND SPATIAL PERCEPTION
13 - PATTERN AND SPATIAL PERCEPTION
16 - RHYTHM OF PLANES
20 - TEXTURAL VARIATIONS - PLANES
22 - SPATIAL PROPORTIONS
23 - SPATIAL PROPORTIONS
27 - BARRIERS DIRECT VIEW
30 - VIEW OF ATRIUM EDGE
38 - WINDOW FORM AND MOVEMENT
40 - CIRCULATION
42 - MULTIPLE EGRESS

Note: The numbers above refer to principle numbers in preceding section.
Transition from the exterior to the interior is a critical principle to design for in an underground building. Several factors can contribute to a smooth transition which doesn't make the entry dominant, overpowering, or ominous. The form of the atrium needs to provide an open area which moves the person from grade to below grade smoothly. The scale of the entry is critical. Do not make it apparent that one is being squeezed down into a "dark hole." By bringing a person up steps, or some level change that moves upward, the perception at an entry will not be one of normal downward movement into an underground building. Depending on the scale of the project, the circulation may have various levels of complexity. It should maintain an easy level of perception so that people do not get lost. Open circulation is best, and circulation can be directed as it enters a building.

Note: The numbers above refer to principle numbers in preceding section.

2 - FROM - FLOOR
4 - PERCEPTUAL EFFECTS OF ATRIUM FORMS
6 - SCALE AT ENTRIES
40 - CIRCULATION

TRANSITION TO INTERIOR — 119
Connections between exterior and interior spaces can serve two functions. First, by attempting to connect the interior with the exterior, the sense of isolation will be reduced and isolation from the exterior physically and visually will contribute to the feeling of confinement. Second, by connecting the spaces through similarity of materials or reducing the perception of spatially defining edges, the interior space may be perceived as being larger. The spaces may be perceived as one large space. This results in a less confining space.

Note: The numbers above refer to principle numbers in preceding section.
The amount of visual stimulation on the interior of a space will affect the amount of exterior visual stimulation needed to provide a satisfactory and habitable environment. An interior which does not provide a minimum level of visual stimulation, will cause the occupant to be uncomfortable. Interior and exterior visual stimulation are both necessary. The level and quality of interior stimulation is extremely important to the perception of the space. The interior represents the more intimate scale and may involve more interaction with the occupant than the exterior. The interior becomes the major focus at night in a residence, for instance, and thus represents a critical element in providing an adequate environment. The variation of interior forms in all planes is recommended. Color can be used to provide emphasis and variety in a space. The introduction of visual elements which break the space into zones or provide visual foci is important. Texture can also provide visual articulation but it is critical to keep texture within a limit so that it is adequate but not overstimulating to the point where it begins to make the space uncomfortable for occupants.
1 - FORM-WALL
3 - FORM-CEILING
9 - PATTERN OF MATERIALS
13 - PATTERN AND SPATIAL PERCEPTION
15 - PATTERN AND TEXTURE AT APERTURES
17 - RHYTHM AND TEXTURE
18 - TEXTURAL VARIATIONS - PLANES
19 - TEXTURAL VARIATIONS - ELEMENTS
20 - TEXTURAL VARIATIONS - PLANES
32 - COLOR & TONE VALUES - PLANES
33 - COLOR & TONE - ELEMENTS

Note: The numbers above refer to principle numbers in preceding section.
Perception of the size of an atrium from the interior may have an effect on the adequacy of the view provided and the effects on perceptual confinement of the space. One possible approach is to allow the occupant to see the defining edges of an atrium and thus know exactly how it relates to the interior space. The other approach is to minimize the contact with these defining edges and attempt to make the space appear as if it is continuous. When not designing to make the atrium boundaries seem limitless, the defining edges may become more important to see. The barriers, both in the introduction of interior walls and the edges of walls at windows, in a space will direct movement and view and change perception of the atrium. The connection between interior and exterior will affect the perceived size of the interior space and the relationship to the atrium. This will directly affect the perceived spatial openness of the interior environment.
4 - PERCEPTUAL EFFECTS OF ATRIUM FORMS
14 - PATTERN IN MATERIALS AS SPACE CONNECTORS
15 - PATTERN AND TEXTURE AT APERTURES
26 - BARRIERS & MOVEMENT/VIEW
27 - BARRIERS - DIRECT VIEW
30 - VIEW OF ATRIUM EDGE
34 - SATURATION OF IMAGE & VIEW

Note: The numbers above refer to principle numbers in preceding section.
DECISION MAKING MODEL
The purpose of the decision making model is to provide an organized approach to design problem solving based on the psychological aspects of perception. The model is directed to underground solutions. The model also serves as a method by which the general underground principles and the more specific detail concepts can be summarized and organized. It is impossible to determine one exact solution for each psychological concept identified because every design problem is slightly different. More importantly, a single solution for each concept is not completely valid since all design solutions take into account a vast number of variables which interact with one another and must be analyzed as a complete unit. Therefore, with all the complex relationships possible, a particular solution for a given context would not necessarily satisfy a different setting.

The model therefore, will look at all of the variables as they affect a design problem. A specific solution will not be offered, rather, a process for looking at the variables that are significant to an underground solution. The
model will categorize the variable concepts into a logical order through which a final solution may be arrived at. The "first priority" variable concepts will be those initial, often large scale, variables which must be discussed and solved first. The solution for the "first priority" variables will affect the solutions for "second priority", and the "second priority" those of the "third priority". The process and priority of variables may be applicable to above ground designs as well as underground. The important point is that the model and its priority of variables is based on the design of underground buildings.
FIRST

CLIENT
BUILDING TYPE
PROJECT SCALE
PROGRAM
TASKS
SITE CONTEXT

SECOND

SPATIAL ORDERS
SPATIAL PROPORTION
FORM
ZONING
SCALE
CIRCULATION / TRANSITION
VISUAL STIMULATION

THIRD

CIRCULATION / TRANSITION

NATURAL LIGHT
interior/exterior contrast
emphasis of form

ARTIFICIAL LIGHT
day/night contrast
mood of space
type of source

COLOR
hue, saturation, brightness
effect on moods

TEXTURE
heavy to light
perception of confinement

PATTERN
de-emphasis of corners
effect on depth perception

RHYTHM
in pattern
planes and elements

SYMBOLS
graphics
spatial markers

COMPLEXITY
spatial variety
in form and details

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DEcision making model --- 128
First priority variables represent the initial steps to problem solving in a design. First, the type of building must be determined. The building type will obviously affect all of the other variables. The client is also important to understanding the project and its financial limitations. The scale or size of the project will affect the amount of spaces in the program as well as the overall size of each space. The program must be determined to adequately provide the necessary number and size of spaces required. The tasks or activities that take place are the first major determiners of the physical requirements of the building as well as the proportions and forms of individual spaces. For instance, a space which has a high level of detailed technical activity taking place or high security needs may not require as much view. This obviously affects the location within the building. The site context may determine the placement of a building within the ground. The site may also determine the exterior views which are available. All of the first priority variables are important in determining the major thrust of the design and influence all of the subsequent variables which are considered.
The second priority variable solutions are dependent upon the solutions derived from an analysis of the first priority variables. The client's perceptions, the program, the task types, and the project scale along with the site context will determine the next level of variables. For instance, the determination of a program and its associated tasks may inherently determine whose spatial orders are most important and what spatial proportions are necessary. They may determine the most efficient form and directly influence zoning of spaces. The scale of individual elements, the importance of transition zones and the requirements for visual stimulation may be directly related to program or other first priority criteria. Individual clients and owners have their own individual spatial ordering systems which affect their perception of an environment. These must be pinpointed where possible. These orders affect all areas of the client's use of a building. The spatial proportions involving provision of adequate room volumes which are not confining is a critical variable. The form which provides the definition of the spaces must now be determined. The forms in the walls, ceiling, floor, and atrium may be manipulated as necessary to
create the desired level of spatial variety and openness.
The forms are the primary determiners of physical boundaries.
They may also begin to determine the type of structure to be
used. The zoning of spaces within a building can be a use-
ful tool particularly in an underground building. Spaces
which do not require a view may be placed in an area of the
building not having a possible view. The scale of elements
and the spaces is critical to an occupant's perception of
confinement. A poorly scaled building can be tremendously
detrimental to the quality of a finished space. Basic cir-
culation paths and transition points need to be set. In the
underground building circulation should be as open as pos-
sible although it may be closed and directed at some points.
Smooth transitions in scale and proportion is very important.
The level of visual stimulation needed must be determined,
as well as, the method for providing a view. Since view is
one of the most critical aspects to consider when basing an
underground design on the psychological points, the solutions
for providing view can easily affect the results of other
variable decisions. It is imperative that all of these var-
iables be considered, as well as the relationships between
each. The list of second priority variables is not totally complete as other variables may take precedence depending on the actual project. This is why it is important to consider more than one variable at a time.
The following variables are again dependent upon the solutions for the preceding variables. The third priority variables are more detailed and specific and of a wider variety than the preceding criteria. The sample list in the decision making model chart is only a small representation of the vast number of variables and criteria which may be analyzed at this level. Any variable in the second group may determine a solution in the third group. For example, if the basic form is determined, it may affect the method of introducing natural and artificial light. The light may be used to enhance the form. Color and texture on a form are very significant to the overall perception. The form may have a series of elements which have a sub rhythm or a particular pattern. The form could be symbolic of something or represent a complex order of spaces in the building. Natural light can be looked at based on the contrast between interior and exterior. It is psychologically pleasing to incorporate as much natural light as possible in a space. The method for admitting the natural light should be decided at this point. Artificial light needs can now be assessed based on previous variable criteria. Day and night contrasts
are important to consider. The moods or activities in the
space will help determine lighting needs. In an underground
building artificial lighting may be used to represent natural
light. The need for this lighting technique should be investigat-
ged after the restrictions of second priority variables
are applied and natural light levels analyzed. Color applied
to surfaces and materials can have a tremendous effect on the
psychological perception by occupants. The intensity, hue
and brightness of a color will have different psychological
effects on different planes and surfaces. The moods of oc-
cupants will also be affected by color and thus are critical
to consider. Textures and patterns are two variables which
must be looked at simultaneously with color in order to make
a proper analysis of their perceptual effect on occupants.
The rhythms in elements and patterns can assist in defining
a space. Another third priority variable is the perceptual
symbol or graphic symbol. Graphics often play an important
part in any building and may be used in the underground build-
ing to provide a higher level of visual stimulation. Sym-
bols can also act as spatial markers or definers of territory.
Complexity is a critical variable to consider. The level of
complexity can significantly affect the perception of a space. In underground buildings complexity can be very beneficial in some circumstances as well as very detrimental in other situations. If circulation patterns and room forms are too complex they may be perceived as confining in the underground scenario. Thus complexity at this level is not recommended. However, complexity in details and patterns may provide a necessary spatial variety. All of these third priority variables must as always be considered in relation to all of the other variables.
The conceptual scenarios are designed to be a prototypical approach to the design problem using the decision making model. They will systematically answer each variable in the model when possible. The final result is not seen as the only solution or the best solution to that particular problem. Rather, the emphasis of the scenario development is to study the general process of the decision making model. Since each actual project is different, as clients and architects are different, no two projects should arrive at the same endpoint. All underground designs should be able to adapt the decision making model. The scenarios will attempt to show the flexibility of the model for allowing different interpretations by architects and the various clients. Each scenario will choose an arbitrary client, site, and program. The process of the model will be followed through each priority level. The individual variable answers will be shown. The effect of each variable on the variables of the next priority level will be discussed. The solutions for the variables, though arbitrary, will be tied to the variables above it in sequence. The scenario will illustrate how each successive variable
will determine the variables following it. Two different scenarios will be offered involving two greatly different project clients and project scopes.
FIRST PRIORITY VARIABLES

BUILDING TYPE

Residential

CLIENT

Middle age couple with one child living at home.

Child will be leaving within 5 years.

SCALE OF PROJECT

2000 - 2200 square feet

PROGRAM

Main living space
Master bedroom
Second bedroom
Kitchen
Dining
Two baths
Den
Garage (two car)

TASKS

Normal tasks involved for each programmed space.
SITE CONTEXT
Mildly sloping hill to west with a forested area at bottom of hill.
Entrance to site is at top of hill.

SECOND PRIORITY VARIABLES

SPATIAL ORDERS
Separate entries for public and private.
One bedroom to be completely away from major spaces.
Dining is very much open to the rest of the house.
Not a totally separated zone.
Maximum privacy should be provided between the two bedrooms and the other rooms in home.

SPATIAL PROPORTION
With all spaces around a central atrium the depth should not exceed a 1:2 relationship of height of room to depth of rear wall from atrium. No light or view will be introduced from rear of spaces.

FORM
Wall form to be arched.
Ceiling to be sloped in main living space.
ATRIUM FORM

Stepped for maximum view down hill.

Form at entry to atrium is to imply continuation
of atrium beyond area actually seen from interior.
Depth of atrium is to be equal to depth of interior
space from aperture plane to allow maximum light
entry.

ZONING

Central atrium.

Major living spaces to face atrium.

Garage - no view - place to rear.

SCALE OF ELEMENTS

Scale of elements should create an intimate feeling
for the occupants.

Due to age of occupants, elements should not be
overpowering.

Scale at entry is to be low.

TRANSITION

Transition to the interior from above grade will
be made by a series of level changes through the
atrium. Scale of elements in atrium and their
placement will attempt to make atrium appear larger than it is. Strong visual link from exterior to interior will assist in transition. Upward movement from atrium to main entry.

CIRCULATION

Open circulation on interior - no major hallways. Secondary entry implied on the interior, but no visual contact. Entry from atrium into a major node.

VIEW

Natural site views preferred where possible. Site view mandatory from living room and den areas. "Artificial" view of atrium is adequate for all other areas.

WINDOW PLACEMENT

Window in main living space will run full width of room and run floor to ceiling. Rooms having two walls facing earth will have a vertical window running floor to ceiling at earth edge. Not less than ½ of wall area to be window aperture on atrium side of any space.
Any walls within the space that are not necessarily opaque for privacy reasons, i.e. bedroom, must be as transparent as possible.

**THIRD PRIORITY VARIABLES**

**NATURAL LIGHT - SKYLIGHTS**

Due to the relative shallow nature of the spaces and orientation around atrium, no rear skylights are provided.

**ARTIFICIAL LIGHTING**

Exterior lighting on major elements in atrium for night.

Interior lighting - intimate - drop spot lights in living room.

Light on stone walls to prevent appearing visually heavy and ominous.

**COLOR**

Due to heavy texture on some interior walls, a light colored stone was chosen for these walls.

Light beige was chosen for other plaster walls and white ceiling where applicable.

Color for visual elements, a medium value and
intensity wood color is chosen.

CONTRAST

Minimal contrast desired between interior and exterior during daytime.

Moderate contrast between interior and exterior atrium at night.

TEXTURE - PLANES

Rough textured stone on side walls (interior) perpendicular to atrium face.

Smooth texture on earth facing walls.

Floor texture smooth.

ELEMENT TEXTURE

Moderate level on walls.

Moderate level on all furnishings.

PATTERN

Wood floor pattern is of alternating widths running parallel to aperture in living room.

Horizontal pattern in stone on walls.

COMPLEXITY

The clients prefer a low level of complexity in their house decor. Their lives away from home are
very active and complex so they prefer simplicity
at home.
FIRST PRIORITY VARIABLES

BUILDING TYPE

Commercial stores.

CLIENT

Private developer.

SCALE OF PROJECT

Twenty 2000 square foot stores.

PROGRAM

Twenty stores - capability of joining two or more stores.

Service core common to all stores.

Exterior atrium.

Potential to cover atrium but to be open at beginning.

Parking for limited number of cars.

No multi-story building.

TASKS

Shopping/sale of goods in individual stores.

Area for sitting, eating, general socializing.

SITE CONTEXT

Flat site.
Adjacent forest all around.

SECOND PRIORITY VARIABLES

SPATIAL ORDERS
Client wants all shops as closely spaced as possible.
Minimal walking distance for customers.

SPATIAL PROPORTION
Maintain as much horizontal dimension as possible facing atrium.
Depth of store no more than 50 feet.
Open up vertical space where possible.

FORM
Form of shops and atrium to provide a spatial variety.
Floor will raise several steps as it approaches rear.
Minimal wall articulation needed.

ATRIUM FORM/DEPTH
Atrium form follows shop layout
Width of atrium to be three times final height of store front facade.
ZONING

Shops toward atrium, facing exterior.
Storage at rear of stores.
Service core next to earth side.

SCALE

Scale of buildings is to be kept low and well within limits of human scale. Maintain single story.
Elements and graphics should also be scaled down so that they do not overpower.

TRANSITION TO ATRIUM TO INTERIOR

Enter atrium near center of stores.
Minimize perception of earth cover on stores.
Maintain a normal scale at store entries.
At entry and from atrium - do not allow perception or view of earth cover on shops.

CIRCULATION

Very open circulation in shops.
Open circulation in atrium.
Linear pattern to circulation in shops.

VIEW

Site view is not necessary, no exciting site features.
View to atrium adequate.
View from display space not critical, simply maintain a visual connection.

WINDOW PROPORTION
Horizontal window proportion is dominant.
Maximum light entrance.

BARRIERS - MOVEMENT/VIEW
Physical barriers may divide store and direct movement.
No visual barriers within store due to surveillance and security needs. Maintain easy visual access through store with minimal structural interference.

THIRD PRIORITY VARIABLES

WINDOW PLACEMENT
Where glass does not run full length of store front, place one edge of glass at interior wall edge to minimize definition of that edge.

NATURAL LIGHT - SKYLIGHTS
Skylight provided at rear of store to give natural light.
Reduces confining depth of store.
Provides natural light for viewing clothes.
(Closer to actually being outside with exterior lighting conditions and qualities.)
Skylight to maximum of $\frac{1}{2}$ the width of store.

**ARTIFICIAL LIGHTING**
Use a continuous even level of lighting throughout space.
Minimize contrast between interior and exterior during day.
Allow inside to be significantly brighter at night than exterior.

**COLOR**
Floor color dark brown range.
Ceiling color light.
Wall colors must be light particularly in areas that are the most distant from windows.

**TEXTURE ON ELEMENTS**
Keep elements smooth.
Use as many mirrors as possible for people to view products in, and to perceptually open up the space.
TEXTURE - PLANES

Floor plane is to be medium textured tile surface at entry and short pile carpet in the remaining part of store.

PATTERN

Use square pattern in tile at entrances.
No pattern in ceiling or walls as pattern is not necessary as a visual stimulator in the already highly varied commercial atmosphere.

RHYTHM

The rhythm of store fronts and projecting wall planes combined with the bent form of the atrium and store alignment helps to denote a node where it is interrupted at the bends and at the entrance.

COMPLEXITY

Due to the inherent complexity in the products which are in stores the material patterns in building should be simple.
CONCLUSION
Architects often shy away from including members of other related disciplines in their design process. Any time that constraints are placed on the normal perceptions by occupants of a building, the importance of including a consideration for psychology in the design increases dramatically. The underground environment is a prime candidate for including psychology in the design process. By basing decisions in the design process on the psychological aspects studied in this thesis, an underground design can begin to counteract the aversive stigmas often associated with living and working underground. Not all of the psychological aspects could be identified in a single study of the underground environment. This thesis study, however, has made a significant attempt to analyze as many of the aspects as possible. Very few studies have been done on the application of psychology to the design process of underground buildings. The typical application of large atriums for view and skylights for ample natural light represent only a tiny fraction of the numerous design principles affecting perception which may be used. Through this thesis it has become evident that all of the principles and concepts discussed must be looked
at in totality. In a real situation each variable has an effect on nearly every other variable. As a thesis project, this contributes to the overall body of knowledge in a three-fold manner. First, since few if any studies have been done on the psychological aspects of underground design, the thesis serves to bring together many separate ideas from a wide variety of sources into a single source book. Secondly, it attempts to generate a new conceptual understanding of the relationship between man and the underground environment. Hopefully it will stimulate both an interest in the subject and future research in a conceptual or detailed scenario. As a concept generator, it serves to link architects with social scientists and generate a basis for more scientific study. Finally, for the architectural profession a decision making model for attacking a design problem was constructed. This model sets up a process by which the numerous psychological aspects can be organized and successfully included in the design process. Through this thesis project, the designs for underground buildings will hopefully provide a more satisfying environment for people to live and work in. It should always be remembered that anytime a building is
placed in an unusual environment the design must actually be done better in order for the building to be perceived as equal to those in normal environments. Considering the perceptions of occupants and trying to predict the psychological impact of a design is an important part of creating a superb design product.
PERSONAL STATEMENT
The purpose of this statement is to give a personal insight on the thesis element of architectural training and serve as a guide for any future students who are considering a research oriented thesis as their project. The thesis part of one's training should serve as a synthesis of all the elements of architecture previously studied. My thesis has helped me to synthesize and apply my understanding of architecture and related fields. I chose to do this thesis because I did not want to do the normal one year building design project. I felt that I could benefit more by undertaking a thesis which would teach me far more than how to put a single building type together. I believe I now have a greater understanding of the inter relationships in architecture. Also, I have now done something different from the norm and this sets off my personal experience to future employers. It illustrates my personal philosophy of a totally comprehensive design which includes a consideration for underlying elements in design which are sometimes neglected. As a suggestion for anyone undertaking a research
thesis, I would encourage a thorough outline of the project far in advance. Choose a thesis mentor and discuss with him the objectives, goals, and process at great length before the beginning of your first quarter of thesis. A research thesis not only requires as much or more work as a traditional project, but is more difficult to undertake because of the non-traditional approach and structure which you must develop. Good luck on your project.
APPENDIX-A
RESEARCH PAPER
OUTLINE

INTRODUCTION: PSYCHOLOGY IN ARCHITECTURE

PSYCHOLOGY IN UNDERGROUND DESIGN

SCOPE OF PAPER AND RESEARCH BASE

SENSE PERCEPTION AND DEPRIVATION
  - VISUAL PERCEPTION
  - NOISE PERCEPTION
  - ODOR PERCEPTION
  - TEMPERATURE PERCEPTION

COLOR PSYCHOLOGY

ZONING IN DESIGN

NATURAL AND ARTIFICIAL LIGHTING

ARCHITECTURAL DETAIL PSYCHOLOGY
  AND PERCEPTION "TRICKS"

TRADITIONAL VS. NON-TRADITIONAL MATERIALS

SPATIAL ORDER PERCEPTION

TRANSITION
  - ABOVE GROUND/UNDERGROUND
  - INTERIOR/EXTERIOR

CONCLUSION
  - SUMMARY
  - FUTURE PREDICTIONS

BIBLIOGRAPHY
INTRODUCTION: PSYCHOLOGY IN ARCHITECTURE

Psychology is an important part of any successful design problem. Often as designers we approach a problem with many preconceptions about what a specific structure and its spaces should feel like. The psychological effect that a design has on its inhabitants is of great significance. Perception of the space is important to the amount of use and the success of the problem solution. Upon entering a space you begin to perceive at both a conscious and subconscious level. No matter how good the building looks visually, if it creates a bad feeling one will not continue to occupy it comfortably. All sense perceptions and personal interactions that take place are extremely important.

Designers often include design principles in their personal design theory which may involve psychological considerations. However, their psychological considerations are often dealt with on a subliminal level without actually consciously thinking about them. The designer may rely on his past experience when determining what looks and feels right for his design. A specific solution may be included to manipulate the activities of people based on past experience or an understanding of how elements of space affect people. The key here is that these solutions have been dealt with on a subliminal level without thinking about, or possibly even knowing, why those design principles affect people in the specific or general ways in which
they do. It becomes vitally important as a designer that as we evolve in our skills we become aware of the "whys" and "hows" of psychology on a conscious level. If one migrates an understanding and a process of thought for psychology of design from the subconscious to the conscious it will allow a clearer perception of the design possibilities. Not only will those principles which were originally dealt with on a subconscious level be handled more efficiently, but the subconscious will begin to perceive more information from conscious thought and the subconscious design will become even more sophisticated. The higher sophistication in both conscious and subconscious will lead to new insights on design.
PSYCHOLOGY IN UNDERGROUND DESIGN

Underground buildings deserve major consideration concerning psychological elements of design. If psychology is considered a major factor in design, then one can assume that a well-developed design will certainly be approached from the psychological considerations inherent in that design. The necessary amount of emphasis put on the psychological elements of a design will certainly vary from project to project. The need for psychological considerations varies from little or none to that of being a prime design element. At one end of the spectrum, a garage would require little or no psychological consideration in its design. In marked contrast to this would be the design of a space station where the adverse psychological and physiological restrictions placed on individuals are at a maximum. Here psychological considerations are vital to a successful design of usable space. Somewhere within this polarity lies design for underground structures.

Being a non-traditional area of design, there are numerous stigmas associated with designing, working, living, and occupying an underground space. The stigmas attached vary from the "like living in a cave" image to that of feeling "as if back in the womb". No two individuals will perceive a space exactly the same. Those stigmas which instill unwelcome thoughts about a design need to be dealt with from a psychological level. Whether or not that stigma is derived from experience or hearsay, the
feeling of aversion may be very strong. Psychology in design becomes extremely important in underground schemes due to increased restrictions on the occupants. Using principles of psychological design can assist in leaving the underground occupant with a good feeling about being underground and thus breaking through various aversive stigmas.
SCOPE OF PAPER AND RESEARCH BASE

This paper will discuss several elements of design on a psychological level. Many of these points may be applicable to design in general; however, the thrust will be to make adaptations and analogies to use in designing underground structures. Some points may seem elementary; some may have been used before but not understood, while others may be new adaptations of older ideas. In any case, the point here is that the discussion will attempt to bring together many aspects concerning the psychology of design for underground structures in a concise form where they may serve as a reference and guide for conscious thought of design principles which might have once been carried on in the subconscious.

Since comparatively little research has been done in the area of underground structures most of the information and ideas have been adapted from related areas. Sensory deprivation, basic design psychology, social interaction, environmental psychology, arctic habitation, submarine living, and outer space habitation are but a few of the possible areas of related research. The time span of research for this paper and the large number of sources prohibited in-depth investigation into all areas; however, generalizations will be made concerning most of the related research. Future research and design in these areas will be imperative in the continuing study of psychological adaptations to "non-traditional" environments. Some of the
researched areas involve direct experimentation such as the sensory deprivation studies. Other research development in space habitation designs are more speculative in nature and obviously have not been extensively tested to date.
SENSE PERCEPTION AND DEPRIVATION

Sensory deprivation studies have had a major impact on our understanding of the effects of taking away stimuli which one normally experiences on a day to day basis. Most sensory deprivation studies entailed a near total elimination of all stimuli that a person might experience. These particular studies have been short term deprivation studies due to the inability of the subjects to withstand deprivation of severe nature for extended periods of time. Other studies have been done using minimal levels of deprivation and constant monotonous levels of stimulation such as "whitenoise". Such studies give an indication of the expected reactions to deprivation. However, these studies can only be considered as generalizations since they deal with studies of only a few hours to several days, and in underground design, people are subjected to low level deprivation for much longer periods. Although many sensory deprivation studies were done twenty to thirty years ago, it can be assumed that the human physiology has held at a constant over this period and what was true then is predictably true today.

Deprivation of perception and sensory stimuli, for example, is an obvious problem in underground habitation. In related sensory deprivation studies, "hallucinations were reported by the perceptually isolated subjects" (Zubek, 1969, pg. 85). An equally if not more significant finding in sensory deprivation studies is the effect of