Challenging the Statics of Architecture

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Bachelor of Architecture Thesis
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I would like to thank:

mom and dad
for their sacrifices,
support, and guidance

advisors
andrea swartz, rod underwood,
jeff culp

family
david, stephanie,
andrew, and philip

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wagner, and numerous others

studio family

Without the help, guidance,
and support of everyone in my life
I would not be where I am today.
Over the last five years I have
learned to be a better designer and
better person as a result.
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"because of its dedication to permanence, architecture is one of the last modes of thought based on the inert, more than even its traditional role of providing shelter, architects are expected to provide culture and stasis. This despite the timelessness is intimately linked with interests in formal purity and autonomy, challenging these assumptions by introducing architecture to modes of organization that are not inert will not threaten the essence of the discipline, but will advance it" – Greg Lynn
This thesis confronts the traditional conceptions of permanence and stability, and seeks to redefine the negative associations with movement and change. For the purposes of this investigation, a challenge to the “permanence” of architecture implies in no way that the built form of architecture should be temporary, but rather to challenge the association of “permanence” with motionlessness. Also the stability of architecture is not in question, only the underlying connection of stability to a static state. Architecture which “moves” can still maintain desirable attributes of “permanence” and stability. Bringing architecture out of the illusion of permanence and stasis, by exploiting the advantages of movement, can create opportunities for extraordinary spatial experiences.

Physical movement is an important aspect of architecture that will provide a means to redefine traditional conceptions of “permanence” and stability. Characteristics that are intrinsic with the physical movement of panels, skin and structure make possible the redefinition of “permanence” and stability in architecture. These intrinsic qualities formulate the basis of this thesis: an acceptance of the passage of “time” as a reality in architecture, the ability to customize space, and allowing architecture to accommodate/benefit from environmental forces.

The thesis is explored through a caving exploration center for training and education. The challenge of permanence is explored through the metaphor of cave formation, the embodiment of time, and the movement contained within caves. This facility allows for manipulation by individuals in response to their psychological needs of the space. Spatial customization will take place on three different levels: individual, group, and environment.

The site location of the thesis project is on the mountains above Manitou Springs, Colorado. At an elevation of 6,800 feet, the site overlooks the transformation of the Great Plains into the rugged Rocky Mountains.
Architecture, as traditionally conceived, manifests stability and permanence which has lead to expectations of an illusion of permanence and place. We are all affected by the constant movement that surrounds us: expansion, contraction, growth, decay, sedimentation, and erosion. Some of these movements are apparent while others are not. The constant movement of the Earth through space, the folding of the Earth through plate tectonic, and the daily expansion and contraction of biological entities are examples of motions intellectually understood but invisible to the eye. As our surroundings move through time, we too change, decay, and move. Even when aware of the constant movement around us, we, as architects, attempt to integrate into the dynamic world with the intent to make buildings that are static. A state of tension is the result of placing such buildings into the constant fluctuation of the environment which surrounds it. We have been brought up under the illusion that architecture can exist in a vacuum of space and timelessness, without change or movement.

This thesis confronts the traditional conceptions of permanence and stability, and seeks to redefine the negative associations with movement and change. For the purposes of this investigation, a challenge to the “permanence” of architecture implies in no way that the built form of architecture should be temporary, but rather to challenge the association of “permanence” with motionlessness. Also the stability of architecture is not in question, only the underlying connection of stability to a static state. Architecture which “moves” can still maintain desirable attributes of “permanence” and stability. Bringing architecture out of the illusion of permanence and stasis, by exploiting the advantages of movement, can create opportunities for extraordinary spatial experiences. In order for architecture to respond to notions of movement, one must first distinguish between the two different categories of movement: perceptual and “physical” movement.

Movement that is perceptual only implies movement, mostly through visual sensations brought about by the expression of movement. This classification can date back into the Baroque and Renaissance times when the use of curvilinear and fluctuating forms first challenged the state of stasis in architecture. Master architects, such as Michelangelo and Borromini, produced great designs executed from pushing strong design issues. The steps entering the Laurentian Library, by Michelangelo, appear to float and move as they undulate across the space. With the chapel San Carlo alle Quattro Fontane, Borromini explored movement with the undulating façade and plan of the entry. Architects today are aware of the dynamics of formal expression which allow percep-
-tual movement to be advantageous to design.

The new frontier of architecture, in the perceptual boundary, is made possible largely by the advent of advanced computer technology and is led by Greg Lynn. Greg Lynn constantly pursues infusing the evolution of time into projects. Striving to bring about a consciousness of how surfaces evolve and transform into a final form/space. However, the fluctuating forms of his work, like those of Michelangelo, exist in the perceptual boundary of movement, even though societal acceptance of movement is greater now than in any time before in history. Although his work deals with the animation of space in perception, his ideas give inspiration for the further pursuit of physical movement in architecture. Some architects have been able to cross over the perceptual boundary into the realm of physical movement of architecture.

Movement in architecture that is physical refers to actual movement. Structure, “walls”, panels, skin, and shading devices are architectural elements commonly set into movement. Many present day architects have explored the notion of physical movement. Glenn Murcutt and Jean Nouvelle have explored physical movement as a way of manipulating environmental conditions of a building. Steven Holl executes movement in his Void space/Hinge space apartment building in Japan with “walls” that rotate on pivots to transform function and the spatial impact of the space. Holl presents issues that are important to the investigation of user interaction and manipulation of their environment.

One the most highly regarded architects/engineers to bring physical movement to buildings is Santiago Calatrava. Key concepts of movement, both perceptual and physical, can be recognized in all of his work. He has pushed architecture into the realm of physical movement with the Kuwaiti Pavilion and Swissbau Concrete Pavilion. The Kuwaiti Pavilion, built in 1992 in Seville, Spain, contains a series of palm fingers that cantilever to form a protective shading device and transform, which opens the space up to the sky, when they are rotated to point skyward. Much like the Kuwaiti Pavilion the Swissbau Concrete Pavilion contains cantilevered elements to define the space, however, the thin-finger like elements are a test of materials as well as human intuition because they are made of concrete. These concrete fingers dance up and down to form a dynamic expression in the different forms that can be taken in conjunction with light and shadow patterns that result. The precedents and methods that he created by transforming space will be an integral investigation in conjunction with this thesis. The work of Calatrava, Lynn, Murcutt, Nouvelle, Holl and other architects attempt to redefine the constraints under which
basis for thesis

Physical movement is an important aspect of architecture that will provide a means to redefine traditional conceptions of "permanence" and stability. Characteristics that are intrinsic with the physical movement of panels, skin and structure make possible the recreation of "permanence" and stability in architecture. These intrinsic qualities will formulate the basis of this thesis: an acceptance of the passage of "time" as a reality in architecture, the ability to customize space, and allowing architecture to accommodate/benefit from environmental forces.

Time, as an element of progression and change, is an important factor in designing the experience of space to further the distance between "permanence" and motionlessness. Our preconceptions of architecture to be a permanent icon have resulted in buildings that create the illusion of standing in defiance of time. This defiance of time does not allow building to respond to changing societal and environmental needs thus creating singular and unchanging experiences. When movement manifests itself in design, infinite experiences and infinite moments occur. Even when we are aware that a space moves and changes space, the experience of the architecture cannot be defined solely by its starting and ending status. Only when involving the "becoming" of the space can the true experience be knowledgeable. This occurs because experiences of space, as well as outside of space, are both dependant upon and a result of time. Creating physical movement, through the acceptance of time, reinforces the redefinition of "permanence". This is obtained through temporal experiences that create temporary space. Temporal experiences, defined as the experience of the "becoming" of space, and temporary space, as the space that occurs during the "becoming" of the space. Even though the building is "permanent," movement creates temporal experiences, which means experiencing moments of time. User manipulation of space further reinforces the element of time as well as "permanence".

The ability to customize space in response to primal human spatial needs can be incorporated through movement and change. Built into the human mind are primal emotive feelings of space and towards space. Individuals need different spaces to accommodate these natural emotive feelings. At one moment a compressive, surrounding space may be needed to create a comfortable space while at a different moment may require a level of comfort obtained by an expanded, uncompressed space. The involvement of the user into the movement process will also aid in breaking down the psychological preconceptions of space. By focusing on comfort levels and individual perceptions of space,
the need for static elements for psychological stability will not be necessary.

Along with the qualities of time and customization is the quality of allowing architecture to accommodate/benefit from environmental forces. Buildings are surrounded by numerous forces that make up earth’s climate. Responding to the environmental conditions of the climate and site will minimize our building’s impact on the environment and create a more efficient use of mechanical conditioning systems. By minimizing these systems we consume less energy and produce less waste. The responses that movement allows will also minimize the impact of the building beyond just its envelope.

This thesis poses many questions and challenges traditional preconceptions of architecture. It is the desire of this thesis to acquire an answer to these questions. Do buildings have to be unstable because parts may move and/or change? Can architecture maintain meritorious qualities of “permanence” and stability, while incorporating moveable/changeable elements? Can additional benefits be derived when architecture of movement/time is conceived?
speleologic exploration center

This thesis was explored through a Speleologic Exploration Center which focused on moveable environments for both interaction with the environment and interaction with architecture. Caving professionals and amateurs come to the center in order to learn about caves, with an emphasis on cave formation and ecology, before developing caving techniques. Accommodations are provided for eighteen spelunkers, who will use the facility or the surrounding caves, for durations up to one week. In addition to long term spelunkers, up to forty public users will be able to visit the exhibits, lectures, library and interact with the changeable training environment. The architecture of the building involves characteristics of movement in order to further learning about natural processes and caving technique.

This facility undertakes the ability to be manipulated by individuals in order to respond to their psychological needs of the space. In order to respond to time, human comfort, and the environment, the spaces occupied by the private visitors and the public are customizable for certain needs. The movement of panels and skin make customization possible.

<table>
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<th>space summary</th>
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<tr>
<td>Entry</td>
<td>1,800</td>
<td>Vertical training 1,500</td>
</tr>
<tr>
<td>Vestibule</td>
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<td>Horizontal training 3,500</td>
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<td>Lobby</td>
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<tr>
<td>Coat room</td>
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</tr>
<tr>
<td>Restrooms</td>
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<td></td>
</tr>
<tr>
<td>2 @ 200 sq.ft. each</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Administration</td>
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<tr>
<td>Open-Plan Office</td>
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<tr>
<td>3 @ 150 sq.ft.</td>
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<tr>
<td>1 for each administrator</td>
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<tr>
<td>1 @ 200 sq.ft.</td>
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<tr>
<td>for two assistants</td>
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<tr>
<td>Visiting</td>
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<tr>
<td>Living</td>
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<tr>
<td>18 @ 50 sq.ft each</td>
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<td></td>
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<td>Commons Area</td>
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<tr>
<td>Kitchen @ 600 sq.ft.</td>
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<td></td>
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<tr>
<td>Dining @ 400 sq.ft.</td>
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<tr>
<td>Lounge @ 300 sq.ft.</td>
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<tr>
<td>Restroom/Shower</td>
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<tr>
<td>2 @ 480 sq.ft. each</td>
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<tr>
<td>Laundry Room</td>
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<tr>
<td>Resource Center</td>
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<tr>
<td>Print Media Stacks</td>
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<tr>
<td>Computer Resource</td>
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reading pod
movement study fall 2001

Net Area 19,210
Gross Area 33,617

Exterior Spaces 8,500
Drop-off 500
Exterior Terraces 1,000
Parking 7,000
The site location of the thesis project is on the mountains above Manitou Springs, Colorado. At an elevation of 6,800 feet, the site overlooks the transformation of the Great Plains into the rugged Rocky Mountains. Jagged rock with little ground cover is common on the steep slopes. The physical context of the site is a raw and natural environment which encourages interior and exterior interaction. Existing in conjunction with the site is the Cave of The Winds, a popular recreation destination for cavers. The thesis project will not interfere with the existing context nor the natural cave environment. Within the immediate context of the mountain exists the cities of Manitou Springs and Colorado Springs which are clearly visible in the distance. This creates and interesting relationship between the built, bustling city and the pristine natural environment. Folded, bent, and jagged stratifications in the rock are apparent from the result of dynamic forces the mountains. Intrinsically in the location of the site are environmental impacts of wind through the canyon, direct sunlight, and variable weather conditions that may envelope the site with clouds. This mountain site can receive dramatic temperature swings through the season which will have a strong impact on the architectural design.

Along with the physical environment exists a strong cultural dynamic for exploration and outdoor activities. Colorado Springs and surrounding areas have a high awareness of their natural landscape and ecology. A large network of infrastructure exists for maintaining and exploring the natural environment through parks, trails, and various recreational facilities. Centers for sustainability, astronomy and ecology education show the involvement and dedication to the environment by the citizens of the area.

The way in which the site is used is the result of ecological, social, and natural relationships to the surrounding areas. A primary design objective is for the architecture to weave in to the natural environment in a delicate manner to blend in environmentally and visually.
Kuwaiti Pavilion (for Expo '92)
Architect: Santiago Calatrava
Location: Seville, Spain
Type: Physical Movement

The pavilion was built for the country of Kuwait in the 1992 Expo, Seville, Spain. It was built as a reminder of the gulf war and as a representation of culture of Kuwait of which little was known. Two exhibit areas are contained within the pavilion: one enclosed area partially underground and below the upper platform, and one exterior exhibit area elevated on a platform that forms the ceiling of the lower room. The spatial and daylight qualities of the upper platform can be dramatically altered by 17 timber fingers that dance overhead.

Main Elements
17 alternating timber palms approximately 82 feet in length.
Each is made of wood in a triangular truss design.
Infill is of wood lattice.
Palms are supported by concrete columns in between each.

Now.
Each palm starts in a heavy counterweight before crossing the pivot point and then tapering to a point. (simple machine - lever)
Through the aid of the counterweights and hydraulics the palms can be set in an infinite number of configurations.

Swissbau Concrete Pavilion
Architect: Santiago Calatrava
Location: Basle, Spain and similar at Museum of Modern Art in New York
Type: Physical Movement

This project is like the Kuwaiti Pavilion in what it tries to do and how it is accomplished. It was executed mostly as a sculptural piece with the intent of exploring limits of materials and the impacts of shadow and form from the dynamic undulation of the concrete fingers.

Main Elements
Concrete fingers
How
Mechanical elements raise and lower the ends of each of the concrete fingers about a pivot point.

Void Space/Hinged Space Housing

Architect: Steven Holl
Location: Fukuoka, Japan, 1989-91
Type: Physical Movement

This is a complex of apartments in which no apartment is the same as another. Each is designed to accommodate changes of the functional and spatial need of the apartment dwellers. Enclosed rooms can easily be opened to become part of a larger space or open to a similar sized room and become a larger sub-room.

Each “wall” and/or panel is essentially free floating allowing a pivot movement. The only connection to the floor and ceiling is the pin of the pivot point.

Artists Space Installation
Architect: Greg Lynn
Location: New York City, New York
Type: Perceptual movement

This installation was developed to showcase four projects while also exhibiting itself as a project. The perceptual movement of the design attempted to capture the character of the gallery as well as the essence of the process for the four projects on exhibit.

Main Elements
Movement takes place through the animation/undulation of the encompassing wall surfaces.

How
Through the use of digital animation software, five nodes were created and then expanded into blobs. The boundaries of the blobs form the wall surfaces.

"These explorations result in the discovery, the unearthing, of geomorphic and cultural deformations or indications that act independently or intersect and animate one another...really looking at the underlying strata and the history of the larger geographic and cultural environment, not over just centuries but millennia: upheavals in the land, the changing course of water, paths that people have traveled - both physical and spiritual. These all become primary indicators for architecture" – Antoine Predock
conceptual approach

The conceptual guidelines for the caving center establish a focus for the development of the site and the building integrated into it. Contained within the site itself is a long history and spirit of time, environment, and movement which inspired the conceptual foundations for the project development. Natural and raw, the site drew its formation and evolution from geology and tectonics.

gеology & tectonics

Inspired by the site the first conceptual foundation was in acknowledging stratification and layering. Each layer of rock contained its own identity, texture, color, composition, and place in time while being part of a whole system which appears to be solid. These strata mark time in a physical sense and also in the perceived expression of time as a person moves past each layer. The deformation of the layers is also relevant to time and draws to light the history and forces that lead to its development.

The abundance of caves in Colorado and the historic development of the caves were also a source of conceptual inspiration. Cave formation itself is very dynamic, making itself a strong concept for the development of movement and spatial awareness in design. Caves can form through many different forces, however the caves in this area were formed by the movement of water and the dissolution of the rock strata. This formation process creates a cave that is fluid and has a natural flow through it. The soft elements of a strata are removed to form a void while the solid elements are left to enclose the cave system.

Cave formation and geologic strata concepts were also used to address the formation of perceptual and physical movement throughout the project.

heighten spatial awareness
perceptual movement
cave formation
physical movement
establish flow
"decisions are made slowly, after thoughtful investigation, because they are a commitment that has consequence" — Todd Williams
design process

The design process occurred through many different media and studied a wide range of design issues. In order to grasp the complexity of the site and of the building program both physical models and computer models were used. Each resolved certain issues while posing new questions and challenges in design.

design vocabulary

The first challenge in the design process was to define an architectural vocabulary relating to the concepts and site spirit of form, landscape, geology, and caves. The terrain of the site poses many obstacles and is in a remote and precarious location, yet there weren't any other constraints. Site limitations were soon derived in model form to formulate a minimal appearance on the site from major public thoroughfares, advantageous views, and daylight potentials. Physical mass models attempted to capture the initial site orientations. Further investigations involved the separation of public, semi-public, and private, resolution of the vertical site usage, circulation placement and method, amount of site integration, and passage through the mountain. Issues considered consistently in each phase were movement methods and placement, as well as keeping the spirit of the concepts.

architectural implications

After a vocabulary for the site had been developed, the architectural implications of the conceptual foundation had to be developed. Integrating the design concepts into a true architectural expression of space externally and on the interior proved to be difficult. The massing of the tectonic strata of the building evolved to become walls, rib structure, and ceiling plane. Numerous layers of building skin, ranging from concrete to perforated metal, to glass, were developed to shape the effects of light in the spaces of the building. Circulation paths through the building were resolved to incorporate the horizontal erosion, through and across each band, and the transition to vertical space in the canyon. Solid and void relationships were also shaped by the erosive circulation pattern.

movement

Architectural movement also developed through the site and cave vocabulary. Pieces of the program were highlighted for specific areas of movement development. Those spaces included circulation paths, the cave exhibit, vertical and horizontal training, administrative offices, and living quarters. Issues of how pieces move and where in the building movement would take place were acknowledged. Spatial configurations and aspects of surrounding, compression, embrace, and release were studied. Panelized and gravity endured system evolved as a response to spatial needs.
The first schematic organization posed a loose banding of program elements which were carved out by the circulation. Each element had its own competing identity and circulation became a large element. It was also placed on-top-of the site which did not acknowledge the terrain. This study encouraged better site integration and more programmatic cohesiveness.

This study sought to further define the vocabulary of geologic strata through the grouping of program elements into defined bands. The bands slowly progressed into the ground. At this point a timid gesture was made to push the geologic vocabulary over the cliff edge. A new push to understand the vertical nature of the site and a desire to further develop geologic reference was a result of this exploration.

By wrapping the geologic forms over the edge of the cliff, the form became more anchored to the site. It became more integrated with the site than an object imposed on it. Because of the form transitioning from horizontal to vertical, new ideas of circulation had to be developed. Placing spaces into the vertical form would also be a challenge. A clear hierarchy and division between each band was beginning to develop. New issues of transitioning circulation, vertical space organization, and architectural response to form were posed as a result of this exploration.
The second phase in the development of the thesis was to bring an architectural resolution to the vocabulary established in the first set of models. Physical modeling on a site model became difficult and time consuming so computer models were also used.

The first computer models were simple massings of each band. Space sizes and relationships were the first issue to be undertaken architecturally. Circulation placement was also investigated. Vertical circulation proved difficult to integrate into the mass of the building. Just as difficult as the vertical circulation was the horizontal circulation that needed to cut across each band.

Circulation in the north-south direction was resolved by creating a break in each band. It would allow the circulation to erode through each band. While bringing some resolution to the horizontal circulation the vertical circulation was left unresolved. By using the computer generated mass models on a digital site, new issues of emergence into the site, vertical site integration, and progression arose.
Along with the digital exploration of architectural responses, physical models were developed. These models and sketches show a potential response to the circulation breaking the bands in order to connect to all spaces. These established that the vertical arrangement of spaces was possible while posing various ways in which the spaces could be integrated into the form bending over the cliff. The building has been developed to progress through the mountain and emerge on the cliff side.

The plan was developed to be bent and tectonic to become more dynamic like the rock strata surrounding it. Circulation paths have also been developed to erode internally in the band to leave the solid mass of the program spaces.

These sketches show the development of the break in the bands for the circulation. Individual elements within the vertical towers are also explored for structure and interaction with exterior space. The vertical circulation began to be developed in conjunction with the break for the horizontal circulation. Originally only a two-story vertical circulation, it needed further resolution.
The computer model was refined along with the physical model to address a more architectural response to the program in the vertical sections, horizontal bands, and circulation break.

The structure of the bands was explored through a plan and computer model. Each had the intent to create a clear span across each individual band. Solid and void relationships were also tested in section.

For mid-reviews a circulation model was built to help convey the spirit and organization of space that the circulation created. In correlation with section drawings, a space was carved out of the rock behind the vertical towers to form the canyon space for circulation. Elevators and stair locations were still unresolved. Issues posed and unresolved were relating to the location of specific programmatic spaces, further definition to the canyon space, and the placement of vertical stair elements.
This physical model integrated circulation elements with the architectural strata. Circulation elements were developed in the space between each strata. The strata began to take on architectural definitions in wall and ceiling plane, mass, and better understanding of site integration.

Sketch and model explored the progression emerging from and across the rock. The architectural strata were to appear to bend over the rock face in a continuous motion to represent continuity. The idea of maintaining the continuity posed questions of the structure in the vertical sections. Skin and enclosure were also issues posed.
The skin was developed to have multiple layers ranging in density and light transmittance. Solid elements of concrete were layered by glass glazing and then perforated with copper.

To resolve the structural problems, a new system was developed. The system would contain the band and allow solid and void circulation, as well as a slab at the skin impacts a section study model.
"the explorations come back to a consistent impulse of mine - to encounter the subject, deeply, empathetically; to get out of my head and back to some original impulse, some original power that touches different chords rather than work that is more cerebral, the intellectual component, the rational component. Is there in my work and in my life, but it is tempered and balanced by this impulse to go deeper each time" – Antoine Prendik
final resolution

The final design for the Speleologic Exploration Center is a direct evolution of the design process. Decisions pertaining to programmatic layout, horizontal and physical circulation, site integration, spatial sequence and experience, structure, as well as construction technology have been based on the controls set forth by the issues of the thesis and conceptual approach: acceptance of time, customization of space, response to the environment, spatial awareness, geology, caves, and movement. The final design attempts to bring each element together to form a dynamic spatial environment that questions the stability and "permanence" of architecture and displays the benefits of movement in design.

The building takes on the form of three bands of strata which are integrated into the site. Each band is carved down into the rock and extends back into the mountain with the primary public band emerging through the mountain to formulate the entrance. Carving into the landscape, the building dissolves itself into its surroundings becoming neither foreground or background. The material choices of the exterior skin and the overall form enhance this perceptual blend.

Each strata is formulated to carry its own identity resulting from the programmatic divisions of the building. The primary strata contains public spaces focused on general education about caves. Spaces include: entry, equipment shop, cave history exhibit, lecture hall, and cave resource center. Progressing into the primary band, the building intends to compress and engage visitors into the natural environment with exposed rock enveloping the building as it carves itself through the mountain. The raised grate walkway allows views to the rock on all sides. The horizontal circulation transitions to vertical as the building structure bends over and down the cliff walls. Carved slightly into the cliff walls, the lecture hall and resource center are protected from direct light. The primary band introduces the dynamic relationship between the man-made strata and the natural rock strata when the building is integrated into the landscape.

The second strata contains the semi-public areas of vertical and horizontal caving technique training. Exploration in these areas helps cavers to develop skills in a controlled spatial environment. Configurations can be transformed to form tight passages and open passages for the various experience levels of the users.

The third strata includes the private areas for the living quarters and commons areas for dining and relaxing as well as the mechanical supports for the building. Support spaces and commons areas extend back into the mountain allowing cavers in the living units to experience the views to the surrounding mountains.
main level floor plan
scale: 1/32" = 1'

1. entry
2. equipment shop
3. lobby
4. admin. corridor
5. restroom
6. main circulation
7. cave exhibit
8. lecture hall balcony
9. canyon circulation
10. funicular elevator
11. stairs
12. vertical training
13. training preparation
14. horizontal training
15. administration
16. lounge
17. dining
18. kitchen
19. receiving
* movement areas
- .5 living quarters level
(-1.5, -2.5, -3, similar)
scale: 1/32" = 1'
1. canyon circulation
2. stairs
3. funicular elevator
4. living quarters
5. fire stairs
* movement areas

and plains. The living quarters offer transformable space to vary amounts of enclosure and privacy.

As a resolution to the thesis questions, the final design has attempted to engage the passage of time. Buildings interact with the effects of time but remain static in their appearance and in their form. The final design allowed the experience of time within the building. Immersion into the rock allows the progression past the historic rock strata that was developed millions of years ago. By progressing past these strata time can be traversed by new experiences. Time is also represented in the perceptual erosion within the building which is formed by the circulation path eroding past the solid of the cave exhibit spaces. Time is also expressed physically by the physical movement of elements within the circulation, administration, training, and living spaces. Moveable panels allow users to shape their own space, and in doing so create experiences in time which only exist for moments as each piece moves into place. The movement of filtered light through spaces also marks time and movement.

Customization of space has also been resolved throughout the design process. In various spaces throughout the building spaces contain the ability to manipulated by individuals in order to react to their needs for spatial enclosure. The customization can occur on both sides of the manipulated plane creating dynamic changes in spatial volume to numerous users on both sides.
-1 level floor plan
scale: 1/32" = 1'

1. canyon circulation
2. lecture hall
3. funicular elevator
4. stairs
5. vertical training
6. living quarters
7. exhibit preparation
8. storage
9. mechanical
10. elevator
11. fire stairs
* movement areas
-2 living quarters level  
scale: 1/32" = 1'

1. canyon circulation  
2. resource center  
3. funicular elevator  
4. stairs  
5. vertical training  
6. living quarters  
7. fire stairs  
* movement areas

The final resolution addresses a response to the environment. The overall form of the building responds to environment by allowing itself to become part of the environment rather that a piece in the environment. The landscape protects the building from elements and creates stability in thermal comfort. Using supplemental natural heat sources, such as geothermal heat, aid in anchoring the building to the ground. By utilizing multiple layers of exterior skin the building creates buffers and protects itself from a wide range of conditions.
Band 1 longitudinal section
1. entry
2. lobby
3. main circulation
4. canyon circulation
5. lecture hall balcony
6. lecture hall
7. resource center

Band 2 longitudinal section
1. administration
2. horizontal training
3. canyon circulation
4. vertical training

Band 3 longitudinal section
1. access tunnel
2. receiving
3. kitchen
4. dining
5. canyon circulation
6. lounge
7. mechanical
8. storage
9. living quarters

The sections represent each band and its relationship to the site. Each band develops its own character and sequence of compression, summersion, emergence, and verticality.
stair section
Movement elements within the main circulation path are resolved. The spatial changes are caused by gravity depression mechanically moving panelled elements. Space changes as cavens traverse through the building. Contrasted with the dynamic movement to the circulation is the solid exhibit hall.
The living quarters area also a key area of movement development. Each space is defined by a panel system that hinges like a door, but moves in dynamic fashion to formulate the size and shape of the enclosure on both sides. The degree of enclosure is defined by the spelunkers of the facility. Space can be customized to different comfort levels of enclosure or openness.

The space is also customizable in section as well. An element of the ceiling and wall planes is animated to allow for various light conditions, exterior relationships, and personal space comforts.
floorplates and circulation elements

structural rib system bending to form vertical structure
1. entry perspective

circulation path band 1

2. circulation band 1
(with movement panes)
3. canyon circulation (from main circulation)

4. lecture hall (from lecture balcony)
1. main level canyon (from north)

2. canyon circulation (-1 level from south)
3. canyon circulation (-2 level to north)

4. living quarters
1. vertical training (from top)

2. vertical training (from bottom)
exterior perspective (without site)

exterior perspective
exterior perspective (from south)

exterior perspective (from bottom of cliff)
“Development, exploration, is a voracious notion. It is being a cosmic omnivore. It is a kind of benign pathology, with every project, there is an attempt to digest and consume – to first, but not entirely burn up, the right kind of fuel. On the ride there have to be quiet points of reference, pauses that allow the opportunity to appreciate, to understand – like eddies that reside in the flow of the deeper channel, each possessing a different manifestation as a river moves through space and time. To move from one eddy to another, you have to reenter the main current” – Antoine de Saint-Exupéry
This thesis posed many challenges in the complexity of the thesis topic, site, and thesis program. To the amazement of myself and others, the complexity was brought to a level of resolution in the final design. By maintaining a clear objective within the thesis and pursuing the challenges of the complexity, dynamic spatial environments and design opportunities resulted. It was a tough road to travel, with many pit stops to contemplate why I had pursued a difficult site and a program that proved to be too large to attack certain issues in detail. The thesis could have been explored through a smaller project creating the ability for a more detailed study of movement and movement systems. However, I enjoyed working on this thesis, on this site, and with this program. The challenges pushed me further into certain design issues and forced me to think in ways that I had not first envisioned for this project. I also think that the thesis was pursued continuously through the design process and the spirit of the conceptual intent was maintained in the final product.

Throughout the project I was constantly wondering how I was going to answer the questions I had posed for this thesis. When I had first began my investigations into movement during the fall semester it had become apparent that there were numerous ways of achieving movement in architecture: physical, perceptual, human, and environmental. Each of those could be broken down into even more numerous variations. I became fixated on the aspect of physical movement and pursued it through the thesis. Physical movement became an enormous challenge to pursue because it required my mind to think in terms of time and space. Some questions that arose were what spaces would benefit from movement, what kind of space is created by movement, and how am I going to accomplish it. Soon, it was realized that the project I was developing contained qualities of movement in the perceptual, human, and environmental boundaries. I readily accepted these qualities as they had a great impact on the design I was developing. Capturing physical changes in space is still difficult, even after this thesis, but I have a better understanding of its impacts and its complexities on design. As a result, I can better understand the questions I had posed earlier.

Buildings do not have to be unstable because the architecture or pieces of architecture move. Movement happens all around buildings every fraction of time. The environment around the building is never the same. The landscape is under tremendous forces of erosion, upheaval, and decay which causes it to change over slow or fast time periods. We are around the movement in the exterior world, but maintain buildings to be unchanging to our needs. The stability of architecture is perceived in a different way than the stability of the environment around it.

Architecture can maintain its perceived qualities of perma-
-nence while engaging moveable systems. As with stability, buildings are in a continually changing environment, the same environment that buildings attempt to dominate over. Only by engaging the changing environment and allowing responses to it can we achieve a level of balance of permanence and decay. Moveable architecture does not destroy the perceived permanence of architecture, but reinforces the buildings relationship with time. Permanence can be learned from natural processes and then explored through movement in architecture.

Additional benefits are gained from architectural movement such as increased spatial awareness, manipulation of the personal environment, and capturing moments of time. By allowing the user to engage with the environment their awareness of material, space, and experience of space become heightened and further refined. This creates opportunities for the architecture to truly impact the comfort and experience of the users. Each person's psychological needs of enclosure, release, and social interaction change from day to day and continually throughout the day. Architectural movement allows the user to manipulate their spatial enclosure and volume to accommodate their psychological needs of space. While in motion, architecture becomes accepting of time and allows moments of time to be visually engaged.

I am pleased with my progress this semester, although progress wasn't made as planned. I don't have any regrets regarding my choices and design decisions just lessons and inspiration for future design challenges. I will continue to challenge myself with the complexity of movement.
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